UNIVERSITY OF STIRLING

Stirling Management School

DEVELOPING A CONCEPTUAL FRAMEWORK FOR INTEGRATING RISK MANAGEMENT IN THE INNOVATION PROJECT

By

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A thesis submitted to the Stirling Management School
in fulfilment of the requirement for the degree of
DOCTOR OF PHILOSOPHY

Stirling Management School
University of Stirling

March 2011

DEDICATION

To my parents and my wife, Leila

Declaration

This thesis is submitted in fulfilment of requirements for the degree of Doctor of Philosophy in Stirling Management School at the University of Stirling, Scotland, United Kingdom. I declare that this thesis is based on my own original work except for quotations and citations which I have duly acknowledged. I also declare that this thesis has not been previously or concurrently submitted, either in whole or in part, for any other qualification at the University of Stirling or other institutions. I am responsible for any errors and omissions present in the thesis.

Signed ________________

Alireza Khorakian

March 2011

Acknowledgment

The completion of this study marks a milestone in my life, which would not have been possible without generous assistance from many individuals and organisations. My research owes something to all who have helped me. It would be impossible to express my thanks to all in depth.

My chief debt of gratitude is to my supervisor Professor John Bowers, for his expert supervision, invaluable guidance, constructive criticism and his understanding and faith in me which made it possible for me to complete this thesis.

I would like to extend my gratitude to the representatives of companies for donating their precious time and providing me with data for this study. In addition, I would like to single out for special thanks: Dr Gerry Edgar for his patience in listening and calm support throughout my study, Professor Kazem Oraee for his guidance, Ms Gill Mould for her kindness and encouragement and my good friend Caroline Dukelow-Stewart who generously took time out to read the drafts and the final proofs. I am also grateful to my PhD colleagues and Stirling University staff.

I am indebted to my family for supporting me in many ways throughout my years of study. In particular, they have tolerated me when I was unable to fulfil my duties as a family member on many an occasion. I hope that I can make it up to them in the future. I want to express my everlasting debt to my parents for their unconditional love and unfailing support and providing me with the best situation to study. And I thank my sister and brother who believed in me all these years. My love and my thanks also goes to my parents and brothers in law for their constant and untiring support and encouragement.

Last but not least to my wife Leila, who is my eternal sunshine, words alone cannot describe how thankful and blessed I am to have her love, understanding, support and patience in making this thesis come to fruition.

Abstract

Increased competition, rapidly changing technology and customer expectations have caused the innovation process to become more complex and uncertain. This study examines the possible benefits of integrating some of the concepts of risk management into the innovation project. However, adopting rigorous risk management at every stage of the innovation process could be costly: some risk management could be valuable, but too much, or inappropriate risk management might stifle innovation.

There are many separate models for innovation and risk management. This study develops a combined theoretical model which aims to help the understanding of appropriate risk management in innovation. The theoretical model is based on the classic innovation process but emphasises critical decision points and information needs at various stages, with various possible contributions from risk management. The stage-gate innovation process model, with its emphasis on decisions, provides a basis for incorporating risk management with decisions related to criteria and information needs; this stage-gate model was employed in the study as the core of a theoretical model combining innovation and risk management.

The theoretical model was tested in a series of empirical case studies in the United Kingdom and Iran. These involved 40 detailed interviews in five medium-large companies from a variety of industries. The case studies suggest that the combined model of risk and innovation management should be relevant across diverse industries: staff from different countries (UK and Iran), industries and functional backgrounds could all relate to it and the

theoretical model provided a useful structure for developing a more detailed understanding of the possible roles and implementation of risk management in innovation.

The study suggests that there is no simple guidance that companies can apply in all situations. The choice of risk management techniques varies with different innovation projects, the characteristics of the particular industry and the environment. In addition, different aspects of the risk management system are useful in different stages of the innovation project and attempting to apply a standard technique throughout the innovation project could lead to failure. A prime example is in the creativity stage: simple risk identification at this stage may be useful but more rigorous risk analysis may be stifle creativity. More rigorous risk analysis may be more appropriate in the later stages of the innovation process. Companies can use this theoretical model to help people appreciate the possible contribution of risk management at the different stages of the innovation project.

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Chapter 1 Introduction

This chapter introduces the research. Section 1.1 explains the background of this study. Section 1.2 and 1.3 then provide a brief definition of innovation management and risk management providing a review of the major issues addressed in this study. Next, in Section 1.4, the aims and research questions of this research will be explained. Section 1.5 defines the scope of the study. Finally, this chapter proceeds to illustrate the relationship between the different chapters in the Structure of the Research section.

1.1 Background of the Study

Many studies discuss the importance of innovation: companies must be innovative if they wish to survive (Biemans, 1992; Trott, 2002; Taplin and Schymyck, 2005). Innovation gives companies a chance to attain a competitive advantage by enhancing and sustaining high performance, attracting new customers, retaining existing ones, reinforcing ties with the distribution network and creating profits (Urabe, 1988; De Maio, Verganti and Corso, 1994; Gopalakrishnan and Damanpour, 1997; Chandra and Neelankavil, 2008). However risks are intrinsic within innovation (Cooper, 1993; De Maio, Verganti and Corso, 1994; Zhao, 2005). Increased competition, rapidly changing technology and customer expectations can cause innovation to become more complex, thus making the possible outcome considerably less certain (Keizer, Vos and Halman, 2005).

The success rate of innovation projects is still low (Stevens and Burley, 1997; Griffin, 1997). Innovation inevitably involves uncertainty, for instance product innovation is one of the riskiest activities in business with 35% of products launched failing commercially; approximately 45% of new product expenditure is associated with unsuccessful projects

(Halman and Keizer, 1994). Companies therefore require a strategy, not of risk avoidance, but of early risk diagnosis and management in order to launch new products speedily and successfully. Consequently the ability to diagnose, manage and reduce risk is increasingly considered to be of vital importance (De Maio, Verganti and Corso, 1994; Keizer, Halman and Song, 2002). Identifying and managing risk is becoming an increasingly important subject in innovation project literature (Keizer, Vos and Halman, 2005); although at present the literature contains very few papers explicitly considering risk and innovation.

The probability of failing to identify potentially significant events is higher when using informal risk assessment (Keizer, Vos and Halman, 2005). Therefore, it can be concluded that it may be worth adding a systematic component of risk management to the innovation project in order to manage innovation in a better way. Although there are many separate models for managing innovation and risk, no substantial models combining innovation and risk explicitly currently exist. A combined model might help encourage an integrated approach and result in the appropriate risk management tools being deployed at each stage of the innovation process (Edwards and Bowen, 2005). The purpose of risk management is to improve project performance by means of systematic identification, appraisal and management of innovation project-related risk. A systematic approach to risk management aims to encourage decision-making which is more controlled, more consistent and yet at the same time more flexible in recognising that different forms of risk management may be needed at different stages of the innovation process.

Previous studies have usually focused on experiences in the USA and other developed countries. This study explores the particular problems of innovation risk management in a developing country: Iran. The Five-Year Economic, Social and Cultural Development

Plans (FYDP) in Iran illustrates that the Iranian government appreciate the importance of innovation and the need to create an environment that encourages it (Komijani, 2006). The researcher has some practical experience in the field of industry, and his previous research, ‘Technology Transfer from University to Industry’, involved issues relevant to the current study. While undertaking this research, it was proposed that Iranian companies are afraid of the risk involved in new ideas. In some situations, particularly valid knowledge (identified through a university research group) that could be applied to commercial products was developed, but companies were reluctant to accept these new ideas. For instance, one project involved the university designing a special tool, for automatically de-burring products instead of using the traditional manual process. For the team involved, it was a successful project and the tool could perform the job, but the company did not adopt it. This was one of the experiences that motivated the researcher’s thoughts about the barriers that occur when companies pursue innovation. This suggests that perhaps companies do not have enough information about risks and methods of managing them; they are not willing to accept the risk involved in commercialising new ideas. In addition, many Iranian companies appear to have a lack of direction due to the uncertainties that arise from ambiguous and often changing regulations (Javidan and Dastmalchian, 2003). These additional sources of risk, in conjunction with more common sources such as technical and market risk, suggest that it may be especially important for countries such as Iran to consider integrating a risk management system into the innovation process.

1.2 Innovation Management

Innovation has been studied at various levels: macro, micro (or company) and project level (Goffin and Pfeiffer, 1999). There is no one generally accepted definition of innovation

(Section 2.2). Researchers within each field conceptualise innovation differently, and have differing views of the impact they can have on a firm's productivity, growth, survival and performance (Gopalakrishnan and Damanpour, 1997). Since managers have different views about the nature of innovation, creating an understanding of the aspects of innovation is important (Goffin and Mitchell, 2005).

If innovation is defined as the first commercial introduction of a product or process to the world, there is very little action that might be described as "innovation", especially in developing countries such as Iran. Therefore innovation is something 'new' but not in absolute terms. Some ideas might be innovative in developing countries but would not be regarded as such in developed economies. Subsequently, this study adopts a broad definition of innovation as an activity that involves substantial novelty for the adopting company, but is not necessarily new to the world.

Even though thousands of new products are introduced every year, more of these fail than succeed (Simon, 2009). Chandra and Neelankavil (2008) argue that the process of product development is complex, expensive, time consuming and risky. They go on to say that in industrialised countries the success rate of innovation is relatively low and is even lower in developing countries. Since risk and uncertainty are inherent in the nature of innovation, the most important factor when considering innovation is to pay attention to the risks and how to manage them (Branscomb and Auerswald, 2002; Storey and Salaman, 2005). Tidd, Bessant and Pavitt (2005) emphasise that although innovation varies extremely by type, scale and sector, it is a process and it needs to be managed. Unfortunately, many managers either fail to identify the risks involved, or are uncomfortable with the idea of dealing with risk (Lee-Mortimer, 1995). The analysis of many innovations over the years suggests that although there may be technical difficulties, the majority of failures occur because of weaknesses in the way processes are managed (Tidd, Bessant and Pavitt, 2005). Tushman and Nadler (1986) predicted that managing innovation would become the most significant organisational task of the future.

Innovation inevitably involves high risk activities and in order to be successful, management needs to manage this process and consider the risks involved. Researchers have tried to consider innovation management from different perspectives. It seems that the challenge for management, is how to integrate risk management into innovation management in order to exploit the combined power, without imposing additional bureaucracy and stifling creativity. This research will look at this when considering the different steps of the innovation process. Consequently, in Chapter 2 (Section 2.5 and 2.6), the different stages of innovation will be described, in order to identify common stages which can then be used to make a general innovation management process, that can be integrated within the stages of the risk management system (risk management is discussed in detail in Chapter 3).

1.3 Risk Management

No single definition of the word ‘risk’ is universally employed (Section 3.2), as there are many ways in which the term is used (Green and Serbein, 1983). Due to the increase of knowledge in technological fields and the development of technology, the complexity of industrial systems has considerably increased over the last few decades (Salvi, Merad and Rodrigues, 2005). Therefore, the definition of risk changes as it becomes intertwined with innovation within a rapidly globalised world (Taplin and Schymyck, 2005).

The standard definition of risk states that it is, 'the combination of the frequency or probability of occurrence and the consequence of a specified hazardous event' (Edwards and Bowen, 2005). In more specialised literature, the word risk is used to imply a measurement of the chance of an outcome, the size of the outcome or a combination of both (Wharton, 1992). In classical decision theory, risk is commonly conceived as reflecting the variation in the distribution of possible outcomes, their likelihoods, and their subjective values (March and Shapira, 1987). Any factor which can affect project performance can be a source of risk, when this affect is both uncertain and significant in its impact on project performance, risk arises (Chapman and Ward, 1997). In this study, the focus is on risk more than uncertainty and risk events are presented as leading to negative consequences.

Change in the business environment happens at a rapid pace. Science and engineering increasingly progress rapidly through major projects, many of which are high risk, consequently there is an urgent need to integrate a risk management system into the projects (Williams, 1995; Emblemsvåg and Kjølstad, 2006). Mu, Peng and MacLachlan (2009) emphasise that without suitable risk assessment and risk management, projects can easily escalate out of control, consume significant additional resources, greatly expand project costs and may lead to failure. Based on Taplin and Schymyck's (2005) definition, risk management means 'the process of understanding the nature of uncertain future events and making positive plans to mitigate them where they present threats or to take advantage of them where they present opportunities.' Edward and Bowen (2005) believe that a systematic approach to risk management develops the organisation's ability to manage risk at all stages.

It seems that although some models for managing risk have been introduced in various studies (Section 3.4), very few studies examine the specific issue of integrating project risk management into the innovation process. This is suggestive of the fact that further investigation is needed.

1.4 Aims and Research Questions of the Research

As mentioned in Section 1.1, there appears to be a significant gap in both the theory and practice of integrating risk management into the innovation process. This study aims to develop a combined risk and innovation management model based on a review of the literature, and to explore its relevance in a series of case studies. In other words, this investigation wishes to test whether a theoretical model is useful as a framework for developing a better understanding of risk management in an innovation project. More specifically, the objectives are:

- To develop a combined risk and innovation model.
- To test the relevance of the model in a series of case studies.
- To identify the need for risk management within the stages of innovation and also the form and type required.
- To identify the main types of risk associated with the innovation process and methods of managing them.

Therefore the question which shaped this research is:

- How can risk management fit into the innovation project in an explicit way to manage innovation in a better way?

In addition, besides this main question, other issues which will be considered during this research include:

- During which stage of innovation, and of what form and type, is risk management needed?
- What are the main types of risk associated with the innovation process and how can we manage them?

The research questions are described in more detail in Section 4.2.2.

1.5 Scope of the Research

As discussed earlier in Section 1.1, there appears to be a significant gap in both the theory and practice of integrating risk management into the innovation process. The present contribution therefore should be seen as a basis for further empirical testing and theorising of the relationship and integration between risk management and the innovation project. Thus, in order to develop a combined risk and innovation model (see aims of this research, Section 1.4) this study should justify the scope of the research in the first stage.

This study concentrates on product innovation rather than process innovation. Usually, incremental innovations are more common in companies; therefore this study is limited to this type of innovation rather than radical innovation. In order to test the relevance of the theoretical model in a series of case studies, this study has been limited to the manufacturing sector, rather than service sector, and companies of medium and large size.

In addition, the scope was limited by practical issues such as access to companies; this is also reflected in the choice of the four Iranian and one UK case study (see Section 4.3.3 for greater detail).

1.6 Structure of the Thesis

This thesis contains eleven chapters. The remainder of the thesis is organised as follows. As Figure 1.1 shows, Chapter 1 provides a general introduction.

Chapter 2 and Chapter 3 provide a review of the relevant theoretical and empirical literature on innovation management and risk management, which are related to the research problem identified by this research. Based on these two chapters, the process of innovation and risk management systems are discussed in detail separately; the initial theoretical model is then developed in Chapter 3 by integrating concepts from the innovation and risk management literature. Since several of the empirical case studies examine companies based in Iran, Chapter 2 and Chapter 3 also strive to include literature that might provide some theoretical insight into innovation and risk management in the context of developing countries.

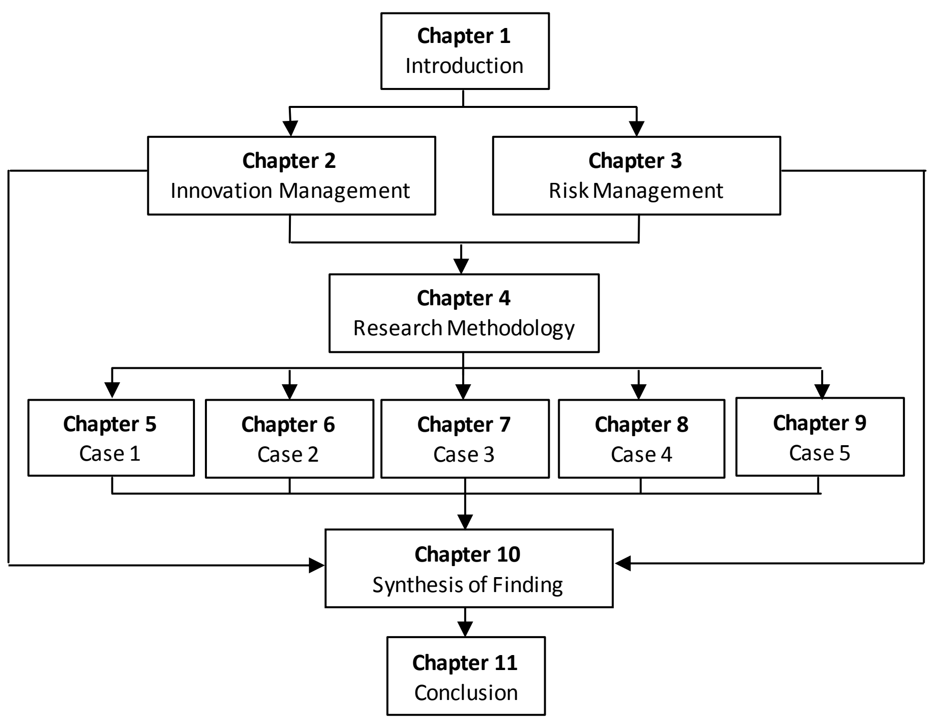


Figure 1.1 - Structure of the study

Chapter 4 explains the research methodology by discussing the research philosophy, purpose and approaches. Also, it explains the research strategy in order to fully understand the research question. In addition, the importance of the theoretical model is explained in this chapter. The remaining sections in this chapter focus on the detailed research design, data collection and the methods of analysing data.

Since the case study strategy was chosen to carry out this research, Chapter 5 to Chapter 9 explains the results regarding the five different case studies. In these chapters, findings regarding the innovation process and risk management within each company will be explained based on their employees' opinions.

In Chapter 10, the findings of five different cases are synthesised and compared to the literature examined in Chapter 2 and Chapter 3.

The theoretical and practical implementations of this research are discussed in Chapter 11, together with the limitations of the study and future work.

1.7 Conclusion

This chapter has provided an introduction of the topics that are to be considered in this study. Increased competition, rapidly changing technologies and customer expectations have caused the innovation process to become more complex and uncertain. Various studies have identified a low success rate in major innovations. More explicit risk management might help achieve success in innovation projects. To our knowledge, most research has focused on either innovation management or risk management, but not on both. Hence, this study examines the possible benefits of integrating some of the concepts of risk management into the innovation project. In other words, it describes a theoretical model which combines the generic innovation process with risk management. The outline of the thesis is examined later at the end of this chapter in order to familiarise the reader with the following chapters.

Chapter 2 Innovation Management

This chapter provides an overview of the literature available on innovation management and related issues. It focuses on establishing background and provides the foundation for our understanding of the process of innovation. Therefore, it will be used as guidance for developing a model and appropriate factors. The chapter commences with an overview of the importance of innovation (Section 2.1). Next, the definition of innovation and its classification will be discussed in Section 2.2 and Section 2.3. Section 2.4 will discuss how innovation inevitably involves high risk activity, and in order to be successful management need to manage the process and consider the risk. It seems that the challenge for management is integrating risk management into innovation management in order to exploit their combined power, without imposing additional bureaucracy and stifling creativity. This research will look at this when considering the different stages of the innovation process. Consequently, different stages of innovation should be described in order to find commonality. This can then be used to make a general innovation management process that can be integrated within the proper stages of the risk management system. Section 2.5 surveys literature regarding the process of innovation in order to find common stages of the innovation process. Based on the results of the previous section, the development of the core of the theoretical model and its definition will be discussed in Section 2.6. In the proposed theoretical model, each stage of innovation consists of an information gathering activity followed by a decision point. At each decision point the company can decide whether to progress to next stage, return to previous stages for additional work or abandon the process entirely. In order to consider the wide range of factors (from technical to business) which have an effect on process of innovation, the company should consider various success factors at each decision point. These factors will be mentioned in Section 2.7. Although this research aims to concentrate on the process of innovation within the company, it seems that viewing factors from a macro level can be useful as well. Therefore, the role of the innovation system will be examined in Section 2.8. Since the IPR is an important issue in recent decades, especially in developing countries, the possible role of this issue will be discussed in Section 2.9. Finally, in Section 2.10 this chapter proceeds to discuss the situation of developing countries, and Iran, in order to comment on the importance of considering innovation and risk in these countries.

2.1 Importance of Innovation

Many studies discuss the importance of innovation: companies must be innovative if they wish to survive (Biemans, 1992; Trott, 2002; Simon, 2009). Innovation gives companies a chance to achieve a competitive advantage by enhancing and sustaining high performance, attracting new customers, retaining existing ones, reinforcing ties with their distribution network and creating profits for the firm (Urabe, 1988; Gopalakrishnan and Damanpour, 1997; Chandra and Neelankavil, 2008).

The relationship between economic development and innovation is extensively recognised. For a long time innovation has been considered one of the most essential requirements for whole economies (Storey and Salaman, 2005). Economic growth now relies more upon innovation than ever before (OECD, 2002) and has become the main source of economic growth and a source of new employment (Urabe, 1988; Foxon *et al.*, 2005). Throughout economic recessions innovation provides an opportunity to convert a crisis into an opportunity (Mahroum, 2008; Lazzaron, 2010). But unfortunately in an economic crisis since companies want to reduce costs, one early victim in some of them is the amount of money spend on innovation activities (Mahroum, 2008). Based on another point of view, in the global economy where economic actions can be more cheaply carried out in the low-wage economies such as China, then the main way, probably even the single way is to find new and better products and process; in other words, to innovate (Storey and Salaman, 2005). It should be noted that innovation is important for developing countries as well. For instance, the ability to innovate successfully is one of the main requirements for success in economic and industrial development in developing countries (Gerstenfeld and Wortzel, 1977).

It is important mentioning that various authors consider the different aspects of innovation in developed or developing economy, so paying attention to this different point of views is important and this study tries to consider this issue through their investigation.

2.2 Definition

Innovation has been studied at various levels: macro, micro (or company) and project level (Goffin and Pfeiffer, 1999). According to Gopalakrishnan and Damanpour (1997) there is no one generally accepted definition of innovation. They declare that researchers within each field conceptualise innovation differently, and have differing views of the impact they can have on a firm’s productivity, growth, survival and performance. However, they emphasise that the criteria used to conceptualise innovation in various disciplines are not entirely independent of each other. For instance, economists tend to define only early adopters as innovators which are related to profitability and greater performance and tag late adopter companies as ‘copycats’, ‘counterfeits’ or ‘bandits’ (Bolton, 1993; Gopalakrishnan and Damanpour, 1997). Since managers have different views on the nature of innovation, creating an obvious understanding of the aspects of innovation is important (Goffin and Mitchell, 2005).

According to the Oxford Dictionary of Business and Management, innovation is 'any new approach to designing, producing, or marketing goods that gives the innovator or his company an advantage over competitors' (Law, 2006). Urabe (1988) states that innovation is the generation of a new idea and its implementation into a new product, process, or service. Afuah (2003) says that innovation is the employment of newly acquired knowledge which then provides a new product or service that customers want; this can be simplified to invention + commercialisation. The distinction between invention and innovation is explained by various researchers (e.g. see: Schon, 1967; Biemans, 1992). In general, an invention refers to the direct result of research activities, while an innovation concerns a commercial product. Accordingly, an invention is assumed to precede an innovation. van de Ven (1986) describes innovation in terms of a new idea, which may be a recombination of old ideas, a plan that challenges the present order, a formula, or an exclusive method which is perceived as new by the individuals involved. Damanpour (1992) presents an even wider description of innovation and speaks of innovation as the adoption of an idea or behaviour, whether a system, policy, program, device, process, product or service, which is new to the adopting company.

Slappendel (1996) stresses that the term innovation is employed to indicate both the product and the process of innovating. He emphasises that the term "innovation" is also used to refer to the process, even though in which new ideas are already shaped, developed, or reinvented. In its conceptualisation, the innovation process contain periods of design and development, adoption, implementation, and diffusion. Whilst new products are frequently considered as the cutting edge of innovation in the market, process innovation plays just as significant a role (Tidd, Bessant and Pavitt, 2005). Although Schumpeter's (1961) comprehensive definition of innovation was developed many years ago, it is relevant in terms of:

- Introducing a product (which is new to consumers, or one of better quality)
- Methods of production (which are new to a special sector of industry. These are not necessarily based on new scientific findings and could have been previously employed in other industrial segments)
- Opening up new markets
- Employing new sources of supply
- New ways of competition (which can lead to the restructuring of an industry)

There is also the issue of how new an innovation should be (Drejer, 2002). Hobday (2005) believes that in a strict definition, innovation is the successful introduction of a new or improved product or process to the marketplace. He adds that this definition is unable to capture the incremental innovations that can lead to a huge gain in productivity and the quality of the product; they are frequently a source of structural change and economic growth. Based on Cooper's (1993) opinion "newness" can be defined in two senses:

- New to the company; the firm has never made or sold this type of product before, although other firms might have.
- New to the market; the product is the first of its kind on the market

Based on these two dimensions six different classes of new product can be identified, these are (Cooper, 1993): New to the market product, New product lines, Additions to existing product lines, Improvements and revisions to existing products, Repositioning and Cost reduction. In developing countries, innovation tends to happen from ‘behind the technology frontier’; thus in some studies innovation is defined as a product or process new to the company, not simply to the world or market (Hobday, 2005). For instance, Rogers (2003) describes innovation as the adoption of ideas that are new to the adopting company. However, Assink (2006) defines innovation in his survey as “the process of successfully creating something new that has significant value to the relevant unit of adoption.” In addition, Kaufmann (2004) says that an idea deserves to be described as original if it is novel for the individual who produces it, without necessarily being novel for society as a whole.

In summary, if innovation is defined as the first commercial introduction of product and process in the world, there will be very little action that might be described as “innovation” especially in developing countries such as Iran. Therefore innovation is something ‘new’ but not in an absolute terms. Some ideas might be innovative in developing countries but would not be regarded as such in developed economies. Subsequently, this study adopts a broad definition of innovation as an activity that involves substantial novelty for the adopting company, but is not necessarily new to the world. This novelty is important as a potential source of risk: inevitably there will be new challenges for the adopting company.

2.3 Classification of Innovation

The classification and definition of various types of innovation have been examined by many studies (e.g. see: Henderson and Clark, 1990; Afuah, 2003; Moore, 2004; Tidd, Bessant and Pavitt, 2005). According to Gopalakrishnan and Damanpour (1997), researchers usually categorise innovation into a set of different types. These categories distinguish: type, degree, competence, impact, and ownership (Narvekar and Jain, 2006).

For example, Moore (2004) classifies and defines various types of innovation into eight groups, these are: Disruptive, Application, Product, Process, Experiential, Marketing, Business Model , and Structural. Tidd, Bessant and Pavitt (2005) believe that opening up new markets is not the only important fact about innovation. They classify innovation into four groups (the ‘4Ps’ of innovation): Product, Process, Position, and Paradigm. Nevertheless, based on Kuratko *et al.* (2005) innovation is often seen as product or process improvements that provide increased value for the firm’s customers and in doing so help the firm achieve a competitive advantage. For instance, according to Gopalakrishnan and Damanpour (1997), innovations have been viewed both as products ‘a new idea, method or device’ and as processes ‘the process of introducing something new’. Although companies can innovate in a variety of ways, these innovations range from minor changes to current products, service, or processes, to radically new products, services, or processes (Worthington, Collins and Hitt, 2009).

In summary, innovation is generally considered to be related to a product or process. Therefore, in the following sections (2.3.1 - 2.3.4) meaning of product and process innovation, range of innovation (incremental to radical) and their effects on product and process innovation, the effect of the kind of firms (manufacturing or service) on product and process innovation, and the role of company size on innovation will be explained in greater detail.

2.3.1 Product and process

Nieto (2004) argues that the concepts used in explaining the innovation phenomena are not generally well defined. Therefore, various terms and definitions are used inconsistently. The lack of a commonly used vocabulary in innovation management studies leads to the terms “innovation” and “technology” being used interchangeably to signify the same idea and may lead to ambiguity. As an example, Wonglimpiyarat (2004) describes innovation as a process of transforming the technology frontier into the commercialised product or process innovation in a competitive market. Betz (1993) defines technological innovation as an invention of new technology and the development and the introduction of the resulting products, services or processes into the marketplace. According to Nieto (2004) the term technological innovation is a process through which technological advances are produced. He says that the innovation process involves a set of activities that contribute to the increase in the capacity to produce new goods and services (product innovations) or to implement new forms of production (process innovations). Therefore, the concept of technological innovation is associated with the idea of a flow – generation, application, dissemination – of technologies. Bagherinejad (2006) states that this process involves assembling current potential resources to supplement the firm’s innovation capacity, resulting in the introduction of a new or better product or production process. Consequently, by considering these definitions, this study places stress upon product and process innovation and in the following of this section, these types of innovation will be explained in more detail.

The distinction between product and process relates to areas and activities that innovation affects (Gopalakrishnan and Damanpour, 1997). Based upon the phases of development in the industry, the rate of adoption for process and product innovation differs (Utterback and Abernathy, 1975). However, according to the result of a survey of executives, firms on average introduce more product than process innovations (Damanpour, 1996). In the early phases, when the company is small and has a simple structure, it primarily introduces product innovation, but as the firm matures and becomes more complex, it introduces process innovation (Utterback and Abernathy, 1975).

Product innovation implies introducing new products or services to achieve an external market or to satisfy user need (Utterback and Abernathy, 1975; Ettlie and Reza, 1992). According to Tidd, Bessant and Pavitt (2005), product innovation is transformed in the services or products which an organisation offers. In other words, product innovation takes established offers in established markets to the next level, the focus can be on performance increase, usability improvement, cost reduction, or any other product enhancement (Moore, 2004). Tidd, Bessant and Pavitt (2005) define process innovation as changes in the way in which products or services are created and delivered. Process innovation refers to the introduction of new elements (e.g. input material, work and information flow, task specifications and equipment) into the organisation's production process or service operations that are then used to make a product or service (Utterback and Abernathy, 1975; Ettlie and Reza, 1992). Therefore process innovation creates processes for established offers in established markets which are more efficient or effective (Moore, 2004).

2.3.2 Incremental and radical

Innovation can be classified according to the degree of change associated with it (Damanpour, 1996). Therefore innovation contains both major and minor changes. According to a basic definition, major change is deemed radical innovation, and minor changes are incremental innovation (Urabe, 1988). It could be said that innovation can occur along an axis, moving from incremental through to radical change (Tidd, Bessant and Pavitt, 2005). Put differently, innovation covers the range from sustainable or incremental innovation (remodelling functionality) to disruptive or radical innovation (breakthrough, paradigm shift) (Assink, 2006). Therefore minor changes can lead to improvements in reliability, performance, size or specific product features; on the other hand, radical breakthroughs in products, processes, or services can introduce exclusive and attractive features or substantial cost improvements (Worthington, Collins and Hitt, 2009). Drejer (2002) declares that sustainable or incremental changes follow the same basic pattern and can be measured by the same performance measure, whereas disruptive or radical change commence a totally new S-curve (when compared with previous curves) and needs to be measured by a new performance parameter.

As each type of innovation can occur over a range from incremental to radical, the meaning of these two kinds of innovation will be explained in greater detail in this section. Many studies have defined the meaning of radical and incremental innovation. For instance, Ferguson and Ferguson (1994) mention that incremental innovation entails the introduction of an improved product, which in comparison with its predecessor has at least one additional attractive characteristic or has a better capability but with the same characteristics. Therefore, incremental innovation only calls for a marginal departure from existing practices and largely reinforces the existing potential of firms (Ettlie, Bridges and O'Keefe, 1984; Dewar and Dutton, 1986; Henderson and Clark, 1990). Assink (2006) believes that since incremental innovation remains within the boundaries of the existing market, technology or processes of an organisation, it has lower financial and market risks.

In contrast, radical innovation takes place when a new market is opened up and the innovator starts to satisfy an unseen demand (Ferguson and Ferguson, 1994). This kind of innovation creates fundamental changes in the actions of the firm or industry and deviates from existing activities (Gopalakrishnan and Damanpour, 1997). In other words, radical innovation refers to new products that result from advances in technology or knowledge (Bala Subrahmanya, 2005). In radical innovation, first-time improvements or performance characteristics are obtained; also it represents major changes in technology regarding materials and functions, newness to the market, substantial cost and time (Keizer and Halman, 2007). Therefore, it can be said that radical innovation has the highest technical and market risk (Branscomb and Auerswald, 2002). Process innovation can also take several forms. For instance Ferguson and Ferguson (1994) believe that new techniques may be identified that enable the firm to use less of, at least, one input or alternatively, a way may be discovered which will enable lower-cost inputs to be applied.

Tidd, Bessant and Pavitt (2005) mention that although innovation involves a discontinuous shift, it often takes place in an incremental style. Products are seldom new to the world and processes are mostly about optimisation. Therefore, radical innovation is on average, adopted less frequently than incremental innovation (Damanpour, 1996). New to the world, or disruptive innovation, makes up only 6% to 10% of all innovation projects (Tidd, Bessant and Pavitt, 2005). Radical innovations present a more severe challenge to the current structure of political influence, causing more resistance throughout their implementation; they are more original, appear more complex to organisational members, and generate greater uncertainty about the structural requisites to develop and implement them (Damanpour, 1996). Research has indicated that the economic impact of incremental innovation and continuous improvement is greater than radical innovation (Nieto, 2004). Incremental development studies show that the cumulative gains in efficiency are often greater over time than those which come from occasional radical changes (Tidd, Bessant and Pavitt, 2005). It seems that these greater benefit in incremental innovation may be due to lower risk. Hence, firms usually assign approximately 80 percent of their innovation activities to the development of existing products and only 20 percent on the creation of new ones (Nieto, 2004).

Urabe (1988) says that it is frequently in the early stages of a new industry, radical product innovation is the most common form of innovation. In contrast, the cumulative effect of incremental innovation through minor changes in established products seems to have a more important economic impact on protecting competitive advantage. Studies have argued that radical innovation has a longer life cycle, is harder to predict, may slow or terminate progress, and may often include cross functional teamwork; while incremental projects are more linear and predictable, have fewer uncertainties, and need simpler collaboration relationships (McDermott and O'Connor, 2002; O'Connor and Ayers, 2005; Keizer and Halman, 2007). Tödtling, Lehner and Kaufmann (2009) emphasise that advanced innovations might draw more upon scientific knowledge from universities and research organisations. On the other hand, incremental innovations seem to occur frequently through interaction with partners from the business sector and at higher spatial levels. They conclude that pure science seems to be more effective in stimulating advanced innovations than applied research which focuses on commercialisation.

In summary, each kind of innovation can happen in the range of incremental to radical change. As discussed earlier in Section 2.2 (ideas that might be innovative in developing countries would not be regarded as such in developed economies), incremental and radical innovations are related to their environment and are not an absolute term. Studies have indicated that more factors have an effect on radical innovation in comparison with incremental, and as a result the rate of radical innovation is less than incremental.

2.3.3 Manufacturing and service

Innovation can be found in manufacturing and service industries. As mentioned before, innovation is generally considered to be related to a product or process. Therefore, in this section these two kinds of innovation will be explored in greater detail based on manufacturing and service industry.

Johne and Storey (1998) define new product development within the manufacturing industry as a development of tangible products which are new to the firm. Two types of innovation within the manufacturing industry as described by Goffin and Pfeiffer (1999) are: 1- New products, by which companies develop ideas and turn these into products, and 2- Improving manufacturing process, also referred to as process innovation. Since the concept of product and process innovation is explained within the context of the manufacturing industry (see Section 2.3.1), in the following section stress is placed more upon defining the service industry.

Services often have very different characteristics when compared with manufacturing. For instance, services are intangible, perishable and heterogeneous (Johne and Storey, 1998; Song, Di Benedetto and Zhao, 1999). Oke (2007) argues that the importance of the service sector is increasing in western economies. An example of this is the UK, where there has been a growth in the service sector contribution to the GNP. de Brentani (2001) believes that in terms of economic activity, innovations in services have been at their highest levels over the past several years. There is agreement upon the fact that various types of innovation exist within service companies, however there is still little agreement on what these types are (Menor, Tatikonda and Sampson, 2002). According to Oke (2007), there are two types of innovation in the service sector: “service product innovation” and “service innovation”.

In literature the terms “service product innovations” and “product innovations” are interchangeable when explaining a particular set of innovations in service sectors (Johne and Storey, 1998; Oke, 2007). “Service product innovations” are associated with new developments in the core offering of service companies that tend to make new revenue streams (Oke, 2007). For instance, in the financial services sector, this kind of innovation includes new or improved mortgage products, or various credit card options such as gold cards. Gadrey, Gallouj and Weinstein (1995) define “service innovations” as innovations in the processes of existing service products; new developments in activities undertaken to distribute core service products, for example, in order to create core service products more appealing to consumers. According to Oke (2007) service innovations are associated with variations in new ways of delivering products to customers. An example in the financial service sector would be service innovation providing a faster process for the issuing of credit cards.

In summary, product and process innovation can be considered in both the manufacturing and service sectors. Although there are some differences between these two sectors (e.g. tangible and intangible), it can be said that the general definition of innovation are the same for both.

2.3.4 Firm size

It is widely accepted that large established companies are capable of producing and commercialising new products that offer incremental benefits to the market (O'Connor, Ravichandran and Robeson, 2008). Some researchers have argued that size would affect innovation positively because large organisations have more financial and marketing skills, research capabilities, and product development experience (e.g. see: Kimberly and Evanisko, 1981; Damanpour, 1992). However, there may be both advantages and disadvantages associated with large size. While large firms have greater resources for new projects and more control over the external environment, they are also more bureaucratic, less flexible, unable to adapt quickly, and have impersonal work environments. On the other hand, small firms are regarded as more innovative as they are flexible, have a greater ability to improve and adapt and show little difficulty in accepting and implementing change (Damanpour, 1996). Therefore the researcher’s view on the relation between innovation and size is often dissimilar and each group of researchers can find sufficient empirical evidence to support their argument (Damanpour, 1996).

The University of Cambridge in its study of SMEs pointed out that a high percentage of SMEs across industries were engaged in product as well as process innovations, though weight was placed more upon new product development (Bala Subrahmanya, 2005). Innovations in these organisations may take different forms. These include: new product development, substituting raw materials in order to improve the stability of a product or in order to reduce cost and changing product designs based on their own ideas or because of customer feedback (Bala Subrahmanya, 2005).

Biemans (1992) argues that when discussing the relationship between organisation size and innovativeness, the discussion usually focuses on two extremes: small and large firms; the average sized firm is frequently lost or neglected. This group consists of companies of a medium size which have been in existence for several years and strive to turn out innovative products. He believes that mid sized firms are of significant economic importance and a failure to innovate within these companies is caused by factors related to management (e.g. high-level management support, planning, management quality and style).

In summary, different kinds of innovation can be created by companies of differing size. Although there are many diverging ideas regarding the relation between size and innovation, it can be said that company size can have more effect on the range of change, incremental to radical, than process of innovation.

In conclusion, since innovation is generally considered to be related to a product or process, from the different classifications of innovation, product and process innovation were selected (however, much of the literature and the empirical study focused on examples of product innovation). Although Gobeli and Brown (1993) stress that generally the product innovation process can also be applied to process or operations innovation with only minor adjustments (e.g. renaming of some stages), this study concentrated more upon products than process innovation. In addition, although the context of company's environment has an effect on the type of innovation (see Section 2.2), generally the majority of innovations within companies are related to incremental development (e.g. see: Nieto, 2004). Therefore this study concentrates more on empirical innovation rather than radical innovation. Although there are some differences between the manufacturing and service sectors (Section 2.3.3), it can be said that the general definitions of innovation are the same for both. However, this study concentrates more upon the manufacturing industry. As discussed before, it seems that company size, rather than the process of innovation, can have an effect on the range of incremental to radical change; however this study is limited to medium and large companies. It should be noted that it was not possible for this study to consider the topic within companies of the same size (Section 4.3.3).

In order to find the general process of innovation, in Section 2.5 various innovation processes will be considered and the core of the theoretical model will be explained in Section 2.6.

2.4 Innovation Management and Risk

Even though thousands of new products are introduced every year, many more of these fail than succeed (Simon, 2009). Tidd, Bessant and Pavitt (2005) emphasise that although innovation varies extremely by type, scale and sector, it is a process and it needs to be managed. Tushman and Nadler (1986) predicted that managing innovation would become the most significant organisational task of the future. The challenge that any organisation has, is to find ways of controlling this process in order to provide a solution to the problem of renewal (Tidd, Bessant and Pavitt, 2005). Chandra and Neelankavil (2008) argue that the process of product development is complex, expensive, time consuming and risky. They go on to say, that in industrialised countries the success rate of innovation projects is relatively low and is even lower in developing countries. For instance, in some industrialised countries (e.g. USA) the success rate of new products is one out of 6.6 ideas generated; in these countries, for a firm to have a successful new product 6.6 initial ideas are needed (Ozer, 2006). Among developing countries, such as Hong Kong, only one out of 46.51 initial ideas is successful (Ozer, 2006). In another example, approximately 15% of new items introduced into the consumer packaged goods industry in 2000 were still on the retail shelf two years later (Simon, 2009). In addition, she adds that the success rate has been steadily declining over time; about 45% of new products were successful in the 1970s using the same definition.

Tidd, Bessant and Pavitt (2005) state that there is no easy formula for success. They believe that at first glance it may seem that it is impossible to manage something so complex and uncertain. There are problems in developing and refining new key knowledge, problems in adopting and applying it to new processes and products, difficulty in the attainment of support and adoption of the innovation, problems gaining acceptance and so on. Therefore, since risk and uncertainty are inherent in the nature of innovation, the most important factor when considering innovation is paying attention to its risks and how to manage that risk (Branscomb and Auerswald, 2002; Storey and Salaman, 2005). Some of the situational parameters that innovation managers need to consider, are: the state of the environment, availability of resources that can be invested in new products and processes, organisational expertise and their capacity to deal with risks and the uncertainty associated with innovation (Gopalakrishnan and Damanpour, 1997). As these parameters show, considering uncertainty and risk are important for innovation managers.

Unfortunately, many managers either fail to identify the risks involved, or are uncomfortable with the idea of dealing with risk (Lee-Mortimer, 1995). For instance, Andrews (2007) states that without calculated risk no progress is made. He believes that since innovation is risky, many people habitually look for things that could go wrong and that innovation is often stopped once risks are identified. He argues that a clear view of risks balanced against benefits can create a culture where innovation is nurtured. As Lee-Mortimer (1995) explains, a key element of management in the real world of product development is not trying to avoid unexpected work, but dealing with it, and a major force for doing this is through risk management. He emphasises that to innovate successfully, and transfer this into leading products, the inherent risks need to be managed effectively from the outset. Johnson (2010) believes that risk management not only drive innovation forward but can also speed it up. Risk management can be achieved by identifying risk factors, assessing their likelihood and their possible impact, preparing an overall action plan to deal with them in order to reduce the likelihood of their occurrence and if they do occur by minimising the impact, allocating responsibilities and monitoring progress (Lee-Mortimer, 1995).

Analysis of many innovations over the years suggest that although there may be technical difficulties, the majority of failures are because of some weaknesses in the way that processes are managed (Tidd, Bessant and Pavitt, 2005). Afuah (2003) believes that a firm's success in innovation may depend on what it does to the capabilities of its innovation value-added chain of customers, suppliers, and complementary innovators. Tidd, Bessant and Pavitt (2005) emphasise that successful innovation management is related to the building and improving of effective routines and processes. To do this, firms should recognise and understand effective routines and processes and facilitate their implementation across the organisation.

In summary, innovation inevitably involves high risk activity and in order to be successful, management need to manage the process and consider the risk. Researchers have tried to consider innovation management from different perspectives. For instance, Moore (2004) in order to answer to the questions, "how should managers and executives decide where to focus?" and "which types of innovation should they pursue?", describes a more reliable way to solve the problem of focus, which is to think of different types of innovation as being privileged at different points in a market's life. It seems that the challenge for management, is integrating risk management into innovation management in order to exploit the combined power, without imposing additional bureaucracy and stifling creativity. This research will look at this when considering the different steps of the innovation process. Consequently, in Section 2.5 and 2.6, different stages of innovation will be described in order to find common stages which can be used to make a general innovation management process that can then be integrated within the proper stages of the risk management system (risk management is discussed in detail in Chapter 3).

2.5 Process of Innovation

The success of innovation is decided by external influences and internal situations in which all these factors act on each other (Keizer, Halman and Song, 2002). Trott (2002) suggests that innovation is not just a singular event, but a series of activities that are related to each other. Innovation can be understood as a process which has several stages (Gopalakrishnan and Damanpour, 1997). Several studies suggest that companies with a high performance in innovation generally have a formal process for developing new products and services (Griffin, 1997; Tatikonda and Rosenthal, 2000; Shaw *et al.*, 2001), therefore considering and identifying the stages of these processes can be useful. Narvekar and Jain (2006) argue that although many models of the innovation process exist, the process is still an 'enigma'; therefore this process cannot be pinned down easily. Tidd, Bessant and Pavitt (2005) believe that although innovations vary in scale, degree of newness and nature, it is possible to observe similar fundamental processes common to all firms at the level of generalisation. Linsu and Youngbae (1985) suppose that although these stages developed on the basis of studies undertaken in developed countries, they do not necessarily reflect all events in developing countries; they are however useful for examining the innovation process in developing countries.

2.5.1 Linear vs. multiple sequence models

While some believe that these stages progress in a sequential linear fashion, which is labelled the ‘unitary sequence model’, others regard innovation as a complex process with a multiple, cumulative and related series of parallel, convergent, and different activities, a ‘multiple sequence model’ (Gopalakrishnan and Damanpour, 1997). Berglund (2007) states that the innovation process traditionally has been seen as linear, including distinct stages such as: basic research, applied research, product development, production, marketing and diffusion. He adds that this model is frequently criticised as it is simplistic and deterministic; as a result, more complex models have been suggested that stress causal feedback loops between stages, de-emphasise the role of basic science and emphasise interaction with external actors. Narvekar and Jain (2006) argue that the early linear and simplistic innovation models were replaced by the interactive model of market pull and technology push and later by the value build up model by Jolly (1997). Assink (2006) believes that opposite to the incremental innovation process, which is linear, disruptive innovation is an interactive and complex process and is a circular development process of continuous fast feedback and feed forward loops.

Many studies have examined the various stages for the process of innovation (e.g. see: Cooper, 1990; Gobeli and Brown, 1993; Goffin and Pfeiffer, 1999; Tidd, Bessant and Pavitt, 2005; Narvekar and Jain, 2006; Chandra and Neelankavil, 2008). For instance, Tidd, Bessant and Pavitt (2005) believe that there are four main stages at the heart of the process, these are: searching, selecting, implementing and learning.

Cooper (1990) recommends a stage-gate model (Figure 2.1) which has been adopted by many firms in order to manage the process of innovation, a model that enables firms to manage, control and direct their innovation efforts. This model recognises that product innovation is a process and like other processes, can then be managed.

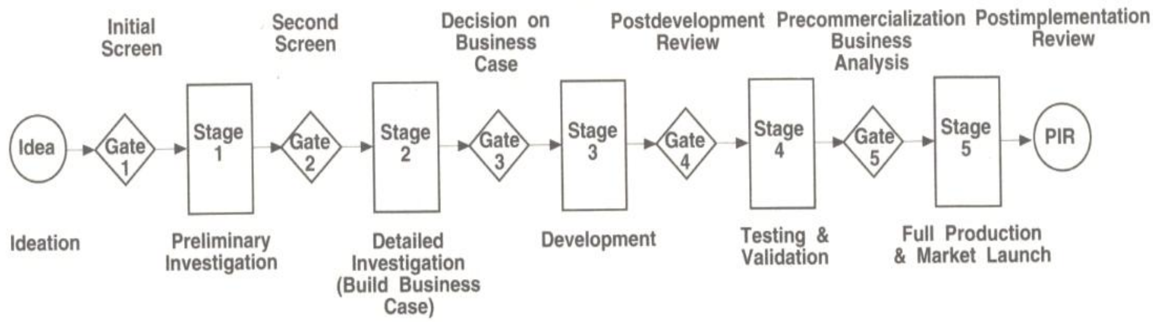


Figure 2.1 - The stage gate system (Cooper, 1990)

Stage-gate processes have their roots in much earlier models, the first generation used for product development was developed by NASA in the 1960s (Cooper, 1994). Oke (2007) states that one major criticism of Cooper's stage-gate model, is that it focuses too heavily upon process factors, as other organisational factors that can have an impact on innovation performance definitely need to be considered. Cooper (1994) says that the model applies strictly to the physical design and development of the product (for example, marketing was not part of the scheme), and it was designed only to deal with technical, but not business, risks.

Wheelwright and Clark (1992) present another model for the innovation process. Their model has six steps in which projects are defined, followed and evaluated according to a predetermined set of decision criteria. These stages are: idea, feasibility, capability, launch preparation, post launch evaluation and rollout contender.

Gobeli and Brown (1993) say that the product innovation process contains four basic stages which are: Discovery, Decision, Development, and Delivery (Figure 2.2). They believe that in practice, this process may be more complicated, and may not follow the sequence suggested in the model (for instance, the decision stage may lead to a 'restart' in order to find a better product concept before any products are agreed upon for development). The main advantage of clustering the innovation process into four stages is that it allows a general format for the discussion of problems and solutions. In addition, Gobeli and Brown (1993) mention that although their research focuses on product innovation, this framework can also apply to process or operational innovations as well. When reviewing this framework with several production managers, they approved the framework for process innovation and recommended that the fourth stage should be renamed "Deployment" rather than "Delivery". This change mirrors the fact that most process innovations are adopted by the innovating organisation.

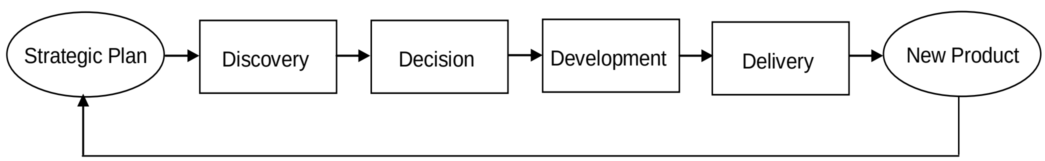


Figure 2.2 - Stages in the product innovation process (Gobeli and Brown, 1993)

Cooper (1994) believes that while the second generation process (Figure 2.1) for product development represents a major improvement over the NASA-based first generation process of the 1960s, it still has a number of weaknesses; it is too bureaucratic, time consuming and has no provision for focus. He mentions the nature of an emerging third generation of new product processes (Figure 2.3) which revolve around four Fs: Fluidity, Fuzzy, Focused, and Flexible. In the following, a brief definition of these four Fs based on Cooper's statements (1994) will be explained in greater detail.

This model is fluid and adaptable, with overlapping and fluid stages for greater speed. Some activities, usually undertaken in the next stage, will begin before the present stage is completed; long lead time activities might be brought forward from one stage to an earlier stage; and the separation between stages will be more fluid.

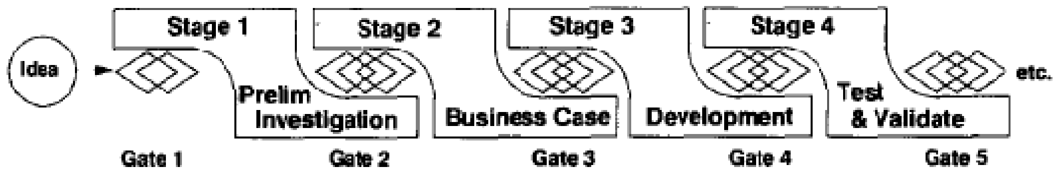


Figure 2.3 - Third generation of stage-gate system (Cooper, 1994)

Fuzzy gates feature conditional ‘Go’ decisions (rather than absolute ones), which are dependent on the situation. The whole new product process can be viewed as a series of steps, stages, and activities designed to gather the information needed for the next decision point in order to manage risk. Sometimes the information is missing, however, resulting in a postponed decision and serious delays at the gates. In order to minimise these time delays, this model has “fuzzy” gates. These fuzzy gates mean that Go decisions are not necessarily absolute or “solid green lights”. Rather, gates are situational and conditional. Therefore, the balance between timely decisions and risk management is precarious.

Focused means that, this model uses the prioritisation methods which look at the entire portfolio of projects (rather than one project at a time) and focuses resources on the “best bets”; not only will a project be judged against a standard set of criteria, but the issue of the “optimal set of projects, given our limited resources” will enter the Go/Kill/Hold decision.

This model is flexible and is not a rigid stage-and-gate system. Each project is unique and follows its own route through the process. The method here involves breaking some rules, as it suggests that there is no need to pass through all gates or all stages and there is no obligation to go through all prescribed activities. As it may be more appropriate for large, high-risk projects to follow the stage-gate process rigidly, this may not always be the case for all the projects.

Cooper (1994) believes that this new stage system has a strong cross-functional nature as activities today involved in each stage are from various departments in the corporation. Any one function 'owns' the No Stage. For instance, there is no "Manufacturing Stage" or "Marketing Stage". Rather, at each stage, players from all functions (such as Marketing, R&D, Engineering, Manufacturing, and so on) are the active players on the project team and work on the field together. Also the third generation process signifies an precarious balance between the need for thoroughness of action and complete information versus speed; however it is still regarded as a system and therefore requires discipline.

The Pentathlon Framework (Figure 2.4) is a simple framework that indicates several soft process and organisational issues (Goffin and Pfeiffer, 1999). This model is a general framework for managing innovation, and was developed from a wide comparative study of innovation management practices for manufacturing companies in Germany and the UK.

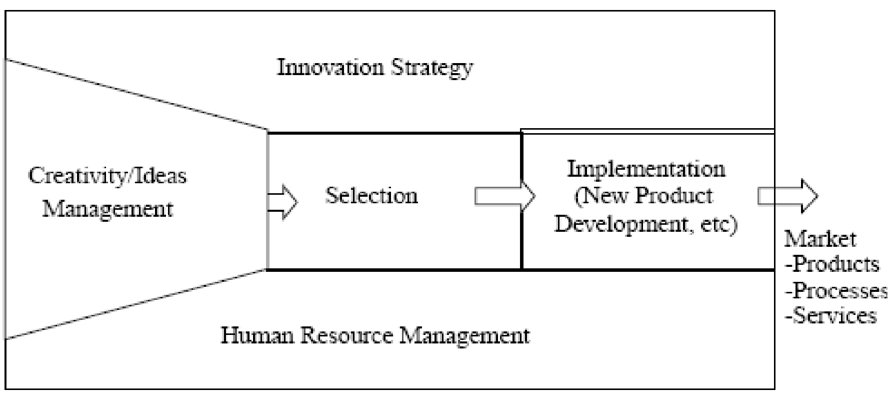


Figure 2.4 - The "innovation pentathlon" (Goffin and Pfeiffer, 1999)

It is argued that, in order to achieve successful innovation management, good performance must be accomplished in five areas and companies should ensure that efforts in these areas are integrated (Goffin and Pfeiffer, 1999). The five areas in this model are: innovation strategy, creativity and ideas management, selection and portfolio management, implementation management and human resource management.

Narvekar and Jain (2006) suppose an interactive three stage innovation process (Figure 2.5). These stages are: ideation, incubation and demonstration. The inputs to the process are generated through in-house R&D (human and structural capital), feedback from customers (relational capital) or through an accidental event, which as Figure 2.5 shows are labelled ‘intellectual capital’. Intellectual capital is defined as any parameter that contributes to the value generating processes of the firm, is created by the company and is under the control of the firm (Bontis, 1998).

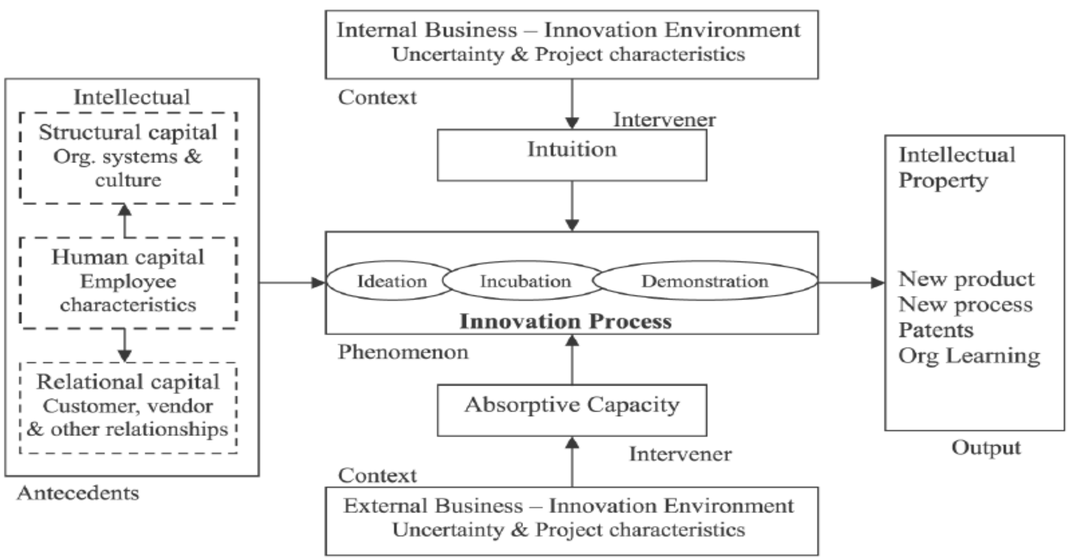


Figure 2.5 - Narvekar and Jain’ s framework (2006)

In this model the absorptive capacity of the organisation and the intuitive nature of the individuals which are involved in the innovation process, are the two influential factors in the innovation process. Zahra and George (2002) define absorptive capacity as “a set of organisational routines and processes by which firms acquire, assimilate, transform and exploit knowledge to produce a dynamic organisational capability”. The second intervening variable - intuitive nature of the individuals – based on Narvekar and Jain’s (2006) definition, is introduced to consider the uncertain elements and change and the tacit knowledge mobilisation in the innovation process. Intuition provides a particular ability to handle conflict and accelerate change by supplying an internal support system with an intense level of awareness of the problem. The background and the influencing factors that characterise an innovation depend on drivers that are internal and external to the organisation. Internal drivers could be in-house technology developed by the R&D sector, employee's personal initiatives or the top management's vision of change. Likewise, external triggers could be the degree of market competition, market requirements, and the geographical location of the company. Usually, the output of the process is a new product, a new process or a patent.

A commonly used new product development process based on Chandra and Neelankavil (2008) study is shown in Figure 2.6. They believe that to find success in new product development each of these stages is crucial.

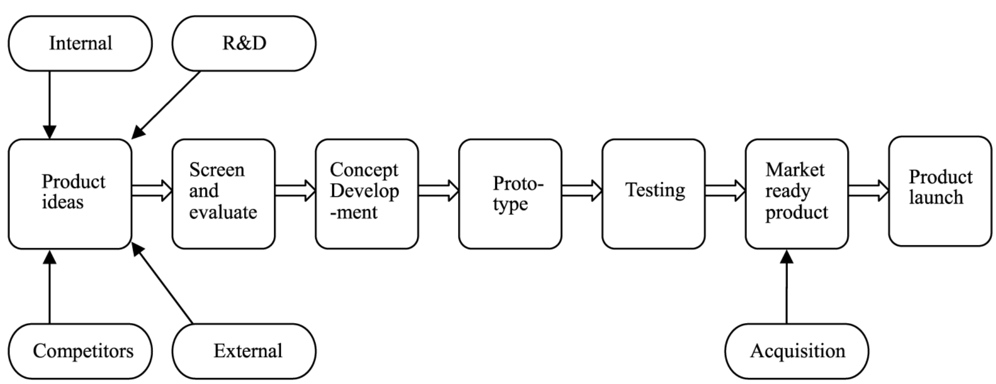


Figure 2.6 - Product development process (Chandra and Neelankavil, 2008)

Since the amount of uncertainty during the innovation process is high, Rogers (2003) describes the innovation decision process as the process through which a person (or other decision making unit) passes; from achieving primary knowledge of an innovation, to shaping attitudes towards the innovation, to making a decision to adopt or refuse, to the implementation of the novel idea and finally to the confirmation of this decision.

2.6 Developing the Core of the Theoretical Model

By considering these different stages which are mentioned in relation to the innovation process, it seems that finding a common stage at the level of generalisation is possible. Five stages are selected for this process, these include: creativity, selection, incubation, implementation and learning (Figure 2.7). Different models apply different names to indicate their stages and sometimes some functions are combined in one stage, while in other models these functions are extracted at different stages. In the following sections (2.6.1 - 2.6.5) the core concepts of these five stages will be explained in more detail based on their responsibility and their functions.

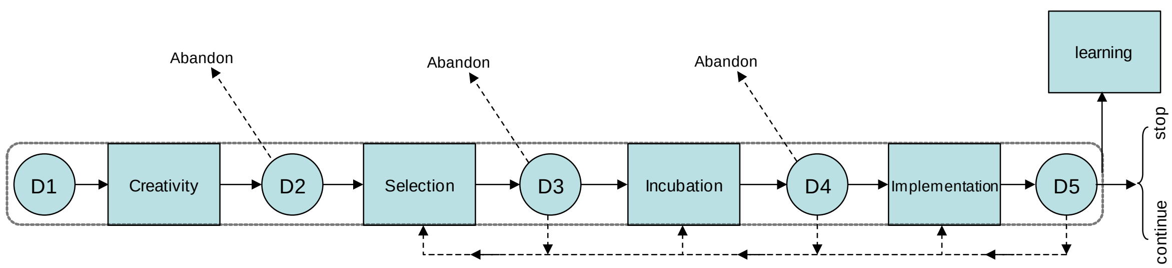


Figure 2.7 - Innovation process

Before moving to the next section, it is necessary to explain Figure 2.7 for greater clarity. Each stage consists of an information gathering activity (e.g. the rectangle ‘selection’) followed by a decision, e.g. D3, (as in the stage-gate models, see Section 2.5.1). Information gathering may involve laboratory tests, preparation of paperwork based on various activities and resources to enable decisions at the following decision point (expanding the scope of the stage-gate model in order to incorporate a wider range of issues and potential risks). One of the most important questions to ask here is ‘can we improve the way which information is collected and analysed so the people can get better decision and then identify better actions?’ The explicit focus on decision points provides a mechanism for incorporating additional features into the innovation process model. Each decision has ‘criteria’ (or risk factors) and requires information (such as that provided by risk management). Thus the decisions offer a means of integrating risk management concepts into the classic innovation model (e.g. see: van Oorschot *et al.*, 2010). In other words, risk management may help to contribute to these decisions and provide information evidence at different stages of the innovation process. The stage gate model could be viewed as a risk management mechanism; filtering out innovation products at different stages and reflecting the perceived risk. However, there may be value in adopting more formal risk management and improving the information considered at each decision point. Thus, the proposed model is based on a stage-gate model. However, it is more about the flow of information in risk management. It helps to make sure right information is being collected and is being presented after analysis. Therefore, in terms of the decision points, instead of only saying ‘Yes’ or ‘No’, this model identifies the risk and says we can proceed but may need to investigate the practical issues more thoroughly as we now appreciate it could be a major source of risk.

Cooper and Kleinschmidt (2007) state that a lack of tough Go/Kill decision points resulted in product failures, resources being wasted on inappropriate projects, and a lack of focus. In order to remove this weakness, at each decision point in the proposed model the company can decide whether to continue with the process, return to previous stages for additional work or abandon the process entirely. Simply having a formal new product process does not lead to positive performance. Cooper and Kleinschmidt (2007) say that many firms are currently documenting their product innovation processes simply to meet ISO standards; the end result is a "formal process" that is likely to lead to no increase in performance. Rather, companies should consider the success factors of a high quality innovation process and introduce them into their new product process. In decision points, firms need to consider the criteria for passing from one stage to another (otherwise risk may arise in the subsequent stages). These criteria are success factors that a company can consider and use to make decisions about each stage before progressing to the next stage. There is a mutual relationship between the criteria at each decision point and the preceding data gathering activities, which improves the quality of each stage. As examined earlier in Section 2.5.1, one major criticism of Cooper's (1990) stage-gate model (Figure 2.1), is that it focuses too heavily upon process factors as it was designed to deal with technical, not business, risks. The proposed model cannot be criticised in the same way as it considers the various success factors in each decision point. The success factors will be explained in greater detail in Section 2.7, although some will be explained by defining each stage of the innovation process (Section 2.6.1 to Section 2.6.5) as well.

In D1, the company encourages creative expression, in other words the company invites ideas. In the creativity stage, the company collects these ideas and at the following decision point (D2) broadly filters them. In addition, the broken line rectangle around all stages shows that learning is present for the whole of the process.

The model indicates sequential stages, since according to some researchers' opinion (e.g. see: Gobeli and Brown, 1993; Gopalakrishnan and Damanpour, 1997) this format allows for the identification of similar types of innovation processes in order to facilitate the discussion of problems, identify solutions, enable comparison across innovation situations, and also it is useful for considering and indicating the process of risk management more clearly. This process may be more complicated in practice and may not always follow the sequence suggested as there is overlap between stages. By considering the definition of the proposed model, with the feedback loops and decision points allowing for the consideration of different issues, it can be said that this model is inherently not linear and can be viewed as an interactive model. This model, like the third generation stage gate model (Cooper, 1994), is cross-functional and each stage involves activities from many different departments.

This research focuses on the development of a model to help manage an individual innovation, but should be viewed in the context of a potential portfolio of projects (Cooper, 1994). As Figure 2.8 indicates, the company should prioritise and select the best idea from the ideas which were generated and have the capability for development as resources are limited.

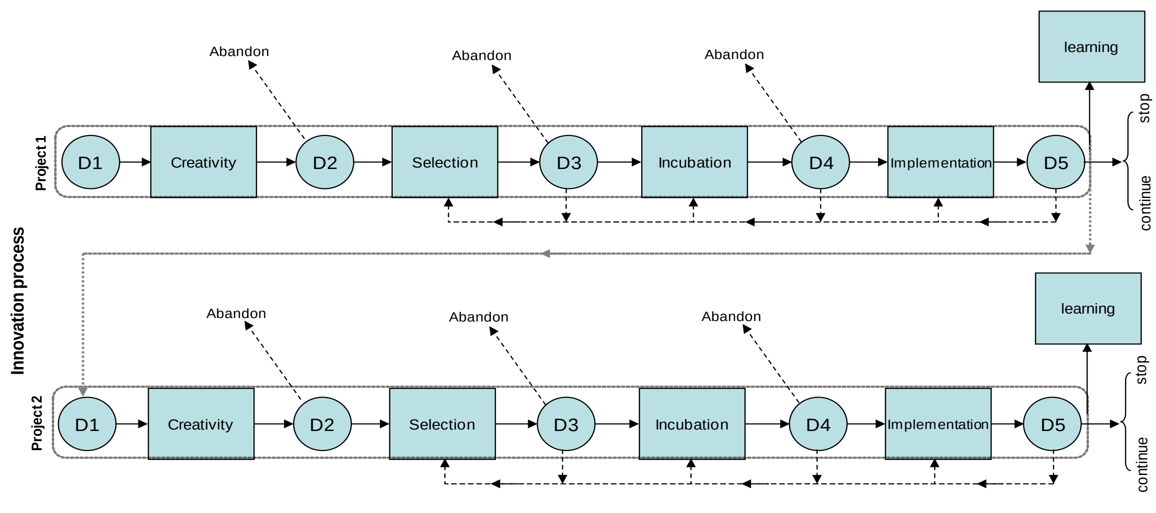


Figure 2.8 - Parallel innovation processes

In other words, at the selection stage more relative decisions than absolute decisions are made. In addition, the output of one project can often be a useful input for the next process. For instance, it is possible for a single innovation to be a financial failure, however companies can sometimes develop technical skills and an understanding of the market which can then be the basis of subsequent innovations (see Section 3.8, benefits of learning from the experience of failure is explained).

Before attempting to define each stage of innovation, it seems that it is important to describe the balance between innovation and risk management. As Figure 2.9 indicates, the amount of investment in the idea differs in the various stages of innovation (e.g. see: Salomone, 1995). Typically in creativity the amount is lowest while in implementation the amount may be at its highest (at the implementation stage the company must buy raw material, instruments, etc). In order to reduce expensive failure at advanced stages, as Figure 2.10 suggests companies attempt to minimise the number of inappropriate ideas through rejection in early stages.

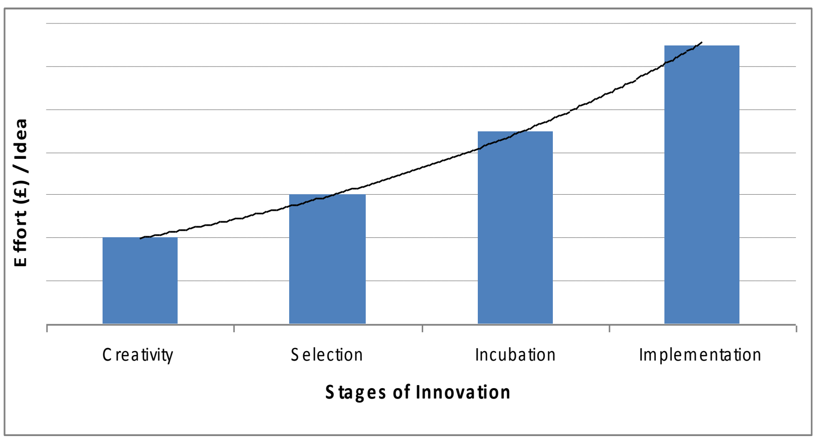


Figure 2.9 - Effort (£) per idea in different stages of innovation process

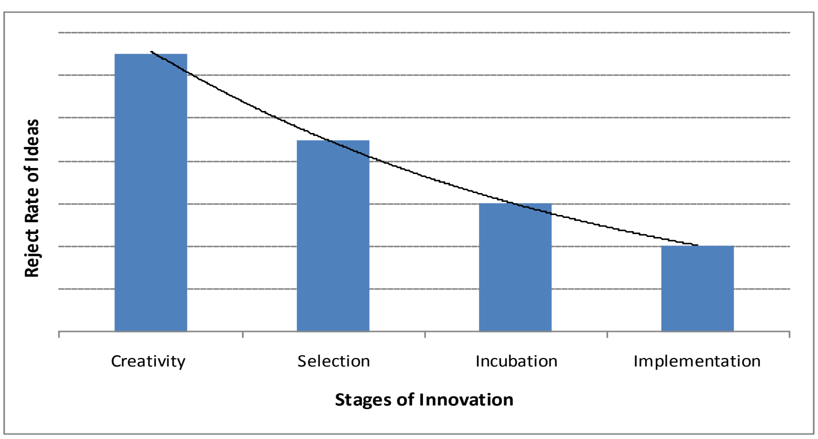


Figure 2.10 - Reject rate of ideas in different stage of innovation process

While companies attempt to maximise the rejection of potential failures and inappropriate ideas, they may also potentially reject some good ideas (e.g. see: van Oorschot *et al.*, 2010). As Figure 2.11 indicates, there are four different zones which highlight the relationship between the rejection of good and bad ideas.

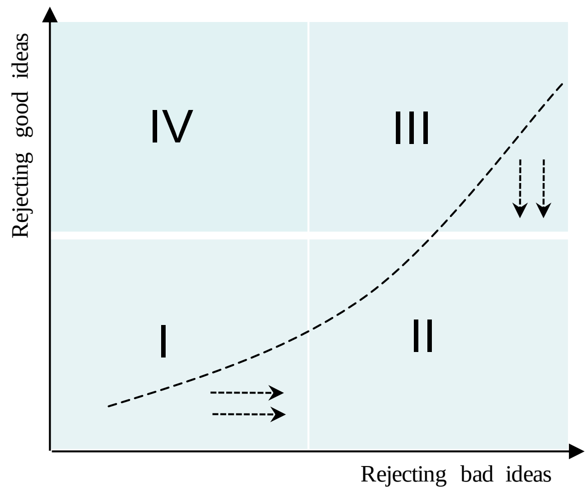


Figure 2.11 - Relationship between rejecting bad and good ideas

If the management is very relaxed, as in zone I there is no filter, and very few ideas, good or bad, are rejected. In a very critical environment, as in zone III, many good and bad ideas may be rejected. Zone IV is the worst as it rejects all good ideas, while in zone II there is a good filter, perhaps provided by appropriate risk management. Companies usually operate in zones I and III, but they would prefer to move to zone II. However it should be noted, that in reality rejecting some good ideas in zone II is unavoidable. The danger of operating in zone III is that minimising bad ideas can stifle creativity; consequently, companies need to create a balance between minimising bad ideas and encouraging creativity. One route to achieving the optimal balance of zone II may be the adoption of appropriate risk management.

2.6.1 Creativity

At this stage the company should scan the environment (internal and external) and consider any signs regarding threats and opportunities for change (Tidd, Bessant and Pavitt, 2005). Therefore this stage can be defined as the search for and identification of an idea for a new product (Gobeli and Brown, 1993). Goffin and Pfeiffer (1999) believe that creativity and ideas management is the stimulation of ideas which address customer requirements. They claim that ideas should be broad, all employees should be involved and customers' ideas should be cultivated. Some mechanisms that firms can apply in order to adopt innovation are: internal development, acquisition, licensing, joint venture or alliances, internal venture, venture capital and nurturing, and educational acquisition (Roberts and Berry, 1985). Companies can choose each of these mechanisms based on how unfamiliar or familiar the market and technology are (Afuah, 2003).

It seems that for many, considering the source of creativity is one of the most important issues at this stage. For instance, Sheth and Ram (1987) consider the factors that drive change in many markets and which combine to generate the need for more innovation. The four drivers based on their study are: changing customers (market pull), technological breakthrough (technology push), new competition, and changing regulations. Tidd, Bessant and Pavitt (2005) state that ideas may be expressed through market research, initiated by competitors actions, from R&D work in-house or externally (e.g. via technology transfer, strategic alliance). Firms enter into relationships with other firms and organisations for many reasons. Hendry, Arthur and Jones's (1995) state that one important reason for forming such relationships is that it allows a company to gather the information needed for the processes of developing or adopting innovation. In this area Jantunen (2005) argues that companies depend upon their suppliers, customers etc. to start the process of product improvement and as a source of novel ideas. In general, it can be said that communication in a network for innovation may happen amongst the firm and its partners beyond the value adding chain (supplier, customer) or other organisations such as technological intermediaries (Hadjimanolis, 1999). Based on Chandra and Neelankavil's (2008) opinion, in most cases, companies employ technology driven product development or attempt to identify the customer needs for creative purposes. In the technology driven method, new external technology developments or internal R&D efforts are the driving force of new product developments; however customer driven new product development involves companies attempting to solve customer's problems with very little, or no, extra technology. They believe that both approaches are possible in industrialised countries, but in developing countries technology push is weaker and the customer driven approach appears to be a more common method of stimulating creativity. Lee-Mortimer (1995) explains the characteristics of companies that provide the optimum environment for creativity. These characteristics are: encouragement and rewards, easy access to development funds, anticipating tomorrow's customers' values, ensuring close interaction between the technical and marketing departments at all levels and the acceptance of failure. It is interesting to mention a device for finding the opportunity for creativity based on Lee-Mortimer's (1995) definition. He believes that one tool effective in classifying ideas is a product innovation matrix. This matrix is developed jointly by technology and marketing staff within a firm, and highlights where there is an opportunity for customer-driven innovation. To develop the matrix, the results of brainstorming customers' needs are valued, the team then rates/compares the company's own existing product (if it exists) and competitor’s products against the determined needs of the customers to decide how well these requirements are being satisfied. Companies can also apply scenario planning in order to explore the environment for disruptive innovation (Drew, 2006; Worthington, Collins and Hitt, 2009). Worthington, Collins and Hitt (2009) say that this approach may require companies to shift their scenario planning from risk mitigation to opportunity recognition; therefore recognising that uncertainty in the firm’s environment is an indicator of potential opportunities. They add, for example, that firms may differentiate their strategy by providing goods or services to customers that have current needs or are likely to have special needs in the near future.

In summary, at this stage the company should consider the internal and external environment in order to find new ideas for creativity. As discussed earlier in this section, different factors such as customers’ needs, competitors, in house R&D etc. can be sources of creativity for the firm.

2.6.2 Selection

In this stage, companies based on their strategic view of how the firm can best develop, should decide (e.g. at D3, see Figure 2.7) which signals are worth responding to (Tidd, Bessant and Pavitt, 2005). Based on Gobeli and Brown’s opinion (1993), the decision process is defined as the evaluation of new product concepts and the approval of funds needed for development. Goffin and Pfeiffer (1999) believe that selection and portfolio management is an effective means of choosing the best ideas for implementation from the various ideas generated (see Figure 2.8). According to Linder, Jarvenpaa and Davenport (2003) to create innovation, companies must develop and use novel ideas in ways that generate value. Therefore the company, at this stage, should select ideas which will create value.

One important issue as Gopalakrishnan and Damanpour (1997) mention is that the success of an organisation's innovation, to a large extent, depends upon finding a match between its expertise and the time at which they decide to produce it. They believe that under certain situations - when there are learning curve advantages, advantages from R&D patents, and high switching costs – an emphasis on early adoption may present a competitive advantage to firms. However, at other times, early adopters or first movers can experience serious disadvantages; for example, when buyers are unwilling to try a first generation product (Abrahamson, 1991) or when there is difficulty in the appropriation of property rights (Gopalakrishnan and Damanpour, 1997). Therefore, under these circumstances (i.e. lack of necessary marketing expertise, limited resources etc.) it might be effective for firms to select imitation or delayed adoption over innovation or early adoption (Gopalakrishnan and Damanpour, 1997).

In summary, in this stage companies should select the best idea for future development based upon their strategy and criteria. Also, as mentioned earlier in this section, the timing of decision plays an important role in the success of innovation.

2.6.3 Incubation

Cooper and Kleinschmidt (2007) say that too many projects move from the idea stage straight into development with little or no assessment. They believe that the results of this "ready, fire, aim" approach are usually disastrous and inadequate up-front homework has been found to be a major cause of failure in product development. Therefore firms, at the incubation stage, should take an idea and create a prototype to test it on a small scale

(Chandra, Srivastav and Shah, 2003; Andrews, 2007; Chandra and Neelankavil, 2008). Two important responsibilities at this stage are: obtaining the knowledge resource that will enable the innovation and testing the project in situations of uncertainty, which will allow for extensive problem solving (Tidd, Bessant and Pavitt, 2005). In this stage the company should consider the preliminary market and technical assessments, the real design and development of the new product should be undertaken so the prototype can be tested in the marketplace in order to validate the proposed new product, its production and marketing (Cooper, 1993). This stage plays the role of risk sharing and provides credibility to an idea as it progresses from an idea to a physical product, it can help to reduce uncertainty and increase the chances of success (Chandra, Srivastav and Shah, 2003). Tidd, Bessant and Pavitt (2005) argue that if the new idea involves an incremental adaptation to an existing design, there will be little activity within this stage. On the other hand, if the concept involves an entirely new concept, there is substantial extent for creativity.

In this stage where some activities are similar to those of the R&D department, the company should prepare the prototype and consider this prototype on a small scale in order to find any possible problems and solve them before progressing to the next stages.

2.6.4 Implementation

Implementation involves transforming the initial idea into something new and launching it in the market (Tidd, Bessant and Pavitt, 2005). This stage is therefore fundamental for translating new ideas into new products, processes and services (Goffin and Pfeiffer, 1999). Cozijnsen, Vrakking and IJzerloo (2000) believe that it is only throughout the implementation stage that the innovation is really given form and shape, which creates considerable demands on organisational conditions and the commitment of the people involved. This stage is at the heart of every process of innovation and they expect most failures to occur during this stage. Many innovation projects fail as a result of the implementation stage not being handled correctly; therefore the implementation stage is seen as one of the most difficult. Tidd, Bessant and Pavitt (2005) argue that at the early stages of the innovation process there is a high amount of uncertainty as details of technological feasibility, competitor behaviour, regulatory, market demand and other influences are insufficient and selection must be based on a chain of ‘best guesses’. However throughout the implementation stage this uncertainty is replaced by knowledge acquired through various routes (methods of analysing and managing risk is discussed in details in Chapter 3). Gobeli and Brown (1993) say that in some firms, manufacturing and R&D build the first prototypes, R&D then refine the product until production is acceptable. They believe that such techniques can ensure that products are ready for production.

In summary it can be said that during this stage the company should start to generate an approved prototype on a real scale and launch it in the market. As the prototype is to be tested in real situations, the majority of failures occur during this stage. It seems that the company can reduce the probability of failure by considering the previous stages precisely and passing through them successfully.

2.6.5 Learning

Jantunen (2005) believes that an organisational learning capability is crucial for a firm’s innovation performance. He says that companies make use of processes in order to obtain information, assimilate it into their organisational knowledge base (formal documentation of past projects, individual memories, experiences) and act upon the knowledge in order to identify changes in the environment and maximise opportunities. Therefore, the ability of a company to obtain knowledge efficiently, incorporate it, and use it to commercial ends is crucial to its innovative capabilities and performance (Cohen and Levinthal, 1990).

It should be noted that one of the success factors of a project is an effective means of learning from experience (Cooke-Davies, 2002). Therefore, the capability of knowledge management can be particularly worthy to firms because of the difficulty that competitors have in understanding and assessing the implicit knowledge owned by a company (Reed and DeFillippi, 1990; Martin and Salomon, 2003). For instance, Stewart and Fortune (1995) define a historical document as a contemporary record that presents information about the method in which a project was managed, the actions undertaken, and the level of performance achieved. They argue that if the document is employed suitably, it presents insights that facilitate organisational learning and in return improve the performance of future project management.

In addition, it is argued that product innovation needs an extensive amount of information from different functional units; an efficient and effective information exchange in the process of new product development is also vital for generating successful outcomes (Ozer, 2006). In fact, information sharing has been recognised as an significant success factor in new product development (Brown and Eisenhardt, 1995; Sheremata, 2000). Song and Thieme (2006) report that their findings, based on cross-sectional surveys in Japan, China, and the US, highlight the importance of information sharing between marketing and R&D departments. Furthermore, Miller, Fern and Cardinal (2007) found in their research that inter-divisional knowledge has a positive effect on learning in innovation contexts.

In summary, it is argued that effectively managing knowledge leads to capabilities which allow the company to differentiate its services and goods from those of competitors as it attempts to offer better value to customers; therefore contributing an improvement in competitive advantage (Worthington, Collins and Hitt, 2009). Consequently, companies with well developed knowledge processing capabilities are able to renew their asset base and utilise the assets that they already have when developing products that are able to match market needs (Jantunen, 2005). It can therefore be said that acquiring external knowledge, learning from experience and sharing knowledge within companies is essential for a firm's innovation activities. As a result, firms have the opportunity to learn from progression, expand their knowledge base and improve the methods in which the process is handled (Tidd, Bessant and Pavitt, 2005).

It is important to mention that if companies focus on short term financial performance they may benefit from placing stress upon expanding their absorptive capacity and learning (Collins and Hitt, 2006). Jantunen (2005) believes that a company must have the ability to renew and update its knowledge base in order to sustain innovativeness in a dynamic environment. Attention should be drawn to the fact that the degree to which a company effectively manages its knowledge stocks is influenced by its ability to learn from different experiences and knowledge inputs (Worthington, Collins and Hitt, 2009).

2.7 Success Factors in Innovation

As discussed earlier in Section 2.6 companies should consider the success factors of a high quality innovation process and introduce them into their new product process (Cooper and Kleinschmidt, 2007). New product success is a critical challenge as we move into the future; so it is important to consider critical success factors that can enable better performance of a new product and increase the chances of its success (Cooper and Kleinschmidt, 2007; Simon, 2009). Research in this area is conducted at various levels, such as macro (firm) level or micro (project) level. Although examinations undertaken at the project level have provided information which has led to success and parallel those factors found at the firm level, it is also necessary to look at the firm level in order to achieve a complete picture (Cooper and Kleinschmidt, 1995). It should be taken into consideration that type of innovation may be an important moderator variable in the relationship between the factors and performance. There may not be a single set of failure or success factors, but rather, a collection of main determinants of performance which rely upon the kind of innovation the company is developing (Montoya-Weiss and Calantone, 1994).

The concept of success for product development has many aspects and each of them might be measured in a variety of ways; new product performance is defined by several widely used groupings of measures (Griffin and Page, 1993). For instance, Cooper and Kleinschmidt (2007) measured performance in different ways such as profitability, success rates and percentage sales of new products. Or Montoya-Weiss and Calantone (1994) explain three broad categories that capture the measures of new product performance which are: (1) market share objectives, (2) financial objectives (profit, sales, payback period, costs), and (3) technical objectives.

Many factors that impact new product outcomes have been identified based on various point of views (some of these factors are indicated in Table 2.1). For instance Biemans (1992) argues that although every researcher uses a different list of criteria, the factors influencing the success of innovations can be classified into five broad categories (which are shown in Table 2.1). In another categorisation, Montoya-Weiss and Calantone (1994) classify factors into four groups at the project level. Cooper and Kleinschmidt (2007) in their study exposed nine success factors that propel performance at the business unit level. Keizer and Halman (2007) in their literature review identified the factors that researchers have deemed crucial for the success of radical innovation projects and categorise them into five groups. Cooper (1998) has spent almost 25 years considering the causes of failure and success in new products. His findings, based on research into almost 2000 products, in many countries and industries, state that success depends mainly on six factors. In general, Gobeli and Brown (1993) believe that innovation managers by using the three leading principles of total quality management (Table 2.1), can advance through every stage of the process of product innovation.

Table 2.1 - Factors which have an affect on succes of innovation

Author(s)	Factors
Biemans (1992)	Marketing, Management, Technology, Financial resources and External events
Gobeli and Brown (1993)	Customer orientation, Continual improvement, Employee involvement
Montoya-Weiss and Calantone's (1994)	Market Environment Factors, Strategic Factors, Development Process Factors, Organisational Factors
Cooper (1998)	Differentiated, Superior products, Sharp, Early product definition, Solid up-front homework, Technology actions executed well, Marketing actions executed well, True cross-functional teams.
Keizer and Halman (2007)	Strategy (technology as well as market strategy), Product characteristics and production processes, Human Capabilities, Internal organisation, Knowledge.
Cooper and Kleinschmidt (2007)	A high-quality new product process, Adequate resources of people and money, A defined new product strategy for the business unit, R&D spending for new product development (as a percentage of sale), Senior management committed to, and involved in, new products, An innovative climate and culture, High-quality new product project teams, The use of cross-functional project teams, Senior management accountability for new product results
Simon (2009)	Fit with company, Patent protection, Proactive vs. reactive stance, Organisation, Financial requirements, Market size, Customer needs, Distribution channels, Competition, Government regulations

Regardless of the nature of a project, innovative or not, project management literature has related project success to time, cost, inter-personal interaction, quality of product, and the development of a “warm relationship” based on openness and trust (Genus and Coles, 2006; Aloini, Dulmin and Mininno, 2007). This stream of research on new product successes and failures identified various clusters of important managerial issues: product performance-related factors, market factors, marketing factors (understanding the market and customer needs), synergy factors (good fit between product and marketing requirements and the resources of the firm), and organisation and project management factors (Keizer, Vos and Halman, 2005).

Some studies have investigated the factors which can cause the failure of new product development and be a barrier in this process. It seems that considering these factors can help improve chances of potential success; success commences with knowing what you are trying to achieve, probable resistance, and planning (Andrews, 2007). van de Ven (1986) discusses, that from a managerial viewpoint, understanding the process of innovation is required to understand the factors that hinder and facilitate the development of innovations. He says that these factors include ideas, transactions, people, and context over time. Gobeli and Brown (1993) speculate that the first step for improved management of the innovation process is identifying potential process problems, determining precisely what those problems are for given firms, then customising solutions for each problem area. Consequently, it can be said that both approaches (considering success and failure) lead to identifying factors that determine the outcome. Some of the most important causes of failure, based on different studies, are: Inadequate funding, Risk avoidance, Incorrect measures (e.g. higher cost than anticipated), Inadequate market analysis (e.g. Insufficient market), Product defects, Poor timing, Competitive reaction, Inadequate sale effort, Inadequate distribution, Managerial incompetence and a lack of technology base (Biemans, 1992; Andrews, 2007; Chandra and Neelankavil, 2008).

Although this research concentrates upon the project level, in order to achieve a complete view of the success factors which can be useful when considering different stages of the innovation process, both levels (macro and micro) are considered jointly to find the valuable insight. As mentioned before, various factors have been identified based on different point of views in the literature which have an effect on new product outcome. However, most of the researchers did not link a factor to a particular stage of the innovation process.

2.8 Innovation System

From a macro level, innovation is observed as the process of matching technical capabilities to market opportunities, including various interactions and types of learning (Freeman and Soete, 1997). Porter (1990) argues that the innovativeness of a company is decided by the four characteristics of its local environment, which in formation he calls the ‘‘diamond’’. These characteristics are: factor conditions (natural resources, capital, skilled labour, and educational institutions); demand conditions; related and supporting industry; and firm strategy, structure, and rivalry. Therefore, from a macro level the innovation system has an effect on innovation in each country. The innovation system approach proposes that successful innovation needs different players with distinctive roles to work together towards common goals, therefore developing a shared vision is important between industry, the research community and government (Foxon *et al.*, 2005). Branscomb and Auerswald (2002) believe that innovation systems are the key to resolving the tension between the scarcity of successful innovation and the need for a dependable sequence of innovation. Lundvall’s (2010) definition states that a system is comprised of a number of elements, relationships between these elements and utilisation of new knowledge in production and diffusion. As mentioned in Section 2.6.5, learning plays an important role in innovation. Some believe that the creation and the diffusion of ‘new’ knowledge is one of the tasks performed in an innovation system (Foxon *et al.*, 2005). Lundvall (2010) believes that learning is a central activity in the innovation system. In some cases there is obvious synergy between these elements, which, in turn, generates the supportive circumstances within which innovation can grow (Tidd, Bessant and Pavitt, 2005).

Innovation systems exist on different scales, including the corporation, city/regional, national and transnational region (Branscomb and Auerswald, 2002). The innovation system may also be different for different technologies and different countries. Lee and von Tunzelmann (2005) believe that the focus on the national innovation system (NIS) is due to industrial countries possessing similar institutions for developing innovations (e.g. corporate laboratories, public research institutes, private R&D contract firms, and universities), which differ substantially in how they pursue the innovation process; in other words, in the structure of the underlying 'system'. In a study of the Japanese economy in the late 1980s, the concept of a national system of innovation was first developed (Foxon *et al.*, 2005). Niosi (2002) believes that the concept of a national system of innovation has been expanded towards that of the innovation system. He adds that there are obviously industrial, local, regional, national, and may be international innovation systems. The national innovation system is a broad concept which aims to achieve a network of institutions in the private and public sectors, whose activities and interactions results in importing, generating, diffusing, changing and developing technologies (Bagherinejad, 2006). National and regional systems of innovation include a set of interconnected players such as industrial firms, government, universities and labour markets which characterise the context within which companies operate their innovation process (Niosi, 2002; Tidd, Bessant and Pavitt, 2005). Bagherinejad (2006) believes that the creation of such a system can play an important role in the process of technological development in developing countries. Some researchers compared the national innovation systems of 15 countries and found that the differences between these systems indicate different institutional arrangements, including: systems of university research, training and industrial R&D; public infrastructure; management skills; financial institutions; and national monetary, fiscal and trade policies (Foxon *et al.*, 2005).

In summary, although this research aims to concentrate on the process of innovation within the company, it seems that viewing factors from a macro level can be useful as well. For this reason, the role of the innovation system and factors which exist within the system were explained.

2.9 Intellectual Property Right (IPR) and Innovation

Intellectual property rights can sometimes protect a new product and be an incentive for innovation. However, at other times it can actually limit innovation. It seems that through rising globalisation, recent decades have witnessed a significant growth in the importance of intellectual property (Kingston, 2001). In the last two decades, patents have become broader and stronger, and for the first time have become more accessible to the public research community; they are now available for a number of significant types of innovation that were un-patentable in the past and have extended within the developing countries (Jaffe, 2000). However it should be taken into consideration that the effects of IPRs (their cost and benefit) fluctuates according to countries' level of technological, industrial, and economic development (e.g. see: Maskus, 2000). For instance, Lall (2003) argues that the importance and benefits of IPRs vary based on the nature of the economy and the activity.

In recent years, the protection and tightening of intellectual property rights has been a subject of much debate in developing countries (Lall, 2003; Chen and Puttitanun, 2005). This debate is frequently located within the framework of a North–South divide, where the principal vision is that southern (developing) countries are likely to lose from protecting IPRs (Chen and Puttitanun, 2005). The reason for this loss is that IPR protection strengthens the market power of northern innovating firms and raises prices in developing countries (e.g. see: Deardorff, 1992). Chiang (1995) states that a modern intellectual property system that aims to encourage invention by international or universal standards has little relevance for industrialisation and may even be disadvantageous for industrialisation. Moreover, Kale and Little (2007) state that the universal adoption of strong patent protection will affect the application of imitation and decrease the opportunity for firms in developing countries to use this method of knowledge gain. They add that this condition certainly raises a question about strengthening patent laws globally, regardless of the capabilities of domestic industry, especially in developing countries where strong patent laws will hinder the development of basic or intermediate capabilities. Chen and Puttitanun (2005) point out that, whilst weak IPRs make the imitation of foreign technologies simpler, stronger IPRs encourage domestic innovative activities. They believe that there is an inverted U-shaped relationship between the income levels and strength of IPRs. Firstly, the strength of IPRs falls with rising incomes, as countries shift to lose IPRs to make domestic capabilities by copying, it then grows as they engage in more innovative activity (Lall, 2003). Thus, for the developing country, there could be an optimal level of IPRs, that balances the trade-off between providing motivation for local innovations and facilitating the imitation of northern superior technologies (Chen and Puttitanun, 2005).

Lall (2003) says that the weak IPRs aid local firms make technological advances by allowing reverse engineering and imitation. This is demonstrated by the practice of East Asian countries such as Taiwan and Korea that developed tough original capabilities in a collection of sophisticated industries. It also seems that various sectors in developing countries need different degrees of IPR.

Sarkissian (2008) - while considering the role of IPR in developing countries especially in Iran - says that although Iran has a long history of IPR legislation, the initial study of the Iranian business sector, as well as its patenting performance, indicates that the IPR system might not serve as an encouragement to innovation. He adds that the major benefits of current developments (depending on other factors) may come from the transactional function (e.g. FDI, interfirm north–south cooperation) and membership in international bodies rather than via the incentive function.

Whilst encouraging low cost imitation is a dominant policy for countries until they shift into a middle income range with local innovative and absorptive capabilities (World Bank, 2002), Lall (2003) argues that stricter IPRs may facilitate the international transfer of technology to developing countries and also its local diffusion. He believes that this may be of special significance for technology-intensive products and activities where innovators tend to be averse to dealing with weak IPR countries (where weak IPR is a real risk).

2.9.1 Global trend in IPR

The Trade Related Aspects of Intellectual Property Rights (TRIPs) agreement has implications for some trends, such as the standardisation of IPR regimes and infiltration of IPR into developing countries; thus, a brief introduction to TRIPS would be useful here.

Based on Sarkissian's (2008) research, increasing concerns about counterfeiting and piracy of IPR in industrialised countries, where much intellectual property exists, was the reason the protection of IPR was a major topic of negotiation at the Uruguay Round of the General Agreement on Tariffs and Trade (GATT). The negotiations led to the establishment of the WTO (World Trade Organisation) to administer the GATT, the TRIPS and the General Agreement on Trade in Services (GATS). The TRIPS agreement is a legally compulsory part of the WTO that needs all member countries (151 countries from 27 July 2007) to grant patents for creativities in all fields of technology. The TRIPS agreement, trade in services (GATS), and trade in goods (GATT) are the three pillars of the WTO.

The main benefits of TRIPS are for the developed countries that produce innovations; there are few advantages for developing countries in terms of motivating domestic innovation (Lall, 2003). Therefore, the middle income and low income countries have to cautiously consider the introduction of TRIPS and its protection for IPRs as it would decrease their access to technology and information (World Bank, 2002). Sarkissian (2008) says that conforming to the TRIPS agreement for most member countries involves initiating much severe IPRs protection. He adds that this is expected to have extensive consequences on the international transfer of technology and the trade relationship between the developed and developing countries.

In summary, as discussed in this section, considering the IPR is an important issue in recent decade, especially in developing countries. There are various discussions about the role of an IPR as an incentive for innovation within different countries. However, this research will not look at the IPR in greater detail as the IPR is not a major issue in this particular research. Firstly because the IPR environment might determine whether or not companies decide to start the process, but it has little influence within the innovation process. The only exception may be when companies review product development. At this time the company may decide to abandon the process if they are concerned that the lack of an IPR will result in the product being duplicated by competitors; therefore this issue can be a factor which can create risk in innovation process.

2.10 Developing Countries and Iran

Most innovations in developing countries which are relatively major at a local level, are not original in the global level (Linsu and Youngbae, 1985). Altenburg, Schmitz and Stamm (2008) mention that while innovation capabilities have remained extremely concentrated in the United States, European Union, and Japan; this is starting to change. They argue that there are signals that developing countries (e.g. India and China) are developing important innovation. Although OECD countries are still in front in almost all technological fields, the gap between them and developing countries has narrowed during the last few years.

For analytical and operational objectives, the World Bank usually categorises economics based on different criteria. This time, the World Bank's main criterion for categorising economies is gross national income (GNI) per capita. Based on this criterion, every economy is categorised as high income, middle income (subdivided into lower middle and upper middle), or low income. According to the World Bank (2010) based on GNI many of the countries in the world are categorised as low and middle income. Chandra and Neelankavil (2008) believe that in these countries, companies may not focus their efforts on a large section of the population due to the expense involved. They add that the process of new product development in developing countries has to begin with finding the answer to two crucial questions, both based on the customer's point of view: first "what price point" would the low income population be able to pay for a product or service, and secondly what is the "value-added" aspect for customers utilising the new product (i.e. can the new product solve a number of customer problems?). It seems that since radical innovation usually has a high price, companies in these countries concentrate more on incremental innovation, though they should consider the price of these innovations as well.

Archaeological studies indicate that Iran was a pioneer in the formation of industry among ancient nations (Rahimi, 1993). For instance Bagherinejad (2006) mentions that weaving and textile technology began in Iran about 7,000 years ago, bricks about 6,000 years ago, carpet making 1700 years ago and enamelling 1400 years ago. The starting point of Iranian industry occurred in 1821, with the initial attempts to form industry by Amir Kabir (one of the Iranian Prime Ministers) and continued until 1900 when numerous companies were set up. After a period of depression due to the World War II, the creation of 'heavy and assembly' industries commenced once more around 1960. Based on World Bank's (2010) classification, Iran is now a developing country and in the upper middle income group. Iran's economy is heavily reliant on the primary sector[1] and dominated by oil exports; also, the local manufacturing industry has been constructed largely through the licensing of technology from other countries and, in a number of cases, through imitation (UNCTAD, 2005; Komijani, 2006). Iran has a important industrial base among developing countries, comparatively good human development, and a well-developed science and technology infrastructure (UNCTAD, 2005).

[1] 'The oil and gas and the agriculture sectors together account for 25.1 percent of GDP, and the industrial sector accounts for 23.4 percent, including water supply, electricity and gas (UNCTAD, 2005)'.

Based on Javidan and Dastmalchian (2003), while Iran is a Middle Eastern country, it is not part of the Arab culture. Instead, it is classed as part of the South Asian cultural group which consists of countries such as India, Malaysia and Thailand. According to them the confusing geographic position and cultural proximity leads to a misunderstanding of Iranian culture. In their study they declare that the Iranian cultural practices are distinguished by individualism, high power distance, high performance orientation, high male orientation, and low future orientation. Low future orientation shows that planning, investing, and other future oriented behaviours are not mainly emphasised due to unclear and often changing rules.

In 1988 after finishing the war with Iraq, Iran commenced a rebuilding program to deal with the extremely centralised economy shaped during the war (Komijani, 2006). For this purpose Five-Year Economic, Social, and Cultural Development Plans (FYDP) were prepared for every five years. Each of these plans has focused on different goals. For instance the First FYDP (1989-1993) focused on the development of the infrastructure of the economy; the Second FYDP (1995-1999) focused on the promotion of non-oil exports to lower Iran's reliance on oil; the Third FYDP (2000-2004) wanted to restore market-based prices, decrease the size of the public sector and motivate private sector investment, and the Fourth FYDP (2005-2009) puts emphasis on a more open economy based on competitiveness, the adoption of policies for improving innovation, external and internal sources of R&D and systems for creating technological and innovative capacity; it also committed the government to a program of liberalisation, privatisation and diversification (UNCTAD, 2005; Komijani, 2006). It seems that moving away from a centralised economy can improve innovation, as a government with high authority and strong controls can cause people to be risk averse and stifle innovation. On the other hand, this policy can decrease the motivation for innovation since there is not enough governmental support to guarantee the market.

One of the major challenges that Iran faces is a high level of unemployment, creating employment for the people is one of chief responsibilities of the Iranian government (UNCTAD, 2005; Komijani, 2006). As mentioned in Section 2.1, a key source of new employment opportunities is innovation; Iran should therefore attempt to encourage innovation. Innovation and private business are seen as a major source of employment growth. Another challenge is the unsteady political situation in the region, and somewhat complicated international relations due to issues related to Iran’s nuclear energy program (Komijani, 2006). Based on UNCTAD’s (2005) research in Iran, rivalry between companies (which is a source of innovation) is missing in some sectors. Also, there is an inadequate R&D and innovative capacity at the company level in Iran. Only a few large companies have their own in-house R&D capabilities. In addition the supply network in Iran is weak. Iran has important production capabilities in some industries such as automotive, pharmaceuticals and telecommunications; however, even these large manufacturing companies depend upon imported raw materials as an input for production.

In summary, Five-Year Economic, Social, and Cultural Development Plans (FYDP) indicate that the Iranian government perceived the importance of innovation and attempted to create a situation that would encourage it; although different aspects of these plans have not until recently been implemented. However, the government wants to complete all aspects in future plans and activities. For instance, putting emphasis on a more open economy based on competitiveness or going to privatisation are some parts of these plans.

Some research shows a lack of future orientation for many Iranian firms due to uncertainty, unclear and often changing rules. Therefore, it is important at this time, for Iranian companies to know how they can integrate a risk management system into their process of innovation (although knowing this issue is very important for developed countries as well).

2.11 Conclusion

Innovation inevitably involves high risk activity and to be successful, management need to manage the process and consider the risk. It seems that the challenge for management, is integrating risk management into innovation management in order to exploit the combined power, without imposing additional bureaucracy and stifling creativity. In order to find a model for this purpose, different stages of innovation were described for the identification of common stages, which can be used to make a general innovation management process that can then be integrated within the proper stages of the risk management system. By surveying the literature about the stages, which are mentioned in relation to the innovation process, it seems that finding a common stage at the level of generalisation is possible; therefore five stages are selected for this process. In the proposed theoretical model each stage of innovation consists of an information gathering activity followed by a decision point. At each decision point the company can decide whether to continue to next stage, return to previous stages for additional work or abandon the process entirely. In order to consider the wide range of factors (from technical to business) which have an effect on the process of innovation, the company should consider the success factors at each decision point. In order to integrate this proposed model of innovation process within risk management, in the following chapters (Chapter 3) the concept of a risk management system will be considered in order to identify the proper stages of the risk management system.

Chapter 3 Risk Management

This chapter provides an overview of the literature on risk management leading to the development of a theoretical model integrating innovation and risk management. It tries to provide the basis for our understanding of the risk management system and related themes. Therefore it will be used to identify the proper phases of the risk management system in order to integrate it into the process of innovation. The chapter commences with an overview of the importance of considering risk in the innovation project (Section 3.1). Next, in Section 3.2, the definition of risk will be explored. A wide range of factors can create risk in innovation and the categories are discussed in various studies. By considering these factors and their categorisation in Section 3.3, the categorisation of risk factors in innovation projects can be adopted. Section 3.4 surveys literature on the risk management system in order to find common phases of risk management. The common phases will be discussed in greater detail in four separate sections: Section 3.5 will discuss the different methods used to identify risk factors, Section 3.6 will explore the different methods used to analyse the risk factors, Section 3.7 will consider various actions for managing risk and Section 3.8 will explain the monitoring and controlling activities in the process of the risk management system. In Section 3.9 this chapter discusses risk management in the context of the innovation project and develops the core of the theoretical model to offer a combined model of risk and innovation management. Section 3.10 summarises two literature case studies that offer further insight into aspects of innovation and risk management. These were used for preliminary verification, leading to some refinement of the initial theoretical model. Finally, this chapter proceeds to discuss how company can measure the success of their innovation in Section 3.11

3.1 Risk and Innovation

Innovation is a major driver of growth and sustainable competitive advantage for firms (De Maio, Verganti and Corso, 1994). In other words, in order for companies to survive they must innovate in a framework of great uncertainty (Taplin and Schymyck, 2005). The essence of innovation is to create or establish something new (Keizer, Halman and Song, 2002). Risks are intrinsic within innovation (Cooper, 1993; De Maio, Verganti and Corso, 1994; Zhao, 2005; Wang, Lin and Huang, 2010), but increased competition, rapidly changing technology and customer expectation can also cause innovation to become more complex, thus making the possible outcome considerably less certain (Keizer, Vos and Halman, 2005). Also, from an economists' point of view "innovation is risky in the sense that innovative actions aimed at the future always confront uncertainty. In reality, acting under conditions of uncertainty always entails more or less tangible risks, as the innovator stands to gain or lose things like waged capital, corporate promotion, social standing, or self-esteem" (Berglund, 2007).

The success rate of innovation projects is still low (Stevens and Burley, 1997; Griffin, 1997). Product innovation is one of the riskiest activities in business as about 35% of products launched fail commercially; approximately 45% of total new product expenditures are on unsuccessful projects (Halman and Keizer, 1994). Companies therefore require a strategy, not of risk avoidance, but of early risk diagnosis and management in order to launch new products speedily and successfully. Consequently the ability to diagnose, manage and reduce risk is increasingly considered to be of vital importance for firms (De Maio, Verganti and Corso, 1994; Keizer, Halman and Song, 2002). It is no surprise then, that identifying and managing risk has become an increasingly important subject in product innovation literature (Keizer, Vos and Halman, 2005).

3.2 Definition

No single definition of the word "risk" is universally employed, because there are many ways in which the term is used (Green and Serbein, 1983). Due to the increase of knowledge in technological fields and also the development of technology, the complexity of industrial systems has considerably increased over the last few decades (Salvi, Merad and Rodrigues, 2005). Therefore, the definition of risk changes as it becomes intertwined with innovation within rapidly globalized world (Taplin and Schymyck, 2005).

According to the standard definition of risk, it is "the combination of the frequency or probability of occurrence and the consequence of a specified hazardous event" (Edwards and Bowen, 2005). In more specialised literature, the word risk is used to imply a measurement of the chance of an outcome, the size of the outcome or a combination of both (Wharton, 1992). In classical decision theory, risk is commonly conceived as reflecting variation in the distribution of possible outcomes, their likelihoods, and their subjective values (March and Shapira, 1987). The definition of risk differs from one point of view to another. For instance from the owner-manager/entrepreneur's view, risk can be defined as the probability that a new venture will fail to achieve satisfactory sales, profit or ROI (Return on Investment) target (Dickson and Giglierano, 1986).

It has been argued that since the nature of risk reflects the uncertainty of the future event, the impact of event may be positive or negative: risk represents threats as well as offering significant opportunities (Turner, 1993; Edwards and Bowen, 2005; Taplin and Schymyck, 2005). In this area Berglund (2007) believed that the traditional definition of risk which comes from decision theory, sees risk being associated with positive and negative outcomes. However, over time risk has become almost exclusively associated with negative outcomes, and today risk is commonly seen as “the possible loss of something of value”.

Some writers in this field distinguish between uncertainty and risk. For instance, a risk situation is defined as one in which a probability distribution for consequences is made on a meaningful basis, agreed upon by a set of relevant experts; therefore it is ‘known’ and can be measured (Hertz and Thomas, 1983; Loch, Solt and Bailey, 2008). However, a situation where it is not possible to attach a probability of occurrence to an event is defined as uncertainty (Clemen, 1996; Taha, 1997). Uncertain situations arise when an agreement among the group of experts can not be attained (Hertz and Thomas, 1983), therefore uncertainty is the consequence of a lack of information or clarity (Morgan and Henrion, 1999; Emblemsvåg and Kjølstad, 2006).

In this study the focus is concentrated on risk more than uncertainty, since risk is more related to incremental innovation and this research wants to concentrate more on this kind of innovation; and risk events are presented as leading to negative consequences.

3.3 Sources of Risk

As examined in Chapter 2 (Section 2.4), innovation inevitably involves high risk activity and in order to be successful, management need to manage the process and consider the risk. For this purpose management should be familiar with probable sources of risk. Any factor which can affect project performance can be a source of risk, when this affect is both probable in its occurrence and significant in its impact on project performance (Chapman and Ward, 1997). It must be noted that the intervening factors which are a source of risk can cause the planned outcome to differ greatly from what is actually achieved (Taplin and Schymyck, 2005).

Some authors believe that risk is often systemic in nature and a risk event in one category may mean the likelihood of a risk event occurring somewhere else; for instance, when a supplier goes out of business it will have an impact on a specific aspect of the engineering field (Taplin and Schymyck, 2005; Ackermann *et al.*, 2007). So a systemic perspective on risk has to include multiple causal sources and the compound interaction of technological, social and physical systems. A systemic risk management system requires to consider the chain of risk producing factors, towards surrounding root causes (Hellström, 2003).

Edwards and Bowen (2005) argue that the classification of risk helps the users to consider them in a more coherent framework. However they emphasise that even within a recognised discipline area that little uniformity exists in the classification of risk. It is important to point out that every company should set up its own risk categories based on its own needs (Royer, 2000) also it does not mean that all risks within a specific risk category will be identified in each project (Edwards and Bowen, 2005). This issue is explored later in the context of checklists in Section 3.5.1.

Smith (1999) stresses that although some people may think risk is solely a technical issue and it is related to the R&D department, most risk issues have much broader roots. In other words, the success of product innovation is determined by both internal circumstances and external influences in which all factors interact, therefore an effective risk assessment method needs to help recognise potential risks in areas other than technology (Keizer, Vos and Halman, 2005). Based on Cooper's classification (1998) of success factors in new product development, only one item ('technology actions executed well') resides solely in R&D. The others are dominated by marketing or are cross-functional in nature. If managers view risk as an R&D subject, they naturally focus on technical risk. This consequently leads them into unproductive areas of risk management, as most products are not commercially successful due to market risks (Smith, 1999). Chapman and Ward (1997) argue that the multiplicity of people and/or organisations that are involved in a project can be one of the main sources of uncertainty. In addition they explain that setting unreasonably small cost and time targets can make a project more risky in terms of cost or time, therefore the achievement of targets is more uncertain if targets are tight. On the contrary, setting time or quality requirements that are too flexible creates time and quality risk; they may overrun schedule or be of inferior quality. They conclude that the explanation of project objectives and performance criteria has a fundamental influence on the stage of project risk.

A wide range of factors can create risk in innovation and their categories are examined in various literature (e.g. see: Green and Serbein, 1983; Turner, 1993; Conrow, 2000; Royer, 2000; Eden, 2001; Keizer, Halman and Song, 2002; Cooper, 2003; Keizer, Vos and Halman, 2005; Taplin and Schymyck, 2005; Berglund, 2007; Keizer and Halman, 2007; Mu, Peng and MacLachlan, 2009). Table 3.1 indicates some of these factors. For instance, Keizer, Halman and Song (2002) name four domains which allow for the categorisation of risk factors, these are: Technology, Market, Finance and Operations. Conrow (2000) identifies common risk categories for the Department of Defence and non Department of Defence programmes, but he emphasises that maybe risk is not limited to one category. These categories are: Cost, Design/engineering, Functional, Integration, Logistics/support, Manufacturing, Schedule, Technology, and Threat. In addition, some authors explain the categorisation of risk from a different point of view. For instance Gilmore, Carson and O'Donnell (2004) say that there are four dominant fields in which risk is perceived by owner-managers/entrepreneurs. These are company size, cash flow, entrusting staff with responsibilities and entering a new market/area of business.

Although in some categorisation, the factors were grouped together based on internal and external factors (e.g. see: Turner, 1993), it seems that other types of categorisation – with different grouping based on different areas – might be easier for users to apply in their activities in their particular context.

Table 3.1 - Sources of risk

Author(s)	Factors
Green and Serbein (1983)	Property and personnel, Marketing, Finance, Personnel and production, Environment
Royer (2000)	Management, Operational, Financial, Project management, Strategic, Technology and Failed assumption
Eden (2001)	Political, Customer, Partner and Supplier, Joint venture, People, Reputation, Market, Operational and Financial
Conrow (2000)	Cost, Design/engineering, Functional, Integration, Logistics/support, Manufacturing, Schedule, Technology, and Threat
Keizer, Halman and Song (2002)	Technology, Market, Finance and Operations

It seems that these studies have tried to provide general categorisation for risk factors based on their point of view, although experience in specific industries or environments has led to the development of different categorisation schemes. For instance, Conrow (2000) provides a categorisation based on his experiences in the Department of Defence in the United States of America. In this study by considering the different risk factors and their categorisation, which is discussed in this section, the following categorisation of risk factors in innovation projects can be adopted. It seems this categorisation is the most appropriate for understanding risk factors in innovation management (Chapter 2). This categorisation is largely based upon on Royer (2000), Eden (2001) and Keizer, Halman and Song (2002); however some refinement was developed in order to provide a good match with the particular issues in innovation management. In addition, an attempt was made to have general categorisation, consequently different factors can be put under these categorisation based on each companies' requirements. These categories are: Environment, Technical, Resources, Management, Marketing, Integration and Strategy. In the following, some of the factors associated with this categorisation will be explained.

- Environment: government policy (Eden, 2001; Foxon *et al.*, 2005), currency rates (Eden, 2001), weather (Green and Serbein, 1983), intellectual property (Keizer, Vos and Halman, 2005), society's characteristic (e.g. poverty, crime, culture (Green and Serbein, 1983))
- Technical: new methods and materials (Branscomb and Auerswald, 2002; Christensen, 2003), technology constraint (Foxon *et al.*, 2005; Mu, Peng and MacLachlan, 2009)
- Resources: staff (Eden, 2001), raw materials (e.g. supplier, availability (Cooper, 2003)), finance (Royer, 2000)
- Management: project management techniques (Royer, 2000), set the tight goals (Chapman and Ward, 1997), co-development (Keizer, Halman and Song, 2002), failed assumption (Royer, 2000), organisation (organisation structure, behaviour, top management's priority and support for the project and culture (Keizer, Vos and Halman, 2005)), multiple parties' experience (Chapman and Ward, 1997), product transition management (van de Ven *et al.*, 1999)

- Marketing: customer (Berglund, 2007), competitor (Keizer, Vos and Halman, 2005), market (Mu, Peng and MacLachlan, 2009)
- Integration: hardware/hardware, hardware/software, software/software (e.g. new & old systems) (Conrow, 2000; Christensen, 2003)
- Strategy (Royer, 2000)

3.4 Risk Management System

Change in the business environment happens at a rapid pace. Science and engineering increasingly progress rapidly through major projects, many of which are high risk, consequently there is an urgent need to integrate a risk management system into the projects (Williams, 1995; Emblemsvåg and Kjølstad, 2006). For instance, some of the chief problems the Swedish-Swiss engineering giant ABB was facing in 2002 were caused by ‘‘poorly understood operational risk’’(Economist, 2002). Another example is that Unilever - one of the major players in fast moving consumer goods - suffered a dramatic new product failure in its detergent section (Keizer, Halman and Song, 2002). The company spent $175 million developing the product and another $292 million marketing it. In order to learn from this experience, Unilever evaluated the process that led them to such dramatic and unforeseen consequences. Unilever concluded that it must improve its risk management methods and procedures in order to prevent such failures in the future. Although one key characteristic of innovation will always be risk, risk management needs to facilitate innovation rather than stifle it (Taplin and Schymyck, 2005). In addition, time and resources are limited for any project, so it is not possible to manage all risks in each project (Royer, 2000).

Mu, Peng and MacLachlan (2009) emphasise that without suitable risk assessment and risk management, projects can easily run out of control, consume significant additional resources, greatly expand project costs and may lead to failure. These situations clearly indicate that growing uncertainty increases the need for the application of the risk management system. In addition, a model (e.g. about risk management) can provide a means to form our points of view, developing a shared understanding and making the concept more tangible; thus we can communicate opinions to others through words, mathematics or graphics (Smith and Merritt, 2002). This is especially helpful in topics such as project risk which are often faced with different interpretations. Furthermore models can also present a systematic way of dealing with risk. Smith and Merritt (2002) also emphasise that the models also have some weaknesses. For instance, models always only represent a partial picture of reality. Also, no matter how complex the model made, something is always missing; they often idealise association between the components.

Based on Taplin and Schymyck's (2005) definition, risk management means 'the process of understanding the nature of uncertain future events and making positive plans to mitigate them where they present threat or to take advantage of them where they present opportunities.' Edward and Bowen (2005) believe that a systematic approach to risk management develops the ability of an organisation to manage risks at all stages. It promotes internal clarity, a perceptive of the business activities of the organisation, and facilitates the establishment of an organisational culture of managing risk. A risk can be characterised by the risk event; the probability of its occurrence and the amount of potential loss or gain (Lam *et al.*, 2007). So the main purpose of risk management is to improve project performance by identifying the risk factors, estimating their impact, analysing their interactions and controlling them within a risk-management structure (Williams, 1995; Chapman and Ward, 1997).

A good risk management system will let an organisation look ahead of each project while also maintaining the capacity to look backwards to learn from prior projects risk experience (Edwards and Bowen, 2005). On the other hand, effective risk management should start at the very beginning of the project, and go well beyond technical areas to capture anything which may affect the success of the project (Smith, 1999). In this area Edwards and Bowen (2005) emphasise that a systematic approach to risk management has to encourage decision-making inside an organisation; decision making which is more controlled, more consistent and yet at the same time more flexible. Two criteria that should be used to judge the quality of a risk model are: the clarity of intention of the model and whether it is user-friendly (Smith and Merritt, 2002). It is argued that the benefit of the risk management system has to be determined by the organisation. However, the difficulties will certainly exist when attempting to measure benefits and their costs (Edwards and Bowen, 2005).

The issue of when and where risk management should be applied in the project is widely discussed. Williams (1995) believes that once the project begins, risk management must be an on-going process. In regards this area, Salomone (1995) mentions that the cost of changes and iteration in the design stage is less than changes at the start of the implementation phase. Hence the early discovery of risk events which could lead to downstream losses is preferable to managing the events only when they actually occur (Ahmed, Kayis and Amornsawadwatana, 2007). The project life cycle can be divided into four phases (Conceptualisation, Planning, Execution, Termination) and at all stages in the project life cycle, formal risk management processes should be applied (Chapman and Ward, 1997). Also Stewart and Fortune (1995) believe that the life cycle for all projects consists of a series of stages and activities, from origin to completion, and there is always a degree of risk related to each stage. However, the impact of risk might differ throughout the project management life-cycle; for instance, the later in the cycle risks occur, the more expensive their consequences (Turner, 1993).

It is argued that since an innovation strategy based on risk avoidance is not an option for many companies, proactive risk management is needed in which risks are identified in the early phases of product development, as there is still time to influence the route of events (Wheelwright and Clark, 1992; Cooper, 1993). Companies can manage risk effectively by starting early in the project, around the same time the project schedule, budget and specification are created; working to manage risk throughout the project will keep the level of risk under control and reduce the likelihood of problems actually occurring (Smith, 1999). During conception which is the earliest stage of a project, uncertainty is at its highest point and the risk assessment may be imprecise before the development has taken place (Chapman and Ward, 1997; Smith, 1999). The purpose for which the project is required and the parties who will be involved may not be clear. During design and planning, by attempting to specify what is to be done, how, when, by whom and at what cost, much of this uncertainty is removed (Chapman and Ward, 1997). Based on Keizer, Halman and Song’s (2002) opinions the most powerful contribution risk assessment makes comes at the end of a stage in the innovation process, where the transition to the actual product development and engineering of a particular product or product range takes place. They say that uncertainty has to be managed by considering potential risks which are related to all aspects of manufacturability, marketability, finance, human resources and so forth. They believe that in this phase of the project, management still has the ability to substantially influence the course of events and make a considerable impact on the eventual outcome; however, a periodical reassessment of potential risks in subsequent stages is still required.

Many studies have examined the various phases for risk management system (e.g. see: Wideman, 1992; Turner, 1993; Chapman and Ward, 1997; Conrow, 2000; Pyra and Trask, 2002; Smith and Merritt, 2002; Edwards and Bowen, 2005; Smith, Merna and Jobling, 2006; Aloini, Dulmin and Mininno, 2007; Lam *et al*., 2007). Table 3.2 indicates some of these phases.

Table 3.2 - Phases for risk management system

Author(s)	Phases
Conrow (2000)	Risk planning, Risk Assessment, Risk Handing and Risk Monitoring
Pyra and Trask's (2002)	Identifying Risk, Quantified Risks, Develop Risk Mitigation Strategies, Monitoring and Controlling Risks
Smith and Merritt (2002)	Identifying, Analysing, Prioritising and Mapping, Resolving and Monitoring
Aloini, Dulmin and Mininno (2007)	Context analysis, Risk Identification, Risk Analysis, Risk Evaluation, Risk Treatment, Monitoring and Review, Communication and Consulting
Edwards and Bowen (2005)	Establishing suitable context(s), Recognising the risk of the project, Analysing the identified risk, Developing responses to those risks, Controlling and Monitoring the risks during the project and Allowing post-project capture of risk knowledge
Smith, Merna and Jobling (2006)	Risk Identification, Risk Analysis, Risk Response and Risk Review

Based on Keizer, Halman and Song's (2002) opinion, a comprehensive risk assessment approach has to:

- Evaluate the likelihood, controllability and importance of each potential risk factor.
- Take a cross functional view in order to identify risk in different areas.

- Perform the risk assessment at the end of the feasibility stage and regularly reassess the project for unexpected risks and deviations from the risk management plan.

Conrow (2000) argues that there is no single or greatest risk management process for any program, and it is difficult to claim that a risk management process can be universally applied to all programs. However, he believes that a good risk management process structure that is appropriate for a variety of programs was developed by the U.S. Department of Defence, from 1996 to 1998. The stages of this process are: Risk planning, Risk Assessment, Risk Handing and Risk Monitoring.

Smith and Merritt (2002) provide the other process for managing risk. As Figure 3.1 shows, this process consists of 5 steps which are: Identifying, Analysing, Prioritising and Mapping, Resolving and Monitoring.

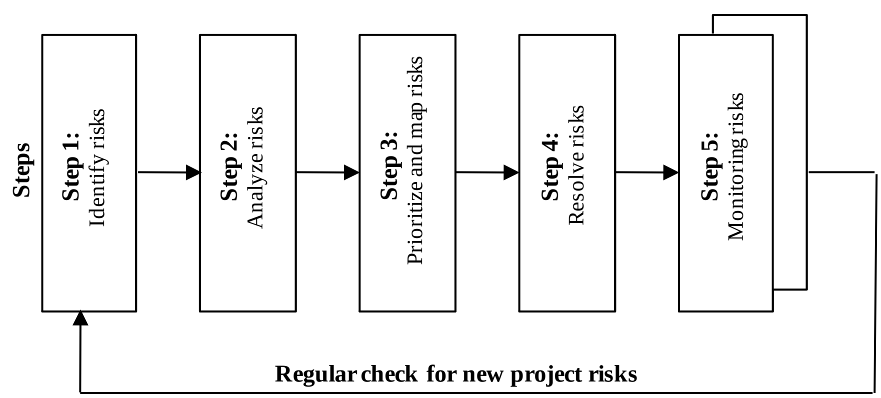


Figure 3.1 - Risk Management Process (Smith and Merritt, 2002)

Edwards and Bowen (2005) claim that as shown in Figure 3.2 a good risk management system for a project should include these processes: Establishing suitable context(s), Recognising the risk of the project, Analysing the identified risk, Developing responses to those risks, Controlling and Monitoring the risks during the project and Allowing post-project capture of risk knowledge.

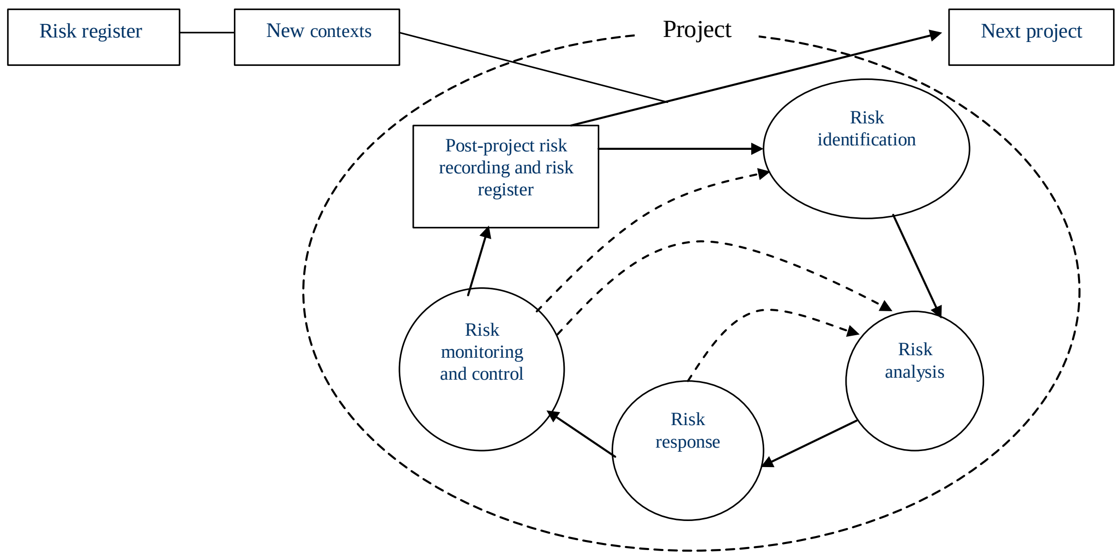


Figure 3.2 - Risk Management System (Edwards and Bowen, 2005)

It seems that the core activities in all of these risk management systems are the same and the differences between them are not substantial. This means that some of these differences are related to different contexts and the type of industry. Also, sometimes different words are applied to explain the same activities (such as risk response or risk treatment when explaining action taken against risk). However, sometimes some activities are combined in one phase while in other systems these activities are extracted at different phases (for example, identifying probabilities, impact and prioritising risk). Thus, by considering the different phases which are discussed by literature in relation to risk management system (particularly: Smith and Merritt, 2002; Smith, Merna and Jobling, 2006), also two criteria which Smith and Meritt (2002) mention about the quality of risk management system model, four phases (Figure 3.3) are selected. These are: Identifying risk, Risk analysis, Risk management action, and Monitoring and Controlling. It should be noted that these four phases are common to all most risk management systems which were examined in literature.

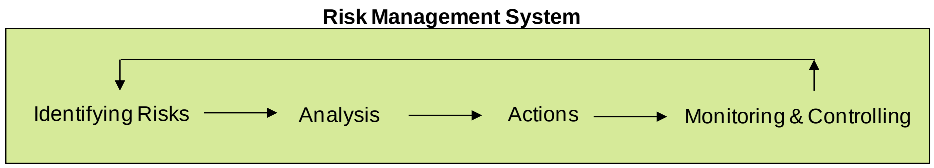


Figure 3.3 - Risk Management System

In identifying phases, factors which are capable of creating risk should be diagnosed. In the risk analysis phase, these risk factors should be prioritised. In the third phase - risk management action - a suitable response strategy for each risk should be defined. In the final phase - monitoring and controlling – the status and closure of targeted risk should be assessed and new risks have to be identified. In Section 3.5 to 3.8 these phases will be explained in greater detail.

3.4.1 Organisational characteristics and risk management system

From Emblemsvag and Kjolstad's (2006) point of view, two important aspects are usually neglected in the process of risk management: 'the capability of the organisation and management of information quality'. It is argued that organisational characteristics and routines - such as the degree to which a firm is risk taking and the nature of the organisational culture - appear to influence the conduct of comprehensive risk management (Genus and Coles, 2006). Organisational culture is one of the parameters which can hamper the innovation process (Berglund, 2007). Project failure is often related to the inability or unwillingness of employees to communicate regarding issues that can ultimately jeopardise project success, illustrating the importance of employees' characteristics (Keizer and Halman, 2007). This section will attempt to explain these characteristics.

Cultural Theory (Thompson, Ellis and Wildavsky, 1990; Douglas, 1992) suggests that there are different stereotypes and that each has a typical attitude towards risk. Taplin and Schymtck (2005) emphasise that based on the cultural context, the management of risk is always varied and in a globalised world it is vital to recognise the variation in risk taken at a cultural stage which, in turn, affects business decisions. For instance, if one society is risk taking and another risk averse it will affect the conduction of business.

Jackson and Carter (1992) believe that risk is a human problem since the people involved in the design, construction and operation of a system fail to perceive some set of situations which might arise and cause the system to fail. Risk tendencies depend on how the situation is perceived by people (Berglund, 2007). Some research revealed that individual characteristics and specific aspects of internal organisation (such as organisational constraint) can have an affect on risk perception, control and the tendency to avoid or accept risk (Keizer, Vos and Halman, 2005; Genus and Coles, 2006). A number of variable factors such as: mood, feeling, and the way in which problems are framed, education, training, culture and experience all appear to affect and shape perception and attitudes towards risk (March and Shapira, 1987; Edwards and Bowen, 2005). On the other hand, the attitude towards risk has an influence on organisational decision making, as these will also influence the development of a policy of risk management (Edwards and Bowen, 2005). Many decision-makers are not consciously aware of their risk attitudes most of the time (Edwards and Bowen, 2005). There are two main types of people, risk avoiders and risk takers (Smith, Merna and Jobling, 2006). Based on March and Shapira's (1987) definition, 'risk averse decision makers prefer relatively low risks and are willing to sacrifice some expected return in order to reduce the variation in possible outcomes; while risk seeking decision makers prefer relatively high risks and are willing to sacrifice some expected return in order to increase the variation'. Generally it is said that entrepreneurs and investors are risk lovers, while people who take on a low paid but safe jobs and those who invest money in savings accounts are risk averse (Smith, Merna and Jobling, 2006).

Specialists are needed in different fields, such as technical, economical, communication in order to assess the different dimensions of risk in risk management (Salvi, Merad and Rodrigues, 2005). Researchers recommend managers take a diverse range of functional experts in their risk assessment team (Keizer and Halman, 2007).

3.4.2 Learning and risk management system

One of the most important factors for a successful project is an effective way of ''learning from experience'' (Cooke-Davies, 2002). This combines tacit with explicit knowledge in a way that encourages people to learn and to embed that learning into continuous improvement of project management processes and practices. On the other hand, it is argued that the capability for organisational learning generates new knowledge that in turn helps the company respond and adapt to challenging environmental surroundings (Worthington, Collins and Hitt, 2009). Therefore, there is a need for an organisational learning process to be embedded within an organisation as it allows for the continuous improvement of project management (Williams *et al.*, 2005).

It is commonly accepted that a lack of information contributes to unforeseen systematic failures and it is assumed that accidents can be avoided through rational action if more information were available (Jackson and Carter, 1992). Cooper (2003) argues that knowledge management systems have the potential to assist in reducing risk through the gathering and processing of relevant information and encapsulated knowledge from various internal (e.g. through experiments and test) and external (e.g. throughout consultants, searches) sources. For instance O'Connor, Ravichandran and Robeson (2008) in their study of the relation between risk management, organisation learning and the success of radical innovation, conclude that 'learning oriented risk management practices will have a positive effect on success of radical innovation efforts in firms'. A key challenge faced by new product development projects is the question of how to obtain knowledge and manage sources of uncertainty in order to reduce the risk of failure (Cooper, 2003). Bowers (1994) believes that all sources of data should be considered within a comprehensive risk analysis. He states that data may come from different sources, 'representing experiences of the project team, the organisation and the outside world, and in various form, both quantitative and qualitative'.

Ackermann *et al*. (2007) believe that by considering previous projects and their histories, the expertise, knowledge and wisdom gained can be elicited, and consequently a worksheet model, that acts as a powerful risk assessment device, can be produced. For instance, Royer (2000) supposes that if an organisation spends time documenting risk and their mitigation strategies, reviews them at project closing (successful or not), and shares them with a readily available knowledge repository, new project managers and the organisation itself will be more successful. In other word, in future projects this knowledge repository can serve as the starting point when attempting to identify potential risk areas and analyse them (Stewart and Fortune, 1995; Royer, 2000). In addition new and experienced project managers can employ these past experiences to reduce risk and increase the likelihood of success (Royer, 2000). However, it should be noted that the injection of irrelevant information can divert attention from important tasks, consume valuable resources, force users into information overload and decrease sensitivity to main problems (Cooper, 2003).

In summary, uncertainty comes from lack of knowledge. Therefore, knowledge and information are an important factor in risk management systems and companies should try to obtain useful internal and external knowledge. Since knowledge based on previous projects (successful or failure) are a useful means for identifying potential risks within future projects, in order to collect this kind of knowledge companies should embed an active learning system within the companies processes.

3.5 Identifying Potential Risk Factors

As discussed earlier in Section 3.4 (Figure 3.3), identifying potential risks is the first phase of a risk management system. This phase typically identifies potential events which could be problematic and in the next phase, after analysis, the company determines which of these events should be categorised as 'risks' requiring action and monitoring. It is argued that the prime task of the risk manager is to recognise and identify the sources of loss from unexpected events and also their potential consequences before mitigating them (Green and Serbein, 1983; Ahmed, Kayis and Amornsawadwatana, 2007). Based on this, the situation must be considered in order to identify what could go wrong, at any given point in time during the project, whether at the product design stage or during development (Ahmed, Kayis and Amornsawadwatana, 2007). In this phase, risk events and their potential consequences that could hinder the project from achieving defined goals such as schedule, cost, resource consumption, or quality are recognised (Smith and Merritt, 2002). It is important to pay attention to the fact that each risk event comes hand in hand with its impact, that is, the loss (in terms of money, time, quality, etc) that the risk event could create (Smith and Merritt, 2002).

Smith (1999) emphasises that the risks that a company identifies in one project will be very specific to this project. Also, he believes that many important risks will be cross-functional, so a cross-functional team is more likely to identify them. For example, if only engineers look for risks, it is likely they will miss market risks. This view that risk is specific to each project may contradict the whole notion of a check-list or any model that claims to represent past knowledge or good practice (check-lists will be explained in Section 3.5.1). A good check-list simulates the experience, and in practice the company has to use experience from across projects, so using a check-list provides a starting point (e.g. see: Figure 3.5).

Risk factors can be identified by using any creativity tool that brings a group's ideas to the surface, such as brainstorming (Smith, 1999). Edwards and Bowen (2005) believe that the element common to most identification techniques is brainstorming. They say that no automated techniques of risk identification at present exist. So at relevant period in the risk identification process, the people involved should be asked to respond to this question: 'what could happen in this particular context to threaten a satisfactory outcome for this organisation on this project?'. In this area Keizer, Halman and Song (2002) mention that risks are often identified in group meetings and the outcomes of such meetings may be biased by group-thinking; effects can be introduced through the composition of the group and the process it applies. They add that people do not like to label factors as certain or uncertain if leaders within the group have different views and opinions. They believe that one way to avoid these group effects is to gather potential risk factors from each member individually and then evaluate these factors the same way. Based on Edwards and Bowen's (2005) opinions brain storming is easier in reality, and usually more successful when it is directed in some way, for instance applied within more structured identification techniques.

Several risk identification techniques exist, such as: loss exposure surveys and check-lists, use of financial statements, failure mode and effect analysis, fault trees, event trees, cause and effect diagrams and influence diagrams. Although some of these methods (such as FMEA) are used to identify risk events, it seems that their main role is during the analysis phase of risk management. These methods will be explained more in the analysis methods section (Section 3.6). Consequently, some of these methods (check-list, Cause and effect analysis, Influence diagram, HAZOPS) which are more common and useful for innovation projects are explained in greater detail in the following section (3.5.1 - 3.5.3).

3.5.1 Checklist

It is argued that providing a checklist as a framework helps the application of knowledge within an organisation and allows them to recognise and control risk (European Federation of Chemical Engineering, 1985). A risk reference framework reflecting company-specific, as well as generic success factors will help team members think of less obvious issues (Keizer, Halman and Song, 2002). One of the major advantages of this technique is that knowledge which is achieved over many years of experience, is incorporated into the company's practices and thus is available for application throughout all stages (European federation of chemical engineering, 1985). Keizer, Halman and Song (2002) claim that many companies have their own lists of crucial failures that management hope future projects will not suffer from. Check-lists are simple to use and frequently develop over time through contributions from various functional experts and collective experiences (Chapman and Ward, 1997; Ward, 1999). It is important to mention that individual experiences which is expanded by information about the experiences of others is a fundamental part of this identification method (European federation of chemical engineering, 1985). Edwards and Bowen (2005) believe that check-lists are seldom completely sufficient for effective risk management as they are unlikely to help recognise risks that have not previously been practised or identified. It seems that this criticism of check-lists could also apply to other methods of risk identification as well. Inevitably, the process relies upon previous experience, so the challenge is to assimilate experience from a wider range. It should be noted that a check-list may not be a complete method if it is limited to personal experience or at least very local experience. A more useful check-list approach may be one that assimilates experience from a wider range, for instance across the whole organisation or even beyond (such as research into other organisations' experiences).

Some studies have described the use of a risk register. It is argued that a risk register tool is normally used as a means of documenting information generated through risk management (Patterson and Neailey, 2002). Also, the risk register should involve a list of adverse events that might occur (Williams, 1994). The project risk register has two main roles (Williams, Ackermann and Eden, 1997). Firstly it is 'of a repository of a corpus of knowledge; and secondly it is the foundation for the analysis and management that flows from a knowledge of the risk'. In this area, Patterson and Neailey (2002) mention that the risk register is an effective tool which enables everyone involved in the project to evaluate and manage risk as element of the decision making process. It presents a platform on which the mitigating actions and decisions can be made in the future, through ensuring a greater understanding and acceptance of visible risks. On the other hand, this method enables risk reduction and mitigation plans to be documented within the project itself. Comparing the risk register with the check-list indicates that while the check-list is more related to previous activities and concentrate on identifying the factors, the risk register is a more dynamic and holistic approach which includes identifying, reduction and mitigation. A typical risk register form in Figure 3.4 indicates the features of this method.

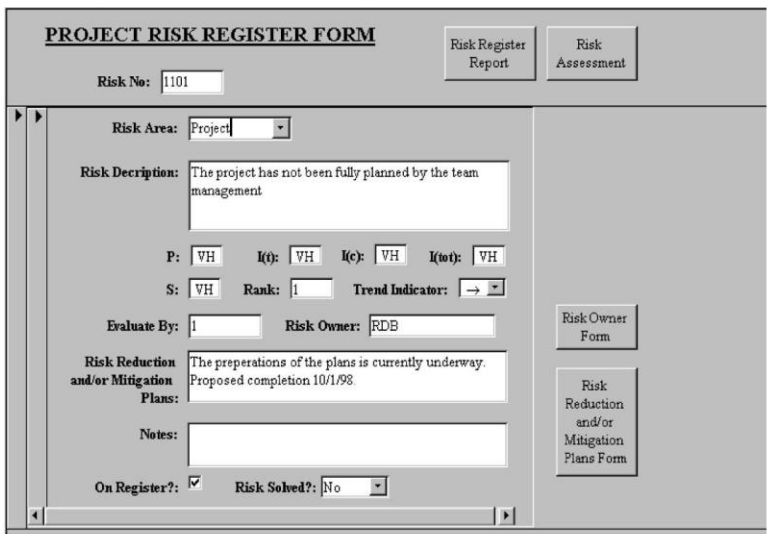


Figure 3.4 - Risk Register Form (Patterson and Neailey, 2002)

Ackermann *et al*. (2007) argue that traditional risk registers ignore the most important features of risk which are related to each other. In order to remove this weakness they introduce the risk filter method. The risk filter was developed to mirror a network of interrelated possible risk events and also to relate risk to characteristics of projects. Williams, Ackermann and Eden (1997) believe that the connection between some risks are direct and obvious where as other risks will be more subtly interconnected. They suggest that 'the impact that some risks have might compound the impact of others, so the effect of two risks might be more than the sum of the two individual effects'. The risk filter appears as an organisation specific questionnaire within which were embedded the systemic properties. As the individual risks were considered independently their impact was determined by considering the whole portfolio of answers and their effect on each other.

Figure 3.5, which is drawn based on the previous issues which were discussed in this section, could be useful in helping the managers appreciate the role of check-list.

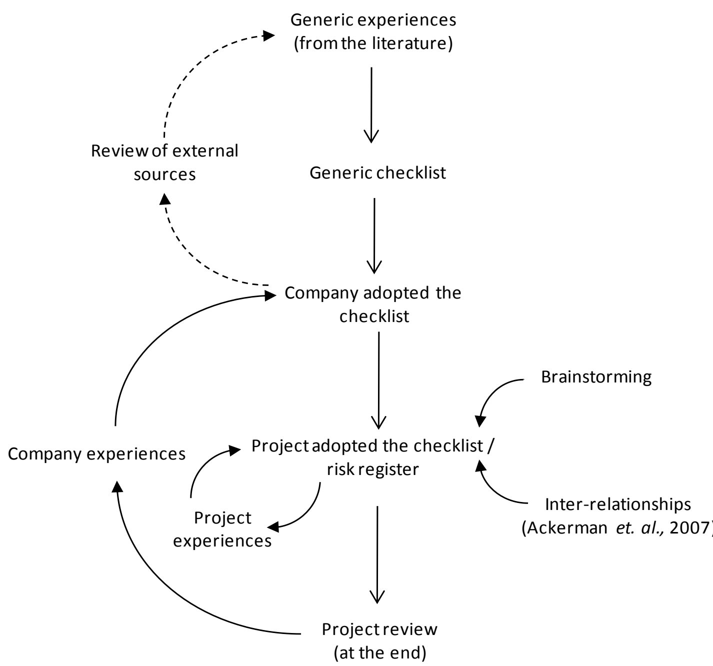


Figure 3.5 - The dynamic risk checklist

3.5.2 Cause and effect diagrams

A fish-bone diagram, or a cause and effect diagram, is a graphical representation of the root causes of quality problems, where the major causes of final problems are gathered and broken down into detailed sources (Russell and Taylor, 2000). Ahmed, Kayis and Amornsawadwatana (2007) argue that the cause and effect diagram is easy to use but it does not provide a foundation for further analysis, such as the relative importance of the individual causes of a problem. Therefore, cause and effect diagrams are implied for deterministic problems in a very specific domain.

3.5.3 Influence diagram

An influence diagram is the graphical technique of illustrating the dynamic structure of a system and discovering the important relationships between components within a system and between the system and its environment (Stewart and Fortune, 1995; Flett, 2001). Developing a model that clearly explains risk factors and their relationships without getting into unnecessary detail is the key to successful risk analysis (Ashley and Avots, 1984). In this area, Stewart and Fortune (1995) mention that most of the techniques do not allow the uncertainty surrounding projects to be considered as they ignore the interaction between different risks. For example, in this area Williams, Ackermann and Eden (1997) discuss that the project risk register is unable to capture knowledge about the interrelation between risk events, and show that extra benefit can be gained when it is turned into a cause and effect map. In addition, they suggest the use of scenario planning for possible future exploration which facilitates coherent planning of future scenarios as well as gaining greater understanding of the risk structure. In regards to this area, Drew (2006) explains that one of the advantages of scenario planning is it identifies critical uncertainties and risks for various levels and types of planning. He adds that every firm will wish to customise the process to suit its own situation, needs, and culture.

An influence diagram can graphically explain the structure of the decision in context by showing processes such as decisions, uncertain events, consequences and their interrelationships (Clemen, 1996). By using the influence diagram, key events can be recognised, this visibility allows for better planning and contingency management (Ashley and Avots, 1984). It should also be noted that the strength of an influence diagram can provide inputs for a critical successful factor analysis (Stewart and Fortune, 1995). Ahmed, Kayis and Amornsawadwatana (2007) believe that the visual display of an influence diagram along with a cause and effects diagram can be used to recognise risk situations before they occur.

By comparing the influence diagram with the cause and effect diagram, it appears that the cause and effect diagram is a more structured approach and encourages thinking about categorising risk; the influence diagram, however, is a flexible approach and encourages thinking systemically about risk. Influence diagram can make a great contribution to understanding one dimension of risk (impact) but need to considered in conjunction with some assessment of probabilities of events' occurrence.

3.5.4 Hazard and operability study (HAZOPS)

Ahmed, Kayis and Amornsawadwatana (2007) believe that HAZOPS is a variant of FMEA where check words are used as process parameters which identify safety and operational problems frequently found in new systems. They state that check words generate alternative perspectives of the overall process and focus attention on unpredictable areas. Edwards and Bowen (2005) mention that 'while the HAZOPS technique can be adapted to provide a basis for risk identification in other type of projects, it is best suited to flow processes that are relatively straightforward and linear in nature'. In project risk management, HAZOPS can be applied by considering project parameters such as budget, strategy and schedule which then aid in identifying risk situations (Ahmed, Kayis and Amornsawadwatana, 2007).

This technique identifies risks that occur mostly during the technical part of product production, so it is less suited to situations that entail other types of risk (Edwards and Bowen, 2005). HAZOPS can lead to difficulties in application, especially for a less experienced team (European federation of chemical engineering, 1985). In addition, this technique assumes that the majority of details involved in project design have been completed by this point; this assumption makes it inappropriate for identifying risk in the early stages of many projects (Edwards and Bowen, 2005).

3.6 Methods of Analysis

As examined in Section 3.4 (Figure 3.3), analysis is the second phase of the risk management system following the preliminary identification of potential risks. Edwards and Bowen (2005) argue that risk analysis is an evaluation procedure that helps establish some understanding of the magnitude of risks in a project. Hence, they conclude that proper risk analysis lets a company achieve an understanding of the severity of risks in a project.

Many studies have stated that assessing the probability and impact of risk events, and their subsequent ranking, should be undertaken during risk management (e.g. see: Smith and Merritt, 2002; Emblemsvåg and Kjølstad, 2006). Under ideal situations, the company would be able to recognise all unknown factors and apply a risk management system to indicate them (Cooper, 2003). However, in the real world, resources are limited for projects and there is neither time nor resources to deal with all risks; therefore, management must decide which risk will be explored and mitigated (Royer, 2000). Baccarini and Archer (2001) emphasise that ranking risk allows for the efficient and effective allocation of resources for risk management. Once the company has identified potential risks, it needs to find a way to prioritise and track them (Smith, 1999). Consequently, it can be said that the main purpose of this phase of the risk management system is the prioritising of risk factors.

In order to enable the prioritising of risk factors, it is important to create an objective method which categorises risks and establishes priorities (Royer, 2000). Smith and Merritt (2002) state that risk contains indecision, and indecision is measured by using probability. Therefore, probability as the best-known factor, should be used as a tool for quantifying uncertainty and analysing risk (Morgan and Henrion, 1999; Smith and Merritt, 2002). However, Berglund (2007) believes that 'still in most organisations, decisions are made by professional managers who focus on specific outcomes with expected amounts of risk but without factoring in their likelihoods'.

According to various studies, risk can be measured by using two parameters: probability and consequence (e.g. see: Chapman and Ward, 1997; Royer, 2000; Baccarini and Archer, 2001; Patterson and Neailey, 2002; Pyra and Trask, 2002; Smith and Merritt, 2002; Zhao, 2005). For instance, Turner (1993) states that the impact of a risk is generally explained based on its probability of occurring and the consequences if it does occur. Smith (1999) says that the level of risk is the product of two parts: its impact, which is the severity of the risk should it occur, and the probability of occurrence. Risk likelihood or probability explains the chance of a risk event occurring whilst risk impact, consequence or severity indicates an outcome generated from the risk event (Ahmed, Kayis and Amornsawadwatana, 2007). Consequently, it seems that to measure the risk magnitude, the probability and impact should be determined; this constitutes the function of this phase of risk management system. Based on Edward and Bowen's (2005) opinion, in order to assess the consequences of a risk event, it is assumed that the impact can be explained in terms of cost to the risk bearer. They emphasise that one problem with this method is that not all risk consequences are directly related to costs. For example: the outcomes may lead to damage to reputation, loss of staff, loss of capacity or difficulty in recruiting staff.

3.6.1 Qualitative and quantitative methods in general

Decisions are frequently based on qualitative risk analysis results more than the quantitative ones (Patterson and Neailey, 2002). Edward and Bowen (2005) believe that in much project risk analysis, qualitative analysis is sufficient, as the main principle of risk analysis is simply to achieve an understanding of the relative severity of the risk that the organisation faces in the project. Ahmed, Kayis and Amornsawadwatana (2007) argue that the quantitative method for determination of risk parameters needs analysis of historical data through statistical analysis. They add that in many cases, quantitative data is difficult to attain and is limited to a very small area of the problem where historical trends can be sustained. Quantitative data is not always accessible when needed and is not always in the form required, consequently qualitative approaches which use subjective assessment methods are frequently more appropriate for risk analysis. Consequently, it can be said that if companies focus too much on quantitative risk analysis they can only analyse a few aspects of the project that can be measured readily (e.g. see: Ahmed, Kayis and Amornsawadwatana, 2007). Also, the quantitative nature of the data may disguise the fact that some of the information is still subjective (e.g. see: Bowers, 1994).

Qualitative assessment is subjective because it relies on human judgement, feelings and opinions in comparison to ideal conditions, therefore that judgement will be influenced by personal bias, experience and preference (Edwards and Bowen, 2005). Companies use a qualitative assessment approach to recognise risk since the opinion of an expert is the best source available (Ahmed, Kayis and Amornsawadwatana, 2007). In addition, qualitative assessments are generally quick to apply, simple to understand and easier and less costly to complete than utilizing quantitative techniques. However their weakness lies in the fact they can contain potentially less accurate information and that errors in judgement become frequently difficult to distinguish and eradicate (Patterson and Neailey, 2002; Edwards and Bowen, 2005).

The problem of collecting necessary input data for any method of risk analysis is a critical issue. The availability of data (or the cost/time to collect more) may well dictate the choice of risk analysis method, as mentioned above. It seems that this also relates to organisational learning. It means that one mechanism for learning is to collect data which will provide a basis for risk analysis in future innovation projects.

In the following sections (3.6.2 - 3.6.8), different methods for analysing risk factors, which can also be used to prioritise them, are explained in greater detail. Although it can be said that some methods, such as ‘Risk mapping’, are usually applied as qualitative methods and ‘Monte Carlo’ (which will be explained in Section 3.6.3) is used as a quantitative approach, in some situations it is possible that the company will use a subjective method to elicit quantitative estimates of probabilities and impact as input to a quantitative approach.

3.6.2 Risk mapping

Risks need to be prioritised. A useful method by which this can be achieved is risk mapping (The Institute of Chartered Accountants in England and Wales, 1997). In this method, risk events are indicated on a chart based on their impact (cost, time or performance) and the likelihood of their occurrence, this enables risks to be prioritised (The Institute of Chartered Accountants in England and Wales, 1997; Smith, 1999). This method is often used to label threshold regions on the grid, which signify high risk events

(Chapman and Ward, 1997; Royer, 2000). Therefore, the company should define their threshold line according to their own tolerance for risk and any risk above this line should be considered an important one (Smith, 1999). A typical risk mapping chart is shown in Figure 3.6.

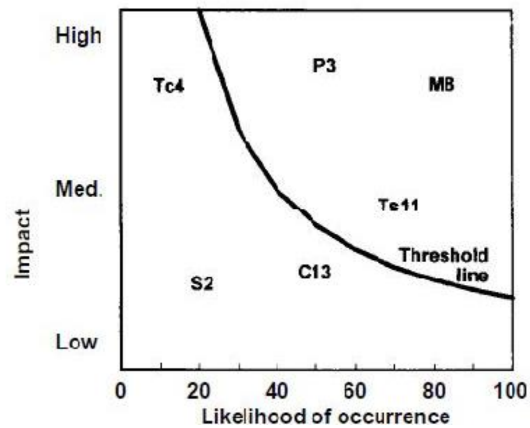


Figure 3.6 - A risk mapping chart (Smith, 1999)

3.6.3 Quantitative risk analysis (QRA)

Sluijs *et al*. (2005) state that although quantitative techniques are crucial for analysing uncertainty, they can only account for what can be quantified in a reliable way. Hence they can only provide an incomplete insight into what is usually a very complex mass of uncertainties. In regards to this area Branscomb and Auerswald (2002) mention that 'risk comes in many forms, often difficult to enumerate, much less quantity'. The purpose of a quantitative risk analysis is to determine the combined impact of the uncertainties presented by the model in order to identify the likely distribution of possible model outcomes (Vose, 1996). A number of techniques are used to calculate the distribution of possible outcomes, these are: Methods of moment, Monte Carlo simulation and Exact algebraic solution. A brief explanation of these methods follows below.

Based on Vose's (1996) definition, in methods of moment, each uncertain variable is replaced by its mean and variance; some rules are then used to estimate the mean and variance of the model's outcomes. He believes that this technique can become complicated to execute in all situations.

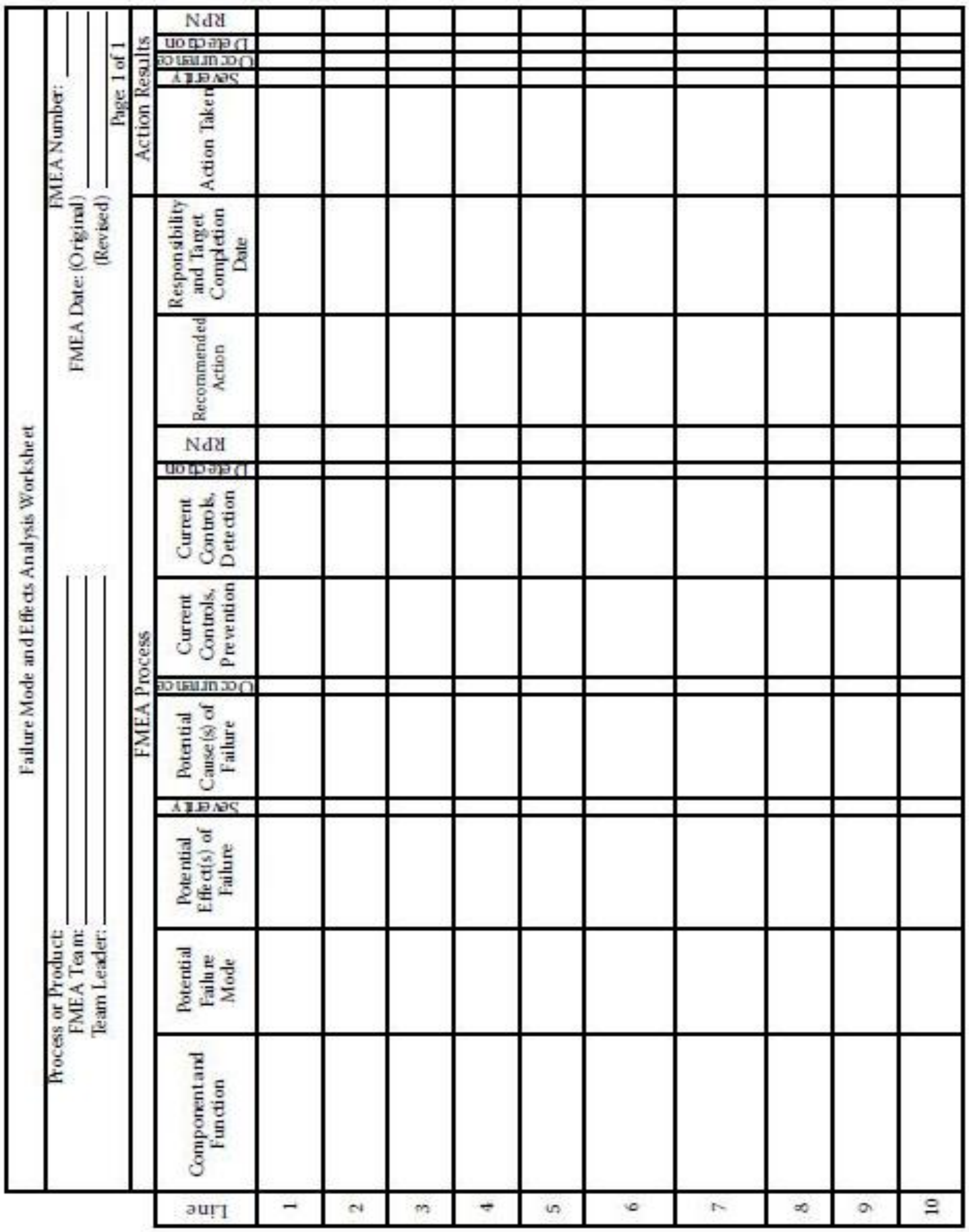
The Monte Carlo process is an effort to create a series of probability distributions for probable risk items, randomly sample these distributions, and then employ a mathematical model to determine the consequent outcomes, typically duration and cost. Repeating this process enables the construction of distributions of the outcomes describing the risks of a real project situation (Zhao, 2005). In the limit, the approach effectively accounts for all possible values and variables in each possible scenario by the likelihood of its occurrence (Vose, 1996). Based on Zhao's (2005) opinion, one of the purposes of this technique is 'to derive quantifiable risk impacts based on probability ranges that are assigned to each variable or risky component'.

Vose (1996) believes that 'algebraic methods have been developed for determining the probability distribution functions of some combination of variables'. He says, since this technique becomes complex very quickly and the equations are often intractable, therefore it can not be considerable as a practical solution. Modern computing power has made Monte Carlo simulation preferable to algebraic methods in most circumstances.

3.6.4 Failure modes and effect analysis (FMEA)

This process is a method used to recognise the known and/or potential failures, their effects and risk within the product or process, it then allows for the mitigation or elimination of them before reaching the customer (Mcdermott, Mikulak and Beauregard, 1996; Stamatis, 2003). FMEA therefore presents a structure for determining causes, effects and relationships in a technical system (Kumamoto and Henley, 1996; Ahmed, Kayis and Amornsawadwatana, 2007). Mcdermott, Mikulak and Beauregard (1996) explain that the risk and effects of failure are determined by three factors: severity, occurrence and detection. They add that a risk priority number is determined for each potential failure mode and effect by multiplying the ranking of these factors. In short, based on Stamatis's (2003) definition a good FMEA should identify known and potential failure modes, recognise the cause and effect of each failure mode, prioritise the identified failure mode and provide corrective action for problems. Based on Mcdermott, Mikulak and Beauregard's (1996) definition 'ways in which a product or process can fail are called failure modes. Each failure mode has a potential effect, and some effects are more likely to occur than others'. Figure 3.7 illustrates a typical blank FMEA worksheet.

FMEA aids manufacturers in avoiding faults, enhancing safety and raising customer satisfaction (Keizer, Vos and Halman, 2005). This method is useful for the analysis of critical processes but is very time consuming if applied on too broad a scale (European federation of chemical engineering, 1985). Mostly, FMEA is performed in the product design or process development steps, but it can be conducted on existing processes and products as well (Keizer, Vos and Halman, 2005). Although Stamatis (2003) says that FMEA is used to identify and eliminate failures from the system, design, process, and/or service; Smith (1999) believes that FMEA is design oriented; it is based on a specific design, so the company cannot start using it until it has a design to analyse (this means much later than the company needs the initial risk assessment).



Failure Mode and Effects Analysis Worksheet

Process or Product: ______
FMEA Team: ______
Team Leader: ______

FMEA Number: ______
FMEA Date: (Original) ______
(Revised) ______
Page: 1 of 1

	FMEA Process												Action Results				
Line	Component and Function	Potential Failure Mode	Potential Effect(s) of Failure	Severity	Potential Cause(s) of Failure	Occurrence	Current Controls, Prevention	Current Controls, Detection	Detection	RPN	Recommended Action	Responsibility and Target Completion Date	Action Taken	Severity	Occurrence	Detection	RPN
1																	
2																	
3																	
4																	
5																	
6																	
7																	
8																	
9																	
10																	

Figure 3.7 - Blank FMEA worksheet (Mcdermott, Mikulak and Beauregard, 1996)

FMEA was developed as a tool for engineering design but can be employed more widely to consider a great range of risks. However, historical FMEA has concentrated on design and it is unlikely to discover marketing or management issues that may be vital to the project but not the design (Smith, 1999; Keizer, Vos and Halman, 2005). It is important to mention that in the ISO 9001, FMEA was recognised as a means to focus on both reduction in failures and continual improvement in several parts of the standard process (Stamatis, 2003).

3.6.5 Fault tree analysis (FTA)

This analysis starts by selecting a top event, then looking at the combination of failures which could cause this event to happen (European federation of chemical engineering, 1985). FTA is a visual method used to break down failure into source events (Birolini, 1993; Kumamoto and Henley, 1996). Therefore, based on Stamatis' (2003) definition, FTA is a model that graphically and logically indicates various combinations of normal and possible faulty events which can occur in a system, thus leading to the top undesired event. FTA is a deductive analytical procedure of reliability and safety analysis, it determines the various combinations of software and hardware failures and human errors that could cause undesired events (Stamatis, 2003; Keizer, Vos and Halman, 2005). Figure 3.8 shows a typical use of this method.

FTA uses event and gate symbols to show cause and effect relationships between failures and the various contributing causes (Stamatis, 2003; Ahmed, Kayis and Amornsawadwatana, 2007). It is a simple technique and helps to determine the probability or a failure event occurring in the project structure, which is characterised in a fault tree (Ahmed, Kayis and Amornsawadwatana, 2007). It is argued that FTA can be used as a risk identification technique or as a risk analysis method (Edwards and Bowen, 2005; Keizer, Vos and Halman, 2005). In order to use FTA for risk analysis, probability must be determined for each of the nodes in the diagram in order to explain the chance attributable to any of these events occurring (Edwards and Bowen, 2005).

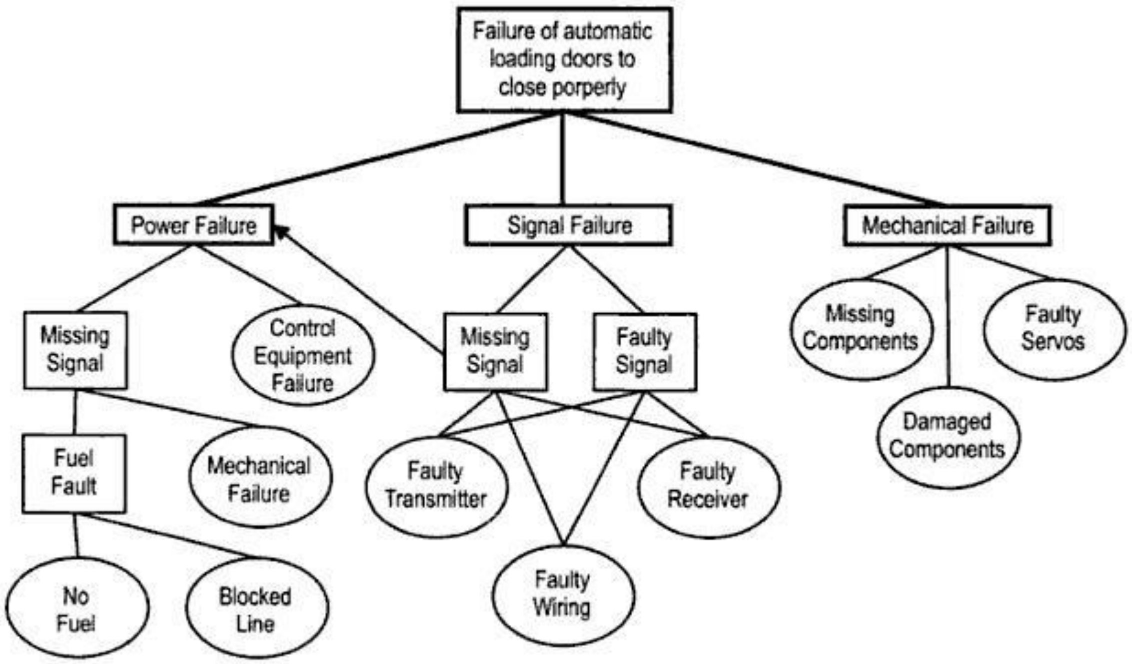


Figure 3.8 - A sample of FTA (Edwards and Bowen, 2005)

Stamatis (2003) believes that 'the fault tree analysis always supplements the failure modes and effect analysis and not the other way around'. Both FTA and FMEA are useful aids in identifying risk as they both structure and document the analysis (European federation of chemical engineering, 1985). Based on Keizer, Vos and Halman's (2005) opinion, since FTA and FMEA primarily focus on potential failures in the technology of the new product, they ignore market and organisational related risks. In addition, this method in project risk analysis is complicated due to the large number of events and gates; however, it could be used in a smaller area to analyse a particular failure (Ahmed, Kayis and Amornsawadwatana, 2007).

3.6.6 Event tree analysis (ETA)

This analysis starts with a selected event, known as the initiating event, and determines how likely a particular event, represented on an event tree, is to happen from this initial event (European federation of chemical engineering, 1985; Ahmed, Kayis and Amornsawadwatana, 2007). It should be noted that ETA is a graphical illustration of potential consequences occurring from a failure where possible consequences are generated and broken down from an initial event (Kumamoto and Henley, 1996). In this analysis, the probability of occurrence of an exact outcome is determined as a result of all probabilities in the related branch (Ahmed, Kayis and Amornsawadwatana, 2007). Figure 3.9 indicates an example of this method for a shipping company using the ferry loading door (Edwards and Bowen, 2005).

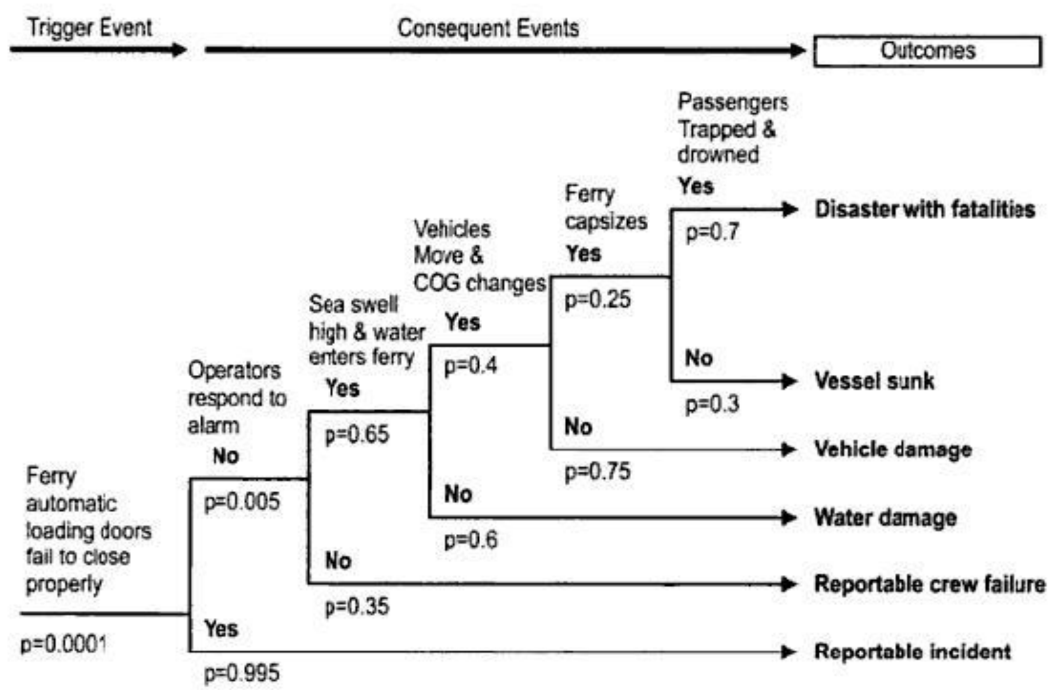


Figure 3.9 - A sample of ETA (Edwards and Bowen, 2005)

Ahmed, Kayis and Amornsawadwatana (2007) believe that project risk analysis application of ETA is similar to FTA and ‘works only on a small zone of influence of potentially damaging consequence arising from a risk event’. In this area Edwards and Bowen (2005) mention that ETA adopts the opposite approach to FTA. It means, inductive logic is used to explore the consequences of an activating event in ETA, while FTA uses deductive logic. The top event can be found by any given event in a FTA as well as the initiating event in an ETA (European federation of chemical engineering, 1985).

3.6.7 Standard risk model

In their book, Smith and Merritt (2002) name the different risk management models: Simple risk model, Cascade risk model, Ishikawa risk model, Standard risk model. They believe that the standard risk model is one of the most helpful in comprehending project risk and its related losses when compared with other models. Since this model integrates a number of concepts of the other models discussed in the earlier sections, it seems reasonable that this model should be explained in more detail based on Smith and Merritt (2002) definition.

As Figure 3.10 indicates, in this method risk is assessed by combining the probability of its occurrence with its consequence. In this model, development of ‘drivers’ for each risk event and its impact play a main role in assessing risk. ‘Drivers’ refer to existing facts in the project environment that can lead to a particular risk event or impact occurring.

This model also captures the essence of resolving risks. For example, referring to the left side of the model, by changing the risk event drivers the probability of the risk event occurring can be reduced. Additionally, this model supports a cause and effect relationship. This means the risk event is the factor which causes the impact and thus its total loss. For effective risk management the company must be proactive in terms of preventing risk. They must remove the cause (the risk event) so the effect (the impact) will not occur.

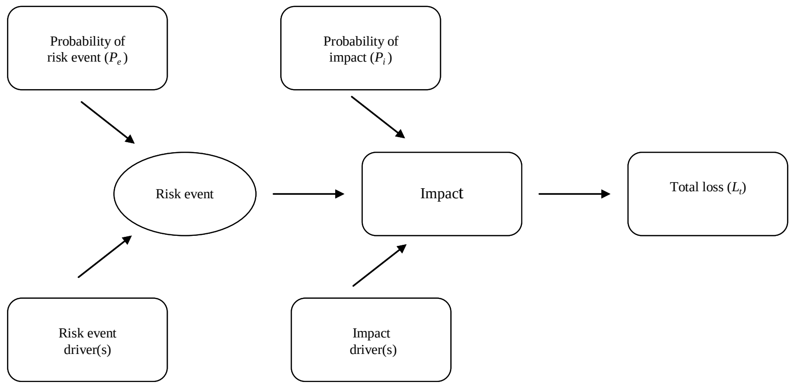


Figure 3.10 - Standard Risk Model (Smith and Merritt, 2002)

As discussed before the risks have to be prioritised as only limited resources are available. Expected loss is a major criterion for this as it assesses the damage that can happen in a project by each risk. In order to compare risks, all expected losses should be measured in the same units (e.g. days of delay or specific financial units). As Figure 3.11 portrays, expected losses can be calculated with this formula.

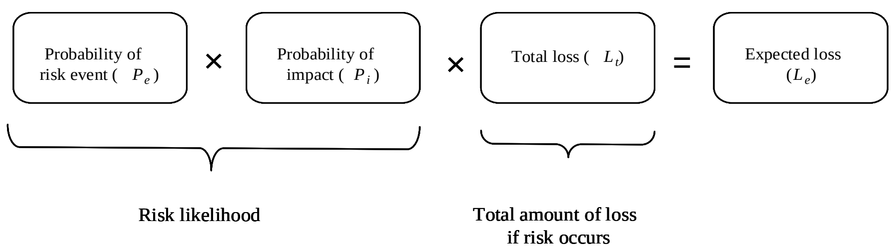


Figure 3.11 - Formula for calculating expected loss from its components (Smith and Merritt, 2002)

Expected loss is just one measure. Sometimes decisions may be made on the basis of other measurements, such as expected utility or expected value (which will be explained in Section 3.6.8). If only expected loss is implied, a risk that has a very high value of total loss but a low likelihood of occurrence might be missed (using a risk map beside these criteria can help solve this weakness). Also, in some cases the decision might be based upon the probability that the critical measurements are greater than the threshold (e.g. probability of internal rate of return (IRR) greater than the specified target).

3.6.8 Decision analysis

Edwards and Bowen (2005) argue that expected utility (EU) and expected monetary value (EMV) are other risk analysis techniques which can be used either objectively or subjectively, according to the circumstances. They mention that the expected utility technique originates in decision science, and is the product of impact and probability. For instance, in this area French and French (1997) state that three main methods of decision making under uncertainty are: expected utility theory (EU), stochastic dominance (SD) and mean variance analysis (MV) which deal with quantitative assessments of risk. Since these techniques are related to the concept of decision science, it seems useful to briefly explain the definition of decision analysis and some of the techniques which can be used for risk analysis in greater detail.

Decision analysis can incorporate a number of different forms of analysis (e.g. multi-criteria decision making or MCDM; see Sadiq and Khan, 2006). Therefore, it can be said that decision analysis provides a discipline to help decision makers operating under conditions of uncertainty; the quality of this decision has an impact on the schedule, cost and performance (Schuyler, 1996). Decision analysis can be used to find the best strategy when a decision maker is faced with several alternatives and risky future events (Anderson, Sweeney and Williams, 1998). Decision analysis presents a consistent, logical way to incorporate judgements about uncertainties and risks into an analysis; therefore these methods represent the best movement towards reliable project decisions when uncertainty is significant (Schuyler, 1996). It is useful to remember that based on French and

Geldermann's (2005) definition, the three phases of the decision analysis cycle are: problem formulation, evaluation of options, and review of the decision models.

According to Edwards and Bowen (2005) expression, EU technique could be applicable when the indirect and direct financial impact of risk events are difficult to predict. They define utility, in this case, as 'measure of the loss of worth, or loss of usefulness, to the risk taker if the risk event should happen'. In this area French and French (1997) believe that EU theory is the fundamental principle of economic behaviour in uncertain situations. However, they emphasise that the measurement of risks involved in alternative decisions is not the main issue for EU theory; EU theory instead focuses on the decision maker's attitude toward risk (French and French, 1997). Expected monetary value is a financial version of EU, and exists in conditions where logically exact estimates of various possible financial outcomes can be found, as well as the likelihood associated with their occurrence (Edwards and Bowen, 2005).

It seems that explaining the role of the decision tree can be useful here. A decision tree gives a graphical illustration of the process of decision making (Anderson, Sweeney and Williams, 1998). It can be said that decision tree is used to structure a process of decision and assess outcomes from uncertain events (Clemen, 1996; Taha, 1997; Russell and Taylor, 2000). For instance, in deducing the expected monetary value using decision trees, chance nodes and decision nodes are depicted graphically and interim expected monetary values are attached to each nodes; EMV is then used to compare the expected returns for each options and that offering the maximum returns is chosen (Clemen, 1996; Russell and Taylor, 2000). In short, as Ahmed, Kayis and Amornsawadwatana (2007) argue, decision tree analysis incorporates the likelihood of returns related to decisions and estimation of expected returns.

3.7 Risk Management Actions

As examined in Section 3.4 (Figure 3.3), this phase is the third phase of the risk management system. Any risk event above the threshold line should receive active risk management, which means that the company creates a proper plan to manage that risk (Smith, 1999). For instance, Zhao (2005) believes that risks with a 50% likelihood of occurrence and substantial impact should be analysed before placing them into trends (the threshold will vary with the context, e.g. industry). Lam *et al*. (2007) mention that risk response is the process of formulating a management strategy which then leads to the recognition of action owners and the risk action plan. Smith and Merritt (2002) also emphasise that in this phase the company should create an action plan for each risk that they have decided to manage. They believe that this plan should be specified: objective, means of measuring when the objective has been found, responsible individual, completion date and sufficient resources allocated to complete the risk.

Note that risks are normally quite diverse; consequently each risk requires a customised plan that will address it most effectively (Smith, 1999). Also, as Ahmed, Kayis and Amornsawadwatana (2007) believe, risk action plans can be determined based on past experiences, best practices, lessons learnt, organisational knowledge, standard practices and industry benchmarks. In addition, the company must be cautious in how to apportion risk in the project. It is in this area that Reinertsen and Smith (1998) believe that is ‘best to concentrate risk in a few known areas where the company can watch it especially carefully’.

Many studies have mentioned the various types of action which deal with risks (e.g. see: Halman and Keizer, 1994; Kartman and Kartman, 2001; Pyra and Trask, 2002; Smith and Merritt, 2002; Zhao, 2005). By considering these studies it seems that most of the risk actions for identified risk can be categorised into five different response styles. These are:

- Acceptance: The company decide to do nothing about the risk, accept the risk and deal with its consequences (Smith and Merritt, 2002; Pyra and Trask, 2002).
- Avoidance: Recognising the risk and re-planning to remove it (Turner, 1993). This means the company avoids the risk by removing its specific causes (Pyra and Trask, 2002).
- Transfer: This action is part of the process of apportioning risk in the most appropriate manner. For instance, Smith and Merritt (2002) say that the company uses this action when it recognises that it does not have enough experience to introduce a new technology in a new product. Some companies may try to transfer risk even when it is not appropriate; it may suit the individual company objectives but not the project as a whole.
- Redundancy: This action comes into play when the company uses a parallel solution paths to improve the probability that an effective solution will emerge (Smith and Merritt, 2002). For instance, if the company is concerned that a new custom part will not meet specifications, in this situation it may decide to have more than one supplier developing the part.
- Mitigation: Reducing risk probability or reducing risk impact (Ahmed, Kayis and Amornsawadwatana, 2007).

Since Smith and Merritt (2002) emphasise that mitigating actions are the most powerful type of action[1], they will be explained in the following paragraph in greater detail. Based on Zhao's (2005) opinion, any one of these actions has the potential to cause extra cost. For this reason, decisions regarding risk response choices are seldom simple (Edwards and Bowen, 2005). Moreover when responding to risks any combination of these actions is also possible (Kartam and Kartam, 2001).

Risk mitigation plans consist of two activities: actions for reducing the likelihood of the risk occurring and contingency plans which reduce the consequences of the risk if it does occur (Williams, 1994). Therefore, a reactive approach refers to risk mitigation actions started after risk events occur and can be seen as a contingency plan. On the other hand, a proactive approach refers to actions started based on the chance of a risk event happening (De Maio, Verganti and Corso, 1994; Kartam and Kartam, 2001). Therefore, it can be said that in proactive risk management the company works on reducing the probability of occurrence throughout the project (Smith, 1999). In other words, deterring the risk event by changing their risk event drivers (Smith and Merritt, 2002). But it should be noted that in proactive risk management the risk is still there and the company does not attempt to remove all risks, the company can only keep them under control and manage them by reducing the likelihood that they will affect the company (Smith, 1999).

3.8 Monitoring and Controlling

This is the last phase of the risk management system (see Section 3.4, Figure 3.3). In this phase, there is a regular review of the action plans to ensure that they remain effective and make the desired progress (Smith and Merritt, 2002). Therefore, monitoring and

[1] It seems reasonable in compare with other actions.

controlling allows updates of the recognised risks and the addition of new ones as they are identified (Edwards and Bowen, 2005). It can be said that after prioritising the risk factors and defining plans for managing them, managing risk involves ongoing work on each of the plans, as well as keeping risk priorities up to date (Smith, 1999). In this area, Pyra and Trask (2002) argue that ‘similarly, the priority of identified risks could be adjusted, progress or problems with the existing mitigation strategies for each risk could be taken into account, and the strategies themselves could be updated’. Sveral types of process for monitoring the progress can be used; these are: checking expenditures relative to the budget, considering progress on tasks relative to schedule, checking expected loss (if the action plans are working this should be declining), and assuring that deliverables are acceptable (Smith, 1999; Smith and Merritt, 2002).

A number of studies has examined steps for monitoring and controlling, so it can be said that generally the following steps can be considered for this purpose (e.g. see: Turner, 1993; Smith, 1999; Smith and Merritt, 2002).

- Monitoring the progress against the risk events which are under active management.
- Stopping the action plans for those risks that have moved below the threshold line.
- Reassessing risks at regular periods, at key landmarks or stage transition. Also identifying any new risks that have arisen during progress (since the environment of the project changes continually, potentially revealing new risks that have not been observed before).
- Taking action plans to overcome any risks now appearing above the threshold line.

Product development could be described as a process of learning, and the company can gain valuable knowledge through in experiments (Smith, 1999). Edwards and Bowen

(2005) mention that 'planning and rehearing disaster recovery procedures, using information gathered from real life project risk experiences, can contribute enormous value and capacity to an organisation's risk management capability'. Therefore, they believe that the benefits of learning from the experience of failure will frequently go beyond those derived from repository of success. It can be said that failure provides valuable knowledge that then aids the company in developing products quicker, and consequently should not be avoided (Smith, 1999).

3.9 Risk Management in the Innovation Project

One key characteristic of innovation will always be risk (Taplin and Schymyck, 2005). A innovation will be perceived as "risky" if: Uncertainty is high; Controllability is low and Relative importance is high (Keizer and Halman, 2007). Smith (1999) believes that 'as product development cycles shrink, and as the products themselves grow more complex, managing risk in a product development project becomes increasingly critical'. In this regard, Section 3.9.1 summarises the literature explicitly considering risk and innovation and Section 3.9.2 describes an initial integrated theoretical model offering a combined model of risk and innovation management.

3.9.1 Risk and innovation

Traditionally, the process of innovation has been seen as linear, consisting of distinct stages such as: basic research, applied research, product development, production, marketing and diffusion (Berglund, 2007). Frequently, this model is criticised for being overly deterministic and simplistic. Hence, more complex models have been introduced that highlight feedback loops between stages, downplay the role of basic science and emphasise interplay with external actors (e.g. Kline and Rosenberg, 1986). This means that the risks of innovation, which are perceived by corporate management, should be related to: recognising and managing partners, suppliers and other sources of inputs, risks of distribution and delivery, risks inherent in the relevant internal transformation processes and consumption risks regarding, e.g., output markets and ways to package the offer (Berglund, 2007).

Halman and Keizer (1994) state that various techniques for managing project risk have been developed over time such as FMEA, FTA. Although there is a valuable literature on risk behaviour, risk perception and risk taking tendencies; an accepted model of strategic risk taking which identifies the contextual interaction among organisational processes, decision makers, market and industry factors that influence judgments of risk and strategic risk taking is still lacking (Ruefli, Collins and Lacugna, 1999). In addition, while many innovation management studies show that innovation is hazardous, they also show that a practical measurement of risk in product innovation is lacking (Keizer and Halman, 2007). In regards to this area, Smith (1999) believes that the time taken to market a product is vital for many projects therefore risk management is more difficult in speedy projects as less time is available to respond to anything that goes wrong; techniques which worked before may no longer be sufficient as production schedules accelerate at such a rapid rate. Keizer, Halman and Song (2002) mention that many researchers in the last 30 years have recognised critical success factors in product innovation. They believe an effective risk assessment procedure should draw on this knowledge; however, to recognise the risks in a particular product innovation project, one must go beyond these generic factors and also recognise context specific ones.

One of the methods defined for managing risk in innovation projects is RDM, Risk Diagnosis Methodology (Halman and Keizer, 1994). This method presents strategies that can improve the likelihood of a project's success by recognising and managing possible risks. RDM is applied at the end of the feasibility phase; it should indicate issues such as consumer and trade acceptance, competitive reactions, commercial viability, external influential responses, manufacturability and human resource implications (Keizer, Halman and Song, 2002). This model includes several different steps: Risk identification, Risk assessment, Risk response development and control.

A significant feature of this approach is that in order to prevent negative effects from group sessions the members of the risk team are individually interviewed in order to identify potential risk factors (Halman and Keizer, 1994). In its risk diagnosis methodology, each interviewee is asked to reflect on the project as a whole as well as its component parts and to identify issues that might jeopardise the project. Participants are asked to prepare for the interview by studying a company specific risk reference list as well as their own project plan. This interview outline is deliberately chosen in order to prevent "shooting from the hip" brainstorming sessions in which people only record what they think of spontaneously (Keizer and Halman, 2007). In RDM the assumption is made that the impact of a risk not only depends on the probability of its occurrence and the impact, if it does occur, but also on the ability or the inability to influence the situation (Halman and Keizer, 1994). A factor which should be considered for applying the RDM is related to the amount of time required. This means that the time investment required must be considered in relation to the complexity, innovativeness and importance of the project (Halman and Keizer, 1994).

3.9.2 Developing an integrated theoretical model

Although some models for analysing risk have been introduced in various studies, there is relatively little literature that examines the specific issue of integrating risk management into the innovation process. This is suggestive of the fact that more investigation is needed to cover this purpose and this thesis attempts to address this gap. In Section 2.6 a core model based on innovation management literature was shown in Figure 2.7. Now this model is expanded to include the particularly relevant ideas from risk management which were discussed in Section 3.4 and illustrated in Figure 3.12.

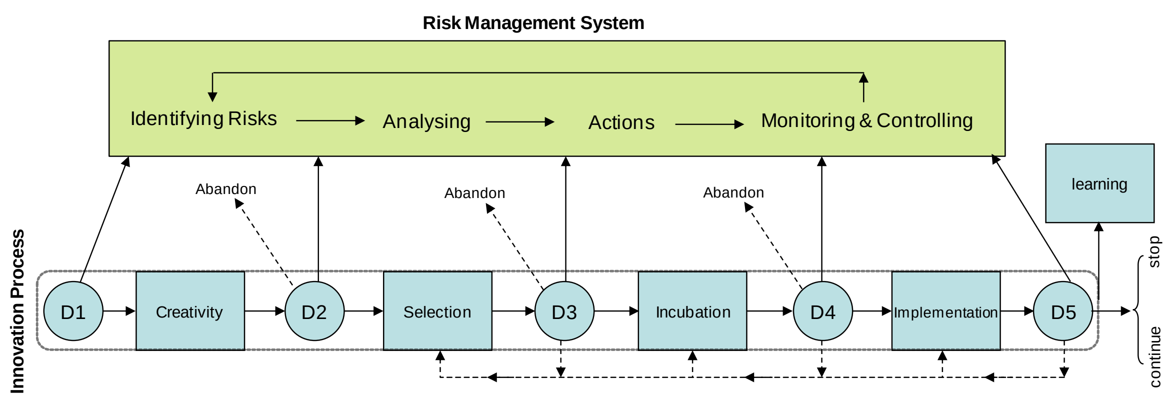


Figure 3.12 - Initial theoretical model

Figure 3.12 indicates that the core of the initial theoretical model offers a combined model of risk and innovation management. This model should be checked in a practical situation, however before that occurs it will be tested and refined by using two literature-based cases in Section 3.10. The model will also be developed from this core by incorporating more detail. Based on discussions in Section 2.6 each stage of the innovation process includes an information gathering activity (e.g. the rectangle ‘selection’) followed by a decision. This information then enables decisions at the following decision point. Suitable information for these decision points and details of each phase of the risk management system, based on the literature review, will be examined in Figure 3.13, after refining the initial theoretical model based on literature-base case studies.

3.10 Refining the Theoretical Model

Many literature case studies do not provide enough detailed information, but the two selected cases[2] in innovation and risk management provide sufficient detail to help test and refine the initial theoretical model developed in Sections 3.9.2. In this section, the initial theoretical model is tested and refined incorporating more detail through a comparison with the experience described in literature case studies, resulting in the model illustrated in Figure 3.13. Therefore in the following, the major features of these two case studies are compared to the initial theoretical model. This comparison considers the following issues:

- The stages of the innovation process
- Decision points
- Use of risk management

The general stages of the innovation process in the initial theoretical model are very similar to those observed in case 1 (HP) and case 2 (3M). Although some criteria were mentioned (e.g. case 1) in order to select the idea and progress to next stage, however no further information was found about the type of meetings and whether they were formal decision points or not.

The case studies provide little detail confirming the existence of distinct decision points: neither case study provides information about decision point 2 and this could imply that creativity and selection takes place in one stage. Therefore, as Figure 3.13 indicates, decision point 2 is shown by a broken line in comparison with other decision points in the

[2] The two literature cases (HP, 3M) are summarised in in Appendix 7

initial theoretical model (Figure 3.12). This issue needs to be tested in empirical cases study as well.

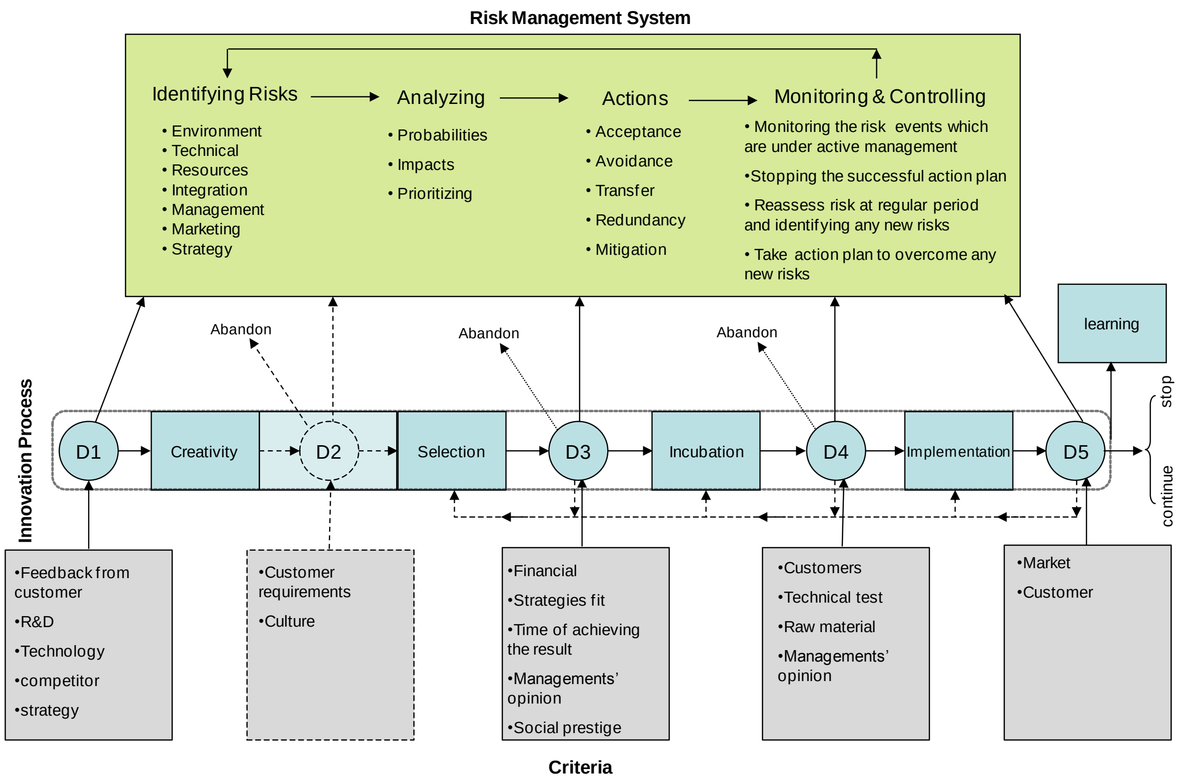


Figure 3.13 - Refined theoretical model based on literature case studies

Learning is fundamental for case 1 (HP): failure is viewed as an opportunity to learn and is recognised as an important source for improvement in future projects. This feature (learning) of the theoretical model is supported by case 1. Also, Figure 2.8 showed that the output of one project can often be a useful input for the next project. In this regard, case 1 illustrates this issue as it believes that failing is an important source for improvement in future projects of the company.

As noted in Section 2.5.1, one major criticism of Cooper's (1990) stage-gate model (Figure 2.1), is that it focuses too heavily upon process factors as it was designed only to deal with technical, not business, risks. There are some business risks in the two literature case studies. For instance, in case 1 (HP) the company lost its first major potential customer in the third month of production, or in case 2 (3M) factors such as management and market are business risks. Therefore, the proposed model addresses this criticism by considering various success factors at each decision point, including business factors. In terms of criteria at each decision point, although most literature did not consider these factors exactly at each decision point, a number of these criteria which were discussed in the literature and also criteria which were mentioned in these two cases, are shown in Figure 3.13. In fact Figure 3.13 is a refined model of Figure 3.12.

In terms of a risk management system, it seems that most of the factors which create risk in case 1 and case 2 during the innovation project can be classified using categorisation which was discussed in Section 3.3. Although no further information was identified regarding the analysis phases of the risk management system, case 2 employs the hurdle rate in order to consider and evaluate the innovation. In one action plan in order to reduce the probable risk of investment for new technology, case 1 used outsourcing (transferring to a third party). Although as mentioned, it seems that learning is an important activity for case 1, however no further information was found regarding the importance and methods of monitoring in the risk management system in case 1 and case 2.

In summary, it can be said that literature case studies helped develop some of the detail of Figure 3.13 (such as various criteria in different decision point, risk factors), but the basic components of the model as illustrated in Figure 3.12 were confirmed by these two cases.

3.11 Measuring Success in Innovation

One of the important issues is how company can measure the success of their innovation based on this model compared with when this model was not employed. Although measuring the success of innovation project is out of the scope of this study, however brief explanation of this issue could be useful for further analysis.

The concept of product development success has many dimensions and each may be measured in a variety of ways (Griffin and Page, 1993). Thus a firm can assess the success or failure of a development project in any of many terms. Griffin (1997) claims that success firms appear to be more efficient in weeding out less probable projects earlier in the process and developing products in less time.Table 3.3 indicates the different criteria for measuring the success of innovation based on different categories.

Table 3.3 - Criteria for measuring the success of innovation

Author(s)		Criteria
Page (1993)	Financial	Return on investment; Various profit margin measures; Sales and sale growth; Various profit measures; Payback and payback period; Internal rate of return; ROA, ROE, and ROCE; Share and market share; Return on sales; Net present value; Other financial measures
	Nonfinancial	Sale performance of new products; Market share achieved; Satisfy customer needs; Other marketing-related benefits; Strategic issues/fit/synergy; Technical aspect/performance; Uniqueness of the new products; Other nonfinancial factors
Griffin and Page (1993)	Companies	Customer Measures (Market Share; Volume; Customer Acceptance; Customer Satisfaction) and Financial Measures (Margin Level)
	Researcher	Firm-Level Measures (% of Sales for New Products; Success/Failure Rate) and Product-Related (Performance; Speed to Market; Completed in Budget; Subjectively "successful"; Technically successful)
Griffin and Page (1996)	Project-level	Customer based success; Financial success; Technical performance success
	Firm-level	Development program ROI; New products fit business strategy; Success/failure rate; % profit from new products; % sale from new products; Program hit 5-year objectives; Products lead to future opportunities; overall program success; % Sale under patent protection; % profit under patent protection

Page (1993) discusses different criteria based on financial and nonfinancial categories. Griffin and Page (1996) believe that success may be measured not only at the level of the individual project, but also at the firm level. Also based on Griffin and Page’ s opinion

(1993) academics and managers tend to focus on rather different sets of product development success/failure measures. Academics tend to investigate product development performance at the firm level, whereas managers currently measure, and indicate that they want to understand more completely, individual product success. With so many variables to consider and so many stakeholders involved, managers face a difficult challenge deciding which measures are useful for measuring product development success (Griffin and Page, 1996).

3.12 Conclusion

The success rate of innovation projects is still low and they are one of the riskiest activities in business. Identifying and managing risk has become an increasingly important subject in innovation literature. It seems that although some models for managing risk have been introduced by various studies, there is little literature that examines the specific issue of integrating project risk management into the innovation process. This suggests that more investigation is needed and this thesis attempts to address this gap. Thus as discussed in Section 1.4, the main question that shaped this study is: “How can risk management fit into the innovation project in an explicit way to manage innovation in a better way?”

It seems that the theoretical model which was examined in Section 3.10 is an appropriate model for combining theoretical knowledge about innovation and risk management in order to manage innovation in a better way. This model was based on different theories and knowledge discussed in Chapter 2 and Chapter 3. In addition, two literature case studies were used in order to refine and support the first theoretical model. In order to specify a model for this purpose, different stages of innovation were described in Chapter 2 to find common stages which can be used to make a general innovation management process that can then be integrated within the proper stages of the risk management system. In this chapter by surveying the literature about the phases, which are mentioned in relation to the risk management system, four common phases are selected. In addition, various methods for identifying and analysing risk factors, actions for managing the risk and activities for monitoring and controlling them were discussed, leading to an initial theoretical model integrating risk and innovation management.

Chapter 4 Research Methodology

This chapter describes the methodologies employed in this research, the logic behind them and their application in this research. The remainder of this chapter is organised as follows. Firstly, Section 4.1 describes the philosophy, approach and purpose of this research which underpinned the research strategy and the methods selected as part of that strategy. Section 4.2 explains how the case study was selected as a suitable research strategy for consideration. Next, in Section 4.3, the type of required data, method of gathering, process of sampling and pilot testing will be discussed. In the Quality of Research Design section, the quality of this research will be assessed in regards to different issues; such as Validity, Generalisability, Reliability and Bias. Finally, this chapter proceeds to discuss how the data is analysed according to qualitative approaches in Section 4.5.

4.1 Research Philosophies, Approaches and Purposes

The research philosophy reflects significant assumptions about the way in which the researcher views the world. These assumptions will underpin the research strategy and the methods selected as part of that strategy (Saunders, Lewis and Thornhill, 2007). Two main ways of thinking about research philosophy are: Epistemology and Ontology.

Various studies have considered the definition of different aspects of research philosophy (e.g. see: Smith, 1991; May, 2001; Robson, 2002; Silverman, 2005; Neuman, 2006; Bryman and Bell, 2007; Saunders, Lewis and Thornhill, 2007). In general, 'a particular issue in epistemology is the question of whether or not the social world can and should be studied according to the same principle as the Natural Science World' (Bryman and Bell, 2007). There are different points of view in the field of epistemology, which are: positivism, realism, and interpretivism. Saunders, Lewis and Thornhill (2007) believe the reality is that research seldom falls exactly into only one philosophical area; so business and management research is frequently a combination of positivist and interpretivist epistemology. Therefore this research's point of view is a mixture between positivism and interpretivism. How does this point of view have an effect on this research? As will be discussed later, this research combines both an inductive and deductive approach. This indicates that, on one hand, the research has a positivist point of view as it is attempting to deduce a model from current theory and literature and wants to test it in empirical case studies. On the other hand, this research also employs interviews to gather qualitative data (see Section 4.3), which mirrors the interpretivism view.

Two aspects of ontology are: objectivism and subjectivism; 'objectivism portrays the position that social entities exist in reality external to social actors concerned with their existence; while the subjectivism holds that social phenomena are created from the perceptions and consequent actions of those social actors concern with their existence' (Saunders, Lewis and Thornhill, 2007). This study had a subjectivist view since it believes that the perception and characteristics of interviewees may have an effect on their responses (for example, some employees may feel obliged to claim to follow company policy; even though in practice it may be quite different). For this reason, different people were interviewed in each organisation rather than relying on one person's perspective in order to have more reliable data.

When a researcher begins with a clear scope of the theory involved in his/her research, it will have an effect on the sketching of the research design (Saunders, Lewis and Thornhill, 2007). Therefore considering the role of theory is important before beginning any research. In some research, theory guides and influences the collection and analysis of data (deductive approach); but an alternative position (inductive approach) views theory as something that arises after the collection and analysis of the data (Bryman and Bell, 2007). In other words, in a deductive approach, theorising comes before research, research then produces empirical evidence in order to test these theories; in an inductive approach, research comes before theory and the researcher looks to discover a theoretical proposition (May, 2001). In a deductive approach, the researcher, on the basis of what is known about a particular area and theoretical considerations in relation to that area, deduces a hypothesis(es) that must then be subjected to empirical study (Bryman and Bell, 2007). While the quantitative experimental approach is largely hypothetical deductive and qualitative approach is largely inductive, a study can include elements of both strategies (Patton, 2002). Saunders, Lewis and Thornhill (2007) believe that not only is it possible to mix induction and deduction within the same piece of research, but also it is frequently advantageous to do so.

As Figure 4.1 shows, this research adopts a mixed approach: deducing a model from the theory and literature on the risk management system and the innovation project process. This theoretical model should be tested in different cases by using empirical evidence in order to provide recommendations and further refinement to the prior theoretical model. In addition, it will collect more information which will, in turn, lead to a more detailed model help to develop an understanding. Since theories in the field of this research usually come from developed countries, such as the USA and UK, the researcher could assume that it would be possible for the theoretical model to not to work for Iranian cases and fail after the first empirical case study. In order to solve this situation, besides the research process which is shown in Figure 4.1, this research put in place a contingency plan. In different and unexpected situations, the research will use a completely inductive approach and employ grounded theory. If the situation of innovation and risk is different from the first model, it is then possible to improve the current situation based upon the grounded model.

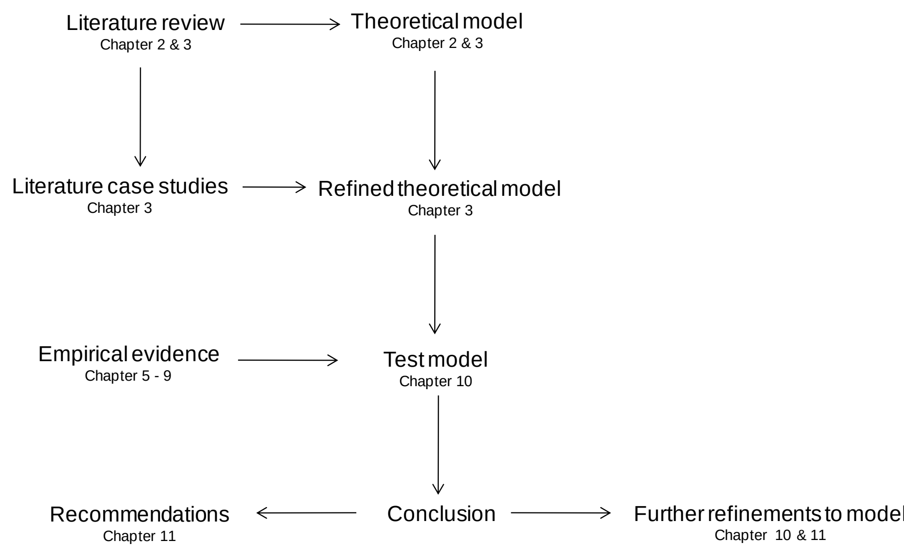


Figure 4.1 - The process of this research

The last issue in this section considers the purpose of research. There are three purposes for any research: exploratory, explanatory and descriptive. Research projects may have more than one purpose (Saunders, Lewis and Thornhill, 2007). Also, the purpose of the research may change over time (Robson, 2002). So, it is possible to apply multiple strategies in any study (Yin, 2003).

An exploratory study is a valuable means of finding out 'what is happening; to seek new insight; to ask questions and to assess phenomena in a new light' (Robson, 2002). In this type of research, the researcher must be willing to change his/her methods as a result of data that emerges and insights that occur (Saunders, Lewis and Thornhill, 2007). Adams and Schvaneveldt (1985) support this point by arguing that the flexibility intrinsic in exploratory research does not mean an absence of direction in the enquiry. What it does mean is that the focus is at first broad and becomes progressively narrower as the research progresses. Another purpose of research is explanatory. Studies that establish causal relationships between variables may be deemed explanatory studies. The emphasis here is on studying a condition or a problem in order to clarify the relationships between variables (Saunders, Lewis and Thornhill, 2007). The third purpose of research is descriptive. Robson (2002) says that the object of descriptive research is ‘to portray an accurate profile of persons, events or situations’. This may be an extension of a piece of exploratory research or a piece of explanatory research (Saunders, Lewis and Thornhill, 2007).

By considering these definitions regarding the purpose of research, it seems that the purpose of this research is explanatory and exploratory. As will be discussed in Section 4.2.2, the main question of this study is, how does risk management fit into the innovation process in an explicit way. Therefore, this study commences research (as Figure 4.1 indicates) by deducing a model from theory and literature (see Section 4.2.3) in order to examine this model in empirical case studies. In this situation the focus is explanatory. From another point of view, this research wants to understand what is happening and seek out new insights about the details of the different stages of the theoretical model; therefore the focus of this part of the research is exploratory. Case study strategy contributes to both theory-testing and theory-building (e.g. see: Eisenhardt and Graebner, 2007). Therefore empirical case studies have been used for explanatory and exploratory purpose of this research. It means that these cases help to test the theoretical model and also help to develop it.

4.2 Selecting the Research Strategy

Many social scientists believe that case studies are only suitable for use in exploratory study; surveys only appropriate for descriptive study, and experiments are the only method of explanatory study or causal inquiry (Yin, 2003). Saunders, Lewis and Thornhill (2007) emphasise that no research strategy is naturally superior or inferior to any other. Yin (2003) believes that all research strategies can be applied for all research purposes of research. Consequently, what is most important is whether the research strategy will enable researchers to achieve an answer to their research question(s) and meet their objectives (Saunders, Lewis and Thornhill, 2007). These conditions differentiate strategies: the type of research question(s), the extend of control a researcher has over actual behavioural events, the degree of focus on contemporary or historical events, the amount of available time and other resources (Yin, 2003; Saunders, Lewis and Thornhill, 2007).

The main way of distinguishing the various research strategies is to recognise the type of research question being asked (Yin, 2003). Brown (1998) believes that defining the research question is the most important phase undertaken in any research study as it provides necessary information regarding use of the appropriate research tool. A basic classification format for the various types of question is the common series: 'who,' 'what,' 'where,' 'how,' and 'why'. Yin (2003) says that 'why' and 'how' questions are explanatory and will probably to lead to the employment of case studies and experiments as the preferred research strategies. This is because such questions deal with operational links that need to be traced over time, rather than mere frequencies or incidence. Also, he adds that the "what" questions may be exploratory or regarding prevalence.

Several research strategies exist for management studies. It can be said that the most common ones are: Case study, Experiment, Survey and Action research (Robson, 2002; Yin, 2003; Saunders, Lewis and Thornhill, 2007). These strategies are briefly explained here; the research strategy for this study is considered in more detail in Section 4.2.1.

The case study strategy is useful as it allows for a rich understanding of the context of the research and the process being enacted (Saunders, Lewis and Thornhill, 2007). The case study strategy should not be confused with "qualitative research". Case studies can be based on any combination of qualitative and quantitative study (Yin, 2003). The case study strategy has the ability to answer the question ‘why’, as well as ‘what’ and ‘how’ (Robson, 2002; Saunders, Lewis and Thornhill, 2007). For this reason, the case study strategy is most frequently used in exploratory and explanatory research. A case study examines contemporary events and it will have little control on behavioural events (Yin, 2003).

The reason for conducting an experiment is to study causal links; whether a change in one independent variable produces a change in another dependent variable (Hakim, 2000). Therefore, experiments tend to be used in explanatory and exploratory research to answer the ‘why’ and ‘how’ questions (Saunders, Lewis and Thornhill, 2007). However, in comparison with case studies, experiments are undertaken when a researcher can manipulate behaviour directly and systematically (Yin, 2003).

The survey strategy is typically associated with the deductive approach. It is often used to answer questions like ‘who’, ‘what’, ‘where’, ‘how much’ and ‘how many’. Thus it tends to be used for descriptive and exploratory research (Saunders, Lewis and Thornhill, 2007). The methods employed in surveys include interviews and questionnaires (Robson, 2002).

A survey may be too static to capture the variation of organisational activity, particularly where it changes quickly (Cassell and Symon, 1994).

Action research differs from other research strategies since it explicitly focuses on action, particularly promoting change within the organisation (Saunders, Lewis and Thornhill, 2007). Therefore the purpose of the research is: research in action rather than research about action (Coghlan and Brannick, 2005). For example, ‘the research is concerned with the resolution of organisational issues such as the implications of change together with those who experience the issues directly’ (Saunders, Lewis and Thornhill, 2007).

In this section, the characteristics of various types of research strategy were examined. Which of these strategies is appropriate for this study? The strategy chosen to carry out this research has been determined by considering the following factors: First of all - research purpose - as discussed in Section 4.1, the purpose of this research is exploratory and explanatory. Secondly – the type of research question - by considering the research question it seems that the main question this research asks is related to ‘how’ (see Section 4.2.2 for greater detail). Finally - the availability and opportunity to access data and the amount of control over events - this research does not have a lot of control over behavioural events, also there is some difficulty in access to data (see Section 4.3.3 for more detail). By considering these factors, it seems that the case study is a suitable research strategy for this study. Therefore, in the next section (4.2.1) the advantages and characteristics of case study will be explained in greater detail.

4.2.1 Case study

One of the main research strategies is case study. Case study is neither a data collection method or a design feature, but it is a comprehensive research strategy (Yin, 2003).

Robson (2002) defines case study as ‘a strategy for doing research which involves an empirical investigation of a particular contemporary phenomenon within its real life context using multiple sources of evidence’. Researchers would employ the case study method, as he/she wants to cover contextual situations that might be relevant to his/her phenomenon of study (Yin, 2003). Case studies have been extensively employed in studies of organisational behaviour, particularly in understanding organisational change and innovation, as formed by both the external environment and internal forces (Cassell and Symon, 1994). Saunders, Lewis and Thornhill (2007) indicate that a case study strategy can be a very valuable way of exploring existing theory (see purpose of this study, which is mentioned in Section 4.1). Based on a technical definition, a case study is empirical research that considers a contemporary phenomenon inside its real-life context, particularly when the boundaries between context and phenomenon are not clearly evident (Yin, 2003). Woodside and Wilson (2003) believe that case study research focuses on understanding, describing, predicting, and/or controlling the individual (i.e. process, animal, person, household, organisation, group, industry, culture, or nationality). Based on their definition of case study, which is wider than Yin’s definition, case study research is not limited to real-life contexts or contemporary phenomenon, particularly when boundaries between phenomenon and context are not clearly evident. Cassell and Symon (1994) believe that the main feature of the case study approach is not method or data but an emphasis on understanding processes as they occur within their context (this research also has the similar aim). Indeed, the case study as a research vehicle is a means through which to accomplish a detailed examination of a situation or event (or a series of these) which the researcher believes exhibits the operation of some identified general theoretical principles (Brown, 1998).

These characteristics and advantages of case study suggest that this kind of research strategy suits the purpose of this study and will help achieve an answer in this research. In the meantime, there are some criticisms about the case study method, particularly generalisability, which will be discussed in greater detail in Section 4.4.

4.2.2 Research questions

Defining the research questions is one of the most important steps when undertaking research (Lewis, 2003). Based on this question(s), the researcher can select a research strategy and way of research. Research questions need to meet a number of requirements, for instance they should be clear, focused, feasible, relevant and useful (Lewis, 2003).

As discussed in Section 4.1, based on the positivism point of view, this research aims to deduce a model from the theory and literature, and this model will then be tested in some empirical case studies. On the other hand, since one of the purposes of this study is exploratory (see Section 4.1), this study was started with some prior knowledge and related questions. However after collecting data and improving understanding, the research questions and theoretical model were refined slightly.

The research questions of this study come from a gap in the knowledge and understanding of possible practical needs. Some months before starting to form questions and the theoretical model, the researcher had the chance to have meetings with different academic and industrial experts in order to gather their opinions regarding the topic of research and any relevant issues surrounding the study. These opinions helped improve the researchers understanding of practical needs. Besides these opportunities, the researcher has had some practical experience in the field of industry and his previous research was associated, in some regards, to the relevant issues of current study.

As discussed in Chapter 3, increased competition, rapidly changing technologies and customer expectations have caused the innovation process to become more complex and the possible outcome become considerably less certain (Keizer, Vos and Halman, 2005). The success rate of innovation projects is still low (Stevens and Burley, 1997; Griffin, 1997). Finding a method to integrate risk management in the innovation project in order to manage the innovation in a better way could help increase the success rate. Although many models for innovation and risk management were examined by various studies, until now, the explicit combined model which shows how a risk management system is embedded in the process of innovation still needs more investigation. Based on various research, a methodical approach to risk management should enhance the ability of an organisation to manage risk at all stages (Edwards and Bowen, 2005). The purpose of risk management is to improve project performance by means of a systematic identification, appraisal and management of project-related risk. In addition, a systematic approach to risk management has to encourage decision-making inside an organisation which is more controlled, more consistent and yet at the same time more flexible. Therefore the question which shaped this research is:

- How can risk management fit into the innovation project in an explicit way to manage innovation in a better way?

In addition, besides this main question, other issues which will be considered during this research include:

- During which stage of innovation, and of what form and type, is risk management needed?
- What are the main types of risk associated with the innovation process and how can we manage them?

4.2.3 The theoretical model and its role

Cassell and Symon (1994) clarify the importance of the theoretical model in case study research. They say, without a theoretical framework a case study would rapidly become overwhelmed with data and may produce details about life in a particular organisation that has no wider significance. Indeed, a case study without the discipline of theory can easily degenerate into a story (an account of events without any attempt at analysis). The point is that without a theoretical framework, the researcher is in danger of providing description without any wider meaning. Therefore, a theoretical model can provide structure for analysis and comparison. A conceptual framework is essential, even if the researcher knows that the framework may change as a result of data which comes to light. Therefore, the initial identification of research questions and theoretical framework will work best when it is tentative, with a recognition that the issues and theory may move as the concept and framework are repeatedly examined against the data which is systematically collected. In deductive analysis, this framework may have given rise to the hypothesis that should be tested during study (Saunders, Lewis and Thornhill, 2007).

Because of the importance of the theoretical model in any kind of case study, this study should begin with a theoretical model. For this purpose, in Section 2.6 and Section 3.4 the core of the theoretical model of innovation process and risk management will be developed from current literature. Then, in Section 3.9.2, these models will be combined in order to integrate a risk management system into the innovation project (Figure 3.12).

One purpose of this investigation is testing whether the theoretical model is useful as a framework for developing a better understanding of risk management in an innovation project. Therefore, there should be four distinct phases to the model's development:

- The initial core model based on a review of the innovation management theory (Section 2.6).
- A combined model developed from the core, integrating potentially relevant aspects of risk management: the initial theoretical model (Section 3.9.2).
- A refined theoretical model based on a comparison of the initial theoretical model and the literature case studies (Section 3.10).
- A further refined model incorporating analysis of the empirical cases (Section 10.13); this is an output from the current research that might be tested in further research.

This research uses a proven, standard innovation process model as the core of theoretical model. However, the details proposed in the refined model require testing and additional revisions may be suggested by the empirical data obtained in the interviews in the case study companies. The purpose of this research was two fold: it attempted to test a partial model framework based on the theory and case studies from the literature (for a positivism view of this research, see Section 4.1), and to collect more insights into managing risk in innovation projects (as an exploratory part of this research, see Section 4.1). This additional information could, in turn, lead to the proposal of a better model reflecting an enhanced understanding. In practical terms it seems sensible to undertake these two objectives at once, yet at the same time this research attempts to combine the approaches in an academically rigorous way, which is supported by other management researchers (see Section 4.1). In addition, the present contribution should therefore be seen as a basis for further empirical testing and theorising of the relationship and integration between risk management and the innovation project.

4.3 Data Gathering

Every research project can use a single data collection technique and corresponding analysis procedure (Mono Methods), or more than one data collection and analysis procedure (Multiple Methods) for gathering the data (Saunders, Lewis and Thornhill, 2007). It is argued that different methods can be used in a case study. These may be either quantitative, qualitative or both; stress is generally placed more upon qualitative methods because the questions are best addressed through the case study method (Cassell and Symon, 1994). Creswell (2003) says that by employing qualitative data in the case study, the company can explore processes, activities, and events. He adds that qualitative research focuses on the processes that occur.

Data for case studies can come from many sources of evidence. Some of the most important, which are explained in different sources, are: documents, archival records, interviews, direct observation, participant-observation, physical artefacts, audio-visual material and questionnaires (Cassell and Symon, 1994; Creswell, 1998; Yin, 2003; Saunders, Lewis and Thornhill, 2007). The data collection techniques employed are various and may be used in combination (Saunders, Lewis and Thornhill, 2007). Yin (2003) emphasises that no single source of data has an absolute advantage over all others. In fact, different sources are highly complementary, and a good case study will consequently attempt to use as many sources as possible. Cassell and Symon's (1994) state that many case study researchers use a mixture of methods, partly because complex phenomena are best approached through several techniques, and also to triangulate and thus improve validity. They add that a case study researcher is likely to take advantage of other sources of data within the organisation; some of it opportunistic and some of it deliberately sought out. For example, the analysis of documentary materials or conversations in corridors. Yin (2003) says that for case studies, the most important use of documents and archival records is to confirm, and enhance evidence from other sources.

As discussed in Section 4.1, one purpose of this research is exploratory while one of the philosophical views of this research is interpretivism; it therefore seems that qualitative data can be more useful than quantitative (this issue will be explained further in Section 4.3.1). As stated in this section, data can come from many sources. However, it is argued that interviewing is the most fundamental of all qualitative data gathering methods (Easterby-Smith, Thorpe and Lowe, 1991), and also one of the most important sources of case study information (Yin, 2003). Therefore, interviewing was selected as the main method for gathering qualitative data in this thesis (it will be explained in greater detail in Section 4.3.1). Other sources of data, such as reviewing information from other sources (e.g. internet sites) were also used in this research, these too will be explained in greater detail in Section 4.4 as triangulate source of data.

4.3.1 Comparing the interview with other methods

The various advantages of interviews when compared with other methods of data gathering were examined in several studies (e.g. see: Yin, 2003; Creswell, 2003; Bryman and Bell, 2007). For instance, interviewing is targeted (focuses directly on case study topic) and insightful (provides perceived causal conclusions); while direct participant observation is time consuming (Yin, 2003). Furthermore, personal interviews may attain a higher response rate than questionnaires; managers may be more inclined to agree to an interview than complete a questionnaire (Saunders, Lewis and Thornhill, 2007). Creswell (2003) says that interviewing is helpful when the participant cannot be observed directly. Also, he adds that interviews, give the participants a chance to provide historical information and can give the researcher control over the line of questioning. By using interviews, researchers can find a rich source of data through people's experiences, aspirations, opinions and feelings (May, 2001). Saunders, Lewis and Thornhill (2007) believe that it is essential to employ a qualitative interview where it is necessary to understand the reasons for the decisions that the research participants have taken, or to understand the reasons for their opinions and attitudes. However, there are some limitations when using interviews (particularly 'bias' which will be discussed in Section 4.4.4) and the researcher should acknowledge these when using this method (Creswell, 2003).

When considering the advantages of interviews, in comparison with other methods, the following question needs to be answered: 'why can we not send the questionnaire to many people?'. One answer is that the issues raised in this research are sophisticated, and as the research employs a specific vocabulary of terms and people often need these terms explained, hence questionnaires or short interviews are not suitable for mass distribution and use. Since the issues in this thesis are sophisticated, when the research began, the researcher was able to assume that finding a person with perfect knowledge would be difficult; it was therefore decided to approach a large number of people within each company in order to cover all aspects of research. In addition, as discussed in Section 4.1, this study has a subjectivist view and wanted to undertake in depth studies, it needed to involve many interviewees from each company. Having multiple interviewees provided an opportunity for the cross-checking of responses and leads to more reliable data. Furthermore, Risk/innovation management is not a responsibility that can be allocated to a single individual but can involve many people at different stages of the innovation process, therefore no one person is likely to be able to offer a complete perspective.

When answering a research question, a questionnaire tends to be used in the next stage of work, when understanding is much greater (as discussed in Section 4.1, one of the purposes of this study is exploratory) as we want to be able to come up with a quantification of our data. In other words, at the start of this research understanding was not sufficiently developed in order to determine appropriate survey questions, therefore at this stage, when we are trying to improve understanding, interviews are more appropriate.

4.3.2 Defining the interview

In the interview process, the two following jobs are important: following the line of investigation, and asking questions in an unbiased manner (Yin, 2003). There are several different categories of interview. One typology that is commonly used for categorising interviews is related to the level of formality and structure. Interviews may therefore be categorised as: structured interviews, semi-structured interviews, and unstructured or in-depth interviews (Saunders, Lewis and Thornhill, 2007). By shifting from a structured interview to an unstructured interview, it can be said that the research shifts from a situation in which the researcher tries to control the interview and teach the respondent to answer in accordance with interview-schedule directions (standardisation), to a situation in which the interviewee is encouraged to reply to a question in his or her own terms (May, 2001). Standardised interviews are usually employed to collect data, which in turn becomes the theme of quantitative analysis for example as part of a survey strategy, while non-standardised (semi-structured and in-depth) interviews are employed to collect data which are usually analysed qualitatively, for example as part of a case study strategy. Data from semi-structured and in-depth interview can be used to disclose and understand the 'how' and the 'what' also explore the 'why' (Saunders, Lewis and Thornhill, 2007).

Structured interviews use questionnaires based on a predetermined and standardised set of questions and are referred to as interviewer-administered questionnaires (Saunders, Lewis and Thornhill, 2007). In semi-structured interviews the researcher has a list of questions and themes on specific topics that should be covered, although these may differ from interview to interview (Bryman and Bell, 2007). In this type of interview, questions are usually specified but the interviewer is free to go beyond the answers (May, 2001). Semi-structured interviews may be used in an explanatory study in order to understand the relationships between variables, such as those revealed by a descriptive study; this kind of interview is also used in relation to an exploratory study (Saunders, Lewis and Thornhill, 2007). Unstructured interviews are informal; they are employed to discover more information about a general area in which researchers are interested and there is no predetermined list of questions to work through, although the researcher needs to have ideas about the features that he/she wants to explore (Saunders, Lewis and Thornhill, 2007). In-depth interviews can be very useful in exploratory study in order to 'find out what is happening to seek new insights' (Robson, 2002). semi-structured and In-depth (unstructured) interviews are often referred to as qualitative research interviews (Bryman and Bell, 2007). It should be noted that research may incorporate more than one kind of interview (May, 2001).

Interviews may be conducted on a one-to-one basis, between the researcher and a single participant (Creswell, 2003). Such interviews are normally conducted in a ‘face to face’ meeting. In other situations, the researcher may conduct the interview through group discussions such as focus group interviews (Saunders, Lewis and Thornhill, 2007). Group interviews allow the researcher to focus upon group norms and dynamics around the topics they wish to consider (May, 2001).

There are various ways of classifying the questions (e.g. see: Bryman and Bell, 2007; Saunders, Lewis and Thornhill, 2007). The classification of various types of questions that the researcher will employ during semi-structured and in-depth interviews are: Open questions, Probing questions, Specific and closed questions. Probing questions can be employed to explore responses that are of significance to the research subject. Also, they may be worded in the form of an open question but ask for a particular direction or focus (Saunders, Lewis and Thornhill, 2007).

The purpose of this study is explanatory and exploratory, therefore, rather than having a set of rigid questions we need to be flexible our interviews. In order to gain an understanding of risk management within the context of the innovation project, semi-structured interviews (and in some parts unstructured interviews) were considered to be an appropriate means of investigation as it allows individuals to describe what they do, how, when, where and why. Probing questions were used to invite the interviewees to expand upon the points that they raised, although open questions were also used to an extent. In addition, face to face interviews were used in this research as other types of interviews were not deemed to be proper ways of finding the information needed for this research. For instance, group interview was not practical considering the different conditions of environment in each company (such as cultural situation).

4.3.3 Case Selection

A sample is a selection from the population (Robson, 2002). Types of sampling are usually divided based on probability samples, and on non-probability samples (Adams and Schvaneveldt, 1985; Robson, 2002; Saunders, Lewis and Thornhill, 2007). In probability sampling, statistical conclusions about population can be made from the responses of the sample (the sample is taken as representative of the population); while in non-probability samples, the researcher cannot make such statistical conclusions (Robson, 2002). Probability sampling is often related to experiments and survey research strategies (Saunders, Lewis and Thornhill, 2007). Small-scale surveys usually employ non-probability samples (Robson, 2002). Qualitative samples are usually small in size (it would be impossible to conduct and analyse hundreds of interviews/observations, unless the researcher intended on spending years doing so), thus qualitative research employs non-probability samples when choosing the population to study (Ritchie, Lewis and Elam, 2003). Saunders, Lewis and Thornhill (2007) believe that non-probability sampling is normally used when employing a case study strategy. Since this research is qualitative and uses the case study as a strategy of research, non-probability sampling is selected. In the following, the meaning of non-probability sampling is explained in greater details.

Ritchie, Lewis and Elam (2003) believe that in a non-probability sample, units are deliberately selected based on particular characteristics (e.g. maturity of the company and experience of innovation projects) of groups inside the sampled population. They add that the sample is not intended to be statistically representative: the probabilities of selection for each unit are unknown but, instead, the features of the population are employed as the basis of selection. It is these characteristics that makes them well suited to small-scale and in-depth studies. The understanding and validity that researchers achieve from their data in non-probability sampling is more to do with their data collection and analysis skills than with the size of their sample (Patton, 2002). Adams and Schvaneveldt (1985) argue that it is wasteful to get a larger sample than necessary, particularly if it is not a probability sample. However, Yin (2003) believes that multiple cases are more robust than a single case as comparisons can be made across cases and they are less tied to an exacting context, so multiple-case designs may be preferred over single-case design.

Non-probability sampling provides a range of alternative techniques to select samples, such as: Quota, Purposive (extreme case, heterogeneous, homogeneous, critical case, and typical case), Snowball, self-selection, and convenience sampling (e.g. see: Adams and Schvaneveldt, 1985; Robson, 2002; Saunders, Lewis and Thornhill, 2007). For many research projects researchers need to employ a combination of different sampling techniques (Saunders, Lewis and Thornhill, 2007). Purposive technique, which is related to this research, will be explained in greater detail in the following.

In purposive or criterion based sampling the sample units are selected because they have particular features or are very informative, which enable detailed understanding and exploration of the main issues and puzzles the researcher wishes to study (Adams and Schvaneveldt, 1985; Ritchie, Lewis and Elam, 2003). Purposive sampling simply means that cases are selected because they are particularly suitable for illuminating and extending relationships and logic among constructs (Eisenhardt and Graebner, 2007). Purposive sampling demands that researchers think carefully about the parameters of the population they are studying and, based on this, select their cases such that they address the detailed research questions (Silverman, 2005). One of the purposive sampling strategies is heterogeneous. Heterogeneous or maximum variant sampling enables researchers to gather data in order to explain and describe the issues that can be observed (Saunders, Lewis and Thornhill, 2007). Patton (2002) argues that although this might emerge as a contradiction, a small sample may contain cases that are completely different and that this is in fact a strength. In this study this implies that it may be useful to select cases from a range of industries: this can help enhance generlisability of the results.

The case study is useful for both generating and testing hypotheses (Flyvbjerg, 2006). So, as discussed in Section 4.2, this research uses case study as a research strategy and qualitative method for gathering data, therefore the non-probability sampling method is selected for this study. In this regard, purposive sampling technique (respecting the desired criteria for each company) was used to select cases. The purpose of the research is to develop theory, so purposive (not random or stratified) sampling is appropriate (Eisenhardt and Graebner, 2007). As discussed in Section 4.2.2, the main question of this study is to explore how risk management can fit into the innovation process in an explicit way, in order to manage innovation in a better way. The initial criterion used to select cases was innovation. This means searching for companies which have an innovation or at least claim to have an innovation. To find information about the companies, in order to choose them based on the selected criteria, different sources were used, these included: Ministry of Industries and Mines, and Industrial Managers Association of Iran. Also, the researcher had some meetings with experts from industrial and academic fields in order to find complete information.

It should be noted that when selecting the desired cases, some difficulty existed which limited the selection in reality. For instance, companies often worry about the confidentiality of their information. In addition, because of the nature of this research (see Section 4.1, purpose of the research), the researcher attempted to choose companies which granted in-depth access rather than superficial access. In-depth access means that: 1) Interviewees willing to devote sufficient time to explore issues in detail; 2) Sufficient number of interviewees in each company to permit some validation and reduce bias or cross-checking; 3) Range of interviewees to span the company's innovation activities; and 4) Interviewees with sufficient experience to provide informed opinions. These requirements restricted the choice of case study companies and it was not possible to consider just one specific field of industry. However, the selection of four companies, each operating in a different industry, offers a broad empirical basis for the research. While single-case studies can richly describe the existence of a phenomenon (Siggelkow, 2007), multiple-case studies typically provide a stronger base for theory building (Yin, 2003). Different cases often reveal various aspects of a phenomenon (Eisenhardt, 1991).

Finally, as Table 4.1 illustrates four companies were selected in Iran and one company in the UK. It is important to highlight why this research considered the UK Company. Theory in innovation and risk management is usually written from the perspective of developed countries such as the USA and UK. So, if this research just considered theory in Iran and found that it did not work, what was the reason? Is it because the theory is not practical or because the theory is more suited to developed countries and, therefore, not Iran? By considering the UK Company and testing this issue, the research will be able to answer the above question. If this research was only applied in Iran and it was found that the theory did not work, it would not be able to distinguish whether the failure indicates a problem with the theory (it is not practical) or if it does not work for developing countries only.

As Table 4.1 shows the average age of the companies is more than 10 years (mature companies were selected as very young companies may not have accumulated the needed risk management skills and experience, thus constricting their risk management efforts (Mu, Peng and MacLachlan, 2009)), and the majority of them have more than 300 employees (the nature of the risk management is related to the firm size (Mu, Peng and MacLachlan, 2009)).

Table 4.1 - The case study companies

Case number	*Companies*	*Example of innovation**	*Number of interviewees*	*Location (year formed)*
Case 1	Bus manufacturing	Converting from diesel to gas	10	Iran (1982)
Case 2	Tile manufacturing	Unifying the formula of floor and wall tiles	8	Iran (1994)
Case 3	Dairy product manufacturing	New milk flavours	7	Iran (1993)
Case 4	Porcelain manufacturing	New variety of raw materials to reduce the breakage rate	7	Iran (1993)
Case 5	Scottish & Southern Energy	Using palm waste as a fuel	8	UK (1998)

* some of these developments have since been approved and are now being implemented

A covering letter[1] and questions (both English and Farsi versions in case of Iranian companies) were sent to all companies. The respondents had an opportunity to prepare themselves for the interview by reviewing the framework and its intended scope. The interviews were conducted in the companies' office and the researcher had the opportunity to visit the firm's production plants. The interviews were face to face and each interview lasted about 60–90 minutes. To ensure confidentiality, I agreed not to reveal the name of the employees. I tried to select interviewees from various fields, although it was somewhat

[1] A sample of this letter is shown in Appendix 4

out of my control, as the companies selected the interviewees. However, a wide range of interviewees from different fields were eventually selected from: financial, production, operation, quality assurance, technical, marketing and sale, business development, research and development. The majority of interviewees had more than five years experience and some had been working on particular innovation projects while others had a broader knowledge. In addition, most had at least an undergraduate degree in wide range of subjects (from engineering to business and finance). Table 4.1 indicates the large numbers of employees selected from each company; this helps ensure the robustness of the data collection, even if some of the interviewees fail to provide complete information. During each interview, the purpose of the research and meaning of different words were explained for each interviewee in order to identify common language. The interviewees were asked to state their opinions, based on their experiences and their responsibilities within the company. In the interviews, non-technical terms were often used; these have been translated into standard terms in the interview reports. After each visit, a case file was prepared containing the recorded material (although some interviewees refused to use the recorder), interview notes (which were prepared during all interviews) and other information that was found during visits to the company plant, from brochures and documents and by chatting with people from the companies.

Yin (2003) argues that the pilot case study will help researchers refine his/her data collection plans with respect to both the content of the data and the procedures to be followed. He adds that pilot testing is more formative and assists the researcher develop related lines of enquiry and may even offer some conceptual clarification for the research design. In order to undertake the pilot study, the framework and related questions, used as the tool to collect data, were designed in English based on a literature review [2]. In order to use it in Iranian companies, it was translated into Farsi (Persian), the formal language of Iran[3], then translated back into English (‘Back Translation’) in order to overcome any possible inconsistencies in meaning between the two languages (e.g. see: Neuman, 2006). This procedure was carried out using experts. Yin (2003) believes that in general, convenience, access, and geographic proximity are key criteria when choosing pilot case(s). As a pilot study, this framework and related questions were considered in relation to two different companies in Iran with three interviews in each. The pilot study revealed that while people may relate to the concepts of innovation management, they are less familiar with the detailed technical terms. As a consequence, some terms were revised and also the sequence of questions was adjusted. In addition, this framework was considered by different experts, with academic and industrial experience, individually before starting to gather data. In order to do pilot testing in the UK, meetings were arranged with a representative of the selected company and after some revision, a framework was prepared for gathering data. Questions were then adjusted, corrected and re-worded according to the results of the pilot testing in Iran and the UK. This feedback helped to finalise the questions and ensure its style and wording met Iranian and UK conditions.

4.4 Quality of Research Design

Smith (1991) argues that case study research strategy including qualitative approaches are often more appropriate when undertaking management research; it is often difficult to undertake reliable quantitative comparisons since there may be many uncontrollable

[2] English format of interview’s framework is mentioned in Appendix 1
[3] Persian format of interview’s framework is mentioned in Appendix 2

variables. Some believe that case study is ‘meaningful’ and ‘rich’ in comparison with quantitative techniques (Cassell and Symon, 1994). However, there are also criticisms of the case study. For instance, some argue that case studies lack rigour, reliability and that they do not address issues of generalisability which can be effectively tackled by quantitative methods (e.g. see: Cassell and Symon, 1994; Brown, 1998; Woodside and Wilson, 2003; Saunders, Lewis and Thornhill, 2007). Cassell and Symon (1994) emphasise that this type of argument is outdated as there is nothing about a method which makes it inherently strong or weak. They believe that the argument about the method is based on two key issues: the relationship between theory and method; and how the researcher attends to potential weaknesses of the method.

There are different measures of the quality and rigours of research, which are achieved through certain methodological principles (Mason, 2002). Yin (2003) argues that some tests are normally employed to establish the quality of any empirical research; as case study is one form of such research, these tests also are applicable to case studies. As this research is employing case study and qualitative data, in the following sections (4.4.1 to 4.4.4), a number of data quality issues that can be identified in relation to this kind of research will be considered in more detail. These issues are related to: Validity, Generalisability, Reliability, and Bias (e.g. see: Mason, 2002; Yin, 2003; Saunders, Lewis and Thornhill, 2007). Different tactics are available to deal with these issues, a number of them take place during the data collection, data analysis, or compositional phases of the research (Yin, 2003).

4.4.1 Validity

Validity is concerned with whether the findings are really about what emerges (Saunders, Lewis and Thornhill, 2007). Yin (2003) says that validity can be considered in three fields. These fields, along with a brief definition, are:

- Construct validity: are the sources of data relevant?
- Internal validity: is the model consistent with the theory?
- External validity: how far can the results can generalised?

Construct validity and Internal validity will be explained in the following of this section. External validity is related to generalisability and it will be discussed separately in the next section (4.4.2).

Yin (2003) describes construct validity as establishing correct operational measures for the concepts being studied. He states that one of the tactics used to increase construct validity is employing multiple sources of evidence, in a way that encourages convergent lines of investigation; this tactic is applicable during data collection. Saunders, Lewis and Thornhill (2007) argue that the validity of qualitative studies based on interviews is not an issue. They say that validity refers to the extent to which a researcher achieves access to their participants' experience and knowledge, and is able to deduce the meaning that the participant intended from the language that was employed. A high level of validity is possible, in relation to non-standardised interviews, since the responsive and flexible interaction between the respondent(s) and the interviewer allows this theme to be covered. Questions can be developed during the course of the interview resulting in future probing of key issues while ensuring that any ambiguities are clarified for the interviewee.

How does this study improve construct validity? This research has used a non-standardised approach for gathering data in the interviews (see Section 4.3.2). Also, this research has used different sources of information (triangulation); this will be explained in greater detail in Section 4.4.4. In addition, at the formulation of questions stage, the researcher used the opinions of experts from different fields of knowledge (academic and industrial).

Bryman and Bell (2007) describe internal validity as whether or not, there is a good match between a researchers' observations and the theoretical ideas they develop. Some tactics for addressing internal validity, such as explanation building, addressing rival explanations and using logical models can be applied in the data analysing stage (Yin, 2003).

How does this research improve internal validity? As mentioned, Yin (2003) believes that the tactic researchers can use to improve internal validity is related to the analysis stage of their study. Therefore, this research, as Section 4.5 will show, has applied explanation building for the analysis data which improves the internal validity.

4.4.2 Generalisability

Generalisability is sometimes referred to as external validity. External validity is defined as establishing the domain to which a study's achievements can be generalised (Yin, 2003). The core criticism of case study research by a researcher using large samples and quantitative methods is that case study findings cannot be generalised and applied to a population; the particular case included in a given case study is so unique that it indicates a singular context (Woodside and Wilson, 2003). The question is whether case study results can be equally applied in other research contexts, such as other organisations? (Saunders, Lewis and Thornhill, 2007)

Cassell and Symon (1994) argue that employing a quantitative approach can only make generalisations from the sample to the population. But what occurs when the sample is not typical? They argue that this is not to suggest that generalising from case studies is less problematic, but rather to suggest that, while generalising from case studies can be difficult, the same is true for quantitative studies. It seems that this argument about the quantitative analysis is true, when the sample is not typical; its size is also not large enough. Gummesson (2000) argues that generalising from statistical samples is just one type of generalisation; however, it is not general and it is rarely applicable to case study research. Generalisation from case studies has to be approached differently. He says that generalisation has two dimensions. The first is that quantitative studies, based on a large number of observations, are required to determine how much, how often, and how many. The other dimension entails the use of in-depth studies based on comprehensive investigations and analysis to recognise certain phenomena. Therefore, generalisation in case study is about theoretical propositions not populations (Cassell and Symon, 1994). Yin (2003) mentions that the case study does not represent a “sample”. In undertaking a case study, the aim is to generalise and expand theories (analytic generalisation) and not to consider the frequencies (statistical generalisation). He stresses that in analytical generalisation, the researcher attempts to generalise a particular set of results to some broader theory.

Saunders, Lewis and Thornhill (2007) believe that this may be a particular worry if case study research is performed in one organisation, or a small number of organisations. Therefore, where the researcher has been able to conduct his/her research in more than one case study, this increases confidence in the results (Cassell and Symon, 1994). Multiple cases create more robust theory because the propositions are more deeply grounded in varied empirical evidence (Eisenhardt and Graebner, 2007). Furthermore, the choice of cases from different industries can enhance the generalisability. Yin (2003) states that a theory has to be checked by replicating the results in a second or even third case study. When such direct replications have been completed, the findings might be accepted as providing strong support for the theory, even though additional replications have not been carried out.

In order to develop a conceptual framework for integrating a risk management system in the innovation project in this study, theoretical generalisation was considered to be of more importance than statistical generalisation. It can be said that the reason for this relates to the goal that researchers set: to deepen scientific knowledge about risk management systems in the innovation project. In addition, this study involves five companies in different fields (see Section 4.3.3), therefore it seems that the theoretical model can be applied to other companies and sectors as they provide a generic method for integrating risk management in the innovation project.

4.4.3 Reliability

Reliability can be interpreted as two or more investigators, studying the same phenomena with similar purposes achieving roughly the same findings (Gummesson, 2000). Saunders, Lewis and Thornhill’s (2007) definition states that, reliability refers to the extent to which analysis procedures or data collection techniques yield consistent results. Therefore, it can be said that the objective of reliability is to be certain that if a later researcher follows the same procedures as a prior researcher and conducts the same case study, the later researcher should achieve the same results and conclusions (Yin, 2003). Bryman and Bell

(2007) believe that this is a difficult criterion to achieve in qualitative investigation, since it is not possible to 'freeze' a social context and the circumstances of an initial study to make it replicable in the sense the term is used. In addition, the findings derived from employing non-standardised methods are not necessarily intended to be repeatable as they mirror reality at the time they were collected (Marshall and Rossman, 1999).

However, in a case study context, there are two tactics to improve reliability: using the case study protocol (including the interview guide), and developing the case study database (Yin, 2003). This research employed a list of themes which were sent to interviewees before any interviews took place, it was also a supportive guideline for interviewer (researcher) which is included in Appendix 1. In addition, in order to further corroborate the evidence and to provide a formal assembly of evidence, a case study database was established. The case study database includes a copy of the completed interview guide for each firm, any additional notes taken outside of interview guide, and a detailed summary write-up of each case[4].

4.4.4 Bias

The last issue, which is related to the quality of this research, is bias. Yin (2003) argues that bias can also occur in experiments and other research strategies, such as designing questionnaires for surveys or performing historical research. He believes that the problems are the same, but in case study research, they may more frequently occur and be less frequently overcome. There are various types of bias that should be considered, such as researcher bias, interviewee bias, and selection (of cases or interviewees) bias (Saunders,

[4] Chapter 4 to Chapter 9 include the detailed write-up of each case studies, also Appendix 3 includes the summaries of interviews and addition notes. In addition, each companies has own file separately which includes the all related materials.

Lewis and Thornhill, 2007). It is argued that informant bias is one criticism of research that uses interviews (Ellram, 1996). Yin (2003) explains that researchers need to be careful about becoming excessively dependent on a key informant, particularly because of the interpersonal influence that the informant may have on them.

There are some tactics in place to help deal with bias. For instance, Cassell and Symon (1994) say that careful checking of constructs and theory against various sources of evidence helps avoid being biased by early impressions. Also, employing other investigators, friends or even readers during the research can reduce bias. Yin (2003) argues that a reasonable way of dealing with this issue is to rely on other sources of evidence (triangulation) in order to confirm any insight by informants and to search for opposing evidence as carefully as possible.

In order to overcome researcher bias, this research employed content analysis (see Section 4.5.1). This method provides a structure that encourages objectivity and a degree of traceability by allowing others to check the qualitative analysis easily (in principle). This research used different sources of evidence (triangulation) to decrease the interviewee bias. In the following section, the role of triangulation will be explored in greater detail. In addition, Section 4.3.3 explained the complete history of sampling in relation to selection bias.

There are several overriding purposes of triangulation. Triangulation is defined as the use of various data collection techniques within one research in order to ensure that ‘the data are telling you what you think they are telling you’ (Saunders, Lewis and Thornhill, 2007). The primary purpose of triangulation is to reduce or eliminate bias and increase the validity and reliability of study (Jonsen and Jehn, 2009). Based on Saunders, Lewis and Thornhill’s

(2007) opinions, if the researcher is employing a case study strategy, he/she is likely to need to employ and triangulate multiple sources of data. Triangulation of data helps to overcome this potential problem (bias) by employing some combination of multiple informants, internal company memos, use of direct observation, procedures and other data gathering techniques (Ellram, 1996).

It is thought that multiple data sources can enrich research. Therefore, this research used information from different sources as a triangulate source of data. The data sources for this study were the literature reviews, interviews and all related company documents and information (such as application forms or website material). In addition, most of the case studies included on-site visits and the exchange of documents; other discussions were conducted in order to clarify issues and corroborate data where the researcher deemed it necessary. Furthermore, the observations made during meetings and by comparing the explanations of each interviewee in order to find if they approve or disapprove of each other, could be considered as another means for this purpose.

4.5 Methods of Data Analysis

There are different techniques for analysing quantitative and qualitative data. Saunders, Lewis and Thornhill (2007) believe that there is no standardised approach to the analysis of qualitative data. They say that approaches to analysing qualitative data may be highly structured, whereas others adopt a much lower level of structure; in other words, some approaches may be highly proceduralised and formalised, while others rely more on the investigator's interpretation. Generally, based on the kind of approach the research takes, which is usually deductive or inductive, different techniques can be applied for analysing qualitative data. In a deductive approach, data classifications and codes to analyse data are derived from theory and a predetermined analytical framework; whereas in an inductive approach, theory is the result of research and there are no predetermined, classifications or codes to direct the analysis (Saunders, Lewis and Thornhill, 2007; Bryman and Bell, 2007). Yin (2003) stresses that, where the investigators have employed existing theory to formulate the research objectives and questions, investigators may also employ theoretical propositions that helped him/her create a framework in order to assist with the organisation of data analysis. This approach reveals a preference for starting with and utilising theory in qualitative research, rather than allowing it to develop from the research.

As examined above there are different techniques for analysing qualitative and quantitative data. A number of deductively based techniques for analysing qualitative data are: pattern matching, explanation building, and content analysis; in the same way a number of inductively based techniques for analysing qualitative data are: data display and analysis; template analysis; analytic induction; grounded theory; discourse analysis; narrative analysis (Easterby-Smith, Thorpe and Lowe, 1991; Yin, 2003; Saunders, Lewis and Thornhill, 2007). As discussed in Section 4.1, this research combines both deductive and inductive approaches. So in the following, some of these techniques (in both deductive and inductive categories for qualitative data) which are related to this study will be explained, after which the method(s) that this study applies will be mentioned.

4.5.1 Deductive based techniques

In this section, three techniques based on deductive analysis - which are pattern matching, explanation building, and content analysis - will be explained briefly.

Yin's (2003) definition states that pattern matching entails forecasting a pattern of outcomes based on theoretical propositions in order to explain what the researcher expects to find. To employ this approach, developing an analytical or conceptual framework is needed, then the utilisation of existing theory, and after that testing the adequacy of the framework as a means to explain the results.

Another pattern matching procedure entails efforts to make an explanation while collecting data then analysing them, rather than testing a predicted explanation as set out above (Saunders, Lewis and Thornhill, 2007). Yin (2003) recognises that this procedure (explanation building) appears to be similar to grounded theory or analytical induction. However, he differentiates between these, since explanation building is still designed to test a theoretical proposition rather than to generate a 'grounded' theory. The hypothesis-testing approach is related to explanatory case studies, while the hypothesis-generating approach is relevant for exploratory studies. It can be said that in explanation building, a theoretically based proposition is suggested initially, even though this may be revised through the iterative stages of the process involved (Saunders, Lewis and Thornhill, 2007).

Content analysis is used to make valid inferences from text (Krippendorff, 1980). Contents analysis is rooted in quantitative research strategy, in that the aim is to produce quantitative summaries of the raw interview data in terms of the categories specified by the rules (Bryman and Bell, 2007). Content analysis has been defined as a systematic and replicable technique for compressing many words of text into fewer content categories based on clear rules of coding (Stemler, 2001). In some classifications, content analysis is used as a technique of deductive based analysis (e.g. see: Easterby-Smith, Thorpe and Lowe, 1991); while other studies state that content analysis is applicable to many different forms of unstructured information, such as transcripts of semi and unstructured interviews and the qualitative case studies of organisations (Bryman and Bell, 2007).

A key idea of content analysis is that many words of text are categorised into much fewer content categories (Weber, 1990). What makes the technique particularly meaningful and rich, is its reliance on categorisation and the coding of data (Stemler, 2001). Weber (1990) says that each category may contain one, several, or many words. Phrases, words, or other units of text classified in the same category are presumed to have similar meanings. Depending on the purpose of the research, this similarity may be based on the words sharing similar connotations, or may be based on the precise meaning of the words. This approach to presenting and describing data will provide a helpful supplement to the principle means of analysing qualitative data (Saunders, Lewis and Thornhill, 2007). In addition, content analysis is helpful for examining patterns and trends in documents (Stemler, 2001).

4.5.2 Inductive based techniques

In this section two techniques based on inductive analysis, which are analytical induction and grounded theory, will be explained briefly.

Analytic induction is an inductive version of the explanation-building procedure which was mentioned in Section 4.5.1. As an inductively led approach to analysing qualitative data, it starts with a general explanation of the phenomenon to be explored, which is not derived from existing theory (Saunders, Lewis and Thornhill, 2007).

In grounded theory, data collection starts without the formation of a primary theoretical framework; theory is then developed from data created by a series of observations (Saunders, Lewis and Thornhill, 2007). The aim of grounded theory study is to discover or generate a theory, an abstract analytical scheme of a phenomenon that relates to a particular condition (Creswell, 1998). Glaser and Strauss (1968) believe that grounded theory is seen as a relevant approach to generating, even from a limited number of cases. They say that ‘since accurate evidence is not so crucial for generating theory, the kind of evidence, as well as the number of cases, is also not so crucial. A single case can indicate a general conceptual category or property; a few more cases can confirm the indication’. Before using grounded theory, the researcher is required to consider the time that he/she has to conduct the research, the level of competence needed for his/her study, and their accessibility to data (Saunders, Lewis and Thornhill, 2007).

4.5.3 Combining deductive and inductive techniques

By considering issues, such as the fact this research combines both deductive and inductive approaches (see Section 4.1), employs qualitative data (see Section 4.3), its purpose is placed between explanatory and exploratory (see Section 4.1), and the definition of different techniques which are mentioned in this section, it seems that the explanation building is the most appropriate technique for this study. As discussed in Section 4.1, this research deduces a model from the theory and literature surrounding the risk management system and the process of the innovation project; this theoretical model should be tested in different cases by using empirical evidence in order to provide recommendations and further refinement to the prior theoretical model (the process is illustrated in Figure 4.1). On one hand this research starts by using a theoretical model, but on the other it wants to refine this theoretical model. Therefore, explanation building is the appropriate technique for this purpose.

Besides this technique, the simple content analysis technique is also applied in order to structure the qualitative analysis and compare different situations within the various companies. In other words, a preliminary analysis of the interview data, providing an indication of the possible relative importance of different criteria influencing risk and innovation; provides a structure for the more detailed examination of the interview transcripts.

In addition, the influence diagram is used in conjunction with content analysis to develop an understanding of important criteria and organise information from the interview reports. The influence diagram indicates all the factors, which are regarded as being relevant to the problem by the analyst and also suggests how these factors influence or interact each other, based on cause and effect relationships (Flett, 2001). Therefore, by using influence diagrams dynamic behavior can be described, and hence highlight the underlying structure of events (Balle, 1994). The components in an influence diagram can have both positive and negative feedback, and incorporate delayed feedback. The influence diagram notation includes a +/- symbol indicating the nature of the relationship between the factors linked by the arrow (Wolstenholme, 1994). This mechanism captures the detail that distinguishes the positive and negative feedback.

4.5.4 Implementing the chosen methods

In each empirical case study (Chapter 4 to Chapter 9) the interview reports will be related to each stage of innovation and risk management of theoretical model, also influence diagrams will be used to develop an understanding of the relationships between the various possible important factors relevant to each stage. Each case study is then used in the synthesis chapters (Chapter 10) for: 1- constructing a generalised influence diagram drawn from the individual case diagrams and 2- assimilating interview reports using a content analysis to help provide a structure for comparing the theoretical model with empirical data.

This research applies a simple form of content analysis in order to structure the qualitative analysis and comparisons of the different companies. Given the small number of interviewees, 7-10 per company, this measure has no statistical significance but it offered a useful filter suggesting patterns that were then investigated in more detail using interview reports to substantiate the preliminary results suggested by various figures (see Chapter 10) based on this analysis. To use content analysis, the data was coded and categorised based on various groups which will be explored in greater detail in Chapter 10.

4.6 Conclusion

This chapter described the methods and data analysis undertaken in this study in order to answer the research questions. The case study research strategy utilising a semi-structured (in some parts unstructured) interview appears to be the most appropriate way of acquiring data, allowing the topic of integrating a risk management system into innovation project to be explored in considerable depth. The case study strategy chosen to carry out this research has been determined by considering the following factors: the purpose of this research (Section 4.1), research question (Section 4.2.2); and finally, the availability and opportunity to access data. At the start of this research, understanding was not sufficiently developed in order to determine appropriate survey questions; therefore at this stage when we are attempting to improve understanding, interviews are usually more appropriate. In addition, since the issues raised in this research are sophisticated and this research uses specific terms, people need these terms explained to them, hence they are not suitable for questionnaires or short interviews. This research starts by deducing a model from the theory and literature available, but on the other hand it wants to refine the theoretical model and explore more data. Explanation building is therefore the proper technique for analysing data in this research. Besides this technique, the simple content analysis technique is also applied in order to compare different situations within the various companies.

As discussed in this chapter, this research uses a proven, standard innovation process model as the core of theoretical model. However, the details proposed in the refined model require testing and additional revisions may be suggested by the empirical data obtained in the interviews in the case study companies. Thus in the following (Chapter 5 to Chapter 9), the process of innovation and risk management will be considered in five empirical case studies. The present contribution should therefore be seen as a potential basis for further empirical testing and theorising of the relationship and integration between risk management and the innovation project.

Chapter 5 Case 1- Shahab Khodro (SK)

Shahab Khodro[1] is one of the oldest and most famous manufacturers of commercial vehicles, mostly buses, in Iran. In the beginning, the company served as the commercial agent of British Leyland Motors in Iran. In 1963 the company entered into a joint venture with Leyland Motors (UK) and the name was changed to Leyland Motors of Iran. At that time double decker buses were manufactured. After the Islamic Revolution of Iran in 1982, the name was changed again to Shahab Khodro and a type of city buses was locally designed in association with Mercedes Power Train. At the moment, this company produces a range of commercial vehicle such as city buses, intercity buses, CNG buses, middle buses. They also produce specialist vehicles including fire engines, garbage collectors, cesspool drainer, tankers and other trucks based on special orders. At present, this company has more than 800 employees.

Figure 5.1 - Example pictures of Shahab Khodro's (SK) products

The company has six internal competitors in this industry which are:1- Oghab, 2-Zamiad, 3- Pishro Yadak, 4- Ana Kaveh, 5- Kerman Khodro, 6- Zarrin Khodro (nom.: 1.7, Busi.)

[1] Accessed on 03.11.2008: www.shahabkhodro.com

and each of them has a specific share of the market (nom.: 1.1, QA)[2]. It should be noted that the tariff for importing foreign cars is high, so the bus and truck manufacturing industry (and to an extent, the car manufacturing industry) in Iran is limited to domestic companies.

In the following discussion, the interviewees' opinions about innovation and risk in this company will be explained. Also, for greater clarity, the influence diagram will be used to show the effect of different factors on each stage of innovation.

5.1 Innovation

Based on the number of interviewees' opinions (nom.: 1.3, Prod.; nom.: 1.8, QA), most Iranian companies follow the stages of theoretical model for innovation but in an unstructured and informal manner. This means that there may not be enough formal documentation of their activities. Although the interviewees could relate to these stages of innovation, usually there are no formal meetings put in place at points of decision to allow a project to progress from one stage to the next.

One interviewee said that, in practice, there are some barriers which may cause the company to stop following these stages precisely (nom.: 1.7, Busi.). Occasionally high-level management opinion causes a change in the priority of the stages of innovation (nom.: 1.2, Design). Or based on one interviewee's opinion (nom.: 1.5, Proj.), the attitude of high-level management towards innovation can be a barrier or an incentive in this

[2] Appendix 3 includes the summary of each interview in five separate cases which are indicated by number of meeting (nom.) and their job and their date in related company.
The abbreviations of the interviewees' job title for this case are: Quality Assurance Manager (QA); Design Manager (Design); Production, Planning, and Control Manager (Prod.); Project Manager (Proj.); Industrial Engineering Manager (Indus.); Business Manager (Busi.); Finance Manager (Fina.).

process. It can then be said that the attitude of high-level management can sometimes create the risk in this process.

Additionally, each interviewee had some opinions regarding the different stages of this process. For instance, one interviewee (nom.: 1.1, QA) stated that:

> *"Creativity and selection are part of one stage because sometimes there are not different kinds of ideas. We do not have many choices, because most of the time, our ideas are based on customer's needs."*

Therefore it can be said that creativity and selection are part of a single stage. This is because the company has limited options due to the customer's requirements. Also, a number of interviewees (nom.: 1.3, Prod.; nom.: 1.2, Design) believed that using the feedback between the different stages of the innovation process is necessary.

Interviewees explained the different factors which have an effect on the process of innovation and they should be considered at different decision points. These opinions will be considered in the following sections.

5.1.1 Creativity

One interviewee (nom.: 1.1, QA) stated that there is some creativity within the company but that there was little variety. This is because the company produces heavy vehicles (i.e. buses) and their customers have standardised but specific requirements (although some other small customers exist, they do not have as big a share in the market). For example, one of Shahab Khodro's main customers is the Ministry of Interior. It seems (as Figure 5.2 shows) this situation (limited customers) causes a lack of competition and consequently a lack of creativity in the company as the company does not need to compete for customers and at any given moment it has a minimum amount of market share.

In general – as one interviewee said (nom.: 1.4, Prod.) – there are two kinds of innovation in this company: improvement (incremental) and completely new (radical). While one interviewee (nom.: 1.5, Proj.) believed that the company is capable of improving different parts of the product but it is not capable of producing a completely new product; another interviewee said (nom.: 1.8, QA) that the number of improvement (incremental innovation) is normally more than producing a new product (radical Innovation) in Iran, but it can be said that both processes exist in this company. For example, changing the diesel to gas or producing articulated buses (nom.: 1.6, Indus.; nom.: 1.9, Fina.). Also, there are some process innovations in the company (nom.: 1.10, Indus.). For instance, the position and arrangement of driving forces and colour in the line for increasing the yield, or different kinds of ISO, EFQM (European Fundamental Quality Management) model or PDCA (Plan, Do, Check, Act) cycle which they apply here can be viewed as process innovation. In the meantime, one interviewee (nom.: 1.6, Indus.) claimed that this company is one of the most innovative companies in Iran within this industry. Based on the classification for different kinds of innovation which was discussed in Section 2.3, it can be said that in this company there are various innovation (product and process) from incremental to radical.

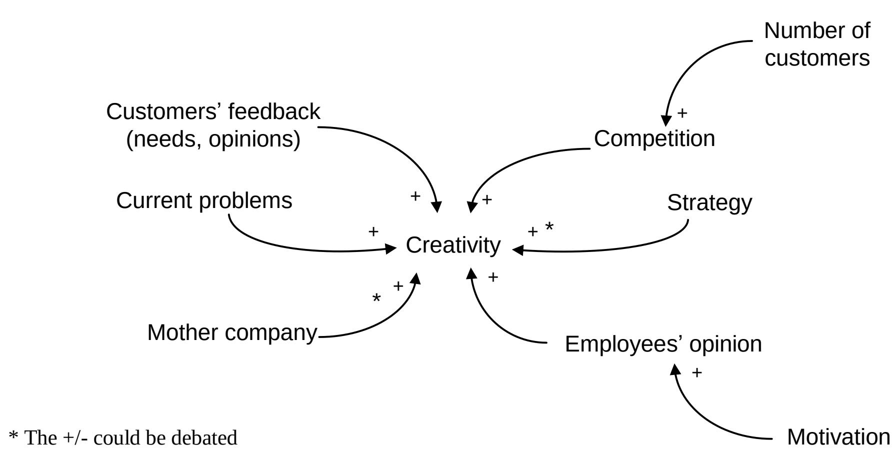


Figure 5.2 - Influences on creativity at SK (I)

As Figure 5.2 shows the creativity stage can be stimulated by various means such as customers' needs and opinions (nom.: 1.1, QA; nom.: 1.5, Proj.; nom.: 1.6, Indus.). There are two kinds of customer in this industry: general and particular (nom.: 1.3, Prod.). There are also formal systems in place so the company can attain feedback (opinions and needs) from customers (direct and indirect)[3], but based on one interviewee's opinion (nom.: 1.7, Busi.) the company does not make full use of these systems or the results. For example, to get a customers' opinion, the company uses a questionnaire and collects answers from various places, such as bus stations (nom.: 1.1, QA; nom.: 1.7, Busi.). There is also a committee, which includes several customers and a representative of the company. This allows the company to collect the customer's opinions and discuss any problems directly (nom.: 1.4, Prod.). Another employee said (nom.: 1.5, Proj.) that the company has contact with one of their biggest and most important customers (Ministry of Interior) every two weeks. Also, the sale division gets feedback from the customers by using its specific method, called the 'voice of customers' (nom.: 1.3, Prod.). It should be said that the results of these different methods are used throughout various stages (i.e. selection, incubation and implementation) as well as creativity. However, one interviewee (nom.: 1.6, Indus.) stated that the company considers ideas from outside sources but cannot develop them very well.

Based on one interviewee's opinion (nom.: 1.2, Design), there are five different contributing factors that enhance creativity in this company (Figure 5.2): 1- Customer Feedback, 2- Proposal System (which gains employees' opinion), 3- Mother Company, 4- Strategy, 5- Current Problems.

[3] Direct customers are the people who buy the vehicles. Indirect customers describe the people who use this vehicle in different situations (e.g.: passengers).

One of the factors which has an effect on the creativity stage is employees' opinion. A system was created within the company which enabled them to collect these ideas and opinions (nom.: 1.1, QA; nom.: 1.10, Indus.). To collect the ISO the company created two mechanisms. These mechanisms allow the company to utilise employees' ideas in order to correct current problems and undertake activities which will prevent potential problems. The company now wants to create new and better mechanisms (software system) for the collection of employee and customer proposals. This provides a means through which the proposal can be submitted and also encourages employees to explain their opinions (nom.: 1.1, QA; nom.: 1.3, Prod.; nom.: 1.6, Indus.). Although there is a system within the company for attaining employees' proposals, one interviewee (nom.: 1.4, Prod.) believed that the employees are not given strong enough motivation for suggesting improvement and innovation (Figure 5.2). It can be said that, this issue (lack of motivation) is caused by management and is a parameter which can create risk in this company.

One of the interviewees explained (nom.: 1.2, Design) that the documentation of previous projects could play a role as an input of the creativity stage (Figure 5.3). Also, some activities enhance the company's creativity. For example (Figure 5.3): research and development and competitors' products (domestic and international) (nom.: 1.3, Prod.).

Another parameter which may have a negative affect on creativity is the cost of research (Figure 5.3). One interviewee (nom.: 1.3, Prod.) stated that, one of the important barriers for innovation is cost. In other words, high-level management should accept that innovation will inevitably cost money which must be spent in order to progress.

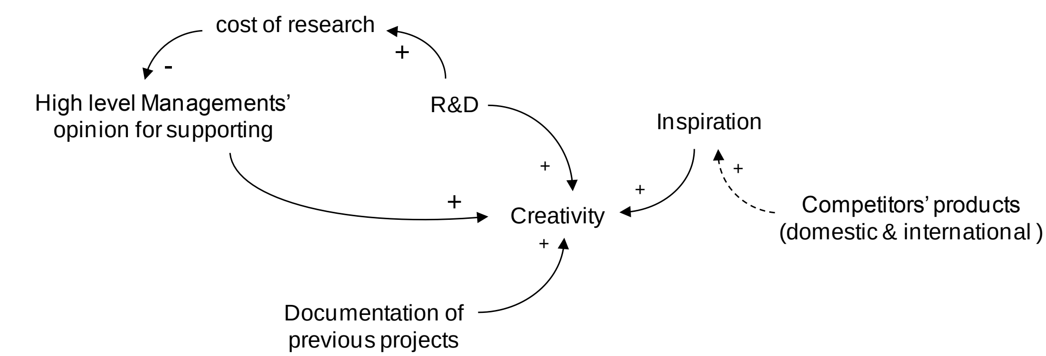
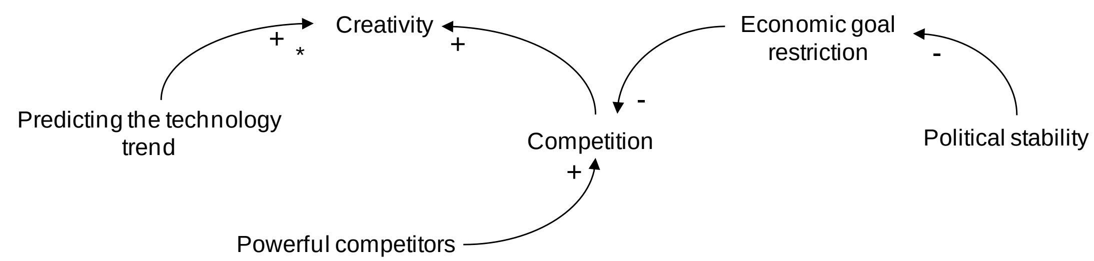


Figure 5.3 - Influences on creativity at SK (II)[4]

As mentioned before, the rules in Iran are not fixed and they change frequently due to political instability. This situation can have a negative affect on creativity. For instance as Figure 5.4 illustrates, these rules often restrict the economical goal and decrease competition (nom.: 1.8, QA). So usually there is little or no competition between companies for producing different kinds of products. This means that creativity will decrease. Also as one interviewee said (nom.: 1.7, Busi.) this issue is one of the most important barriers when making long term plans.



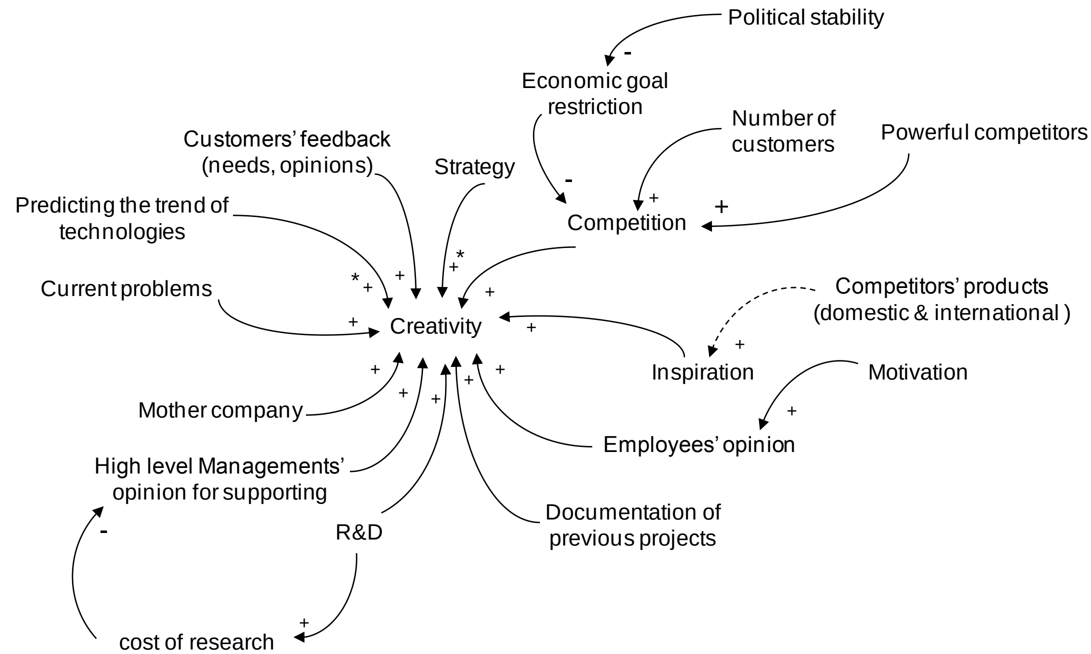
* The +/- could be debated

Figure 5.4 - Influences on creativity at SK (III)

Based on one interviewee's responses (nom.: 1.5, Proj.), two factors have an effect on creativity at this stage (Figure 5.4): competitors and predicting technological trends. It means that powerful competitors with new products will motivate the company to be more creative.

[4] The continuous lines represent influences explicitly identified by the interviewees; the broken lines are influences which are inferred from interviewee comments.

Figure 5.5 illustrates all of the factors which were discussed previously and have an effect on creativity stage based on various interviewees' opinions of this company.



* The +/- could be debated

Figure 5.5 - Combining the influences on creativity at SK

5.1.2 Selection

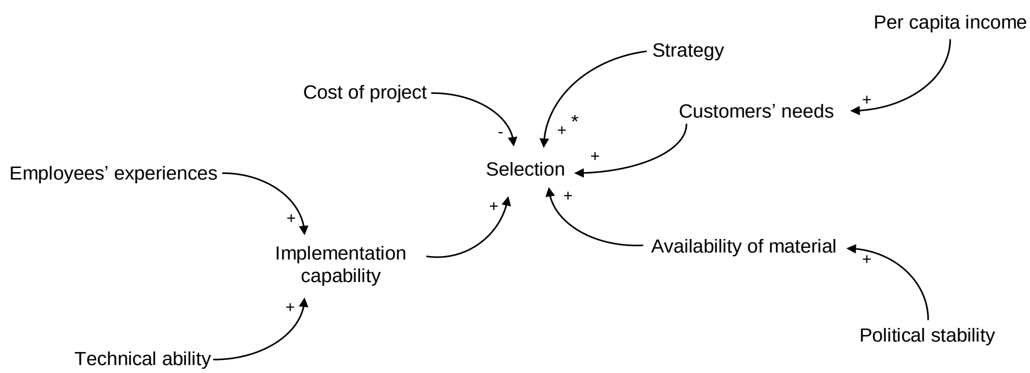
The company considers the feasibility of customers' requests at the selection stage in relation to different attributes such as financial assessment and technical ability (nom.: 1.1, QA; nom.: 1.5, Proj.; nom.: 1.6, Indus.; nom.: 1.9, Fina.). One of the interviewees (nom.: 1.5, Proj.), a project manager, believed that:

> *"In a feasibility study, all parameters should be considered and only after that should a final decision be made. For instance, when producing a truck, after consideration of the situation, we found out that it is not commercially viable to compete with our rivals."*

Another interviewee (nom.: 1.6, Indus.), manager of the industrial engineering division, said that:

> *"For going to new product, the company should do the feasibility study and answer this question: is it possible for the company to move to the new project by considering the financial, technical and engineering issues?"*

One interviewee (nom.: 1.1, QA) suggested that a team from each division should consider the situation before and after this stage. It is easier to see how a feasibility study would work by examining an influence diagram based on the factors attributing to it (Figure 5.6).



* The +/- could be debated

Figure 5.6 - Influences on selection at SK (I)

One of the most important criteria in the selection stage as one interviewee (nom.: 1.4, Prod.) said is the implementation capability of any new project. Also one interviewee (nom.: 1.2, Design) mentioned the role of employee's technical experience on the selection stage. It seems that the company's technical ability and employees' technical experience have a direct effect on the implementation capability of a new project (Figure 5.6). Thus the degree of this capability has a direct relation to the selection of a new project.

One respondent (nom.: 1.1, QA) stated that the availability of raw material is also an important factor which may have an effect on selection stage (Figure 5.6). Especially in Iran where the political situation is unstable: the international trade sanctions are at work while 85% of company's raw materials are imported from abroad (nom.: 1.9, Fina.). Also, as Figure 5.6 indicates, customers' needs, the cost of this project (nom.: 1.2, Design) and strategy (for instance, producing the articulated bus is a strategic purpose of the company) are other factors which have effect on this stage (nom.: 1.1, QA). Based on another interviewee's opinions (nom.: 1.7, Busi.) the amount of per capita income has an effect on customer consumption (Figure 5.6). It can be said that with an increase in the per capita income, customers' needs will change. For instance, the previous model of a city bus did not have air conditioning facilities but now the needs of the customer have changed and they are willing to pay more for this addition (nom.: 1.7, Busi.). Therefore, the company designed and developed a new air conditioning system for their city buses (incremental innovation). The company believes that in order to predict customer's future needs, other countries which are more developed than Iran must be considered as they can provide examples of passengers' demands. Although the company considers customers needs in the selection stage, they do not assess these needs in a structured manner; however, this might be encouraged by the use of a theoretical model.

As discussed in the creativity section, there are two kinds of innovation in this company. A number of interviewees (nom.: 1.4, Prod.; nom.: 1.5, Proj.; nom.: 1.6, Indus.) believed that before going ahead with a completely new project (incremental), high-level management must make the final decisions as the product needs their approval (Figure 5.7). It can be said that the effect of high-level management opinions on the selection stage vary based on the kind of innovation. No useful information about the process of this decision-making was found. But as interviews suggest, high-level management can veto ideas which were previously selected by expert groups. It is probable that high-level management also use experts' opinion when making their final decision but they will not explain their reasons to all employees. It looks like this parameter has an effect on the selection stage in this company.

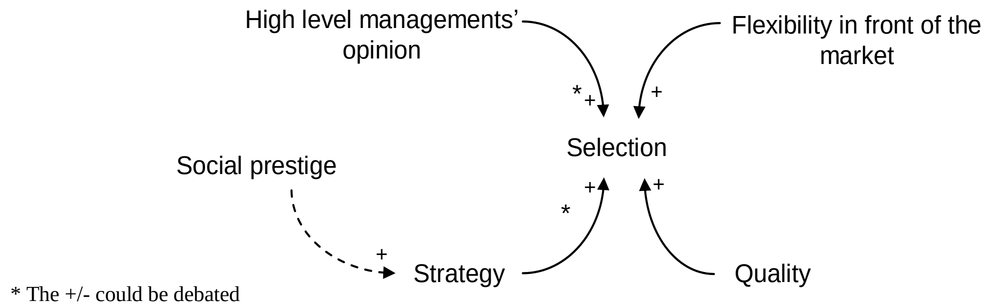


Figure 5.7 - Influences on selection at SK (II)

Based on one interviewee's definition (nom.: 1.5, Proj.) some factors like social prestige, quality, flexibility within the market, should be considered at the selection stage (Figure 5.7).

Figure 5.8 illustrates all of the factors which were examined earlier and have an effect on the selection stage based on the interviewees' explanation.

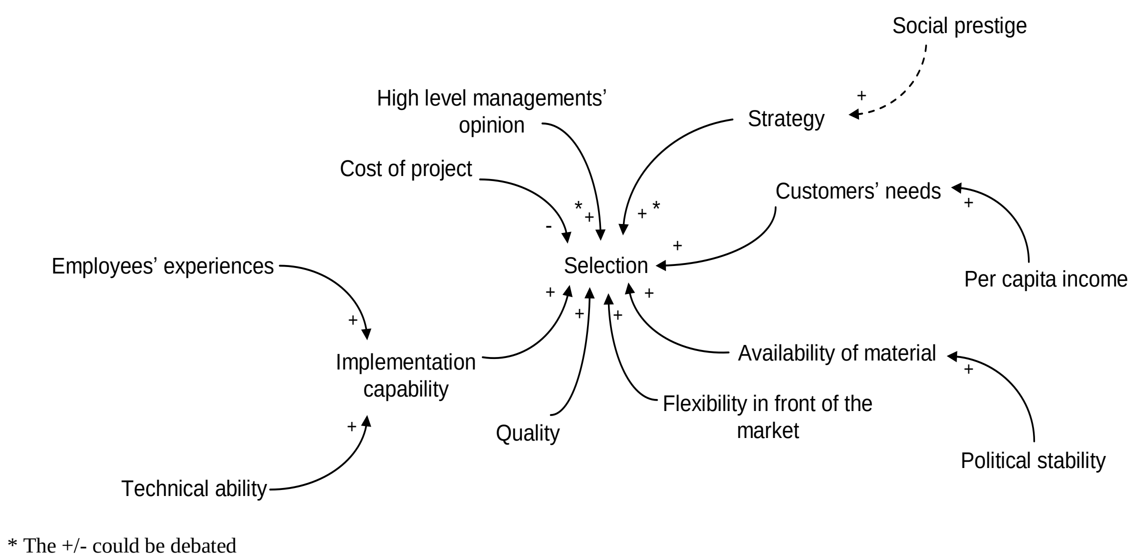


Figure 5.8 - Combining the influences on selection at SK

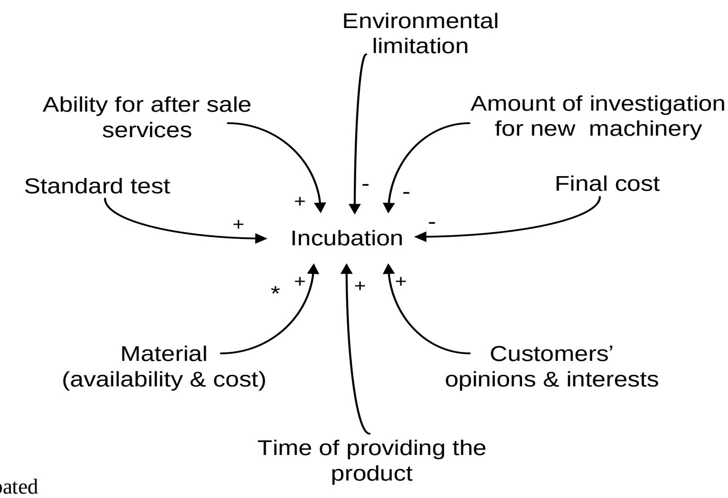
5.1.3 Incubation

One of the interviewees (nom.: 1.1, QA) said that before the item is produced, there is another stage for production of the prototype. In this stage, the company only produces one or two samples. It can be said that this stage (producing the prototype) is the incubation stage (nom.: 1.2, Design). This product is then shown to customers in order to receive their feedback and allows the company to consider their opinions (nom.: 1.2, Design; nom.: 1.5, Proj.). Based on one interviewee's idea (nom.: 1.1, QA) the availability of raw material and cost plays an important role in this stage.

Before the mass production stage, there are some checklists that should be considered regarding the prototype. These checklists are an important way to ensure the improvement of the product at this stage before progressing to mass production (nom.: 1.1, QA). In addition one interviewee (nom.: 1.2, Design) emphasised the importance of quality standards at this point. This means completing tests to approve the product should be done in this stage. In other words, after approving the prototype we can progress to the implementation stage (nom.: 1.4, Prod.).

One interviewee (nom.: 1.5, Proj.) said that before going to the implementation stage the company should consider: final cost, environmental limitations (occasionally production may be deemed harmful to the environment and rules will prohibit production), the length of the period of production and the ability to provide after sale services. After this stage the company will make a decision as to whether it can go to the implementation stage or not (nom.: 1.2, Design). In addition, before going to the implementation stage, the company should consider its current equipment and assess if any investment will be required for new machinery in order to produce the new product (nom.: 1.4, Prod.).

Figure 5.9 indicates all of the factors which were discussed earlier and have an effect on the incubation stage based on the interviewees' opinions of this company.



* The +/- could be debated

Figure 5.9 - Influences on incubation at SK

5.1.4 Implementation

It can be said that in this company, the implementation stage is divided into two parts: pilot production (10-15 products in total) and mass production (3-7 products a days). Based on one interviewee's opinion (nom.: 1.1, QA) the pilot production is like the implementation stage but on a smaller scale. In this stage the company produces a small number of products to check the system. In other words in pilot production, the company wants to check any problems that may arise through mass production. For example: is there enough space on the production line and what, if any, changes need to be made to the production line? This stage is essentially a simulation of mass production.

The industrial engineering division and manufacture engineering division undertake the activities of the implementation stage (nom.: 1.2, Design). To do this job they utilise the product design division's opinion. These two divisions undertake the technical assessment and calculate the final cost of the product. For instance, the industrial engineering division calculates the Bill of Material (BOM) for all raw materials and calculates the final cost.

Also, the manufacture engineering division translates the design plan for production. Basically the manufacture engineers prepare the final instructions for production.

One interviewee (nom.: 1.1, QA) declared that market, customers' opinions and the amount of sales are important factors in this stage that the company should consider them when progressing to mass production (Figure 5.10). Also, he added that when producing the product, the production line has two needs: 1-production plan, 2- instruments (these instruments are either from Iran or outside). In this stage the company should measure the results and compare them with their goals, they should also analyse any deviation and provide correction comments (nom.: 1.5, Proj.). There are two kinds of problems in the implementation stage: 1- there is a flaw in the design of the product, 2- the product is fine but there is a problem in production (nom.: 1.4, Prod.). In the company and also at this stage there is a continuous improvement system in operation. It means that different parts of the product, supplier etc will be checked in this stage (nom.: 1.5, Proj.; nom.: 1.1, QA).

Figure 5.10 illustrates all of the factors which were examined earlier and have an effect on the selection stage based on the interviewees' explanation

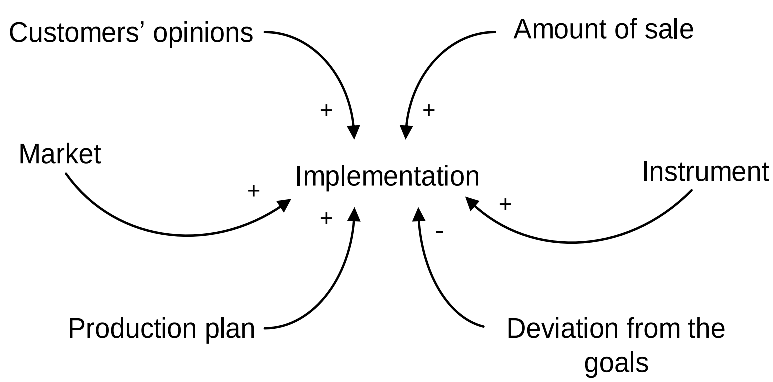


Figure 5.10 - Influences on implementation at SK

5.1.5 Learning

Based on one interviewees' opinion (nom.: 1.1, QA) learning is one of the strategic purposes of this company. He stated that:

> *"Each project (product) has its own notebook. In this notebook the production processes for this product are written down. For gaining ISO, having these notebooks are necessary."*

As another interviewee said (nom.: 1.2, Design), in the incubation stage the process is completely documented. The documentation starts earlier but is completed at this stage (nom.: 1.3, Prod.). It is possible then to follow the documentation from selection to incubation as it is being completed throughout the entire production process and also at the same time the prototype is being produced.

Based on one interviewees' opinion (nom.: 1.2, Design) the prototype production and documentation are completed by the product design division. He said that documentation includes different activities such as the planning of the product, method of production and a list of different parts. He emphasised that to attain the standard, the company needs documentation.

It seems because of the nature of this industry, documentation is necessary for this company especially in order to set different standards. Also, one interviewee claimed that this documentation can be used as a source of creativity. It seems that although there is some documentation undertaken effectively in this company, the learning and documentation are not currently a formal requirement.

5.2 Risk

Most of the interviewees believed that there are a lot of risks facing the company and the company should consider them. One of the interviewees (nom.: 1.9, Fina.) mentioned that some industries have a monopoly in Iran, and as there is not enough strong competition there is no need to consider every risk. For instance, the bus and truck manufacturing industry is limited to domestic companies as the tariff on importing foreign cars is high (e.g. this company has only six internal competitors and each of them has a specific market share). As one interviewee (nom.: 1.6, Indus.) emphasised it should be considered that the characteristics of each industry play an important role on innovation and risk management, so familiarity with the situation of the manufacturing industry in general and also each industry in particular is very important.

Based on one interviewee's opinion (nom.: 1.2, Design), it is better to consider the risk at all stages of the innovation project because risk is a continuous issue. The manager of quality assurance (nom.: 1.8, QA) mentioned that:

> *"For example, sometimes the product will progress to the implementation stage (by approving the criteria in incubation stage) but it will face a lot of risk at this stage. This means the prototype may not have any major problems but in mass production some problems will occur."*

According to the responses of some interviewees (nom.: 1.2, Design; nom.: 1.8, QA), the unstable economic and political situation of Iran means that creativity suffers from a high degree of risk, thus company should consider risk at the creativity stage as well.

One respondent (nom.: 1.2, Design) claimed that risk management in the incubation and implementation stage (especially in implementation stage) plays a very important role for each company. At these decision points, risk must be considered carefully. In addition one of the interviewees (nom.: 1.8, QA) stressed that the selection stage was vulnerable to risk and that the company should consider different kinds of risk in this stage as well.

5.2.1 Identifying potential risk factors

During interviews, each interviewee explained the different factors which create the risk based on his/her point of view. One interviewee (nom.: 1.8, QA) claimed that the unstable situation of Iran causes different and difficult situations for the managers which they should face and deal with effectively, so their ability to recognise factors which create the risk increase.

Based on one interviewee's opinion (nom.: 1.1, QA) one of the most important factors which creates risk is coordination between company and customers. Another interviewee (nom.: 1.4, Prod.) also mentioned that a problem in relation to customers is a lack of common language when communicating with the company.

One respondent (nom.: 1.1, QA) claimed that in a large company such as this, coordination between different parts is often difficult and sometimes causes problems. For instance, there is usually some contradiction between engineering, which is related to the prototype and implementation stage (nom.: 1.4, Prod.). Another interviewee (nom.: 1.2, Design) explained that some situations expectation and job specifications do not work well together; this is one of the barriers for scientific implementation of the innovation process which can then create risk. Also one interviewee (nom.: 1.5, Proj.) mentioned that the culture of the company does not encourage creativity as there is no motivation provided. Another respondent (nom.: 1.4, Prod.) added that there are problems in the organisational structure of the company. It seems all these factors can be categorised in the field of management as these factors can create risk in the process of innovation.

One of the factors which is out of the control of the company and related to the situation of Iran is the government's laws (nom.: 1.8, QA). The laws in Iran are not fixed and as such they are liable to change at any time. These changeable laws can play an important role in creating risk. In general, the role of the government in the bus and truck manufacturing industry is stronger than the small car manufacturing industry (nom.: 1.3, Prod.). Essentially, the government's decisions have a direct effect on this industry, as the government is their biggest customer and also helps other small customers in this industry by giving them loans.

One interviewee (nom.: 1.4, Prod.) in the manufacturing division, believed that new technology is one of the parameters which creates risk at the implementation stage. In addition, based on the number of interviewees' statements (nom.: 1.9, Fina.; nom.: 1.6, Indus.) some other important factors which help create risk are economical, social and political issues. For example, 85% of raw materials are imported from abroad but during the current international trade sanctions the company should try and source materials from internal resources. Also, inflation rate and the required funds (e.g. to buy raw materials) are two other parameters that the company should consider as factors which can create risk in this process (nom.: 1.9, Fina.).

Based on the opinion of one interviewee (nom.: 1.3, Prod.) in the planning and control division, there are some factors that should be considered as parameters which create risk within a different division. These are: plan of sale division, raw material, staff, equipment and required space. He believes that all of these parameters should be considered and added that none is more important than another. However, if they all create risk and the probability and degree of their threat are different it seems that finding a priority amongst them is necessary, because the company will not have unlimited resources to manage all of them.

All of these factors which create risk in this company based on interviewees' opinion can be elicited from these different interviews and can be categorised in the following areas. These factors are:

- **Resources:** raw material, funds, required space, staff.
- **Environment:** government's laws (not fixed), political issues, economical (e.g. inflation rate), social.
- **Technical:** new technology, machine and equipment, coefficient of solidity.
- **Management:** coordination between different parts (e.g. contradiction between incubation and implementation), coordination between company and customer (lack of common language), high level management opinion and attitude, not harmony between job specification and expectation, organisational structure, lack of motivation, plan of sale division.

5.2.2 Analysing risk

During the analysis, the probability of each risk and its impact should be found and the company should prioritise them. However, there is little consideration of these two tasks and the company usually consider risk based on predictions, previous trends and employees' experiences (nom.: 1.8, QA; nom.: 1.3, Prod.). One interviewee believed that as there is no specific and formal method for calculating the probability of various kinds of risk in this company (nom.: 1.4, Prod.), each division should consider risk individually (nom.: 1.6, Indus.). This company has knowledge of FMEA but it does not use it completely (nom.: 1.1, QA).

One of the interviewees (nom.: 1.3, Prod.) stated that there are two types of factors which create risk: Internal and External. The company can identify the probability of an event and the required action for some internal factors, but for external factors it is more difficult to do so. For instance, there is documentation regarding the internal factors which can highlight potential risk such as machinery. Also there are some methods which can solve these events, but external factors are usually out of the company’s control.

Based on one interviewee’s opinion (nom.: 1.1, QA) before the mass production stage, there are some checklists that must be undertaken when considering the prototype at the incubation stage. It seems these checklists can be interpreted as a risk analysis tool. In addition one of the interviewees (nom.: 1.2, Design) emphasised that the prototype product needs some standards. This means that some tests for approving the type of product produced should be completed at this stage. These kind of tests can play a role as a sensible risk management. As discussed in the implementation section, pilot production is like the implementation stage but on a smaller scale (nom.: 1.1, QA). At this stage the company produces a small number of products to check the system. In other words in pilot production, the company wants to check for any problems that may arise during mass production. It can then be said that the pilot production plays a role as a sensible risk management as well.

One interviewee (nom.: 1.9, Fina.) said that the company should use different opportunities to find more benefits. For instance, a lack of fuel that increases the price of fuel can be seen as a good time to produce a new engine which replaces the current fuel. He claimed that to find the opportunity and threat (which can create the risk) the company uses a SWOT analysis. It seems this method can be used as a risk management tool to identify the factors which can create risk rather than analysing them.

5.2.3 Risk management action

One of the respondents (nom.: 1.2, Design) explained that within this company, risk is not considered on some internal projects which are on a small scale because the cost is lower than the cost of a risk management assessment. In this area, another interviewee (nom.: 1.4, Prod.) said that if there is only a small change in the new product then the amount of risk is not worth considering.

A number of interviewees believed that managing the product portfolio in a proper way can help to reduce the risk of production. For instance one interviewee (nom.: 1.9, Fina.), a finance manager, believed that:

> *"The risk of producing one kind of product is higher than producing several kinds of product. It means that threats in producing one product are more than other situations."*

Therefore the company should produce several kinds of products more often and provide them during a shorter period of time (nom.: 1.6, Indus.).

One interviewee stated that (nom.: 1.5, Proj.) there are two models which the company uses in response to risk. These are: transference of the risk to other parties and redundancy (parallel solution paths). For instance suppliers are changed during a specific period or two suppliers are used, or the machinery is checked at regular intervals (nom.: 1.3, Prod.).

5.2.4 Monitoring/Learning

There are some methods in this company for controlling the different stages of innovation but in some situations it is not directly related to the risk management system. For instance, one interviewee (nom.: 1.1, QA) mentioned that there is some control in the implementation stage such as controls based on ISO. By using these standards, quality assurance and production division control the product and are responsible for finding any problems which may occur. Another interviewee (nom.: 1.10, Indus.) stated that to control the process in the implementation stage, the company uses the OPC (Operation Process Chart) method. He added that this method helps the company to find existing problems and provide corrections for them. Also, the company uses employee's proposals for the prevention of some potential problems (nom.: 1.1, QA).

The project management division reviews the whole project based on the project map (nom.: 1.5, Proj.). The main responsibility of this division is to set timescales for each activity (simultaneously or consequently) in each project. It also identifies the resources which are needed for this project such as: number of employees, number of experts and how many hours. Based on one interviewee's opinion (nom.: 1.10, Indus.) when assessing the timescale of an activity, the company considers the parameters which have an effect on the process. It can be said that by controlling the project map, the company can then find potential problems which create risk in this process but also discover solutions to help manage them. Unfortunately there is no acknowledgement of the difficulties and uncertainties regarding such resources which are estimated at the innovation project.

Another monitoring mechanism is the division of planning, control and production who send feedback to other divisions within the company in order to aid corrections (nom.: 1.3, Prod.). This division acts as the centre of the company; it receives reports from different divisions and also sends feedback to them about their activities. For example, sending feedback to the engineering division about safety, or sending feedback to the sales centre regarding supply the products and current situation of the inventory, or the sending of feedback to the production division, marketing division, logistic division and also administrative division about employee satisfaction.

5.3 Conclusion

There is some creativity within this company but there was little variety. This is because the company produces heavy vehicles (i.e. buses) and their customers have standardised but specific requirements. Since the company does not need to compete for customers, and at any given moment it has a minimum amount of market share, there is lack of competition and consequently a lack of creativity in the company.

Although the interviewees could relate to the stages of innovation of the proposed model, usually no formal meetings are put in place at points of decision to allow a project to progress from one stage to the next. Also, in this company, creativity and selection are part of a single stage. This is because the company is limited to a few options due to the customer’s requirements. In this company, the implementation stage is divided into two parts: pilot production (10-15 products) and mass production (3-7 products in a day). Because of the nature of this industry, documentation is necessary for this company in order to set standards. It seems that although there is some documentation undertaken effectively, documentation and learning are not currently a formal requirement.

Interviewees believed that it is better to consider risk at all stages of the innovation project as risk is a continuous issue. However, there is little consideration given to analysing tasks in this case and the company usually considers risk based on predictions, previous trends and employee’s experiences. As there is no specific or formal method for calculating the probability of various kinds of risk in this company, each division should consider risk individually. This company has knowledge of FMEA but does not use it completely. Before the mass production stage there are some checklists and standard tests that must be undertaken when considering the prototype at the incubation stage, which can be regarded as sensible risk management. One interviewee explained that the company applies a SWOT analysis to the risk factors. He claimed that in order to find opportunities and threats (which can create risk), the company uses a SWOT analysis. It seems this method can be used as a risk management tool to identify factors which create risk rather than analysing them.

Some actions were undertaken by this company in order to manage the risk. For instance: the transference of risk to other parties and redundancy. Also interviewees mentioned that managing the product portfolio in a proper way can help reduce the risk of production. Some methods are employed in this company to control the different stages of innovation (such as ISO, OPC and Project Management) but in some situations it is not directly related to the risk management system.

Chapter 6 Case 2- Firoozeh Tile (FT)

In 1994 Firoozeh Tile[1] was established with capacity to produce over 750000 square meters of tiles per year. After the first developmental phase this number has been increased up to two million square meters. By getting official loan from Ministry of Industries & Mines, the second developmental phase was started in order to produce 5 million square meters floor and wall tiles. All machineries have been purchased from Italy accompanied by the related experts in order to launch modern mechanised systems. Now the production capability of the company is 5 million square meters different kinds of floor and wall tiles per year and 10 to 20 percent export capability of their production. At present, the company has more than 400 employees and is one of the top ten producers in the tile industry (nom.: 2.8, Admin.)[2].

Figure 6.1 - Example pictures of Firoozeh Tile (FT) and its products

In the following passages, interviewee's opinions about innovation and risk in regards to this company will be examined. Also, for greater clarity, the effect of different factors on each stage of innovation will be shown using influence diagrams.

1 Accessed on 11.12.2008: www.firoozehtile.com

2 The abbreviations of the interviewees' job title for this case are: Technical Manger (Tech.); Production Manager (Prod.); Operation Manager (Oper.); Business and logistic Manager (Busi.); Research and Development Manager (R&D); Marketing and Sale Manager (Mark.); Quality Assurance Manager (QA); Administration Manager (Admin.).

6.1 Innovation

15 years ago there was no competition in this industry, thus the customer had no choice but to purchase tiles no matter what their quality. However, in recent years (especially after the war between Iran and Iraq) the market began to change. Competition has increased and innovation is now prompted by changes in technology and the market. With the speed of development and a greater range of innovative products, innovation is needed in companies in order to remain competitive and progress; unfortunately, innovation carries a degree of risk which must be assessed (nom.: 2.3, Oper.; nom.: 2.6, Mark.; nom.: 2.4, Busi.). In other words, without innovation, producers are doomed to failure. It can be said that the most important factor for consideration, when investigating any new idea, is not funding but rather if the investors have any new innovation scheduled (nom.: 2.3, Oper.).

This company is currently working on several different kinds of innovation (nom.: 2.5, R&D). For example unifying the formula of floor and wall tiles (nom.: 2.5, R&D). Also, one new idea developed by this company involves the combination of tile and nanotechnology to produce ceramics which are anti-fungal and anti-bacterial (nom.: 2.3, Oper.; nom.: 2.4, Busi.). This idea comes from outside the company. During the interviews it seemed the company had limited confidence in the idea and little knowledge of the risk; therefore they hesitated when progressing with the idea. This example suggests that if the company had a more structured approach to managing risk, they might have felt more confident and pushed forward with this idea: they might be able to identify probable risks during the different stages of the innovation process and consider the action required to manage them. According to one interviewee (nom.: 2.5, R&D), there are also some innovations regarding the design of tiles within the company. One interviewee (nom.: 2.1, Tech.) said that 90% of new designs are created by the design team within Firoozeh Tile company, only 10% are imported from other countries. The laboratory usually produces a new design each month, which is then eliminated after a number of productions and replaced by a new design (nom.: 2.1, Tech.). One interviewee believed that (nom.: 2.2, Prod.) as costs are low in incremental innovation, the implementation division would utilise existing facilities and try innovative ideas (e.g. different colours on current products) that involve applying different designs to current platforms. It should be noted that the opinions and feedbacks of customers are sometimes in favour of incremental innovation (nom.: 2.2, Prod.).

One of the interviewees (nom.: 2.1, Tech.) mentioned that two important barriers to innovation for this company are: financial issues and technology, although high-level management usually support new ideas financially and try to reduce risk. However, it can be said that financial issues are a parameter which might create risk in innovative projects.

Some interviewees explained a number of characteristics of high-level management that may be a barrier to innovation within the company. For instance, one interviewee stated (nom.: 2.5, R&D) that high-level management do not have scientific expertise to aid in the decision making process. He said that if they can assess different ideas based on scientific methods, it would enable them to choose the most appropriate idea. Another interviewee (nom.: 2.6, Mark.) mentioned that:

> *"High-level management will not accept the risk of innovation and stakeholders are not educated enough to aid in the decision making process. Most of our managers' would choose short-term benefits over long-term benefits. However there is, fortunately, a potential for high-level management to accept risk."*

Another interviewee (nom.: 2.2, Prod.) explained that if some opinions failed, high-level management would accept it. One interviewee (nom.: 2.3, Oper.) emphasised that by considering the role of high-level management at different stages of the innovation process, and tough competition in the marketplace, management must have the technical knowledge to minimise risk and promote creativity in the workplace. In addition they should utilise employee's knowledge and believe in innovation, in order remain innovative in the market (nom.: 2.4, Busi.).

According to one interviewee (nom.: 2.7, QA) another barrier to creativity in FT is unfamiliarity with innovations existing throughout the world. Therefore, the lack of connection and information exchange between foreign professionals and producers creates this barrier to innovation.

6.1.1 Creativity

According to one interviewee (nom.: 2.1, Tech.) one of the factors that forces the company to be creative is the current political situation in Iran (Figure 6.2). The political situation (e.g. international trade sanctions) has an effect on the process of 'order and receive' as raw materials from foreign suppliers are often more expensive and take longer to arrive. Thus, by considering this situation, the company should utilise internal abilities when attempting to increase the life cycle of products and help minimise risk. One interviewee (nom.: 2.2, Prod.) explained that there are three sources of innovation in this company, these are: 1- Problems within the company, which in order to be resolved push the company down the innovation path, 2- Employee's opinion and 3- Customer's needs which are reported by marketing and sale division. Also, another interviewee (nom.: 2.3, Oper.) emphasised that producers must compete to satisfy the market and customer's needs. This means producing designs they like or identifying their opinion on current products (nom.: 2.7, QA). Sometimes the request comes directly from the customer, however the company also provides new designs and when these permeate the cultural zeitgeist they can be added to their list of most popular designs (For example, granite designs with different colours or large tiles ($60\times60cm^2$) with smaller thickness (2-5mm instead of 8-10mm)) (nom.: 2.7, QA; nom.: 2.4, Busi.). There are two kinds of customers in this company: internal and external (nom.: 2.3, Oper.). An internal customer is where one division satisfies the needs of the next division; in other words, each division is the customer of another. External customers on the other hand, are real customers in the market and are the most important factor in the innovation process.

Employee opinion is one source of creativity within this company (Figure 6.2). It should be noted that motivation is needed for creativity and different people will need different motivation, for instance some employees need to be psychologically encouraged before they put forward creative ideas (nom.: 2.3, Oper.). One interviewee (nom.: 2.2, Prod.) claimed that there is a procedure in place that helps gather employee's opinions and those who contribute ideas are encouraged. However, another interviewee (nom.: 2.8, Admin.) believed that:

> *"There is no formal encouragement system for innovative people within the company; however high level management will encourage employees to be innovative in a non systematic way."*

It seems that the company has a policy which encourages employee creativity and welcomes their ideas, however the policy is improperly implemented, hence the interviewee's divergent views. In regard to this, one interviewee (nom.: 2.8, Admin.) explained that there is a pilot suggestion system in place in one division which serves two purposes: 1- Receives employee's comments and 2- Satisfies employees by letting them contribute ideas. After testing this system, the management intend to apply it to the whole of the company. The company is trying to create a competitive atmosphere where the employees try to increase and update their ability and knowledge; this in turn has an effect on their creativity (nom.: 2.4, Busi.).

As mentioned earlier, the problems within the company is one of the sources of creativity (Figure 6.2). The management board will organise some meetings and attempt to identify problems in order to solve them. During these meetings, staff from several divisions gather alongside high-level managers to discuss constructive ideas which help target problems and identify possible solutions. The cycle of decision, correction and implementation is always undertaken for different projects (nom.: 2.2, Prod.).

One factor, which can have an effect on the creativity stage, is customer opinion (nom.: 2.5, R&D). In order to identify potential gaps in the market, the 'design group' gathers customer' ideas and opinions and designs new products based on these opinions (nom.: 2.1, Tech.). Also, one interviewee (nom.: 2.2, Prod.) believed that because customer opinion is conveyed through high-level management, customer opinion must be acted upon. He added that the design group uses the opinions of sales representatives, inside and outside the country, to gather the opinion of national and international customers (it must be noted that most of FT's exports are to countries which cannot afford foreign products, however FT's products are better than their own (nom.: 2.6, Mark.)). In addition, another method the company uses to identify customer's needs and gather feedback is to distribute questionnaires through sales representatives (nom.: 2.6, Mark.; nom.: 2.4, Busi.). But it should be noted that there is a percentage of error in this method. Moreover, the company runs a program which involves inviting sales representatives to visit the company to elicit their opinions, make them familiar with the processes involved in production and assess the market situation (FT has approximately 180 sales representatives). This program runs at least once a year in order to obtain representatives ideas directly; these can then be assessed alongside other opinions that have been gathered through out the year (nom.: 2.7, QA). Figure 6.2 indicates various factors which were discussed earlier and have an effect on creativity in this company.

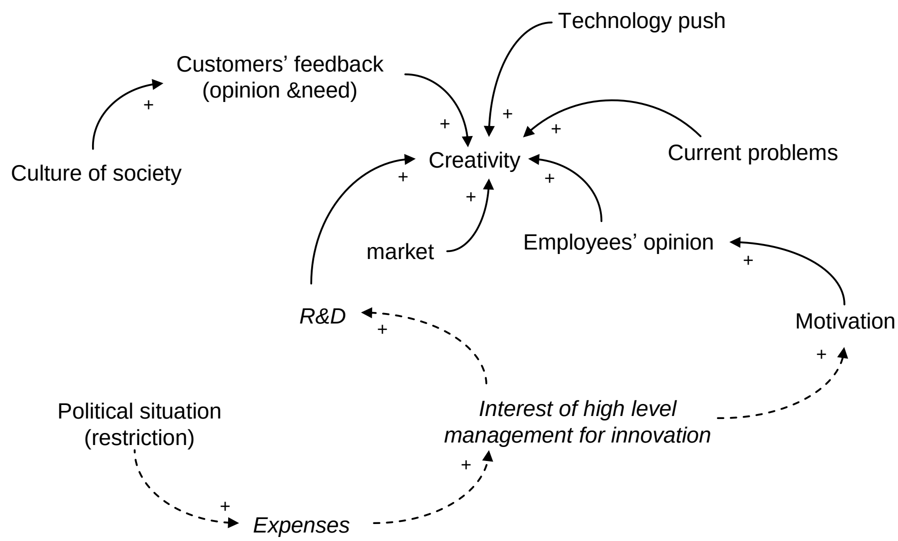


Figure 6.2 - Influences on creativity at FT (I)[3]

One source of innovation is information received from high-level management, which is gained from new items introduced to internal and international markets (nom.: 2.2, Prod.). This means that by considering domestic and international competitor's products the company may be able to identify gaps in the market and create new and innovative products (Figure 6.3).

According to one interviewee (nom.: 2.2, Prod.), competitors will occasionally create products which are not urgently required by customers. However, in these cases, they attempt to create a brand image in the mind of the customer that will in turn create desire

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[3] The continuous lines represent influences explicitly identified by the interviewees; the broken lines are influences which are inferred from interviewee comments.

and need of the new product (e.g. opaque tile designs); FT needs to be aware of this issue and must not be left behind in the market. As Figure 6.3 indicates, it can then be said that competitors and culture of society have an effect on creativity stage.

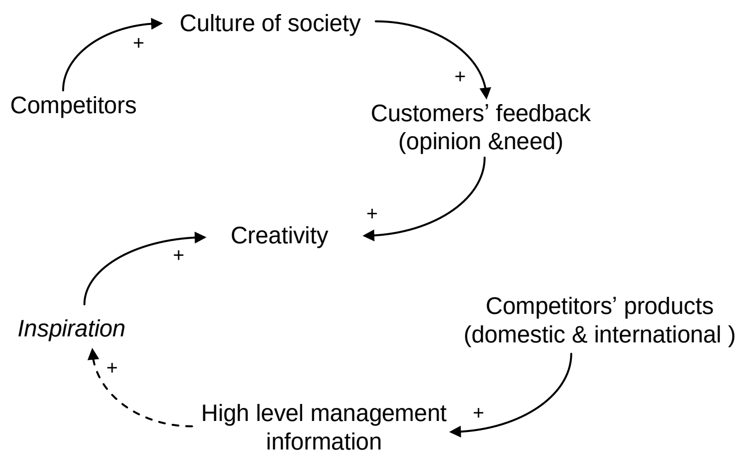


Figure 6.3 - Influences on creativity at FT (II)

One interviewee (nom.: 2.5, R&D) explained that ideas from other industries are a factor which can have an impact on the creativity stage (e.g. cloth industry). This means that by considering new designs and idea in similar industries, the company can begin creating new products (Figure 6.4).

Raw material suppliers can also be seen as a source of creativity. These companies often produce designs based on their own raw materials in order to market new materials; these designs can then offer ideas for new product (nom.: 2.7, QA).

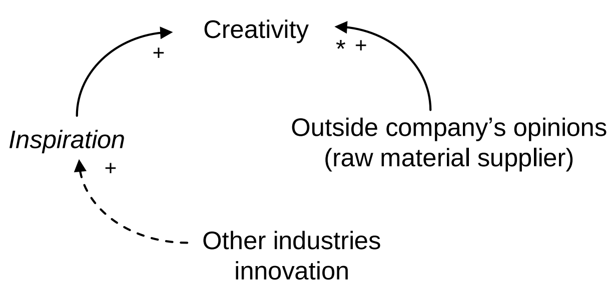


Figure 6.4 - Influences on creativity at FT (III)

The following influence diagram (Figure 6.5) shows all of the factors which were discussed earlier and have an effect on the creativity stage based on various interviewees' opinions for this company.

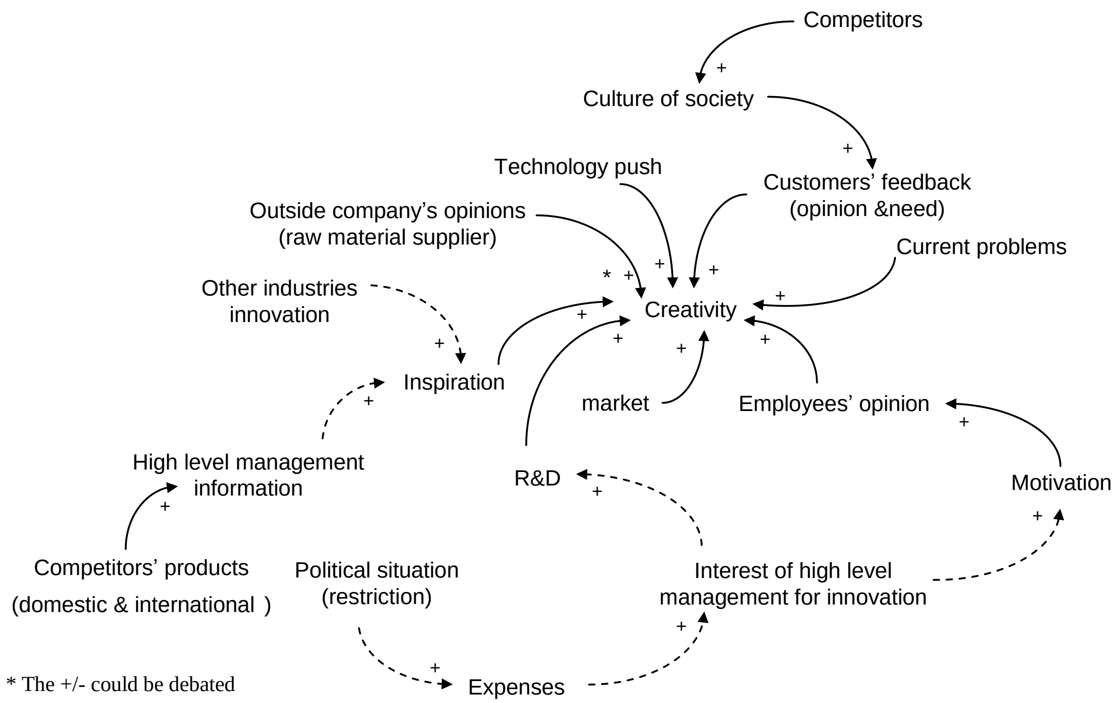


Figure 6.5 - Combining the influences on creativity at FT

6.1.2 Selection

Some interviewees (nom.: 2.1, Tech.; nom.: 2.5, R&D; nom.: 2.6, Mark.) believed that the opinion of high-level management, and shareholders, could effect the selection of new ideas (Figure 6.6). In board meetings, new ideas and existing problems are discussed and high-level management then decide whether to give new ideas priority over the solving of any existing problems (nom.: 2.2, Prod.). It can then be said that formal decisions are made regarding at least some types of innovation at this stage.

One factor which can have an effect on selection is technical ability (nom.: 2.1, Tech.; nom.: 2.7, QA). In other words, technology will effect the selection, continuation or elimination of a project (Figure 6.6). The technical division must make a report to the management regarding the technical ability of the company before any decisions are made regarding the production of a new product. If there is a need for alterations, the technical division must mention this in their report (e.g. to produce tiles bigger than 40×40 cm^2 the company must purchase new equipment) (nom.: 2.1, Tech.).

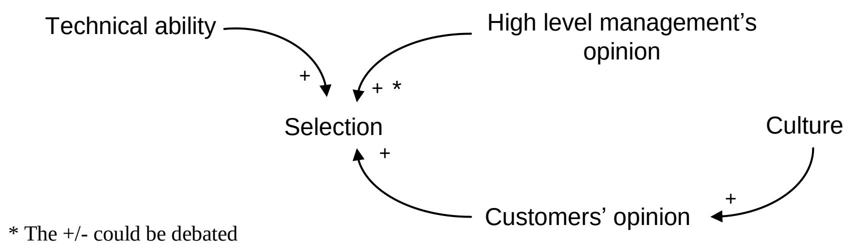


Figure 6.6 - Influences on selection at FT (I)

Some interviewees believe (nom.: 2.2, Prod.; nom.: 2.3, Oper.) that one of the most important factors which should be considered in the selection stage of new product development, is the culture of society (Figure 6.6). In this respect, another interviewee (nom.: 2.1, Tech.) emphasised that the customer opinion varies due to the tastes and cultures of the different regions. As Iran is a large country, it has a wide variety of cultures with varying tastes (e.g. north of Iran prefers cool blue shades and in south of Iran they prefer dark, warm tones). This inevitably effects the selection and the continued production of new designs. As one interviewee (nom.: 2.3, Oper.) declared, sale representatives are the most important people when it comes to gathering customer's opinion. Sales representatives are able to travel across the country, gathering feedback and identifying different cultural ideas which then aid in the design of new products (nom.: 2.7, QA). The company uses this information throughout other stages as well.

According to one interviewee (nom. 2.3, Oper.), two factors which affect the selection stage are: 1- financial issues and 2- time to achieve end result (Figure 6.7). Financial issues are important as they involve assessing the cost of production, as new products must have a good profit margin (nom.: 2.6, Mark.). In addition to this, the time it takes to produce any new item must be kept to a minimum as a long production time can lead to competitors filling gaps in the market. Predicting market acceptance also plays an important role in this stage (nom.: 2.7, QA).

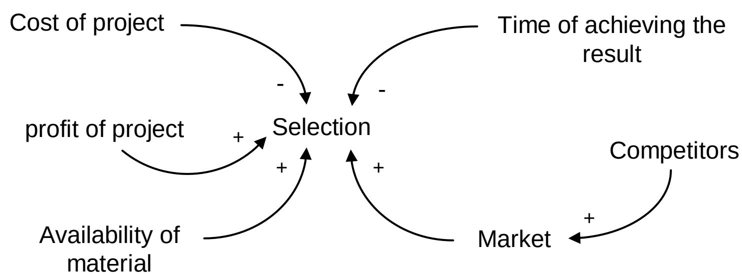


Figure 6.7 - Influences on selection at FT (II)

One interviewee (nom.: 2.3, Oper.) stressed that when selecting any new project, the company uses a feasibility study. In this study different attributes, which were examined earlier, are considered. These include: technical ability, cost, competitors, and availability of raw material. It seems then, that the degree to which these attributes are considered and the attention dedicated to them must be assessed on the kind of innovation (incremental or radical). Also, for greater clarity, it is better to present these attributes separately in the influence diagram (Figure 6.7). Although some interviewees claimed that the company employed a feasibility study in the selection stage, it seems that at least for some specific examples the feasibility was not properly assessed. For instance, in one product, the company only became aware of a problem with the supply of a key imported raw material at a reasonable price after implementation. They attempted to reduce the final price of enamel by substituting imported raw materials for Iranian raw materials (nom.: 2.5, R&D). Although the company managed to find an alternative Iranian material, such a problem should have been identified and resolved earlier. This experience suggests that if the company had used the theoretical model, it might have considered the risk involved in the availability of raw material and subsequent possible actions at the selection stage before the product entered the implementation stage. Therefore avoiding the risk of very expensive failure at the later stage of product development.

The following influence diagram (Figure 6.8) shows all of the factors, which were discussed earlier and have an effect on the selection stage according to several interviewees.

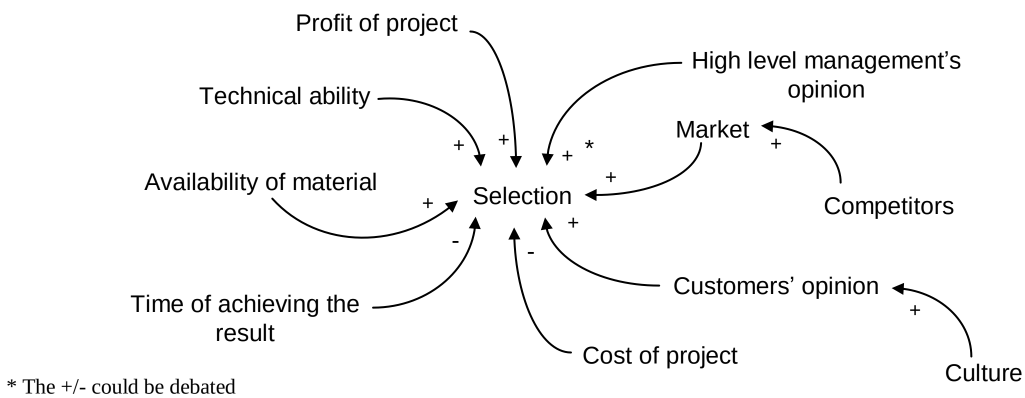


Figure 6.8 - Combining the influences on selection at FT

6.1.3 Incubation

As one interviewee (nom.: 2.5, R&D) explained, the research division (laboratory) produces a prototype using a small-scale pilot production designed for this purpose. After designing the first version of the mould, 50 samples are produced and the laboratory begins testing and reports any problems (e.g. technical problems like fractures) in order to make improvements and alterations in preparation for mass production (nom.: 2.1, Tech.). Moreover, the quality control division applies some tests to the prototypes (nom.: 2.5, R&D). For example: testing the shock endurance of the tiles, the quality of enamel, firmness of the tiles and the colour quality. Besides some internal tests, the National Standard Organisation puts in place product quality standards, which must be passed successfully. For instance, based on the research and development manager's statement (nom.: 2.5, R&D):

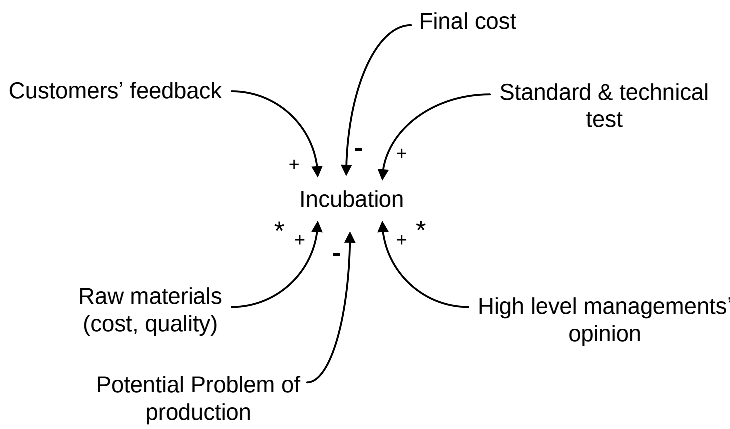
> *"In regards to wall tiles, the maximum water absorption level should be 10% and for floor tiles this should be 6%. These are the minimum standards which must be applied; however it is always better to improve these norms."*

However, it is interesting to note one interviewee (nom.: 2.7, QA) claimed that internal standards are tougher than rigid governmental standard tests. This is because the company respect their customers and want to provide them with the best possible product (nom.: 2.7, QA).

After passing the quality control division, the product is taken back to the laboratory (research division) who use the finished sample to calculate the final cost more precisely; supplying raw material and potential problems which may occur in production (e.g. time of abrasion and density of enamel) are all taken into consideration for final decision about continuing the process. As one interviewee (nom.: 2.5, R&D) mentioned, sometimes transportation costs effect which raw material is selected. In these cases, high-level management will consult with other divisions and consider the cost and quality before making any decisions. After these quality tests and high-level management approval, the sample products are distributed to sale representatives in order to connect with customers and gather feedback (nom.: 2.1, Tech.; nom.: 2.2, Prod.; nom.: 2.3, Oper.; nom.: 2.7, QA). This activity is undertaken, particularly, for unusual and expensive products (nom.: 2.6, Mark.). The product will then progress to the implementation stage for pilot production (e.g. producing $20m^2$) (nom.: 2.5, R&D). However, one interviewee said (nom.: 2.5, R&D)

that occasionally, due to special circumstances, the company has to progress to mass production without considering customer opinion.

The following influence diagram (Figure 6.9) shows all of the factors which were discussed above and have an effect on the incubation stage based on interviewee's accounts of this company. These factors are: Final cost, Customer's feedback, Standard and technical test, Raw material, High-level management opinion, Potential problems in production.



* The +/- could be debated

Figure 6.9 - Influences on incubation at FT

6.1.4 Implementation

As the manager of the production division explained (nom.: 2.2, Prod.), one of this division's tasks is to implement the pilot production based on prototype models from the research division (laboratories). It can then be said that the implementation stage consists of two tasks, pilot and mass production. He claimed that:

> *"Occasionally ideas from the research division are not practical enough to be produced; thus this division makes changes to the prototype in order to make it functional. This is because the situation in the laboratory differs from the reality of implementation. For instance measuring in the lab is in milligrams but at the implementation stage it is in grams."*

There must be an iterative cycle between this stage and the incubation stage to help identify problems and solve them (nom.: 2.5, R&D; nom.: 2.7, QA). A degree of iteration may be viewed as good, however uncontrolled iteration can lead to innovation cycling for a long time and incurring considerable cost, so may be some of the iterations could be avoided by better decision making in earlier stages.

After pilot production, the product returns to the quality control division and is subjected to 22 standardised tests which it must pass (Figure 6.10). These include testing colour, quality etc. (nom.: 2.5, R&D; nom.: 2.7, QA). Also there are some standard forms which should be filled in by laboratories, quality assurance division and high level management, in order to confirm their approval of the final tests of the new product (nom.: 2.7, QA). If the pilot production does not produce the desired outcome, the process will be discontinued (nom.: 2.5, R&D). These standard tests can be considered a sensible risk management as they are part of a strict process and allow an opportunity for improvement, without which the prototype cannot progress to mass production. It should be noted that the situation of the ceramic industry is changeable and can change at each stage of production. Thus, testing is repeated at the prototype, pilot and mass production stages (nom.: 2.5, R&D). For instance, after the implementation stage, some standard tests are applied to the product again (nom.: 2.5, R&D). Some interviewees (nom.: 2.3, Oper.; nom.: 2.7, QA) mentioned that before progressing to mass production, products which were produced in pilot production and retain high-level management approval are again sent out to sales representatives. This is to investigate the amount required to satisfy market demand and confirm the numbers that need to be produced (e.g. crystal designed tiles, which passed the same process).

When moving to mass production, the company needs a production plan. In order to sketch a production plan, the planning division uses information about the timing of the production line and problems encountered when producing similar products (supplied by the production division) (nom.: 2.2, Prod.). One interviewee (nom.: 2.1, Tech.) said that the production plan is determined monthly. However, after considering feedback from the first sale, if the market needs more products the production plan will be reconsidered. It is at this point that the planning, sales and research divisions alongside high-level management can decide whether a product should be continued or terminated (nom.: 2.2, Prod.). For example, market share, customer interest and total sales are assessed every two months and the company continues or terminates the project based upon these figures (nom.: 2.6, Mark.). Overall, some products have a long life cycle and some have a short life as they quickly become unfashionable (nom.: 2.3, Oper.).

Figure 6.10 shows all of the factors which were discussed above and have an effect on the implementation stage based on interviewee's accounts of this company.

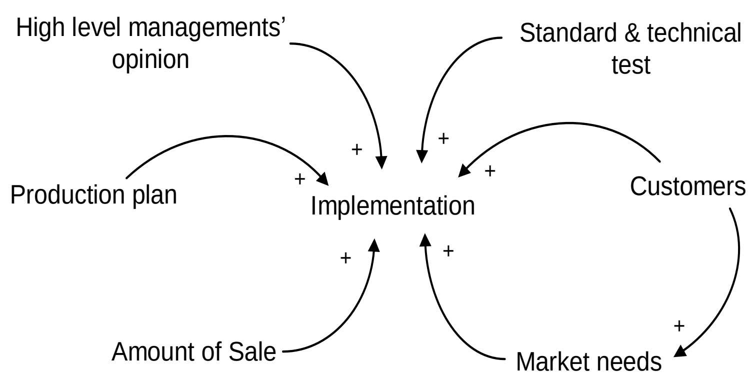


Figure 6.10 - Influences on Implementation at FT

6.1.5 Learning

Since this company possesses ISO (2000) certificates, all processes and events must be documented officially and reported in formal meetings (nom.: 2.5, R&D; nom.: 2.6, Mark.; nom.: 2.8, Admin.).

One interviewee (nom.: 2.1, Tech.) claimed that all technical reports and information are archived within the company. In other words, reports are collected from different divisions about each project. These reports are then examined in meetings and archived as a written documentation (nom.: 2.2, Prod.; nom.: 2.7, QA).

The manager of the administrative division (nom.: 2.8, Admin.) explained how they hold and manage educational classes within the company, based on the requirements of employees within each division. He also added that experienced employees teach new employees in order to transfer their knowledge and experiences to them (e.g. in the field of auto mechanic).

Although most of the interviewees claimed that the company archives all technical reports and information, there was no suggestion that the claims of using the information as a source of creativity and effective learning were justified.

6.2 Risk

According to one interviewee's opinion (nom.: 2.5, R&D), risk management is vitally important for success. He added that if the research division consider the chances of success and control risk properly it could affect the function of other divisions as well. One respondent (nom.: 2.7, QA) believed that because of the large amount of product required by the market, the company may not feel that risk management is necessary. However in a tough and competitive market, risk management is absolutely essential. In addition to this, the instability of Iran's political situation means that more risks must be considered during the innovation process (nom.: 2.3, Oper.).

As one interviewee (nom.: 2.1, Tech.) said, the goal of risk management should be to decrease the probability and impact of risk; to do this the process of risk management must be applied in all stages. In other words, risk needs to be considered at both the elementary and implementation stages in order to limit, or stop, failure (nom.: 2.2, Prod.; nom.: 2.7, QA). Regarding this, one interviewee (nom.: 2.6, Mark.) from the marketing division believed that:

> *"Risk needs to be controlled in all stages of innovation as it is a continuous issue. However if we control risk too much in the creativity stage, we might limit the company's success."*

It is interesting that the interviewee appreciated the balance between a need for risk management and the impact of managing the risk excessively. This interviewee has a holistic view regarding the process of innovation. It should be noted that this risk consideration must not be time consuming; the novelty surrounding the new product will vanish and the market will inevitably fill with similar competitors' products (nom.: 2.3, Oper.). Risk management should be undertaken for all projects but with consideration given to economical issues (nom.: 2.3, Oper.). In other words, from an economical point of view, risk management must be profitable.

The method used to manage risk is dependent upon the attitude (personality) of high-level management and the environment. This means that some managers are risk averse, thus they choose strategies which are less risky, and, therefore, might be less innovative (nom.: 2.3, Oper.; nom.: 2.8, Admin.).

6.2.1 Identifying potential risk factors

One interviewee (nom.: 2.2, Prod.) believes that the ceramic industry is very dependent on experience. Various problems (e.g. with raw materials or machinery) can occur during the production process and it is difficult to predict them beforehand. Therefore long term planning is very difficult and sometimes impossible in this industry (nom.: 2.3, Oper.). As one interviewee (nom.: 2.3, Oper.) mentioned, when identifying factors which create risk, in meetings attended by high-level management, risk factors and the person in charge of controlling that risk are decided. It can then be said that manager's experience is used to identify factors which create risk (nom.: 2.7, QA).

One interviewee (nom.: 2.3, Oper.) said that the environment is one of the most important risk factors. He added that the internal environment is usually controllable but external environment is not. Another interviewee (nom.: 2.1, Tech.) explained that technology, new methods and raw materials are factors which create risk in innovative projects. For example, in regards to raw material, one interviewee (nom.: 2.3, Oper.) said that after pilot production, and the company is able to progress to mass production, obtaining a supply of raw material is sometimes impossible and the project fails. Sometimes the quality of raw materials can create risk in the innovation process due to the instability of the source of raw material; political issues can often affect the supply of raw materials (nom.: 2.5, R&D). This explains why many tests are undertaken to ensure the quality of the raw material (nom.: 2.3, Oper.). In addition, one interviewee (nom.: 2.5, R&D) said that completely new material is another factor which can create risk in innovative projects, especially as FT produces both floor and wall tiles.

One interviewee (nom.: 2.2, Prod.) declared that integration (between old and new technology) and management can create risk in innovative projects. Another interviewee (nom.: 2.3, Oper.) mentioned that one important factor that must be considered when purchasing new technology is the possible integration between the old and new systems. From one interviewee's point of view (nom.: 2.5, R&D) the implementation stage does not hold with changing long established projects and usually creates conflict. This resistance is related to management structure and can act as a parameter which then creates risk in innovative projects.

Based on one interviewee's opinion (nom.: 2.2, Prod.), the skilled labour plays an important role in the purchase and operation of new technology. However, two other interviewees (nom.: 2.5, R&D; nom.: 2.8, Admin.) emphasised that the lack of experienced employees is one an important factor which must be considered when examining risk. It can then be said that skilled labour can sometimes create risk in innovative projects and must be classed as a risk factor.

One of the interviewees (nom.: 2.2, Prod.) believed that the risk involved in producing a tested innovative item, which is based on competitor's products, is less when compared with the risk of producing an entirely new product. This is because the product is already proven and it has an established customer base. However, for a completely new product, the customer and market opinion is undetermined. In regards to the existing products, by using this as a base for their own product the company will have less expense and can attempt to gain a share in the market but it should be considered that they must have an advantage (e.g. price) over the existing products in the market. A number of interviewees (nom.: 2.3, Oper.; nom.: 2.7, QA) stressed that two important factors which can create risk are satisfying the market and customer acceptance of the new product. It can then be said that the market and the customer are two factors, which can create risk throughout the innovation project, and the company must consider them.

As this industry has a lot of waste, one of the interviewees (nom.: 2.7, QA) mentioned that environmental waste is as a parameter which can create risk. Another factor which creates risk is government policy (nom.: 2.4, Busi.). For example, these policies will occasionally lead to an increase in price.

All of the factors that create risk for this company can be elicited from various interviews and be categorised into the following areas. These factors are:

- **Resources:** raw material, financial, energy, lack of skilled & experienced labour
- **Environment:** different culture, government policy, environmental waste
- **Technical:** technology, new method, new material
- **Integration:** new & old system
- **Marketing**: customer, market
- **Management:** high-level management opinion, organisation behaviour (e.g. implementation stage disagrees with changes), high-level management without expertise, shareholder

6.2.2 Analysing risk

One interviewee (nom.: 2.1, Tech.) stated that this company normally use the experience of managers and archived information (standards described in various documentation) in order to calculate the probability and impact of risk. In other words, the prioritisation of risk in FT is based on the manager’s experience (nom.: 2.2, Prod.; nom.: 2.4, Busi.; nom.:

2.7, QA). Although one interviewee (nom.: 2.3, Oper.) claimed that the company tries to make risk factors quantitative, and financially evaluate them.

One of the interviewees (nom.: 2.3, Oper.) stated that the company, in order to prioritise factors which create risk, first identify issues that are important to their activity. He said that:

> *"The most important issue for this company is the financial one (sale and profit margins) thus the factors which create risk should be prioritised based upon the amount of impact on this issue."*

Another interviewee (nom.: 2.6, Mark.) explained an alternative method for analysing risk. He said that each organisation has a specific budget allocated for each project titled the 'investment budget'. According to this budget, the company decides which risks to manage and with what expenses and which ones to ignore. The company usually continues projects with a risk of less than 50% of the budget. If it is more 50%, they must reconsider the project and the risk.

Although the interviewees explained different methods that were used to analyse risk factors, no evidence of this was found. It seems that there is no formal method to manage risk within the company. In addition, it seems there is no formal quantitative risk analysis in this company either.

6.2.3 Risk management action

One of the methods the company uses in order to decrease the market risk is to manufacture the product in varying amounts before moving to mass production (nom.: 2.1, Tech.; nom.: 2.7, QA). Regarding this issue, one interviewee (nom.: 2.5, R&D) said that:

> *"After pilot production, the product will go to short-term mass production in order to reduce the cost of risk; for instance, one day (producing 13000 m2), two days or one week production in real situation."*

This means that by manufacturing selective amounts of product and sending them to the market, the company can make customers familiar with the new products and assess the market before deciding on the amount for long-term mass production. Occasionally short-term mass production is omitted due to lack of time (e.g. changing the mould takes 45 days, thus shortening the time available for production) (nom.: 2.7, QA; nom.: 2.5, R&D). Another way to reduce the risk created by customers and the market is to display products in different places (e.g. flats and houses) for free in order to show and assure the customers that the product is practical and accepted by the market (nom.: 2.6, Mark.), this in turn increases consumption and production. By accepting these risks and attempting to control it, the market experiences the product and the company will have a better chance of success.

One interviewee (nom.: 2.6, Mark.) believed that, in order to satisfy the needs of customers, and solve the problem of customers as a parameter which create risk, the company must pay attention to cultural norms. For instance, in some cities quality is unimportant but the price is crucial (in other cities the opposite is true). In these situations the company should produce one product with two qualities in order to achieve success in the market of both cultures. There are some standards in mass production in order to identify a first or second-class quality product (nom.: 2.7, QA). In addition, one task the company faces is influencing the culture of the customer and market. When marketing any new product, the company must prepare the market and create a potential customer base.

To minimise the risk posed by competitors, the company try to keep its new and specialist designs secret, this enable them to enter the market in a powerful manner and saturate the market with their new product (nom.: 2.1, Tech.). In these situations, competitors are unlikely to imitate designs so the risk created by competitors decreases.

As discussed before, one factor which creates risk is raw material. To solve this problem, the laboratory will work with imperfect raw materials when producing the prototype. If the company encounters unforeseen changes at the implementation stage they can then control it and not let it affect the system (nom.: 2.5, R&D). Also, the company cannot buy large quantities of raw material because of their short shelf life and the space they occupy, thus, raw materials are bought in short term periods. Another method of solving the risk involved in the difference in quality of raw material is by applying formulas developed in the laboratory. These formulas can be applied in different circumstances based on the type of raw material available. This way is not the best solution but it is often the only one good enough (nom.: 2.5, R&D). Also, because of the market situation, if the company sources raw material from one supplier and they encounter a problem this will affect FT as well. Alongside these two methods, the company will order its required raw materials from two suppliers. This anticipates any problems that may arise (e.g. if there is a rise in one supplier’s price) regarding raw materials and will prevent any negative effects (nom.: 2.4, Busi.). For example, FT had a problem with one of their Italian sources (political issues) so it established a contract with a German source in order to have two sources at the same time. Also, since the problems were related to foreign raw material supplies, the company tried to substitute external raw materials with internal ones (nom.: 2.4, Busi.). In order to do this, the company tried to change its culture and persuade different divisions to use different materials. In addition to this, one of the company strategies is to use internal facilities and experts, in order to increase their internal ability and reduce their dependency on foreign companies in general (nom.: 2.4, Busi.).

Another risk factor in this company is the needed energy for production. To decrease the impact of this problem, the company tries to use several sources of energy at one time (e.g. liquid fuels alongside standard gas) (nom.: 2.4, Busi.).

6.2.4 Monitoring/Learning

FT does employ methods that control the different stages of the innovation process but the majority are not directly related to monitoring the risk management system.

One interviewee (nom.: 2.5, R&D) said that there are always some initially approved samples in order to regularly compare the latter products with them. Mass production must be controlled hourly in order to make sure there is no difference between the products and the approved sample. The approved sample is the pre-approved product that every item should closely match. They must be nearly identical in regards to raw material, quality, size and colour in order to gain approval (nom.: 2.7, QA). Also, since this company applies the ISO (2000), frequent quality checks must be undertaken at different stages (nom.: 2.7, QA).

One of the interviewees (nom.: 2.6, Mark.) identified the different methods for monitoring within the company. He stated that in situations where the expense of the project is more than in the progress plan, the project will be terminated. He also mentioned that in order to monitor each project, diagrams are produced based on the selling rate of the new product, development plan and human resources. He added that financial documents are often used for monitoring within the company. By using these every two months, the market share and sales are assessed and according to this information the company decide whether it is worth continuing with the project.

6.3 Conclusion

This company is currently working on several different kinds of innovation. One of the factors that forces the company into creativity is the current political situation in Iran. The political situation (e.g. international trade sanctions) has an effect on the process of ‘order and receive’ as raw materials from foreign suppliers are often more expensive and take longer to arrive. By considering this situation, the company can utilise their internal abilities when attempting to increase the life cycle of products and minimise risk.

Some interviewees mentioned that a number of characteristics of high-level management may be a barrier to innovation within the company. For instance, high-level management do not have the scientific expertise to aid in the decision making process. Another barrier to creativity in FT is an unfamiliarity with innovations that exist throughout the world; this is due to the lack of connection and information exchange between foreign professionals and producers. This indicates that probably there are some problems in the innovation system in Iran, as the company cannot obtain the latest knowledge.

It seems that formal decisions are made regarding some types of innovation at the selection stage in FT. As Iran is a large country, it has a wide variety of cultures with varying tastes. For example, in the north of Iran they prefer cool blue shades and in south of Iran they prefer dark, warm tones. This factor inevitably affects the selection stage.

The implementation stage in FT consists of two tasks, pilot and mass production. Occasionally ideas from the research division are not practical enough to be produced; thus the production division makes changes to the prototype in order to make it functional. This is because the situation in the laboratory differs from the reality of implementation.

Although most of the interviewees claimed that the company archives all technical reports and information, there was no suggestion that the claims of using the information as a source of creativity and effective learning were justified.

It seems that there is no formal method for managing risk within the company. Some interviewees believed that because of the large amount of product required by the market, the company may not feel that risk management is necessary. However in a tough and competitive market, risk management is absolutely essential. In addition to this, the instability of Iran's political situation means that more risks must be considered during the innovation process. Interviewees stressed that the process of risk management must be applied in all stages but controlling risk too much in the creativity stage might limit the company's success. A number of interviewees said that risk consideration must not be time consuming as the novelty surrounding the new product will vanish and the market will inevitably fill with similar products from competitors.

This company normally uses the experience of managers and archived information (standards described in various documentation) in order to calculate the probability and impact of risk. In addition the most important issue for this company is financial (sale and profit margins), thus the factors which create risk should be prioritised based upon the amount of impact on this issue. One interviewee said that each organisation has a specific budget allocated for each project known as the 'investment budget'. According to this budget, the company decides which risks to manage with what expenses and which ones to ignore. On the other hand, there are some standard tests for various products in FT. These standard tests can be considered sensible risk management as they are part of a strict process and allow an opportunity for improvement, without which the prototype cannot progress to mass production.

One of the methods the company uses in order to decrease market risk is to manufacture the product in varying amounts before moving to mass production. By manufacturing selective amounts of product and sending them to the market, the company can make customers familiar with new products and assess the market before deciding upon an amount for long-term mass production. Another way to reduce the risk created by customers and the market, is to display products in different places (e.g. flats and houses) for free in order to show and assure customers that the product is practical and has been accepted by the market. To reduce the risks involved with raw material there are different formulas that can be applied in different circumstances based on the type of raw material available. Also FT employs more than one supplier.

FT does employ methods that control the different stages of the innovation process but the majority are not directly related to monitoring the risk management system. For instance, initially approved samples are always produced in order to regularly compare later products with them.

Chapter 7 Case 3- Razavi Dairy Products Corporation (RDPC)

Razavi Dairy Products Corporation[1], located in Mashhad, was founded in 1993. Initially the company focused on the production of milk. However, as the price of milk is unstable and environmental parameters (e.g. government) can have an effect on this price, the company could not rely solely on this product for profit. In order to solve this problem, the company diversified and began producing different dairy products. They achieved this by purchasing machinery from two foreign companies. At first, the company focused on cheese production, however they now produce over a dozen different kinds of products. The total area of the site occupied by the company is approximately 8000 m^2 and the area of the production halls is approximately 1550 m^2.

Figure 7.1 - Example pictures of Razavi Dairy Products Corporation (RDPC) and its products

While the production buildings were under construction, the machinery required for the production line and cooling storage were purchased from Denmark and transported to the

[1] Accessed on 17.01.2009: www.razavi-dairy.com

site. The exploitation license with the nominal production capacity of 20408 metric tons per year for various dairy products (e.g. cheese, milk, yoghurt) was issued by the Ministry of Industries. There are various departments within the company including production, technical, commercial, quality control and laboratory, financial, and administrative. At present more than 100 permanent personnel are employed by the company. Around 200 temporary staff are also employed throughout the year according to the increase in customer demand (nom.: 3.1, Prod.)[2].

In the following discussion, various interviewees' opinions regarding innovation and risk within this company will be explained. Also, for greater clarity the effect of different factors on each stage of innovation will be shown using the influence diagram.

7.1 Innovation

A few years ago, Razavi Dairy Products Corporation (RDPC) had only two main competitors; there are now more than thirty. As the number of competitors increased, the company began to receive indications that the market may have become saturated. In order to remain competitive in this market the company needed to satisfy the needs of its customers, and to create high levels of customer satisfaction the company had to be innovative (nom.: 3.3, Mark.; nom.: 3.4, Prod.). One interviewee (nom.: 3.2, Busi.) said that if a company wants to increase the efficiency of its production line it should begin by looking to innovation. Unfortunately, innovation projects are always costly and risky (nom.: 3.6, Indus.). Another interviewee (nom.: 3.2, Busi.) explained that innovation can be defined as new ideas and products, although a high percentage of current innovation

[2] The abbreviations of the interviewees' job title for this case are: Production Manager (Prod.); Business Manager (Busi.); Marketing and Sale Manager (Mark.); Quality Assurance Manager (QA); Industrial Engineering Manager (Indus.); Technical Manger (Tech.).

within this company is based upon existing products. He added that new and innovative products are of great benefit to the company, as they tend to draw in a variety of new customers. RDPC has some innovation in products and processes (e.g. attempting to decrease the price of production) and tries to consider all new ideas, thus creating a separate file for each one (nom.: 3.4, Prod.).

One interviewee (nom.: 3.2, Busi.) claimed that there are two kinds of innovation. The first is based on current products and can be likened to incremental innovation while the second involves producing novel products, which have not been seen in the marketplace (radical innovation). He added that leading companies usually employ the second model. In regards to this area, another interviewee explained two changes which are usually applied to products by RDPC as part of the incremental innovation process: change of formulation and change of packaging (nom.: 3.1, Prod.). For example, in buttermilk production, the company identified a second source; instead of using just milk they began to use the whey (water that was produced during the making of cheese). They also changed the flavour (e.g. mint, oregano) of buttermilk and its packaging. In addition, he said that producing milk with different flavourings can be seen as a form of radical innovation.

One interviewee (nom.: 3.5, QA) stated that one barrier to innovation within RDPC is the amount of investment available for the development of new ideas. He also mentioned that the management structure of this company, which is non-private[3] (a strict hierarchy with a

[3] Given the context of Iran and that the terms private and public sector do not have the same meaning as they do in the UK, the following terms are given to explain the two categorisations the Iranian companies of this study belong to.
In private companies, the owners invest their own money when establishing and managing their companies, whereas non-private companies are not owned by an individual or government but are owned by a non-profit making organisation. The difference between the two is that in a private company the owners are aware of what activities they are doing, as they invested their own money in the future of the company. However in non-private companies, which are similar to governmental companies, the managers receive a monthly salary

strict definition of responsibilities), can have an effect on the priority of certain parameters and the decision-making process. Another interviewee (nom.: 3.6, Indus.) claimed that private companies are more innovative than non-private companies as the decision-making process is faster and they are willing to take more risks. Unfortunately, most high-level managers in RDPC are risk averse (nom.: 3.3, Mark.) and thus the decision-making process is slow (nom.: 3.4, Prod.).

7.1.1 Creativity

One interviewee (nom.: 3.1, Prod.) said that a force that has a major effect on RDPC when it comes to developing new technology or producing new products is competition (Figure 7.2). He said that:

> *"Our competitors, who produce new types of cheese (UF) by using new technology (technology push) and with greater efficiency can provide their products at a lower market price. During the last decade the younger generations of Iran began to express a preference for UF cheese instead of traditional cheese (in salt water). Because of the pressure exerted by competitors and the demands of the customer base, the company began production of this new product."*

In addition to this, one interviewee (nom.: 3.2, Busi.) emphasised that technology in developed countries and competitors' products can be a source of creativity to RDPC. In regards to this field, one interviewee (nom.: 3.4, Prod.) said that the research and development division is responsible for creativity (Figure 7.2). Any new activities and information about competitors are reported to the company via the marketing and business division.

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regardless of the outcome of the company, as the owners success and financial gain does not depend on the success of the company.

Another interviewee (nom.: 3.3, Mark.) said that traditional culture can also be a source of creativity. As Figure 7.2 indicates, this means that the company can find new ideas by considering traditional culture.

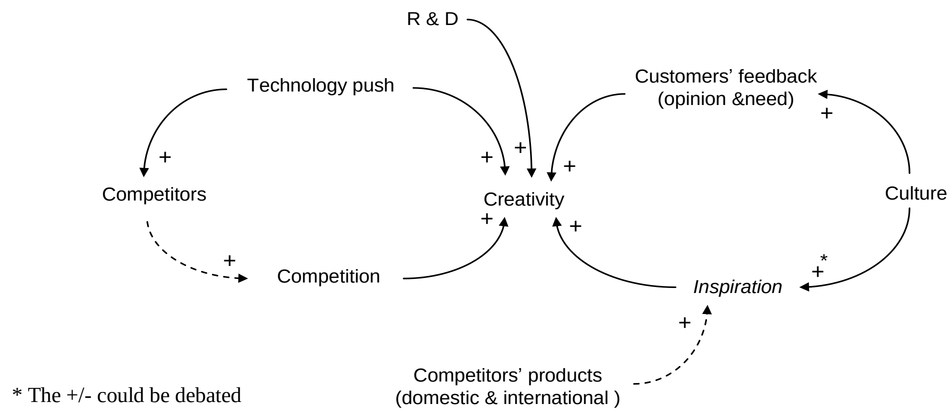
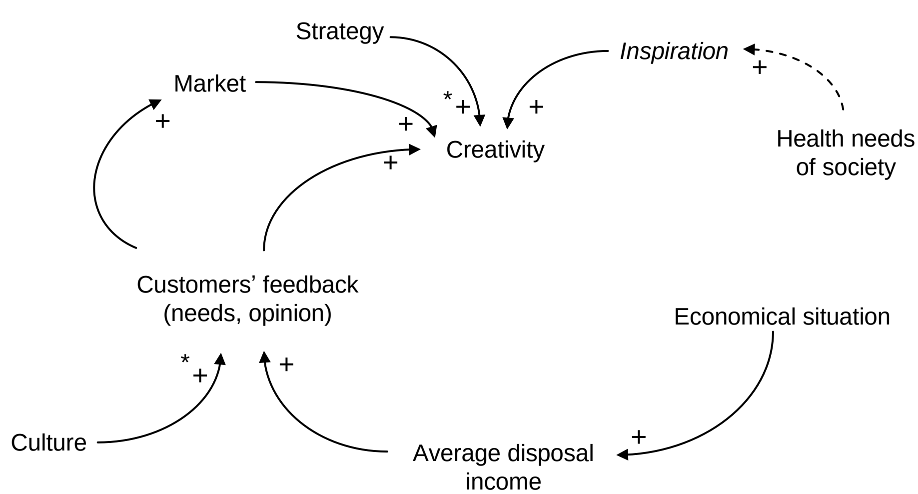


Figure 7.2 - Influences on creativity at RDPC (I)[4]

Based on one interviewee's point of view (nom.: 3.2, Busi.), the market situation (e.g. market saturation), the health needs of our society and the economic situation (e.g. average disposable income) can have an effect on creativity (Figure 7.3). For example, Iranian people do not get enough vitamins through their diet so vitamin enriched milk can be helpful and will find a place in the market. One factor, explained by most interviewees, which has an important effect on creativity is the customer (Figure 7.3). Different feedback regarding the customer's needs, their opinions regarding current products and their personal situation (e.g. age and culture can effect their needs and opinions) can have an effect on the creativity stage (nom.: 3.1, Prod.; nom.: 3.2, Busi.; nom.: 3.4, Prod.; nom.: 3.5, QA; nom.: 3.7, Tech.). As there are different cultures and regions within Iran and each one has their own taste preferences (e.g. the north of Iran prefers sweet yoghurt and the south prefers sour), company will receive various feedbacks and should select the

[4] The continuous lines represent influences explicitly identified by the interviewees; the broken lines are influences which are inferred from interviewee comments.

appropriate ones based on their strategy (nom.: 3.3, Mark.). It seems that market strategy plays an important role in selection stage when selecting an appropriate idea (Figure 7.3). RDPC tried to be a leader within this industry but as it did not receive sufficient data regarding the market and customer's needs, some of its innovative products failed to find a place in the market (nom.: 3.3, Mark.). For example, the company developed a fruit yoghurt (an innovation in Iran where the market was dominated by plain yoghurts) for one year but discovered there was no demand in the market place (nom.: 3.1, Prod.). This was contrary to the experience of other countries where there was large market for such products. One interviewee (nom.: 3.3, Mark.) believed that, unfortunately, there was no system within this company to enable an early recognition of the market's requirements. Moreover, people within the company lacked expertise in market research so were unable to develop better methods of customer feedback. If the company had used the theoretical model it might have considered market risk at a stage before the product launch: recognising a high degree of market risk could have led to appropriate actions, e.g. abandoning the innovation before costly full scale implementation or commissioning advertising to promote the new product.

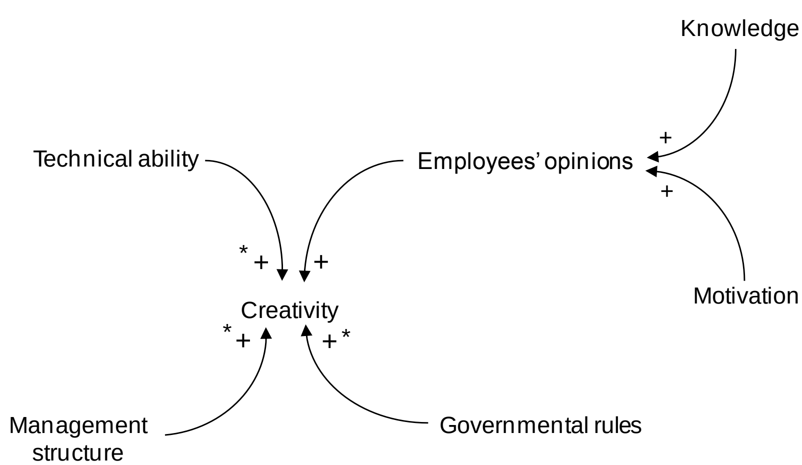


* The +/- could be debated

Figure 7.3 - Influences on creativity at RDPC (II)

The business and marketing division plays an important role in the sending and receiving of market and competitor information and customer feedback to the different divisions of RDPC (nom.: 3.1, Prod.; nom.: 3.2, Busi.). One interviewee (nom.: 3.1, Prod.) said that initially, the company had one main distributor and that the company received customer feedback through the distributor. After an increase in production, the company began creating sale centres in different cities. These centres helped acquire customer feedback (e.g. identifying new needs, absence of desirable products) in a better way. It should be noted that there is another system in place which enables the company to receive customer’s feedback; this is called the “voice of customer” (nom.: 3.1, Prod.; nom.: 3.3, Mark.). Telephone numbers are placed on each product so that the customer may call the company and relate opinions regarding the quality of product, their needs, desires etc. These opinions are then categorised and sent to the relevant division. Customers welcome the opportunity to provide feedback and the company can then begin to improve their products based on this feedback. For example, diet yoghurt, butter with better packaging and in a selection of weights have been developed through this system. Nevertheless, this system is not a powerful and proactive one (nom.: 3.3, Mark.). The company should not wait to receive customer’s feedback; it should be actively seeking them out. Also, another way RDPC occasionally gather customer feedback regarding new products is to supply questionnaires to people, such as students, who come to visit the factory (nom.: 3.1, Prod.). One of the interviewees (nom.: 3.2, Busi.) said that technical ability can have an effect on the creativity stage and that the company should concentrate on creating products that utilise their current abilities (Figure 7.4). However, it seems that this function decreases creativity as some new ideas that are worthy of new investment may be discarded. Another interviewee (nom.: 3.3, Mark.) believed that one factor which has an effect on creativity is employee's opinion (Figure 7.4). He claimed that, unfortunately, this company does not consider employees to be valuable assets. In addition he stated that, employees need motivation to provide their opinions; the company should respect all ideas even if they are not useful and encourage their employees to share their ideas. Also, he stressed that employee knowledge is a parameter which can have an effect on innovation. If employees have a good knowledge base this effect is positive, but if they do not the effect is negative and can be a barrier to innovation. He also added that training classes for employees can be helpful and may increase their knowledge.

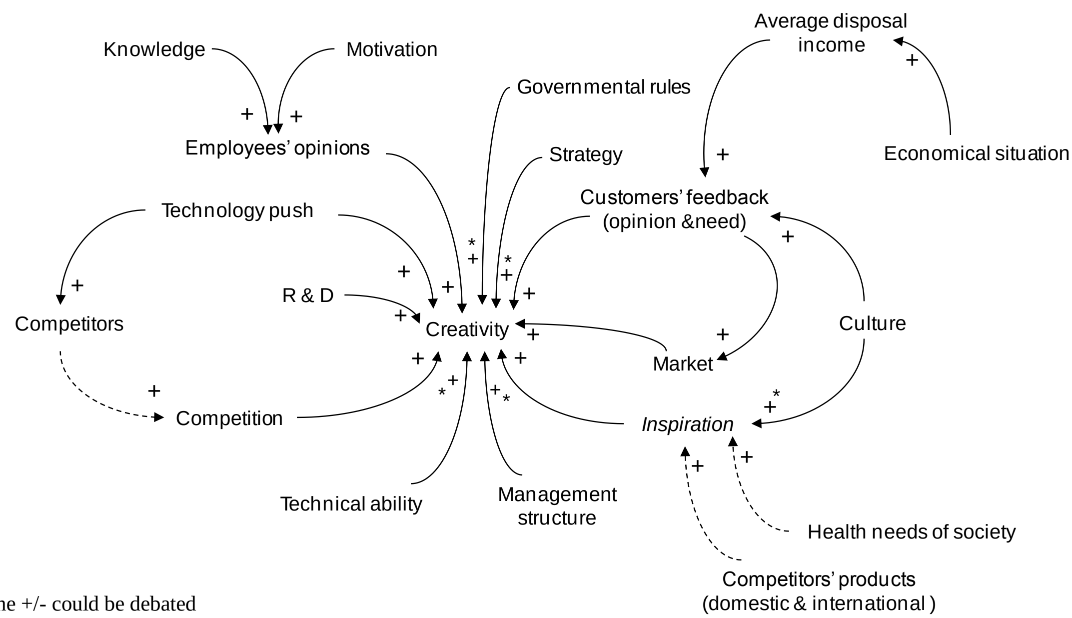
One interviewee (nom.: 3.5, QA) stated that the management structure of RDPC and governmental rules are two other factors which can effect creativity as well (Figure 7.4).



* The +/- could be debated

Figure 7.4 - Influences on creativity at RDPC (III)

Figure 7.5 shows all of the factors which were discussed earlier and can have an effect on the creativity stage according to interviewees from this company.



* The +/- could be debated

Figure 7.5 - Combining the influences on creativity at RDPC

7.1.2 Selection

One interviewee (nom.:3.2, Busi.) stated that the company must select one idea from the many at this stage. Two respondents (nom.: 3.2, Busi.; nom.: 3.3, Mark.) said that there are several factors which can have effect on the selection stage as they aid in the decision making process by allowing the prioritising of ideas (Figure 7.6). These factors are: market (e.g. size and demographic of market.), customer's needs and characteristics (e.g. the age of a customer can have an effect on taste preferences), time required to achieve end product (a product that takes time to develop may be produced by a competitor at a quicker rate and the market opportunity is inevitably lost), final cost (predicted amount), profit and investment rate of return (IRR).

Another important factor that can have an effect on this stage is technical ability (nom.: 3.1, Prod.; nom.: 3.2, Busi.; nom.: 3.3, Mark.; nom.: 3.4, Prod.; nom.: 3.5, QA). A manager of the technical division (nom.: 3.7, Tech.) said his division must consider the company's technical ability when they begin to implement new ideas, as it is their responsibility. This division assesses the technical ability of the company before any new projects are begun and then advise on the purchase of new machinery or the outsourcing of production. For example, specialist machinery is required for the production of flavoured milk. With the company's current technology the risk involved in producing this product is high it has a short shelf life (nom.: 3.1, Prod.).

Based on several interviewees' statements (nom.: 3.3, Mark.; nom.: 3.5, QA) another factor, which should be considered at the selection stage, is the culture of society (Figure 7.6). This factor can create the risk if the company neglect it. For example, the culture of society can change over time and may alter the customer's taste preferences in regards to national and traditional products.

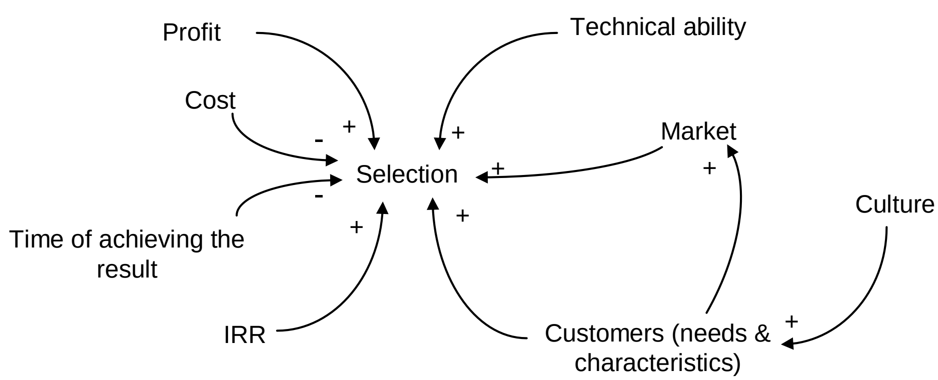


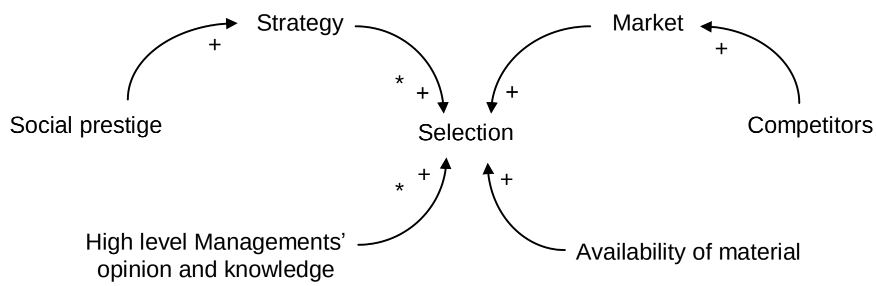
Figure 7.6 - Influences on selection at RDPC (I)

The company usually uses a feasibility study when undertaking most new projects (nom.: 3.1, Prod.). In a feasibility study the company considers all factors, which were examined earlier, such as: competitors, market, investment rate of return (IRR), profit, technical ability and what materials are needed (availability) (nom.: 3.2, Busi., nom.: 3.5, QA). However, one interviewee (nom.: 3.4, Prod.) claimed that based on the type of innovation (incremental or radial) the consideration of these factors are different. For instance, in cases where the technical capability does not exist and must be investigated further, the company considers all factors in order to make a final decision (e.g. modernised traditional cooking oil). It seems that the company try to consider all factors at the selection stage but the degree of this consideration is different based on the type of innovation. For greater clarity, it is better to show the different factors of the feasibility study separately in influence diagrams (Figure 7.6 and Figure 7.7).

As Figure 7.7 shows another factor which has an essential role in selection at the implementation stage is company strategy (nom.: 3.1, Prod.; nom.: 3.2, Busi.). For example, the business manager (nom.: 3.2, Busi.) explained that:

> *"Airplane desserts were selected for production as they fit in with our strategy and enable us to be a leader in the marketplace. Sometimes a company strategy will involve entering new products to the market, not solely for profit, but also to create a positive image (social prestige) of an innovative market leader in the mind of the customers"*

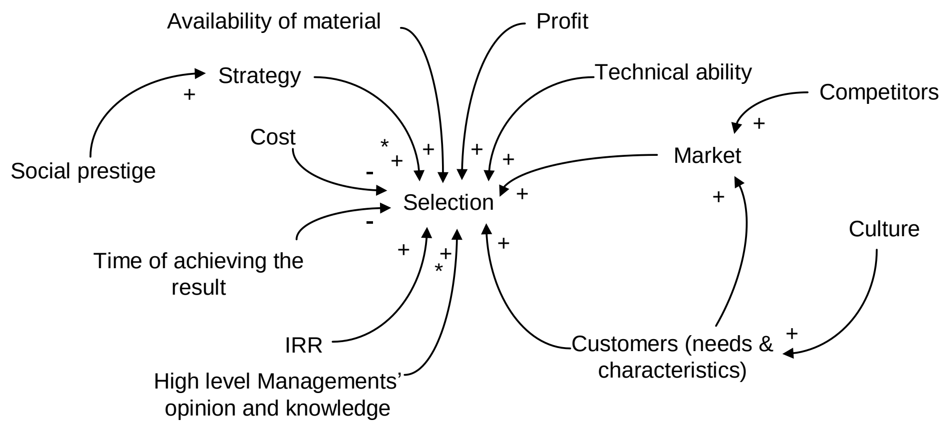
After the feasibility studies have been assessed, the management board will select one idea for implementation (nom.: 3.1, Prod.). It seems there is no formal requirement to meet specific criteria for this selection to take place (nom.: 3.3, Mark.). It can be said that besides the feasibility study, the opinion and knowledge of the management board have an effect on the selection stage (Figure 7.7). In regards to this, one interviewee (nom.: 3.2, Busi.) said that the amount of risk deemed acceptable by high level management can have an effect on this stage. He added that, in general, the size of the company can also have an effect on selection. It seems these two parameters (size of the company and amount of acceptable risk) have an effect on the type of innovation (incremental or radical) that is selected.



* The +/- could be debated

Figure 7.7 - Influences on selection at RDPC (II)

Figure 7.8 shows all of the factors which were discussed earlier and have an effect on the selection stage based on interviewee's opinions regarding this company.



* The +/- could be debated

Figure 7.8 - Combining the influences on selection at RDPC

7.1.3 Incubation

Based on one interviewee's point of view (nom.: 3.1, Prod.), the customer's opinion is one factor which can have an effect on this stage (Figure 7.9). He said that the company will usually gather customer feedback at two stages: after production of the prototype (incubation stage) and after pilot production. In addition, one interviewee (nom.: 3.4, Prod.) explained that after producing a prototype an assessment panel is formed. The panel is made up of employees from different divisions within the company who then aid in the continued development of the prototype. During the assessment, this first prototype is developed until a completely workable prototype is achieved. At this point, the prototype is tested in a sample marketplace to gather customer feedback and is also sent to the management board for further analysis. After receiving feedback from these groups, the prototype is developed and improved before a final product is produced and sent to management board for approval. This is an iterative cycle as these steps are often repeated more than once. One interviewee (nom.: 3.1, Prod.) claimed that because it is difficult to predict the market of products within this industry, the ability to be competitive and create contact with customers in order to attain feedback are considered at the implementation stage more than at the incubation stage. Therefore it is usual for dairy companies to enter the market with a variety of products and, after feedback has been received, the popular products will be chosen and continued.

One important factor, which should be considered at the incubation stage before progressing to the implementation stage, is the assembling of government certificates, such as hygienic approval (Figure 7.9). Without these certificates the company cannot go into mass production (nom.: 3.5, QA).

One interviewee (nom.: 3.1, Prod.) stated that if RDPC has experience relevant to the production of a new product, the financial issue is considered before going to incubation. However in cases that are completely new to the company, the final costs are estimated after the production of the pilot product as a sample of new product is available. It can then be said that the final cost has an effect on the incubation stages (Figure 7.9). Also, one interviewee (nom.: 3.4, Prod.) said that it is at this stage the company should set the price of the product. He added that the opinions of the marketing and business division, regarding the price, play an important role in progressing to the next stage. Sometimes the marketing and business divisions will reject this price and the process is stopped. Furthermore, he mentioned that:

> *"If the new product is similar to one already on the market, we will compare our prototype with the similar product at the incubation stage. This is in order to improve the prototype and make it capable of competing in the market in aspects like price, durability, packaging etc."*

It seems that it is more economical for the company to consider other similar products and the probable price of the new product at an earlier stage of process, like the selection stage.

The following influence diagram (Figure 7.9) shows all of the factors which were discussed above and have an effect on the incubation stage based on interviewee's explanations regarding RDPC. These factors are: Customer's opinion, Final cost, Management board's opinion, Standard certificates, Market and Product price in market.

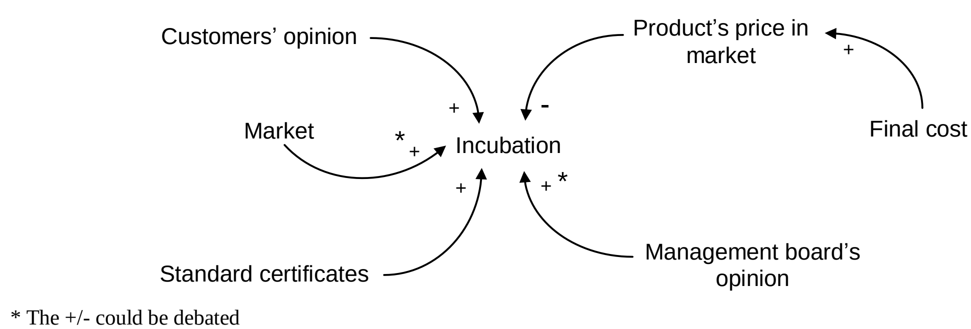


Figure 7.9 - Influences on incubation at RDPC

7.1.4 Implementation

After the incubation stage, the prototype will progress to pilot production in order to test the production line. This is so the company can check the quality of production in a real situation and compare it with prototypes produced in the laboratory and identify any differences. In pilot production, the company tests machinery at minimum capacity (nom.: 3.1, Prod.). According to one interviewee (nom.: 3.5, QA), the process of production is made up of three stages: input (raw material), progress, output (final product). Some tests and controls should be undertaken at each of these stages in order to approve the product, such as bacteriology control or chemical control (Figure 7.10). Some of these tests are based on mandatory standards set by a National Standard Organisation for the dairy industry and all products must pass these tests (nom.: 3.5, QA).

Before going to mass production, the products should be sent to the marketplace in order to research market feedback and customer's opinion and to reduce the probability of failure (nom.: 3.2, Busi.; nom.: 3.3, Mark.; nom.: 3.5, QA). Market testing is possible in this industry although it needs time and money (nom.: 3.2, Busi.). This product should only be tested in its target market, which the company has already selected, in order to gather relevant feedback. Unfortunately, sometimes the company does not follow this process and it is only after mass production that the product is sent to the marketplace for feedback (nom.: 3.3, Mark.). According to the quality assurance manager (nom.: 3.5, QA):

> *"Sometimes the market response and customer feedback, in pilot production and mass production, are radically different. When a product is given a pilot production this does not give the company an accurate view of the market or customer opinion (because of the limited numbers). Also, the high cost of market testing means the company will only supply products to a few selected customers and wholesalers, especially those who are outside the company's geographical region."*

There are some criteria which the company should consider when continuing the process of mass production. As Figure 7.10 shows one of the most important conditions to consider when continuing production of the new product is market interest and its ability to compete (nom.: 3.1, Prod.; nom.: 3.3, Mark.). In order to do this, the company must consider the market and customer feedback (nom.: 3.4, Prod.). This feedback is usually received via the business and marketing division and plays an important role in the process of mass production as it can often cause minor changes to be made to the product.

One interviewee (nom.: 3.1, Prod.) said that as some products are only made for particular customers the market is not large enough to maintain profitable production and they are inevitably withdrawn. It can then be said that the amount of profit plays an important role at this stage as well (Figure 7.10).

As discussed earlier in the discussion of the selection process (Section 7.1.2), another factor which plays a role in mass production is company strategy (nom.: 3.1, Prod.; nom.: 3.2, Busi.). As Figure 7.10 shows sometimes companies base their strategy on entering new products to the market in order to create a brand image in mind of customers (social prestige) that suggests the company is innovative and a leader in this market (nom.: 3.2, Busi.).

Figure 7.10 shows all of the factors which were discussed earlier and have an effect on the selection stage based on interviewee's opinions regarding this company.

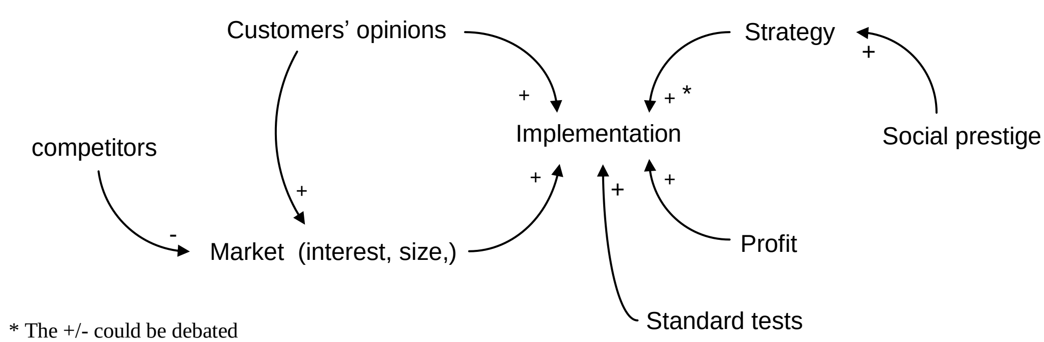


Figure 7.10 - Influences on Implementation at RDPC

7.1.5 Learning

Based on two interviewee's explanations (nom.: 3.2, Busi.; nom.: 3.7, Tech.), there is no formal method for documentation within RDPC. Different divisions try to document their processes and various reports are written regarding the final decision. Although one interviewee (nom.: 3.1, Prod.) said that all products in this company have a BOM (Bill of

Material). This means all ingredients and the quantities of each needed to manufacture an end item are listed.

One of the interviewees (nom.: 3.5, QA) stressed that since as RDPC possesses ISO 9001 and 2000, all the processes of production should be documented. This ISO has an effect on the management system and tries to control it. However, another interviewee (nom.: 3.4, Prod.) said that the company documents the process until the end of the selection stage but after this there is no formal documentation. Two other interviewees (nom.: 3.3, Mark.; nom.: 3.6, Indus.) mentioned that the company recently began documenting their processes in a formal format. Another interviewee (nom.: 3.3, Mark.) emphasised the importance of this information and the company should use them in later projects (e.g. considering the reasons for the failure of previous products can allow RDPC to select the proper market and method of distribution for new products), although the company does not currently use them.

It seems as though this company has a common attitude to documentation and learning. The necessary formal documentation may be undertaken (based on ISO) but it does not really contribute to effective learning; therefore companies do not use this documentation as a source of new creativity.

7.2 Risk

Some interviewees (nom.: 3.1, Prod.; nom.: 3.2, Busi.) believe that most managers in non-private companies in Iran (like RDPC) are risk averse when compared with private companies, this can often be due to management turnover. Accepting risk means that the manager accepts responsibility for any hazardous situations that arise during the search for innovative products. Finding such innovative solutions are not necessary in non-private companies as managers are not under the same pressure and do not often make risky decisions.

Another interviewee (nom.: 3.2, Busi.) confirmed the lack of interest in accepting risk in non-private sector companies, but the knowledge of risk is better in these companies when compared with private companies. In private companies, management and ownership is often the same. However, the owner will often only provide financial backing and lack knowledge of the industry. One interviewee (nom.: 3.1, Prod.) stated that another important difference between these two types of companies is that private companies make decisions faster than non-private sector companies, this can affect the novelty of a new idea and lose market share.

One interviewee (nom.: 3.6, Indus.) explained that to achieve success in innovative projects, the company needs to manage risk and this function should be undertaken at various stages of innovation.

7.2.1 Identifying potential risk factors

The dairy market is very different from other food markets as certain dairy products (like milk) are regarded as a food staple. Because of this, the environment (especially government policy) is seen as the most important risk creating area within this industry (nom.: 3.1, Prod.; nom.: 3.3, Mark.; nom.: 3.4, Prod.; nom.: 3.6, Indus.). For instance, one interviewee (nom.: 3.1, Prod.) explained that:

> *"The government plays a powerful role in fixing the price of dairy products. In 2007 the government did not permit dairy companies to increase the price of some products although inflation existed and the price of raw material had increased. So predicting the risk created by the environment is difficult in this industry."*

Another issue which, is related to government policy and can create risk is obtaining different certificates (e.g. hygienic approval) from government departments (nom.: 3.5, QA). Because of tough bureaucracy and unclear rules, obtaining these certificates is difficult and often filled with unforeseeable problems. This issue is a parameter which can create risk in innovative projects as time can be waste and market opportunities may be lost.

The culture and knowledge of customers are other parameters that the company must consider as risk factors (nom.: 3.1, Prod.; nom.: 3.2, Busi.; nom.: 3.3, Mark.). If a company is unfamiliar with the culture of its market, it cannot select an appropriate idea. Sometimes customers do not often understand scientific terms; this can exaggerate the differences amongst similar products when comparing raw materials and their health benefits. In this situation customers may select other products based solely on price or appearance (nom.: 3.2, Busi.; nom.: 3.3, Mark.; nom.: 3.6, Indus.).

One interviewee (nom.: 3.2, Busi.) said that competitors are another factors which can create risk in innovative projects. Sometimes they can replicate new products very quickly and decrease the company's market share. In regards to this field, another interviewee (nom.: 3.6, Indus.) said that intellectual property rights in Iran are an important factor that can create risk in innovative projects; the rules surrounding intellectual property are weak and replicating a product often results in minimal punishment.

Prediction methods are imprecise and the size of sample for testing the final product is not large enough to obtain pertinent data for efficient prediction regarding the market, final price and production needs (e.g. raw material). In addition to this, predictions are often made based on manager's opinions of customers and markets instead of being identified through scientific means. This inability to give precise predictions is another factor which can create risk in RDPC (nom.: 3.2, Busi.).

Two interviewees (nom.: 3.3, Mark.; nom.: 3.5, QA) emphasised the fact that the market can also create risk. Selecting the correct market and the time of production are important parameters which should be considered when producing new products (nom.: 3.3, Mark.). For instance, the company developed a specialist caramel dessert but it failed upon launch, as the company had not identified the correct target market. The company distributed this product in regions that were culturally and economically backward, and therefore unsuitable for this product. Consequently, the company received unsuccessful feedback for their new dessert after distributing in the wrong market. In addition, this dessert was marketed and produced in summer which adversely influenced sales. Since the temperature in Iran is high during the summer, people prefer products such as ice-cream during the warmer weather. If the company had used the theoretical model it might have considered market more precisely at an earlier stage before the product launch.

Another factor which creates risk in innovative projects is raw material (nom.: 3.4, Prod.; nom.: 3.5, QA; nom.: 3.6, Indus.). The company must consider the availability of raw material, method of supply, price, time to receive and the amount required are the parameters that should be considered when buying raw materials.

Some interviewees (nom.: 3.2, Busi.; nom.: 3.3, Mark.; nom.: 3.6, Indus.) mentioned that the system used to distribute the final product is very important for success. Occasionally, problems in this system can cause the failure of the product in the market. Another interviewee (nom.: 3.5, QA) stated that the distribution mechanism for products in Iran is difficult and complicated; this mechanism can affect the process of production and in some cases can cause the new product to fail. It can then be said that these factors can create risk in innovative projects.

Packaging and advertisement are two other parameters which have an effect on the success of a product and can create risk if the company does not consider them (nom.: 3.2, Busi.). One interviewee (nom.: 3.3, Mark.) believed that in this industry, advertising plays a vital role in the success of a product. Good advertising can attract customers and convince them to use a new product.

The management structure (a strict hierarchy with a strict definition of responsibilities which create barriers for employee contribution) is another parameter which can create risk in RDPC (nom.: 3.3, Mark.; nom.: 3.4, Prod.; nom.: 3.5, QA; nom.: 3.6, Indus.; nom.: 3.7, Tech.). Management structure causes managers to be risk averse and slows down the decision-making process. Employees that are dissatisfied in the workplace can have a negative effect on the process of production and can also create risk (nom.: 3.3, Mark.). Although in regards to this area, one interviewee (nom.: 3.3, Mark.) said that high-level management have attempted to implement change and move to a scientific method of management.

One interviewee (nom.: 3.3, Mark.) claimed that the company strategy and especially the company plan for new products are unclear. By changing the management hierarchy, some interruption can occur between different activities. It can then be said that the lack of a clear strategy can sometimes create risk.

Several interviewees (nom.: 3.4, Prod.; nom.: 3.6, Indus.; nom.: 3.7, Tech.), stated that a lack of skilled and knowledgeable labour and worn out technology are other risk factors for RDPC. In addition, the integration between new and old technology can create risk. In order to reduce this, the company must ensure that any new technology is compatible and can be integrated into the older system (nom.: 3.1, Prod.; nom.: 3.3, Mark.; nom.: 3.4, Prod.). Financial resources are another factor which can create risk in innovative projects (nom.: 3.1, Prod.; nom.: 3.3, Mark.).

All of these factors, which create risk in RDPC, can be elicited from various interviewees' statements and can be categorised in the following areas:

- **Resources:** financial (low level of investment), raw material (supply, availability, price, amount required, time to receive), unskilled labour and low level of knowledge
- **Environment:** government policy, culture, obtaining certificates from government, intellectual property rights
- **Technical:** technology (e.g. worn out)
- **Integration:** old and new technology
- **Marketing:** knowledge & culture of customers, competitors, system of distribution, advertising, kind of packaging, market (e.g. correct market and time of production)
- **Management**: poor prediction, structure of management (traditional, risk averse and slow decision making), employee dissatisfaction
- **Strategy:** unclear strategy

7.2.2 Analysing risk

As some interviewees said, the company often utilises the experience of managers to predict the probability of risk factors and prioritise them; and usually tries to consider all the risks (nom.: 3.1, Prod.; nom.: 3.2, Busi.; nom.: 3.4, Prod.; nom.: 3.7, Tech.). No formula or scientific method is used to identify probability and analyse these risk factors (nom.: 3.2, Busi.; nom.: 3.3, Mark.).

Sometimes for predicting future, the company uses different scenarios. These scenarios are written before making the final decision based on the market, environmental and technical aspects but also consider the factors which create risk (nom.: 3.1, Prod.). Although the scenario based analysis is potentially useful, very little information was available as only one employee explained it. It seems that this method, instead of being used formally within the company, is used on an individual basis and is, presumably, only applied in regards to specific issues.

7.2.3 Risk management action

One important factor which can create risk in innovative projects is financial issues. This is where the company lacks the funds and technical ability to fully implement a new idea; the company can sometimes decrease this risk through outsourcing (nom.: 3.1, Prod.; nom.: 3.3, Mark.). Because of the high price of the machinery needed to produce new ideas, the company will use outsourcing first. By using this method, the company can identify the market share and consider the market as a whole before purchasing new machinery. Before outsourcing any production, the company must check the quality of companies which produce this product. After this, in order to decrease the risk involved in the price and time to receipt of the product the company may contract more than one company for production (nom.: 3.1, Prod.).

Before launching a new product the company must create desire for their product within society and prepare the market by decreasing the risk surrounding customer’s culture (nom.: 3.1, Prod.; nom.: 3.3, Mark.; nom.: 3.5, QA). One of the ways the company can do this is to produce new products over a period of time in order to familiarise the customers with new ideas (nom.: 3.1, Prod.). However, because dairy products are a staple food in

Iran, changing the taste and culture of the people is difficult for this industry (nom.: 3.5, QA).

According to some interviewees (nom.: 3.4, Prod.; nom.: 3.6, Indus.), in order to reduce the risk regarding raw materials (e.g. supply and price) and increase the ability to resolve any problems with this issue, the company employs two raw material suppliers at the same time. This means that if one supplier encounters delays or increases their prices, the company will be able to continue production as they are buying raw material from more than one source, thus risk is reduced. In addition to this, the manager (nom.: 3.6, Indus.) of the industrial engineering division explained that:

> *"Our division set a minimum amount of raw material which should be held in their inventory. This amount is monitored and before the stock levels are depleted, we order more raw materials."*

It can be said that this is another method used to decrease the risk of delay in the supply raw material as the company always has the minimum amount of raw material for production.

As discussed before, market testing is possible in this industry but it needs time and monetary investment, however it is always difficult to forecast the demand (nom.: 3.1, Prod.; nom.: 3.2, Busi.). Considering customer feedback at the incubation stage is difficult in this industry, so before progressing to mass production, a small amount of products are produced to send to the market in order to reduce the probability of failure and loss. This enables market feedback and customer opinion to be gathered which aid in the decision regarding the amount to be produced in the first mass production run (nom.: 3.2, Busi.; nom.: 3.3, Mark.; nom.: 3.5, QA). So it seems this method helps the company to reduce market risk.

7.2.4 Monitoring/Learning

There are some mechanisms and plans in this company for controlling the process of production (nom.: 3.1, Prod.), for instance the mechanism based on ISO (nom.: 3.5, QA), but most of them are not related to monitoring the process of risk management.

One interviewee (nom.: 3.6, Indus.) mentioned that the industrial engineering division should control and check the process of production regularly. He added that this division controls the amount of raw material consumption by considering the quantity of input raw material and quantity of products output, so if the amount of consumption is a higher than reasonable amount the production process needs revision.

The company usually assesses machinery in different terms (e.g. safety, age, maintenance) based on a specific plan (nom.: 3.5, QA; nom.: 3.7, Tech.). For instance the main duty of the technical division is to maintain and repair the machinery and control them during the production process (nom.: 3.7, Tech.).

7.3 Conclusion

There are various sources of creativity in this company. Based on interviewees' opinions, one force which has a major effect on RDPC, when it comes to developing new technology or producing new products, is competition. This company does not consider employees to be valuable assets when it comes to creativity. Interviewees believed that the company should respect all ideas even if they are not useful and encourage employees to share their ideas.

There are several factors (such as customer's needs, characteristics and final cost) which can have an effect on the selection stage in this company, as they aid in the decision making process by allowing the prioritising of ideas.

After the incubation stage, the prototype will progress to pilot production in order to test the production line. This is so the company can check the quality of production in a real situation and compare it with prototypes produced in the laboratory and identify any differences. As it is difficult to predict the market for products within this industry, the ability to be competitive and create contact with customers in order to attain feedback is considered at the implementation stage rather than the incubation stage. Therefore it is usual for dairy companies to enter a variety of products into the market; only after feedback has been received will the popular products be chosen and production continued.

There is no formal method for documentation within RDPC. It seems as though this company has a common attitude to documentation and learning. The necessary formal documentation may be undertaken (based on ISO) but it does not really contribute to effective learning; therefore companies do not use this documentation as a source of new creativity.

Interviewees believed that to achieve success in innovative projects, the company needs to manage risk and that this function should be undertaken at various stages of innovation. The dairy market is different from other food markets as certain dairy products (like milk) are regarded as a food staple. Because of this, the environment (especially government policy) is seen as the most important risk creating area within this industry. Consequently, predicting risk created by the environment is difficult within this industry. Another issue related to government policy which can create risk is the obtaining of certificates (e.g. hygienic approval) from governmental departments. Tough bureaucracy and unclear rules, mean that obtaining these certificates is often difficult and subject to unforeseeable problems.

This company often utilises the experience of managers to predict the probability of risk factors and prioritise them; and usually tries to consider all the risks. No formula or scientific method is used to identify probability and analyse these risk factors.

The company can occasionally decrease some of their risk through outsourcing. The high price of machinery needed to produce some new ideas means that RDPC will employ outsourcing before attempting production. In order to decrease the risk involved in the price and time taken to receive the raw materials, the company establishes production contracts with more than one supplier. In addition to this, the company sets a minimum amount of raw material which should be held in their inventory. This amount is monitored and before stock levels are depleted, the industrial division order more raw material. It can be said that this is another method used to decrease the risk involved in the supply of raw material as the company always has a minimum amount of raw material for production, therefore avoiding any potential delays in supply.

There are some mechanisms and plans in place within this company which control the process of production; for instance, the mechanism based on ISO, however most are not related to monitoring the process of risk management.

Chapter 8 Case 4- Sepideh Jam Toos (SJT)

Maghsoud Porcelain Company[1] was founded in 1993; initially they had the capacity to produce 3000 tonnes of porcelain each year. By expanding the company's production, they were able to increase this to 5000 tonnes. This company exports its products to more than 50 countries and have been awarded the title of 'Best Export Company of the Year' in Iran. They have also qualified for several standard certificates, such as ISO 9001:2000, ISO 14001:2003. The Maghsoud Company has five industrial factories, of which the biggest one is 'Sepideh Jame Toos' (SJT). This factory contains an array of modern equipment that is made by a consortium of five European companies.

Figure 8.1 - Example pictures of Sepideh Jam Toos (SJT) and its products

The products manufactured by this factory include different types of glass plates, which are heat and shock resistant. These plates are constructed from glass similar to Pyrex but marketed under the brand name IREX; there is also a range of matt plates with the name

[1] Accessed on 20.02.2009: www.maghsoudporcelain.com

IROPAL. This company can produce 10500 and 12000 tonnes yearly of IREX and IROPAL respectively and as it adheres to international standards they now export to other countries and while still meeting the needs of Iran. The factory has approximately 700 employees (nom.: 4.2, Prod.)[2].

In the following sections, interviewee's opinions regarding innovation and risk within the company will be explained. Also, for greater clarity, the effect of each factor on the individual stages of innovation will be shown in an influence diagram.

8.1 Innovation

One respondent (nom.: 4.1, QA) defined creativity as a means of developing new and better ideas. One interviewee (nom.: 4.6, Prod.) emphasised the importance of creativity in order for the company to survive in the market, this is because many foreign products are imported into the internal market. However, he pointed out that the company export products to several countries where market competition is high. In addition to this, one interviewee (nom.: 4.1, QA) stated that the company often wants to increase efficiency; therefore, it should look to creativity (for example, to decrease the cost).

There are two types of product innovation in this company (nom.: 4.2, Prod.). The first is incremental innovation, which is based on current products; the second is radical innovation, which involves producing a completely new product (nom.: 4.1, QA; nom.: 4.2, Prod.). In addition to product innovation, the company tries to create innovative processes (nom.: 4.4, Indus.). Sometimes, in order to improve the product, the company must identify ways of advancing their processes as they have an effect on the product's

[2] The abbreviations of the interviewees' job title for this case are: Technical Manger (Tech.); Production Manager (Prod.); Research and Development Manager (R&D); Industrial Engineering Manager (Indus.); Technical Manger (Tech.).

features (nom.: 4.2, Prod.). In one process innovation, there was little space in the factory to allow for the re-production of a collection's damaged parts and sometime these re-production parts were lost in the company. By dividing the space of the company based on a specific written format this problem was solved (nom.: 4.4, Indus.).

One interviewee (nom.: 4.1, QA) asserted that, in general the risk of incremental innovation is less than that of radical innovation. Based on his claim, the company has focused development on existing products rather than creating completely new ones; this is because most high-level managers are risk averse and the risk of incremental innovation is low, hence the interviewee maintained that the requirement for finding the probability of risk is low. Another interviewee (nom.: 4.4, Indus.) said that the current situation of the company (e.g. current financial situation) is very important and has an effect on kind of creativity selected by the company.

One interviewee (nom.: 4.6, Prod.) pointed out that the company tries to support all new ideas, even after receiving an unsuccessful result. Accepting new ideas plays an important role in providing encouragement for employee creativity (nom.: 4.4, Indus.). Thus, the company encourages employees to provide ideas on how to improve the situation (nom.: 4.3, R&D). Sometimes the company invites non-professionals (e.g. employees who are inexperienced or lacking in industry knowledge), to give their opinion about the new idea which consequentially has a negative effect on innovation (nom.: 4.4, Indus.). In regards to this area, one interviewee (nom.: 4.6, Prod.) claimed that the company usually dedicates one percent of its sales revenue to innovation and often the company receives more successful results than unsuccessful ones. Based on one staff member's point of view (nom.: 4.3, R&D) the company feeling towards new ideas is generally positive.

8.1.1 Creativity

According to one interviewee (nom.: 4.2, Prod.) new ideas can come from inside or outside the company. For example, he said that raw material suppliers or visitors to the company can be a source of external creativity. In regards to external sources of creativity, some interviewees (nom.: 4.1, QA; nom.: 4.2, Prod.; nom.: 4.3, R&D; nom.: 4.5, Prod.; nom.: 4.6, Prod.) said that customer feedback (needs and opinions) is one of the most important sources of creativity for the company (Figure 8.2). One staff member (nom.: 4.1, QA) said that main customers often explain their needs directly and ask the company to produce certain items. Therefore the company must consider customer's needs and opinions at this stage (nom.: 4.4, Indus.). One respondent (nom.: 4.5, Prod.), a manager of production, claimed that:

> *"We receive information on customer's needs and use QFD[3] to transform them into engineering characteristics for products or services. This method helps the company select the best customer requests based on their current ability."*

Some respondents (nom.: 4.3, R&D; nom.: 4.4, Indus.) said that customer feedback is submitted to the company through the sales division. This feedback is then sent to the relevant division so they may assess the information and act accordingly; unfortunately the process of receiving customer feedback is not undertaken fully by the company (nom.: 4.4, Indus.). It seems then that there is no formal method for receiving customer feedback within the company and it is probably based more on occasional conversation. In regards to this area, one interviewee (nom.: 4.6, Prod.) said that sometimes customers cannot explain their needs clearly; but in order to survive the company must identify the customer's needs and create desire for new products. Thus, the company tries to create

[3] Quality Function Deployment (e.g. see: Salomone, 1995)

need and desire within their customer base by inventing and providing new products. In addition, he said that the company must realise that bombarding customers with a selection of new products will cause a delay in the customer's decision; therefore there must be a proper interval between the introduction of new ideas.

In some cases competitor's products help the company gather information on customer's needs; in other words, as Figure 8.2 shows, the company is inspired to create new ideas by competitor's products (nom.: 4.3, R&D; nom.: 4.5, Prod.; nom.: 4.6, Prod.). In this type of situation, the company first analyses the product and then attempts to make improvements by creating products with better features than their competitor's, thus making their items more popular (nom.: 4.3, R&D; nom.: 4.5, Prod.; nom.: 4.6, Prod.). The lack of powerful internal competitors has a negative effect on the company as their customers do not have wide range of ideas and cannot send valuable feedback to the company (nom.: 4.6, Prod.). Another interviewee (nom.: 4.6, Prod.) added that the company sometimes uses products from foreign companies as inspiration and tries to produce similar products. He emphasised that, in these cases, the company attempts to improve upon these products and change them based on internal culture and market need. In these cases the company also attempts to apply some creativity. One interviewee (nom.: 4.3, R&D) explained that competitors can also push the company into creativity (Figure 8.2). For example, the quality of new products manufactured by competitors often presses the company into creativity, as they do not wish to lose their share in the market. He added that different research undertaken by the company can be another source of creativity (Figure 8.2).

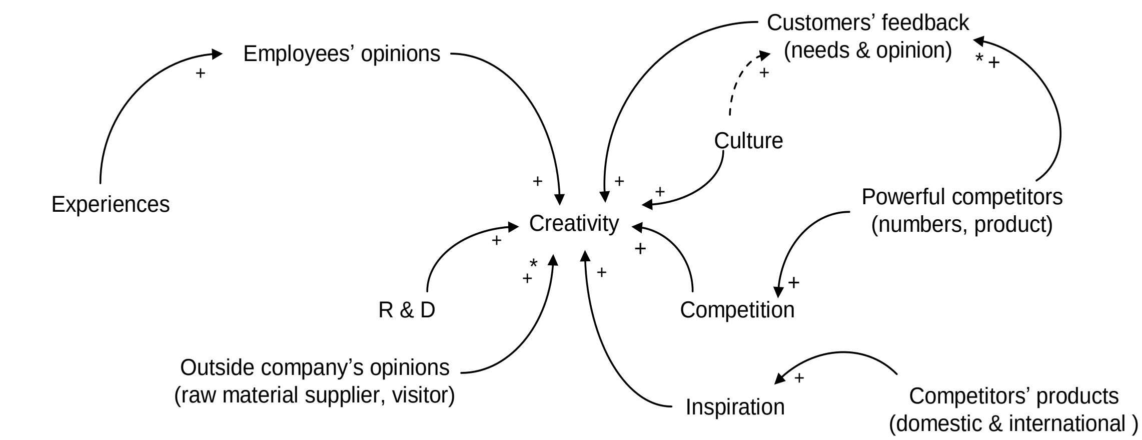


Figure 8.2 - Influences on creativity at SJT (I)[4]

One important input for creativity is the employee's opinions (nom.: 4.1, QA; nom.: 4.2, Prod.; nom.: 4.5, Prod.). One interviewee (nom.: 4.6, Prod.) explained that some innovations within the company are based on employees' ideas. For instance, the company had a problem with their furnace during the implementation stage. This meant that the final stage of product baking was imperfect, as the company did not check the condition of their furnace beforehand. The company, by using employee knowledge, could develop their furnace; however this issue suggests that if the company had used the theoretical model it might have considered this issue at an earlier stage. This experience suggests that if the company had considered the potential risks associated with their technical ability at the selection stage, this problem might have been foreseen and solved, therefore avoiding difficulty during the implementation stage. Also, one interviewee (nom.: 4.4, Indus.) claimed that employee experience plays an important role in creativity within each company (Figure 8.2); this is because each company and industry has a different situation when compared with others. As SJT employs a mechanism, the 'suggestion system', to gather suggestions, all employees (from low level to high-level) can submit ideas about

[4] The continuous lines represent influences explicitly identified by the interviewees; the broken lines are influences which are inferred from interviewee comments.

improvements or the production of new products (nom.: 4.2, Prod.; nom.: 4.5, Prod.). The company considers these ideas in different committees and encourages the employees to provide further ideas (nom.: 4.2, Prod.).

As Figure 8.3 shows, problems currently being experienced by the company can also be seen as a source of creativity, methods used to solve these problems often result in creativity (nom.: 4.1, QA; nom.: 4.3, R&D; nom.: 4.4, Indus.; nom.: 4.5, Prod.). One interviewee (nom.: 4.5, Prod.) believes that the company needs to identify problems in a systematic way; to identify problem the company uses the six-sigma method and to find methods of problem solving the company uses the brain storming meetings. Another interviewee (nom.: 4.4, Indus.) claimed that the company uses the TRIZ[5] method for solving current problems, which sometimes results in creativity. TRIZ generates general ideas and the company can then adapt the results for a more practical solution. In addition, there are fixed and regular meetings within the company (management review) where they attempt to identify current problems within the company and the process of management for each project is considered from various points of view (e.g. based on budget, plan or customer's complaints) (nom.: 4.5, Prod.). In some cases the results of these meetings can cause creativity, as the company must find answers in order to solve current problems (nom.: 4.5, Prod.). The method of solving these problems must be in harmony with the company situation and must also decrease cost and failure within the company (nom.:4.4, Indus.). For instance, one kind of ceramic product was breaking during production in the implementation stage (nom.: 4.6, Prod.). As this was a current problem the company considered this issue. This in turn stimulated creativity and the company identified a new

[5] In Russian: Teoriya Resheniya Izobretatelskikh Zadatch. In English the name is typically rendered as the Theory of Inventive Problem Solving.

raw material, which resolved the problem. If the company had followed the stages of the theoretical model it might have considered this issue at an earlier stage, therefore avoiding unnecessary exposure to risk in the later stages of product development. This means that the company could consider the prototype in the incubation stage with a more precise test or to try and check this prototype in pilot production before entering mass production and wasting their budget.

One respondent (nom.: 4.5, Prod.) claimed that other industries can, occasionally, be a source of creativity (Figure 8.3). By considering products from other industries, the company can identify possible new ideas. He also mentioned that the needs and situation of the market play an important role in the creativity stage. Another interviewee (nom.: 4.6, Prod.) said that political issues can motivate creativity (Figure 8.3). For instance, international trade sanctions currently imposed on Iran cause an increase the length of time it takes to receive raw materials and also increases expense, faced with this situation the company tries to be independent and rely less heavily on external raw materials and consequently more creative.

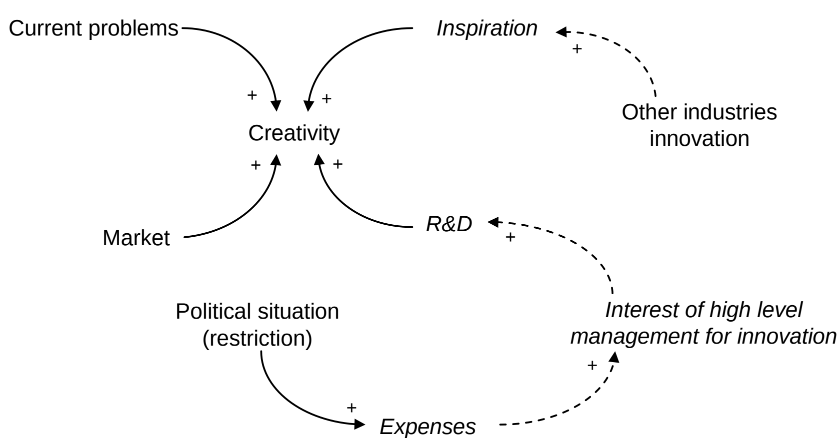


Figure 8.3 - Influences on creativity at SJT (II)

Figure 8.4 shows all of the factors which were discussed earlier and have an effect on the creativity stage based on various interviewees' opinions of this company.

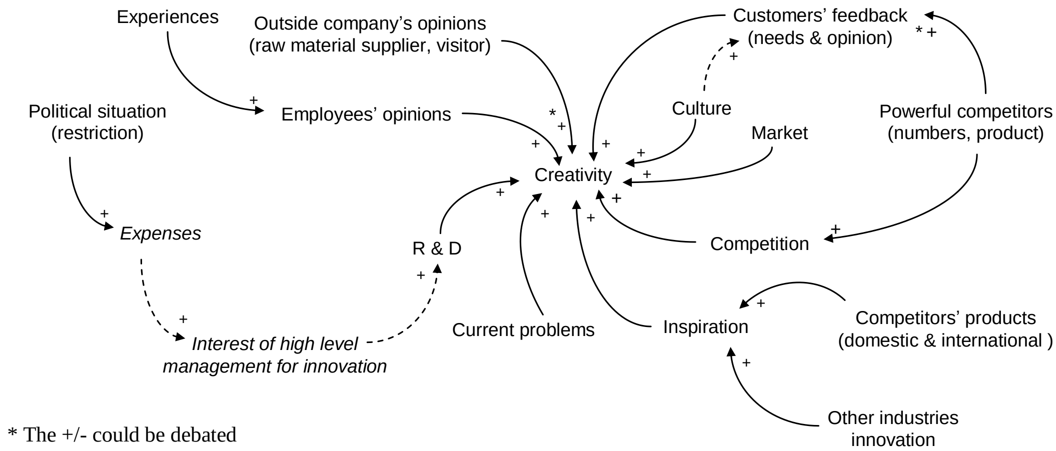


Figure 8.4 - Combining the influences on creativity at SJT

8.1.2 Selection

Some parameters have an effect on the selection stage. Some interviewees (nom.: 4.1, QA; nom.: 4.2, Prod.; nom.: 4.5, Prod.; nom.: 4.6, Prod.; nom.: 4.7, Tech.) believed that the most important factor, which should be considered in selection stage, is financial viability. The company considers their financial ability, amount of investment and profit of each new idea in order to select the most appropriate ones (nom.: 4.3, R&D; nom.: 4.4, Indus.; nom.: 4.6, Prod.). In addition, some interviewees (nom.: 4.1, QA; nom.: 4.2, Prod.) explained that the company also considers the required numbers of employees, final cost and time needed to achieve the final result (Figure 8.5). Predicting the precise final cost can help the company select ideas based on financial ability (nom.: 4.4, Indus.). One interviewee (nom.: 4.5, Prod.) said that development sometimes causes the company to lose market share as it can an increase the final price of the product. He said in this situation the amount of investment would not provide a return for the company, thus the company must decide on the level of development so that it does not lose market share because of a high increase in price. It can then be said that the investment rate of return (IRR) plays an important role in the selection stage (Figure 8.5).

The goals and strategy of the company also have significant influence when it comes to selecting a new idea (nom.: 4.1, QA; nom.: 4.4, Indus.; nom.: 4.5, Prod.). One important goal for this company, and other private companies, is to achieve greater benefits (nom.: 4.2, Prod.; nom.: 4.6, Prod.). Certainly, this goal has an effect when selecting new ideas. As one interviewee (nom.: 4.3, R&D) said, the company selects ideas which are consistent with its goals. In other words, strategy fit is one factor which has an effect on selection of a new idea (Figure 8.5).

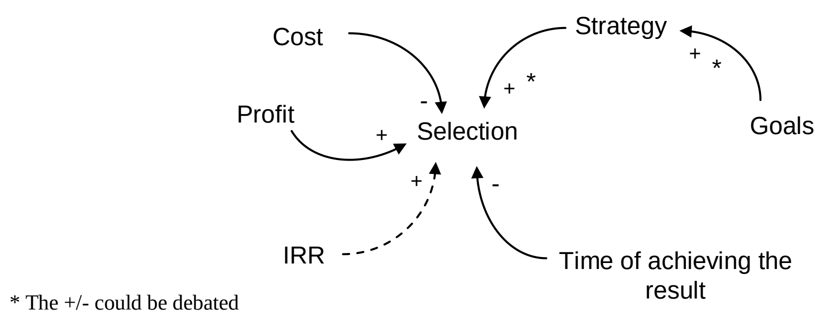


Figure 8.5 - Influences on selection at SJT (I)

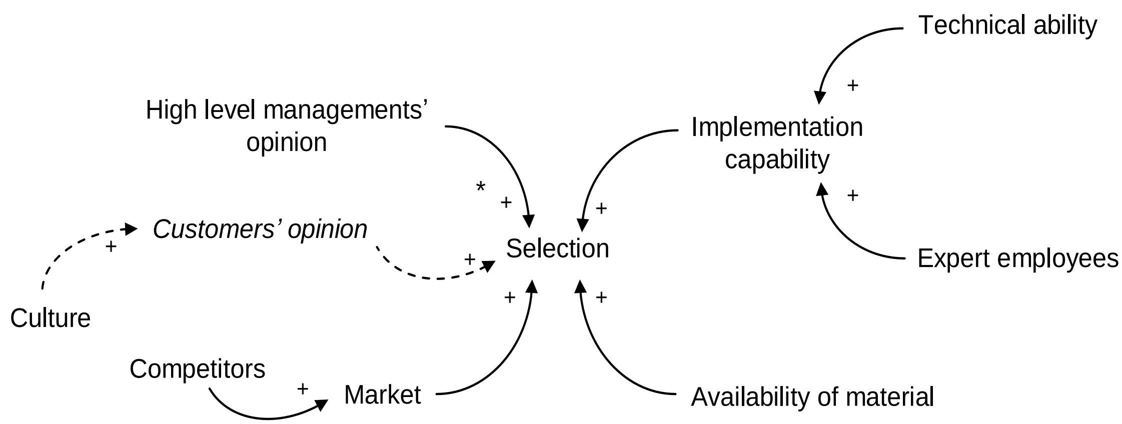
According to several staff (nom.: 4.1, QA; nom.: 4.6, Prod.), the culture of society plays a major role in the selection stage (Figure 8.6). For example, the culture of different regions within Iran can affect the colour and design of a product's colour (nom.: 4.1, QA). In regards to this, one respondent (nom.: 4.6, Prod.) said that:

> *"As Iran is a large country with different regions and cultures, the company must recognise the culture of each area. In order to do this the company divides Iran into a number of regions and each region has its own director. Sales representatives within each region send ideas and information to their local director, who then assembles pertinent information about the culture and opinions of the area, enabling the information to be used at the selection stage."*

A number of interviewees (nom.: 4.1, QA; nom.: 4.3, R&D; nom.: 4.4, Indus.; nom.: 4.6, Prod.; nom.: 4.7, Tech.) emphasised that technical ability and required knowledge are two criteria which can have an effect when selecting any new idea (Figure 8.6). Sometimes when implementing a new idea, the company needs to buy new machinery or hire expert employees. By considering all the factors (e.g. the expense of new technology) the company is able to select the most beneficial idea (nom.: 4.6, Prod.). One respondent (nom.: 4.6, Prod.) stated that a team, consisting of experts from different divisions (from technical, production, laboratory etc.), considers any new ideas and identifies the technical viability of the project. Also, the technical manager (nom.: 4.7, Tech.) said that the company always takes into consideration the opinions of the technical division when assessing technical viability (e.g. the ability of machinery to produce new size of product).

Based on one interviewee's responses (nom.: 4.7, Tech.), high-level management's opinions usually have an effect on the selection of new ideas (Figure 8.6). Another respondent (nom.: 4.3, R&D) said that when selecting a new idea each division which is related to the idea or has provided it, must consider the idea internally before it is sent to high-level management for their final decision; these ideas must be explained in detail within management meetings in order to make a final decision. It seems that within the company there are some formal meetings (at least for certain type of innovations) when selecting new ideas at this stage, although no more information was found during interviews.

One important factor, which the company usually considers at the selection stage but before producing prototypes, is competitors (nom.: 4.1, QA). Based on some interviewee's responses (nom.: 4.1, QA; nom.: 4.3, R&D) the company also consider market opportunity at the selection stage (Figure 8.6). They mentioned that market need plays a significant role when selecting new ideas.

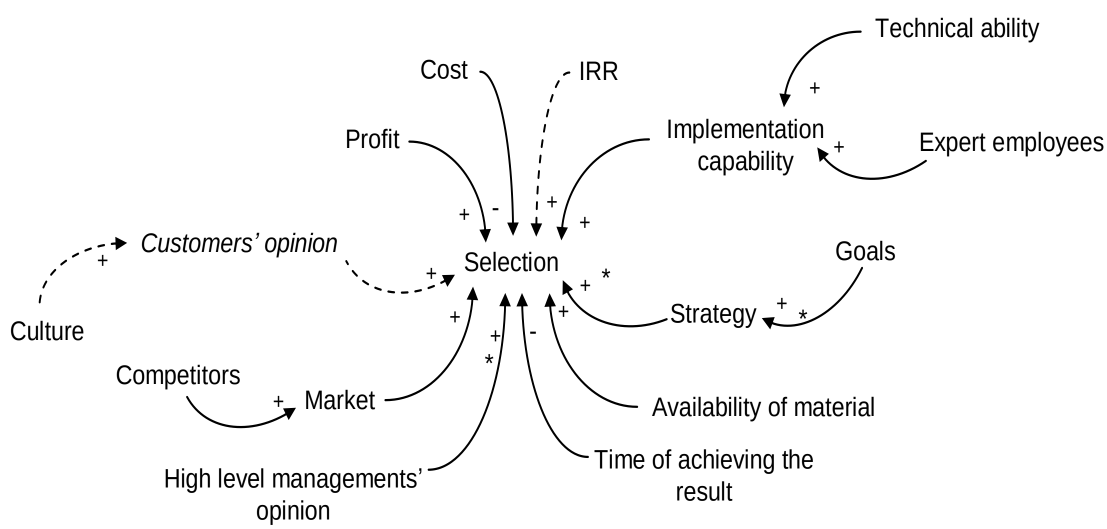


* The +/- could be debated

Figure 8.6 - Influences on selection at SJT (II)

One of the respondents (nom.: 4.1, QA) said that the availability of raw material is a factor which the company considers at the selection stage (Figure 8.6). He emphasised that the company usually prepares a feasibility study at this stage and considers the different factors, which are mentioned above, in this study. Showing these factors separately in an influence diagram (Figure 8.6) can provide greater clarity.

Figure 8.7 shows all of the factors, which were discussed above, and have an effect on the selection stage according to interviewee's responses within this company.



* The +/- could be debated

Figure 8.7 - Combining the influences on selection at SJT

8.1.3 Incubation

One respondent (nom.: 4.4, Indus.) believed that:

> *"The incubation stage plays an important role in the success of an innovative project as approving the complete prototype can cause success in other stages. So the company should employ a precise control system in this stage."*

The manager of the research and development division believed that (nom.: 4.3, R&D) his division was responsible for several important processes; these include the analysis of raw material and different processes of production and the approval of the final prototype through different standard and technical tests (Figure 8.8).

At the end of the incubation stage, but before moving to the implementation stage, the prototype is shown to some select customers in order to receive their opinions on the new product; these opinions can have a positive effect and aid in the success of the product (nom.: 4.1, QA; nom.: 4.4, Indus.; nom.: 4.6, Prod.). One interviewee (nom.: 4.1, QA) pointed out that the company might only satisfy 90% of the customer's needs, customers can accept the product in this state or the company may decide to try and improve upon it. Another interviewee (nom.: 4.2, Prod.) claimed that the company usually gets feedback about qualitative parameters. Changing the prototype based on customer opinions usually involves only minor changes at this stage so the time and effort required is minimal (nom.: 4.6, Prod.). To gather customer opinions, the company uses sales representatives who know the market and can assess customer need (nom.: 4.6, Prod.). One interviewee (nom.: 4.6, Prod.) believed that, in some situations, the sales representative influences customer opinion. Based on this, sales representatives play an important role in the gathering and shaping of customer opinion.

Another interviewee (nom.: 4.7, Tech.) explained that high-level management's opinion usually effects the approval of the prototype and its progression to the next stage (Figure 8.8).

Figure 8.8 shows all of the factors, which were discussed above and have an effect on this company's incubation stage according to interviewee opinions. These factors are: Customer's opinion, High-level managements' opinion and Standard and technical tests.

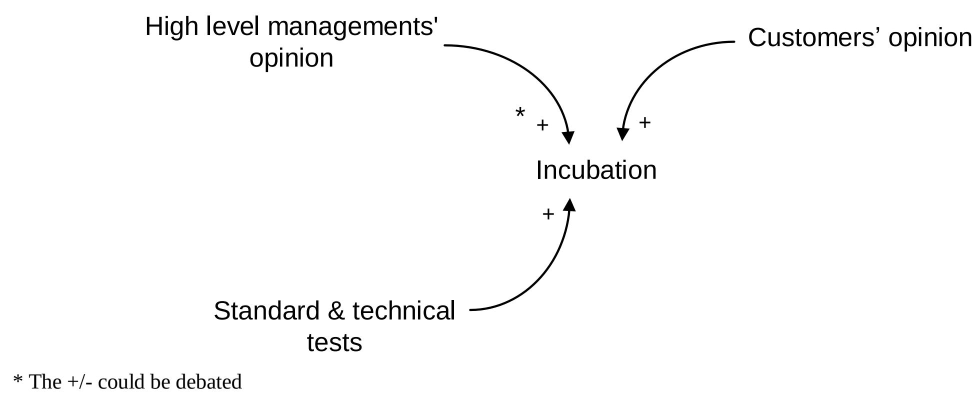


Figure 8.8 - Influences on incubation at SJT

8.1.4 Implementation

Usually, the conditions of the incubation and implementation stage are radically different, as the scales used within the laboratory are smaller and the instruments more precise (nom.: 4.3, R&D). After producing and approving the prototype at the incubation stage, it is sent for pilot production. Pilot production allows the company to check the reality of implementation, identify any possible problems with production or the product and allows the company to make adjustments if necessary (nom.: 4.1, QA; nom.: 4.3, R&D). In pilot production the company checks the product on a larger scale (nom.: 4.1, QA). One interviewee (nom.: 4.6, Prod.) said that during pilot production, the company frequently uses employees from various divisions with different expertise (e.g. technical manager, production manager) along with the employee(s) who provided this idea in the first place to identify possible problems and suggest methods in which they can be resolved.

In pilot production the product is manufactured in small amounts. After gaining approval at this stage, based on customer's opinions, inside controls and market feedback and needs, the company assesses the amount that will be manufactured during mass production (Figure 8.9). If any problems arise, the product is returned to the previous stages for development based on feedback received from customers and the market in general (nom.: 4.1, QA; nom.: 4.2, Prod.; nom.: 4.6, Prod.). There is an iterative cycle between the incubation and implementation stages in order to identify problems and solve them (nom.: 4.1, QA; nom.: 4.2, Prod.). However, one interviewee (nom.: 4.1, QA), the quality assurance manager, claimed that:

> *"The company tries to place a limit on the iterative cycle. The company limits the number of times a product can repeat each stage when attempting to resolve problems. After that, if the company cannot find a solution, the product is sent back to the previous stage. For example, if a solution cannot be identified within 20 cycles of production during pilot production, the product is returned to the incubation stage. Also, the new product may be abandoned at this point, although in most situations refinements are made and the project continues."*

Three main activities undertaken to manufacture the product during the implementation stage are: 1- forming (shaping the raw materials and putting them in the furnace), 2- labelling and designing and 3- packaging (nom.: 4.7, Tech.). One interviewee (nom.: 4.6, Prod.) claimed that forming is the most important part of the implementation stage; if this activity is successful the following activities usually find success as well.

Two important factors that have an effect on continuing mass production, as Figure 8.9 shows, are market need and customer opinion (nom.: 4.6, Prod.). One interviewee (nom.: 4.5, Prod.) said that after launching any new product, market acceptance plays a significant role in success. Based on market feedback on needs, interest in the product and volume of sales the company will decide whether to continue and renew the production plan of a new product (nom.: 4.2, Prod.). Another interviewee (nom.: 4.1, QA) explained that competitors are a factor which can have an effect on the implementation stage (Figure 8.9). Sometimes the market is saturated by similar items which are produced by the company's competitors, in these cases the share and value of the market will decrease. He said it is possible to stop production at this point, as the company will only receive minimal benefits.

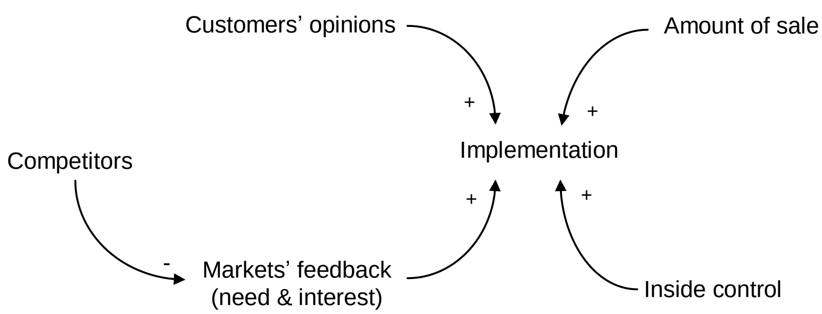


Figure 8.9 - Influences on Implementation at SJT

8.1.5 Learning

One interviewee (nom.: 4.4, Indus.) claimed that the company documents all processes. Although another interviewee (nom.: 4.1, QA) believed that whilst the company tries to document all processes, this may not be the case.

One of the respondents (nom.: 4.6, Prod.) said that as the company has ISO 9001, all processes must be documented. He added that for this purpose the company utilises an official documentation form. Also, there are some training courses which increase and transfer knowledge to employees (nom.: 4.6, Prod.). Each division usually tries to document its own processes; if this documentation relates to only one division it is kept within that division, if it is generalised it is sent for archiving (nom.: 4.3, R&D).

It seems although this company documents (or tries to document) all process, there is no evidence that the documentation enhances learning or that it can be a source of creativity.

8.2 Risk

According to one interviewee (nom.: 4.4, Indus.) innovation always includes risk, as the end result is neither clear nor guaranteed before implementation. He claimed that risk management helps the company to implement projects with greater confidence; it allows the company to prepare itself for any problems as the company will have an idea of any possible issues before they arise.

Some respondents (nom.: 4.2, Prod.; nom.: 4.4, Indus.) stressed that the company must consider risk in all stages of the innovation project. Also, based on another staff members' response (nom.: 4.4, Indus.) risk management is a continuous process that should be undertaken at all times.

In the risk management system, after recognising factors which create risk, the company should identify the probability and impact of each one; the company can then look for methods to decrease the probability and impact of each risk factor and also consider different systems to control them (nom.: 4.2, Prod.). Another interviewee (nom.: 4.6, Prod.) stated that one important parameter which can help the company to implement risk management and control risk is experience.

One respondent (nom.: 4.4, Indus.) believed that it could be useful for the company to create a separate division, which is responsible for managing risk within the company. He also mentioned that a model for managing risk throughout innovative projects could be useful, but this model should be customised to fit the company's needs.

8.2.1 Identifying potential risk factors

As one interviewee (nom.: 4.2, Prod.) said, in order to find and list all the factors that can create risk in a new project, the company uses their manager's experiences and compare designs and practices with the standards described in various documentation. The company organises meetings with relevant managers where they usually adopt the Fish Bone approach in order to identify factors which can create risk within the project. Regarding this approach the production manager (nom.: 4.2, Prod.) said that:

> *"The Fish Bone approach involves all managers expressing ideas about factors which can create risk in brain storming meetings. After this, the factors that are deemed to pose the greatest risk are selected. Sometimes the methods for solving or correcting problems can cause creativity."*

In regards to this, another respondent (nom.: 4.3, R&D) explained that each division is tried to consider risk factors within their own division. The company then asks for these suggestions to be submitted before making any final decisions.

One of the interviewees (nom.: 4.6, Prod.) claimed that some risk factors are common (e.g. raw material, energy) and the company will consider them in all projects; yet some risk factors are unclear (e.g. breakage) and the company must identify them during the manufacturing process based on the kind of the project. He stated that in companies with little experience of production, a lot of new risk may occur, but this happens rarely in companies with experience. It should be noted that no evidence was found to show that the company uses a formal method to identify common factors that create risk, the company can probably find these factors based on their experience.

One interviewee (nom.: 4.6, Prod.) believed that the timing of production is another important factor, which is capable of creating risk, and the company must consider it. He said, for example, there are several religious and national events in Iran and during each of these events some products experience greater sales.

One respondent (nom.: 4.2, Prod.) claimed that the company should complete the project based within a specified time frame, if the company takes a long time developing a product their competitors may saturate the market with similar products and the novelty value of their product will be reduced. So the Gantt chart (which is made after selecting the idea) is very important and should be prepared based on realistic situations, not tough situations and goals. Therefore, it can be said that competitors and tough goals are two factors which can create risk in innovative projects.

According to one interviewee (nom.: 4.4, Indus.), the final cost prediction can be a barrier to the acceptance of the idea by high-level management and can also create risk if the company cannot predict the final cost exactly. In other words, the inability of the company to predict the final cost can create risk within the project.

Political issues, raw materials, technology, market, strategy, management structure, weather (affect on the instrument and transportation) and a lack of skilled labour are some other factors which can create risk in innovation projects and were mentioned by several interviewees (nom.: 4.3, R&D; nom.: 4.6, Prod.; nom.: 4.7, Tech.).

All of the factors, which can create risk within company based on interviewee’s responses, can be categorised in the following areas. These factors are:

- **Resources:** raw material, energy, lack of skilled labour
- **Environment:** weather, political issues
- **Technical:** technology
- **Marketing**: market, timing of production, competitors

- **Management**: management structure, lack of experience, tough goals, inability to predict final cost
- **Strategy:** strategy

8.2.2 Analysing risk

One of the methods the company uses to manage risk is FMEA (nom.: 4.1, QA; nom.: 4.2, Prod.). This allows the company to assess the quality of their product as it examines potential product failures and the effect on the customer, thus giving the company an opportunity to increase the quality of their product (nom.: 4.2, Prod.). As one interviewee (nom.: 4.2, Prod.) said the company applies this method in design (DFMEA) and also process (PFMEA) as well. Another respondent (nom.: 4.5, Prod.) stated that the company tries to use FMEA to manage risk in all innovative projects. He added that the company needs time to apply this method throughout the company as employees must be prepared and trained in its use. The company usually applies 1, 3 and 9 ratings to the different factors in this method, as the larger interval increases the power of decision and clarity (smaller intervals make decisions more difficult). By using this method the company can recognise and analyse failure modes before trying to decrease the probability of occurrence and impact (nom.: 4.1, QA; nom.: 4.2, Prod.). The company recently tried to use this method (FMEA) in a systematic and written format and it can be said that in some part its implementation is based on this (nom.: 4.2, Prod.).

Experts in various fields produce FMEA indexes and tables for each industry (nom.: 4.1, QA). In order to customise these tables and indexes for use in their company, SJT applies the FMEA method several times, holds meetings with managers and then identifies parameters which can be improved (nom.: 4.2, Prod.).

One respondent (nom.: 4.2, Prod.) said that if the company wants to manage most problems, it must use the FMEA method continuously. Another interviewee (nom.: 4.4, Indus.) explained that FMEA is a continuous process and using this method to manage risk requires a constant team, as they will be considering all projects within the company. This team should include industry experts and, based on the type of project, expert staff from other divisions (nom.: 4.2, Prod.; nom.: 4.5, Prod.). As one staff member (nom.: 4.2, Prod.) stressed, the company must apply the FMEA method at all stages, before and after implementation and even in the creativity stage. One interviewee (nom.: 4.6, Prod.) claimed that although the company tries to apply the FMEA method to manage risk, until recently the company has not applied the method completely. In some cases the company will use the manager's experience to identify and analyse general risk factors that are related to common development (nom.: 4.1, QA; nom.: 4.6, Prod.; nom.: 4.7, Tech.). It seems a full FMEA for every project could discourage innovation but used appropriately it could be a most valuable tool, so presumably not all projects are subject to FMEA. As this method was not applied formally within the company until recently, little information was available about the extent to which the company will use this approach when analysing risk in innovation projects.

Another interviewee (nom.: 4.2, Prod.) pointed out how factors that create risk can have an effect on financial issues therefore the company must consider risk by using financial methods. He added that the company considers the cost, expected loss, profit and required loan when implementing any new idea.

8.2.3 Risk management action

In this stage, the company identifies methods for decreasing the probability and impact of each risk factor in an innovation project (nom.: 4.2, Prod.). Based on the kind of innovation (incremental or radical), the amount and impact of risk can be vastly different (nom.: 4.5, Prod.). One interviewee (nom.: 4.2, Prod.) claimed that decreasing the impact of risk is difficult; therefore it is better for the company to decrease the probability of risk and increase control (no examples of how the company attempts to control probability were discovered).

As one respondent (nom.: 4.4, Indus.) said, some of the risk factors are thought to be relatively unimportant as their effects on the project are insignificant. However, he said that some of these factors can influence the project and also the company, therefore these factors should be considered and methods to resolve them found. One member of staff (nom.: 4.2, Prod.) said that a threshold line is usually fixed by high-level management using customer opinion as a base, but it is better for the company to consider the first 20% of risk factors and after decreasing them, it can begin to consider the next 20% and so on.

As discussed before, one factor that can create risk within the company is the supply of foreign raw materials. To decrease the risk posed by the supply of raw materials, the research and development manager (nom.: 4.3, R&D) said that:

> *"The company is trying to identify alternative raw materials inside Iran, the company can then use these should any unforeseen problems occur with their foreign suppliers. Also we have begun replacing raw materials sourced internally with foreign ones."*

8.2.4 Monitoring/Learning

One interviewee (nom.: 4.7, Tech.) stated that there are some control systems within the company which allow monitoring the process of production. He said, for example, a proactive and regular system is in place which allows employees to check the machinery and to prevent any malfunction; the company tries to prevent problems occurring rather than waiting for them to happen.

According to one interviewee (nom.: 4.5, Prod.), after selecting an idea in the selection stage, the company makes a plan to enable them to control the project at different stages. For example, after selecting an idea the company makes a Gantt chart for the project and uses it to follow different stages at specific times (nom.: 4.2, Prod.; nom.: 4.5, Prod.).

One respondent (nom.: 4.2, Prod.) believed that after implementation the most important task for the company is controlling the processes of production. He said that by controlling these processes, the company can identify areas which may be in need of improvement. Another interviewee (nom.: 4.3, R&D) said that the company always checks the quality of production after the implementation stage based on approved prototype to ensure the quality is constant.

It seems that SJT does employ methods that control the different stages of the innovation process but the majority are not directly related to monitoring the risk management system.

8.3 Conclusion

There are different sources of creativity within this company. For instance, problems currently being experienced by the company can also be seen as a source of creativity, methods used to solve these problems often result in creativity. To identify problems the company uses the six-sigma method and to find methods of problem solving the company uses brain storming meetings. The company uses the TRIZ method for solving current problems, which sometimes results in creativity. TRIZ generates general ideas and the company can then adapt the results for a more practical solution. Another source of creativity is customer feedback. After receiving information on customer's needs, the company uses QFD to transform them into engineering characteristics for products or services. This method helps the company select the best customer requests based on their current ability. Sometimes customers cannot explain their needs clearly; in order to survive the company must identify the customer's needs and create desire for new products. Thus, the company tries to create need and desire within their customer base by inventing and providing new products. However, the company must realise that bombarding customers with a selection of new products will cause a delay in the customer's decision; therefore there must be an appropriate interval between the introduction of new ideas.

The culture of society plays a major role in the selection stage. For example, the culture of different regions within Iran can affect the colour and design of a product. When selecting a new idea each division which is related to the idea, must consider the idea internally before it is sent to high-level management for a final decision. These ideas must then be explained in detail within management meetings in order to make a final decision. It seems that within the company some formal meetings (at least for certain type of innovations) take place when selecting new ideas at this stage, although no more information was found during interviews.

After producing and approving the prototype at the incubation stage, it is sent for pilot production. Pilot production allows the company to check the reality of implementation, identify any possible problems with production or the product and allows the company to make adjustments if necessary. There is an iterative cycle between the incubation and implementation stages in order to identify problems and solve them. The company limits the number of times a product can repeat each stage when attempting to resolve problems.

After that, if the company cannot find a solution, the product is sent back to the previous stage.

It seems although this company documents (or tries to document) all processes, there is no evidence that documentation enhances learning or that it can be a source of creativity.

In order to find the factors that can create risk in a new project, the company uses their manager's experiences and compares designs and practices with the standards described in various documentation. The company organises meetings with relevant managers where they adopt the Fish Bone approach in order to identify factors which can create risk within the project. The Fish Bone approach involves all managers expressing ideas about factors which can create risk in brain storming meetings. After this, the factors that are deemed to pose the greatest risk are selected.

The company tries to use FMEA to manage risk in all innovative projects. However the company needs time to apply this method as employees must be prepared and trained in its use. It seems a full FMEA for every project could discourage innovation but used appropriately it could be a most valuable tool, therefore it is presumable that not all projects are subject to FMEA. As this method was not applied formally within the company until recently, little information was available about the extent to which the company use this approach when analysing risk in innovation projects.

A number of interviewees claimed that decreasing the impact of risk is difficult; therefore it is better for the company to decrease the probability of risk and increase control (no examples of how the company attempts to control probability were discovered). To decrease the risk posed by the supply of raw material the company is trying to identify alternative raw materials within Iran, the company can then use these should any unforeseen problems occur with their foreign suppliers. Also the company has begun replacing raw materials sourced internally with foreign ones.

It seems that SJT does employ methods that control the different stages of the innovation process but the majority are not directly related to monitoring the risk management system.

Chapter 9 Case 5- Scottish and Southern Energy (SSE)

SSE[1] owns around 10,700MW of electricity generation capacity, including its share of joint ventures and associates. This makes SSE the second largest electricity generator across the UK and Ireland. The capacity comprises 4,500MW of gas - and oil - fired capacity, 4,000MW of coal-fired capacity (with biomass ‘co-firing’ capability), and over 2,200MW of renewable capacity. This company supplies electricity and gas to over 9 million customers within the UK’s competitive electricity and gas supply market, with growth continuing in the current financial year. It is the second largest supplier of energy in the UK. SSE holds 50% of the equity of Scotia Gas Networks plc, which owns and operates the Scotland and the Southern gas distribution networks. The networks comprise some 74,000km of gas mains, delivering gas to around 5.7 million industrial, commercial and domestic customers.

Figure 9.1 - Example pictures of Scottish and Southern Energy (SSE)

SSE’s contracting business has three main areas of activity: industrial, commercial and domestic mechanical and electrical contracting; electrical and instrumentation engineering;

[1] Accessed on 10.06.2008: www.scottish-southern.co.uk/SSEInternet

and public and highway lighting. It is one of the largest mechanical and electrical contracting businesses in the UK. The core purpose of this company is to provide the energy people need in a reliable and sustainable way. Also the strategy is to deliver sustained growth in the dividend payable to shareholders through the efficient operation of, and investment in, a balanced range of regulated and non-regulated businesses. To help achieve this, the company plans to invest around £6.7 billion between 2008 and 2013. The principal focus of this investment is renewable energy, but investment is also planned in thermal generation, electricity networks and in other areas.

It should be noted that SSE has characteristics of both manufacturing and service industry, so it is not possible to simply say that SSE is manufacturing or service industry. For instance, while the SSE is one of the largest suppliers of energy in the UK, it also produces the electricity and other products such as wind turbines. Therefore, it can be said that SSE is partly manufacturing and partly service industry. In the following section, various interviewees' opinions regarding innovation and risk within the company will be discussed. Also, for greater clarity, the effect of different factors on each stage of innovation will be shown using influence diagrams.

9.1 Innovation

Apart from some new creative developments the company is working on (e.g. can palm waste, not palm oil itself, be used as a fuel), one method of innovation within this company is the combination of proven technologies with commercial implementation. For instance, one interviewee (nom.: 5.3, Busi.)[2] stated that in one project (refuge derived fuel)

[2] The abbreviations of the interviewees' job title for this case are: Director of Energy Services (Ene.); Corporate Finance (Fina.); Business Research Analyst or Business Development Manager (Busi.); Project Manager (Proj.); Risk Manager (Risk); Technology Development Ventures (Tech.).

innovation relied upon the effective combination of individual components of this project with those which have been proven before. Another interviewee (nom.: 5.7, Busi.) said that innovation at SSE in one specific case (Class II wind turbine) is the combination of the components of this project in a community and commercial package.

Some interviewees explained their opinions regarding the different stages of this process; they also explained the different factors which can have an effect on this process and the company should consider them at various decision points. For instance, one interviewee (nom.: 5.3, Busi.), a business research analyst, mentioned that:

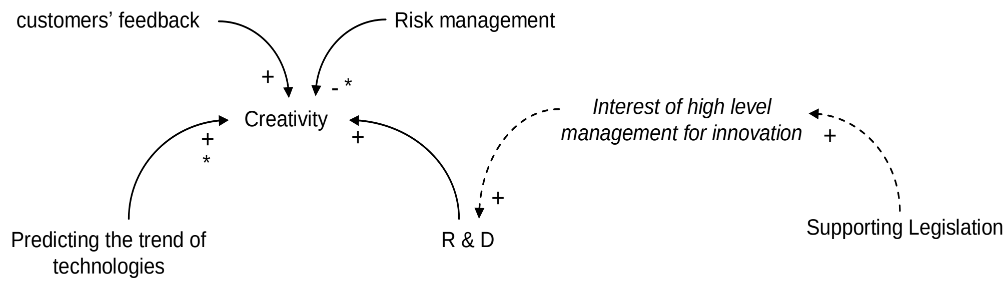
> *"There is no formal process for the first stages (creativity) of innovation. This is because the employee should be thinking about new ideas as part of their job."*

Another interviewee (nom.: 5.6, Busi.) emphasised the importance of feedback between these stages. In the following sections, different factors which have an effect on the stages of innovation in this company will be examined and explained in greater detail.

9.1.1 Creativity

One of the interviewees (nom.: 5.3, Busi.) said that creativity can be stimulated by means such as: customers' feedback, legislation changes and trends in vehicle and fuel needs (Figure 9.2). She also emphasised that, despite its usefulness, the financial appraisal is not used at this stage due to insufficient data. She believed that there is a need to energise from the creativity through to the selection stage. In other words, volunteers need to be encouraged to champion ideas, so risk management is appropriate for later stages but not for this stage. Also, another interviewee (nom.: 5.5, Risk) emphasised that there is a need to balance risk and creativity. This means that the risk management needs to avoid using too many onerous controls at this stage. It seems that at the early stages of development, there will never be sufficient data to support a detailed risk analysis and it may constrain creativity.

Based on some interviewees' opinion (nom.: 5.3, Busi.; nom.: 5.6, Busi.) another factor which can be viewed as a source of creativity is research and development, although recently the company began to use "venture" for new projects, (Figure 9.2).



* The +/- could be debated

Figure 9.2 - Influences on Creativity at SSE (I)[3]

One interviewee (nom.: 5.4, Proj.) declared that there is a reluctance to pursue innovation at SSE and that it relies heavily on individuals (Figure 9.3). Also, one interviewee (nom.: 5.3, Busi.) stated that there are insufficient questions at SSE which can have a negative effect on creativity. However, another interviewee (nom.: 5.8, Tech.) believed that:

> *"The staff of SSE have viable and creative ideas. The problem may then be related to the inability or unwillingness of them to develop or nurture their ideas into a viable business plan."*

It seems that there are few incentives or time provided for employees meaning they do not feel motivated into creativity. Although one interviewee (nom.: 5.4, Proj.) claimed that SSE's "licence to innovate" is meant to encourage innovation and enables direct access to the Chief Executive. Also, one interviewee (nom.: 5.6, Busi.) stated that a SSE executive is attempting to change the culture of the company by encouraging employee creativity. He added that the motivation for this change is largely due to the present Chief Executive, the

[3] The continuous lines represent influences explicitly identified by the interviewees; the broken lines are influences which are inferred from interviewee comments.

predecessor was risk adverse and more interested in control than innovation. So it can then be said that manager's targets and company strategy have an effect on the processes of innovation and creativity (Figure 9.3).

One interviewee (nom.: 5.4, Proj.) believed that SSE does not fully utilise its employees' thinking power. Based on his idea, SSE needs to assemble small think groups to generate ideas. Also, he added that there is a lack of innovation in SSE but it is not due to a fear of risk or risk management. Some individuals may lack confidence outside their own areas of expertise, so a lack of confidence has a negative effect on the creativity stage (Figure 9.3). The important point here is that the fear of risk or risk management does not have a negative effect on this stage, but it may slow the creativity process. So maybe a softer method of risk management can be useful at this stage.

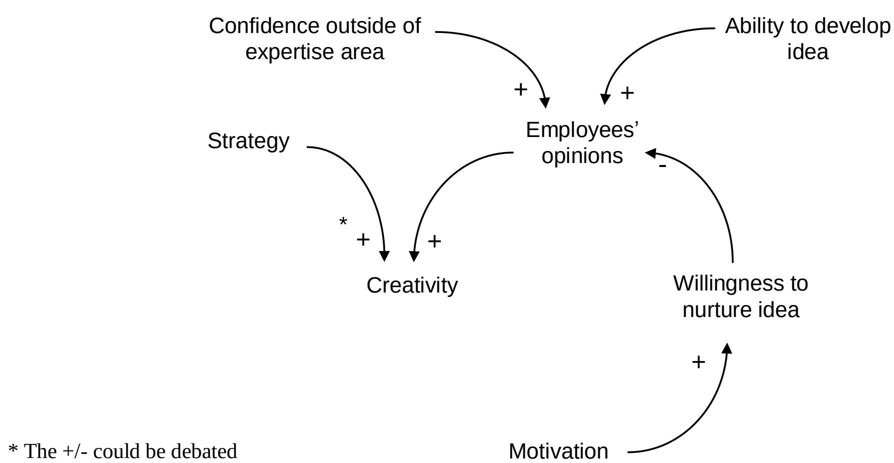


Figure 9.3 - Influences on Creativity at SSE (II)

Since Christmas (2008), SSE has been restructured and there is now a more formal method of reporting to the senior management (nom.: 5.4, Proj.). In particular, market risk is considered at an early stage. One interviewee (nom.: 5.1, Ene.) explained that occasionally SSE arranges exclusive deals with the objective being to exclude competitors from access to certain technologies or markets. These issues suggest that the market and competitors have an effect on creativity stage (Figure 9.4).

One interviewee (nom.: 5.5, Risk) talked about the role of lobbying, for example the code for shipping/transhipping gas. He mentioned that lobbying could be viewed as a contributing factor to both innovation and risk. As Figure 9.4 indicates lobbying can result in change and act as a stimulant for innovation by providing new opportunities, thus it can have an effect on creativity. But on the other hand lobbying can also stop change and reduce risk.

One interviewee (nom.: 5.6, Busi.) said that customers are frequently enquiring about the availability of renewable powered CHP (e.g. biomass). It can then be said that the customers' needs have an effect on the creativity stage (Figure 9.4). Another interviewee also explained the importance of the customer's role (nom.: 5.1, Ene.). He said that the SSE has three types of customers (building, commercial and domestic) who play a specific role in the creative process (Figure 9.4).

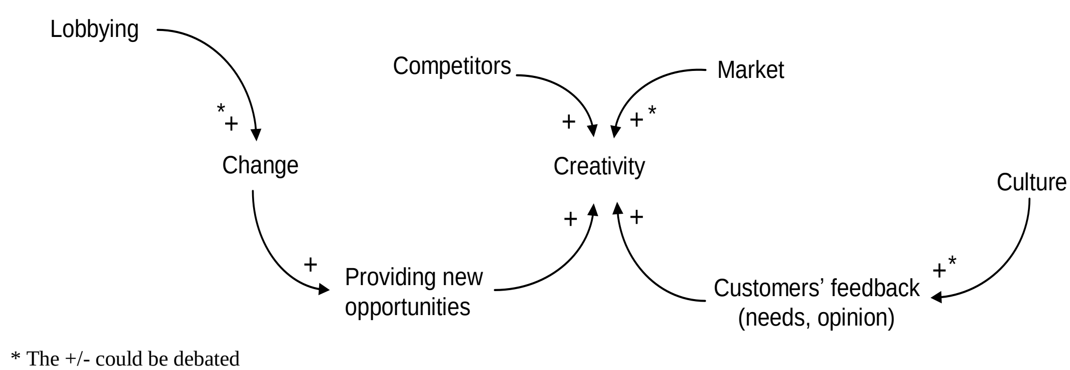
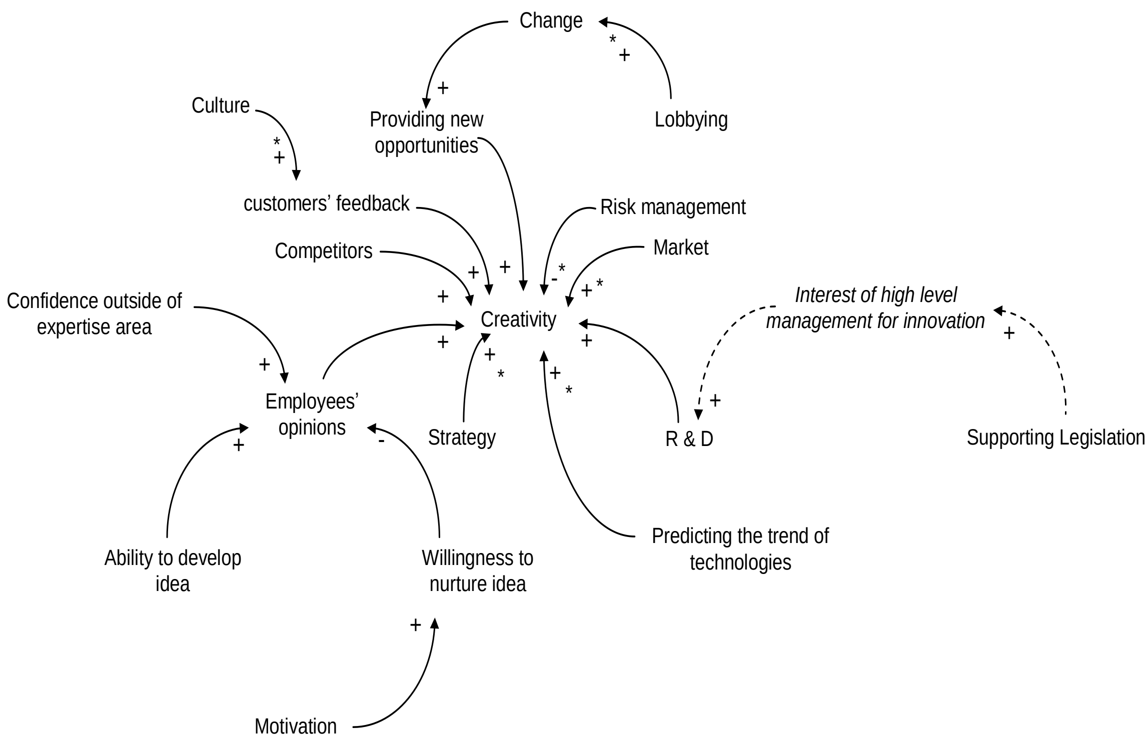


Figure 9.4 - Influences on Creativity at SSE (III)

One of the interviewees (nom.: 5.1, Ene.) said that display panels provide a better approach for the monitoring of electricity use and allow a clearer understanding of the relationship between energy consumption and the environment (e.g. external temperature), which then enables customers to use energy more efficiently. It can be said that culture has an effect on customers (Figure 9.4); and the company can have an effect on the manner of customer consumption (in other words customers' culture) by using different methods (i.e. training programmes).

Figure 9.5 shows all of the factors which were discussed above and have an effect on the creativity stage based on interviewees' explanations for this company.



* The +/- could be debated

Figure 9.5 - Combining the Influences on Creativity at SSE

9.1.2 Selection

Based on one interviewee's opinion (nom.: 5.1, Ene.), one of the important factor in the selection stage is customer's needs (Figure 9.6). Some parameters have an effect on the customer, and the company must consider these parameters. For instance, one interviewee (nom.: 5.7, Busi.) said that customers are motivated by company social responsibility. The schemes appeal to customers since they provide stability in energy prices and low carbon impact.

Three respondents (nom.: 5.1, Ene.; nom.: 5.6, Busi.; nom.: 5.7, Busi.) said that reliability and value are two significant factors that should be considered at this stage when selecting new ideas. So it seems that the investment rate of return (IRR) plays an important role at this stage for the company (Figure 9.6). Another interviewee (nom.: 5.3, Busi.) emphasised that during the selection process, more information is collected and a more formal risk assessment is possible at this stage. She also said that cost is one of the most important criteria which should be considered at this stage (Figure 9.6).

One interviewee (nom.: 5.3, Busi.) explained that engineering consideration is an important criterion at this stage. In regards to this idea, another interviewee (nom.: 5.6, Busi.) claimed that one of the problems at this company is that technologists are involved in creativity and implementation processes but not in the selection and incubation stages (Figure 9.6).

One respondent (nom.: 5.1, Ene.) said that tax changes often force decisions and selections to be made in haste. It can then be said that political issues can sometimes have an effect on this stage (Figure 9.6).

One of the factors that must be considered at the selection stage is raw material (nom.: 5.3, Busi.). One interviewee (nom.: 5.5, Risk) said that SSE, following scenario analysis, rejected Liquid Natural Gas. He explained that during the analysis the following factors are considered: obtaining the gas (challenging and unreliable supply) and shipping and re-gas at the market end. This suggests that raw material can play an important role in the selection stage. Although the company do not use a formal method (such as the theoretical model) for managing risk during the innovation process, it seems that they employ an informal checklist to consider some factors in proper stages of the innovation process. For instance, with regards to this issue (raw material), another interviewee (nom.: 5.4, Proj.) said that:

> *"In one of SSE's projects a question was posed: how can SSE get biomass crops into London cheaply? It is not possible to buy ahead in biomass, so should SSE invest long term in biomass given the unpredictable nature of the supply? Perhaps SSE could buy or lease land?"*

It seems, since SSE is an example of a very experienced company, they consider raw material at an appropriate stage of the innovation process and identify potential and appropriate actions before any issue becomes too problematic and leads to financial disaster.

Based on two interviewees' opinions (nom.: 5.4, Proj.; nom.: 5.6, Busi.), one of the factors which can have an effect on this stage is strategy (nom.: 5.3, Busi.). One interviewee (nom.: 5.4, Proj.) said that the company mission has changed; where it was once very much focussed on reducing costs there is now a genuine mission to achieve sustainable (e.g. low cost) low carbon alternatives. Another interviewee (nom.: 5.6, Busi.) added that this mission is the Chief Executive's personal initiative.

Figure 9.6 shows all of the factors which were discussed above and have an effect on the selection stage based on several interviewees' explanations in relation to this company.

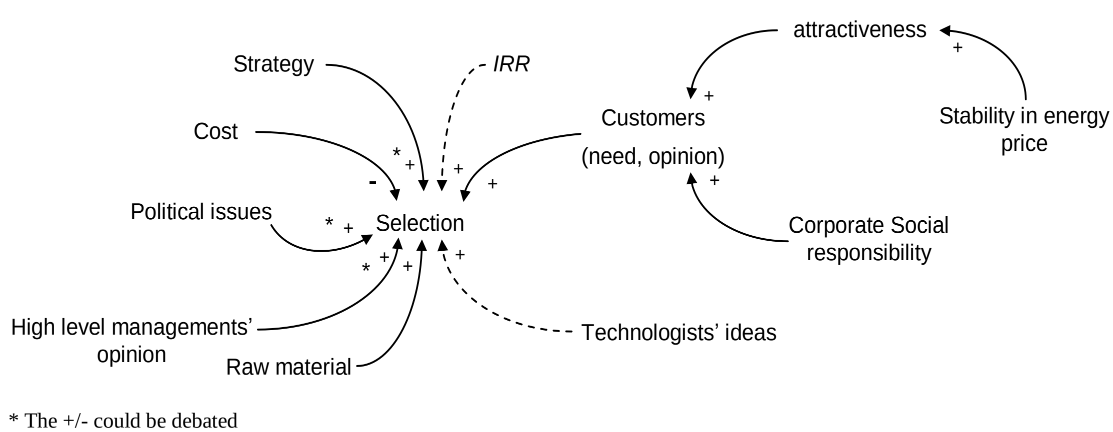


Figure 9.6 - Influences on selection at SSE

9.1.3 Incubation

Based on one interviewee's point of view (nom.: 5.3, Busi.), incubation and implementation are two important stages at this process. One of the innovation projects in this company was the SWIFT Wind Turbine. One problem, related to this innovation, occurred because the responsibilities for carrying out test specifications were not clearly allocated (nom.: 5.1, Ene.). During this project, lab-testing results proved positive but in real-life prototype installations it still encountered many problems: notably the electricity generated was much less than expected. This means that other tests should have been undertaken in the lab to ensure these problems would not occur. This issue suggests that if the company had followed a more structured approach, such as that of the theoretical model, it might have considered specific test criteria at earlier stages which would have removed possible risk factors before they occurred in the later stages.

One interviewee (nom.: 5.1, Ene.) believed that SSE could use similar issues encountered by other companies to aid in problem solving (e.g. H2 fuel cells). Another respondent (nom.: 5.4, Proj.) said that one of the most important criteria that should be considered at this point, before progressing to the next stage, is technical success. In this respect, another interviewee (nom.: 5.6, Busi.) claimed that technologists should be involved at the incubation stage (Figure 9.7).

One of the interviewees (nom.: 5.6, Busi.) claimed that it is better to change the position of 'stop' and 'continue' of theoretical model (Figure 3.13) at decision point five (D5) to decision point four (D4). It seems he wants to emphasise the importance of project consideration at decision point four, before passing from incubation to implementation. However, there is also the option to 'abandon' at decision point four. Therefore, it may still be better to place ‘continue’ or ‘stop’ after implementation as at this stage the company should still be able to reconsider before continuing with the project to reproduction, going back to last stages for improving or stopping the project.

One interviewee (nom.: 5.1, Ene.) explained the importance of considering the final cost of production for customers at this stage (Figure 9.7).

The following influence diagram shows all of the factors which were discussed above and have an effect on the incubation stage based on interviewee’s explanations in regard to this company. These factors are: technical tests, final cost and technologist’s ideas.

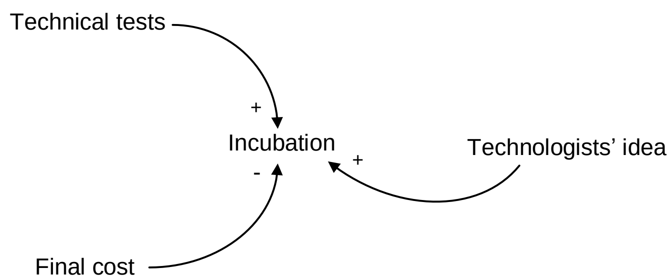


Figure 9.7 - Influences on incubation at SSE

9.1.4 Implementation

One interviewee (nom.: 5.6, Busi.) claimed that implementation and learning are two important stages in the process of innovation. Based on one interviewee’s opinion (nom.: 5.1, Ene.) the typical route in this company is to undertake the initial implementations in commercial sites and then transfer to domestic (and industrial) later, once the operation has been proven. It seems that in this company the implementation stage has two steps; initial and final implementation. One interviewee (nom.: 5.1, Ene.) claimed that abandoning the project is also possible at this stage, like the other stages. Although it seems in this stage refining the project is more probable than abandoning it.

As Figure 9.8 shows two important factors that should be considered at this stage before deciding to continue with or stop the process entirely are commercial success and market (nom.: 5.4, Proj.; nom.: 5.6, Busi.). Based on one interviewee's opinion (nom.: 5.6, Busi.), customer interest and technologist's ideas are important factors which also have an effect on implementation stage (Figure 9.8).

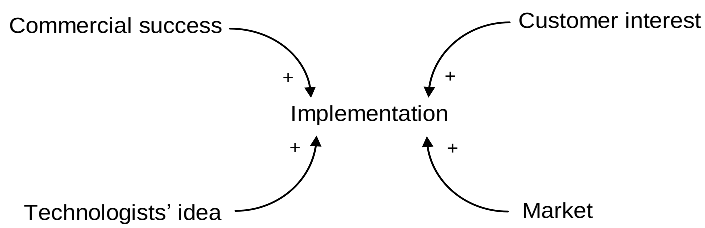


Figure 9.8 - Influences on Implementation at SSE

9.1.5 Learning

One interviewee (nom.: 5.3, Busi.) believed that there are few formal learning mechanisms within this company, so the experience is exchanged informally with no protocol. She said that, for example, some problems in biomass waste are similar to those encountered with any solid fuel (like logistic and storage). It means that SSE can use a learning system to solve similar problems in different projects; hence this issue highlights the importance of learning in the process of innovation. Another interviewee (nom.: 5.6, Busi.) highlighted the fact that:

> *"There is no formal mechanism for learning at SSE. For example, I have been learning by myself during the past year by visiting potential clients and discussions with colleagues: it is all informal; no documentations, workshops or seminars."*

Another interviewee (nom.: 5.5, Risk) stressed that the present approach might fail to capture or exploit all experiences within SSE. On the other hand, one interviewee (nom.:

5.6, Busi.) claimed that it is difficult to devise a system to exploit expertise fully within an organisation as large as SSE.

9.2 Risk

Based on one respondent's opinion (nom.: 5.4, Proj.) risk management can be defined as utilising knowledge to reduce uncertainty. Risk management may also be considered positively as being supportive, it identifies a need for more information and acts as a mechanism to encourage the provision of more knowledge, as well as acting as a filter and blocking some ideas (nom.: 5.5, Risk).

Some interviewees explained the different barriers which have an effect on proper risk management. For instance, some barriers for managing risk come from the commercial/economical team (nom.: 5.4, Proj.); or based on another interviewee's opinion (nom.: 5.2, Fina.) time can also act as a barrier. The different stages of risk management in this company will be explained in greater detail in the following passages based on interviewees' opinions.

9.2.1 Identifying potential risk factors

One interviewee (nom.: 5.3, Busi.) stated that risk management is appropriate for the later stages when undertaking a new project. She believes that:

> *"There is a need to energise the creativity to selection stages. Risk management is appropriate later. Volunteers need to be encouraged to champion ideas in the creativity stage."*

One of the interviewees (nom.: 5.7, Busi.) said that SSE has a safety checklist to help identify potential risks, but there is no formal system to allow quick recognition of other factors which also create risk. He mentioned that SSE has a reasonable attitude towards technical and operational risk but not political ones. Also, he added that a checklist could be useful for SSE, but some risks like political and local planning are difficult to classify.

Based on one interviewee's opinion (nom.: 5.2, Fina.), a subtle parameter that should be considered before the investment is the risk of not being involved in a new development. Therefore this risk has to be compared to the risk of involvement.

A change of subsidy (e.g. Big CHP) can make schemes less attractive and will, in turn, stop active development at SSE (nom.: 5.4, Proj.). So, changes in legislation or subsidies (EU and UK interactions) require a review of technology and SSE's interests. Therefore these factors can create risk in the process of innovation.

One interviewee (nom.: 5.6, Busi.) said that integration is a factor which creates risk in some projects (e.g. ground source heat pumps in CHP). Another interviewee (nom.: 5.3, Busi.) claimed that risk lies in the supply chain (reliable delivery) and markets rather than technology.

All of these factors can create risk in SSE based on interviewee's opinions. The following factors can clearly be elicited from these different interviews and be categorised into the following areas:

- **Resources:** finance, supply chain (unreliable supply), wind resources, staff
- **Marketing:** market, commodity risk (whole sale price)
- **Environment:** government policy (e.g. regulation, EU/UK legislation, change of subsidies, tariff), geopolitical risk (e.g. security of Russian gas supply), political
- **Technical:** technology, delivering technologies on a small scale, construction, maintenance, operational, shipping and re-gas at the market end, transferring of technology to the site (pipes needed to reinforce drain)

- **Integration**: with other systems
- **Management:** local planning, combination in a community/commercial package, collaboration

9.2.2 Analysing risk

One respondent (nom.: 5.2, Fina.) believed that for an appropriate level of risk analysis SSE needs to consider: the time available to perform an analysis, the possibility of information overload for senior managers and the need to avoid stifling innovation. Another interviewee (nom.: 5.5, Risk) emphasised that a single approach to risk management is not appropriate; there is a need for some adaptation to suit particular situations. He added that the risk committee does not have a specific set of criteria and there is no broad template. One interviewee (nom.: 5.7, Busi.) explained that SSE uses an informal method for prioritising risk. Regarding this, another interviewee (nom.: 5.5, Risk) believed that:

> *"The present approach might well fail to capture or exploit all experience in SSE. SSE might be too big for an informal system and a more formal approach (e.g. risk register) might prove to be more useful. This process could form part of the selection stage; collecting relevant experience (e.g. by the project team) and recording it in the risk register which would develop as part of 'due diligence'."*

One interviewee (nom.: 5.7, Busi.) said that although there is no formal risk register this may change and evolve overtime. He believed that since projects are constantly emerging there will be the possibility (and need) for a more formal approach to risk. Also, one employee (nom.: 5.5, Risk) explained that SSE uses a financial approach when prioritising the different risk factors. In addition, he added that risk management is an ongoing process and should be considered at all stages. It seems that SSE tries to transfer all risk into financial risk, since they assume that all factors, which create risk at the final stage, have an effect on financial issues. But if SSE concentrates solely on this method, it will cause them to neglect other types of risk.

Several different methods that SSE uses to analyse risk were mentioned during the interviews. These methods are: SWOT, hurdle rate, risk premium, IRR, sensitivity analysis, @Risk, tornado diagram, scenario approach and risk log. As the Table 9.1 shows, these methods for analysing risk can be categorised based on quantitative and qualitative methods.

Table 9.1 - Methods for analysing risk

Quantitative	Qualitative
IRR	
Hurdle Rate	Risk log
@Risk	SWOT
Tornado diagram	Scenario
Sensitivity analysis	

The most common methods used by SSE for appraising investments are “hurdle rate” and IRR (nom.: 5.2, Fina.). By comparing these parameters and including some sensitivity analysis, company can decide for new investment. Although this method is not directly related to risk analysis, it seems it can provide a structure for considering risk at SSE. As one interviewee (nom.: 5.2, Fina.) said, establishing a hurdle rate involves: cost of capital for the company + risk premium dependent on various factors: construction, market, government policy, whole sale prices, technology, mergers & acquisitions, collaboration. He added that SSE have used @Risk before, but the output was “over the top”; and managers would receive bulky outputs which were ignored. He added that there was a separate risk analysis department but now risk analysis is embedded in the routine appraisal/management, for example using tornado diagrams. In regards to this area, another interviewee (nom.: 5.4, Proj.) said that IRR should be considered at an early stage by using approximate estimation as well. Another interviewee (nom.: 5.2, Fina.) mentioned that hurdle rates are considered a common language when debating risk, whereas the @Risk analysis clouded the issue, as decision makers are not familiar with this language. He said that new or occasionally used techniques may not be appreciated and can introduce communication problems. He added that hurdle rates/risk premiums are reviewed periodically in SSE.

Some interviewees explained that SSE use scenarios to quantify commodity risk and predicting the future (nom.: 5.5, Risk; nom.: 5.8, Tech.). This approach provides a 5-year profit and loss (P&L) estimate and enables decisions to be made regarding future acquisitions and mergers and whether to invest in or buy companies. For example, as was mentioned earlier in the selection section (9.1.2), Liquid Natural Gas has been rejected by SSE following a scenario analysis (nom.: 5.5, Risk).

As mentioned before, one interviewee (nom.: 5.7, Busi.) said that as more projects emerge, there will be a need for a more formal approach to risk. He added that for this reason, one company employee has begun developing a risk log, including control action. In this model, SSE prioritises different risks based on a multiplying likelihood of risk (L) and impact of risk (I) within three categories (high, medium and low level of risk). After this, SSE considers the most important ones (high level and possibly medium level risk). A five-scale category (Highly probable, Very likely, As likely as not, Could happen, Improbable) is used when determining the likelihood of risk. It seems that based on the situation, the type of project and the opinion of the manager, one of these categories is selected when identifying the level of risk posed by factors which create risk. In this method there are six categories for factors which create risk: commercial, project management, technical, operation and maintenance, customer interface, third party. It seems it is better if each of these factors, which create risk, have drivers. Also, based on this model, there are five different risk impact categories (catastrophic, critical, serious, marginal and insignificant). Based on performance and safety in construction, commission and operation, SSE can identify any possible impact of risks. There are also eight different states for risk ownership and also five different activities used to control risk (Hold, Avoid, Reduce, Transfer and Share). Also, the model can show the varying status of risk (New, Ongoing and Closed).

9.2.3 Risk management action

If a proposal passes the risk assessment, a detailed investment plan (such as financial, time schedules and resources) could be then developed (nom.: 5.1, Ene.). Based on one interviewee's opinion (nom.: 5.6, Busi.), if the consequences of failure are important to SSE, they will consider taking action to prevent it. He added that a £10 million loss is a small amount for a company as large as SSE because these projects are part of a bigger portfolio that the total risk to SSE may not be great overall (nom.: 5.3, Busi.).

One interviewee (nom.: 5.2, Fina.) explained that when considering investing in a new technology, through investing in equity, risk is managed by ensuring that SSE has a reasonable portfolio and by buying a percentage share of equity. Based on another interviewee's statement (nom.: 5.1, Ene.), one approach to investment is "pre-emptive" investment. This approach involves an initial investment and then having a right to buy more equity if the venture succeeds; this approach reduces the risk of investment.

Another strategy for managing risk in an intelligent manner is to share the risk through joint venture (nom.: 5.3, Busi.). For instance, owning a power station with a waste company through joint venture would provide an incentive and help ensure a reliable supply of RDF to fuel the power station.

One respondent (nom.: 5.5, Risk) emphasised that lobbying could be viewed as a contributing factor to both innovation and the reduction of risk. For instance he said lobbying can stop the probable changes and reduce the risk.

9.2.4 Monitoring/Learning

Although there is no formal system for monitoring and learning at SSE, most of the interviewees emphasised its importance. For instance, one interviewee (nom.: 5.7, Busi.) said that by understanding the problems in wind turbines (e.g. SWIFT), the company can manage other similar problems.

One interviewee (nom.: 5.3, Busi.) mentioned that SSE only use an informal system with a protocol for learning during risk management. Another interviewee (nom.: 5.2, Fina.) highlighted the fact the company periodically review hurdle rates and risk premiums when monitoring.

It seems that since the company wishes to use a ‘risk log’ for their activities, this plan can provide a formal learning mechanism; it will assimilate experience through new possible risk or responses.

9.3 Conclusion

Some interviewees believed that since the employees should be thinking about new ideas as a part of their job, there is no formal process for the first stages (creativity) of innovation. However, there is a lack of innovation in SSE but it is not due to a fear of risk or risk management. Some individuals may lack confidence outside their own areas of expertise, so a lack of confidence has a negative effect on the creativity stage. Also, it seems that there are few incentives or time provided for employees, meaning they are not motivated into creativity.

One factor which plays an important role at selection stage in this company is investment rate of return (IRR). Some interviewees stated that one of the most important criteria that should be considered at incubation stage is technical success. In this respect, they claimed that technologists should be involved at this stage.

It seems that in SSE the implementation stage has two steps; initial and final implementation. Abandoning the project is also possible at this stage, like the other stages. Although it seems in this stage refining the project is more probable than abandoning it. There is no formal system for monitoring and learning at this company, so the experience is exchanged informally with no protocol. Therefore the present approach might fail to capture or exploit all experiences within SSE.

SSE has a safety checklist to help identify potential risks, but there is no formal system to allow quick recognition of other factors which also create risk. Some interviewees said that SSE uses an informal method for prioritising risk but SSE might be too big for an informal system and a more formal approach might prove to be more useful. For this reason, one company employee has begun developing a risk log, including control action. Some interviewees mentioned SSE uses a financial approach when prioritising different risk factors. It seems that SSE tries to transfer all risks into financial risk, since they assume that all factors, which create risk at the final stage, have an effect on financial issues.

However if SSE concentrates solely on this method, it will cause them to neglect other types of risk. In some situations SSE uses scenarios to quantify commodity risk and predict the future as well.

Based on some interviewees' opinions, despite its usefulness financial appraisal is not used at the creativity stage due to insufficient data. There is a need to energise from the creativity stage through to the selection stage. In other words, volunteers need to be encouraged to champion ideas; therefore risk management is appropriate for later stages but not for this stage. There is a need to balance risk and creativity. This means that risk management needs to avoid using too many onerous controls at this stage. It seems that at the early stages of development, there will never be sufficient data to support a detailed risk analysis and it may restrict creativity. It is possible that a gentler method of risk management could be useful at this stage. Interviewees believed that during the selection process, more information is collected and a more formal risk assessment is then possible at this stage.

Chapter 10 Synthesising the Empirical Studies and the Literature

This chapter aims to develop an understanding of the criteria that affect the innovation process and ultimate success and explain the role of risk management in dealing with these criteria. In the following sections, the results from five different empirical cases are synthesised, and compared to the literature summarised in Chapter 2 and Chapter 3. It should be noted that the results and factors taken from five different case studies, are inevitably based on people's opinions and perceptions. However, interviewees were asked to provide evidence from their own experience to support any judgements. Also, the design of the research was such that there were sufficient interviews in each company to test their validity and reduce bias (Section 4.4.4 describes how this research minimised bias).

To implement the innovation part (Section 10.1 to 10.7) of this chapter, initially the influence diagram for each stage of innovation will be developed from individual case study diagrams and differences and similarities will be highlighted. Then the main candidate criteria will be identified for each stage. These are the criteria which will be used to make progress decisions. The importance of each criterion is then explored using a simple content analysis to structure the examination of the more detailed information from the interviews.

In this chapter the names of some similar factors have been adapted for two significant reasons: consistency and clarity. First of all, interviewees expressed the same ideas but using different words; secondly, to create clarity and reduce complexity, some similar factors have been amalgamated. Therefore in each section these factors will be explained.

10.1 Attitudes towards Innovation Management

Most of the interviewees emphasised how important creativity is, if the company is to survive in the market. For instance, interviewees in case 3 (RDPC) believed that in order to remain competitive in the market, companies need to satisfy the needs of their customers; in order to create high levels of customer satisfaction the company must be innovative.

Interviewees explained their various points of view regarding the process of innovation management and factors which have an effect on this process. Although the interviewees could relate to the stages of innovation in the proposed model (Figure 3.13), it seems that no formal meetings are in place at points of decision to allow a project to progress from one stage to the next. Also, the interviewees differing comments regarding the stages of innovation were received during the interviews. For instance, in case 1 (Bus Co) creativity and selection are part of one stage. This is because the company is limited to a few options due to customer's requirements. Section 10.7 provides a summary of the synthesis of five cases of innovation which will cover these issues in more detail. In the following sections (10.2 to 10.6) five stages of innovation will be developed from the individual case studies.

10.2 Creativity

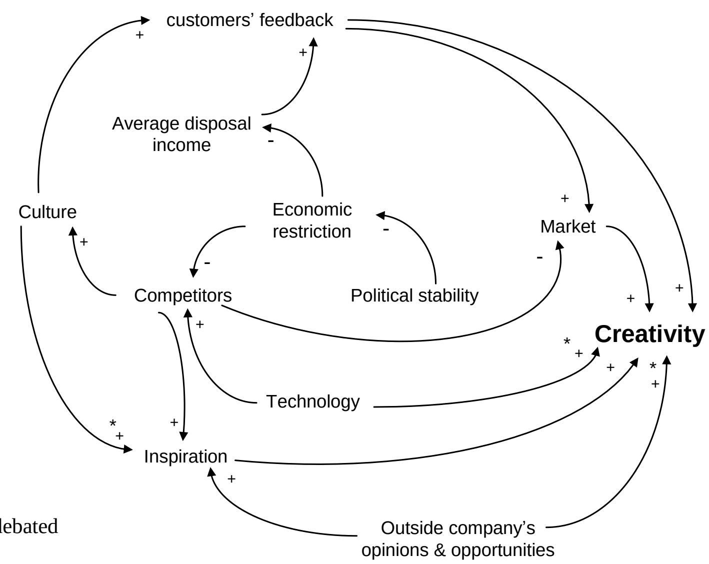
For clarity the final influence diagram is developed in different steps. So factors can be categorised based on internal company factors and external factors. It should be noted that there are some overlaps between the factors in these two steps when drawing the influence diagram (e.g. supporting legislation and political stability were shown in internal factors for drawing its effect inside the company). Also in this section the name of some similar factors has been adapted and some factors which were related to specific situation are eliminated or generalised[1].

10.2.1 External factors

The influences of external factors on creativity, identified in various case studies, have been summarised in Figure 10.1. As discussed in Section 2.6.1 “customer feedback” is one of the drivers for creativity within companies (Sheth and Ram, 1987; Lee-Mortimer, 1995). Figure 10.1 suggests that one of the major sources of creativity is “customer feedback”. This factor has direct and indirect effect on creativity. It means that the company receives the customer feedback directly and also through market. “Customer feedback” is a means of gathering information on the end user’s view of a product or service, new requests and allows a company to adapt. “Culture” of society is one of the most important factors which has an effect on customers’ opinion. It can change the interest of customers and create the new ones. For instance in case 3 (Section 7.1.1): during the last decade the younger generation of Iran developed a preference for UF cheese instead of the traditional one (which is stored in salty water). Sometimes competitors create new products which have no immediate demand (Worthington, Collins and Hitt, 2009) but they work on the culture of customers and make them desire change so they will inevitably need new product (e.g.

[1] For instance, “needs of society” usually mirror in culture of society which is shown with “culture”. Or “other industries’ innovation,” “outside company’s opinion” and “new opportunities” can be categorised as “outside company’s opinions and opportunities”. Also based on all cases it can be said that the “competitors” can be used instead of “competitors’ product” and “powerful competitors”. It seems for more clarity the “competition” can be eliminated and only the “competitors” will be applied for all similar words. In addition the “technology push” and “predicting the technology trend” can be put in one category with name of “technology”. Furthermore, “economical situation” and “economic goal restriction” can be adapted to “economical restriction”. “Governmental rules” and “political situations” can be put in “political stability” category. Some different skills which have an effect on “employees’ opinion” and mentioned in different cases, like “confidence,” “ability,” “knowledge” and “experience” are gathered in one factor. “High level management’s opinion for supporting” can be changed into “interest of high level management for innovation”. “Mother company” (case 1, Section 5.1.1), “lobbying” and “change” (case 5, Section 9.1.1) are eliminated as factors which have an effect on creativity, since they were mentioned in one case and were only related to a specific situation.

opaque tile designs; case 2, Section 6.1.1). Therefore competitors can have an effect on the culture of society and consequently create the new needs for customers. In this respect sometimes the traditional culture can be a source of creativity and has an effect on the inspiration of a company (e.g. case 3, Section 7.1.1). The amount of average disposal income of customers can affect their opinion and needs. It means that by increasing this amount, customers want to find new and better products to take advantage of. This factor is related to the economic situation of society.



* The +/- could be debated

Figure 10.1 - Synthesis influence diagram for external factors in the creativity stage

Another factor which has an important role in the creativity stage is “competitors” (Figure 10.1). Ideas may be initiated by competitors actions (Tidd, Bessant and Pavitt, 2005). Competitors can change the culture of society (e.g. opaque tile designs; case 2, Chapter 6) and push the company into satisfying new needs of customers. Sometimes the company may also create a new product or service by looking at others (domestic and international competitors).

As explained in Chapter 2, relationships with other firms and organisations allows companies to gather the information needed for the innovation processes; they rely upon their suppliers, customers etc. to start the process of product improvement and as a source of novel ideas (Hendry, Arthur and Jones, 1995; Jantunen, 2005). Figure 10.1 suggests that "Outside company's opinions" can be a source of inspiration. For instance, the raw material supplier may provide a new idea, alternatively the company may find new ideas in other industries (e.g. cloth industry, case 2, Section 6.1.1). In addition, Figure 10.1 indicates that new "opportunities outside the company" can have an effect on the creativity stage and play a role as a source of innovation. As the Figure 10.1 suggests, "technology" push can effect on competitors and creativity as well. Also the instability of the "political" situation can restrict the economic goal and decrease competition (e.g. case 1, Section 5.1.1), so by decreasing the competition, the motivation for creating new products will be decreased within the company.

10.2.2 Internal factors

Internal factors which have an effect on creativity stage are shown in Figure 10.2. "Employees' opinion" is one of the most important factors which has a significant role in this stage as a source of creativity (e.g. development of compiler in furnace, case 4, Section 8.1.1). It is interesting to note that in all cases that the importance of this factor was examined, the companies do not fully appreciate the potential value of their employees' input; the system for collecting "employees' opinion" is often ineffective.

Lee-Mortimer (1995) explains that encouragement and reward is one of the characteristics of a company that provides the optimum environment for creativity. Most of the interviewees mentioned that there is no appropriate system which would motivate them into providing new ideas. For instance, based on some interviewees' opinions in case 5 (Section 9.1.1), there is a lack of probing (insufficient questions) at their company, which in turn has a negative effect on creativity. They believed that the staff of their company are good creatively, so the issue is related to inability or unwillingness of them to develop or nurture an idea into a business plan. It seems there is not enough motivation for employees, and they do not like to reveal their creativity. In this area, the “structure of management” and “interest of high level management” are two factors which have a direct effect on creating the “motivation” for employees. The structure of management is related to the method of management, organisational structure and organisational behaviour. Some companies suffer from a traditional structure of management; there is a strict hierarchy with a strict definition of responsibilities creating barriers for employee contribution and in addition this structure causes the managers to be risk averse and the system of decision-making will be very slow (e.g. case 3, Chapter 7). Therefore, these situations have an effect on creativity (for instance in accepting the new idea and making final decisions) and on the other hand in creating the motivation for employees (for instance the lack of providing appropriate employee motivation). In addition, as Figure 10.2 suggests experienced employees with the proper knowledge and confidence can have a more valuable opinion.

It is important to say that one of the common issues in Iranian cases is “political stability”. Particularly with the current international trade sanctions, the costs of some activities like the processing of ‘order and receive’ raw materials are increased. In this situation the “high level management” is more motivated to use their internal resources, so their interest for innovation is increased (e.g. case 2, Section 6.1.1). On the other hand some interviewees said that the cost of research may have a negative effect on creativity (e.g. case 1, Section 5.1.1). They also believed that high-level management should accept that innovation will inevitably cost money which must be spent in order to progress. Therefore as Figure 10.2 shows, "cost" can have a positive or negative effect on "interest of high level management for innovation".

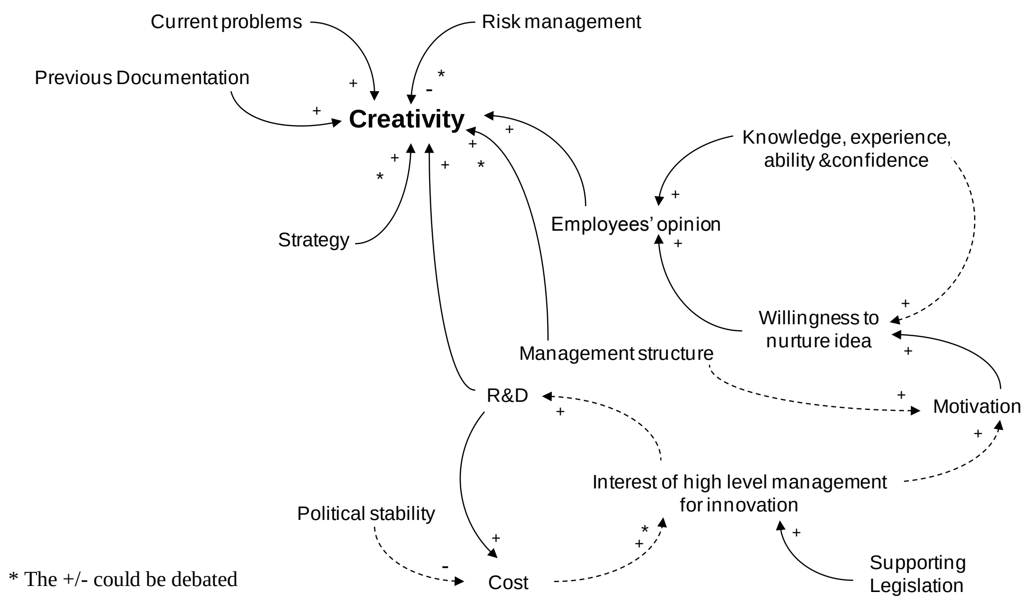


Figure 10.2 - Synthesis influence diagram for internal factors in the creativity stage [2]

This interest of high level management has a direct effect on creating the "motivation" for employees to explain their ideas and also spending more money on internal "R&D". As discussed in Section 2.6.1, ideas may be expressed from R&D work in-house or externally (Tidd, Bessant and Pavitt, 2005). As Figure 10.2 shows another factor which increases the interest of high level management for innovation is the "supporting legislation" which was created by the government.

As the Figure 10.2 suggests "current problems" (which is related to technical problem) are one of the factors which can be used as a source of creativity, since most of the methods for solving these problems result creativity. In case 4 (Section 8.1.1), the company uses a special method (TRIZ) for solving current problems which may sometimes result in

[2] The continuous lines represent influences explicitly identified by the interviewees; the broken lines are influences which are inferred from interviewee comments.

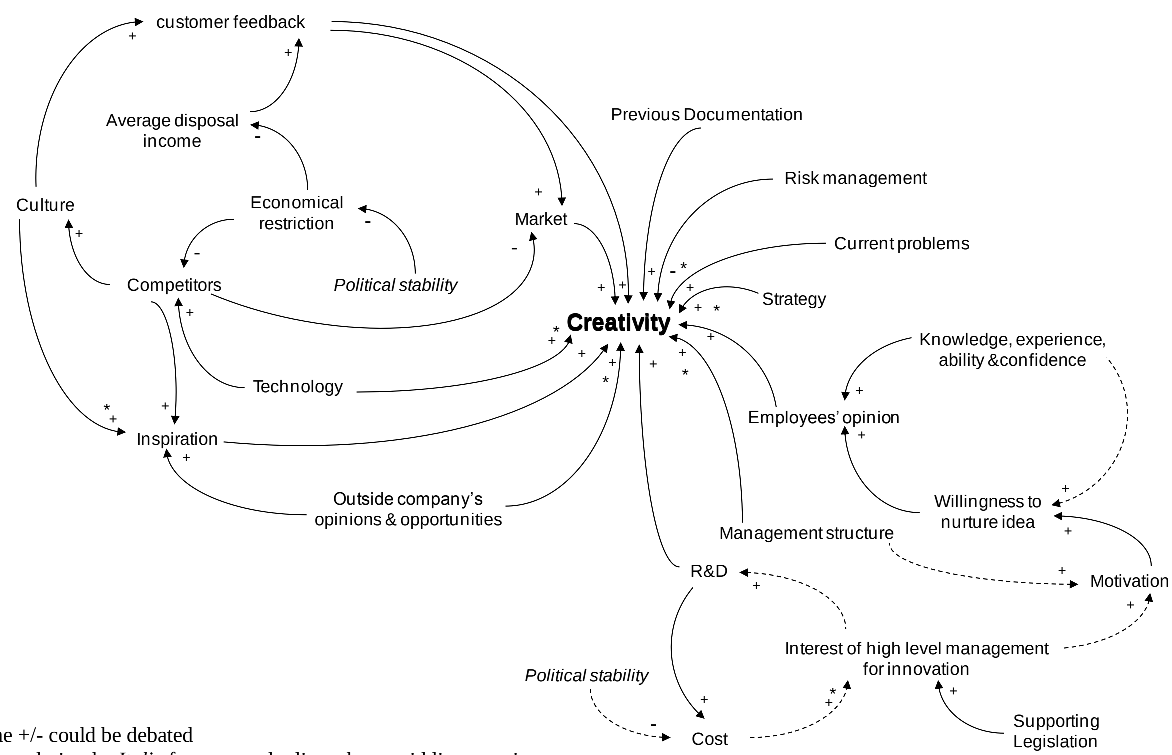
creativity. Although this factor was examined in three Iranian cases, it was not mentioned specifically in the literature. It seems possible that technology in Iran is not new enough and employees will often encounter problems. In addition, technology is usually imported from foreign countries, so knowledge and expertise is not enough to cover all unexpected problems. Therefore, as literature usually considers the situation of developed countries this factor was not perceived as an important factor in developing countries like Iran.

As discussed in Section 2.6.5 acquiring external knowledge, learning from experience and sharing knowledge within companies is essential for a firm's innovation activities (e.g. Jantunen, 2005). Since most of these companies have ISO, all their processes and events should be documented officially, but no evidence was found about the use of these documentations as source of creativity. Unfortunately, in only one of the cases (case 1, Section 5.1.1) "previous documentation" was mentioned as a source of creativity. This issue suggests that companies fail to utilize the formal organisational learning mechanism, such as documentation, for creativity. So the role of "previous documentation" is not perceived by most of the companies as a source of creativity.

Another factor which has an effect on creativity is the "strategy" of the company. As discussed in Section 2.7, "strategy" is a factor which may lead to the success of an innovation project (e.g. Keizer and Halman, 2007). This strategy provides the vision for the company. For instance, some companies base their strategy on a desire to be a leader in their industry (e.g. producing the fruity yoghurt, case 3, Section 7.1.1), and for achieving this purpose, implement the new innovation. Also, in the 3M literature case study (Section 3.10) "strategy" was one of the factors which has an affect on creativity stage.

The opinions of respondents about the amount of “risk management” in the first stage of innovation are different. Some of them mentioned that the risk management should not be applied at the first stage at all (case 5, Chapter 9) while others (most of the Iranian cases) believed that the company could apply the simple methods of risk management at the early stages of innovation. This differentiation between Iranian companies as a developing country and the developed countries suggests that the Iranian companies are afraid of failure in innovation. This concern might be due to their lack of experience in implementing innovation or their unfamiliarity with different methods of managing the risk.

Figure 10.3 (combining Figure 10.1 and Figure 10.2) records all the factors which have an effect on creativity stage and were explained in two different steps (internal and external factors).



* The +/- could be debated
Due to clarity the *Italic* factors are duplicated to avoid line crossing

Figure 10.3 - Synthesis influence diagram for the creativity stage

10.2.3 Criteria's relative importance

The case studies summarised in the influence diagram (Figure 10.3) suggest some factors have a more important role than others in this stage. Some of these factors can be seen as candidate for main criteria - which can be considered in all cases - for three reasons. First of all, some of theses factors are explained more frequently by the interviewees (factors which were mentioned in at least three cases, such as "current problem", "strategy"), secondly a number of them have more connections in the influence diagram with other factors, meaning they have high connectivity (such as "competitors", "customer feedback", "culture", "employees' opinion"). Finally some factors are discussed in literature as main criteria (such as "customer feedback", "competitors", "previous documentation", "R&D", "technology", "outside company's opinion & opportunity"). These criteria can be considered in relation to all different companies and there are suitable variables for considering the importance of them based on different interviewees' points of view in different cases. These candidate factors are: "customer feedback", "employees' opinions", "competitors", "current problems", "outside company's opinions & opportunity", "culture", "technology", "R&D", "strategy" and "previous documentation".

Table 10.1 records all the candidate factors and the number of interviewees who explained these criteria in the five cases as a simple form of content analysis. Also, the number of cases which mention these criteria as important and the percentage of respondents in related cases and in all cases are shown in this table.

For more clarity, Figure 10.4 indicates the importance of each criterion based on the percentage of respondents in all cases. It should be noted that in all graphs, synthesis suggests the percentage of the importance of criteria in all cases (40 interviewees). Since these criteria were mentioned by interviewees in semi-structured interviews rather than asking them to explain their opinions about them. Perhaps it is useful to use the percentage of importance in related cases rather than the percentage of importance in all cases in order to compare it with the situation of each case; however, in general it is not adequate and it seems better to use a simple percentage of importance of criteria in all cases.

Table 10.1 - Criteria in the creativity stage

Criteria	Number of interviewees which mention this criterion	Number of cases which mention this criterion	Number of Interviewees in related cases†	% of interviewees in related cases	% of all interviewees (40)
Customer feedback	29	5	40	72.5	72.5
Employees' opinions	18	5	40	45.0	45.0
Competitors	14	5	40	35.0	35.0
Current problem	6	3	25	24.0	15.0
Culture	6	4	30	20.0	15.0
Technology	6	4	33	18.2	15.0
R&D	6	5	40	15.0	15.0
Outside company's opinions & opportunity	5	3	23	21.7	12.5
Strategy	3	3	25	12.0	7.5
Previous documentation	1	1	10	10.0	2.5

† 'related case' = case in which this criterion is mentioned by at least one interviwee; where no interviewee refers to a particular criteria it could be inferred that it is not relevant to that case.

Figure 10.4 provides a profile summarising the initial impression gained from reading the interview reports by adopting a simple form of content analysis. The profile is then tested by examining the details of the interview reports to determine whether the text is consistent with the summary profile. For example, Figure 10.4 suggests, "customer feedback", "employees' opinion" and "competitors" are three important criteria which can play a role as a source of creativity for all the cases with a high percentage. It means that considering these three criteria in the first stage of innovation (creativity) can be useful for creativity.

Other criteria have different degrees of importance based on interviewees' opinion in this stage.

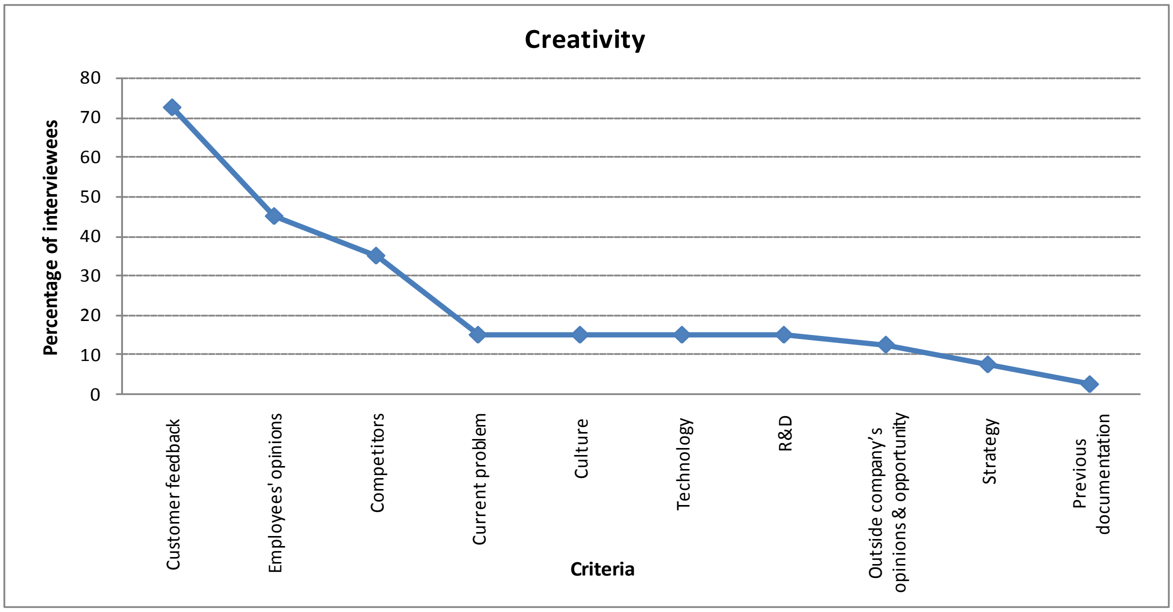


Figure 10.4 - Interviewees (*n*=40) referring to creativity criteria

Based on the type of the company, industry and also the characteristics of interviewees, the importance of each of these criteria is different in each case. So to enable a comparison, the percentages of respondents about these criteria are also calculated and the results are shown on different graphs for each case[3]. It should be noted that only one interviewee and one case referred to "documentation" while twenty nine interviewees and five cases explained "customer feedback". This is convincing evidence of the differences in importance (or perceived importance) of these criteria, but ideally it is better that this result would be accompanied by a statistical test of the significance of the differences. However, the nature of the data (sample size) and low frequencies will be problematic and probably preclude any useful statistical analysis such as a Chi-square test. Appendix 6 contains a

[3] Appendix 5 includes these comparisons for all cases in different stages of innovation.

limited Chi-square (χ^2) test that illustrates the potential of this approach, if more data were available.

Figure 10.5 shows the percentage of interviewees in case 1 (SK) which explained these criteria (other cases and their content analyses are contained in Appendix 5). In order to compare the importance of these criteria with the synthesis, the synthesis situation for cases 1-5 (all cases) was drawn in this figure. In addition since it is possible that UK experiences are different when compared with Iranian cases, the synthesis situation for cases 1-4 (only Iranian cases, 32 interviewees) is also indicated on the following figures.

As Figure 10.5 suggests in case 1 the “competitors” do not have a specific role for creativity. As discussed in case 1 (Section 5.1.1), bus and truck manufacturing industry in Iran, there are large and specific customers (e.g. Ministry of Interior) as main customers (although some other small customers are existing in this market, they do not have big share in this market), so the company does not need to consider the competitors since their market share is guaranteed.

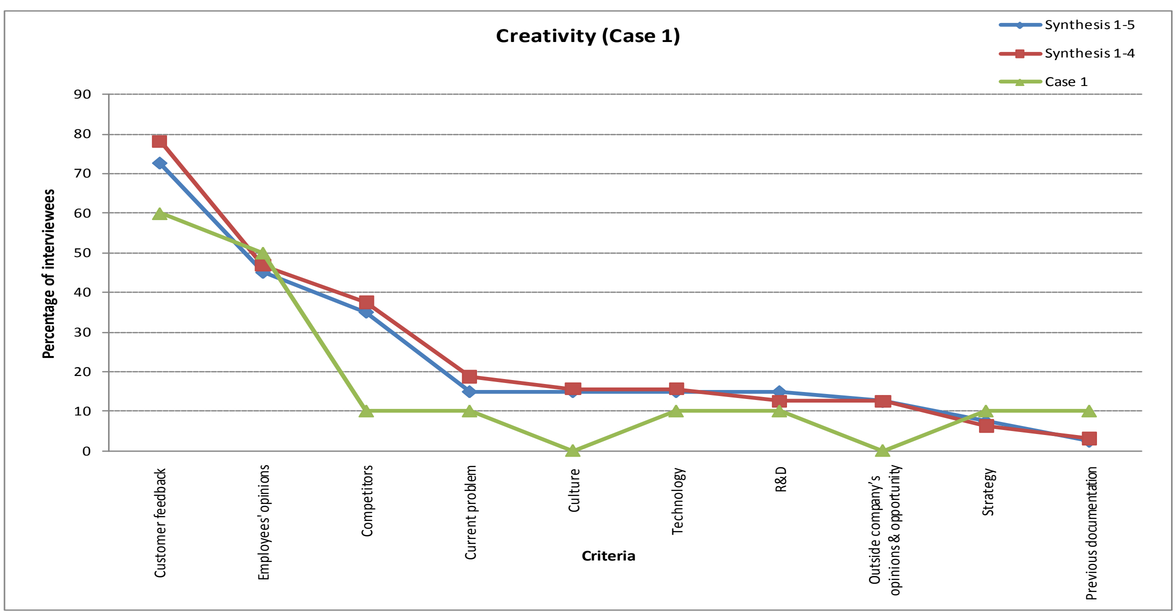


Figure 10.5 - Interviewees (*n*=10) referring to creativity criteria in case 1 (SK)

“Outside company’s opinions” which are more related to raw materials suppliers and visitors to the company cannot be helpful in case 1, since the variety of raw materials are limited in this industry in compare with the other industries. “Culture” and needs of society are useful to consider in a competitive market in order to achieve more customers (for example the kind of driving in developing countries and so on) and, as examined before, because of the lack of competition these criteria are not important when based on this company’s point of view.

Although Figure 10.5 suggests that the difference between “technology” in case 1 and synthesis is not large, detailed texts of interviews provide a slightly different view. The bus and truck manufacturing industry (also in general, car manufacturing industry) in Iran is limited to domestic companies and the amount of tariff for importing foreign cars is high, so the Iranian companies do not need to compete with advanced companies (Chapter 4). Because of this situation the technology push (generally related to developed countries; see Chandra and Neelankavil, 2008) is not perceived as an important criterion in the car manufacturing company.

As Figure 10.5 shows in case 1 the “previous documentation” was mentioned as one of the sources of creativity (Section 5.1.5). It seems that this issue is related to the nature of this industry as the previous technical information has an important role in different stages.

10.3 Selection

For more transparency, the final influence diagram for this stage of innovation (selection) is developed in several different steps. Therefore, for this purpose, factors can be categorised into two groups. The first group, which are more related to internal factors, are: financial viability (profit, cost, IRR), implementation capability (technical ability, employees' experiences), high level management's opinion, time of achieving the result, strategy fit and goals. The second group, which mirror the external factors, are: customers, political issues, competitors, culture, availability of raw materials and social prestige. It should be noted that there are some overlaps between the factors which have an effect on each other in these two steps when drawing the influence diagram. For example social prestige (as will be shown) has an effect on the first and second group of factors. In this section the name of some similar factors has been adapted and also some factors which were related to specific situations are eliminated or generalised[4].

10.3.1 External factors

The first group of factors, which are more related to external factors, are shown in Figure 10.6. One of the most important ones, which can have an effect on selection, is "customer feedback". This feedback highlights the needs, characteristics and opinions of customers that the companies should investigate and consider when selecting new idea.

As the Figure 10.6 suggests, factors such as "per capita income" can have an effect on "customer feedback". Based on some interviewees' opinions, with the increase in per capita income, some customers' needs may be changed (e.g. using air conditioning on in-city buses, case 1, Section 5.1.2). Based on Figure 10.6, "culture" and "social prestige" are other factors which can have an effect on "customer feedback". Since Iran is a large

[4] For instance, different aspects of customers like their "needs," "characteristics" and "opinion" are categorised under one name, which is "customers", but for more consistency with other stages of innovation "customer feedback" is selected for these factors (the purpose of this feedback will be explained more in defining the related influence diagram). It seems for more simplicity, "opinion" and "knowledge" of high "level management" and "stakeholder" and "board" of company can be categorised as "high level management's opinion". One of the factors that can have an effect on "implementation capability" is employees. For more clarity instead of the two aspects of employees, their "expert" and "experiences", the world of "employees' experiences" can be used. The company uses the "technologists' idea" for considering the capability of implementation, so instead of that the word of "technical ability" can be applied. "Social prestige" can be used as "corporate social responsibility". Since the "stability in energy price" is related a special case (case 5, Chapter 9) it can be eliminated as a factor which has an effect on selection stage.

country, it has many different cultures (e.g. in north of Iran they prefer blue shades and in south they prefer dark or warm colours, case 2, Section 6.1.2). Therefore, Iranian companies must realise that “culture” plays a significant role when it comes to selecting a new idea. As discussed in Section 2.6.2, the company should at this stage select ideas which create value (Linder, Jarvenpaa and Davenport, 2003). Certainly value does not only refer to profit. For instance, as discussed in case 3 (Section 7.1.2) companies will occasionally enter new products to the market, not solely for profit, but also to create a positive image (social prestige) of an innovative market leader in the mind of the customers (e.g. desserts served on airplanes, Section 7.1.2).

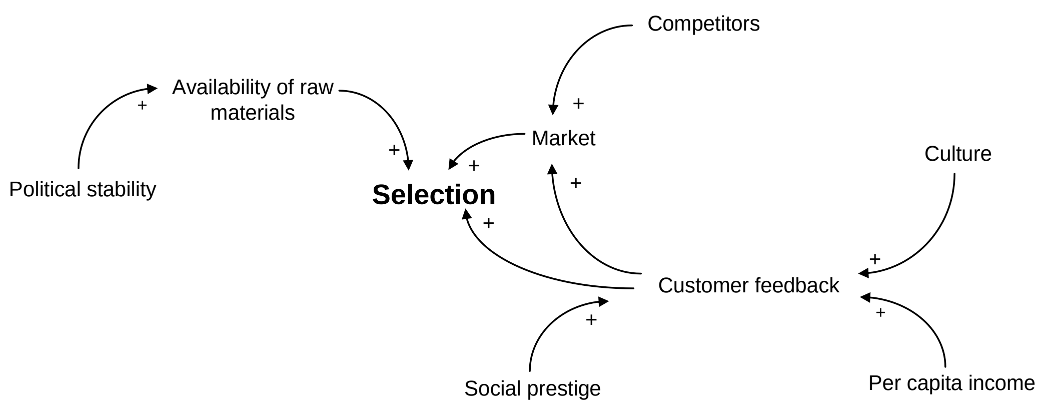


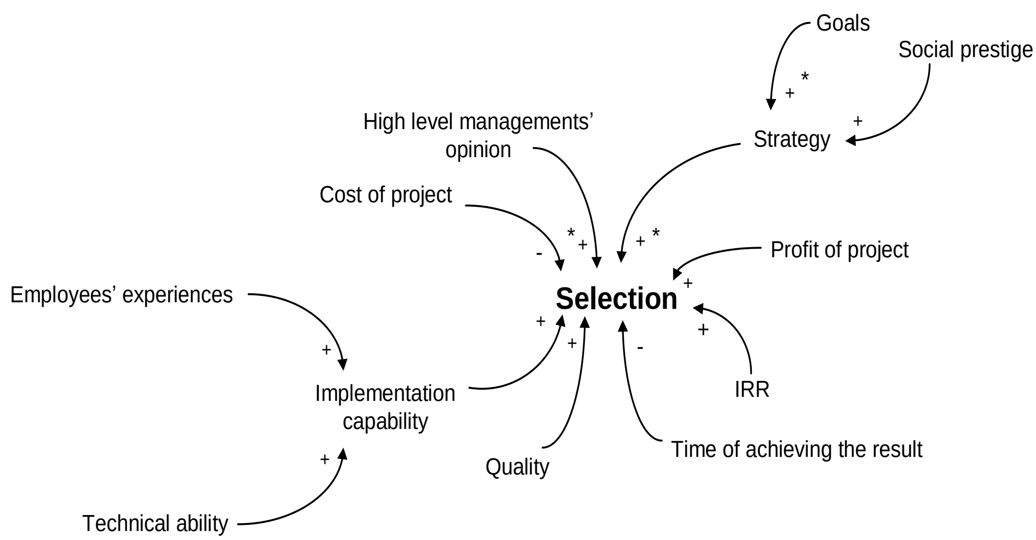
Figure 10.6 - Synthesis influence diagram for external factors in the selection stage

Another factor which has an effect on selection is “market” (Figure 10.6). Based on their strategy, companies will usually consider the size of market. “Competitors” and “customer feedback” are two factors which have an effect on the attributes of the market, such as needs and size. These attributes of the market have an effect on which project the company deems suitable when selecting. The “availability of raw materials” is a factor which all five companies consider in the selection stage. Especially in Iran since some company’s raw materials are imported from abroad (e.g. 85% of raw materials for case 1, Section 5.1.2), “political stability” has an important role for preparing them (Figure 10.6).

10.3.2 Internal factors

Figure 10.7 shows the second group of factors which are more related to internal factors in the selection stage. One of the most important ones is “implementation capability” (this factor describes the capability of a company when starting a new project which is based on the current technical ability of the company and employees’ experiences). The degree of this capability has a direct relation to new project selection. As the influence diagram (Figure 10.7) suggests the “employees’ experiences” and “technical ability” are two significant attributes of this factor. Based on different respondents in different companies, the technical division will report on the final decision about the technical ability of the company producing a new product. If there is a need for alterations, this division should mention the cost of them (e.g. for producing the tiles with the size bigger than 40×40 cm^2, case 2, Section 6.1.2). The company will base its decision on its current capabilities and the cost of achieving the new technical ability.

As examined in Section 2.7, one factor that may lead to success is the choosing of a new idea that is a good fit with the company from a variety of standpoints (Simon, 2009). In the selection stage companies, based on their strategic view of how the firm can best develop, should decide which ideas are worth implementing (Tidd, Bessant and Pavitt, 2005). Figure 10.7 suggests that “strategy” is the other factor which has an effect on this stage. This means that in the selection stage the company’s strategy can have an effect on the kind of ideas being selected. Also, companies should try to select an idea which fits in with their strategy. The “goals” of company and “social prestige” are two other factors which can have a direct effect on the strategy of a company. Based on some respondents’ views, companies sometimes introduce new products to the market based on their strategy not only for monetary benefit but also for creating an image in the mind of customers (social prestige) that the company is innovative and a leader in this market (e.g. special dessert to airplanes, case 3, Section 7.1.2).



* The +/- could be debated

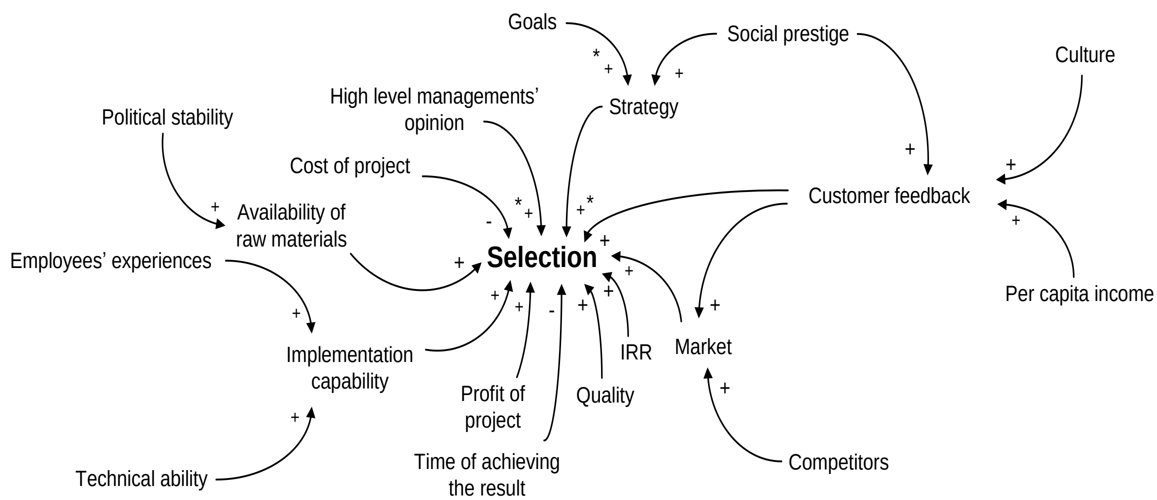
Figure 10.7 - Synthesis influence diagram for internal factors in the selection stage

As discussed in Section 2.6.2 the decision process in this stage is defined as the evaluation of new product concepts and the approval of funds needed for development (Gobeli and Brown, 1993). One of the most important issues that a company considers in this stage, that all companies mentioned, is financial viability. Based on different interviewees' opinions, companies usually consider the "final cost" of a product, the "profit" of that product and the "investment rate of return" when deciding on any new project.

Based on Figure 10.7, the "time of achieving the result" and the "quality" of a new project are other factors which have an effect on this stage. From one point of view "time of achieving the result" means the length of time taken to achieve this project (the length of the process of starting the new project till its production and launch in the market). Some interviewees (e.g. case 2, Section 6.1.2 and case 3, Section 7.1.2) said, sometimes this long time can cause the new product to miss being a unique item in the market as other competitors inevitably produce the same item. As discussed in Section 2.7, poor timing is one of the major causes of failure in the innovation project (Biemans, 1992). Also, some ideas need to change the culture of customers, thus they need a lot of time. So from another point of view the “time of achieving the result” can mean the probable time of finding a result and place within the market. Therefore, “Time of achieving the result” means that the time of implementing the new project for launch in the market and also the probable time of finding a result in market. It can be said that ideas which have the ability to achieve a result sooner than others should be selected.

“High level management’s opinion” is another factor which plays a significant role in the selection stage and was explained by all companies. This factor describes the attitude of high level management regarding the new idea. Based on some interviewees’ opinions (e.g. case 1, Section 5.1.2) it can be said that the effect of “high level managements’ opinions” on the selection stage can vary based on the kind of innovation. In addition, in some cases (e.g. case 4, Section 8.1.2) it seems that there are some formal meetings (at least for certain type of innovations) when high level management are selecting the idea, but in some other cases (e.g. case 3, Chapter 7) there are no formal criteria when high level management are selecting the idea.

Figure 10.8 (combining Figure 10.6 and Figure 10.7) records all factors which have an effect on selection stage and were explained in two different steps (internal and external factors).



* The +/- could be debated

Figure 10.8 - Synthesis influence diagram for the selection stage

10.3.3 Criteria's relative importance

The case studies as summarised in the influence diagram (Figure 10.8) suggest some of the factors have more important roles than others in this stage. Some of these factors can be seen as candidate for main criteria which can be considered in all cases. These candidate factors are chosen on based on three reasons (see Section 10.2.3 for more details): their popularity amongst the interviewees (such as "culture", "competitors", "availability of raw materials", "high level management's opinion"); connectivity in the influence diagram (such as "customer feedback", "implementation capability"); and reference in literature (such as "financial viability", "strategy fit"). These criteria can be considered in relation to all different companies and there are suitable variables for considering the importance of them based on different interviewees' points of view in different cases. These candidate factors are: "implementation capability", "financial viability", "strategy fit", "high level managements' opinions", "culture", "customer feedback", "time of achieving the result", "availability of raw materials", "competitors" and "social prestige".

Table 10.2 records all the candidate factors and the number of interviewees who explained these criteria in the five cases. Also, the number of cases which mention these criteria as important and the percentage of respondents in related cases and in whole cases are shown in this table. To prepare this table some similar criteria were categorised within the one label. For instance, financial viability includes the profit, cost of project and IRR, and implementation capability includes the technical ability and employees' experiences.

Table 10.2 - Criteria in the selection stage

Criteria	Number of interviewees which mention this criterion	Number of cases which mention this criterion	Number of Interviewees in related cases†	% of interviewees in related cases	% of all interviewees (40)
Financial viability	22	5	40	55.0	55.0
Implementation capability	21	5	40	52.5	52.5
High level managements' opinions	15	5	40	37.5	37.5
Customer feedback	14	5	40	35.0	35.0
Strategy fit	11	4	32	34.4	27.5
Culture	7	3	22	31.8	17.5
Availability of raw materials	6	5	40	15.0	15.0
Time of achieving the result	4	3	22	18.2	10.0
Competitors	4	4	22	18.2	10.0
Social prestige	3	3	25	12.0	7.5

† 'related case' = case in which this criterion is mentioned by at least one interviwee; where no interviewee refers to a particular criteria it could be inferred that it is not relevant to that case.

For more clarity, Figure 10.9 indicates the importance of each criterion based on the percentage of the interviewees. As Table 10.2 and Figure 10.9 suggest, "financial viability", "implementation capability", "high level managements' opinion" and "customer feedback" are four important criteria in all cases with a high percentage in the selection stage. It means that considering these four criteria can be useful in the selection process. Other criteria have different degrees of importance based on the interviewees' opinions at this stage.

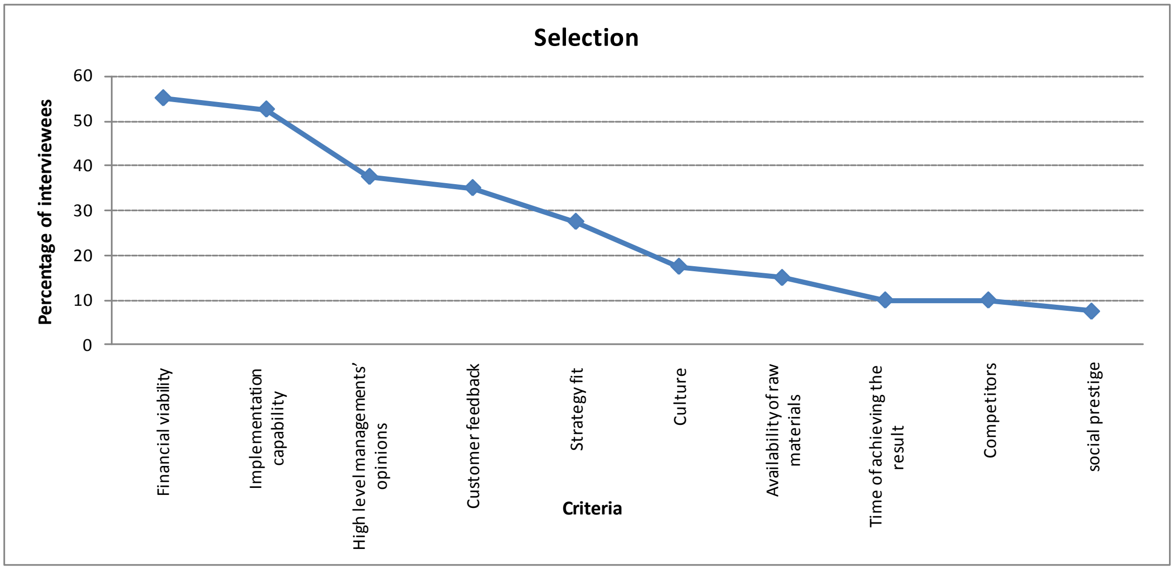


Figure 10.9- Interviewees (*n*=40) referring to selection criteria

Based on the type of the company, industry and also the characteristics of interviewees, the importance of each of these criteria is different in each case. So to enable a comparison, the percentages of respondents to these criteria are also calculated and the results are shown on different graphs for each case.

The percentage of interviewees who explained these criteria in case 2 (FT) are shown in Figure 10.10 (other cases and their content analyses are contained in Appendix 5). It seems that the importance (or perceived importance) of "strategy fit" in this case is less than in synthesis cases and as this figure suggests, "high level managements' opinions" play an important role in this company. So it seems that the strategy applied by high level management and other employees are not closely related with the strategy of company.

Since the flexibility of current technology involved in producing new ideas in FT company is high, the "implementation capability" is not usually perceived as an important criterion like synthesis cases.

Since customers' opinions differ because of the varying tastes and cultures of the different regions in Iran (e.g. in north of Iran they prefer blue shades and in south they prefer dark or warm colours; see Section 6.1.2), it seems that the "customers' opinion" plays a significant role when selecting new ideas in case 2.

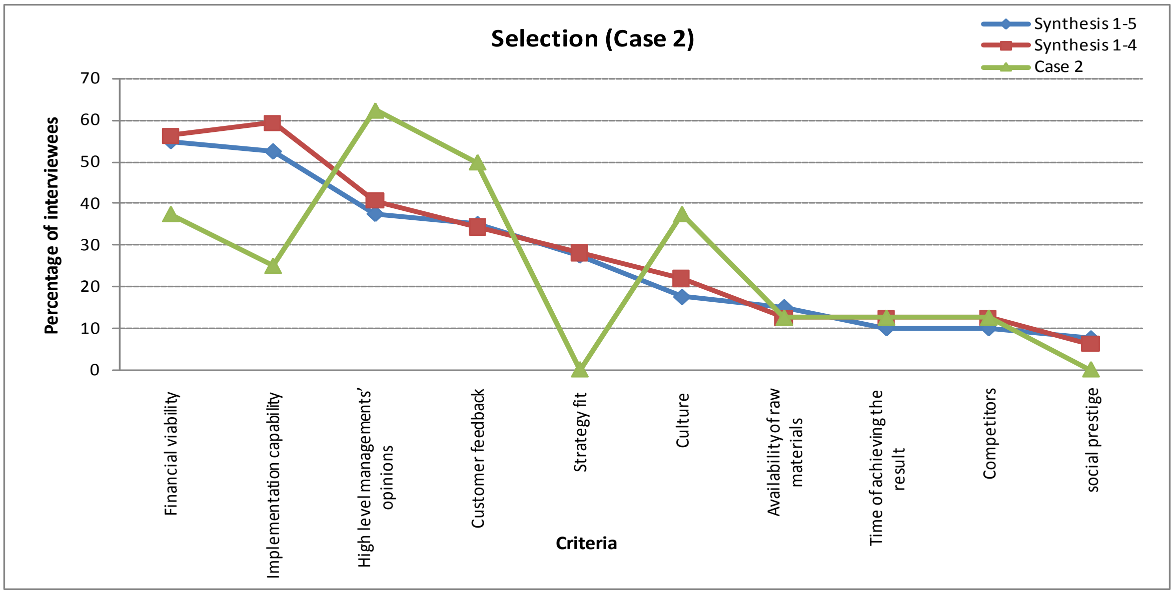


Figure 10.10 - Interviewees (*n*=8) referring to selection criteria in case 2 (FT)

Figure 10.10 suggests that the "social prestige" is not an important (or of perceived importance) criterion for case 2 (FT) when selecting a new project. Since in case 4 (Chapter 8) also this criterion is not perceived as an important one, it may be suggested that the nature of this industry (ceramic industry) causes the company eliminate this criterion at this stage. In addition, it should be noted that "social prestige" is a relatively almost new concept in Iran and the situation of each industry and company can also have an effect on this criterion.

10.4 Incubation

The variety of factors that were explained by interviewees in the five cases for this stage are not as wide; therefore all factors can be shown in one influence diagram and there is no need to divide them into separate figures based on internal ("high level managements' opinion," "standard & technical test," "final cost," "potential problem of production," "technologists' idea," "amount of investment" and "product price in the market") and external ("market," "customers' opinion," "raw materials" and "environmental limitation") factors like the previous stages (although in Figure 10.11 the external factors are marked within a grey circle). Also, in this section the name of some similar factors have been adapted and some factors, which were related to specific situations, are eliminated or generalised[5].

Figure 10.11 displays all factors which have an effect on the incubation stage and were discussed by interviewees in the five different cases. As mentioned in Section 2.6.3, during this stage the company should consider the preliminary market and technical assessments; the real design and development of the new product should be undertaken so a prototype can be tested in the marketplace to validate the proposed product, its production and marketing (Cooper, 1993). Based on the interviewees' opinion, "customer feedback" is one of the main factors which can have an effect on this stage. This feedback allows the company to gain a valuable insight into the prototype they are producing. These opinions have positive effect as they can lead to success. For this purpose some companies distributed the prototype to sales representatives in order to connect with customers and gain feedback (e.g. case 2, Section 6.1.3).

Another factor which can have an effect in this stage is "market" (Figure 10.11). Based on some interviewees' responses in case 3 (Section 7.1.3) if the new idea has a similar model

[5] For instance, ''customers' opinion and interest'' for consistency with previous stages can be categorised as ''customer feedback'', but the purpose of this feedback will be explained more in defining the related influence diagram. ''Standard and technical tests" can be used instead of all technical and standard tests and certificates. It seems that for more clarity it is better to show all different attributes of material like cost, availability and quality with "raw materials". Opinion of management board's usually mirrors in "high level managements' opinion". "Ability for after sale services" and "time of providing the product" are eliminated since they were mentioned in one case (case 1, Section 5.1.3) and were only related to a specific situation.

in the market, the company will compare their prototype with the similar product in order to improve the prototype and make it capable of competing within the same marketplace through aspects like price, durability and form of packaging. It seems this comparison should be undertaken in selection stage. As this comparison is related to the competitive situation, in this instance after selecting the new project, while in the incubation stage, the competitors enter the same product to the market and, therefore, to increase the competitive advantage this comparison is necessary. Although the "customer feedback" usually has an effect on the "market", in this situation the "market" wants to reflect the "competitors".

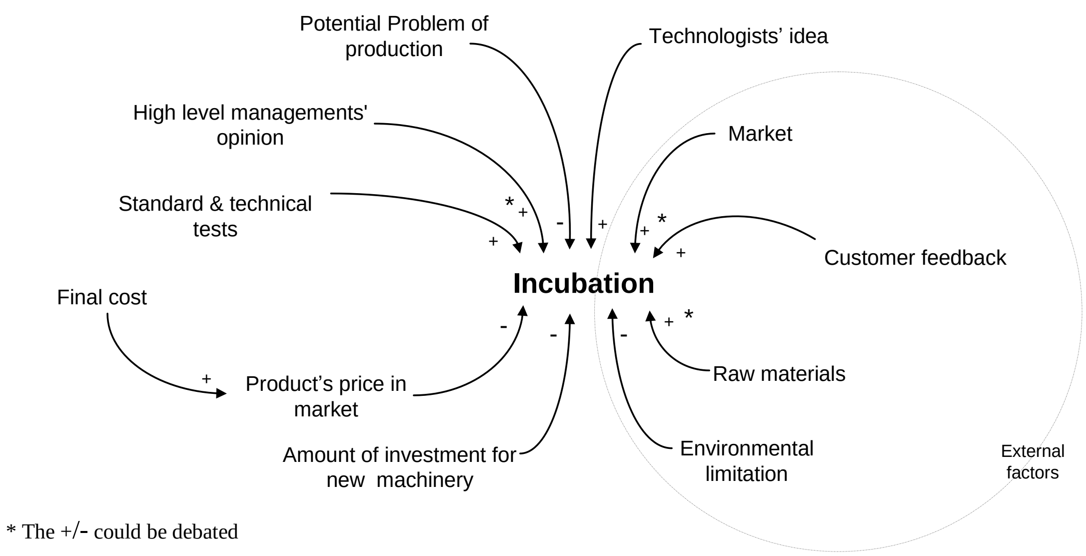


Figure 10.11 - Synthesis influence diagram for the incubation stage

As discussed in Section 2.6.3, firms at the incubation stage, should take an idea and create a prototype in order to test it on a small scale (e.g. Andrews, 2007). As Figure 10.11 suggests, the "standard and technical test" is one of the factors which has an effect on this stage and the company must consider it before progressing to the next stage. It means that the prototype produced during the incubation stage should pass tests, which are set by other companies or other standards authorities, and achieve the necessary quality controls which are compulsory for this product in the market (e.g. case 1, Section 5.1.3). As some interviewees in case 5 (Section 9.1.3) explained, if all the tests are passed in this stage, the probability of a problem occurring in next stage will be decreased.

Based on some interviewees' opinion "raw materials" is another factor which has an effect on the incubation stage (Figure 10.11). In this stage, the company considers the best method of supplying the raw materials and what amount will be required. Sometimes the transportation cost will affect the raw materials selection, so in this situation the company will consider the cost and quality of different options as recommended by different divisions before making a final decision about the kind of raw materials (e.g. case 2, Section 6.1.3).

As discussed in Section 2.7, one of the factors for success in new product development is senior management's commitment to, and involvement in, new products (Cooper and Kleinschmidt, 2007). Based on the interviewees' responses, especially in Iranian companies, before going to the next stage (implementation), the new product should achieve the approval of high level management or the board of directors. So, as Figure 10.11 suggests, the "opinion of high level management" has a direct effect on this stage as the give final approval of the prototype (e.g. case 4, Section 8.1.3).

"Final cost" is another factor which, based on interviewees' opinion, has a direct effect on this stage (Figure 10.11). The "final cost" is usually considered in the selection stage, but when the prototype of a new product is ready in the incubation stage, the company will be able to calculate the final cost more precisely (e.g. case 2, Section 6.1.3). This "final cost" has a direct effect on the final price of a product in the market. Based on some interviewees' opinions in case 3 (Section 7.1.3) at this stage the company should roughly set the “product’s price in market”. They mentioned that occasionally the high final price of product results in the refusal of the marketing and business division; therefore the process is stopped.

Figure 10.11 suggests that “environment limitation” is another factor which has an effect on this stage. Occasionally the effect of the production line is harmful to the environment, some rules prohibit this kind of production, so the company must consider these limitations (e.g. case 1, Section 5.1.3).

Some interviewees in case 5 (Section 9.1.3) claimed that technologists should be involved at the incubation stage. They said that whilst engineers are involved in the creativity and implementation stage, their ideas were often neglected during the equally important incubation stage. So as Figure 10.11 suggests, “Technologists’ ideas” can be just as effective during this stage. This means that companies should utilise their experts and engineers during this stage as their help could prove valuable.

Based on some respondents’ opinions the company should consider the potential problems which may occur in production at this stage when making a plan for production (e.g. time of abrasion and density of enamel in case 2, Section 6.1.3). So as Figure 10.11 suggests “potential problems of production” can have an effect on this stage.

Some interviewees in case 1 (Section 5.1.3) explained that before going to the implementation stage, the company should consider if any new investments are needed for adding new instruments and machinery to their current equipment when producing a new product. So as Figure 10.11 suggests the “amount of investment for new machinery” can have an effect on incubation stage. But it seems more reasonable that the companies considered this factor in selection stage, since the amount of this investment will have a direct effect on the final decision of company. Although some interviewees in one of the cases mentioned this issue in this stage, as showed before in the selection section (Section 10.3) most of the companies emphasised the affect of this issue during the selection stage.

10.4.1 Criteria's relative importance

The case studies as summarised in the influence diagram (Figure 10.11) suggest some factors play a more important role than others in this stage. Some of these factors can be seen as candidates for main criteria which can be considered in all cases. These criteria are chosen on the basis of their popularity amongst the interviewees (such as "final cost", "customer feedback"); and references in literature (such as "high level managements' opinion", "raw materials", "standard & technical tests"). These criteria can be considered in relation to all different companies and there are suitable variables when considering their importance based on different interviewees' point of view in different cases. These candidate factors are: "customer feedback", "standard and technical test", "final cost", "high level managements' opinion" and "raw materials".

Table 10.3 records all the criteria and the number of interviewees who explained these criteria in the five cases. Also, the number of cases which mention these criteria as important and the percentage of respondents in related cases and in whole cases are shown in this table. It should be noted that the interviewees in each case were related to different divisions, so most of them had good information in related responsibility. Since selecting the numbers of interviewees and their responsibility was out of the control of the researcher (see Section 4.3.3), therefore in some stages few related employees were interviewed. The incubation stage is one of the most specialised technical stages and usually only the specialised interviewees have enough information about the functions of that, so the number of interviewees which explained the important criteria in this stage is less than other stages.

Table 10.3 - Criteria in the incubation stage

Criteria	Number of interviewees which mention this criterion	Number of cases which mention this criterion	Number of Interviewees in related cases†	% of interviewees in related cases	% of all interviewees (40)
Customer feedback	15	4	32	46.9	37.5
Standard & technical tests	10	5	33	25.0	25
Final cost	5	4	25	15.2	12.5
High level managements' opinion	3	3	22	13.6	7.5
Raw materials	2	2	18	11.1	5.0

† 'related case' = case in which this criterion is mentioned by at least one interviwee; where no interviewee refers to a particular criteria it could be inferred that it is not relevant to that case.

For more clarity, Figure 10.12 indicates the importance of each criterion based on the percentage of respondents.

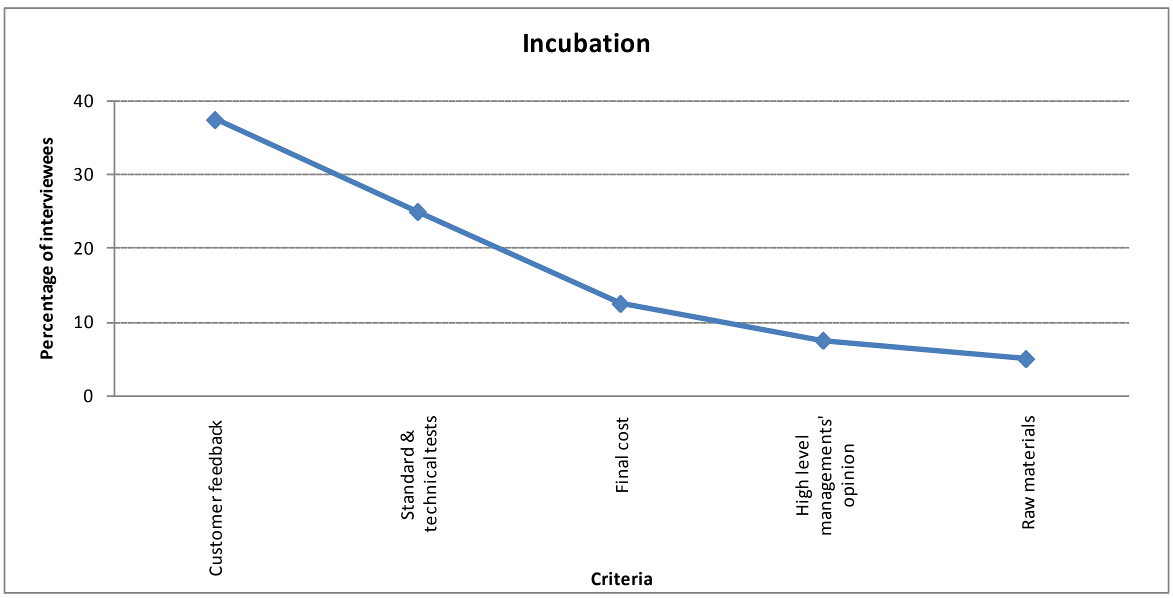


Figure 10.12 - Interviewees (*n*=40) referring to incubation criteria

As Table 10.3 and Figure 10.12 suggest, "customer feedback" and "standard and technical tests" are two important criteria which can play a role as criteria during the incubation stage, in most cases with a high percentage. It means that considering these two criteria in this stage of innovation can be useful in order to achieve success in other stages. Other criteria ("final cost," "high level managements' opinion" and "raw materials") have different degrees of importance based on interviewees' opinions in this stage.

Based on the type of the company, industry and also the characteristics of interviewees, the importance of each of these criteria is different in each case. So to enable a comparison, the percentages of respondents to these criteria are also calculated and the results are shown on different graphs for each case.

Figure 10.13 shows the percentage of interviewees in case 3 (RDPC) who discussed these criteria (other cases (1, 2, and 4) and their content analyses are contained in Appendix 5). It seems that the role of "raw materials" is not an important criterion (or is not of perceived importance) in this stage for this company. Since the company considers this issue in selection stage (Section 10.3.3), probably the employees did not perceive the important of this criterion to consider in this stage. But based on some employees' opinion raw material is one of the criteria which create the risk in this company (Section 10.9), so it seems it is valuable that company consider this criterion in this stage as well.

Figure 10.13 suggests that the importance (or perceived importance) of "customer feedback" in case 3 is less than in Iranian synthesis cases. One of the reasons for this issue is that some interviewees in this case explained that the predicted market situation of this industry is very difficult (Section 7.1.3). Also, creating contact with their customers in order to get their feedback is usually considered in the implementation stage more than the incubation stage, therefore the dairy companies will enter the market with a wide variety of products (but limited numbers) and after receiving feedback, will choose the products which have become more popular and discontinue the rest.

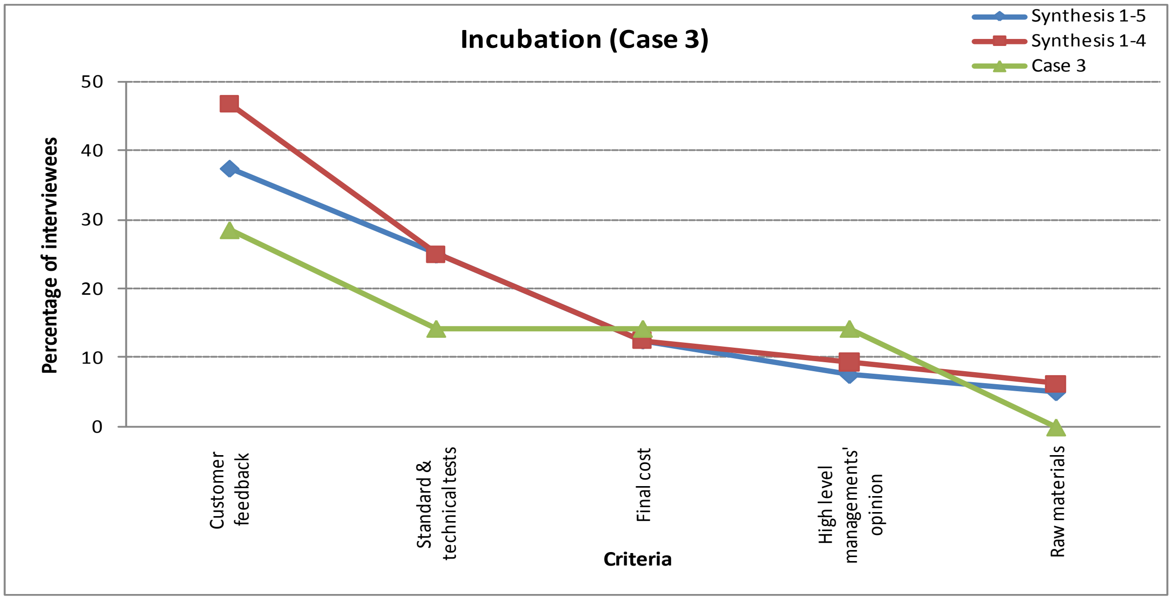


Figure 10.13 - Interviewees (*n*=7) referring to incubation criteria in case 3 (RDPC)

Although Figure 10.13 suggests that in case 3, the difference between "standard and technical tests" and other criteria is not large; detailed texts of interviews provide a slightly different view. Because this industry is related to the health of society, the company should obtain the different standard certificates (e.g. hygienic approval) from the government at this stage and before progressing to the implementation stage (Section 7.1.3). Therefore, it seems that "standard and technical test" is also important (or of perceived importance) in this company.

Figure 10.14 shows the percentage of interviewees in case 5 (SSE) who discussed these criteria. It seems that the role of "customer feedback", "high level management's opinions" and "raw materials" in this case is not an important (or is not of perceived importance) criterion in this stage.

The fact that SSE does not consider various criteria in the incubation stage could be interpreted as disciplined management. It means these criteria were considered in full at earlier stages and there is no need to return to these questions again later in the innovation process. For instance, as discussed in creativity and selection section (Section 10.2.3 and Section 10.3.3) this company considers the "customer feedback" in these two stages. In addition, "customer feedback" here relates to feedback stimulated by viewing prototypes of the new product. Perhaps this is why "customer feedback" is not relevant in this case; since the type of customer is different in this industry in compare with other industries (in SSE usually customers are end user, while in other industries there are intermediate customers who have expertise and their opinion can useful for this stage). So based on the kind of this company, it seems that it is reasonable to consider the "customer feedback" in previous stages in creativity and selection stage or after implementation.

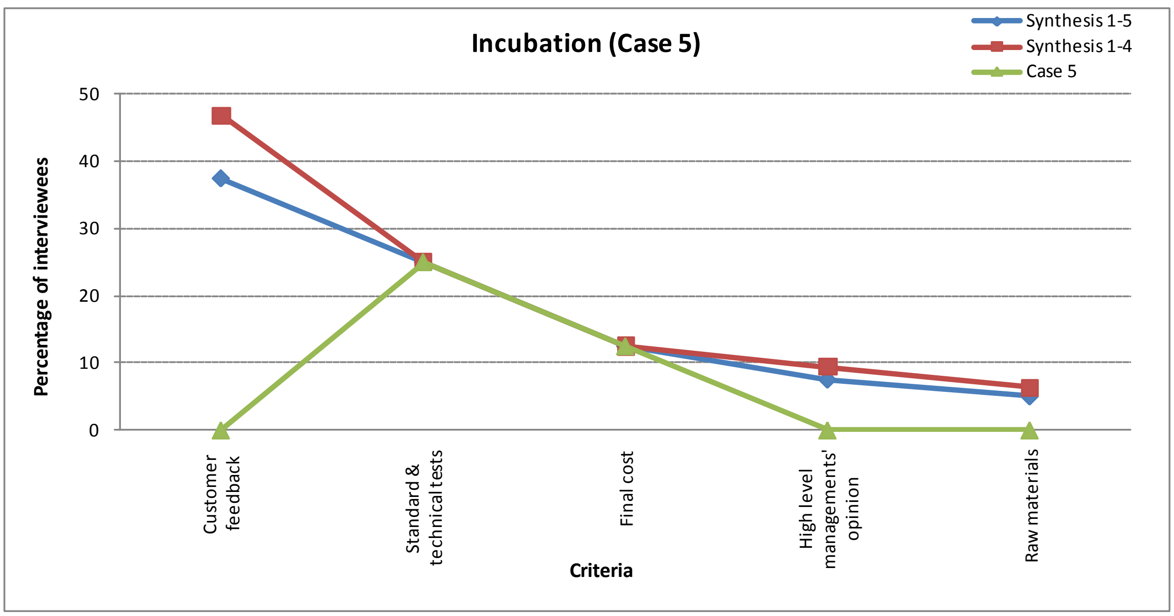


Figure 10.14 - Interviewees (*n*=8) referring to incubation criteria in case 5 (SSE)

Figure 10.14 suggests that the "high level managements' opinion" and "raw materials" are not perceived as important criteria in this stage by SSE interviewees. It seems that since these criteria are considered in the selection stage (Section 10.3.3), the employees do not consider them in this stage.

10.5 Implementation

The variety of factors explained by interviewees in the five cases at this stage are not as wide. Therefore, all factors can be shown in one influence diagram and there is no need to divide them into separate figures based on internal (“high level management’s opinion,” “strategy,” “social prestige,” “internal control,” “production tools,” “production plan,” “profit”) and external (“customer feedback,” “market,” “competitors,” “social prestige”) factors like the previous stages. Also, in this section the names of some similar factors have been adapted and some factors, which were related to specific situations, are generalised[6].

As discussed in Section 2.6.4, this stage is at the heart of every process of innovation and it is expected that most failures will occurr during this stage (Cozijnsen, Vrakking and IJzerloo, 2000). In most of the five studied companies, the implementation stage includes two steps: 1- pilot production and 2- mass production. Based on interviewees’ opinions in several different cases (e.g. in case 4, Section 8.1.4), the situation of the incubation and implementation stages are different, as the scale of the laboratory is smaller and the instruments are more precise than in the implementation stage. After producing and approving the prototype in the incubation stage, it will be sent to pilot production. In pilot production the company wants to check the current status of implementation and improve upon it if necessary in order to produce a product similar to the prototype. There should be an iterative cycle between this stage and the incubation stage in order to find possible problems and improve upon them. It should be noted that a degree of iteration may be

[6] For instance, different aspects of customers like their interest and opinion can be categorised as “customer feedback”. It seems that for more clarity it is better to show all different attributes of the market, like their needs, size and interest with “market”. Since functions like standard and technical tests, considering the deviation from the goals and using technologist’s ideas, show the different types of controls companies apply in this stage, so they can be categorised as “internal control”. Since the amount of sale and commercial success want to show the profit in this stage so it seems they can be classified as “profit”.

viewed as beneficial, but uncontrolled iteration can lead to innovation cycling for a long time and incurring considerable cost; maybe some iteration could be avoided by better decision making earlier in the process (see Section 6.1.4). Regarding this field, some interviewees in case 4 (Section 8.1.4) claimed that, their company sets the maximum number of iterations in each stage in order to complete activities should any problems arise, after this, if the company cannot implement the stage correctly, the product should go back to the previous stage. For instance in pilot production, after 20 iterations, if the company is not satisfied the product must go back to the previous stage (incubation). In addition, the new product might be abandoned at this stage, although in most situations refinements are made and the project continues.

Figure 10.15 suggests all factors which have an effect on the implementation stage and were explained by interviewees in the five different cases. As discussed in Section 2.7, customers are one of the success factors involved in an innovation project (e.g. Gobeli and Brown, 1993). In this regard, based on interviewees' opinions, "customer feedback" is one of the factors which can have an effect on this stage. Usually customer interest in a new product plays a significant role in continuing the mass production. Also, in some companies (e.g. case 3, Section 7.1.4), before progressing to mass production, in order to reduce the probability of failure and loss, the products will be sent to their market in order to receive market feedback and gather customer opinion. As discussed before, in pilot production the product is produced on a real scale but only in a small amount. After approving this stage, the company uses customer opinion and market feedback in order to make a decision about the amount that will be produced in the mass production, otherwise the product will be sent back to a previous stage for further development based on received feedback.

The company needs a "production plan" in mass production. Based on some interviewee's responses, a production plan is decided upon monthly after considering the feedback of the first sales and the amount of profit, if the market needs more the production plan will be reconsidered (e.g. case 2, Section 6.1.4). So, as the Figure 10.15 suggests the "market" and "profit" play an important role when preparing the "production plan". Based on some interviewees' opinions, one important condition when deciding to continue with the production of a new product is market interest and ability to compete (e.g. case 4, Section 8.1.4). This means that sometimes the market is saturated by similar products which are produced by competitors and the worth of the market will decrease (in this situation it is possible to stop production after receiving the minimum amount of benefit which was predicted in prior stages). Therefore, "competitors" is a factor which can have an effect on market situation and consequently on the implementation stage as well (Figure 10.15).

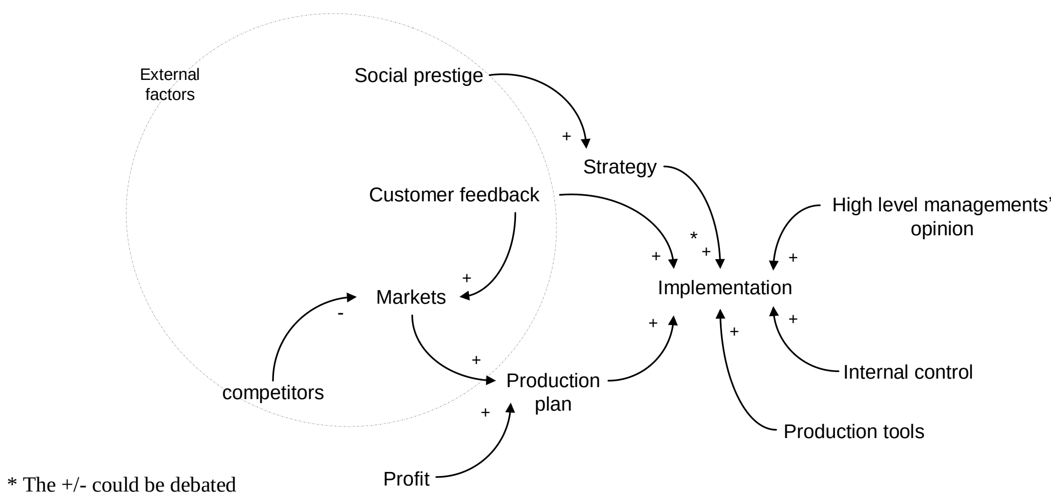


Figure 10.15 - Synthesis influence diagram for the implementation stage

As Figure 10.15 suggests, “internal control” is one of the factors which can have an effect on this stage. Companies usually apply different kinds of control at this stage. Based on several interviewees’ opinions, some tests and controls should be undertaken at each step of the implementation stage (pilot and mass production) in order to approve the product (e.g. bacteriology control or chemical control, case 3, Section 7.1.4). In some companies, after the pilot production, the product will return to the quality control division in order to pass some technical and standard tests. If the pilot production does not result in the desired outcome, the product will be discontinued. At this stage, companies regularly measure results and compare them with goals in order to analyse their deviation and identify corrective action (e.g. case 1, Section 5.1.4).

Some interviewees explained that “high level management’s opinion” can have an effect on this stage (e.g. case 2, Section 6.1.4). In other words, for some companies the approval of high level management is needed for all activities. For instance, after testing and internal controls in the pilot step before going to mass production or deciding to continue the product in mass production, the opinion of high level management plays an important role.

Based on Figure 10.15, “strategy” and “social prestige” are other factors that can have an effect when continuing with the production of a new product. Companies sometimes base their strategy of entering new products to the market, not only on financial benefit but also on creating a brand image in the mind of customers (social prestige) that suggests the company is innovative and a leader in this market (e.g. case 3, Section 7.1.4). It can be said that while profit plays an important part of the decision-making process when continuing the production of a new product, the "strategy" of a company also plays a significant role when producing the new product.

Figure 10.15 suggests that "production tools" are another factor which can be considered at this stage. Based on some interviewees' opinions (e.g. Case 1, Section 5.1.4), when producing the product, the production line has two needs: 1-production plan and 2-production tools. If the production line needs any new tools in order to produce the new product, these production tools should be produced and provided at this stage.

10.5.1 Criteria's relative importance

The case studies as summarised in the influence diagram (Figure 10.15) suggest some factors play a more important role than others in this stage. Some of these factors can be seen as candidates for main criteria which can be considered in relation to all cases. These candidate factors are chosen on the basis of their popularity amongst the interviewees (such as "profit", "internal control"), the connectivity in the influence diagram (such as "market") and references in literature (such as "customer feedback"). These criteria can be considered in relation to all companies as there are suitable variables for comparison when considering their importance based on different interviewees' points of view in different cases. These criteria are: "market", "customer feedback", "profit" and "internal control".

Table 10.4 records all criteria and the number of interviewees who mentioned these criteria in the five cases. The table also shows the number of cases which explained these criteria, the percentage of respondents in related cases and the percentage of respondents from all cases as a whole.

Table 10.4 - Criteria in the implementation stage

Criteria	Number of interviewees which mention this criterion	Number of cases which mention this criterion	Number of Interviewees in related cases†	% of interviewees in related cases	% of all interviewees (40)
Market	16	5	40	40.0	40.0
Customer feedback	13	5	40	32.5	32.5
Profit	9	5	40	22.5	22.5
Internal control	7	5	40	17.5	17.5

† 'related case' = case in which this criterion is mentioned by at least one interviwee; where no interviewee refers to a particular criteria it could be inferred that it is not relevant to that case.

For more clarity, Figure 10.16 indicates the importance of each criterion based on the percentage of respondents. As Table 10.4 and Figure 10.16 suggest, "market" and "customer feedback" are the two most important criteria in this stage, however "profit" and "internal control" also have to be considered since they were explained in all of the cases.

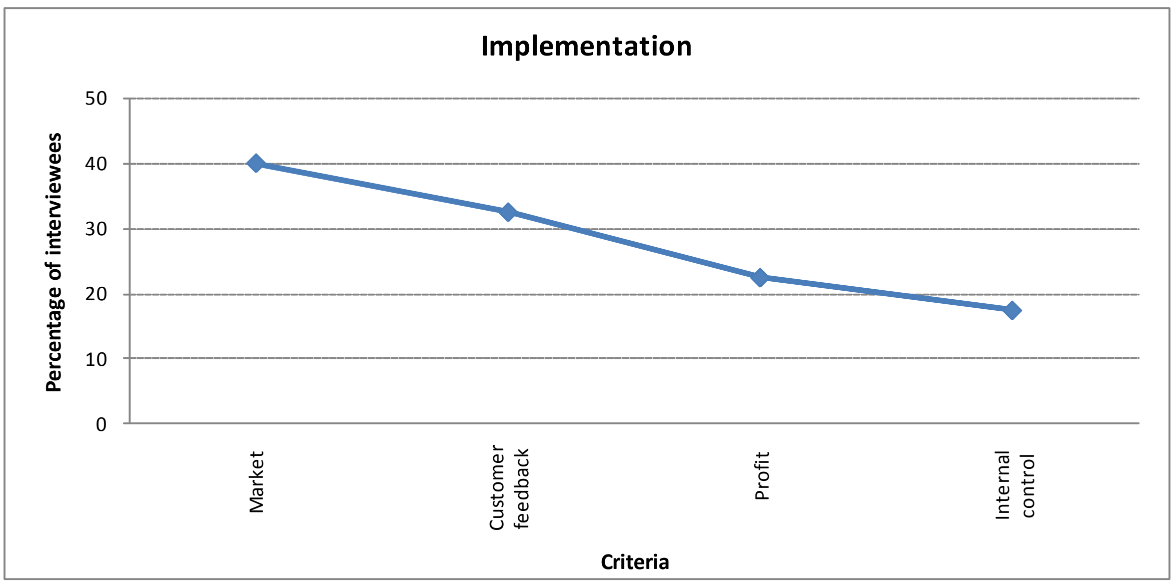


Figure 10.16 - Interviewees (*n*=40) referring to implementation criteria

Based on the type of the company, industry and the characteristics of interviewees, the importance of each of these criteria is different in each case. To enable a comparison, the percentage of respondents to these criteria are also calculated and the results are shown on different graphs for each case.

The percentage of interviewees who discussed these criteria in case 4 (SJT) are shown in Figure 10.17 (other cases and their content analyses are contained in Appendix 5). As this figure suggests, the general pattern of the case 4 profile is similar to the synthesis cases.

Since foreign products are imported by the internal market, so Figure 10.17 suggests the "market" plays a more important role for SJT company in this tough competitive situation. Based on some interviewees' opinions (Section 8.1.4), two important factors in this company which have an effect on continuing the mass production are market need and customer's opinions regarding new products. This means after launching a new product in the market, market acceptance plays a significant role in success. So based on market feedback regarding needs, interest and the amount of profit, the company decides to continue and renew the production plan of a new product.

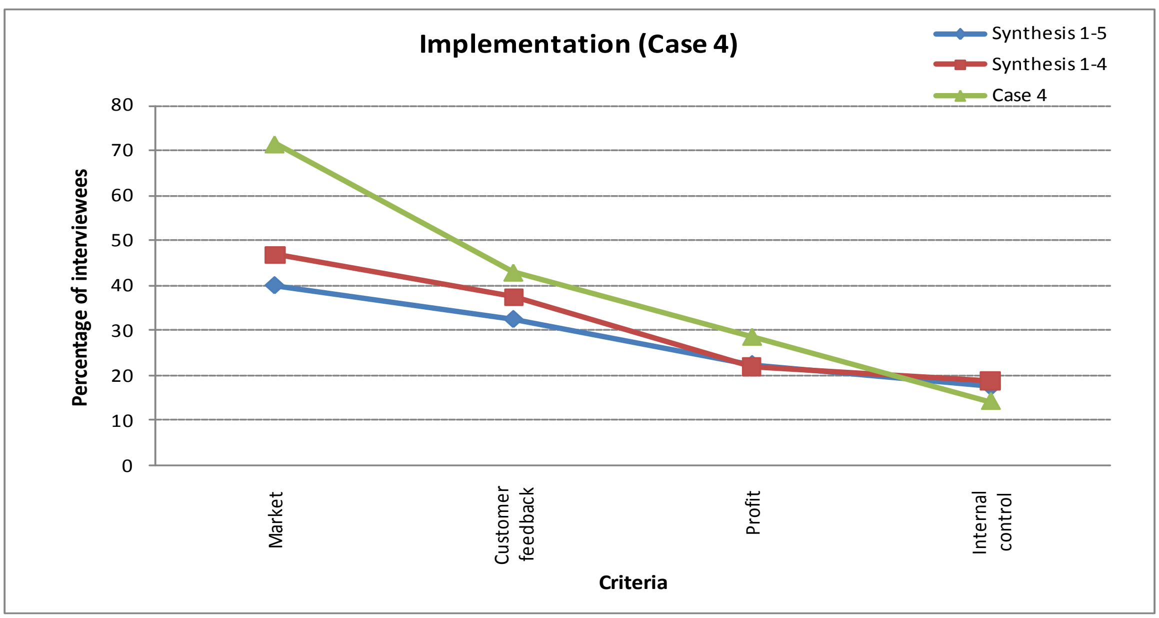


Figure 10.17 - Interviewees (*n*=7) referring to implementation criteria in case 4 (SJT)

10.6 Learning

As discussed in section 2.6.5 an organisational learning capability is crucial for a firm's innovation performance (Jantunen, 2005). Therefore, the ability of a company to obtain knowledge efficiently, incorporate it, and use it to commercial ends is crucial to its innovative capabilities and performance (Cohen and Levinthal, 1990). For most of the companies, the importance of learning and documentation was mentioned by interviewees. For instance, some interviewees in case 5 (SSE) said that by understanding the problem in turbines (e.g. SWIFT), the company can manage other similar problems. On the other hand, since most companies apply the ISO (e.g. case 3, Section 7.1.5) they should document their processes formally. However based on most interviewees' responses, these companies do not fully apply a formal documentation and learning process. In other words, documentation and learning are simply a formality instead of being an effective tool for most of these companies.

Only in case 1 (Section 5.1.5), did an employee explain that documentation plays a part as a source of creativity. It seems for this company, because the nature of their industry (bus and truck manufacturing) is more technical, documentation is necessary especially when attempting to attain different standards. It can therefore be said that there is no evidence (or that none was found) that documentation really enhances learning and that it can be used as a source of creativity for most companies.

To sum up, it seems that although most of the companies have a common attitude towards documentation and learning, the necessary formal documentation may be undertaken but it does not really contribute to effective learning and companies do not use this documentation as a source of new creativity.

10.7 Summary

It seems that providing a brief summary of the synthesis of five cases of innovation can be helpful in order to quickly identify the main theme which is emerging from this analysis. So in this section, the summary of the synthesis of cases will be explained from three different perspectives which are: innovation process, case studies and criteria. It should be noted that there is an overlap between these three perspectives so some repetition is unavoidable.

10.7.1 Summary from the perspective of the innovation process

From the innovation process point of view, it seems that all companies follow the same stages (Figure 3.13). Although formal meetings may not take place at all decision points when deciding to progress to the next stage (e.g. case 1, Bus Co). Also, in some cases (especially Iranian ones), they use different terms to describe these stages. For instance, the term ‘laboratory’ is used instead of the incubation stage (at the start of each interview, it was necessary to identify a common language with the interviewee regarding different stages; see Section 4.3.3).

The purpose of the learning stage is so that the company can build upon their knowledge-base and use this knowledge for future innovation. As Section 10.6 showed, the nature of this stage is different from other stages. The responsibility of other stages is clear but at this stage there is no clear responsibility, also this activity spans many of the stages and the whole company, so explaining this stage in the manner of the other stages is not possible. Although most of the companies emphasised the importance of learning, and the necessity of formal documentation, this is not reflected in practice. There is no evidence of effective formal learning. Learning from past experiences does not play an explicit role in providing input of future innovation. It should be noted that there was evidence that in some cases learning does occur in a less formal way. For instance, in case 5 (SSE), the interviewee said that he has been learning by himself by visiting potential clients and having discussions with colleagues.

Different comments about the stages of innovation were received during the interviews. The different comments relate more to differences in the context of the innovation process rather than to any suggestion that the fundamental process is different. This context is dependent on the company and environment (e.g. government, market). For instance some respondents said that in their company (e.g. case1, Bus Co) creativity and selection take place at the same point, since there usually are no different ideas. Some interviewees said that, since thinking about new ideas was part of an employees' job, there was no need for a formal process in the first stages of innovation (e.g. case 5, SSE). Based on the theoretical model (Figure 3.13) in the creativity stage, the company collects these ideas and at the following decision point (D2) broadly filters them (see Section 3.10). However, it seems that the companies usually omit this decision point when broadly filtering ideas. This may be due to the number of new ideas being relatively low, therefore the companies do not perceive the importance of this decision point. A number of interviewees in different cases believed that a number of iterative cycles between the different stages of the innovation process (or at least between incubation and implementation) is necessary. And that usually the implementation stage includes two important duties: pilot and mass production. A number of these comments were useful for improving the theoretical model; the improved model will be shown in Section 10.13.

Most of the companies emphasised that to survive in the market they need creativity. This is especially due to the increase in competition in Iran (a developing country), as during the last decade companies have developed an enthusiasm for innovation (e.g. case2, Tile Co). Based on several respondents' opinions, there are usually two types of innovation which companies choose (see Section 2.3.2 for more detail regarding the role of the company environment in categorising the kind of innovations within each company). The first is incremental innovation which is based on current products (e.g. changing the current formula of products or changing the packaging in case 3, Dairy Co). The second involves producing a completely new product which is novel to the market (e.g. working on a combination of nanotechnology and tile to produce tiles and ceramics which are anti fungal and bacteria, case 2, Tile Co). Interviewees believed that in general, the risk associated with incremental innovation was less than that involved in creating an entirely new product. Companies therefore focus on developing existing products (incremental innovation) rather than creating completely new products (e.g. case 4, Porcelain Co).

10.7.2 Summary from the perspective of the case study companies

Although each company followed the same basic innovation process, it seems that the type of industry and company has an effect on the process of innovation and the criteria that should be considered in each stage. In order to consider the situations of different cases, the importance of some criteria (which had a high percentage and were explained in most cases) at each stage of innovation will be shown in one graph.

For instance, in case 1 – bus and truck manufacturing (as discussed in Section 10.2.3) – the market share is guaranteed in this industry so the company does not need to consider its competitors. Thus as Figure 10.18 suggests, in the creativity stages it seems that this criterion is less important than others and the company does not consider it as much when compared with other Iranian cases.

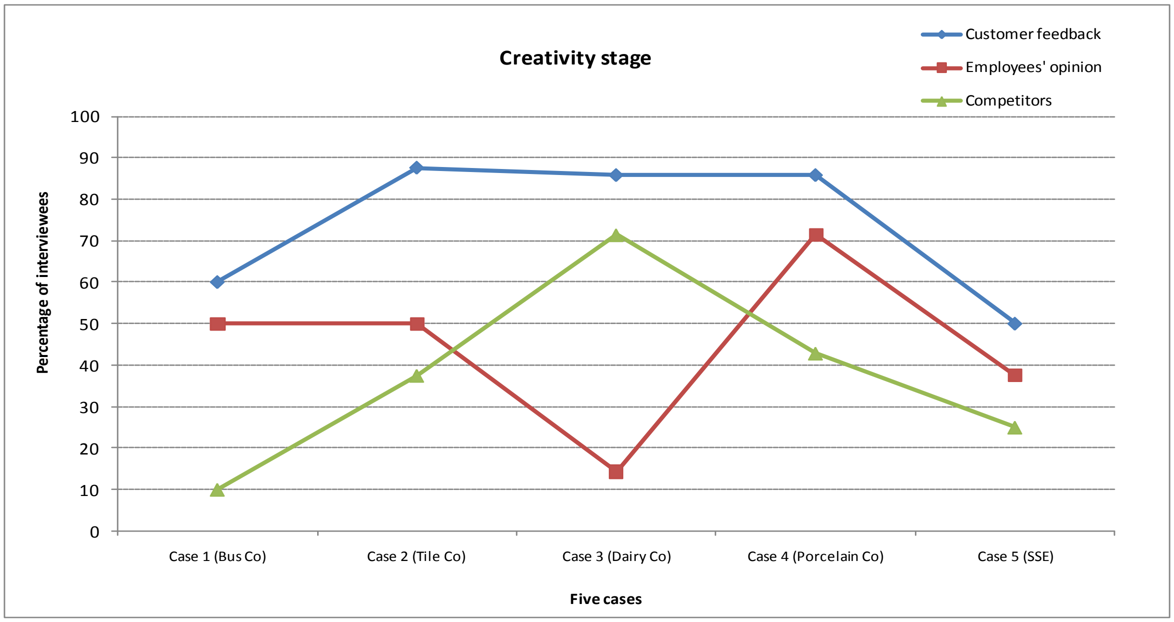


Figure 10.18 - Interviewees referring to creativity criteria in five cases

Figure 10.18 suggests that the “employee’s opinion” is not perceived as an important criterion in case 3 (Dairy Co., Chapter 7) in comparison with other Iranian cases. As discussed in Section 10.2.3, because of the management structure in this company (hierarchical), the percentage of employees who explained the role of “employee’s opinion” is lower in the creativity stage than other cases.

Based on Figure 10.18, a high percentage of respondents in all cases explained “customer feedback” as one of the most important criteria for their companies during the creativity stage. It seems that the Iranian companies put more stress on this criterion in comparison with the UK case. As discussed in Section 2.6.1, companies employ technology driven product development or attempt to identify customer needs for creative purposes. Both approaches are possible in industrialised countries, but in developing countries technology push is weaker and the customer driven approach appears to be a more common method of stimulating creativity (Chandra and Neelankavil, 2008). In regard to this reason, probably "customer feedback" is important (or is of perceived importance) criterion in Iranian companies as they are in a developing country. However, it should be noted that since the market share for case 1 is guaranteed, presumably this criterion has less important affect on this stage in this company in compare with other Iranian companies.

As discussed in Section 10.3.3, technology in case 3 (Dairy Co) is older when compared with its competitors. Also the wide variety of products in this industry requires many different types of technology, so as Figure 10.19 suggests the "implementation capability" is perceived as more important in the selection stage for this company than other criteria in comparison with other companies. In addition, since the flexibility of current technology involved in producing new ideas in case 2 (Tile Co) is high, the "implementation capability" is not usually perceived as an important criterion for this company at the selection stage. So it can be said that the flexibility of technology allows a great diversity of products and many innovative products can be produced without major changes. It seems since case 5 (SSE) wishes to concentrate more upon new ideas, the "implementation capability" is not perceived to be of great importance for this company at this stage.

Figure 10.19 suggests that financial viability plays an important role in case 4 (Porcelain Co). As discussed in Section 10.3.3, some interviewees emphasised that in this company "goals" and "strategy" play a significant role when selecting a new idea. They also stated that one of this company's most important goals is to achieve more profit. Usually the company will consider its financial ability, the amount of investment, required number of employees, final cost and profit of each new idea before making a final decision and selecting appropriate ideas. Therefore "financial viability" is perceived as a more important criterion in this company in comparison with others.

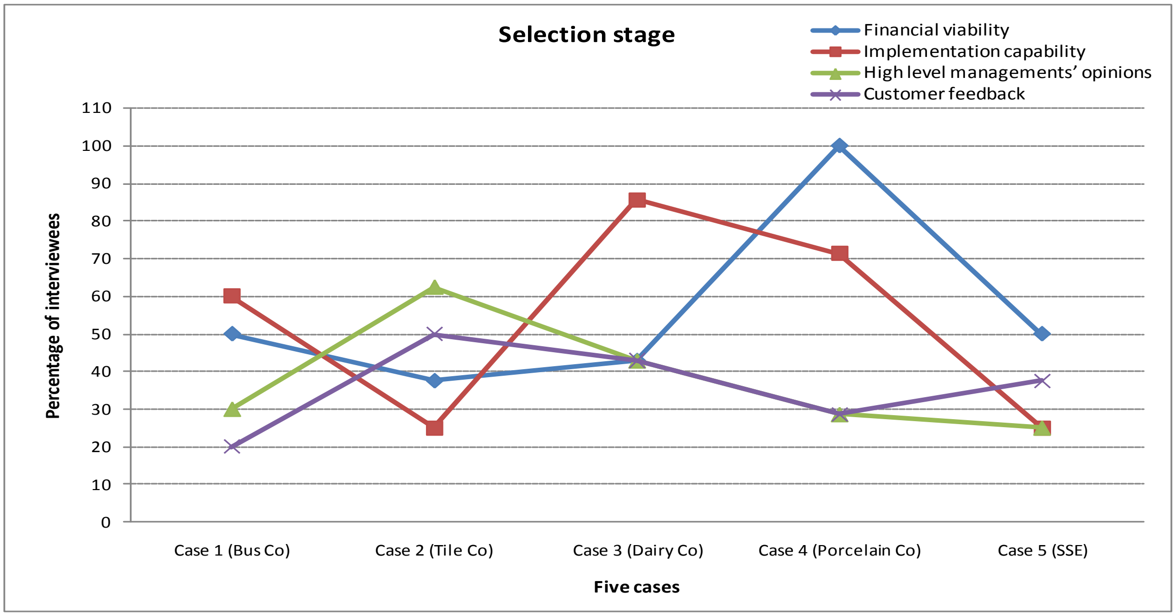


Figure 10.19 - Interviewees referring to selection criteria in five cases

As Figure 10.20 suggests, the role of "customer feedback" in the incubation stage for case 5 (SSE) is less than other companies. As explained in Section 10.4.1, "customer feedback" here relates to feedback stimulated by viewing prototypes of the new product. Perhaps this is why "customer feedback" is not relevant in this case; since the type of customer is different in this industry in compare with other industries (in SSE usually customers are end user, while in other industries there are intermediate customers who have expertise and their opinion can be useful for this stage). So based on the kind of this company, it seems that it is reasonable to consider the "customer feedback" in other stages.

Although Figure 10.20 suggests that the difference between importance of "standard and technical tests" in various companies is not large, detailed texts of interviews provide a slightly different view. Because case 3 is related to the health of society, the company should obtain the different standard certificates (e.g. hygienic approval) from the government at this stage and before progressing to the implementation stage (Section 7.1.3). Therefore, it seems that “standard and technical test” should be very important in this company.

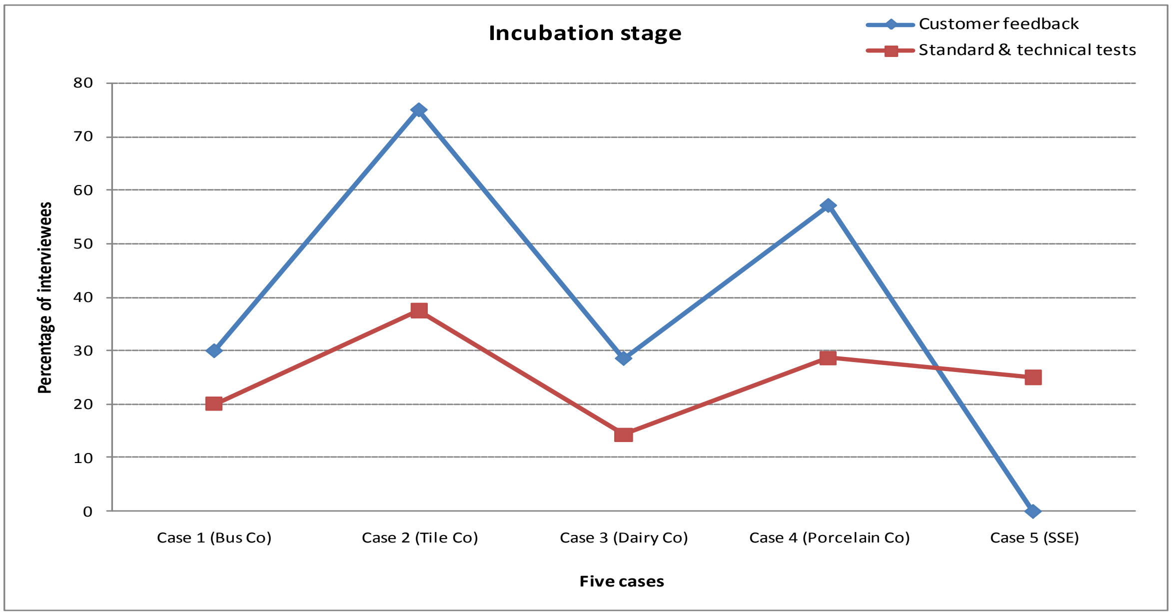


Figure 10.20 - Interviewees referring to incubation criteria in five cases

As discussed in Section 10.4.1, some interviewees in case 3 (Dairy Co) said that because of the conditions of this industry, predicting the market situation in prior stages is difficult as it needs time and money. Therefore, creating contact with their customers in order to get their feedback is usually considered at the implementation stage more than the incubation stage. Dairy companies will enter the market with a wide variety of products (but in limited numbers) and after receiving feedback will choose the most popular products and discontinue the rest. So as Figure 10.21 suggests the role of “market” and “customer feedback” both are very important for this company at the implementation stage.

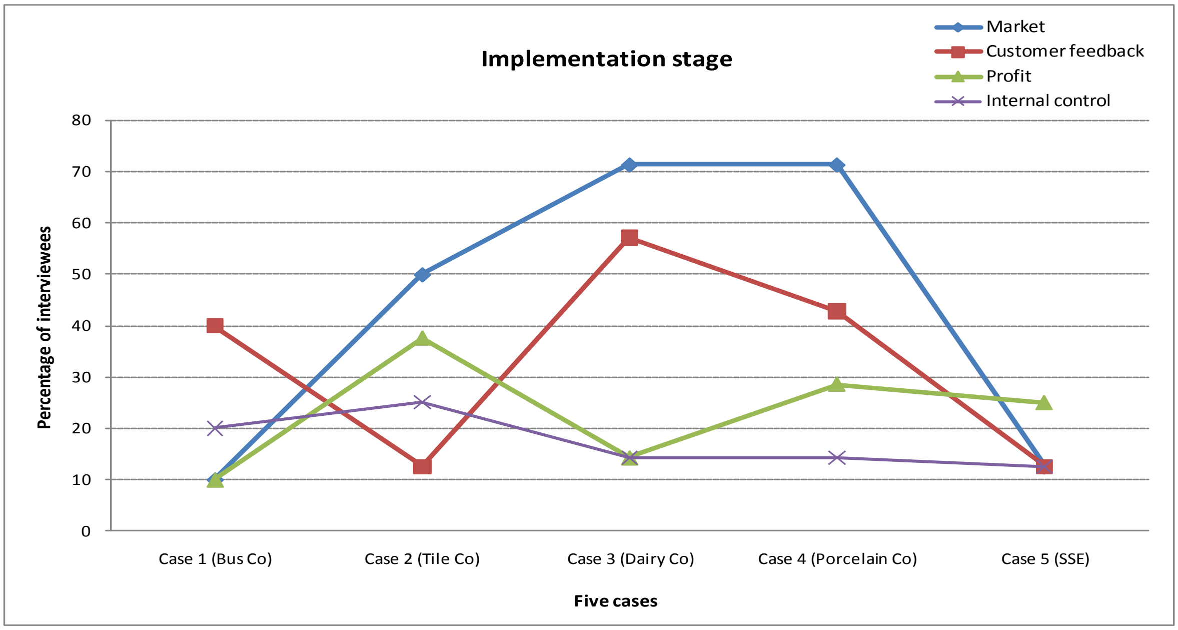


Figure 10.21 - Interviewees referring to implementation criteria in five cases

Although Figure 10.21 suggests that the difference between role of "profit" in case 1 (Bus Co) and case 3 (Dairy Co) with other cases is not large, however based on detailed texts of interviews it seems that this criterion is not of perceived importance in this stage for these companies. First of all since these two companies are non-private (see Section 7.1); the role of profit is not usually perceived as an important criterion for these companies in compare with private companies. In addition, since the market share is guaranteed in the industry of case 1 (Section 5.1.1), employees do not perceive this to be a very important factor at this stage.

10.7.3 Summary from the perspective of the criteria

It seems that, considering the criteria across the stages of innovation could be useful. It should be noted that these criteria should be considered during each stage and they help the decision making process in order to pass one stage and move to the next stage (see Section

2.6). Table 10.5 indicates the percentage of interviewees who explained different criteria in different stages of the innovation process (Section 10.2 to 10.6).

Table 10.5 - Interviewees (*n*=40) referring to criteria in stages of innovation

Criteria	Stages of Innovation Process			
	Creativity	Selection	Incubation	Implementation
Customer feedback	72.50	35.00	37.50	32.50
Financial viability		55.00	12.50	22.50
Culture	15.00	17.50		
Strategy	7.50	27.50		
Competitors	35.00	10.00		
High level managements' opinions		37.50	7.50	
Availability of raw materials		15.00	5.00	
Standard & technical tests			25.00	17.50
Employees' opinions	45.00			
Current problem	15.00			
Outside company's opinions & opportunity	12.50			
Technology	15.00			
R&D	15.00			
Previous documentation	2.50			
Implementation capability		52.50		
Time of achieving the result		10.00		
Social prestige		7.50		
Market				40.00

Figure 10.22 shows some of the criteria of Table 10.5 that were, at least, mentioned in more than one stage, such as “customer feedback,” “competitors,” “culture,” “strategy,” “financial viability,” “high level managements' opinion,” “availability of raw materials” and “standard and technical test”.

Since “customer feedback” and “financial issues” are two criteria which are explained in most of the stages, when compared with other criteria, they will be considered across the different stages of innovation in more detail (Figure 10.23 and Figure 10.24), by comparing their contribution in each case study.

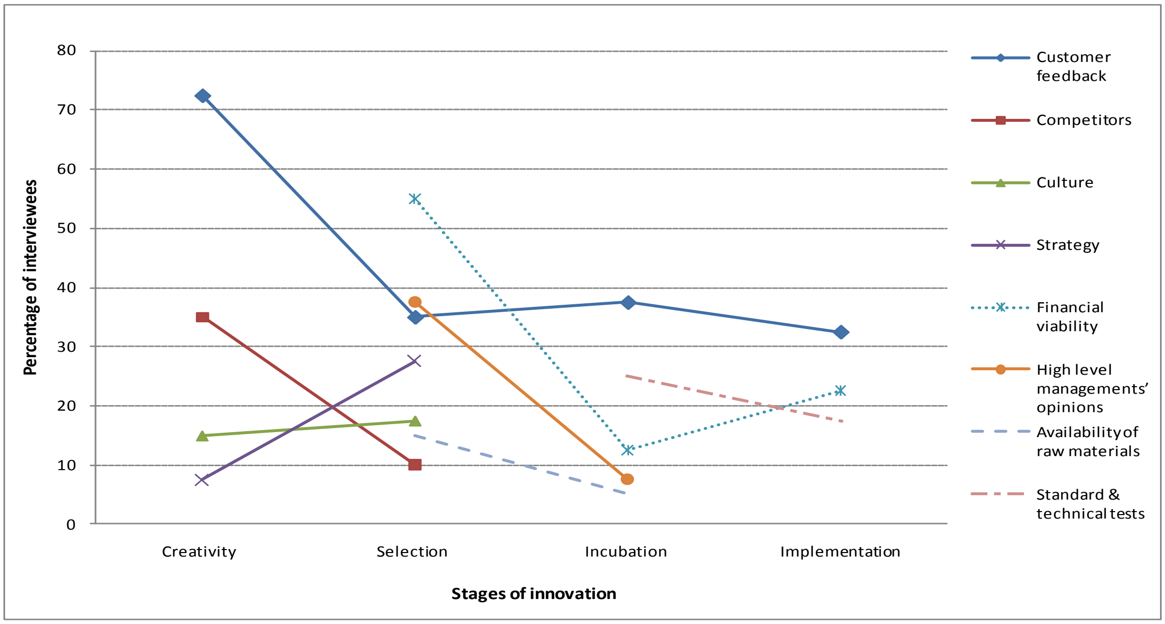


Figure 10.22 - Interviewees (*n*=40) referring to criteria in stages of innovation

As Figure 10.23 suggests the role of "customer feedback" is perceived as one of the most important criteria in creativity stages for most of the companies in compare with other stages (for more detail about the various role of "customer feedback" in developed and developing countries see Section 10.2.3). It seems then that since one of the important inputs for creativity in most of the companies is the customer's opinions and needs, in the selection stage the companies usually put more stress on assessing the ideas based on their financial viability and implementation capability. After selection, companies try to find customer feedback which allows them to gain valuable insight into the prototype they are producing. As discussed in Section 10.7.2, in two companies (case 3, Dairy Co and case 5, SSE) – due to the nature of their industry – finding customer feedback in the incubation stage is not the same as in other cases and these two companies place more stress upon this criterion in the other stages. In the implementation stage, customer interest in a new product plays a significant role in continuing with mass production.

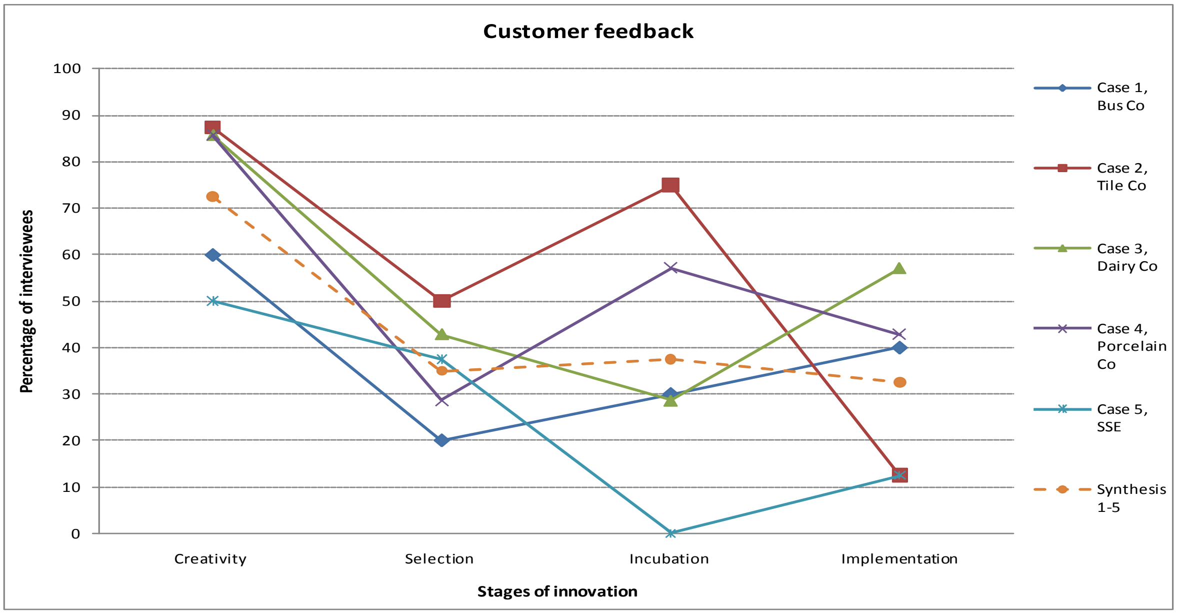


Figure 10.23 - Interviewees referring to "customer feedback" criterion in stages of innovation

As Figure 10.24 suggests, financial issues are another example of a criteria which can be considered during the different stages of innovation. Usually, financial issues do not play any specific role in the creativity stage, although sometimes the high cost of activities causes "high level management" to be motivated in their use of internal resources and therefore their interest in innovation is increased. Figure 10.24 stresses that it is important for most of the companies to consider the financial viability of a project in the selection stage.

The "final cost" is usually considered in the selection stage, but when the prototype of a new product is ready in the incubation stage, the company will be able to calculate the final cost more precisely, so this issue can be considered in the incubation stage as well. Figure 10.24 suggests that case 4 (Porcelain Co) acts in a different way. This company puts a lot of consideration into the "final cost" during the selection stage. It is probable that the employees in this company are more professional, so they may be able to predict the final price at the selection stage more precisely than other companies. All companies in mass production need a "production plan". The production plan is usually decided monthly, after considering the feedback from the first sales and the amount of profit. Therefore companies consider "profit" in the implementation stage when preparing the "production plan".

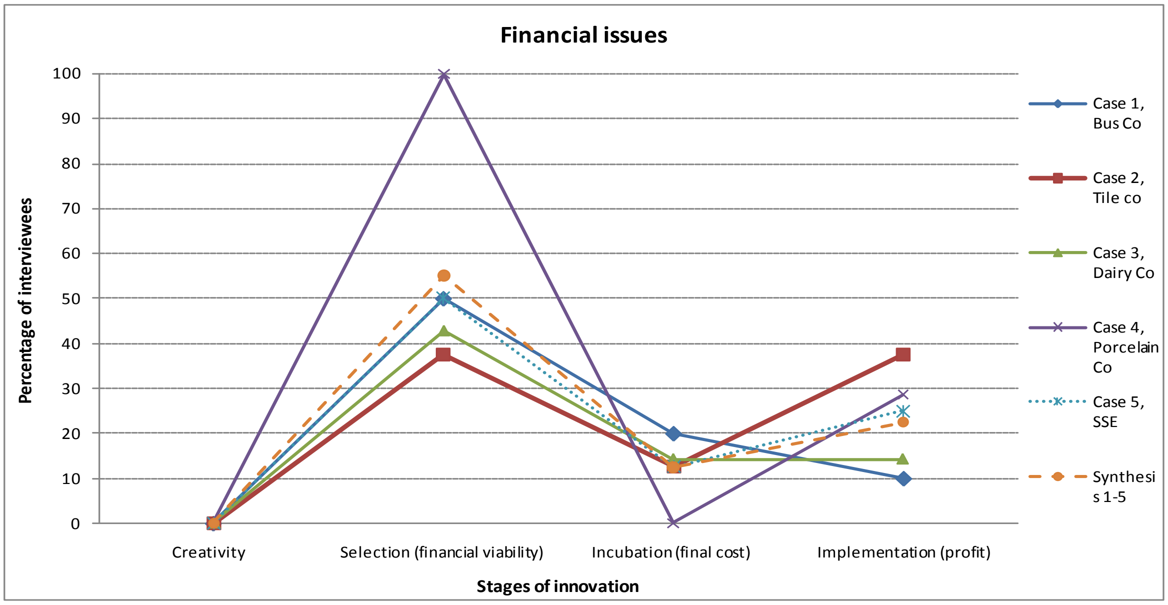


Figure 10.24 - Interviewees referring to financial issues in stages of innovation

10.8 Attitudes towards Risk Management

Having identified the key criteria affecting innovation in the previos sections, the following sections (10.9 to 10.12) of this chapter examine the role of risk management in dealing with these criteria. The results from five different empirical cases are synthesised, and compared to the literature summarised in Chapter 2 and Chapter 3, the results are discussed. In addition, in Section 10.13 the findings of this chapter and Chapter 10 will be compared with the theoretical model, which was made based on current literature and two literature case studies, to improve the primary theoretical model.

Interviewees had various points of view regarding the risk management and explained them during the interviews. Although managers could relate to innovation process (Chapter

10) but not risk management system. They take action to reduce risk in the sense of solving technical or business problems (such as engineering, financial, marketing) but do not think in terms of systematic risk management. At the start of the each interview, different scientific terms were defined and an attempt was made to try and find a common language with the interviewees (see Section 4.3.3). It was surprising that in number of cases - e.g. case 4 (Porcelain Co), case 5 (SSE) - some interviewees had good information about these issues and they used the scientific meaning of risk, although in practice their knowledge was not usually acknowledged by their companies.

Based on some interviewee's responses (e.g. case 4, Section 8.2), it is clear that companies accept that innovation always includes risk, since the final result is not clear before implementation. Risk management helps the company to implement a project with greater confidence, as the company gains an insight into any possible problems before they happen and can prepare itself and manage them should they arise. A number of interviewees (e.g. case 2, Section 6.2) explained that the goal of risk management is to decrease the probability and impact of the risk. Also, some interviewees (e.g. case 3, Section 7.2) stated that to achieve success in innovative projects, the company needs to manage risk and this function should be undertaken at different stages of innovation. Based on some interviewees' definitions (e.g. case 4, Section 8.2) of the risk management system, after recognising factors which create risk, the company should determine the probability and impact of each one. After this, the company can identify methods to decrease the probability and impact of each risk factor and consider different systems to control them. It is interesting that a number of interviewees explicitly think in terms of probability and impact.

Some of the respondents (e.g. case 1, Section 5.2; case 4, Section 8.2) stressed that the company should consider risk at all stages of the innovation project including the first stage, in order to stop or limit failure. They also emphasised that risk management is a continuous process which should repeated throughout the project. Although some interviewees mentioned the need for continuous risk management, it does not seem that they apply this issue in practice. In addition, a number of interviewees in some cases (e.g. case 2, Section 6.2; case 5, Section 9.1.1) believed that if the company controls risk too much in the first stage (creativity), they will not be successful. In other words, risk management is appropriate for the later stages of the innovation project and participants need to be encouraged to champion ideas in the creativity stage. As discussed in Section 3.4, risk management needs to facilitate innovation rather than stifle it (Taplin and Schymyck, 2005) and it is interesting that some interviewees in two cases appreciated this balance between the need for risk management and the possible impact of too much concern about risk. Since case 5 is a developed company, it was expected that this issue would be mentioned, but it seems that the interviewee in case 2 explained this issue more based on his experience than on scientific knowledge. It seems that how risk analysis can be a discouraging element by highlighting problems and the possibility of failure is an issue worth consideration, although no more information was found during interviews.

As argued in Section 3.4, the benefit of the risk management system has to be determined by the organisation (Edwards and Bowen, 2005). Regarding this, some interviewees (e.g. case 2, Section 6.2) emphasised that risk management should be undertaken in all projects, but only with a consideration of its benefits and costs. Risk management has two kinds of cost: direct (such as the time taken by skilled staff to collect information and analysing it) and indirect (such as the cost of deterring innovation, this means the cost of commitment to unacceptably risky projects). Therefore, based on this point of view, the company needs to find a balance between the potential costs of risk management and the benefit for each project.

As discussed in Section 3.4.1, individual characteristics and specific aspects of internal organisation (such as organisational constraint) can have an affect on risk perception, control and the tendency to avoid or accept risk (Keizer, Vos and Halman, 2005; Genus and Coles, 2006). Some interviewees (e.g. case 2, Section 6.2) stated that the method by which risk is encountered is dependent upon the attitudes (personality) of high level management and the environment. There are two main types of people, risk avoiders and risk takers (Smith, Merna and Jobling, 2006). This means that some managers are risk averse, thus they choose strategies which are less risky, and therefore might be less innovative. Also, some interviewees (e.g. case 1, Section 5.2) emphasised that the characters of each industry play an important role in both the innovation project and risk management; familiarity with the situation of the manufacturing industries in general, and also each industry in particular, is very important. For instance, the bus and truck manufacturing industry (case 1, SK Co) in Iran. As the government is one of the main customers in this industry, their decisions play a specific role and often their decisions create risk for companies within this industry (e.g. if the government decides to discontinue the program which involves renewing the buses in the transport system it causes a decrease in market request), while the effect of government decisions on other industries are radically different.

From the section 10.9 to 10.12, four phases of risk management will be developed from the individual case studies.

10.9 Identifying Potential Risk Factors

Different methods for finding factors which create risk during the innovation project were applied by the companies. As discussed in Section 3.5, risks are often identified in group meetings and the outcomes of such meetings may be biased by group-thinking (Keizer, Halman and Song, 2002). Some interviewees (e.g. case 2, Section 6.2.1) said that when identifying the factors which create risk, in meetings which high level management also attend, risk factors are discussed and the person in charge of controlling each risk factor is appointed; however, they did not say anything about how they can remove the bias within this kind of risk identification. So it can be said that usually managers' experiences are used to find factors which create risk. A number of interviewees (e.g. case 1, Section 5.2.1) claimed that the unstable situation of Iran causes unusual situations which the managers must face, so their ability to recognise the factors which create risk increases.

Some other interviewees (e.g. case 4, Section 8.2.1) said that in order to find and list all the factors which can create risk in a new project, the company compares designs and practice standards described in various documentations; this comparison contributes to the form of technical risk identification. They added that some management meetings take place within the company for this specific purpose. In these meetings, the company usually employs the Fish Bone approach to identify factors which can create risk in the project. In this approach, all managers explain their ideas regarding the factors which can create risk in a brain-storming session. After this, some of the most frequently mentioned factors are selected. Sometimes the methods for solving or correcting these problems lead to creativity. A number of interviewees in case 5 (Section 9.2.1) stated that their company has a safety checklist to help identify potential risks (see Section 3.5.1 for more details regarding checklists); however they also stated that no formal system is in place to allow quick recognition of other factors which also create risk, such as political and local planning which are difficult to classify. In this area, some other interviewees (e.g. case 4, Section 8.2.1) claimed that a number of risk factors are common (for instance: raw material and energy) and the company normally considers them in regards all projects. However they also pointed out that some of them are unclear and the company must find them during the process based on the kind of project.

During interviews, each interviewee explained the different factors which create risk based on his/her point of view. All of the factors which create risk within the companies (based on interviewees' opinions) can be categorised into seven areas (which are explored in greater detail in Section 3.3). These areas are: "Environment," "Resources," "Marketing," "Management," "Technical," "Integration" and "Strategy". Therefore, as discussed before, each of these areas include some sub-factors. For instance, "environment" includes: government policy (Eden, 2001; Foxon *et al.*, 2005), currency rates (Eden, 2001), weather (Green and Serbein, 1983), intellectual property (Keizer, Vos and Halman, 2005), society's characteristic (e.g. poverty, crime, culture (Green and Serbein, 1983)). It seems that these seven groups of risk areas are general enough, consequently different factors can be put under these categorisation based on each companies' requirements.

Table 10.6 records all the risk areas and the number of interviewees who mentioned these areas in the five cases. Also, the number of cases which explained these areas, the percentage of interviewees in related cases and the percentage of all interviewees are shown in this table.

Table 10.6 - Risk areas

Risk area	Number of interviewees which mentioned this area	Number of cases which mentioned this area	Number of Interviewees in related cases†	% of interviewees in related cases	% of all interviewees (40)
Resources	24	5	40	60.0	60.0
Environment	21	5	40	52.5	52.5
Management	19	5	40	47.5	47.5
Marketing	15	4	30	50.0	37.5
Technical	14	5	40	35.0	35.0
Integration	6	3	23	26.09	15.0
Strategy	2	2	14	14.29	5.0

† 'related case' = case in which this area is mentioned by at least one interviwee; where no interviewee refers to a particular area it could be inferred that it is not relevant to that case.

For greater clarity, Figure 10.25 indicates the importance of these risk areas based on the percentage of all interviewees. It should be noted that in all graphs, synthesis suggests the importance of these areas based on all interviewees (see Section 10.2.3 for more detail).

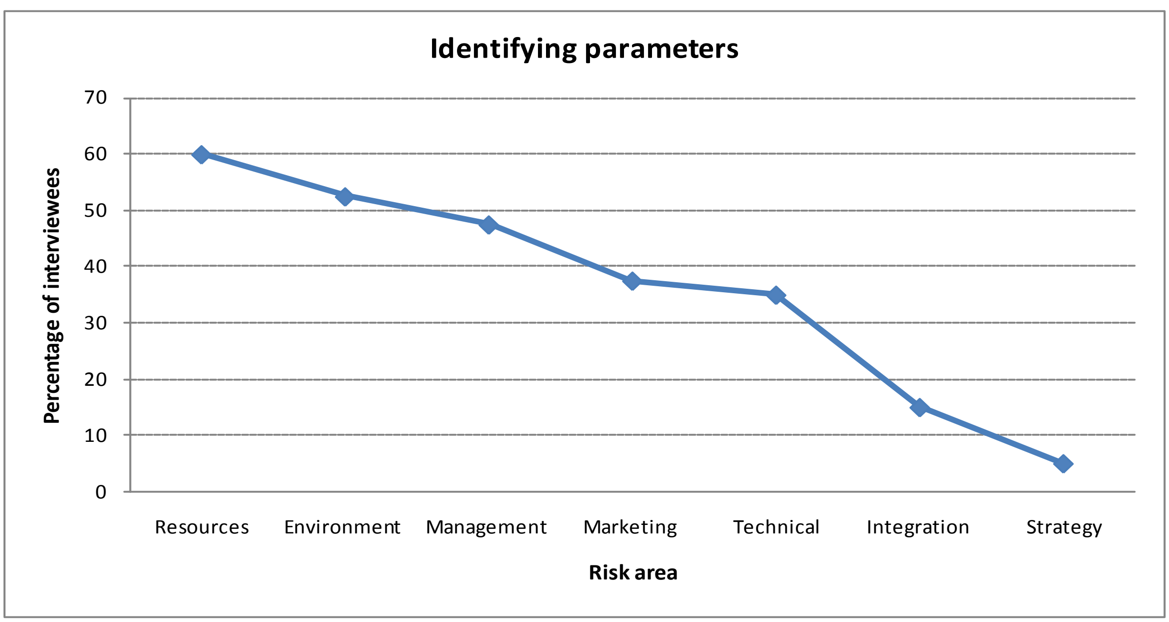


Figure 10.25 - Interviewees (*n*=40) referring to risk areas

Based on the type of company, industry and also the characteristics of interviewees, the importance of each of these areas is different in each case. Therefore, to enable a comparison, the percentage of respondents in each of these areas is also calculated and the results are shown on different graphs for each case.

The percentage of interviewees who discussed these areas in case 3 (RDPC) are shown in Figure 10.26 (other cases and their content analyses are contained in Appendix 5).

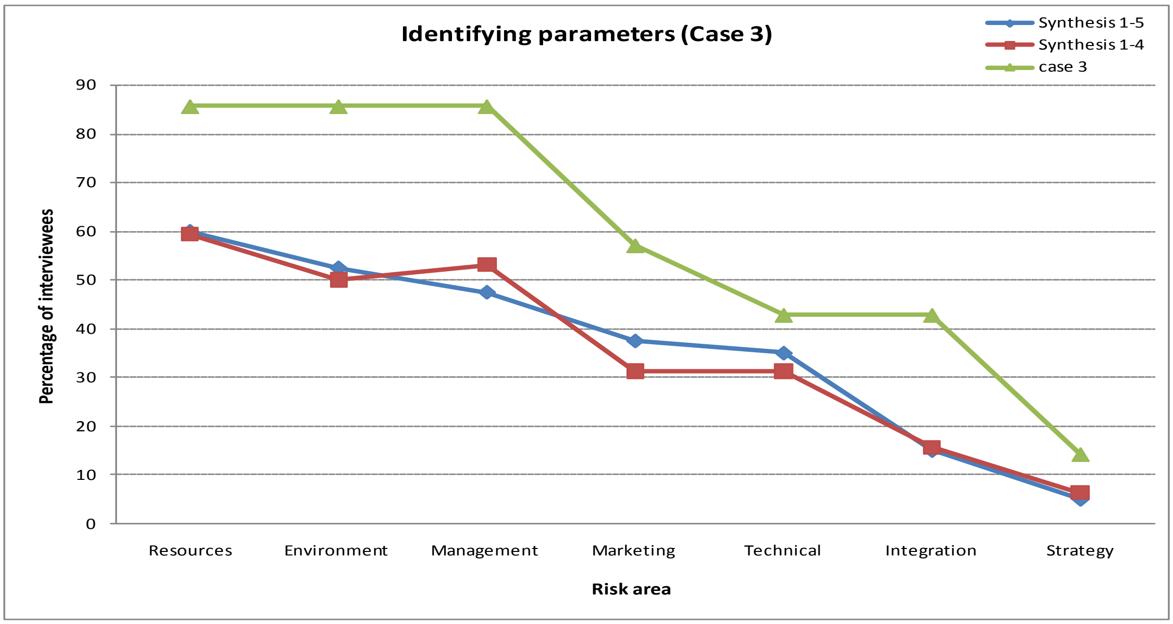


Figure 10.26 - Interviewees (*n*=7) referring to risk areas in case 3 (RDPC)

As Figure 10.26 suggests, “resources,” “environment” and “management” are three risk areas which are perceived as important sources of risk for case 3 when compared with other areas. Based on interviewees’ opinions, the structure of management is the most important factor which can create risk in “management” area. Interviewees also explained that there is a strict hierarchy with a strict definition of responsibilities in this company (Section 7.2.1); this creates a barrier for employee contribution. In addition, this structure causes managers to be risk averse and the system of decision-making is very slow. They added that in this situation employee dissatisfaction has a negative effect on the process of production and can create risk.

Based on the respondents' opinions, government policy and culture are two important factors which create risk in the "environment" area in case 3 (RDPC). For instance, the government plays a powerful role in fixing the price of dairy products (Section 7.2.1). The interviewees said that in 2007 the government did not permit dairy companies to increase the price of some products despite inflation and an increase in the price of raw materials. Predicting the risk posed by environmental factors is difficult in this industry. Another issue which is government related and can create risk is obtaining different certificates (such as hygienic approval after finalising the prototype of new food products in the incubation stage) from the government in order to produce new products. Because of problematic bureaucracy and unclear rules, obtaining certificates from the government is difficult and often unanticipated. This issue is a factor which can create risk in innovation projects as time is often wasted on certification which can then cause a loss of opportunity in the market. Interviewees also said that since there are different cultures and regions in Iran and each one has its own tastes (for instance, the north of Iran prefers sweet yoghurt and south of Iran prefers sour), if the company cannot recognise the culture of society correctly, it cannot select the most appropriate idea, therefore this factor can also create risk.

Interviewees in case 3 (RDPC) stated that financial issues are one of the most important factors which can create risk in the area of "resources". Also, the availability of raw material, methods of supply, price, time until receipt and amount required are other resource based factors which can create risk in this company. In addition, interviewees said that since worn out technology is another factor which can create risk in this company (Section 7.2.1); the company tries to buy and renew some parts of their technology. Therefore "integration" (old and new technology) is another area which can create risk in this company.

As Figure 10.26 suggests, "strategy" is one of the areas that creates risk within RDPC company. As discussed in Section 7.1.1, strategy is a factor which can also have an effect on the creativity stage in this company. For instance, this company bases their strategy on a desire to be a leader in their industry; they produced fruity yoghurt for one year but discovered that there was no demand for it in the market place. Therefore, employees believed that "strategy" is one of the areas which can create risk within case 3.

10.10 Analysing Risk

Based on some interviewees' opinions (e.g. case 5, Section 9.2.2), a single approach to risk management is not appropriate; there is a need for some adaptation to suit particular situations. As examined before (Section 3.6), during the analysis phase, the probability of each risk factor and their impact should be identified in order to prioritise them. Ranking risk allows for the efficient and effective allocation of resources for risk management (Baccarini and Archer, 2001). Although some scientific methods were mentioned during the interviews, it seems that utilising the experience of employees in an informal way plays an important role when identifying the probability of risk factors, at least in some types of innovation such as incremental innovation. For instance, some interviewees in case 1 (Bus Co, Section 5.2.2) explained that, most of the time, the company considers risk based on prediction, guesses, previous trends and employees' experience. They added that there are two types of factors which create risk: Internal and External. A company can identify the probability of events and the action required for some internal factors, but for external factors it is difficult to do so. For instance, there may be some documentation regarding internal factors which create risk, such as machinery. Often there are some methods for solving these events, but external factors are often out of their control. Also, in case 2 (Tile Co, Section 6.2.2) some interviewees said that this company will often use the experience of managers and some archived information (standards described in various documentations) in order to calculate the probability and impact of risk. In other words, prioritisation of risk in this company is based on the managers' experiences. Some interviewees in case 3 (Dairy Co, Section 7.2.2) explained that in order to find the probability of risk factors and prioritise them, the company will often use the experience of managers and try to consider all factors which can create risk. In case 4 (Porcelain Co, Section 8.2.2), several interviewees said that in some projects the company uses the managers' experiences to find and analyse general risk factors which are related to common development. It seems that in most of the companies no formal method is used to find the probability of risk factors, and no analysis is really undertaken. Also, since learning seems to be of a low priority, at least in practice for these companies, the dependence of risk analysis on the individual's experience is risky, given the uncertainty of having the right people available. In regards to this area in case 5 (SSE, Section 9.2.2), some interviewees said that the company uses an informal method for prioritising risk. They added that their company might be too big for informal systems and a more formal approach might be useful. They believed that as more projects emerge, there is the possibility (and need) for a more formal approach to risk. It is important to mention that it is probable that the issue of making the best use of individuals' experience is related to size. In a small company staff often talk to one another and everyone is aware of each others' experiences. However, a large company will have a bigger pool of experience but identifying the correct people might be difficult, therefore a more formal mechanism might be needed to exploit the potential of greater experience.

Various methods for analysing risk factors were examined in Section 3.6.1 to 3.6.8 based on the literature. However it seems in practice not all of these methods are employed by the companies. Different methods were pointed out by interviewees for analysing the risk factors; in the following sections (10.10.1 to 10.10.6) these methods are explained in greater detail.

10.10.1 FMEA

One method that some companies use for managing risk is Failure Mode Effect Analysis (e.g. case 1, Chapter 4; case 4, Chapter 8). As discussed in Section 3.6.4, this process is a method used to recognise the known and/or potential failures, their effects and risks within the product or process, it then allows for the mitigation or elimination of them before reaching the customer (Mcdermott, Mikulak and Beauregard, 1996; Stamatis, 2003). For each industry, there are different indexes and tables for FMEA which were made by expert people in each field. Also as some interviewees in case 4 (Porcelain Co) explained, to customise these tables and indexes based on this company, some meetings with different managers take place for this specific purpose (Section 8.2.2). The company can then improve upon these factors after using and applying them. Some respondents in case 4 said that if the company wants to manage most problems, it should use the FMEA method continuously. In other words, FMEA is a continuous process and to use this method to manage risk a constant team is needed in order to consider all the projects in the company.

This team should include different experts and, based on each project, some expert staff should be invited form other divisions. Respondents believed that the company should apply the FMEA method in all stages, before and after implementation and even in the creativity stage. As discussed in Section 3.6.4, this method is useful for the analysis of critical processes but is very time consuming if applied on too broad a scale (European federation of chemical engineering, 1985). Therefore it seems a full FMEA for every innovation could discourage innovation but when used appropriately it could be the most valuable, so presumably not all projects are subject to FMEA. In addition, historical FMEA has concentrated on design and it is unlikely to discover marketing or management issues that may be vital to the project but not the design (Smith, 1999; Keizer, Vos and Halman, 2005). If the company wishes to use only this method it may not cover all the factors which can create risk.

As this method was not applied formally in the company until now, no more information was gathered about how and to what extent the company want to use this approach to analyse the risk in innovation projects.

10.10.2 Risk log

In case 5 (SSE), the company started to develop and apply a formal method – risk log –for analysing risk factors including control action.This issue reflects the recognition of a need for a more formal system in SSE. In this model, the company prioritises the different risks based on multiplying likelihood of risk (L) and the impact of risk (I) in three categories (High, Medium and Low level of risk). After that the company considers the most important ones, High level and maybe Medium levels of risk, to find a method of solving them (for more detailed see Section 9.2.2).

10.10.3 Hurdle rate and IRR

In case 5 (SSE) which is more developed than Iranian companies, the common method for appraising investment is Hurdle rate and IRR (Section 9.2.2). By comparing these two parameters, including some sensitivity analysis, the company can decide on any new investment. Although this method does not directly relate to risk analysis, it seems that it can provide a structure for considering risk at SSE. Some interviewees stressed that the hurdle rate and IRR should only be considered after technical assessment, although some other interviewees believed that IRR should be considered at early stages by using approximate estimation as well. Based on interviewees' opinion this company has used @Risk before, but the output was "over the top"; and managers received bulky outputs which were ignored. Therefore, interviewees believed that hurdle rates are a common language and help a debate about risk, whereas the @Risk analysis clouded the issues, hence decision makers are familiar with this language.

10.10.4 SWOT

In some cases (case 1, Section 5.2.2; case5, Section 9.2.2) interviewees named the SWOT analysis as a method of analysing risk. For instance, in case 1 (Bus Co), some interviewees said that the company should use different opportunities to identify potential benefits. For instance, the lack of fuel and the increase in price is a good opportunity to identify potential replacement engines and fuel sources. In order to identify the opportunity and threat (which can create risk) the company uses a SWOT analysis. It seems this method can be used as a risk management tool in order to identify factors which can create risk rather than simply analysing them. In addition, this method explicitly distinguishes the internal and external risk factors.

10.10.5 Scenario analysis

Sometimes, in order to predict the future, the company uses different scenarios. For instance in case 5 (SSE), the company uses a scenario approach for quantification of commodity risk and predicting the future. This approach provides profit and loss estimates for the next five years along with decisions regarding acquisitions and mergers and whether to invest in or buy companies (Section 9.2.2). In case 3 (Dairy Co), some interviewees mentioned that different scenarios based on market, environment and technical risk factors are written before final decisions are made. As discussed in Section 7.2.2, very little information was available about scenario based analysis in case 3 as only one employee explained it. It seems that this method, instead of being used formally within the company, is used on an individual basis and is, presumably, only applied in regards to specific issues.

As explained in Section 3.5.3, one of the advantages of scenario planning is it identifies critical uncertainties and risks for various levels and types of planning (Drew, 2006). Therefore it seems that this method is more useful in identifying risk factors than analysing them.

10.10.6 Other methods

Some activities in some stages of the innovation process can be seen as risk management tools or sensible risk analysis, although most interviewees did not consider these activities as risk management tools. For instance, in some companies (e.g. case 1, Section 5.2.2) before the implementation stage, there are some checklists which consider the prototype in the incubation stage and some tests to approve the type of product which should be produced in this stage. Also, in pilot production (before mass production but in the implementation stage) the company produces a small number of products in order to check the system. In other words, in pilot production the company wants to check for any possible problems that may be encountered during mass production. These tests, checklists and pilot production can be classed as risk management tools or sensible risk analysis.

Based on some interviewees' opinions (e.g. case 4, Section 8.2.2; case 5, Section 9.2.2) factors which create risk eventually have an effect on financial issues, therefore companies try to manage risk by using financial methods. For instance, in case 2 (Section 6.2.2) the company firsts selects the issues important to their activity. The most important issue for this company is the financial one (sales and profit margin) thus the factors which created risks should be prioritised based on the amount of impact and the time of revelation on this issue. Or in another method, each company has a specific budget for each project which is named 'investment budget' (e.g. case 2, Section 6.2.2). According to this budget, the company decides which risks and with what expense they should be managed and which ones should be ignored. The company usually continues projects with risk of less than 50% of the budget. If the risk is more than 50%, the company must consider the project and the risk again. This general action limits the negative financial impact to a manageable size. Some companies (e.g. case 4, Section 8.2.2) also consider the expected loss or profit in implementing a new idea and also the cost and loans required for production. It seems that some companies try to transfer all risks into financial risk, since they assume that all factors which create risk, at the final stage have an effect on financial issues. In other words, while it may be argued that the ultimate impact of all events (in a commercial company) is financial, the chain of events may be long and difficult to trace. Sometimes it is better for a company to focus on the more immediate impact of issues such as product quality or time of production.

To sum up, it can be said that in most of the companies there is no formal method for analysing risk. However for most companies, utilising the experience of employees in an informal way plays an important role in predicting the probability and impact of risk factors at least in some types of innovation (like incremental). Although some methods were mentioned for analysing risk within these companies, it seems that most were unable to capture all kind of risks in order to prioritise them.

10.11 Risk Management Action

As discussed in Section 3.7, risk response is the process of formulating a management strategy which then leads to the recognition of an action plan for each risk that has to be managed (Smith and Merritt, 2002; Lam *et al.*, 2007). In regards to this, some interviewees in case 4 (Porcelain Co) explained that in this stage the company should identify methods of decreasing the probability and impact of each risk factor in the innovation project (Section 8.2.3). They said that, based on kind of innovation (which is incremental or radical), the amount and impact of risk is completely different. Also, one interviewee in this case claimed that decreasing the impact is difficult and that it is therefore better that the company tries to decrease the probability and increase control (although no example was found about how they attempt to control probabilities).

Based on some respondents' opinions, some risk factors are not important so may not need to be considered or solved as their effects on the project are limited. For instance, based on some interviewees' opinions in case 5 (SSE), if the consequence and outcome of failure is significant, the company will consider taking action (Section 9.2.3). Or in case 1 (Bus Co), some interviewees mentioned that in their internal small scale projects, risk is not usually considered because the cost is low in comparison with the cost of risk management (Section 5.2.3).

Various types of risk management actions were explained by interviewees. In the following sections (10.11.1 to 10.11.4) these methods are explained in greater detail.

10.11.1 Redundancy

Based on discussion in Section 3.7, this action comes into play when the company uses a parallel solution paths to improve the probability that an effective solution will emerge (Smith and Merritt, 2002). One of the factors which creates risk is raw materials. Companies applied several different methods in order to solve this problem. For instance, in some cases (e.g. case 1, Section 5.2.3; case 2, Section 6.2.3; case 3, Section 7.2.3) in order to reduce the risk surrounding raw materials (such as: supply and price) and increase their ability to overcome these issues, companies have contracted different suppliers and use two raw material suppliers at the same time. This means that the company buys required raw material from more than one supplier. If one supplier delays or increases their price, the company has an opportunity to manage the situation by working with the other as they are not dependent on one source. For instance, in case 2 (Tile Co), because of the problem the company had with an Italian supplier (political issues) the company attempted to make a contract with a German source in order to have two suppliers at the same time (Section 6.2.3). Also, some interviewees in case 1 (Bus Co) mentioned that suppliers are changed during specific periods in this company in order to decrease the risk involved in raw material (Section 5.2.3).

In addition, in another method in case 3 (Dairy Co), the company sets the minimum amount of required raw material which should exist in their inventory and before the amount of raw material falls to less than this amount the industrial division will order raw material again (Section 7.2.3). It can then be said that this method is another approach which deceases the risk involved in the delay of raw material, as the company always has at least the minimum amount of raw materials required for production.

To decrease the risk involved in foreign raw material supply, some companies (e.g. case 2, Section 6.2.3; case 4, Section 8.2.3) try to have an alternative Iranian raw material available, which in unforeseen circumstances they can use instead of their foreign one. Also, some companies started to replace internal raw materials with some foreign ones. For this purpose, some interviewees in case 2 (Tile Co) explained that the company tries to change its culture and persuade different divisions to use different materials (Section 6.2.3). In addition, some interviewees in this case mentioned that to try to solve this problem the laboratory try not to work with perfect raw materials when producing the prototype; if the company face unforeseen changes in the implementation stage the company will be able to control it and it will not affect the system. Also, this company cannot buy a lot of raw material because of the space they occupy and their expiry date, thus, raw materials are bought in over short term periods. Therefore, as another method of solving the risk involved in the potential difference in quality of raw materials, there are different formulas the laboratory can be apply based on the kind of raw material available.

One of the risk factors for some companies is the energy needed for production. To solve this problem, some companies (e.g. case 2, Section 6.2.3) try to use different sources of energy at the same time, for instance, liquid gas alongside gas will decrease the impact of this problem.

10.11.2 Transferring the risk to another party

As discussed in Section 3.7, the company uses this action when it recognises that it does not have enough experience to introduce a new technology in new product production (Smith and Merritt, 2002). Based on the discussion in Section 10.9, one important factor which creates risk in the innovation project is financial issues. Some interviewees (case 3, Section 7.2.3) mentioned that in this situation the company does not have sufficient money or the technical ability to produce a new idea. A method which the company sometimes uses to decrease this risk is outsourcing. Because of the high price of machinery which is needed to produce new ideas, the company will use this method first. So by using this method the company can find a market share and consider the market before deciding to buy any new technology.

10.11.3 Portfolio

Some interviewees in case 5 (SSE) explained that when the company considers investment in new technology, through investing in equity, the risk is managed by ensuring that the company has a reasonable portfolio and by only buying a percentage share of equity (Section 9.2.3). They added that one approach to investment is “pre-emptive” investment. This approach involves an initial investment and then having a right to buy more equity if the venture succeeds, this approach reduces the risk of investment. Also, based on some interviewees’ opinions in this case, one strategy for managing risk in an intelligent manner is to share the risk with joint venture. In addition, some interviewees in case 1 (Bus Co) believed that the risk involved in producing one kind of product is higher than producing several. Therefore the company should produce several types of products and provide them during a short period of time. In other words, managing the product portfolio in a proper way can help reduce the risk of production (Section 5.2.3).

Portfolio management helps to control the risk of investment and production in general; however it seems that other kind of actions are also needed for managing specific kind of risks during the innovation project.

10.11.4 Mitigation methods

As discussed in Section 3.7, in this action the company should reduce the risk probability or reduce the risk impact (Ahmed, Kayis and Amornsawadwatana, 2007). In this respect it seems that companies try to undertake some activities. For instance, based on some interviewees' opinions (e.g. case 3, Dairy Co), it is difficult to forecast demand. So, one way of decreasing market risk is to produce the product in different amounts before going to mass production (e.g. case2, Section 6.2.3; case 3, Section 7.2.3). After pilot production, the product will go to short term mass production in order to reduce the cost of risk (e.g. in case 2, one day {producing 13000 m^2}, two days or one week production). By producing different amounts of product and sending them to the market, the company can make customers familiar with new products, receive their feedback and assess the market before deciding on the amount for final production.

One of the tasks for the company before launching a new product is creating a consuming culture among customers and preparing the market in order to decrease the risk of customer culture. One of the ways some companies (e.g. case 3, Section 7.2.3) do this is by producing new products for a long time in order to familiarise customers with new ideas.

Another method involves the company following the cultural norm of society. For instance, in case 2 (Tile Co) in some cities, quality is not important but the price is (however, in other cities this is vice versa). Therefore the company produces one product of two qualities in order to achieve market share in both cultures (Section 6.2.3).

In case 2 (Tile Co), in order to reduce the risk around customers and markets, products are displayed in different places, like flats and houses, for free in order to show and assure the customers that this new product is practical and accepted by the market (Section 6.2.3). Thus, with the acceptance of risk and its control, the market has already experienced the product and will not be afraid of its failure. In addition, in this case to reduce the risk of competitors, the company tries to keep new and special designs secret, enter the market powerfully and saturate the market with the new product (Section 6.2.3). In this situation, the competitors are not likely to imitate special designs so the worry surrounding competitors decreases.

To sum up, the companies try to address some of their risks in different stages of the innovation process. Often they actually resolve their particular (technical or business) problems and usually do not take risk management actions through a formal system. Although these actions are not employed in a formal process, it indicates that the companies are familiar with some form of action for managing risks.

10.12 Monitoring/Learning

Since learning was examined in Section 10.6, this section concentrates more on monitoring. As discussed in Section 3.8, in this phase there should be a regular review of the action plans to ensure that they remain effective and ensure the company is making desired progress (Smith and Merritt, 2002). Therefore, monitoring and controlling allows updates of the recognised risks and the addition of new ones as they are identified (Edwards and Bowen, 2005). Some respondents in case 4 (Porcelain Co) believed that after implementation the most important duty of the company is controlling the process (Section 8.2.4). They said that by controlling, the company can find possible problems which are in need of improvement. It seems that in the majority of the companies there are some methods for controlling the different stages of innovation and the process of production but most are not directly related to monitoring the risk management system. For instance, since a number of companies (e.g. case2, Section 6.2.4; case 3, Section 7.2.4) apply the ISO (e.g. 2000), some frequent quality checks should be undertaken at different stages. Based on some interviewees' opinions regarding case 1 (Bus Co), by using these standards, quality assurance and production division can control the product and identify any problems which occur (Section 5.2.4).

In case 4 (Porcelain Co), some interviewees explained that after selecting an idea in the selection stage the company makes a plan to control the project in different stages (for instance, make a Gantt chart for the project and based on that follow the different stages at specific times; Section 8.2.4). In regards to this area, some interviewees in case 1 (Bus Co) emphasised that their project management division reviews the whole project based on the project map (Section 5.2.4). The main responsibility of this division is to set the time for each activity (simultaneously or consequently) for each project. They also identify the resources which are needed for the project such as: number of employees, number of experts and how many hours. Therefore it can be said that by controlling the project map, the company can find potential problems which create risk in this process and provide some methods of managing them. Unfortunately there is no acknowledgement of the difficulties and uncertainties about the estimation resources in an innovation project.

In another method of controlling the process in the implementation stage, case 1 (Bus Co) uses the OPC (operation process chart) method (Section 5.2.4). This method helps the company find existing problems and provides a means of correction. In some cases (e.g. case 2, Section 7.2.4; case 4, Section 8.2.4) there some initially approved samples are produced in order to compare the latter products with the first ones regularly. Mass production should be controlled hourly in order to make sure there is no difference between the products and the approved sample, in other words, to ensure the quality of the product is constantly similar to the approved prototype. The approved sample is an already approved product and the final products from all aspects (such as: raw material, quality) should be similar to this in order to gain approval.

Some interviewees in case 3 (Dairy Co) mentioned that the industrial engineering division in this company should control and check the process of production regularly (Section 7.2.4). For instance, this division controls the amount of raw material consumption by considering the quantity of raw material input and quantity of products output. Therefore, if the amount of consumption is a higher than reasonable amount the production process needs revision.

In one monitoring mechanism discussed in case 1 (Bus Co), the division of planning, control and production sends different feedback to other divisions of the company for correction (Section 5.2.4). This division acts likes the centre of the company, it receives different things from different divisions and also sends feedback to them about their activities. For instance, sending feedback to the engineering division about safety, sending feedback to the sale centre about the type of supply, the products and current situation of inventory, or sending feedback to the production division, marketing division, logistic division and also administrative division about the satisfaction of employees.

Companies usually control machinery in different terms (such as safety, maintenance), based on a specific plan. For instance, in case 3 (Dairy Co) the main duty of the technical division is maintaining and repairing machinery and also controlling them whilst there is an active production line (Section 7.2.4). Some interviewees in case 4 (Porcelain Co) said that there is a proactive and regular system which is used to check machinery to prevent any malfunction, therefore, the company should not wait until something happens and instead should attempt prevent it (Section 8.2.4).

In addition, interviewees named other methods they use to undertake monitoring in their companies. For instance in case 2 (Tile Co), some interviewees explained that in situations where the expense of the project is more than the progress plan, the project will be terminated by the company (Section 6.2.4). Also, based on some interviewees' opinions in case 5 (SSE), this company periodically reviews the hurdle rate and risk premium for monitoring purposes (Section 9.2.4). Also, some interviewees in case 2 (Tile Co) claimed that, for each project there are different diagrams used for monitoring purposes based on the sale rate of the new product, development plan and human resources (Section 6.2.4). They added that one of the documents often used for monitoring is financial documents. They said by using such documents, every two months, the market share and sales are elicited and according to this information the company continues the project.

To sum up, as discussed there are various methods for controlling the different stages of innovation and the process of production within the companies, however most of them are not directly related to monitoring risks or a formal risk management system. In other words, there is no evidence of organisations taking a systemic view of risk. It means that most of the duties of monitoring which are related to risk management, such as reviewing the action plans and updating recognised risks and adding new ones, are not usually implemented in the current routine monitoring and controlling activities of the companies.

10.13 A Refined Model Incorporating the Empirical Cases

As discussed in Section 4.2.3, in order to develop the model for integrating risk management into the innovation project, there should be four distinct phases. First of all, in Section 2.6 the initial core model based on a review of the innovation management theory was explained. After that in Section 3.9.2, a combined model integrating the core and potentially relevant aspects of risk management (initial theoretical model) was developed. In the next step, Section 3.10, the theoretical model was refined based on a comparison of the initial theoretical model and the literature case studies. Finally, in this section, a further refined model (Figure 10.27) incorporating the analysis of the empirical cases is developed. This model (that will be explained in more detail in Section 10.13.1 and 10.13.2) emphasises the integration of a risk management system within an innovation project. In addition, the main criteria identified for each decision point (Chapter 10) are shown in the model (the importance of the criteria was explored using the influence diagrams, a simple content analysis of interview material followed by an investigation of the detailed text of the interviews).

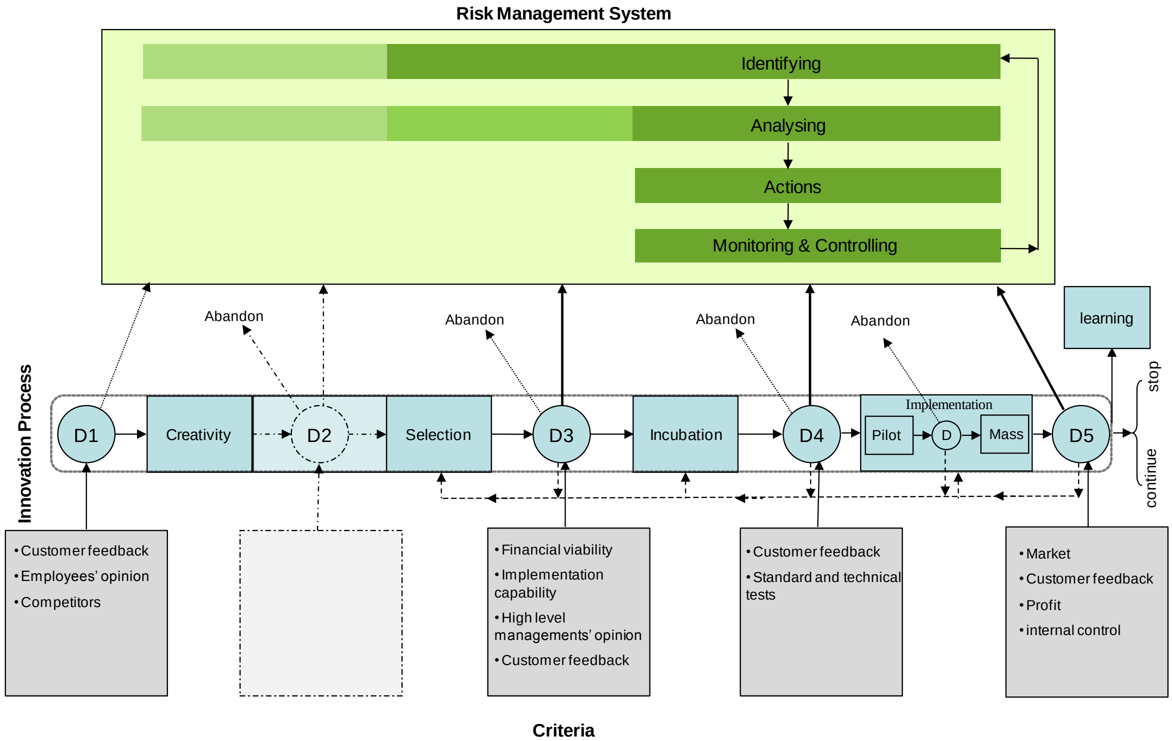


Figure 10.27 - A further refined model incorporating empirical cases

10.13.1 Innovation process

As discussed in Section 10.7.1, from the innovation process point of view, it seems that all companies follow the same stages of the theoretical model (Figure 3.13). Even though some of the terms used in different organisations may vary and formal meetings may not take place at all decision points when deciding to progress to the next stage. Different comments about the stages of innovation were received during the interviews. The differences in these comments relate more to differences in the context of the innovation process rather than to any suggestion that the fundamental process is different (see Section 10.7.1 for more details). However a number of these comments were useful for improving the theoretical model:

- Based on the theoretical model (Figure 3.13), in the creativity stage, the company collects ideas and at the following decision point (D2) broadly filters them (see Section

2.6 for more details). However as explained in Section 10.7.1, it seems that companies usually omit this decision point when broadly filtering the ideas. It is interesting that this issue supports the findings from two literature case studies (Section 3.10). It is possible that since the number of new ideas is not very high in these companies, they do not perceive the importance of this decision point (this issue suggests that risk management is appropriate for the later stages of the innovation project and participants need to be encouraged to champion ideas in creativity; more details will be discussed regarding this point in Section 10.13.2). In Figure 10.27, decision point 2 (D2) is indicated by a broken line. It means that when the number of new ideas entering increases, it is better for companies to use this decision point and allocate appropriate criteria to it. Otherwise, it can be said that creativity and selection can be take place at the same point.

- As discussed in Section 10.5, it seems that the implementation stage usually includes two steps: 1- pilot production and 2- mass production; and it is possible, after pilot production, to return to a previous stages or stop the process entirely. In Figure 10.27, the implementation stage includes two steps and after pilot production it is possible to abandon project, continue to mass production or return to previous stages. The conditions of the incubation and implementation stage are radically different, as the scales used within the laboratory are smaller and the instruments more precise. Therefore in pilot production the company wants to check the reality of implementation and improve upon it if necessary in order to produce a product similar to the prototype.

As discussed in Section 2.6.4 the implementation stage is at the heart of every process of innovation and most failures are expected to occur during this stage (Cozijnsen, Vrakking and IJzerloo, 2000). It is probable that if companies set specific criteria for pilot production, they will improve the chances of success in the implementation stage. It then seems that the main criteria for moving to mass production is producing a qualified product in pilot production, therefore other criteria such as customer feedback and technical testing can be considered in pilot production based on the context (company, environment) of innovation.

- Although some factors which have an effect on the process of innovation were examined in various literature, most of them did not specify at exactly what stage the factors have an effect. In addition, most of the research was undertaken in developed countries. Therefore, the main candidate criteria were identified for each stage based on their importance - explored by using a simple content analysis (Section 10.2 to 10.6) - are also shown in the model (Figure 10.27).

10.13.2 Risk management system

Interviewees had various points of view regarding the risk management system and explained them during the interviews. Also, some activities were undertaken by companies to identify, analyse, take action and monitor risk factors in general. While there are individual actions that can be described as examples of risk management, there is no evidence of organisations taking a systemic view of risk. For instance, there is no particular responsibility for risk management: it is a job which every employee might be expected to do independently. However, it is interesting to note that some of the interviewees (in UK and Iran) explicitly think in terms of probability and impact, and it seems they had good information regarding these issues. Nevertheless this knowledge was not usually recognised by their companies in practice. It can be said that most companies did not have any formal system in place to consider the different phases of risk management in their innovation process. A number of issues regarding the risk management system based on detailed texts of interviews are discussed in the following:

- Some methods were explained for identifying risk; such as checklists (for safety), fish bone, group meetings and brainstorming, most of which are based on employees' experiences. It seems there is no formal approach to allow quick recognition of all factors. Section 3.5 explained the various approaches for risk identification that a company can apply internally. It seems that the dynamic risk checklist (Figure 3.5) is a useful approach for companies as it is formal, easy to use, not time consuming, improves the learning system within the company and requires no additional knowledge in the current situation of the companies. One common criticism about the checklist is that it is fixed and static, while a dynamic checklist evolves during the life of the actual innovation project; it is an example of a simple form of learning. It starts with a previous list of the company's risks but is open to the addition of new risks (as some risks disappear at the start of the project but it is possible they might emerge later in the project).
- It seems that in most of the companies no formal method is used to find the probability of risk factors, and no analysis is really undertaken. Also, since learning seems to be of a low priority, at least in practice for these companies, using an individual's experience rather than using an objective database for estimating probabilities, is risky given the

uncertainty of having the right people available. Therefore a more formal mechanism might be needed to exploit the potential of greater experience.

Interviewees mentioned some methods such as FMEA, risk log, hurdle rate and SWOT. These methods were usually very specific, employed to analyse a particular aspect of risk and some of them, which are more appropriate for analysing, such as FMEA or risk logs are not completely implemented by the companies. A number of these methods do not have a direct relationship to the analysis of risk factors in the innovation project and some others are not a complete method of analysis for all factors. For instance, SWOT can be used as a risk management tool in order to identify factors which can create risk rather than simply analysing them, or FMEA has concentrated on design and it is unlikely to discover marketing or management issues that may be vital to the project but not the design (Smith, 1999; Keizer, Vos and Halman, 2005). In addition, it seems that some companies try to transfer all risks into financial risk since they assume that all factors which create risk at the final stage can have an effect on financial issues. In other words, while it may be argued that the ultimate impact of all events (in a commercial company) is financial, the chain of events may be long and difficult to trace. Sometimes it is better for a company to focus on the more immediate impact of issues such as product quality or time of production. Therefore it seems to need different formal analysis throughout the stages of innovation.

- Companies try to solve some of their risks in different stages of the innovation process (see Section 10.11 for more details). However, they actually resolve their particular problems (technical or business) and usually do not take risk management action. In other words, while there are individual actions that can be described as examples of risk management action, there is no evidence of organisations taking a systemic view of risk. Although it seems these actions are not employed in a formal process, it indicates however, that the companies are familiar with some form of actions for managing their risks.

- There are some methods for controlling the different stages of innovation and the process of production within the companies (see Section 10.12 for more details) but most are not directly related to monitoring the risk management system. In other words, as discussed in the previous paragraph, there is no evidence of organisations taking a systemic view of risk. This means that most of the monitoring duties related to risk management, such as reviewing the action plans, updating recognised risks and the addition of new ones, are not usually implemented in the current monitoring and controlling activities of the companies.
- Risk management is appropriate for the later stages of the innovation project and participants need to be encouraged to champion ideas in the creativity stage. So the broken line in Figure 10.27, connecting D1 to the risk management system, indicates the need for simple risk identification in this stage (in comparison with other decision points). On the other hand, as examined in Section 3.4, the most powerful contribution risk assessment makes comes at the end of a stage in the innovation process, where the transition to the actual product development and engineering of a particular product or product range takes place (Keizer, Halman and Song, 2002); therefore there seems to be a need to implement risk management in a differential manner through the innovation project cycle:

- **In creativity:** simple risk identification and qualitative analysis.
- **In selection:** more formal risk management, analysing and prioritising.
- **In incubation and implementation:** more quantitative forms of risk analysis, risk action plans and monitoring/controlling of risk.

So for this reason, as Figure 10.27 indicates, the identification and analysis phase have different shades, ranging from light through to dark. This means that as we move from a light to a dark colour, our need to identify and analyse is changed from simple to more formal and quantitative methods.

10.14 Role of the Model in Various Industries

The model is refined further (Figure 10.27) incorporating the analysis of the empirical cases in Section 10.13. This model (explained in more detail in Section 10.13.1 and 10.13.2) emphasises the integration of a risk management system within an innovation project. One important question is: How might contingencies in place within different industries affect the model's applicability?

As discussed in Section 4.3.3, in this study the cases are selected from a range of industries as this can help enhance the generalisability of the results. In order to consider the affect different industries have on the model's applicability, some specific characteristics which distinguish the various industries are noted in Table 10.7 with a justification of the ratings in the subsequent Section 10.14.1. The characteristics have been identified from the individual case study analysis of Chapter 5 to Chapter 9. Based on these characteristics and some specific examples, the role of the model will be examined in a practical situation. Therefore, in the following, firstly the meaning of these characteristics and their role will be discussed in Section 10.14.1. After that in Section 10.14.2, time and the nature of innovation risk management will be examined based on different characterestics. Finally in Section 10.14.3, a combination of these characteristics will be discussed in various case studies.

Table 10.7 - Comparing the various characteristics in five cases

Characteristics	Case studies				
	Case 1	Case 2	Case 3	Case 4	Case 5
Competition	*	**	***	**	**
Investment	***	**	**	**	***
Timescale/ cycle	***	**	*	**	***
Government involvement	***	*	***	*	*
Fast moving consumer	*	*	***	*	*
Difficult to access to customers	*	**	***	**	***

High= ***, Medium=**, Low=*

10.14.1 Characteristics of the five case study industries

In this section, the meaning of six key industry characteristics in Table 10.7 and their role in five cases are discussed in more detail.

Based on interviewees' opinions in different cases, it seems that the 'competition' in case 3 (Dairy Co.) is more important than in other cases. Also, as explained in case 1 (Section 5.1.1), bus and truck manufacturing industry in Iran, the main customers are limited to a few large companies and government departments (e.g. Ministry of Interior): the company has a guaranteed market share and therefore does not have to consider competitors to any significant extent.

The amount of 'investment' for innovation differs across the industries. It means that in case 1 (Bus Co.) and case 5 (SSE) current technology does not have enough flexibility to start a new project which demands preparation for new technology, different sets of skills and a large investment on time and capital, while flexibility in other cases is higher than these two cases.

'Timescale/cycle' of producing product is also different in the various industries. For instance, a long time period is often required to produce a new product in case 1 (Bus Co.) and case 5 (SSE), while this time period is usually shorter for Case 2 (Tile Co.), case 3 (Dairy Co.) and case 4 (Porcelain Co).

As discussed in Section 7.2.1 the dairy market is very different from other food markets as certain dairy products (like milk) are regarded as a food staple. Because of this, the 'government involvement' is high within this industry. Also in Case 1 (Bus Co.), one of the large and specific customers is Ministry of Interior, thus government has an important role in this industry as well.

'Fast moving consumer' goods are products that are sold quickly and used on a daily basis. In these industries, companies can receive customer feedback quicker than other companies in different industries. Among these cases only case 3 (Dairy Co.) is categorised in the field of fast moving consumer goods.

'Difficulty in accessing customer' in order to obtain their feedback is different in various cases. In SSE the customers are usually the end user and it is more difficult to gain informed feedback; in other industries there are intermediate customers who have expertise and their opinion can be useful for earlier stages of innovation. Also in case 3 (Dairy Co.) creating contact with their customers in order to get their feedback is usually considered in the implementation stage more than the incubation stage, therefore the dairy companies will enter the market with a wide variety of products (but limited numbers) and after receiving feedback, will choose the products which have become more popular and discontinue the rest.

10.14.2 Managing innovation risk and industry characteristics

It seems that these six general characteristics can provide criteria in order to examine how the model can be applied in various situations. For instance, in terms of innovation process: which stages need more attention; or in terms of selecting the kind of the risk management: which methods (quantitative or qualitative) are more required. Table 10.8 indicates the time (Early or Late) and nature (Quantitative or Qualitative) of innovation risk management based on different characterestics when these characterestics are high.

Table 10.8 - Time and nature of innovation risk management based on different characterestics

Characteristic	Innovation risk management	
	Time Early (+) / Late (-)	Nature Quantitative (+) / Qualitative (-)
Competition ***	+ & -	-
Investment ***	+	+
Timescale/ cycle***	+	+
Government involvement ***	+ & -	-
Fast moving consumer ***	-	-
Difficult to access to customers ***	+	-

High= ***

When competition is high, companies may need to consider the competitors' products in all stages and reduce the time of production. For instance as discussed in case 3 (Section 7.1.3), some interviewees claimed that if the new product is similar to one already in the market, they will compare their prototype with the similar product at the incubation stage. This is in order to improve the prototype and make it capable of competing in the market in various aspects such as price. In addition, since in this situation companies want to reduce the time of production and usually different new factors happen during the process (without historical trends); more qualitative risk management approaches are needed rather than becoming involved in the more time consuming quantitative analysis.

When investment is high (e.g. case 1, Bus Co.) companies need to consider risk in early stage of innovation process (in order to prevent costly failure in later stages) by using more quantitative approaches. While for case 2, since the amount of investment is low for new product development in compare with others, the company needs to encourage more idea, and more qualitative risk management is adequate.

When timescale is long (e.g. case 1, Bus Co.; case 5, SSE), companies need to use more quantitative method for risk management during innovation process since the commitment is greater, and they have the time to implement actions to reduce the probability of failure.

When government involvement is high, usually predicting the possible risk factor in environment area is difficult for companies: there is little point in analysing some risks in great detail when changes in government decisions may have a dramatic effect. In this situation companies can employ techniques such as scenario planning for analysing possible future exploration. Therefore, more qualitative risk management and rigorous monitoring and controlling are useful for companies. Also in this situation companies are better to consider the risk management in all stages of innovation process in order to identify any probable risk factors which are created by the government immediately.

Where company is working in fast moving field, it needs to accelerate the process of innovation and consider customer feedback in implementation stage. For instance in case 3, since it is in a fast moving consumer field, the incubation stage needs to be implemented quickly, however in order to consider the customer it needs to consider the situation in implementation stage in pilot part. Therefore it is better for these companies to enter the market with a wide variety of products (but limited numbers) and after receiving feedback, choose the products which have become more popular and discontinue the rest. Thus in this situation more qualitative and later risk management are desirable.

When it is difficult to access customer feedback, it is better to focus on the implementation stage (e.g. pilot production, Figure 10.27) rather than attempting to collect customer opinions about more abstract, partially completed products. Therefore in this situation companies need risk management in the early stages of innovation in order to reduce the failure in the later stages. Also since in this situation usually there is not enough precise information, more qualitative risk management is useful.

10.14.3 Integrating the guidance

In practice a company will exhibit a combination of the characteristics of Table 10.7. To illustrate the consequences for the selection of the most suitable approach to risk management of innovation, the affect of these six criteria in each of the five cases based on previous definition will be considered.

In case 1 (Bus Co.), based on the Table 10.7, amount of investment for new project is high and also time of production is long. Thus it is better for this company to use risk management in early stages of the innovation process and concentrate more on quantitative methods. On the other hand, since government involvement is high in this industry; it is useful for this company to employ the scenario approach for managing their probable risk factors. However, since the competition in this industry is low and usually the market share is guaranteed if the company wants to use risk management during its innovation process it should consider the profit of risk management in its activities.

It seems that, based on the Table 10.7, case 2 (Tile Co.) and case 4 (Porcelain Co) have less extreme characteristics. Thus the common definition of Figure 10.27 which was examined in Section 10.13 can be applied for these companies. It means that in creativity: simple risk identification and qualitative analysis; in selection: more formal risk management, analysing and prioritising; and in incubation and implementation: more quantitative forms of risk analysis, risk action plans and monitoring/controlling of risk take place.

Case 3 (Dairy Co.) has more distinctive characteristics: it is working in fast moving consumer industry and competition is high. Thus the company needs to accelerate the process of innovation and consider customer feedback in implementation stage. On the other hand, difficulty to access to customer is high so the company needs risk management in the early stages of innovation. Therefore, in order to accelerate the process and consider the risk in the early stages of innovation process, company can use more qualitative risk management such as dynamic checklist during all stages of innovation process. In addition since government involvement is high in this company, company should employ techniques such as scenario planning for analysing possible future exploration.

Case 5 (SSE) is characterised by the high investment required for new products and the long timescales for development. In this situation it is better for the company to employ more quantitative risk management during their process. Also it is useful for the company to consider risk from the early stages of the innovation process since amount of investment and difficulty to access customer are high. In addition, customers are end user in this company therefore for finding the customer feedback the company needs to concentrate more on the implementation stage rather than earlier stages.

Chapter 11 Conclusions

This chapter begins with a brief overview of the study in Section 11.1. The main achievements of this study are then summarised, distinguishing the theoretical implications (Section 11.2.1) and practical implications (Section 11.2.2). The limitations of the research are described in Section 11.3 and Section 11.4 explains the reflection. Finally, Section 11.5 offers suggestions for further study.

11.1 Overview of the Study

Increased competition, rapidly changing technologies and customer expectations have caused the innovation process to become more complex and uncertain. Various studies have identified a low success rate in major innovations. More explicit risk management may lead to success in innovation projects. However, the literature suggests that previous research has focused on either innovation management or risk management, but not the combination of both. The challenge is to integrate risk management into innovation management in order to exploit the combined power, without imposing additional bureaucracy and stifling creativity. This need shaped the main research question: ‘How can risk management fit into the innovation project in an explicit way to manage innovation in a better way?’ It seems that the model which was discussed in Section 10.13 is the correct model to use when combining innovation and risk management theoretical knowledge in order to manage innovation in a better way.

To find the model, different stages of the innovation process and risk management system were described in Chapter 2 and Chapter 3, in order to identify common stages of innovation process which could then be integrated within the proper phases of the risk management system. The core of the initial theoretical model offering a combined model of risk and innovation management was developed in Section 3.9.2 and was shown in Figure 3.12. Before this model was checked in a practical situation it was tested and refined using two literature-based cases in Section 3.10.

As discussed in Chapter 4, the case study research strategy utilising a semi-structured (in some parts unstructured) interview appears to have been the most appropriate way of acquiring data, allowing the topic of integrating a risk management system into the innovation project to be explored in considerable depth. At the start of this research, understanding was not sufficiently developed in order to determine appropriate survey questions; therefore at this stage when we are attempting to improve understanding, interviews are usually more appropriate. In addition, since the issues raised in this research are sophisticated and this research uses specific terms, people need these terms explained to them, hence they are not suitable for questionnaires or short interviews. This research starts by deducing a model from the theory and literature available, however it also wants to refine the theoretical model and explore data further. Explanation building is therefore the proper technique for analysing data in this research. Besides this technique, the content analysis technique is also applied in order to compare different situations within the various companies.

As discussed in Section 1.4 (Aims of the Research), this investigation wishes to test whether the theoretical model is useful as a framework in order to develop a better understanding of risk management in an innovation project. Since the case study strategy was chosen to carry out this research, Chapter 4 to Chapter 9 explained the results regarding the five different case studies used to test this theoretical model. In these chapters, findings regarding the innovation process and risk management within each company were explained based on their employees' opinions. In Chapter 10, the findings of these five different cases were synthesised and, by considering literature which was mentioned in Chapter 2 and Chapter 3, the results were discussed. In Chapter 10, initially the influence diagrams for each stage of innovation were developed from the individual case study diagrams and differences and similarities were highlighted. The main candidate criteria were then identified for each stage. The importance of each criterion is then explored using a simple content analysis to structure the information from the interviews. Chapter 10 proceeded to explain the risk management in innovation and it illustrated a further refined model (Figure 10.27) incorporating the analysis of the empirical cases. This figure indicated the integration model of the risk management system and innovation project. In addition, the main criteria which were identified for each decision point (Chapter 10) are shown in the model; the importance of criteria was explored using a simple content analysis of interview material providing a structure for a more detailed examination of the interview texts.

11.2 Main Contribution

The research findings have several implications for both theory and practice. The theoretical implication section describes recommendations which are relevant to the theory and countries like Iran in general. The practical implication section offers more specific recommendations for better innovation risk management in individual companies, or specifically in Iran.

These findings have been organised around the research questions (see Section 4.2.2), although there is a degree of unavoidable overlap.

11.2.1 Theoretical implication

Research Question: How can risk management fit into the innovation project in an explicit way to manage innovation in a better way?

- The probability of missing significant events is higher when using informal risk assessment. Therefore, it is worth adding a systematic component of risk management to the innovation project in order to manage innovation in a better way. Although many models for innovation and risk management were mentioned by various studies, until now the explicit combined model which shows how a risk management system is embedded in the process of innovation has needed further investigation. It seems that, the model shown in Figure 10.27 is used to combine theoretical knowledge about innovation and risk management. This model presents a combination of innovation and risk management ideas in one model, which helps further understanding of the role of risk management in innovation. This framework visualises the process of the risk management system in different stages of innovation and may help companies decide at which stage(s) risk should be considered. Also, the model indicates critical decision points in the innovation project and by considering some criteria in these decision points the company can increase the success rate of their innovation project.
- The stage-gate innovation process model with its emphasis on decisions provides a useful basis for incorporating risk management with the decisions related to criteria and information needs (see Section 2.6), which was employed for making the theoretical model in this study.

- As discussed in Section 10.13, there is no evidence of organisations taking a systemic view of risk in innovation projects. This model highlights the relationship between the formality of risk analysis and initiating creativity and stresses the importance of organisational learning when integrating risk management into innovation projects. In other words, this model might encourage a more systemic view of risk management in innovation projects.
- Companies can use the framework as a visualisation tool to make people aware of how to and how much to manage risk at different stages of the innovation project. Within each company, the management can take the framework and customise it to use in its own innovation projects.
- This risk and innovation model may also provide a framework for better collaboration between different organisations; helping them identify different roles throughout an innovation project in order to determine how they can manage risk and improve the rate of success within relationships with each other. These organisations could be commercial companies or research institutes.
- Although there was only one UK case in this thesis, it is interesting to observe that the theoretical model was relevant in understanding risk management in the innovation project in the UK case as well as Iranian cases. This suggests that the same fundamental challenges may face all companies.
- According to this model (Figure 10.27) there are five stages for the innovation project, although each organisation adds its own interpretation reflecting the local context. All of the companies studied followed these general stages. Some criteria should be considered at decision points otherwise risk may arise in the subsequent stages. The

perceived importance of these criteria varies across the industries. Also, based on this model there are four phases for managing risk during the process of innovation. According to these phases of the risk management system, the company should identify the factors which create risk, prioritise them based on their probability of occurrence and their impact, identify an action plan in order to manage them and finally control and monitor the process.

- This framework is refined in a fairly robust way in order to aid understanding of the combination of innovation and risk. The combined model appears to be relevant across diverse industries (all recognised the fundamental stages, although this was not always reflected in their formal management systems): staff from different countries (UK and Iran), industries and functional backgrounds could relate to it and the framework provided a useful structure in understanding the detail of implementing risk management. However, there is no simple guidance that companies can apply in all situations. The choice of risk management techniques varies with different innovation projects, characteristics of industry and environment.

Research Question: During which stage of innovation, and of what form and type, is risk management needed?

- Simple risk identification at the creativity stage may be useful in order to prevent stifling innovation. Companies need to have a balance between risk management and encouraging innovation in first stages of the innovation process. As argued in Section 2.6 (Figure 2.9 and Figure 2.10) the amount of investment in the idea differs in the various stages of innovation (e.g. see: Salomone, 1995). For instance, in the creativity stage, the amount is low while in the implementation stage the amount may be at its highest. In order to reduce failure at advanced stages, companies attempt to minimise inappropriate ideas through rejection. While companies attempt to maximise the rejection of potential failures and inappropriate ideas they may also potentially reject some good ideas. Minimising bad ideas can stifle creativity; consequently, companies need to create a balance between the minimising of bad ideas and encouraging creativity.

- Different aspects of this risk management system are more useful in different stages of the innovation project and attempting to apply a standard technique throughout the innovation project could lead to failure. For example, in the creativity stage: simple risk identification at this stage may be useful but more rigorous risk analysis may be inappropriate and could stifle creativity. It seems that the creativity stage is a sensible part of the innovation process. Apparently, a lot of companies (even SSE, see Section 9.1.1) have difficulties in encouraging innovation, therefore tough risk management in the creativity stage might stifle ideas. It needs to implement risk management in a differential manner through the innovation project cycle:
    - **In creativity:** simple risk identification and qualitative analysis.
    - **In selection:** more formal risk management, analysing and prioritising.
    - **In incubation and implementation:** more quantitative forms of risk analysis, risk action plans and monitoring/controlling risk.

11.2.2 Practical implication

Research Question: What are the main types of risk associated with the innovation process and how can we manage them?

- From the innovation process point of view, it seems that all companies follow the same stages. Although, formal meetings may not take place at all decision points when deciding to whether to progress to the next stage. It seems that the type of industry and company will have an effect on the process of innovation and the criteria to be considered in each stage. Therefore, in order to have a systematic process of innovation for integrating risk management the companies should have formal meetings after each stage of innovation. These meetings help companies consider recognised criteria and employ appropriate aspects of the risk management system and make decisions on whether to progress to the next stage, return to previous stage or abandon the process entirely.

- As discussed in Section 10.13, it seems that companies usually omit decision point 2 (D2) when broadly filtering ideas. Since the number of new ideas in these companies is low, it is possible that they do not perceive the importance of this decision point. Companies need to encourage creativity within the company and as argued in Section 11.2.1 they should try to avoid stifling innovation by employing tough risk management in the creativity stage. Therefore, in the situation that the number of new ideas entering the process increases, it is better for companies to use this decision point by allocating appropriate criteria.
- A high percentage of respondents in all Iranian cases mentioned "customer feedback" as one of the most important criteria for their companies in the creativity stage. As discussed in Section 2.6.1, companies employ technology driven product development or attempt to identify customer needs for creative purposes. Both approaches are possible in industrialised countries, but in developing countries technology push is weaker and the customer driven approach appears to be a more common method of stimulating creativity (Chandra and Neelankavil, 2008). However, concentrating too

heavily on “customer feedback” as a source of creativity, in comparison with other sources, may cause companies to be reactive in innovation; while in the competitive market (specifically in the global market, after Iran joins the WTO) companies should consider other sources of creativity, such as technology, in order to be proactive.

- As discussed in Section 10.7.3, it is important for most of the companies to consider the financial viability of a project in the selection stage. Also, based on the discussion in Section 10.9, “resources” (which includes finance, raw material and staff) is the area which can create most risk when compared with other areas. Therefore, it can be said that financial issues are an important factor for most companies when selecting new ideas as they also create risk. Presumably, because of the limitations placed on companies by financial issues, companies are not eager to accept new ideas. On the other hand, as discussed in Section 2.10, Five-Year Economic, Social and Cultural Development Plans (FYDP) indicate that the Iranian government perceived the importance of innovation and attempted to create a situation that would encourage it. Therefore it seems that government, by providing grants for innovative companies, can help them solve financial issues and encourage the pursuit of creativity.
- Usually the implementation stage includes two important duties, pilot and mass production. Pilot production can be classed as risk management tools or sensible risk analysis. Therefore companies, by concentrating more on pilot production and formalising the duties within it can increase the success of their innovation.
- It seems that although most of the companies have a common attitude towards documentation and learning, the necessary formal documentation may be undertaken but it does not really contribute to effective learning, therefore companies do not use

this documentation as a source of new creativity. Learning from past experience does not play an explicit role in the providing of input for future innovation.

- Learning has a low priority in the companies examined. Uncertainty arises from a lack of knowledge (e.g. see: Jackson and Carter, 1992). Many companies fail to exploit potential knowledge from previous innovation projects. Therefore even a simple system of capturing past experience might provide a valuable basis for future risk analysis, e.g. a check-list for analysing the risk based on past experience. The lack of historical data limits the possibility of using many sophisticated forms of risk analysis.
- Managers could relate to the model of the innovation process but were not familiar with the concept of a risk management system. They take action to reduce risk in the sense of solving technical or business problems (such as engineering, financial, marketing) but do not think in terms of systematic risk management.
- As discussed in Section 3.4.1, the approach to risk management is largely dependent upon the attitudes of high level management. In regards to this, interviewees said that some managers are risk averse, thus they choose strategies which are less risky, and therefore might be less innovative. Companies must pay attention to this issue in order to choose appropriate managers.
- Companies either try to respond to all of the possible risks identified or prioritise them using their own experiences in an informal way. In an idealised situation, the company might recognise all unknowns and apply a system to manage them (Cooper, 2003). However in the real world with limited resources, management must select risks which are to be explored in detail and mitigated (Royer, 2000). Even if quantitative risk

analysis is not attempted, more rigorous qualitative analysis to prioritise risk could enhance the management of the innovation project.

- In the second phase of risk management analysis, there are not enough skills and methods for analysing risk factors. The experience of employees (in an informal way) can play an important role in eliciting the probabilities of risk factors. There is an apparent contradiction in basing risk analysis on experience as learning seems to have a low priority. It seems as though risk analysis is dependent upon having the individual experience of the staff. This could be a dangerous approach to risk analysis given the uncertainty involved in having the right people available.

  Perhaps the issue of making best use of an individual's experience is related to size. In a small company staff may talk to one another and everyone is probably aware of others experiences. A medium or large company will have a bigger pool of experience but identifying the correct people may be difficult, and formal mechanisms may be needed to exploit this greater experience.

- Some companies attempt to transfer all risks into financial risk, as they assume that all factors which create risk can have an effect on financial issues in the final stage. In other words, while it may be argued that the ultimate impact of all events (in a commercial company) is financial, the chain of events may be long and difficult to trace. Sometimes it is better for a company to focus on the immediate impact of issues such as product quality or time of production. Therefore, there seems to be a need to have different formal analysis throughout the stages of innovation.

- "Resources", "environment" and "management" are three risk areas which were of most concern when in comparison with other areas during the innovation process (although “marketing” and “technical” areas were also seen as important by some people). While the effects of environmental factors usually come from outside the company, it does not mean that the company cannot manage these types of risk. However it does mean that the company does not have the ability to mitigate the probability of occurrence of all these risks, however the company can mitigate the impact of these factors. For instance, the company can mitigate the impact of government policy or weather.

- By considering the situation of Iran (such as political uncertainty, unclear and often changing rules; see Section 2.10), companies can employ scenario planning for possible future exploration. As discussed in Section 3.5.3, one of the advantages of scenario planning is it identifies critical uncertainties and risks for various levels and types of planning (Drew, 2006).
- One of the risk areas which has the greatest chance of creating risk in Iranian companies is “management”. Interviewees explained different issues in this area as risk factors. It seems that it is necessary for Iranian companies to reconsider their management structure.

  For instance, in case 1 (Bus Co), factors such as co-ordination between different parts of the company, between the company and customers, a lack of harmony between job specification and expectation and a lack of motivation etc. were explained as risk factors in this area.

  In case 2 (Tile Co) the interviewees believed that high-level management did not have sufficient scientific expertise to aid in the decision making process. They stated that if high-level management can assess different ideas based on scientific methods, it will help them choose the most appropriate idea. As discussed in Section 10.3.3, “high level management’s opinions” play an important role in the selection stage for this company. Therefore without scientific expertise, the opinions of high level management can be risky when it comes to selecting new ideas.

In case 3 (Dairy Co), because of the structure of management (a strict hierarchy with strict definitions), the percentage of employees who mentioned the role of “employee’s opinion” was lower in the creativity stage than in synthesis cases. Also, because of this structure the decision process is long; therefore “outside company’s opportunities” do not usually play an important role in this company.

In case 4 (Porcelain Co) some interviewees had detailed information about risk, but this knowledge was not often acknowledged by their companies or management in practice.

In case 5 (SSE) “employee’s opinions” play a significant role in the creativity stage, however interviewees believed that SSE does not fully utilise its employees’ thinking power. However the risk posed by management is perceived to be less than in Iranian synthesis cases. Also, this apparent lack of concern about many issues in SSE may well reflect the more specialised management structure with more clearly defined boundaries of responsibilities. This single case illustrates how management structure in developed countries is significantly different to that found in Iranian companies where managers tend to be more generalist.

11.3 Limitations of the Study

Although efforts have been made to ensure the adequacy of study’s conceptual and methodological contribution, a number of limitations have affected it. These limitations were more or less unavoidable, even though they do not invalidate the findings of the study. On the other hand, some of these limitations can provide practical guidelines for future research.

- The study was restricted by time: ideally more case studies would have been included. In addition, data was collected from four cases in Iran and one case from the UK; therefore the study must be cautious about generalising the results in other contexts. Although these five cases and 40 interviewees took 11 months to transcribe, translate and analyse, using additional cases can help to improve the external validity of the study. Nevertheless, the findings shed some light on how to effectively and efficiently integrate risk management during innovation projects. It would be interesting to examine this issue and broaden research in specific directions in order to increase the generalisability of future research.
- As discussed in Section 4.1, since the vast majority of theories in the field of this research usually come from developed countries, such as the USA and UK, the theoretical model is based upon these countries experiences. Although in practice, empirical observation suggested that these theories are also relevant to Iran; however there is a possibility that the research fails to cover some issues.

11.4 Reflections

In this section, I explore some of my personal experiences and their impact on my research briefly.

- I believe my interview skills developed during the course of the research. During the initial interviews I often found it hard to achieve a balance between allowing interviewees to talk freely and maintaining the structure of interview so that my objectives could be achieved.

- There were times that some detailed reading from the literature proved unnecessary, this is inevitable in any research but indicates that I may not have managed my research time effectively, pursuing same topics that were tangential to my main objectives.
- In any future project I would consider research methodology in parallel to the literature review; the two aspects interact and it is not sensible to regard them as separate, distinct phases of the research project.
- At the beginning of the research project, I had little experience in this style of academic writing; which necessitated considerable revisions during the writing process.

11.5 Future Work

Based on the different ideas that have been noted in this study, some ideas for future research are raised.

- This research used a case study research strategy by utilising a semi-structured interview for acquiring data. As discussed in Section 4.3.3, the number of case studies used in this research was limited to what was available to the researcher at time. In order to overcome this limitation, as examined in Section 11.3, an additional number of case studies can be undertaken.
- As discussed in Section 4.3.1 a questionnaire tends to be used in the next stage of work, in order to quantify data when knowledge of the problem area is greater. Therefore, at some point a questionnaire based approach might be applicable in order

to establish stronger evidence, or for a deeper understanding (if reasonable time is available) participant observation can also be used.

For instance, as discussed in Section 10.13, although some factors which have an effect on the process of innovation were mentioned in various literature, many did not exactly specify the stage these factors will have an effect on. In addition, most of the research was undertaken in developed countries. Therefore the main candidate factors were identified for each stage based on their importance, which was explored using a simple content analysis of interviewee's data. In the next stage this model can be considered in a quantitative approach since understanding is much greater.

- It seems that the refined model which was shown in Figure 10.27 contributes greatly to knowledge; however this study has not tested this refined model, so further testing will be needed in future, for instance by using an action research strategy (working with a company to implement a more formal approach to risk management using the model developed in this research). Consequently, the present contribution should be seen as a basis for further empirical testing and theorising of the relationship and integration between risk management and the innovation project. Potential future researches can be developed based on three stages:
  - First stage is to consolidate the understanding within one country (Iran).
  - Second stage is to develop understanding of the UK and make the comparison between UK and Iran more substantial and reliable.
  - Third stage is to look for other countries to extend the generalisability of the research.

- As discussed in Section 3.9.2 measuring the success of innovation project is out of the scope of this study. Further analysis can consider how companies measure the success of their innovation based on this model in compare with when this model was not applied.
- As argued in the Section 4.3.3, because of the limitations in accessing different companies, it was not possible for this study to consider the topic in companies of the same size within an industry. Therefore, it would be good if the research could consider issues in either the manufacturing or service industry, covering same sized companies within one industry. In addition, this study concentrated more upon incremental product innovation within medium and large companies. Thus it is useful to consider small companies as well as the topic of process innovation and the radical type of innovation.
- In order to find the main candidate criteria for each stage of innovation in Chapter 10, the influence diagram for each stage was developed from the individual case study diagrams. Having developed a greater understanding as a result of this research, I now appreciate that influence diagrams might be used to gain a deeper appreciation of risk in innovation. This deeper understanding could help companies mitigate the probability of risk factors occurring. In addition, a dynamic system approach can be used in order to indicate the relationship between the criteria that should be considered in each stage of innovation and factors which create risk.

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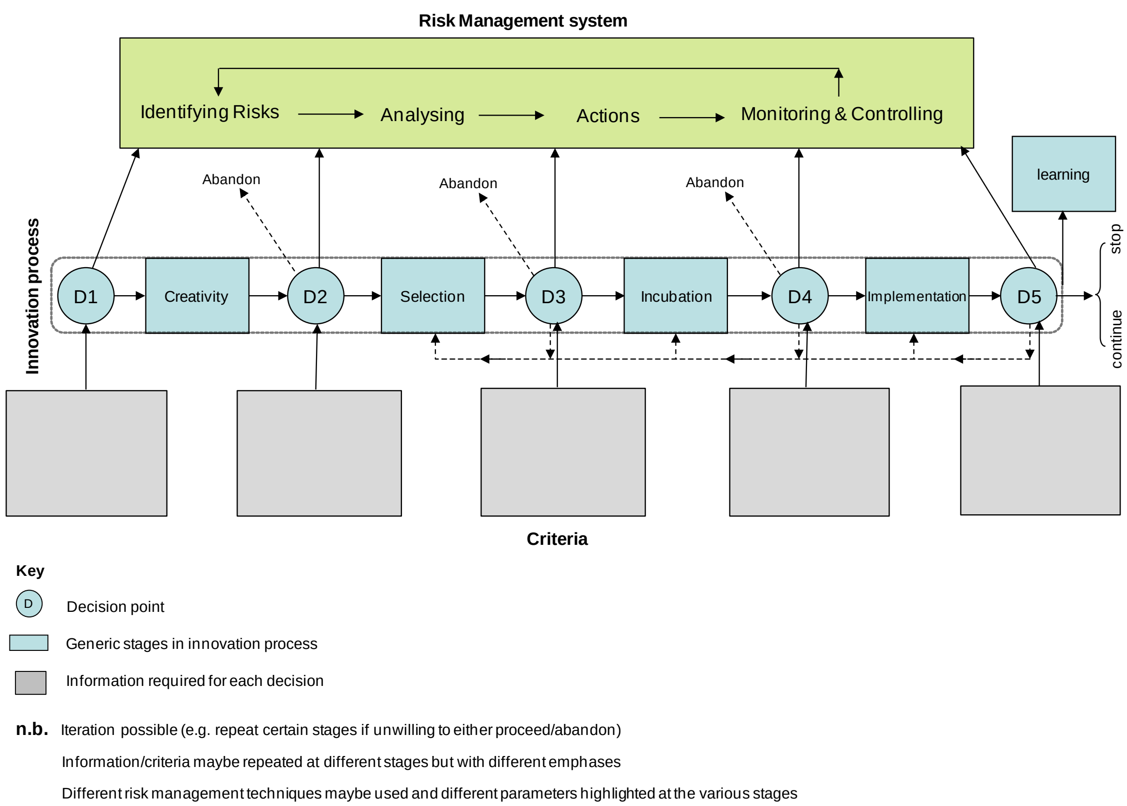
Appendix 1 – English format of interview’s framework

A1.i - English format of what was sent to the participants prior to the interview (for Persian format see Appendix 2). So that participants could be aware of the approach to risk innovation management and questions I hoped to cover.

I hope to have the opportunity to interview a number of staff at your company as part of my PhD research into risk management and the innovation process. I would be most grateful for your assistance, sharing your experience of managing risk and ideas for improving the innovation process. This note provides some background to my study and indicates the topics I would like to discuss. You may not be able to discuss every issue: your particular experience may well be focused on just a few aspects of innovation. Examples of the current use of risk management in the company, and their relation to the innovation process would be very useful.

Snapshot of innovation process and risk management system



Questions:

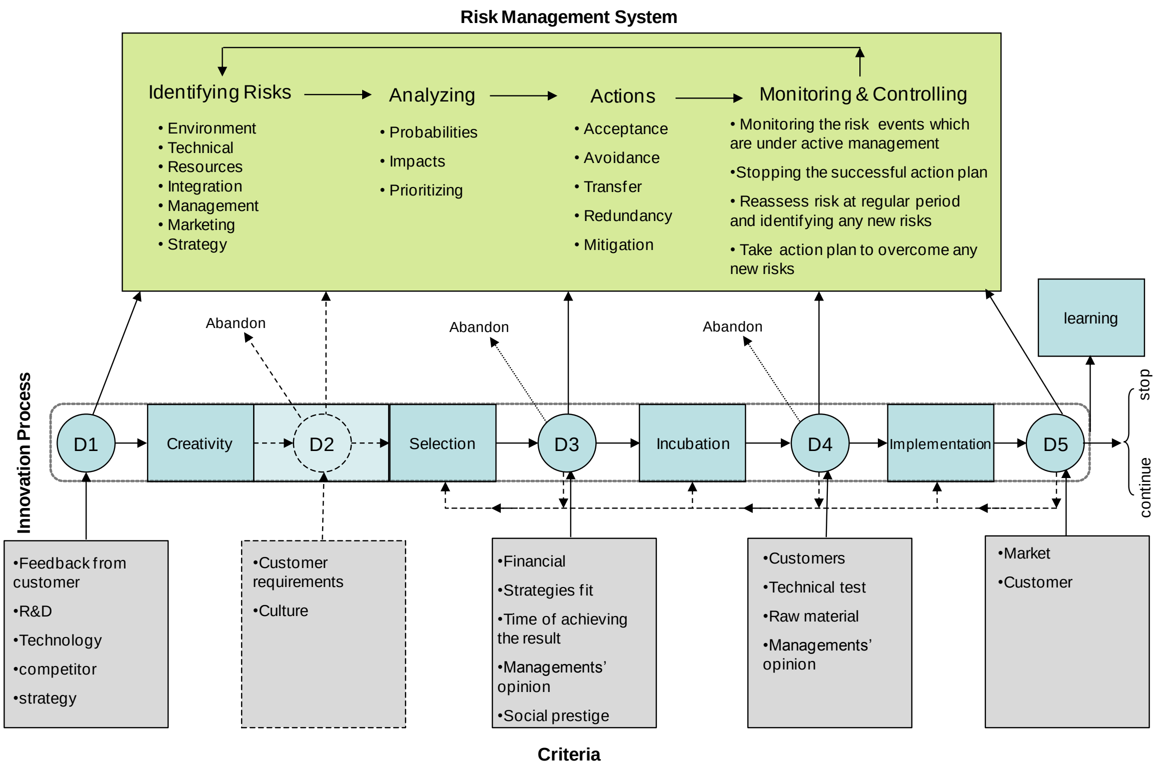
- What is your definition of innovation? Would you please explain some examples?
- Is there a special process (model) for innovation in this organisation? Or does each innovation follow its own process?

- What are the processes of innovation (different steps)?
- What are the key decision points?
- What information is used to make a decision?
- What parameters have an effect on the process?
- How are the innovation projects documented?
- What is your definition of risk and uncertainty?
- What is your definition of a risk management system?
- Is there a formal requirement to include risk analysis in the innovation decision?
- In which steps of the innovation project are risks are considered? (before starting, during the project or after finishing)
- Which departments consider the risk?
- What is the process of considering risk in innovation projects?
- What information and techniques are used to support the consideration of risk in the innovation projects decisions?
- What kinds of risk are considered in different stages of innovation? Is there a common set of priorities used in different innovation projects?
- What approaches are used for identifying risk?
- Is there a list of all parameters which create risk during the innovation process (e.g. a checklist of possible sources of risk)? Does your company maintain a structured checklist reflecting past experience?
- What approaches are used for analysing risk? (Quantitative to Qualitative)
- What approaches are used for prioritising risk?
- What actions are adopted for solving risk?
- Is there a formal risk management system that monitors risks and the effectiveness of actions?
- Is there a mechanism to encourage learning? (e.g. documenting experience for the benefit of future managers)

A1.ii - English format of supporting preparation for the researcher or interviewer

This was the guide that interviewer had in front of him: the interviewee did not have access to the detailed diagram avoiding possible bias. So interviewer could lead the interviewees based on this and back to the structure if they started to talk about irrelevant topics. This enabled the combination of structure and flexibility found in semi-structured interview approaches.

1. Snapshot of innovation process and risk management system:



Key

D Decision point

Generic stages in innovation process

Information required for each decision

n.b. Iteration possible (e.g. repeat certain stages if unwilling to either proceed/abandon)

Information/criteria maybe repeated at different stages but with different emphases

Different risk management techniques maybe used and different parameters highlighted at the various stages

2. Innovation Project

2.1 Definition

<u>*Creativity*</u>

Scanning or searching the environment (external and internal) for, and processing relevant signals about opportunities threats and for change and ideation.

Selection

Selection and Portfolio Management provides an efficient means to select from many ideas generated and choose the best ideas for implementation.

- Includes preliminarily assessment.
- Deciding (on the basis of a strategic view of how the organisation can best develop) which of these signals to respond to.

Incubation

At this stage the transaction to the actual product development and producing the prototype production take place.

Implementation

Translating the potential in the trigger idea into something new and launching it in an internal or external market.

Learning

Enterprises have the opportunity to learn from progressing through this cycle so that they can build their knowledge base and can improve the ways in which the process is managed.

2.2 General questions about the innovation process:

- What is your definition of innovation (e.g.: New product or process which provides a degree of novelty either to the developer, the industrial sector, the nation or the world and success in the market place)? Would you please explain some examples?
- Is there a special process (model) for innovation in this organisation? Or does each innovation follow its own process?
- How are the innovation projects documented?
- What are the processes of innovation (different steps)*?
- What are the key decision points*?
- What information is used to make the decision*?
- What parameters have an effect on the process?

* e.g. see earlier diagram

3. Risk management

3.1 General questions on risk management

- What is your definition of risk and uncertainty?
- What is your definition of a risk management system?
- Is there a formal requirement to include risk analysis in the innovation decision?
- In which steps of innovation project, risks are considered? (before start, during the project or after finishing)
- Which departments consider the risk?
- What is the process of considering risk in innovation projects?
- What information and techniques are used to support the consideration of risk in the innovation projects decisions?

3.2 Risk identification

Definition

Identifies potential events in various areas which could be problematic, such as:

- Environment: government policy, currency rates, weather, intellectual property, society's characteristic (e.g. poverty, crime, culture)
- Technical: new methods and materials, technology constraint
- Resources: staff, raw materials (e.g. supplier, availability), finance
- Management: project management techniques, set the tight goals, co-development, failed assumption, organisation (organisation structure, behaviour, top management's priority and support for the project and culture), multiple parties' experience, product transition management
- Marketing: customer, competitor, market
- Integration: hardware/hardware, hardware/software, software/software (e.g. new & old systems)
- Strategy

Questions:

- ➢ What kinds of risk are considered in different stages of innovation? Is there a common set of priorities used in different innovation projects?
- ➢ What approaches are used for identifying risk?
- ➢ Is there a list of all parameters which create the risk during the innovation process (e.g. a checklist of possible sources of risk)? Does your company maintain a structured checklist reflecting past experience?

3.3 Risk analysing

Definition

Two main functions in this step:

- Estimating probabilities of events and the impact of their consequences
- Prioritising

Different methods for analysing risk from quantitative to qualitative, including:

- Monte Carlo simulation
- Hazard identification methods
- Failure modes and effect analysis (FMEA)
- Fault tree analysis (FTA)
- Event tree analysis (ETA)
- What if' scenarios
- Risk Mapping
- Influence diagram

Questions:

- ➢ What approaches are used for analysing the risk? (Quantitative to Qualitative)
- ➢ What approaches are used for prioritising the risk?

3.4 Risk solving /Action

Definition

Examples of generic actions are:

- Defer action for more information
- Accept risk
- Transfer to a third party
- Redundancy (parallel solution paths)
- Mitigation

Questions:

- ➢ What actions are adopted for solving risk?

3.5 Risk monitoring and learning

Definition

- Monitoring the risk events which are under active management
- Stopping the successful action plan
- Reassess risk at regular period and identifying any new risks
- Take action plan to overcome any new risks

Questions:

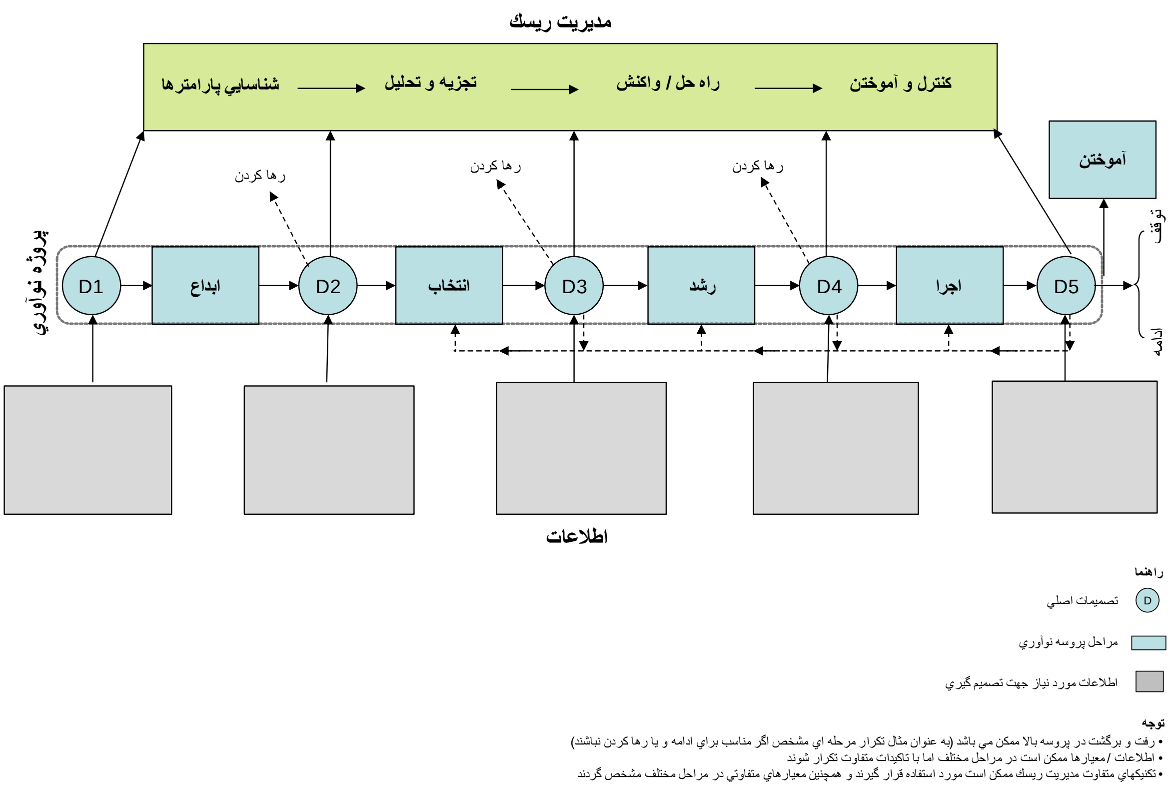
- ➢ Is there a formal risk management system that monitors risks and the effectiveness of actions?
- ➢ Is there a mechanism to encourage learning? (e.g. documenting experience for the benefit of future managers)

Appendix 2 – Persian format of interview's framework

A2.i - Persian format of what was sent to participants prior to the interview

از همكاري شما و همچنين بهره گيري از تجربيات شما در مديريت ريسك و ايده هاي شما براي بهبود پروسه نوآوري كمال تشكر را دارم. ممكن است شما قادر به مشاركت در تمام زمينه ها نباشيد، بلكه تجربيات شما تنها بر قسمتهايي ازنوآوري متمركز شده باشد. لذا مثالهايي از كاربرد هاي موجود مديريت ريسك در شركت شما و ارتباط آن با پروسه هاي نوآوري بسيار سودمند خواهد بود

طرح كلي مديريت ريسك در پروژه هاي نوآوري



سوالات

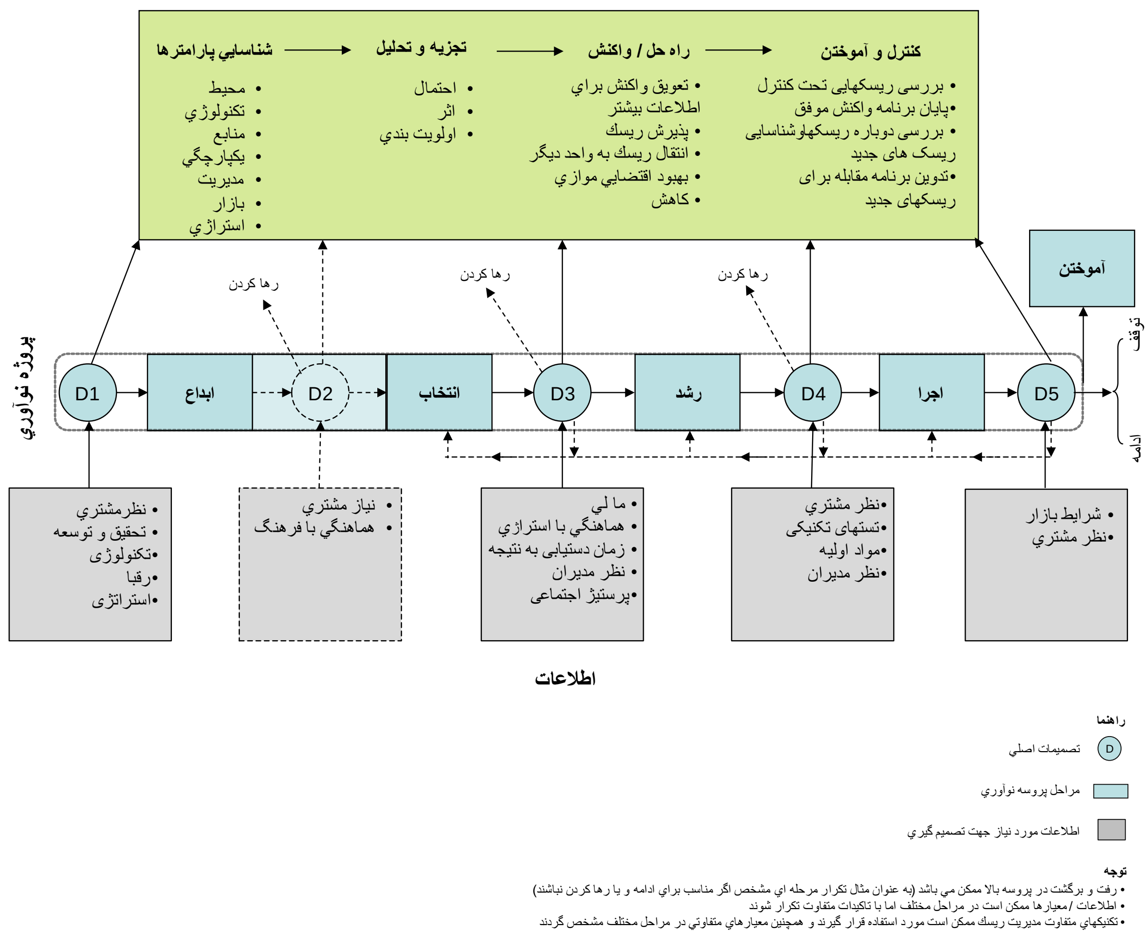
- تعريف شما از نوآوري چيست؟ ممكن است مثالهای بيان فرماييد ؟
- آيا يك پروسه (و يا مدل) ويژه اي براي نوآوري در شركت شما وجود دارد؟ يا هر پروژه ي نوآوري دنبال كننده ي مسير ويژه ي خود مي باشد؟
- چگونه پروژه هاي نوآوري در شركت شما مستند مي شود؟
- مراحل مختلف پروسه ي نوآوري در شركت شما چيست ؟
- نقاط كليدي تصميم گيري در اين پروسه چيست ؟
- چه اطلاعاتي براي تصميم گيري در اين پروسه مورد استفاده قرار ميگيرد؟

- چه عواملي بر روي اين پروسه اثرگذار مي باشند؟
- تعريف شما از ريسك و عدم اطمينان چيست؟
- تعريف شما از يك سيستم مديريت ريسك چيست؟
- آيا يك نياز واقعي و رسمي جهت تجزيه و تحليل ريسك در نوآوري وجود دارد؟
- در چه مرحله اي از پروژه هاي نوآوري ريسك ها بررسي ميگردند؟ (قبل از آغاز، در طول پروژه و يا انتهاي پروژه)
- كدام بخش از شركت مسئول بررسي ريسك مي باشد؟
- پروسه ي بررسي ريسك در پروژه هاي نوآوري در شركت شما چه مي باشد؟
- از چه اطلاعات و تكنيك هايي جهت بررسي ريسك در پروسه هاي نوآوري استفاده مي گردد؟
- كدام نوع ريسك در مراحل مختلف نوآوري برسسي مي گردد؟ آيا يك مجموعه متداولي از الويت ها در پروژه هاي مختلف نوآري استفاده مي گردد؟
- چه روشهايي جهت شناسايي ريسك در مراحل مختلف نوآوري استفاده مي گردد؟
- آيا ليستي از همه پارامترها يي كه در طول پروژه نوآوري ايجاد ريسك مي كنند جود دارد (به عنوان نمونه چك ليستي از منابع ممكن ريسك)؟ آيا شركت شما چك ليستي كه منعكس كننده تجربيات گذشته باشد را نگهداري مي كند؟
- چه روشهايي جهت تجزيه و تحليل ريسك به كار مي بريد؟ (از كمي تا كيفي)
- جه روشهايي جهت الويت بندي ريسك ها يه كار مي بريد؟
- جه روش هايي را جهت حل ريسك به كار مي بريد؟
- آيا يك سيستم رسمي مديريت ريسك جهت كنترل ريسك ها و موثر بودن راه حل ها وجود دارد؟
- آيا مكانيزمي جهت تشويق يادگيري وجود دارد؟ (به عنوان نمونه مستند كردن تجربيات جهت بهره گيري مديران آينده)

A2.ii - Persian format of supporting preparation for the researcher or interviewer

مديريت ريسك در پروژه هاي نوآوري

1- طرح كلي



2- پروژه نوآوري

2-1 تعريف

<u>ابداع</u>

بررسي و جستجوي محيط (خارجي و داخلي) و همچنين پردازش سيگنال هاي مرتبط درباره فرصتها و تهديدها جهت تغير و ابداع.

<u>انتخاب</u>

انتخاب و مديريت پرتفوليو، ابزاري مناسب جهت انتخاب از ميان تعداد زيادي ايده توليد شده و برگزيدن بهترين ايده جهت اجرا، ارايه مي نمايد.

- شامل ارزيابي اوليه

- تصميم گيري در مورد اينكه به كداميك از اين سيگنال ها پاسخ دهد (بر اساس نگاه استراتژيكي كه چگونه يك سازمان مي تواند بهتر بهبود يابد)

رشد
در اين مرحله حركت به سمت بهبود محصول واقعي و توليد محصول نمونه قرار مي گيرد.

اجرا
تبديل پتانسيل در ايده آماده به محصولي جديد و ارايه آن به بازارهاي داخلي و خارجي.

آموختن
شركتها داراي فرصت آموختن از پروسه هاي جاري مي باشند. بنابراين آنها مي توانند دانش خود را بر اين اساس ساخته و مسيري كه در آن پروسه مديريت مي شود را بهبود دهند.

2-2 سوالات كلي در مورد نوآوري

- تعريف شما از نوآوري چيست(به عنوان مثال محصول و يا پروسه جديد كه بيان كننده درجه اي از جديد بودن براي شركت، صنعت، كشور و يا جهان بوده و در بازار موفق بوده است.) ؟ ممکن است مثالهای بيان فرماييد ؟
- آيا يك پروسه (و يا مدل) ويژه اي براي نوآوري در شركت شما وجود دارد؟ يا هر پروژه ي نوآوري دنبال كننده ي مسير ويژه ي خود مي باشد؟
- چگونه پروژه هاي نوآوري در شركت شما مستند مي شود؟
- مراحل مختلف پروسه ي نوآوري در شركت شما چيست *؟
- نقاط كليدي تصميم گيري در اين پروسه چيست *؟
- چه اطلاعاتي براي تصميم گيري در اين پروسه مورد استفاده قرار ميگيرد*؟
- چه عواملي بر روي اين پروسه اثرگذار مي باشند؟

* به عنوان مثال به نمودار صفحه ي اول رجوع شود.

3. مديريت ريسك

3-1 سوالات كلي درمورد مديريت ريسك

- تعريف شما از ريسك و عدم اطمينان چيست؟
- تعريف شما از يك سيستم مديريت ريسك چيست؟
- آيا يك نياز واقعي و رسمي جهت تجزيه و تحليل ريسك در نوآوري وجود دارد؟
- در چه مرحله اي از پروژه هاي نوآوري ريسك ها بررسي ميگردند؟ (قبل از آغاز، در طول پروژه و يا انتهاي پروژه)
- كدام بخش از شركت مسئول بررسي ريسك مي باشد؟
- پروسه ي بررسي ريسك در پروژه هاي نوآوري در شركت شما چه مي باشد؟
- از چه اطلاعات و تكنيك هايي جهت بررسي ريسك در پروسه هاي نوآوري استفاده مي گردد؟

3-2 شناسايي ريسك

تعريف
شناسایی رخدادهای بلقوه در نواحی مختلف که میتواند ایجاد ریسک کند، مانند:

- محيط : سياست دولت، نرخ ارز، در دسترس بوذن كارگران ماهر، آب و هوا، حق مالكيت معنوي، ويژگيهای جامعه (مانند: فرهنگ، فقر، جرم)
- تكنيكي : روشها و مواد جديد، ت محدوديت كنولوژي

- منابع: كارمندان، مواد اوليه (مانند: ارائه كننده، در دسترس بودن)، مالي
- يكپارچگي : سخت افزار /سخت افزار، سخت افزار /نرم افزار، نرم افزار /نرم افزار (مانند: سيستم هاي قديم و جديد، نرم افزاري)
- مديريت : تجربيات قسمت هاي مختلف، استفاده از متد هاي مديريت پروژه، تعين اهداف سخت، مديريت انتقال محصول، سازمان (ساختار سازماني، رفتاراولويت مديريت عالی و ساپورت پروژه و فرهنگ)، همكاری، پيش بينی غير دقيق
- بازار : مشتري، خريدار، بازار
- استراژي

سوالات

- كدام نوع ريسك در مراحل مختلف نوآوري برسسي مي گردد؟ آيا يك مجموعه متداولي از الويت ها در پروژه هاي مختلف نوآري استفاده مي گردد؟
- چه روشهايي جهت شناسايي ريسك در مراحل مختلف نوآوري استفاده مي گردد؟
- آيا ليستي از همه پارامترها يي كه در طول پروژه نوآوري ايجاد ريسك مي كنند جود دارد (به عنوان نمونه چك ليستي از منابع ممكن ريسك)؟ آيا شركت شما چك ليستي كه منعكس كننده تجربيات گذشته باشد را نگهداري مي كند؟

3 -3 تجزيه و تحليل ريسك

تعريف

دو وظيفه اصلي در اين مرحله عبارتند از

- پيش بيني احتمال رويدادها و اثر حاصل از آنها
- اولويت بندي

گرودهي از روش هاي متفاوت براي تجزيه و تحليل ريسك (از كمي تا كيفي) عبارتند از:

- شبيه سازي منتو كارلو (Monte Carlo simulation)
- روشهاي شناسايي خطر (Hazard identification methods)
- تجزيه و تحليل اثر و نقاط خطا (Failure modes and effect analysis, FMEA)
- تجزيه و تحليل درخت خطا (Fault tree analysis, FTA)
- تجزيه و تحليل درخت رويداد (Event tree analysis, ETA)
- سناريو ("What if" scenarios)
- مسير ريسك (Risk Mapping)
- نمودار اثرات (Influence diagram)

سوالات

- چه روشهايي جهت تجزيه و تحليل ريسك به كار مي بريد؟ (از كمي تا كيفي)
- جه روشهايي جهت الويت بندي ريسك ها يه كار مي بريد؟

4 -3 يافتن راه حل و واكنش

تعريف

نمونه اي از راه حل ها:

- تعويق واكنش جهت دست يابي به اطلاعات بيشتر
- پذيرش ريسك

- انتقال به قسمت دیگر
- راههای موازی
- کاهش

سوالات

- جه روش هايي را جهت حل ريسك به كار مي بريد؟

5- 3 كنترل ريسك و آموختن

تعریف

- بررسی ریسکهایی تحت کنترل
- پایان برنامه واکنش موفق
- بررسی دوباره ریسکهاوشناسایی ریسک های جدی
- تدوین برنامه مقابله برای ریسکهای جدید

سوالات

- آيا يك سيستم رسمي مديريت ريسك جهت كنترل ريسك ها و موثر بودن راه حل ها وجود دارد؟
- آيا مكانيزمي جهت تشويق يادگيري وجود دارد؟ (به عنوان نمونه مستند كردن تجربيات جهت بهره گيري مديران آينده)

Appendix 3 – Summaries of interviews

Materials of each interview and additional notes of five companies are mentioned in this appendix in separate sections for each case. Number of meeting (nom) indicates the different interviewees in each case. Also abbreviation of the role of each interviewee is shown in the bracket for each of them. These are the raw materials gathered from interviews after transcribing and translating. These materials were categorised based on innovation, risk and general issues before being analysed.

Case 1: Shahab Khodro (SK)

Number of meeting: 1.1 (25.08.2008)
Quality Assurance Manager (QA)

1. Customers and sale have role in two side of the process. Also company considers the market in last stage.
2. Based on the kind of the company in producing heavy cars (i.e. bus) we have specific customers. For example one of my big customers is Ministry of Interior.
3. Creativity and selection are in the same location. Because some times there are not any different kind of ideas. In other words, we do not have any different choice because most of the times our ideas are based on customers' need.
4. For getting the customers' opinion, company uses the questionnaire.
5. In a large company, coordination between different parts is difficult.
6. The company considers the feasibility of customers' request in two attributes: financial, technical.
7. After considering the feasibility, if the contract is being made, the request goes to the implementation (production) stage.
8. Shahab Khodro has at least six competitors (like: Iran Khodro Diesel, Eagle and etc.).
9. For getting the employees' proposal, there is a system in the company.
10. For getting the ISO the company creates two mechanisms. In these mechanisms the company uses employees' idea for correction of current problem and activity to prevent some potential problems.
11. The company uses the result of two mentioned mechanism for getting the ISO and employees' experience for continuing improvement mechanism. Now the company wants to create the new and better mechanism (software system) for getting the proposal of employees and customer which includes the continuing improvement mechanism and the last mechanism (9) for getting the proposal.
12. There is some creativity in the company but the variety is not very big. Because there are big and specific customers in this industry.
13. Pilot product is like the implementation stage but in a smaller size. In this stage company produces 10-15 products for checking the system. Some time this size of production is enough for customer and the company does not go to the mass production (3-7 products in days).
14. Before the pilot production, there is another stage for producing the prototype. In this stage the company only produces one or two. So it can be said that this stage is like the incubation stage. This product is shown to customer in order to receive their comments.
15. In pilot production, the company wants to check the problem of the mass production, such as: is there enough space in the production line, necessary changes of the production line. In other words, this stage is a simulation of mass production.

16. Availability of raw material and cost of them plays an important role in prototype stage and in later stages.
17. Technical feasibility is one of the important criteria which should be considered in selection stage.
18. One of the important problems is to coordinate between company and customers.
19. The share of market is specific in this industry.
20. Prototype < Pilot Production < Mass Production
21. product line has two needs: 1-production plan, 2- instrument (these instruments are either from Iran or outside)
22. Each project (product) has its own notebook. In this notebook the process of this product should be written. For getting ISO, having these notebooks are necessary.
23. Learning is one of the strategic purposes for this company. Also learning based on the job's need is compulsory for each responsibility and affect on their promotion.
24. there are three different terms of planning in this company: 1-long term (5 year), 2-middle term (1 to 3 year), 3- short term (3 month to 1 year)
25. There is a team in selection from different divisions for considering the situation.
26. There is some control in mass production stage. For instance control based on ISO. In this control, quality assurance and production division control the product for finding any problem which occurs. In another control system, the company uses the employee's proposal for prevention of some potential problems.
27. In mass stage we have continuous improvement. It means different part of product, supplier and etc. will be checked in this stage.
28. Before mass stage there are some checklists for considering the product. It can be said that there is an iterative way between this stage and previous stage for improving the product before going to mass production.
29. Strategy has an affect on selection stage. For instance producing the articulated bus is one of the strategic purposes of company.
30. This company has knowledge about FMEA but it does not use it yet completely. ISO/TS is compulsory for companies which produce the parts of automotive.

Number of meeting: **1.2** (25.08.2008)
Design Manager (Design)

1. It is better to consider the risk at all stages of innovation project.
2. It is necessary to use the feedback between the different stages of innovation process.
3. There are different inputs which create the creativity in this company (it means which parameters affect on creativity in D1): 1-customer feedback, 2- proposal system, 3- mother company (Renault Company), 4- strategy (like using the gas tank for bus), 5- continuing improvement mechanism.
4. In D1 the company should consider the risk in Iran, because of the situation of Iran.
5. There is a form in this company which includes the first information of plan that company wants to follow. It means after the selection stage the company uses this form which includes the first information.
6. There are different criteria which has an affect on selection stage. There are: customer's need, technical experience of employees, primary technical and economical assessment, and ability of doing it with considering the cost of this project.
7. Incubation stage means producing the prototype model.
8. For some inside projects which have a small scale, usually the risk is not considered because the cost is not high in comparing with the risk management.

9. The final cost will be assessed after the prototype production, and after this stage the company makes the decision whether it can go to the mass production stage or not.
10. Risk management in D3 and D4, especially in D4 has very important role for each company. So in these decision points the risk should be considered carefully.
11. After producing the prototype, the company should consider the opinion of customers about this product.
12. Prototype product needs some standards. It means some complete tests for approving the kind of product should be done in this stage. Also the specific number will be given to this product. These activities are necessary for big projects.
13. In incubation stage (producing the prototype), the process is completely documented. The documentation starts before this stage but completes in this stage. In other words, from D3 to D4 documentation is being done, in parallel the prototype is being produced.
14. Documentation includes different activities which are: plan of product, method of producing and list of different parts.
15. For getting the standard, the company needs this documentation.
16. Prototype and documentation are done in the product design division.
17. Industrial engineering division and manufacture engineering division are doing the activities of implementation stage. For doing this job they are using the product design division's opinion.
18. Opinion of industrial engineering division and manufacture engineering division help to find the technical assessment and final cost. For instance the industrial engineering division is doing the Bill of Material (BOM) for all row material and calculates the final cost.
19. The main activity for manufacture engineering division is to translate the design plan for production.
20. The instruments should be produced and provided beside the manufacture engineering division activity.
21. Design engineering → Industrial engineering (Specify the layout) → Manufacture engineering (Fix the instruments, it means where and how the product should be produced, and control plan)
22. The final instruction for production is prepared by manufacture engineers.
23. Quality assurance, planning and supply the different parts, and commercial division use the opinion of design engineering division till the product go to the implementation stage.
24. Some times the high level management opinion causes the change into the priority of different stages of innovation project.
25. Expectation and task explanation do not have harmony with each other, so this is one of the barriers of scientific implementation of innovation process.
26. Engineering organization in this company includes the different divisions like: design engineering, manufacture engineering, industrial engineering, documentation and projects.
27. One kind of input of new process is the documentations of previous process.

Number of meeting: 1.3 (25.08.2008)
Production, Planning, and Control Manager (Prod.)

1. The main activities of this division are controlling and planning. This division plays a role as connector between engineering organization, production, marketing and logistic.
2. This division is like the centre of the company. This division orders the raw materials, receive them, give them to production division and after that receive the final product.
3. The car industry is covering very big range of area. Especially in comparing with light car industry, the heavy car industry covers the bigger range of area.
4. The role of government in heavy car industry is stronger than light car industry. In other words, government's decisions have direct affect on this company (heavy car industry), because the government is the biggest customer and helping the other customer in this industry by giving them loans. But in light car industry the government plays a role as a producer because the government has a share in some car manufacturing company.
5. Also the role of people is different in heavy and light car industry. In this industry, the role of people is higher than the light car industry.
6. There are two kinds of planning: 1- general planning which includes the strategic planning for car industry and usually their time vision is for 5, 10 or 20 years, 2- specific planning which includes: planning, producing and controlling. In this division the second planning is being done.
7. There are some factors that should be considered as parameters which create the risk:
    - Obligation plan of sale division
    - To satisfied the needs
    - Raw material, Staff, equipment, machines, required space
    - Technical ability, technical documentation and procedures
    - Affect of environment on planning
8. These parameters are necessary and should be considered. It means there is not any priority between them but the probability and degree of their threat are different. One of the reasons is that in Iran the situations are not constant and stable.
9. For finding the probabilities, managers usually use their experience. It does not seem there is specific formula for calculating the probability of different parameters which create the risk.
10. It can be said that there are two kinds of parameters which create the risk: Internal and External. Company can identify the probability of event and the required action for some internal parameters but for external parameters it is difficult to do so. For instance there are a lot of documentations about the internal parameters which create the risk like machineries, and coefficient of solidity. Also there are some methods for solving these events but external parameters usually are out off control.
11. For solving the internal parameters which create the risk, the company uses the contingency method. For instance suppliers are changed during specific period or two suppliers are used, or the machines are being checked in regular time basis.
12. The company saves the previous documentation for learning. Also each of the divisions learns by them selves.
13. One of the important barriers to doing the innovation is cost. In other words, the high managements should accept that for being innovative they should spend money.
14. Some activities help the company to be more creative. For instance research, development, competitors' products (domestic and international) and so on. Also some times we have modification in creativity stage not completely new product. In selection stage, company starts the documentation, in incubation stage, company produces the prototype and in implementation stage, company goes to mass production.
15. This model needs a feedback from last stage (learning) to first stage (creativity).

16. This division sends the different feedback to other divisions of company for doing some correction. For instance sending the feedback to engineering division about the safety, or sending the feedback to sale centre about the kind of supply the products and current situation of inventory, send the feedback to production division, marketing division, logistic division and also administrative division about the satisfaction of employees.
17. As mentioned before, this division likes the centre of the company, so it receives different things from different divisions and also sends the feedback to them about their activities.
18. There are two kind of customer in this industry: 1- general, 2-particular. The company has meeting with their customers for getting their opinion and feedback about products.
19. Also the sale division gets the feedback from the market by using the specific program, the name of which is 'voice of customers'.
20. There is a system in the company for getting the opinion of employees for continuous improvement, but this system wants to combine with other system (proposal system) for being better and find the ability to provide encouragement.

Number of meeting: 1.4 (26.08.2008)
Production Manager (Prod.)

1. There are some problems in the organizational structure of company. It means this problem is one of the barriers of innovation.
2. Employees do not have strong motivation for doing innovation.
3. One of the important criteria in selection stage is the implementation capability of new project.
4. There are two kinds of innovation in this company: 1- completely new project, 2- improvement.
5. For doing the completely new project, the final decision is made by high level manager.
6. There is a committee which includes customers and representative of company for getting the customer's opinion and explaining the problem.
7. One of the problems in relation with customers is lack of the common language between company and customers.
8. After approving the prototype we can go to the implementation stage.
9. There are two kinds of problems in implementation stage: 1- the product has problem in the design stage, 2- the product is fine but there is a problem in producing.
10. Usually there is some contradiction between engineering which related to prototype stage and implementation stage.
11. This person has responsibility after incubation stage.
12. If there is small change in new product, the amount of risk is not important for considering.
13. Before going to implementation stage, the company should be considered that are any new investigations needed in instruments and machinery for producing the new product by considering the equipments of company. These parameters also should be considered in selection satge as well.
14. One of the parameters which create the risk in implementation stage is the new technology.
15. There is not any specific method for calculating the probability of different kind of risk in this company.
16. There is some mechanism in this stage for controlling the process like controlling the method for fixing the new machinery instruments.
17. The project manager only has the responsibility until the implementation stage.

Number of meeting: 1.5 (26.08.2008)
Project Manager (Proj.)

1. The main responsibility of this division is to set the time of each activity (simultaneously or consequence) for each project also identifies the resources which are needed for this project like: number of employees, number of experts and how many hours.
2. The whole of project should be considered for setting the time of each activity.
3. In D1 three parameters have on affect on creativity: competitors, predict the new technology and customer feedback.
4. Contact with customer is very important. For instance we have a contact with one of our biggest and most important customer (ministry of interior) every two weeks.
5. Continuous development is an activity which is done every time in company.
6. The very new product needs the approving of high management level. The different parts which are needed for this product are usually provided from inside the company.
7. The company has an ability to improve the different parts of product not to provide the completely new product.
8. Assessing the technical and economical feasibility is very important for each new product.
9. For each product the final cost should be found before starting the project.
10. Two models which company uses for doing the action against the risk are: transferring the risk to other parties and parallel contingency development.
11. In feasibility study all parameters should be considered and after that the final decision should be made. For instance for producing the truck, after considering the situation, we found there is not any capability for competing with other competitors.
12. Attitude of high level management about the innovation can have a role as a barrier or incentive.
13. This division reviews a whole of project based on the project map.
14. Social prestige, quality of product, flexibility in front of the market and technical ability are the parameters which should be considered for selecting the product (D3).
15. For going to implementation stage the company should consider the environmental limitation (since sometimes the effect of production line on environment cause to harm it, some rules prohibit this activities), interests of customer, time of providing the product and ability for after sale services.
16. In D5 the company should measure the result and compare them with goals, also should analyze the deviation and provide the correction comments.
17. Decreasing the damage, increasing the productivity and improving the quality are the parameters which cause that company goes to creativity.
18. Culture of company is not proper for doing the creativity.

Number of meeting: 1.6 (26.08.2008)
Industrial Engineering Manager (Indus.)

1. There are two kinds of license for research which are Private and governmental. There is not any restriction for private research but for governmental license, the company should pay al least 5% of revenue to this activity.
2. The use of Gas as a fuel for bus is one of the innovation projects in this company. In this project diesel changes to gas.
3. There is a written format in this company for doing the routine design activities. The name of this process is Takvin (creativity).
4. This company is one of the innovative companies in Iran in this industry.

5. Some of the most important risks in this industry are: Political, Economical and Social.
6. One of the parameters which has an affect on creativity stage is the customer's needs.
7. The amount of risk is related to the variation of products. If there are the different kinds of products in the company the threat will be decreased
8. There is a difference between economical problem and financial problem.
9. Small number of products causes to have a small turnover.
10. The company should produce the different kinds of products and provide them during the short period of time.
11. Three kinds of different bus which are produced in this company are: 12 meter length, 9 meter length, 18 meter length. All these bus are producing in short and long chassis.
12. Producing the different product should be based on internal and external needs.
13. For making the new products, considering the high level manager is needed. In other words in some projects management decides if they should do this project or not (?).
14. There is not any written method in the company for managing the risk. But each division considers the risk individually.
15. For going to new product, the company should do the feasibility study and answer to this question: is it possible for company to go to the new project by considering the financial, technical and engineering issues?
16. The proposal comments system wants to gather the new idea from inside the company and also the comments which is coming form outside the company.
17. The company wants to create the formal system for encouraging the employees which explain their new idea.
18. Company considers the idea from outside of the company, but it can not develop it very good.
19. Unfortunately political threats are penetrated into the scientific structure and can be considered as one of the parameters which create the risk.
20. Characters of each industry have an important role on innovation project and risk management. So familiarity with situation of industries in general and also each industry in particular is very important.

Number of meeting: 1.7 (26.08.2008)
Business Manager (Busi.), Vice President

1. Company during the recent year could increase the market share from 20% to 25%.
2. One of the goals in this division is to increase the market share and penetrate to other similar markets.
3. There are two mechanisms for marketing in this company: 1- creating the connection with big customers and using the lobby for selling the products, 2- Helping the customers for buying these products, because the individual customers need the huge fund for purchasing and company should provide some parts of this fund with different approaches like leasing.
4. For getting the opinion of customers and also people which use these products, the company used the questionnaire and collected the answer from different places like bus station.
5. Beside the market studying the company should consider the different mechanisms for selling, because these mechanisms have important role in marketing.
6. There are formal systems for getting the feedback from customers also getting their idea and needs in company, but company does not use these systems and their result completely.

7. In practice, there are some barriers which cause the company not to follow these stages precisely.
8. One of the most important barriers of making the long term plan is unstable and changeable environmental situations.
9. there are six competitors for this company:1- Oghab, 2-Zamiad, 3- Pishro Yadak, 4- Ana Kaveh, 5- Kerman Khodro, 6- Zarin Khodro
10. For predicting the future, we can consider the pioneer market in other products in other countries and use their experiences in similar situation. Amount of per capital income has an effect on kind of customer consumption. For instance the previous model of in city bus did not have the air condition but now the need of customer has changed and they agree to pay more money for this facility. For predicting the future customers' need, we must consider the other countries which are one step more developed than us.

Number of meeting: 1.8 (27.08.2008)
Quality Assurance and Organizational Manager (QA)

1. Usually companies consider the risk based on prediction, suspicious and last trend.
2. Probability and impact are two important parameters that should be considered in managing the risk.
3. Improvement normally more than new product in Iran. It can be said that both of them are exist in this company.
4. The company should consider the risk in all stages, because the risk is a continuous issue.
5. There are some criteria for selecting in selection stage. Also in this stage the company considers the different kinds of risk.
6. The rules in Iran are not fixed and they change most of the time, so these changeable rules can have an important role in creating the risk.
7. The situation of Iran (non stable) causes to increase the ability of managers to recognizing the parameters which create the risk.
8. Most of the Iranian companies follow these stages for innovation but in an informal manner and maybe there are not enough formal and good documentation for their activities.
9. The research for doing the creativity has a lot of risk.
10. Some time the product goes to implementation stage (by approving the criteria in incubation stage) but it will face a lot of risk in this stage. It means that the prototype may not have any problems but in mass production some problems and new risk will occur.
11. There are a lot of rules which restrict the economical goal and decrease the competition. So usually there is not enough competition between different companies for producing the different kinds of products.
12. At present this company has 950 employees.

Number of meeting: 1.9 (27.08.2008)
Manager of Finance (Fina.), Vice President

1. This company is almost old.
2. The economy in Iran is monopoly, so there is not any need for considering the risk in every place.
3. The inflation is the important parameter which cerate the risk and should be considered in innovation project.

4. With considering this issue that there is not enough strong competition in Iran, so risk is not considered in every place.
5. The company is doing the feasibility study for new projects. During this study different aspects of project are considered.
6. There are some new projects in this company. For instance producing the articulated bus.
7. The company used to produce only one kind of product for one especial customer (bus for ministry of interior) but now is producing the different kinds of product for different customers.
8. The risk of producing the one kind of product is higher than producing the several kinds of product. It means that threats in producing one product are more than other situations.
9. One of the parameters which create the risk is the political issues. For instance 85% of row materials are imported from abroad but during the sanction we should try to find our needs from internal resources.
10. Due to lack of the fund for buying the whole of the row material, the company buys some parts of their needs. So it can be said that the fund is one of the parameters which crate the risk.
11. There are three sources for finding the fund: customers, stakeholders and loan from banks.
12. Some times one contract can have a negative affect on other contract. It means the political issues can play a negative role in making the contract (for instance for bus with left door).
13. The company should use the different opportunity for finding more benefits. For instance, lack of the diesel and increases the price of it, can be a good situation for going to provide the new engine for replacing the fuel. For finding the opportunity and threat (risk) company uses the SWOT analysis.
14. If the company increases the benefit from different products, so in this situation if it faces with the problem in one product it can still be saved in a safe situation.

Number of meeting: 1.10 (27.08.2008)
Industrial Engineering Manager (Indus.)

1. There are some activities which should be done in this division like: time measurement, setting the layout, assessing the final price and balancing the production line. Most of these activities are done in incubation and implementation stage.
2. For controlling the process in implementation stage, the company uses the OPC (operation process chart) method. This method helps the company to find the existing problems and provide the correction for them.
3. There are some process innovations in the company. For instance about the position and arrangement of driving forces and colour in the line for increasing the yield.
4. Also different kinds of ISO or EFQM (European fundamental quality management) model which they apply here can be viewed as some process innovation.
5. The different stages of innovation process are like the PDCA (plan, do, check, act) cycle in some parts. The company tries to apply this cycle for doing their activities in different situations.
6. If we can say the creativity is thinking about everything, so this kind of creativity is applied in every activities of company.
7. There is the mechanism in company for getting the proposal of employees for improving or correcting the existing activities, but this system wants to be improved and matched with other systems.
8. I think there is not any scientific method for assessing the marketing in the company. The managers use their experience for doing this job.

9. For assessing the time of activities, the company uses the parameters which have an effect on the process. It means that the parameters which have an affect should be recognized for time assessing.
10. For assessing the capacity of machines and number of employees which are needed, we should use the probability.

Case 2: Firooze Tile (FT)

Number of meeting: 2.1 (30.09.2008)
Technical Manager (Tech.)

1. The most important task of this division is repairing the machineries.
2. One of the factors which lead to innovation is financial pressure (e.g. we should designs the more endurable moulds, it means that the materials and making method should be somehow that leads to stronger moulds with longer life cycle). Another factor is the situation of Iran which affects on the process of 'order and receive' and increases the time and expenses. Thus, by considering this situation, the company should rely on internal abilities for increasing the life cycle of products and instruments and decrease the damage.
3. Tile companies try to keep their new special designs secret and enter the market powerfully and saturate the market with their new product. With this situation, the competitors are not likely to imitate this special design so the worry of appearance of competitors decreases.
4. In order to get the customers' opinion and design new products based on their opinion, a committee within the company by the name of 'design group' gathers the customers' opinion.
5. Some of the special designs (e.g. embossed designs) need special moulds.
6. Usually the opinion of high level management affects the selection stage.
7. Usually 90% of designs are created by the design group and 10% are imported from other countries.
8. This division will report the final decision about the technical ability of the company for new product. And if there is a need for any alterations, this division should mention the cost of them (e.g. for producing the tiles with the size bigger than 40×40 cm^2 the company should buy some new instruments).
9. In order to buy new instruments and parts, this division will give its opinion about the circumstance of these three parameters: price, quality and technology (e.g. fluid for heat transformer). If the instruments has a direct affect on the quality of product, price can be less important for the sake of better quality. After considering these three parameters it is probable to cancel buying new instrument.
10. After designing the first version of mould, 50 samples are produced by this mould and laboratories undertakes some tests and report any problems (e.g.: technical problems: like fractures) in order to do any needed alterations and be prepared for mass production.
11. After producing the prototype, they are sent to sell representatives in order to connect with customers and get their feedback.
12. Production plan is decided monthly and after considering the feedback of the first sell, if the market needs more, production plan will be reconsidered.
13. Usually laboratory provides a new design every month. Each design will be eliminated after a number of production and give its place to a new design.
14. Customers' opinion is various because of the different tastes and different cultures of different regions. This will affect the selection of a new design and the continuation of that design.
15. Technology affects on selecting, continuing or eliminating a design.
16. All of the technical reports and information are archived and usually this information is used in future in order to improve.
17. The goal of risk management should be decreasing the probability and impact of the risk and this process of risk management should be applied in all stages. In this company usually in order to calculate the probability and impact of risk, the experience of managers and archived information are used.

18. Technology, new method and raw material (sometimes the quality of materials is different from each other or supplying them is difficult) are parameters which create the risk in innovation project.
19. One of the ways in order to decrease the market risk is to produce the product in different amounts before going to the mass production.
20. Two of the important barriers of innovation are: financial issues and technology, although high level management usually support new ideas financially and tries to reduce the risk.

Number of meeting: 2.2 (30.09.2008)
Production Manager (Prod.)

1. There are 3 sources for innovation which are: 1: customer's needs which are reported through marketing division, 2: employees' opinion, 3: the problems within the company which in order to be solved pushes the company through the innovation path.
2. This division focuses on continuous improvement (incremental innovation) and also tries to find the problems within the company. This division is less encountered with new process.
3. Because of the fact that customers' opinion is basically conveyed through the high level management, thus customers' opinion is a must to be acted upon.
4. The opinions and feedbacks of customers are sometimes along with the continuous improvements (incremental innovation).
5. Sometimes the competitors create new things which are not an urgent need of customers yet. But they work on the culture of customers to make them change their needs into new products (for instance opaque designs). Thus we need to be aware of this issue and try not to be left behind in this procedure.
6. One of the sources of innovation is the information received from the high level management, which is gained from new existing things in the internal markets or of those from abroad.
7. One of the tasks of this division is to implement the pilot production based on the ideas come from the research division (laboratories). The lab gives out the prototype model to this division.
8. Occasionally ideas from the research division are not practical enough to be produced; thus this division makes changes to the prototype in order to make it functional. This is because the situation in the laboratory differs from the reality of implementation. For instance measuring in the lab is in milligrams but at the implementation stage it is in grams.
9. Different staffs along with high level managers are gathered from different divisions and with different constructive ideas which helps in targeting the problems and their solution. The cycle of decision, correction and implementation is always done for different projects.
10. In the beginning of each new project, some samples which are produced in the pilot production are distributed to sale representatives in order to gain their opinions which are based on customers' feedbacks.
11. Because the costs are low in incremental innovation; the implementation division usually uses the existing facilities and tries the innovative ideas like different and new colours on the current products (it means applying different designs to the same platforms).
12. Planning division, high level management, sale division and research division decide whether a product should be continued or not.
13. There are some meetings in order to identify the weaknesses and problems in order to solve them.

14. Risk should be considered in all stages (both in elementary stages and during the implementation).
15. Reports are collected from different divisions about each project. These reports will be examined in meetings and then would be archived as a written documentation.
16. Most important factors which create the risk are: raw materials, technology, integration between new and old technology and management.
17. Skilled labourer has an important role in new technologies but his role is not of that much of importance in normal situations.
18. Ceramic industry is very dependent on experience. Various problems occur during the production process, problems related to raw materials to machineries etc.
19. Prioritization of the risk in this company is based on the managers' experiences.
20. There is a procedure in order to get the employees' opinions, and the ones who contribute their ideas will be encouraged. In sum, innovation is welcomed in this company. And an employee can convey his or her idea to the high level management, directly.
21. If some opinions face with failure, high level management would accept it.
22. Risk factors occur during the process and it is so difficult to predict them beforehand.
23. Different sale branches of this company in other countries convey the idea of international customers.
24. In order to perform the innovations which are based on the competitors' similar productions (and existing products in the market) the company should make sure that it can produce it, since it is already produced. Risks of these kinds of innovations are less in compare with the risk of the whole new innovations since it is already proved that it has its own customers. But for the whole new products, the customer's and market opinion is not determined yet. In the first one, with less expense the company can start to share in the market but it should be considered that it has to have an advantage (i.e. being cheaper) over the existing products in the market.
25. In some special meetings, new ideas and existing problems are both introduced. And the high level management decided whether to give the priority to the new ideas or to the problem solving.
26. In order to start a new project, this division provides some information about timing of the production line and problems of similar products and gives them to planning division in order to sketch a production plan.
27. One of the important factors which should be considered in selection stage of a new product is the culture of society.

Number of meeting: 2.3 (30.09.2008)
Operation Manager (Oper.)

1. Innovation means the things which did not exist before and are derived form the mind of innovative people. Also motivation is needed for creativity.
2. 15 years ago there was no competition, thus the customer would consume any quality of the existing tiles, but now a day with the great range of innovative producers, and customers have a free choice.
3. With the great speed of development, innovation is needed in industrial units in order to survive in the competition. In other words, if there is no innovation, producers are doomed to failure. Producers should compete to satisfy the customers' need. For instance a new issue in this industry is the combination between nanotechnology and tile.

4. Now a day, the first important factor for investigating a new program is not the funding matter but rather it is important to know if the investigators have any new innovation to bring on.
5. Different people need different motivations in order to innovate. E.g. some of them are needed to be encouraged.
6. There are two kinds of customers in this company: internal and external. Internal customers mean that each division satisfies the needs of the next division. In other words, each division is the customer of the other division. External customers on the other hand, are real customers in the market who are the most important factor in order to innovate. This company should satisfy their needs by the help of internal abilities or by buying the new instruments.
7. Some of the important factors affecting the creativity are: competitors and market needs.
8. Some of the factors affecting the selection stage are: 1-financial issues, it means that the cost of new idea should be less and their benefit should be high 2-time of achievement; it means the time of achievements of this project should be short. Some times the second factor is more important than the first one, especially when there are competitors in the market.
9. Customers' culture has an important role in the selection stage. For example, some of the cultures prefer big sizes of the tiles and some prefer small ones.
10. Sale representatives are the most important people in receiving the customers' opinion. For finding the opinion of different customers with different cultures (since Iran is a big country, it has many different cultures gathered together) these sell representatives are sent over to different places in order to find about the different ideas.
11. After producing the prototype, it is sent to different sell representatives in order to get the customers' feedback. Then the prototype will go to pilot production stage and before mass production, it will be sent over to sell representatives again to know the amount of their request (e.g. crystal designed tiles, which passed the same process).
12. In all the stages of innovation, risk should be considered, but this consideration must not take a long time, because the novelty of the new product will be gone and the market will be full of similar products of competitors.
13. Because of the instability in Iran's situation, more risks should be considered and also people will be affected by their personality (courage) or the environment in order to face or averse the risks. The biggest risk is the first risk to take.
14. One of the most important risk factors is environment: 1- internal environment is controllable 2- external environment is incontrollable
15. After preparing the product, the most important parameter which create the risk is satisfying market and customers' opinion.
16. The important issue in this company is financial issue (sell and profit margin) thus the parameters which created the risks should be prioritized based on their amount of impact on this issue. This amount of impact and its time of revelation are recognized by the experience of managers.
17. In some meetings which the high level managements are also attending, risk factors and the person who is in charge of controlling each risk will be decided.
18. We try to make the risk factors quantitative, and have a financial evaluation of them.
19. By considering the tough competition, high level management should have technical knowledge along with potential abilities.
20. Risk management should be done in all projects but with considering the economical issues. In other words, from economical point of view, risk management for a project should be profitable.

21. For doing different projects, the company uses the feasibility study. In this study different attributes are considered like technical ability, cost, competitors, availability of raw material etc.
22. Some products will have a long life cycle and some may have a short one, since the latter ones will be old-fashioned soon.
23. Sometimes after pilot product, we are able to go to mass production but we cannot supply the raw materials so the project will face with failure. The failure indicates that long term planning is very difficult and sometimes impossible in this industry.
24. Most of the tests which are done in laboratories are on raw materials.
25. One of the important factors in developing the company (buying new technologies) is considering the integration between the new and the old system.
26. When a product becomes popular in market and increasing the profit, we can decrease the production expenses.

Number of meeting: 2.4 (02.10.2008)
Business and Logistic Manager (Busi.)

1. The most important task of this division is providing the requests from different divisions about buying machineries, parts and raw materials. For instance, the laboratory usually has new innovative designs and for making them it will need different facilities.
2. We always keep an amount of most wanted raw materials in our storage. So that we can always be sure that we have them.
3. For supplying the raw materials, sometimes there are some offers from the raw material producers about their new raw material and its new aspects. And sometimes because of the market situation, if the company supplies its raw materials from one source, and if that source faces with a problem this will affect the company as well. Thus the company will provide some percentage of its needs from one source and the rest from another, so that if for example there is a rise in the costs in one source, does not have a huge effect on the company.
4. Also the company tries to use different foreign sources instead of depending on one. For instance because of the issues we had with one of our Italian sources (political problems), we try to make contract with a German source in order to have two sources at the same time.
5. One of the important risk factors is government's policy. For instance, these policies will lead to the increase in price sometimes.
6. Usually for analyzing the risk and identifying the priorities, management's experience is used.
7. In the last four months, the company used two new soils in order to make tiles. This means that in the last four months we had two innovations.
8. Company receives the feedback of the customer through the sell division. In order to get this feedback, they use questionnaires, but along with this, the company should also generate new needs.
9. For buying new facilities such as machineries, raw materials, etc, there should be an agreement among the seller of these things, high level management, implementation and incubation stage.
10. One of the most important risk factors is providing raw materials from foreign countries, thus the company tries to substitute the internal raw materials with the external ones.
11. Company tries to change its culture and persuade different divisions to be able to use different materials because of the situation of the market. It means, in the absence of one raw material, they would be able to substitute it easily.

12. One of the strategies of the company is to use the internal facilities and experts, in order to increase the internal ability and be independent from foreigners.
13. The company tries to change the consuming culture of customers, in order to use new technologies. For instance, new technologies in the world are producing large tiles ($60\times60cm^2$) with smaller thickness(2-5mm instead of 8-10mm).
14. Usually all of the processes about raw materials and new products are documented in the company.
15. One of the risk factors is the needed energy for production. For solving this problem, company is trying to use different sources of energy at the same time, for instance, liquid gas along with gas.
16. In order to progress, the company should be innovative, and the high level management has a very important role in this process and should believe in innovation and also use his knowledge and other employees in order to innovate.
17. This company is among the first top ten in this industry. The size of this company is medium.
18. One of the innovation projects in this company is working with nanotechnology which helps producing tiles and ceramics which are anti fungus and bacteria.
19. Sometimes because of the high price of some facilities and materials that the company bought, if these materials have a positive outcome, it is good, and if they are not that useful we try to make use of them in other divisions of the company or if the seller accept, we return some part of them.
20. In order to reduce the probability of risk and their impact on different divisions, the company tries to make strong contracts which satisfy the needs.
21. The company tries to make a competitive atmosphere for the employees, so that the employees try to increase and update their ability and knowledge.

Number of meeting: 2.5 (02.10.2008)
Research and Development Manager (R&D)

1. One of the important activities of this division is considering the quality of different raw materials. Then if the raw materials have a good quality, this division orders them for prototype production.
2. Then in the formulation process we decide how much of the raw material are needed for the final product.
3. There are 2 different formulations in this company. The formulation of floor and wall are different from each other.
4. Different parameters have an impact on the creativity stage: 1- different templates designed by foreign companies 2- using the competitors' products 3- ideas come from other industries e.g. cloth industry 4- customers' idea received through the sell representatives.
5. One of the innovations in the formulation process is the decrease in the final price of enamel by substituting the internal raw materials with the foreigner ones. Also there are some innovations in design of the tiles in this division.
6. There is a simulation of production line in this division which produces the prototypes. Then the product will go to the implementation stage for the pilot production (e.g. producing 20 m^2).
7. Sometimes the transportation cost will affect the raw material selection. In these case the high level management by considering the cost and quality and getting the ideas from different divisions will make decision about the kind of raw materials.

8. The quality control division applies some tests on the prototypes. E.g. testing the shock endurance of the tiles or the quality of enamel, firmness of the tiles and the colour quality. After passing the quality control division, the product will come back to this division. And this division will consider the final cost (since the real sample of new product is ready, the company can calculate the final cost again more precisely), supplying the row material, potential problems which maybe occur in production (e.g.: time of abrasion and density of enamel).
9. After the pilot production, the product will return to quality control division for passing some standard tests. If the pilot production does not give out the desired outcome, the product will not be continued.
10. After the pilot production, the product will go to short term mass production in order to reduce the costs of risk. (e.g. one day{producing 13000 m^2 }, two days or one week production in real situation). Sometimes the short term mass production will be skipped because of the lack of time.
11. After the short time mass production, the final formula (fixed density and viscosity) will be given to the implementation stage, so that they can start to produce at any time.
12. The situations for the ceramic industry are relative and changeable and it is possible to be changed in each stage of production, thus, different tests are repeated in the prototype stage and pilot and mass production. For instance, after the implementation stage, some standard tests will be applied to the product again.
13. There is an iterative cycle between prototype stage (incubation), pilot and mass production (implementation stage) for improving the product.
14. There are always some initial samples retained in order to compare the latter products with the first ones.
15. The prototype products are often sent over to sell representatives in order to get the customer's feedback.
16. Since this company has ISO, all processes should be documented and reported in formal meetings.
17. Standard organization fixes some parameters for products, which should be passed successfully. For instance, for wall tiles, the water absorption level should be 10% and for floor tiles this should be 6%. These are the minimum rates standards which should be applied in formulas, but it is always better to improve these norms.
18. The most important risk factors are: lack of experienced employees, novel technologies, raw materials (difficulty in providing the raw materials and instability of the sources of raw materials) which are affected by political issues, new materials (especially because of the fact that this company produces both floor and wall tiles).
19. One of the creativities which this company is working on is unifying the formula of the floor and wall tiles.
20. We try not to work with perfect raw materials in the laboratories, because if we face with some unforeseen changes in the production line (implementation stage), we want to control it and don't let it to affect our system.
21. Sometimes because of the special circumstances, we have to go to mass production without considering the customers opinion.
22. Predicting the future is so difficult in this industry. On the other hand, we can not buy loads of raw material because of the space they occupy and their expiry date, thus, raw materials are bought in short term periods. Therefore, there are different formulas in this division which can be applied in different circumstances. This contingency formula is not the best but is good enough for this situation.

23. One of the barriers of innovation is the fact that, high level management does not have a scientific and expertise attitude towards innovation, if they assess the different ideas based on scientific methods, then it would be possible for them to choose the best ideas.
24. Risk management is so important for finding the success; especially if this division can control risk properly it will affect the function of other divisions as well. Considering the chance of success is so important.
25. Implementation stage does not agree with changes in the long established ideas and usually disagrees with changes.
26. Going to future prediction, will cause some changes and provides new ideas.
27. Usually the needs and requirements of the implementation stage are sent to the laboratories. So this division knows about their needs.
28. Some of the risk factors are out of the control of this section.
29. One of the important activities of this division is giving the idea about the final price of different tile producing formulas.
30. High level management's opinion is very important in selecting some of the ideas.

Number of meeting: 2.6 (05.10.2008)
Marketing and Sale Manager (Mark.)

1. All companies need to be innovative but there are different risks in the innovation path.
2. Innovation means the new product or service which has not been tried in the market yet.
3. One of the important factors in innovation is reducing the risk of market and customer. For instance, in a specific project in order to increase the consumption and as a result increase the production, products are being used on different places, like apartments for free in order to assure the customers that this new product is practical and good and accepted by the market. Thus, with this acceptance of risk and its control, the market has already experienced the product and will not be afraid of the failure of this product.
4. Success in the first innovation will lead to the later successes and market will trust us more.
5. One of the important goals of innovation is to gain more benefits.
6. Each organization has a specific budget for each project named as 'investigation budget'. According to this budget we decide which risks and with what expenses should be managed and which ones should be ignored. We usually continue those projects which risks are less than 50% of the budget. If more than that, we should consider the project and their risks again.
7. In order to satisfy the customers' need we must pay attention to the cultural norms. E.g. in some cities, the quality is not important but the price is the norm. And in some cities this is vice versa. Thus we produce one product with two qualities in order to achieve the market of both cultures.
8. Another way to find about the customers' need is to give out the questionnaire through sell representatives. It should be noted that there is a percentage of error in the questionnaires.
9. In order to get the feedback of customers about the innovative, special and expensive products, sell representatives give out the prototype into the market.
10. Each project will finally go to the management board in order to be assessed by them and the final decision about the risk of project is made by the management board and stakeholders.
11. The most important barrier of innovation is that the high-level management will not accept the risk of innovation and that stakeholders are not educated enough to aid in the decision making process. Most of our managers' would choose short-term benefits over long-term

benefits. However there is, fortunately, a potential for high-level management to accept risk.

12. Most of the export amount of this company is to the countries which cannot afford the foreigner products and yet this company's product is better than their own.
13. All the processes and information of the current projects will be documented and the company will use them for later projects.
14. For each projects there are different diagrams based on the rate of selling of the new product, improvement plan, and human resource.
15. In situations which the expense of the project is more than the progress plan, the project will be terminated.
16. One of documents which are often used is the financial documents. By using that, each 2 months, the market share, sell and also customers' interest are elicited and according to that we continue the project. E.g. in the last 3 months, the rate of 6 provinces was equal to 16 provinces, since 75% of our sell representatives are located on those 6 provinces.
17. The most important factor in increasing the production is the power of customers to buy the products. In order to achieve this, the company should decrease the cost of production.
18. One of the tasks of the company is to affect the culture of customer and market. Thus, for a new product, the company should prepare the market and make the potential customers for this new product.
19. Risk needs to be controlled in all stages of innovation as it is a continuous issue. However if we control risk too much in the creativity stage, we might limit the company's success.

Number of meeting: 2.7 (07.10.2008)
Quality Assurance Manager (QA)

1. After producing the prototype, the product will go to pilot production, and will undertake 22 standard tests such as colour, quality etc. Also some tests about the kind of enamel and solidity of tile are done as well.
2. After approving the pilot production, product can go to mass production, and if the pilot production is not approved, the product will not go to mass production.
3. Also there are some standards in mass production in order to select if a product is a number one quality or second class quality.
4. There is an iterative cycle between prototype producing stage (incubation) and pilot production, in order to approve the faultless final product.
5. One of the most important criteria which has an affect on creativity is customers' need. It means which design their like or what is their opinion. Sometimes the request is from them and sometimes we provide the design and add it to their favourites. In other words we need to insert our new designs into their accepted culture. For instance, granite designs with different colours.
6. Because of the diversity in the culture of each region, customers have different tastes. For example in north of Iran they prefer blue shades and in south they prefer dark or warm colours.
7. There is a special program in the company in order to invite sell representatives to the company to visit and get their opinions and comments and make them familiar with the process in the company and the situation in the market (this company has an approximate 180 representatives). At least one time a year this program runs in order to get the idea of representatives directly along with the other opinions which are gathered through out the year.

8. Production plan for the mass production of each month will be scheduled in the middle of the last month and will be approved by the high level management and sell division, in order to decide which designs should be produced (production plan is for one month). One of the factors which affect this planning is the market's need, also sometimes checking the market for the new product will affect on the production plan. It means short term production of a product in order to check the market's situation.
9. There are some standard forms in order to perform the final tests of approving a new product which should be approved by laboratories, quality assurance division and high level management.
10. Some parameters which affect the selection stage are: ability to produce, market acceptance, financial issues, culture and high level management's interest (which is derived from the market's feedback). It could be said that the final decision is made by the high level management with considering different divisions'' opinion about this project.
11. Companies which sell raw materials are a source to provide new designs.
12. After selection, the product will go to laboratories and after producing the prototype, the high level management will give their opinion about it and after approving it, the product will go to the pilot production stage. Usually the product in pilot production will be the same as prototype; however, the prototype will be evaluated by high level management again in order to enter the standard tests of mass production.
13. After the pilot production and regaining the high level management's approval, the product will go to mass production stage in order to get the market's opinion and finally to mass production.
14. Sometimes during the innovation process, the market's opinion will be gained at the beginning of mass production stage. In other words by producing one-day to one-week production and sending them to market, market's opinion and the amount they need will be determined.
15. Sometimes it might be that without considering the market's idea in the beginning of the mass production level we enter into mass production. The reason is that we might be pressed by time for producing (e.g. lack of time in order to change the mould. The time period needed for changing a mould is at least 45 days). Sometimes we faced with failure and because of this.
16. Because of having ISO the events and procedures are documented; also some frequently quality checks should be done in different stages
17. Internal standards are even tougher than rigid governmental standard tests. It is because of the fact that we respect our customers and want to provide them with the best.
18. Usually managers' experiences are used for finding the parameters which create the risk and also analyzing and solving them.
19. Because of the big amount of market's need we may not feel that risk management is really needed, however in tough competitions risk management is absolutely essential.
20. It is better to have risk management in all stages of innovation in order to stop or limit the failure.
21. One of the innovative projects in this company is sorting mechanism for changing it to automatic one with helps from an external company.
22. One of the barriers for doing the creativity is unfamiliarity with other innovations in the world. On the other hand not having any connection or information exchange with foreign professionals and producers can be viewed as another barrier for innovation.
23. Some of the parameters which create the risk in the innovation project are: the customer and market's acceptance, the raw materials and sometimes environmental wastes.
24. Mass production should be controlled hourly in order to make sure there is no difference between the products and the sample. Sample product is the already approved model and

every final products from different aspects (such as: raw material, quality) should be similar to this in order to get the approval.

Number of meeting: 2.8 (07.10.2008)
Administration Manager (Admin.)

1. Some activities of this division are: employment of staff, distributing the products, maintaining the security, renewing the building, etc.
2. One of the important activities of this division is managing the educational classes in this company. Based on the different requirement of employees in different division, this division holds different educational classes.
3. Experienced employees teach the new employees in order to transfer their knowledge and experience to them (e.g. in the field of auto mechanic).
4. There is not any systematic approach for teaching and it does not include the outline for each course.
5. Because of having the ISO the company should document any process formally.
6. Company has more than 400 employees and in the top ten producers of the tile industry.
7. There is not a formal encouragement system for innovative people in this company; however the high level management will encourage the employees to innovative in a non systematic way.
8. In order to motivate people, there is a suggestion system as a pilot in one the divisions which has two purposes: 1: receiving the employees comments 2: satisfying the employees by letting them contributing their ideas.
9. One of the parameters which create the risk is lack of the experienced employees.
10. The method for facing the risk is dependent on the attitudes of high level management. It means that some of the managers are risk averse, thus they choose the strategies which are not less risky, and therefore they might be less innovative.
11. The high level managements of this company are usually taking less risk thus they choose the ways which are less risky or without any risk at all.

Case 3: Razavi Dairy Products Corporation (RDPC)

Number of meeting: 3.1 (11.09.2008)
Production and Renewal Manager (Prod.), vice president

1. At first, the main product of this company was milk. But because the price of milk is not stable and the environment parameters (e.g.: government) have an affect on this price, the company could not rely on this benefit. For solving this problem the company went to producing different dairy products by buying the machineries from two foreign companies. At first the company produced cheese and now the company is producing more than 15 different kinds of products (such as different kinds of yogurts, butter, desserts, ice creams, butter milk and so on).
2. One of the forces which has an effect on the company for going to use new technology and producing new product is the competitors. For instance other our competitors who produce new types of cheese (UF) by using new technology (technology push) and with greater efficiency can provide their products at a lower market price. During the last decade the younger generations of Iran began to express a preference for UF cheese instead of traditional cheese (in salt water). Because of the pressure exerted by competitors and the demands of the customer base, the company began production of this new product.
3. Besides going to produce the UF cheese (because of changing in culture of consumption), the company went into new methods of sterile packaging which can keep the product out of the fridge for 6 months.
4. Two kinds of changes which are usually applied to products as incremental innovation are: change in the formulation and change in the packaging. For example for buttermilk, the company changes the method of its production, instead of using just one source like milk in order to get the butter milk, they use another source as well which is the water of cheese. Also changes in the flavour (mint, oreganos, etc) of buttermilk or its packaging are applied.
5. After incubation stage the prototype should go to pilot production for testing the real situations of production line. In other word the company wants to check the quality of real situations and compare it with laboratory situations and find any differences in order to solve them. In pilot production the company tests the machinery with minimum capacity.
6. One of the important factors in continuing the production of the new product is the interest of the market.
7. Two important parameters which have an affect on creativity are customers' need and competitors.
8. For getting the customers' feedback, at first the company had one main distributor and via that the company received its customers' feedback. After increasing the productions, the company started to create different sale centres in the different cities and these sale centres help to find out about the customers' feedback (about their new needs, deficiency of the existing products etc.) in a better way.
9. There is another system of getting customers' feedback in the company which is named as "voice of customer". In this system there are telephone numbers which are listed on the label of each product and customers can call those numbers and explain their ideas about the products.
10. In the creativity stage sometimes by taking into account the similar products, the company will find different formulas and will then choose one of them.
11. Usually the diary companies will enter the market with the variety of products and the products which become more popular and successful will be chosen and continued.

12. One of the tasks of the company is creating the consuming culture among customers, which is not easy to be established. One of the ways for this purpose is producing new products for a long time.
13. One of the ways of getting customers' feedback about the new products is to give the questionnaires to people such as students who come to visit the factory.
14. In cases which the company has experience in, before going to incubation, the financial issue is considered. But in the cases which are new to the company, after the pilot production the company can estimate the costs.
15. In some industries the companies produce the products and products are going to inventory and after that the inventory pushes the marketing and business division. But in this industry the marketing and business division pulls the production and decides which way the company should go.
16. The company usually gets the opinion of customers in two stages, after producing the prototype and also after pilot production. For this purpose there is a panel test in these two stages in the company for getting the opinion of visitors.
17. Because of the situations of this industry ability to competition and creating the contact with customers are considered in implementation stage (D5) more than incubation stage.
18. All of the products in this company have BOM (Bill of Material). It means all ingredients and combination of product are clear, even for a very small change. Also the company has a written report of method of producing each of the products.
19. Environment is one of the parameters which create the risk in this industry. For instance the government plays a powerful role in fixing the price of dairy products. In 2007 the government did not permit dairy companies to increase the price of some products although inflation existed and the price of raw material had increased. So predicting the risk created by the environment is difficult in this industry.
20. Some times for predicting the future, the company uses the different scenarios. Different scenarios based on market, environment and technical etc with considering the parameters which create the risk (by using the managers' experiences) are written for final decision.
21. For finding the probability of risk factors the company uses the experience of managers. Based on these experiences the different risk factors are prioritized. So likely there is not any formula for finding the risk factors probability.
22. Financial resource is one of the parameters which create the risk in innovation projects, especially from investment rate of return point of view. For instance for using the new form of packing at first the company produced the prototype of this new model for considering the amount of investment. In the meantime for doing the projects which their cost is high at first the company considers the feasibility study, even the needed space is considered and if an extra money is needed it will be added to the forecasting price. The financial division uses the IRR for their consideration.
23. Amongst the different feasibility studies the management board selects the best one for implementing. So the management board has an affect on selection stage.
24. For buying the new technology the integration with old system should be checked, since this issue can create the risk in the process.
25. This company has more than 100 permanent employees and roughly 200 temporary employees.
26. Private companies are faster than non-private companies in decision making. Also private companies accept the risk but in non-private companies because of the environmental situations, most of the managers are risk averse.
27. The company sometime uses the consultant of organizations which are outside the company.

28. One of the methods which the company sometimes uses for producing some kinds of other dairy products is outsourcing. Because of the high price of some kind of machineries the company uses this method firstly. So by this method the company can find the market share and also considering the market for deciding about buying the new technology. For using this method at first the company checks the quality and market of different companies which produce this product and after that for decreasing the risk of the price and time of receiving the product (if one company increase the price or can not provide the product at fixed time) the company makes contract with more than one company.
29. The situations of dairy market are so different from the situations of other food market. Since some kinds of dairy products (like milk) are among the main foods for people.
30. Since predicting the market is very difficult in this industry, it is better that the dairy companies enter their new product to the market with the massive amount and find about the customers' feedback. These feedbacks directly go to other stages as well.
31. In some products the company could not be successful. For instance in fruity yogurt, the company was producing this product for one year but after that found that the market does not accept this product. Since this product was pasteurized time of its expiration was short, also the market did not accept it so the company should decrease the variety of its product.
32. Strategy of the company has an affect on selection and implementation stage. For instance for providing the special dessert to airplanes.
33. Some of the products have their own special customers, in this situation since the market is not large enough and constant, the company stops producing of this product and in consequent their variety of their products decreases.
34. Marketing and business division has an important role in success and also receiving the feedback from customers and market and sending them to other division.
35. One of the parameters which create the risk in the innovation projects is culture.
36. There are some mechanisms in this company for controlling the process.
37. One of the parameters which has an affect on selection stage is technical ability. For instance special technology for packing is needed for producing the milk with different flavour. With current technology the risk of production of this product is so high since the time of their expiry is short. In addition producing the milk with different flavour can be seen as a radical innovation from this company point of view.

Number of meeting: 3.2 (13.09.2008)
Business Manager (Busi.), Vice president

1. One of the parameters which should be considered at selection is technical ability. Furthermore, technical ability can affect on creativity stage and company should concentrate more on creating the new idea based on their ability. (author: this function decreases the creativity and maybe some new ideas are worthy enough for new investment)
2. The company should select one of the ideas among the different ones. There are some parameters which have an affect on selection stage and they help for prioritizing the ideas like: final price, market, ability to do it, time of achieving the results (since some times the long time causes the new product miss the novelty in the market and other competitors produce that), benefit, amount of investment and investment rate of return (IRR). Also the amount of accepting the risk by the high level management and size of the company have an affect on this stage.
3. There are two kinds of innovation which companies choose. First one is based on current products and is more like the incremental innovation (for instance changing the current formula of products or changing the packing). Second one is producing the completely new

products which are novel in the market. The second model is more related to leader companies.

4. Airplane desserts were selected for production as they fit in with our strategy and enable us to be a leader in the marketplace. Sometimes a company strategy will involve entering new products to the market, not solely for profit, but also to create a positive image (social prestige) of an innovative market leader in the mind of the customers.
5. Business and marketing division has a role to send the feedback of customers' opinion and competitors to the different division of company. This information is one of the inputs for creativity.
6. The new products and technology in developed country can be a source of creativity in the company. Also situations of customers (e.g.: the age, opinion etc) and market, health needs of our society and situation of economics have an affect in creativity. For instance Iranian people do not eat enough vitamins so the enriched milk with different added vitamins can be helpful and will find a good market.
7. Some other parameters which have an affect on creativity stage are: better using of current machineries for increasing the efficiency, planning for approaching the specific market share when the current products saturate the market.
8. Most of the managers in non-private companies in compare with private companies are risk averse, since the time of management in these companies are short and not constant. Accepting the risk means that the manager accepts the hazardous situations in period of time for finding some benefits, while finding these benefits are not necessary in these companies and on the other hand there is not enough time for investment in order to find that. Also the knowledge about the risk is better in the governmental companies in compare with private companies (since in private companies, management and ownership is the same and most of the time the owner only have money not knowledge), but there is not any interest for accepting the risk.
9. One of the parameters which has an affect on selection stage is strategy of company. It means that based on the strategy, company wants to be a leader or follower in the market.
10. Usually the company selects the ideas which have a specific market. It means some ideas need to change the culture of customers so they need a lot of time and they are not good for getting to the fast result. Another point for selecting the idea is that the more variety of ages of people can use it. So the age proportion of population has an affect on selection.
11. If the company wants to produce new product which already exist in the market, it can find the market's information and customers' opinion about this product by going to the market and asking some questions. After that the company can produce this product with better quality and removes the weaknesses of the products which are already in the market. But for completely novel product in the market the company should test the market in smaller size before going to mass production.
12. For reducing the probability of failure and loss, the company should test the market before going to mass production. Market test is possible in this industry although it needs time and money. Since two years ago the company tries to follow this scientific approach and checks the market before going to mass production although in the past the company did not follow this approach completely.
13. If the company does not want to test the market because of the time and money, it can use the opinion of expert people in this industry about the kind of the packing, preferred price form customers' point of view and so on. Now a day considering the market, finding the customers' need and predicting the tendencies of customers are very important for success.
14. System of distributing the final product is very important for success. Sometimes problem in this system causes the failure of the product in the market. Furthermore the packing and

advertisement are the other parameters which have an affect on success. So it can be said that these parameters can create the risk in innovation projects.

15. The culture and knowledge of customers are the parameters which can create the risk in innovation projects. If the company can not recognize the culture of society correctly, it can not select the proper idea. Also sometimes customers do not have enough information about different scientific words which mirrors the differences among the same products. In this situation it is possible that customers select the other products only based on their price or appearances.
16. Innovation means new ideas and things, although the high percentages of current innovation are based on existence products and they are like development. The company for being in competition and survive needs the innovation. Also most of the times the new product brings more benefits for the company and absorbs the new customers. This company has some innovation in product and process (e.g.: decrease the price of production).
17. There is not any formal method for documentation in the company. But different divisions try to document their process and there are different kinds of written reports for final decision.
18. There is not scientific method for analyzing the risk and most of the time the company uses the managers' experiences for prioritizing the parameters which create the risk.
19. The company uses the feasibility study for most of the new projects. In this study the company considers the competitors, market, benefit, and investment rate of return.
20. One of the parameters which create the risk in innovation projects is competitors. Some times they can duplicate the new products very soon and decrease the market share of the company.
21. One of the parameters which create the risk in innovation projects is poor prediction of the company's needs for producing (e.g.: raw material), final price and market. Since the prediction methods are not precise enough and also sometimes the size of sample for testing the product is not large enough. In addition sometimes the company's prediction relies on managers' opinion about customers and market instead of scientific method.

Number of meeting: 3.3 (13.09.2008)
Marketing and sale Manager (Mark.)

1. One of the important inputs for creativity is customers' feedback. Since there are different cultures and regions in Iran and each one have their own taste (for instance the north of Iran prefers the sweet yogurt and south of Iran prefer the sour one) so the company receives different kind of feedbacks which in some case they are opposed with each other. So the company should select their market based on their strategy, firstly.
2. Some years a go this company only had two competitors but now there are more than 30 competitors. So in order to survive, the company needs innovations.
3. There is a system in this company which name is 'Voice of Customer' for receiving the customers' feedback. Based on this system there are some telephone numbers on each product that the customers can call them and declare their opinion about the quality of product, their needs and so on. These opinions are categorized and will be sent to related division. The customers are going to welcome this service and the company could improve some of their product based on that. For instance diet yogurt or butter with different packaging and weight are some new things based on this system. However this system is not a powerful and proactive system. It means that instead of company waiting to receive the customers' feedback; it should go and find the opinion of customers.

4. Two other parameters which have an affect on creativity are competitors and employees' opinion. Unfortunately in this company, the employees are not considered as a worth assets. In addition the employees need motivation for providing their opinions, so the company should respect to all ideas even if they are not useful and encourage the employees who shared their ideas.
5. The system of management in this company is traditional, but the high level management tries to change the system and go to scientific methods of management. This system has an affect on innovation project and in some part can create the risk.
6. Simultaneous with increase in the number of competitors some years a go, the company received the first input that the market is going to be saturate, so the company needed innovation for survival. In some of their innovation, the company did not achieve success and was failed in the market (for instance for yogurt with taste of strawberry). The main reason for this failure was that the company did not know the major needs of customers and the customers' culture was not familiar with this kind of yogurt.
7. Culture of customer is one of the important parameters which has an affect on success. So the company should consider this factor in selection stage. In addition for completely new products, the company should prepare the market earlier and change the culture of customers.
8. One of the parameters that company should consider in selection stage is that which of the ideas has the ability to achieve the result sooner than others. In addition, the amount of benefit, size of market, technical ability and amount of needed expenses affect the selection stage.
9. In some cases that the company does not have technical ability and sufficient money for doing the new idea, at first it uses the outsourcing method for considering the market of product and after receiving the feedback is going to decision about this new investment.
10. In this industry, advertising has an important role for reaching success. Good advertisement can absorb the mind of customers for using new product.
11. The strategy of the company and especially the plan of company for new products are not clear enough. So sometimes by changing the management some interruption occurs between the different activities.
12. System of distribution is one of the important factors which has an effect on approaching success in new products. In addition selecting the correct market and the time of production are other important parameters which should be considered for producing the new products. So these parameters have an ability to create the risk in innovation projects. For instance, the company was producing the special taste of dessert but it failed in the market, since the company did not recognize the correct market and distributed the product in any regions without considering the culture and level of living of people. In addition this product was produced in summer which is not a good season for that.
13. Considering the market is very important for doing the innovation. Unfortunately, there is not powerful system in this company for recognizing the market's need and selecting the correct market. Moreover the people in the company do not have enough knowledge for methods of receiving the customers' opinion. Also the company does not have sufficient money for investigating on market recognition.
14. One of the parameters which has a negative affect on the process of production and can create the risk is employees' dissatisfaction. Also the knowledge of employee is a parameter which has an affect on creativity. If the employees have good knowledge this affect is positive but if they do not have enough knowledge the affect is negative and it can be a barrier for innovation. Some training classes for employees can be helpful for increasing the knowledge of them.

15. There is not a scientific method in this company for analyzing the parameters which create the risk. Most of the time the company uses the experience of managers for finding the probability of risk factors and prioritizing them.
16. Some of the important factors which can create the risk in the innovation projects are: government policy, financial resources, market, strategy, management and technical integration between new and old system.
17. Most of the high level managers in this company are risk averse, so this is one of the barriers for doing the innovation.
18. The company recently began documenting their processes in a formal format. Since these information are so useful, the company should use them for later projects (for instance by considering the reasons of failure in previous products, the company can select the proper market and method of distribution for new products), although the company does not currently use them.
19. After pilot production the product should be sent to their market for receiving the markets' feedback. This product only should be tested in its own goal market which the company decided before, for finding the correct feedback. Unfortunately, sometimes the company does not do these steps and only after mass production the product is sent to market for receiving the markets' feedback. So after getting the positive feedback the company continues the production, otherwise it will stop it.
20. After selecting the goal market, the company should consider the characteristics of customers and their needs in the selected market at incubation stage. For instance age of customers (kids, young or old) has an important affect on the kind of tastes of products.
21. One of the sources of creativity is the traditional culture. Company can find the good idea by considering this traditional culture.
22. Saving the social prestige is very important for surviving in the market. So missing the customers based on some faults in the products cause in decrease of the level of social prestige. In this tough competitive market re-finding the customers trust is so difficult.
23. Unfortunately the level of people's knowledge about the different kind of raw material and role of them in a healthy is low. So in this situation the people can not recognize the better products. This is a negative parameter which has an affect on this company.
24. The company tried to be a leader in this industry, but since it did not receive the correct inputs based on scientific research about the market and customers, thus it was failed in some of creativity.
25. In selection stage the final cost is predicted. This prediction has an affect on selecting the idea. In addition the investment rate of return (IRR) is considered in this stage as well.
26. It seems there is not any formal meeting with specific criteria for selecting new idea by high level management.

Number of meeting: 3.4 (13.09.2008)
Production Manager (Prod.)

1. Two important parameters which have an affect on creativity are customers' feedback and competitors. Research and development division has major responsibility for creativity. The information about the competitors and their new activities are reported to the company via marketing and business division.
2. After producing the prototype, the assessment panel is formed by people from different divisions for primary consideration of prototype. During this assessment panel the first version of prototype is developed till the completed prototype will be achieved. After that, the prototype is considered in some parts of market (for considering the customers'

feedback) and also it is sent to management board for receiving their idea. After receiving the different feedbacks and improving the prototype based on them, the final prototype is produced and it will be sent to management board for receiving their approvals. This is an iterative cycle between these steps and usually these steps are repeated more than one time.

3. Before going to implementation stage the company roughly should set the price of product in the market. The opinion of marketing and business division about this has an important role for going to next stage. Sometimes the marketing and business division refuses this price and the process is stopped.
4. Now a day there are so many competitors in this industry and the competition is tough. For remaining in this market the company needs the customers' satisfaction and for creating this satisfaction the company should be innovative. Also another force which causes the company follows the innovation is needs.
5. If the new product is similar to one already on the market, we will compare our prototype with the similar product at the incubation stage. This is in order to improve the prototype and make it capable of competing in the market in aspects like price, durability, packaging etc.
6. In implementation stage, the company considers the feedback of market and customers. This feedback which is usually received via business and marketing division has an important role in stopping or continuing the process of production and sometimes these feedbacks will cause minor changes in the products.
7. One of the important factors in selection stage is considering the existing technical ability for forming the new ideas. Based on kind of the innovation (incremental or radial) the type of considering the parameters in feasibility study are different. For instance in cases which the technical ability does not exist and it is needed to be investigated upon, the company considers all parameters in order to decide about the performing of new idea (e.g.: modernized traditional cooking oil).
8. The company tries to consider all of the received new ideas, thus it creates a separate file for each of them.
9. The company formally documents the process until the end of the selection stage but after this stage usually there is not any formal documentation.
10. There are some parameters which create the risk in the innovation project. Some of them are: the government policy, lack of skilled labourer, supplying the raw materials, integration between new and old technology, traditional management structure and technology.
11. The company usually considers all of the parameters which create the risk and prioritize them based on the managers' experience.
12. One of the barriers of doing the innovation in this company is the slow progress of decision making.
13. In order to reduce the risk of supplying raw materials, the company have classified different suppliers and purchases some amount of raw materials from each of them, thus the company is not dependant to only one source.
14. Considering the market's situation has an important role in creativity and selection stage. Thus recently the company tries to use the scientific methods for considering the market.

Number of meeting: 3.5 (14.09.2008)
Quality Assurance Manager (QA)

1. The customers' need, competitors' situations, management structure of the company and governmental rules are parameters which have an affect on the creativity.

2. One of the important parameters which is considered in selection stage is making sure about the technical ability. So, a feasibility study is done in order to know that if the company is going to produce, what kind of materials (for checking availability) or equipments and machineries etc. are needed.
3. One of the important parameters which should be checked in incubation stage and before going to implementation stage is getting different standard certificates from the government, such as hygienic approval. Without these kinds of certificates the company can not go to mass production and only can produce limited amounts in pilot production.
4. Before going to mass production, customers' opinion about the new product is considered by marketing and business division and based on this feedback the company decides about the mass production.
5. There are some mandatory standards in this industry which are set by national standard organization and all of the dairy products should pass these tests during the production.
6. One of the parameters which create the risk in innovation projects is the raw material. Availability of raw material, method of supplying them, their price and amount of requirement are the parameters that should be considered in buying the raw materials.
7. Because of tough bureaucracy and unclear rules, getting the certificate from the government is so difficult and unanticipated. This issue is a parameter which can create the risk in innovation projects, since sometimes the time being wasted on this aspect will cause to lose the opportunity in the market.
8. Sometimes the market response and customer feedback, in pilot production and mass production, are radically different. When a product is given a pilot production this does not give the company an accurate view of the market or customer opinion (because of the limited number of product). Also, the high cost of market testing means the company will only supply products to a few select customers and wholesalers, but especially those who are outside the company's geographical region.
9. For some of the new products, the company should prepare the market and change the customers' culture before launching the products. But because of the attribute of dairy products which are main food in Iran, changing the taste of people is so difficult.
10. Two parameters which can create the risk in innovation projects are distribution mechanism and market. The distribution mechanism of products in Iran is so tough and complicated. This mechanism can affect on the process of production and in some cases can fail the new product in the market.
11. Since this company has ISO (9001 and 2000) all the processes of production should be documented. This kind of ISO has an affect on system of management and tries to control them.
12. One of the parameters which should be considered in selection stage is customers' culture. This parameter can create the risk if the company does not consider it. For instance now a day the culture of people is going to change and prefer the national and traditional products.
13. One of the barriers for innovation is the low amount of investment in this company for new ideas. Also because of the management structure of this company which is non-private (strict hierarchy with a strict definition of responsibilities), some unimportant parameters have an affect on decision making and their priority.
14. Process of production includes three parts: input (raw material), progress, output (final product). Some tests and controls should be done in each of these parts for approving the product (for instance bacteriology control or chemical control).
15. There are some mechanisms for controlling the process of production in this company. Also the company usually controls the machineries in different terms such as being safe, not rusty, maintenance etc.

16. Based on Voice of Customer system which receives the customers' feedback, if some minor changes are needed or the quality of product has some small problems, the research and development division performs the revision. Some times the problem of quality related to system of distribution which can not provide the cool chain (facilities for keeping the product cold) for distributing the product perfectly.
17. One of the important parameters which has an affect on creativity stage is customers' needs.

Number of meeting: 3.6 (14.09.2008)
Industrial Engineering Manager (Indus.)

1. Recently the company started the documentation of their process based on formal format.
2. Some of the issues which can create the risk in innovation projects are: lack of the efficient distribution system, government policy (especially for setting the price of dairy products), tough competition and more competitors, worn out technology, slow decision making, traditional structure of management, traditional culture and low level knowledge of customers about the kind of raw material and their affect on body health, low level knowledge of employees and unskilled employees.
3. Two important parameters which can create the risk are time of receiving the raw materials and the price of them. For solving these problems and increase the ability of company for encountering with these issues, the company uses two raw material suppliers at the same time. It means the company buys their required raw material from more than one supplier. So if one the suppliers delays or increase their price, the company has opportunity to mange the situation by working with the other one.
4. The industrial engineering division should control and check the process of production regularly. The other duty of this division is production planning. This division controls the amount of raw material consumption by considering the quantity of input raw material and quantity of out put products, so if the amount of consumption is higher than reasonable amount the production process needs revision.
5. The industrial division should manage and control the time and procedures of ordering raw material. Our division set a minimum amount of raw material which should be held in their inventory. This amount is monitored and before the stock levels are depleted, we order more raw materials.
6. In selection stage the company forms the separate committees with people from different divisions for considering the ideas and improving them. Each of these committees has a responsibility for considering one of the ideas. In these committees purpose of each project is defined and plan of implementing is done. Simultaneously the feasibility study for this project is performed and after that will be sent to management board for receiving their opinion and approval. If the management board approves the project, it can be sent to the next stage (incubation) and will be done based on planning schedule.
7. Innovation projects always costly and risky.
8. One of the barriers for doing the creativity which also can create the risk in innovation projects is intellectual property right, since the rules of intellectual property right in Iran are not strong and most of the time duplicating the products does not have punishment for the duplicator.
9. The private companies are more innovative than non-private companies, since in private companies decision making are faster and they accept the risk easier than the other ones.
10. For achieving the success in innovation projects, the company needs to manage the risk in different stages of innovation

Number of meeting: 3.7 (14.09.2008)
Technical Manager (Tech.)

1. Technical division has responsibility for considering the technical ability of company for doing new ideas, in selection stages. This division should report that the company has ability for doing the new project or should buy new machineries or use outsourcing method.
2. Two important parameters which can create the risk in innovation project are technology and lack of the skilled labourer.
3. One of the important barriers for doing the innovation is structure of management.
4. The common method which is used in this company for analysing the parameters which create the risk in the innovation projects and prioritizing them is using the managers' experiences.
5. In part of feasibility study, technical ability is considered as well by using the opinion of technical division.
6. There is not formal format for documentation, but the technical division tries to document all technical information for using in future activities.
7. One of the important forces for creativity is needs. It means because of the situation of Iran which company can not supply their needs easily and fast, the company should go to creativity for supplying their needs.
8. The company controls the process of production and the machinery based on the specific plan periodically.
9. The company also has some innovation in producing some kinds of machinery. In this kind of innovation, the company at first uses the trial model and after approval, goes for using it in real situation.
10. The main duty of technical division is maintaining and repairing the machineries and also controlling them in production line.
11. The quality of some parts in machineries is very important, so some times their maintenance is so difficult and if the company can not maintain them correctly some problems will occur in production.
12. For buying new machineries the company considers some important technical features like: the speed of machine, efficiency, length of stop, maintenance, arrangement etc.
13. One of the parameter which can has an affect on creativity and the company should consider it, is the customers' needs.

Case 4: Sepideh Jam Toos (SJT)

Number of meeting: 4.1 (20.10.2008)
Quality Assurance Manager (QA)

1. There are some parameters which have an effect on creativity stage like: customers feedback (needs, opinions, etc), different problems in production line, employees' opinions. Also some times the company wants to increase the efficiency; therefore, it should go to innovation. For instance for decreasing the cost.
2. Creativity means better and newer ideas. It can be said that there are two kinds of innovation in this company: completely new product (radical innovation) and development (incremental innovation). In general the risk of incremental innovation is less than the other one. This company has development on the existing products rather than creating completely new products since most of the high level managers are risk averse and the risk of incremental innovation is low, so the requirement for finding the probability of risk factor is not much.
3. In selection stage the company selects one of the ideas based on some parameters like: required resources, markets' opportunity, strategy of the company, final cost, efficiency coefficient (probability of conformity of result with goal) and availability of raw material (which has an ability to create the risk). In some situations the company should consider which parameter has higher weight.
4. Technical ability and required knowledge are two important parameters which should be considered at selection stage.
5. Culture has an important role on selection stages. For instance the culture of different regions of Iran affects the design of products' colour. The sale managers help the company to find the culture of different regions of Iran.
6. After producing the prototype, it should be shown to customers (or at lease main customers) for getting their opinion. The company may only achieve %90 of the customers' goal, so it should be considered that the customers can accept the product with this situations or the company should improve it again.
7. Two parameters have an important effect on continuing or stopping the product in implementation stage, which are: market' needs and competitors. It is possible to stop the production after receiving the minimum amount of benefit which was predicted in prior stage.
8. The company tries to document all processes. Also some systems which already exist in the company use the documentation, like the system of getting the employees' suggestions in general or for correction of current problems.
9. One of the methods which this company uses for managing the risk is FMEA. By this method the company can analyze and find the probability and impact of risk factors.
10. There are different tables and indexes for using FMEA based on each kind of industries.
11. After producing the prototype the company can go to pilot production. In pilot production the company wants to check the current situations of implementation and improve it if necessary, for producing the new product similar with the prototype.
12. Some times the main customers explain their needs and ask the company to produce that.
13. The company usually uses the employees' experiences for analyzing the risk factors which are general and are related to common development.
14. The company usually considers the competitors in selection stage instead of after producing the prototype.

15. Usually the company prepares the feasibility study in selection stage. In feasibility study the main needs of the project, ability of competitors, amount of investment and so on are considered.
16. After producing the prototype, it will be sent to pilot production. In pilot production the company checks the new product in a bigger scale than laboratory which was produced the prototype. It means in pilot production, the product is produced in real scale but in small amount. After approving this stage and receiving the market feedback the product can go to mass production for producing several times based on the markets' needs. There is an iterative cycle between these two stages for returning to previous stages for improving the probable problems. It means that the company tries to place a limit on the iterative cycle. The company limits the number of times a product can repeat each stage when attempting to resolve problems. After that, if the company cannot find a solution, the product is sent back to the previous stage. For example, if a solution cannot be identified within 20 cycles of production during pilot product, the product is returned to the incubation stage. Also, the new product may be abandoned at this point, although in most situations refinements are made and the project continues.

Number of meeting: 4.2 (20.10.2008)
Production Manager (Prod.)

1. It can be said that there are two kinds of innovation in this company. One of them is based on current products and it is development (incremental innovation). Another one is producing the completely new product (radical innovation).
2. The company usually uses the PDCA (Plan, Doing, Control and Action) cycle for each kind of innovation. Based on this cycle, the company makes the plan for each new idea and considers it, firstly. If this is a completely new idea, it needs high level management approval for implementing, otherwise (it means in development which it does not need high investment) each division can decide about it by itself and after that implement it.
3. One of the important inputs for creativity is the employees' opinions. Since there is a mechanism in this company for getting the ideas, all employees (from low level to high level) can provide their ideas about improving or producing the new product. Also company considers these ideas in different committees and encourages the employees which provide their ideas.
4. The new idea can come from inside or outside of the company. For instance customers, raw material suppliers or visitors of company can be a source of creativity.
5. Risk should be considered in first stage of innovation like other stages as well, so the company tries to do it.
6. Usually parameters which create the risk have an affect on financial issues, so the company tries to consider the risk by using financial methods. Thus the company considers the likely loss or profit for implementing the new idea and also cost, required loan and so on.
7. One of the important goals for this company and also other private companies is achieving more benefits. Certainly this goal (and other goals) has an affect on selecting the new ideas.
8. After recognizing the parameters which create the risk, the company should find the probability and impact of each of them. After this, the company can discover some methods for decreasing the probability and impact of each risk factor and also consider different systems for controlling them.
9. One of the methods which the company uses for managing the risk is FMEA. The company applies this method in design (DFMEA) and also process (PFMEA) as well. By

using this method the company can recognize and analyze the failure modes and after that it can try to decreases the probability or impact of them. But decreasing the impact is so difficult therefore it is better that the company tries to decrease the probability and increase the control.

10. For finding and listing all the parameters which can create the risk in new project, the company compare design and practice with the standards described in various documentations and also uses managers' experiences. In the meantime there are some meetings with managers for this purpose in the company. In this meeting the company usually uses the Fish Bone approach for finding these parameters which can create the risk in the project. The Fish Bone approach involves all managers expressing ideas about parameters which can create risk in brain storming meetings. After this, the factors that are deemed to pose the greatest risk are selected. Sometimes the methods for solving or correcting problems can cause creativity.
11. The threshold line usually is fixed by high level management with paying attention to the customers' opinion. But it is better that the company considers the first %20 of top risk factors and after decreasing them, it can go to considering the second %20 and so on.
12. For getting the ISO/TS the company should consider the FMEA. This is one of the methods for assuring the quality. It means that the company should increase the quality and decrease the failures for customers.
13. Based on each industry there are different indexes and tables for FMEA which were made by expert people in each field. Also for customizing these tables and indexes based on this company, there are some meetings with different managers for this purposes and the company can improve these parameters after sometimes using and applying them.
14. The company recently tries to use this method (FMEA) in a systematic and written format and it can be said that in some part it act based on that.
15. If the company wants to solve lots of problems, it should use the FMEA method continuously. A main team for doing the FMEA and considering the different part of the company is needed. This team should include the different experts and based on kind of each project some expert staff should be invited form other divisions.
16. The company should apply the FMEA method in all stages, before and after implementation and even in creativity stage.
17. Some parameters have an effect on selection stage. One of the important ones is financial issues. The company considers the required numbers of employees, the final cost, amount of benefit and the time of achieving the result for each idea.
18. This company produces the glass plates and it has roughly 700 employees.
19. After incubation stage the prototype should be shown to customers for getting their feedback especially about the qualitative parameters.
20. Based on market's feedback about their needs and interest also amount of sale, the company makes the production plan and also decides about continuing or stopping the new product's production.
21. There is an iterative cycle between incubation and implementation stage for finding the probable problems and solving them.
22. After pilot production based on customers' opinion, market's feedback and inside controls, the company decides about the amount of production and going to mass production or otherwise sending the product to previous stages for developing it based on their received feedback.
23. After selecting an idea in selection stage the company tries to make the Gantt chart for this project and based on that follow the different stages in specific times. The company should complete the project based on specified time, since in longer time maybe the other competitors saturate the market by similar product and the value of new product will be

failed. So this Gantt chart is very important and should be prepared based on realistic situations, not very tough situations.

24. After implementation the most important duty of company is controlling the process. By this controlling the company can find the probable problems which are in need improvement.
25. Sometimes for improving the product the company should improve some processes, since these processes have an affect on the product's feature. The customers only see the product and their ideas relate directly to the product but beside this the company should consider the related processes as well.

Number of meeting: 4.3 (21.10.2008)
Research and Development Manager (R&D)

1. There are some sources for creativity like: customers, competitors and different researches which are done in the company. For instance the quality and new products of competitors always push the company to improve the current situation and going to new products for preventing the loss in the market share.
2. One of the important responsibilities of research and development division is creativity. The new ideas need the high level management's approval, so these ideas are explained in some meeting in order to decide about them.
3. Sale division has an important responsibility to receive the customers' feedbacks (opinion needs and so on) and convey them to the different divisions of the company.
4. The company selects the idea which has consistency with company's goals. In other word, considering the strategy fit is one of the parameters which has an affect on selecting the new idea. Also technical ability and profit are other parameters which company considers in selection stage.
5. Raw materials, technology, market and strategy are the parameters which have an affect on innovation projects and there are capable parameters for creating the risk in these projects.
6. For selecting the new idea, at first each division which this idea relates to their job (or maybe this idea is provided by them) considers this idea internally and after that it will be sent to high level management for final decision.
7. Market is one of the important parameters which the company should consider in selection stage. In other words, needs and request of market has a significant role on selecting the new idea.
8. Usually the different divisions try to document their own processes. If this documentation only relates to division, it stays in division, but if it is more general it will be sent to archive department.
9. The company is trying to identify alternative raw materials inside Iran, the company can then use these should any unforeseen problems occur with their foreign suppliers. Also we have begun replacing raw materials sourced internally with foreign ones.
10. After implementation stage the products should be controlled every time to make sure their quality is constantly similar to the approved prototype.
11. The company tries to encourage the employees which provide their new opinions for improving the situation. So it can be said that the company's atmosphere for accepting the new ideas is positive.
12. Sometime the company creates the new idea by inspiration of new competitors' products. In this situation the company at first analyzes this product and after that tries to improve the current situation for producing the new product with better features than the competitors' product.

13. Usually the situations of incubation and implementation stage are so different, since the scale in laboratory is smaller and the instruments are more precise than the implementation stage. So after approving the prototype in incubation stage, it will be sent to pilot production for checking the real situation and finding the probable problems in actual situations. After receiving the positive feedback in pilot production, the company produces the small amount of product for checking the market and after receiving the amount of market's need the product can go to the mass production.
14. Each division tries to consider the risk factors in their own division. Also usually for finding the parameters which create the risk the company asks all divisions to send their idea.
15. One of the important responsibilities of laboratory division (research and development) is analysing the raw materials and different process of production and approving the prototype by doing the different standard and technical tests.
16. One of the sources of creativity is the current problems in the company. So the company should control the process of production for finding the problem and tries to find the solution for them which sometimes results in creativity.
17. The company usually checks the quality of production based on regular format for finding any variation.

Number of meeting: 4.4 (21.10.2008)
Industrial Engineering Manager (Indus.)

1. Innovation always includes the risk, since the result is not completely clear before implementing that.
2. One of the important sources of creativity is current problems in the company, since most of the time the methods for solving these problems results in creativity. Also sometimes improving the current product and process can cause the innovation.
3. The company uses the TRIZ method for solving the current problems which sometimes results in creativity. TRIZ just gives the general idea and the company should change the results for a practical solution.
4. Another source of creativity is customers' needs. The customers' opinions come to the company through sale division. These opinions are sent to different divisions which are related to these opinions. Unfortunately the process of receiving the customers' feedback is not completely done in the company now.
5. Technical ability in the company has an important role in selecting the new idea. Strategy and resources of the company are other parameters which should be considered in selection stage.
6. Predicting the precise final expenses can help the company to select the proper idea based on financial ability. So this prediction sometimes can be a barrier in acceptance this idea by the high level management or create the risk, if the company cannot predict the final cost exactly.
7. Each company and industry has different situation for creativity in compare with others. Thus experience of employees has an important role for creativity in each company.
8. Accepting the new ideas and not resisting them has an important role in encouraging the employees for creativity. Sometimes the company uses non professional people for considering the new idea which has a negative effect on innovation.
9. Incubation stage plays an important role in the success of an innovative project as approving the complete prototype can causes success in other stages. So the company should employ a precise control system in this stage.

10. The company should consider the risk in all stages of innovation project. Also this is a continuous process which should be done all the times.
11. Risk management helps the company to implement the project with higher confidence, since the company will have an idea about the probable problems before they happen. Therefore the company can prepare itself for facing these problems and managing them.
12. Some of the risk factors are not too important for considering and solving, since their affect are not so imperative on the project. But some of them have a vital role not only on project but also on the company, so these factors should be considered and some methods for solving them should be found.
13. The worth of the new ideas has an important role on selecting them and accepting their risk with the company. It means that sometimes the company should accept the risk of some new idea because this new idea helps the company to survive in the market.
14. All processes usually are documented in the company.
15. FMEA is continues process and for using this method for managing the risk the constant team is needed. The company uses this method in some cases informally.
16. Current situation of company is very important and has an affect on kind of creativity (for instance current financial situation).
17. It can be supportive if the company creates the separate divisions which their responsibility is about managing the risk in the company. Also a pattern for managing the risk in innovation project can be so useful, but this model should be customized based on each company's situation.
18. Beside the product innovation there are some innovations processes in the company as well. For instance there was not enough space in the company for producing the damaged parts of one collection after producing the whole collection and sometime these parts were lost in the company and finding them was so difficult, by dividing the space of the company based on specific written format this problem was solved.
19. There are some main customers which buy the companies products and distribute them to other smaller customers (like different shops).
20. After receiving the feedback from the customers about the current problems in the new product, the company tries to find the cause(s) of these problems by using different models (like Fish Bone). For instance if the problem is a crack, maybe the company finds the new method for packing to solve the problem. The method for solving these problems should be in harmony with the situation of company and also decrease the cost and failure in the company. So the current situation of company has an important role in selecting the idea for solving the problems.

Number of meeting: 4.5 (22.10.2008)
Production, Planning and Control Manager (Prod.)

1. One of the sources of creativity is customers' needs and opinions. We receive information on customer's needs and uses QFD (Quality Function Deployment) to transform them into engineering characteristics for products or services. This method helps the company to select the best customer requests based on their current ability.
2. The company prioritizes the different requests and needs of customers and selects them based on company's ability. In some situations, implementing the customers' needs causes to increase the final price of product and consequently the kind of customers will be changed. Change in the customer may cause the company to lose the market share, since the rich customers which the company needs for buying the new products with higher price, go for foreign products with the better quality than the internal products. Thus the

company should pay attention in implementing the customers' needs. Maybe considering the behaviour of competitors in this situation is helpful for the company.

3. Needs and situations of market have an important role on creativity stage. After launching the new product in the market, the market acceptance has a significant role in success.
4. Goals and strategy of the company have a significant role on selecting the new idea.
5. Sometimes improvement (or innovation) causes the increase in the final price of product and the company loses the market share. In this situation the amount of investigation will not return to the company. So the company should decide about the level of improvement (or innovation) in a way that it does not lose the market because of the high increase in the price. It can be said that the final price of product in the market has an imperative affect on selection stage.
6. One of the sources of creativity is the current problems in the company. The company should find the problems in a systematic way, so the company uses the six sigma method for this purpose and brain storming meetings for finding the methods of solving these problems. Also there is a fixed and regular meeting in the company which name is management reviewing for considering the process of management of each project from various points of views (for instance based on budget, plan or customers' complaint) and finding the different current problems in the company. In some cases the outputs of this meeting can cause the creativity, since the company should find the answers for solving these problems.
7. One of the sources of creativity is employees' opinions. This is a mechanism in this company which name is suggestion system for getting the different idea of employees.
8. Sometimes other industries can be sources of creativity. It means by considering the new products in other industries the company can find some new ideas.
9. After selecting the idea the company makes a plan for implementing and controlling the project in different stages.
10. One of the sources for creativity is competitors. But the company should pay attention that their new product should have more features than their competitors' product, so the competitors should only play a role as inspiring.
11. The company tries to use the FMEA for managing the risk in innovation projects. Certainly the company needs a time for applying this method in the company completely, since the employees should be prepared for this method. Usually the company applies the 1, 3 and 9 for rating the different parameters in this method, since this far interval increases the power of decision and clarity (in close interval description is so difficult).
12. Based on kind of innovation which is improvement or completely new product, the amount and impact of their risk is totally different.
13. For using FMEA the company should make the constant committee which based on the nature of each project different employees from different division join this committee. This committee has responsibility to consider all projects and managing their risk.
14. Some other parameters which have an affect on selection stage are: required resources, organizational structure match and so on.

Number of meeting: 4.6 (30.10.2008)
Production Manager (Prod.)

1. Some of the innovations in this company are based on employees' opinion (For instance, improvement of compiler in furnace).
2. Customers' feedback is one of the sources of creativity in this company. The company should consider the customers' needs and opinion in this stage. In some cases the

competitors' products would help the company to get some idea about the customers' need, thus the company will add another feature to these competitors' products in the market and improves them which would make them more popular.

3. Sometimes the customers cannot explain their needs vividly; on the other hand, the company in order to survive needs to make new needs for customers. Thus the company tries to make new needs for the customers by inventing and providing different kinds of new products in order to help them recognize their new needs. But the company should consider that bombarding the customers with many new ideas would cause the delay in the customers' decision, so there should be a proper interval between providing two new ideas.
4. One of the important issues which should be considered in selection stage is financial issues. The company should consider their financial ability, amount of investigation and benefit of each new idea in order to select the proper ones. It is important to say that one of the important goals of company is finding the more benefit.
5. Culture has an essential role on selecting the new ideas in selection stage. As Iran is a large country with different regions and cultures, the company must recognise the culture of each area. In order to do this the company divides Iran into a number of regions and each region has its own director. Sales representatives within each region send ideas and information to their local director, who then assembles pertinent information about the culture and opinions of the area, enabling the information to be used at the selection stage.
6. Company's technical ability is another criterion which has an affect on selecting the new idea. Sometimes for doing the new idea the company needs to buy new machinery or hires new expert employees, so by considering all (e.g. the expense of this new technology) the parameters the company should decide about selecting the new idea.
7. Since the company has ISO 9001 all processes should be documented based on this ISO. For this purpose there are different formal forms in the company. Also there are some training courses for increasing and transferring the knowledge to employees.
8. Two important parameters which have an affect on stopping or continuing the production of new product are markets' needs and customers' opinion about this product.
9. After incubation stage and before going to implementation the prototype is shown to customers for receiving their opinions about this new product, since these opinions have positive affect in order to gain success. Usually changing the prototype based on the customers' opinion is not major in this stage and most of them are minor.
10. For getting the customers idea the company uses the sale representatives who know the opinion of customers. It is important to say that in some situations the sale representative can affect on customers' mind.
11. Market, management structure, technology and weather (affect on the instrument and transportation) are some parameters which can create the risk in innovation projects. Another important parameter which has capability to create the risk and the company should consider is time of production. For instance there are some religion and national events in Iran which in each of these events some kind of products have more customers.
12. The company tries to support all new ideas even after receiving the unsuccessful result. Usually the company dedicates one percentage of its amount of sale for innovation and often the company receives more successful results than the unsuccessful ones.
13. One of the important parameters which can help the company to implement the risk management and control risk factors in a better way is experience. In companies which do not have enough experiences a lot of new risks may happen, but this situation in experienced companies happens rarely.
14. There are different kinds of innovation in this company. For instance some of the products broke in one stage of production, but the company changed the quality of raw materials and resolved this problem.

15. One of the parameters which can create the risk in projects of innovation is political issue. Also sometimes the political issue can be the source of the motivation for creativity. For instance current international sanction of Iran causes to increase the length of the period of receiving the row materials and also increase the expenses, so for facing to this situation the company tries to be more independent, consequently the company should be going to creativity.
16. The company tries to apply the FMEA for managing the risk, although until now the company does not apply this method completely in all projects. So in some cases the company uses the managers' experiences for finding and analyzing the risk factors. Some of the risk factors are common (for instance: raw material, energy and so on) and the company considers them in all projects normally, but some of them are unclear (for instance: breakage) and the company should find them during the process based on the kind of the project.
17. Sometimes the company uses the new products of foreign companies and tries to produce the similar products. But in these cases the company attempts to improve these products and change them based on internal culture and markets' needs. It means in these cases also the company efforts to apply some creativity.
18. It can be said that lack of the internal powerful competitors has a negative affect on the company, since the customers do not have wide range of ideas and can not send the valuable feedback to the company.
19. The company for surviving in the market needs creativity, since the foreign products are imported in internal market. On the other hand the company export its products to some different countries which have high competition.
20. Usually in pilot production the company uses the employees from different divisions by different expertise (for instance: technical manager, production manager and so on) and also employee(s) which provide this idea for considering the situations and probable problems.
21. After pilot production the company shows the product to the customers for finding their opinions and also finding the amount of markets' need for production planning in mass production. Also amount of sale has an important role for continuing the mass production.
22. The first activity (forming) in the implementation stage is the most important part of producing the products, that if becomes successful, the next two other activities usually become successful as well.
23. A team consisting of different experts from different divisions (for instance from technical, production, laboratory division etc.) consider the new idea to find out if the idea is technically applicable.
24. For each new product there at least 36 moulds required and each mould should be replaced after 8 hours for repair.

Number of meeting: 4.7 (30.10.2008)
Technical Manager (Tech.)

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1. In some cases the company uses the employees' experiences in order to gain the parameters which create the risk and finding probability and impact of them.
2. Raw material and the lack of skilled labourer are two parameters which can create the risk in the innovation projects
3. The company usually considers the technical ability in the selection stage. Thus for this purpose the idea of technical division is taken (for instance the ability of machineries to produce new sizes of product).

4. One of the important problems in selection stage is financial issue. It means the company should consider the amount of investigation, profit and current financial ability of the company in selecting the new idea.
5. High level management's opinions usually affect on selecting and implementing the new ideas.
6. There are some control systems in this company for monitoring the process of production. For instance, there is a proactive and regular system which is used to check the machineries to prevent any malfunction happening. Therefore, the company should not wait until something wrong happens rather it should prevent it.
7. There are some innovations in technical division as well. For instance using the sensor for specifying the input and output of the raw materials.
8. Implementation stage consists of three activities which are: 1- forming (shaping the raw materials plus one stage of furnace) 2- labelling and designing 3-packaging.
9. Two methods for producing the products in this company are: 1- moulding 2- spinning.

Case 5: Scottish Southern Energy (SSE)

Number of meeting: 5.1 (30.04.2008)
Director of Energy Services (Ene.)

1. Remit to deliver low carbon energy to customers in a sustainable and affordable manner.
2. There are 3 categories of customers:
   - building
   - commercial
   - domestic
3. One example of a recent "failure" is the SWIFT wind turbine. This is a small scale wind turbine designed for domestic use costing £10000 with a design output of 1.5kW but in practice the output was much lower (10W?). The turbine was tested in the wind tunnel used by Mclaren for formula 1 car testing; this test suggested excellent performance. However, the turbulence found in domestic locations was very different to the liner flows of the wind tunnel. The wind turbine was installed in 100 trial locations, with detailed monitoring: this quickly revealed that the performance was far below that necessary to be a potential "affordable" supply for customers.
4. It appears that there was some dispute about responsibility and relations between SSE and SWIFT deteriorated such that although the problem was technical the breakdown in the relationship meant that no solution was possible. RC claimed that there had not been "due diligence". In particular it appears that the responsibility for the test specification (e.g. roof top not tunnel test) was not clarified.
5. Later inspection by www reveals that SWIFT are selling this (or similar Product).
6. Solar Century is another venture. There are two products: the C21 photovoltaic tile which could be regarded as a proven, core technology and the solar thermal ? tube.
7. The proven PV technology can provide 2kW for £113 per month, for a 5 year contract.
8. The typical route is to undertake the initial implementations in commercial sites and then transfer to domestic (and industrial?) later, once the operation is proven.
9. New Ventures are responsible for the acquisition and "diligence" of technologies, e.g. biomass.
10. Geothermal International (GI) provide ground source heat pumps. They have an installation at Stirling University though at present it is not yet operational. The technology itself is proven (e.g. it was seen working at St John's Wood) but local implementation is not yet routine.
11. GI (or an equity share?) was bought more hastily than might seem desirable since an imminent tax change forced a quick decision.
12. There is considerably more interest in microgeneration as a result of the requirement in London and Edinburgh to achieve a 20% energy saving/ CO_2 emission reduction on site for new build. The heat pump is a potentially good way of meeting this requirement. Typically electricity generation implies that electricity is 40:40:20 gas:coal:nuclear. Using heat pumps reduces the C impact considerably (though some electricity input required, approx. 1:4 advantage). However, if the heat pump were displacing gas use the C effect would not be so great.
13. Logan Energy (?) fuel cell is an example of a venture that has no expectation of a short term payback. Although the basic technology is proven it is expensive, there is no H_2 infrastructure and little experience in installation and maintenance in a real implementation. H_2 fuel cells have many safety issues which have been solved but at a relatively high cost. SSE invested in LE to develop experience in this technology such that they will be in a good position to benefit in the medium term if this approach to micro-generation takes off. One installation is in the US embassy flats. A major question is the development of a H_2 infrastructure but this would be

most sensibly provided by the major oil companies using their experience of liquid fuel distribution.

14. A risk assessment was undertaken of LE before investing, this covered: SWOT, finances, market sector analysis, reputation of the company. If a proposal passes the risk assessment a detailed investment plan is developed (financial, time schedule, resources.
15. But RC has no knowledge of any formal risk assessment protocol; S D might be able to help.
16. One approach to investment is "pre-emptive" investment. This involves an initial investment and then having a right to buy more equity if the venture succeeds.
17. Sometimes SSE might arrange exclusive deals with the objective of excluding competitors from access to certain technologies/ markets.
18. The ultimate objective for SSE is to offer a range of energy options for their customers, encouraging them to remain with the company.
19. Display panels are another approach: better monitoring of electricity use and an understanding of the relationship between consumption and the environment (e.g. external temperature) enables the customer to use energy more efficiently.
20. SSE have a portfolio of interests: some proven, others not. Examples of non-proven would include: wave (Polaris) and tidal e.g. screw 20% investment. A short term return is not expected.
21. He explained the importance of considering the final cost for providing the product to customers in incubation stage
22. Reliability and customer have an important role for selecting the idea.

Number of meeting: 5.2 (30.04.2008)
Corporate finance (Fina.)

1. JR's role is to provide expertise in investment appraisal of any capital project across the whole group.
2. JC and Andrew provide input for forecasting.
3. Examples include: energy sensors, small scale CHP, gas storage. But also mergers and acquisitions (M&A); often invest an equity stake (e.g. 10%-20%).
4. JR appraises onshore wind proposals though these are now well established and the appraisals are routine. A "hurdle rate" for the IRR is set and the proposal tested. JR's role includes challenging the estimates used in the appraisals, requiring the "experts" to justify their inputs.
5. A wind farm analysis involves: CAPEX (capital expenditure), capacity/ production and wind availability, government subsidies (which could change in the future).
6. Establishing a hurdle rate involves: cost of capital for SSE + risk premium dependent on various factors: construction, market, government policy, whole sale prices, technology, mergers & acquisitions, collaboration. In this way a basic rate (reflecting cost of capital) might be 8% but the addition of various risk premiums could result in a hurdle rate of 15%. E.g. the hurdle rate for an onshore wind farm is now lower than it used to be since the technology is better understood.
7. Before the SSE merger, @Risk was used but "you can analyse too much"; the output was "over the top"; managers would receive bulky outputs which were ignored. There used to be a separate risk analysis department/ section but now the risk analysis is more embedded in the routine appraisal/ management (e.g. the use of tornadoe (?) diagrams).
8. Now the appraisal just uses a comparison of the estimate IRR with the specified hurdle rate, including some sensitivity analysis. The Board paper will include a sensitivity matrix (just considering a few optional values).

9. In addition to the financial appraisal, there is a "due diligence" exercise involving input from various staff (e.g. engineers) contributing to the assessment.
10. When considering investment in a new technology, through investing in equity, the risk is managed by ensuring that SSE has a reasonable portfolio and also just buying a % share of equity. There is always the risk of not being involved in a new development that has to be compared to the risks of involvement.
11. When deciding the appropriate level of risk analysis, need to consider: time available to perform the analysis, possibility of information overload for senior managers, need to avoid stifling innovation.
12. The 100MW Fort Augustus scheme involved many analyses
13. Some ventures require a quick decision and a rapid assessment.
14. The hurdle rates/ risk premiums are reviewed periodically. This provides a structure for considering risk. The hurdle rates are a common language helping a debate about risk, whereas as the @Risk analyses clouded the issues. Decision makers are familiar with this language. New or occasionally used techniques might not be appreciated and introduce communication problems.
15. The most important barriers that block the implementation of the risk management model are time of project

Number of meeting: 5.3 (30.04.2008)
Business research analyst (Busi.)

1. SF joined SSE two years ago; her main role was to bring "fresh ideas". She claims that her views are not typical of those found in SSE.
2. One of her roles is to lead a central research unit, a "foresighting team" which examines geopolitical issues (e.g. the politics of gas supply) and trends in vehicle and fuel needs.
3. A specific interest at present is RDF (refuge derived fuel).
4. Creativity can be stimulated by various means e.g. customer feedback, legislation changes. E.g. can palm waste (not the palm oil itself) be used as a fuel?
5. Then consider the engineering: using waste as part of the fuel input to power stations was not deemed acceptable: too variable and risky. At this stage the finances are not considered. There are insufficient data to make any financial appraisal useful.
6. But during the "selection" more information is collected and a more formal risk assessment is possible. However, given these projects are par of a bigger portfolio the total risk to SSE may not be great.
7. There was an existing clean biomass sector but waste biomass introduces new problems. However, some of these are similar to those encountered with any solid fuel (logistic, storage).
8. Part of the investigation for RDF was expenditure on engineers' visits to Germany to investigate boilers.
9. Only after such technical assessment is it sensible to consider IRR and hurdle rates.
10. RDF may be burnt in a fluidised bed boiler: Slough Heat and Power were bought to provide this expertise.
11. The basic process is waste: fuel: energy. Part of a risk management strategy would be to share the risk in an intelligent manner, e.g. joint venture with waste companies in owning a power station. This would provide an incentive to help ensure a reliable supply of RDF to fuel the power station. The financial risk associated with such a venture is being investigated.
12. The individual components of this project have been proven (sorting of waste and burning): the innovation lies in the combining these elements effectively.
13. Risks lie in the supply chain, ensuring a reliable delivery of fuel (see 11) and the markets (e.g. process of inputs depend on competition for the supply) rather than any technological risk.

14. Another approach is the use of anaerobic digesters (of sewage) to generate methane or biogas (sour gas, not pure methane). This is in contrast to gasification which produces "synthetic" gas from clean biomass (e.g. woodchips) which has been rejected by SSE (why?) after studies but there is a "watching brief" to monitor this technology.
15. In general SF is concerned about the lack of "probing": often insufficient questioning and analysis.
16. There are few formal learning mechanisms: practice is exchanged informally with no protocol (except the risk committee).
17. There is a need to energise the creativity to selection stage. Risk management is appropriate later. Volunteers need to be encouraged to champion ideas.
18. There is no formal process for the first stages (creativity) of innovation. This is because the employee should be thinking about new ideas as part of their job.
19. Incubation and implementation are most important phase in process of innovation

Number of meeting: 5.4 (5.05.2008)
Project manager (Proj.)

1. He is an electrical engineer but has moved into project management, energy trading and strategy. Markets and regulations are particular risk which affect energy strategy.
2. His role is to examine new concepts, answering the question: "What should we get into?"
3. IM is involved in both creativity (concepts) and implementation (markets).
4. SSE is operating in an environment of market risk: EU/ UK legislation; price; geopolitical risks (e.g. security of Russian gas supply, carbon price, food vs. fuel).
5. IM considers new UK/ EU proposals and collaborates with other companies/ organisations to co-ordinate lobbying. For example, the UK's subsidy/ support for renewables can vary: the value of renewable obligation certificates (ROC's) can change (1.5:1.0:2.0 for biomass:onshore wind: offshore wind). The terms of the EU exchange for carbon may be altered.
6. "Big CHP", e.g. Michelin has been in incubation but changes in subsidies now make such schemes less attractive and SSE have stopped active development. This is an example of how (prospective) changes in legislation/ subsidy (EU and UK interactions) require a review of technologies and SSE interests.
7. SSE buy contracts for fuel but do not invest in the supply chain.
8. In one of SSE's projects a question was posed: how can SSE get biomass crops into London cheaply? It is not possible to buy ahead in biomass, so should SSE invest long term in biomass given the unpredictable nature of the supply? Perhaps SSE could buy or lease land?
9. Since Christmas the business has been restructured such that there is a more formal reporting structure to senior management. In particular, market risk is considered at an early stage.
10. IM is involved at an early stage, encouraging developments that fit the UK/EU strategy and questioning the supply chain (reliability/ price).
11. IRR is employed at an early stage, using approx. estimates.
12. The SSE "licence to innovate" is meant to encourage innovation. It enables direct access to the Chief Executive, though this could deter some staff. SSE is not best exploiting employees' thinking power; there is a need for small "think groups" to generate ideas. Management tend to follow traditional routes, reflecting the management targets which do not explicitly encourage innovation. There is a lack of innovation in SSE but it is not due to a fear of risk or risk management. Some individuals may lack confidence outside their own areas of expertise.
13. Perhaps risk management could be interpreted as finding knowledge to reduce uncertainty?
14. There is a reluctance to innovate in SSE: it depends on individuals.

15. SSE's mission has changed; it was very much focussed on reducing costs but now there is a genuine mission to achieve sustainable (e.g. low cost) low carbon alternatives.
16. Some barriers for managing the risk is coming from commercial team and economic team
17. On of the important criteria for considering at incubation stage is technical success and at implementation stage is commercial success and market.

Number of meeting: 5.5 (5.05.2008)

Risk manager (Risk)

1. JC used to work in risk management (e.g. commodity risk: electricity, gas, carbon, fuel oil, coal prices); now works on acquisitions and lobbying.
2. Typically the quantification of commodity risk involves scenario generation. This provides an input to 5 year forward profit and loss (P&L) estimates and decisions about acquisitions & mergers and whether to invest in/ buy companies. The scenarios might be low/ base/ high reflecting a political analysis.
3. JC is largely involved in proven technologies but he could be asked to advise on new sources/ markets e.g. H_2
4. Liquid Natural Gas has been rejected by SSE following scenario analyses. The analysis considered: getting the gas (more challenging: unreliable supply?); shipping and "regas" at the market end.
5. One approach to risk management is not appropriate: there is a need for some adaptation to suit particular situations.
6. The risk committee does not have a specific set of criteria; there is no broad template.
7. The present approach might well fail to capture or exploit all experience in SSE. SSE might be too big for an informal system and a more formal approach (e.g. risk register) might prove to be more useful. This process could form part of the selection stage; collecting relevant experience (e.g. by the project team) and recording it in the risk register which would develop as part of 'due diligence'.
8. JC has been involved in lobbying (gas) e.g. the code for shipping/ transhipping gas. A proposal by the national grid to allow more variation in gas pressure (different specifications in winter and summer) would make gas management easier but it would have affected the turbines.
9. Lobbying could be viewed as contributing to innovation and risk:
   - lobbying can result in change and a stimulant for innovation providing new opportunities;
   - but lobbying can also stop change and reduce risk
10. Risk management might be considered positively as being supportive, identifying a need for more information and acting as a mechanism to encourage the provision of more knowledge, as well as acting as a filter, blocking some ideas.
11. There is a balance between risk and creativity: risk management needs to avoid too many onerous controls.
12. Risk management is a ongoing process and should be consider in all stages.
13. SSE uses financial approaches for prioritizing the risk.

Number of meeting: 5.6 (6.05.2008)
Business development manager-Energy Services (Busi.)

1. SSE has undergone radical change following the merger of hydro-electric and southern electricity 10 years ago.
2. SSE is not an innovative company. SSE invests in other people's innovation but do not themselves innovate.
3. "Ventures" is just 18 months old but it has existed in other guises earlier. This area is now a lot more active.
4. The emphasis on developing more low carbon energy sources is the Chief Executive's personal initiative. However, it is a real mission and not just a branding exercise.
5. AS has been in this role for just 1 year. Energy Services core objective is to add customers to the SSE account and to encourage long term accounts; the low carbon initiative is seen as enabling SSE to offer a more attractive package, such that customers can obtain a range of energy services from a single source company.
6. Energy Services just use reliable technology.
7. AS is mainly involved in the implementation and learning aspects of the innovation process.
8. For example, CHP is well established in the industrial environment and now trying to extend its role to domestic use, i.e. it is the implementation/ environment that provides the innovative element. It is desirable to have a mixed use CHP (commercial/ industrial and domestic) since this provides a smoother load profile. Gas fired CHP involves generating electricity and using the associated heat in district heating.
9. Customers are now asking about the availability of renewable powered CHP, e.g. biomass (so AS is also involved in the "creativity" element of innovation?). The problem is that the reliable technology needs 2-3MW demand, or more, to ensure the efficiency of the steam turbines. Most CHP schemes just require 1MW. However, perhaps there are other solutions, e.g. gasification or direct burn of the biomass? The challenge is to deliver the technologies on a small scale.
10. AS's job involves him reporting the customer interest to the "Ventures" team, asking for renewable CHP. E.g. rooftop wind generation, PV, anaerobic digesters and biogas, fuel cells?
11. CHP always involves incorporating back up technology to guarantee supply.
12. There is no formal mechanism for learning at SSE. For example, I have been learning by himself during the past year by visiting potential clients and discussions with colleagues: it is all informal; no documentations, workshops or seminars.
13. The fuel cell investment was not based on CHP demand.
14. The ground source heatpump decision to invest was based on an assumption that it would be a valuable "extra string" for Energy Services, i.e. extending the portfolio of options that SSE can provide. However, there are fundamental problems in integrating ground source heat pumps in CHP. It provides a steady supply and would require another form of generating capacity to deliver a full CHP (to respond to variable demand). A combination would mean that the demand for each source would be lower and lower demand is difficult to provide efficiently (e.g. see 9). However, in some situations perhaps a combination could be sensible, e.g. a district heating scheme involving one CHP source for the dense, central area and ground source heat pump(s) for low density surrounding areas. This is an example of the considerations necessary when assessing risk (classified as integration (with other systems) risk?).
15. A general problem at SSE is that technologists are involved in "creativity" and "implementation" but not selection/ incubation (given that SSE innovation involves contracting out all of the actual engineering via other companies).
16. With an organisation the size of SSE it is difficult to devise a system for exploiting expertise fully.

17. The SSE executive is trying to change the culture of the company but the motivation is largely from the present Chief Executive. He used to be finance director; his predecessor was "the least innovative person in the world" and very keen on control.
18. It has to be remembered that a few £10 million is a small amount for a company such as SSE: risk management is perhaps not so important when the consequences of failure are not dramatic.
19. One of the important criteria for considering at D5 is commercial success.
20. Is better to change the position of stop and continue and moving them to decision point 4 (D4)
21. Implementation and learning are most important parts of process

Number of meeting: 5.7 (6.05.2008)
Business development manager-Energy Services (Busi.)

1. GW is responsible for 3 staff involved in community and commercial wind. This typically involves installing a large wind turbine with a direct feed to the factory/ demand. There is no grid connection with associated costs. There is such an installation at the Michelin factory in Dundee (though this is not an SSE project; none of their projects are operational yet).
2. SSE finance the build, operation and maintenance of the turbines and guarantee a specified electricity supply for 10 (could be 12/20) years at a fixed price, or may be linked to retail price index (RPI): Jamie Reid constructs a financial model for the assessment of such schemes. However, there is no guaranteed minimum supply at any one time period (just longer term (week/month/year?). the customer must buy x% @ £Y per MW-hour.
3. In theory surplus electricity ("spill") could be sold to the grid but given the unpredictable nature it commands a low price.
4. The primary risk is the wind resource. If the mean wind speed is less than 6m/s the project cannot be justified; power curve such that output reaches maximum at 14 m/s, remains constant and then turbine has to be switched off at 25m/s due to safety/ damage potential.
5. The stages involve:
    - desk top initial feasibility study, e.g. referring to UK wind mapping (costing £75);
    - more detail desk top feasibility study, e.g. proximity of surrounding buildings, obvious air traffic issues, major environmental factors; (£3000?)
    - discussions with all statutory bodies (local council, Scottish Natural Heritage, air traffic, Ministry of Defence (£25000)
6. A community wind turbine project in N.Scotland involves adapting an already advanced scheme.
7. Could the safety risk principles be applied more generally: Eliminate Reduce Isolate Contain.
8. GW is concerned with innovation in implementation/ commercial phases of the process.
9. The schemes are attractive to customers since they provide some stability in energy prices: £27/ MW hour in 2007, £98/ MW hour in 2008. In addition they provide renewable obligation certificate (ROC) revenue (worth £31.58 per MW/ hour?); the schemes also contribute to the target 9% of all energy generation. must be renewable.
10. Customers are also motivated by "corporate social responsibility".
11. The class II wind turbine operates at a lower speed (suitable for low altitude location such as these community and commercial wind applications). They have larger blades (82m or 92m compared to the standard 70m on hill top sites).
12. There are some operational/maintenance risks, e.g. gearbox failure, but since SSE have 100's of wind turbines they have an understanding of the problems (and the risk).
13. All of the components of these schemes are well known; the innovation is the combination in a community/ commercial package.

14. This application could stimulate innovation in the wind turbine design itself, with the demand for low wind speed turbines but this would be a general response to the market rather than being SSE specific.
15. There is a world shortage of wind turbines: manufacturers have the advantage at present. Some have vertical integration, owning gearbox and blade construction facilities; others just buy in components. There is a great premium on reliability, which can be hard to demonstrate if you are a new entrant to the market: this act as a major barrier to entry.
16. The construction risk is low but the transport to the site can be a source of risk (bends, need to reinforce drains). Crane work when erecting the turbines depends on low wind, and there are restrictions on working.
17. While a risk checklist could be useful, some risk is hard to classify, e.g. political, local planning. There is no overall risk register but this might evolve. As more projects emerge there will be the possibility (and need) for a more formal approach to risk. Indeed Cath Cooper has started to develop a risk log, including control actions.
18. In general GW believes that SSE have a reasonable attitude to technical and operational risk but not political risk. For example SSE have a relatively poor record in planning enquiries: even though they are usually successful they are always time consuming and cause delay. Other organisations seem to avoid the need for so many.
19. Recently SSE bought Airtricity; they have a substantial wind capacity but also experience in managing consultation/ avoiding planning enquiries which can take 2/3 years, and sometimes 5 years.
20. There is no formal risk register; just informal process.

Number of meeting: 5.8 (06.05.2008)
Technology Development Ventures (Tech.)

1. He has a bachelor in mechanical engineering and also has some experiences in risk
2. He is specifically working on venture management
3. There are two kinds of venture: direct investment and existing fund investment
4. There are different reasons for venture management: return on investment, Staff knowledge, bringing capability to the group …
5. Funds is more important for finding technology
6. Fuel cell has a niche market in energy market
7. Using scenario for predicting the future
8. Tariff is important part of process
9. Risk register is important in managing the risk
10. Some key risks are: economy, and staff
11. The staff of SSE have viable and creative ideas. The problem may then be related to the inability or unwillingness of them to develop or nurture their ideas into a viable business plan.

Appendix 4 – Covering letter

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بسمه تعالي

مدير عامل محترم

با اهداي سلام،

اينجانب عليرضا خوراكيان دانشجوي دكتراي مديريت در دانشگاه استرلينگ (در كشور اسكاتلند) مي باشم. پروژه دوره تحصيلي اينجانب در زمينه بررسي ريسك در پروژه هاي نوآوري است. همانگونه كه مستحضريد نوآوري همواره داراي ريسك مي باشد. لذا چگونگي كنترل اين ريسك به گونه اي كه اصل فرايند مورد صدمه قرار نگيرد، بسيار با اهميت است.
جهت دستيابي به فرايندي علمي، اين موضوع نيازمند بررسي در محيطي واقعي (تعدادي شركت با قابليتهاي بالا و توانمند در امر نوآوري و توليد) مي باشد. نظر به اينكه اينجانب علاقه مند به بررسي اين موضوع در كشور عزيزمان مي باشم و همچنين با توجه به جايگاه و توانايي شركت شهاب خودرو؛ خواهشمند است در صورت امكان دستور مقتضي جهت بررسي اين موضوع در آن شركت را صادر فرمايند.
فرايند بررسي شامل مصاحبه با تعدادي از متخصصان مجموعه در زمينه هاي مختلف (تحقيق و توسعه، توليد، ريسك و ...) مرتبط با پروسه نوآوري است. لازم به توضيح است، اينجانب متعهد به حفظ اطلاعات بر طبق خواست آن شركت مي باشم.
پيشاپيش از بذل توجه حضرتعالي به تحقيق و پژوهش در موضوع نوآوري كمال تشكر را دارم.

با احترام
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To whom it may concern

Alireza Khorakian

I am supervising Alireza Khorakian's PhD study of **Risk Management in Innovation** based at the University of Stirling. Innovation always involves risk. However, many people claim that risk can be managed and contained. Alireza is investigating the different attitudes to risk in the innovation and commercialisation process. A vital part of his study is to compare real practice with the academic literature. It would help his study greatly if you were able to share your experience of innovation and the risks that you encounter.

If you would like any more details or would like to discuss this research project further please contact me. Alireza has a very good academic record and is most dedicated to his PhD study. Both Alireza and I would be most grateful if you were able to support this project by providing access to relevant staff.

Yours sincerely

J A Bowers

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UNIVERSITY of STIRLING MANAGEMENT & ORGANIZATION

Appendix 5 – Content analysis of the interviews

A5. 1 Criteria's relative importance in creativity

Percentage of interviewees who mentioned these criteria in case 2 (FT) are shown in Figure 5A. 1. As this figure suggests, the general pattern of the case 2 profile is roughly similar with the synthesis cases. In this company, "customer feedback", "employees' opinion" and "competitors" have an important role in creativity stage.

Although Figure 5A. 1 suggests that the difference between "technology" in case 2 and synthesis is not large, however based on detailed texts of interviews it seems that "technology" is an important (or is of perceived importance) criterion in this company. This situation might be because of the fact that the competition in this industry is high (Section 6.1) and the company needs to follow new technologies.

Based on detailed texts of interviews in FT company (Section 6.1.1), ideas from outside of company (such as other industries, raw material supplier) can have an impact on the creativity stage. So as Figure 5A. 1 suggests, the "outside company's opinion and opportunity" is an important (or is of perceived importance) criteria in this company (although the difference between this criterion in case 2 and synthesis is not large in the figure).

It seems in case 2 the "strategy" and "previous documentation" are not perceived as important criteria at this stage. Although some interviewees said that the technical reports are archived (Section 6.1.5) in the company, they did not say anything about using the previous documentations for creativity.

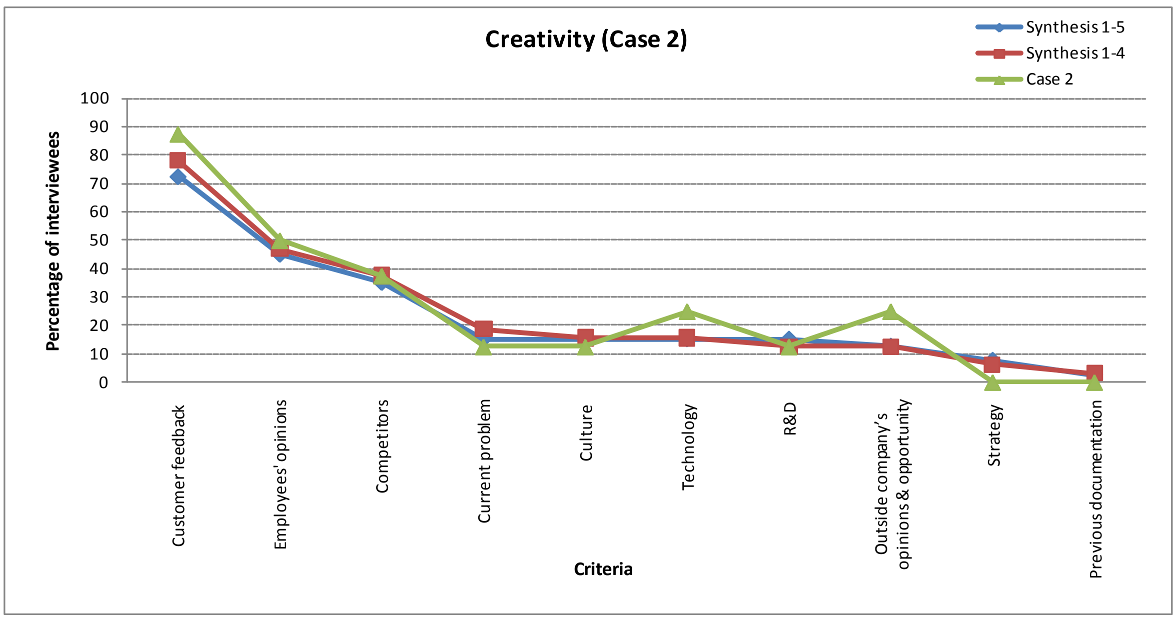


Figure 5A. 1 - Interviewees (*n*=8) referring to creativity criteria in case 2 (FT)

Figure 5A. 2 shows the percentage of interviewees in case 3 (RDPC) who explained these criteria. Based on this figure it is possible to explain the difference between importance (or perceived importance) of these criteria in this case in comparison with synthesis cases.

As discussed in case 3 (Chapter 7), some years ago this company only had two main competitors but now there are more than 30 (not including some small ones). It means there is a competitive market in this industry. Also, these competitors in some cases change the culture of customers and they entered their new products to the market (e.g. changing the customers' preference to use UF cheese instead of the salted ones; see Section 7.1.1). These situations show the significant role of "competitors" in this stage. In addition, since there are different cultures and regions in Iran and each one has its own taste (for instance the north of Iran prefers the sweet yoghurt and south of Iran prefers the sour one; see Section 7.1.1), considering the "culture" of target market is perceived as important in this company. Because of this diversity in culture, the company usually receives different kinds of feedback, which in some cases are opposed with each other. The company should select their market based on their strategy, firstly. So based on detailed texts of interviews it seems that "strategy" has plays a considerable role in this company, although Figure 5A. 2 suggests that the difference between strategy in this case and synthesis is not large.

Because of the structure of management in RDPC company (hierarchical; see Section 7.1), as the Figure 5A. 2 suggests, the percentage of employees who explained the role of "employees' opinion" is lower in creativity stage than synthesis cases. Also because of this structure that the process of decision is long; usually the "outside company's opportunities" do not play an important role in this company. "Outside company's opinions" are frequently related to raw materials supplier which seems to not have an important role in this company since the main raw material (milk) is in constant supply in this company.

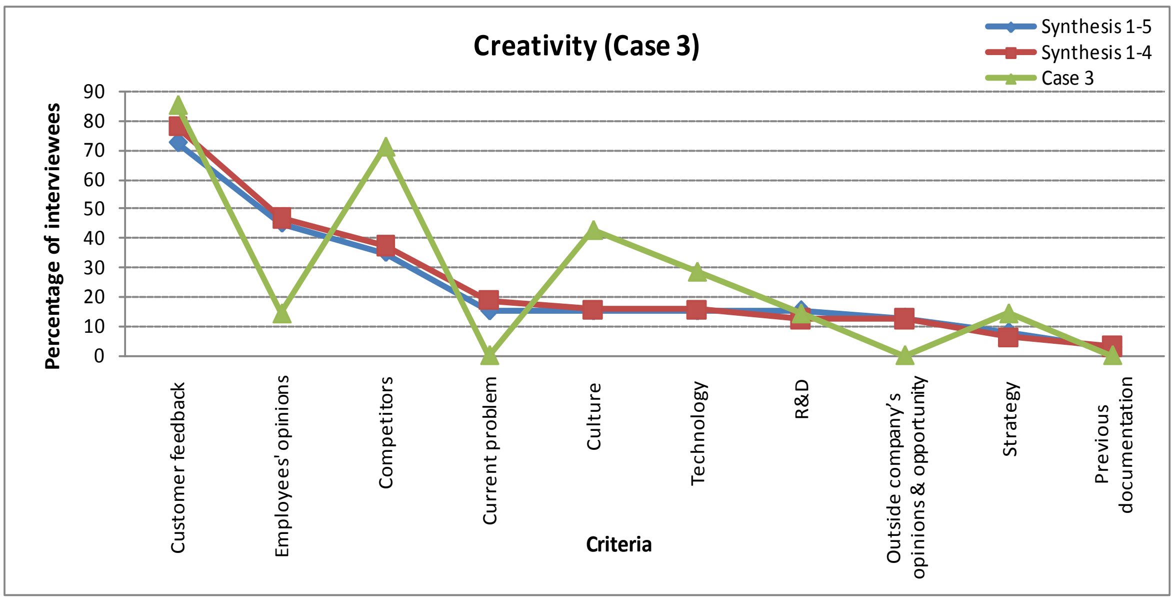


Figure 5A. 2 - Interviewees (*n*=7) referring to creativity criteria in case 3 (RDPC)

As Figure 5A. 2 suggests "previous documentation" and "current problem" are not perceived as important criteria in this stage for RDPC company. Although employees said that technology within the company is worn out (Section 7.2.1), "current problems" are not perceived as an important source of creativity. Possibility since the role of "employees' opinion" is not significant in this company, the employees are not being given enough motivation help solve current problems. Therefore the role of "current problem" is not perceived as an important criterion in this company as a source of creativity.

The percentage of interviewees who explained these criteria in case 4 (SJT) are shown in Figure 5A. 3. As this figure suggests, the importance (or perceived importance) of the "current problem" in this case is more than synthesis cases. It seems that because of the novelty of technology, current problems are unusual and it is probable that knowledge and expertise is lacking within the company. The company will usually employ some scientific methods (e.g. TRIZ; see Section 8.1.1) for solving current problems, which can sometimes result in creativity.

Since SJT company is one of the most developed companies in this industry, as Figure 5A. 3 indicates usually the “technology push” does not play an important role in the creativity stage. Based on Figure 5A. 3 it seems that “strategy” and “previous documentation” are not perceived as important criteria in this stage. As will be shown in Section 10.3.3 the company puts stress on strategy in the next stage (selection) instead of this stage.

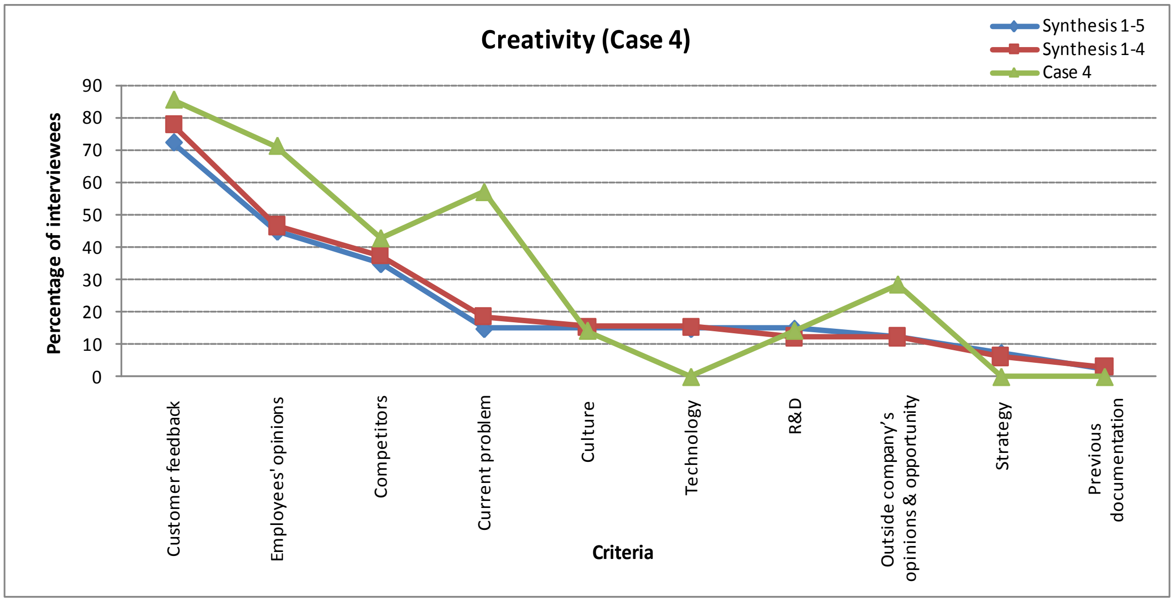


Figure 5A. 3 - Interviewees (*n*=7) referring to creativity criteria in case 4 (SJT)

Based on Figure 5A. 3 “outside company’s opinions and opportunity” is a source of creativity within SJT company. As discussed in case 4 (Section 8.1) new ideas can come from inside or outside the company. For example, interviewees said that raw materials suppliers or visitors to the company can be a source of external creativity.

Figure 5A. 4 shows the percentage of interviewees in case 5 (SSE) who mentioned these criteria. Based on this figure, is it possible to explain the difference between the importance (or the perceived importance) of these criteria in this case by comparison with synthesis one. As this figure suggests, the general pattern of the case 5 profile is quite similar to the synthesis cases. Perhaps the generally lower percentage recorded for this case reflects a more structured management with clearer demarcation of responsibilities. For instance staff have a responsibility to be concerned about “customer feedback” but other staff may not regard it as within their remit.

In SSE the “customer feedback”, “employees’ opinions”, “competitors” and “R&D” are four criteria which were of most concern in the creativity stage than other criteria (although “culture”, “technology”, “outside company’s opinions and opportunity” and “strategy” were also seen as important by some people).

Although “employees’ opinions” has a significant role in this stage however interviewees believed that SSE does not fully utilise its employees’ thinking power (Section 9.1.1). As discussed in case 5 (Section 9.1.1), SSE occasionally arranges exclusive deals with the objective being to exclude competitors from access to certain technologies or markets. This issue suggests that the competitors have an effect on the creativity stage.

Figure 5A. 4 suggests that the role of “customer feedback” in Iranian companies is more important than at SSE. As discussed in Section 2.6.1, companies employ technology driven product development or attempt to identify customer needs for creative purposes. Both approaches are possible in industrialised countries, but in developing countries technology push is weaker and the customer driven approach appears to be a more common method of stimulating creativity (Chandra and Neelankavil, 2008). It is probable that the role of "customer feedback" is not important (or is not of perceived importance) in this company as it is in a developed country.

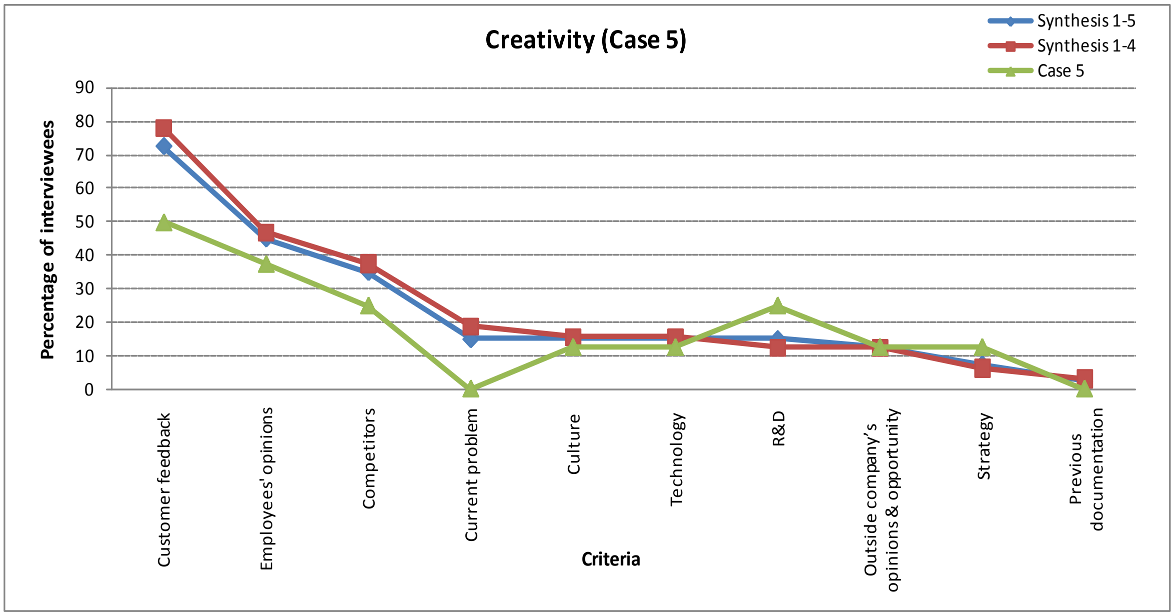


Figure 5A. 4 - Interviewees (*n*=8) referring to creativity criteria in case 5 (SSE)

Since technology in SSE (as a developed country) is more advanced than developing countries and also probably knowledge and expertise is enough to cover most of the unexpected problems, therefore it seems that the role of "current problem" (which is related to technical problem) is not considerable in comparison with Iranian companies.

As some interviewees in SSE explained, there is no formal mechanism for learning at their company like "documentation" (Section 9.1.5), so it seems like most of the other companies; the role of this criterion in the company is not significant.

Figure 5A. 4 suggests that "R&D" is perceived as one of the important criteria in SSE for creativity stage. Although recently this company began to invest in new ventures (Section 9.1.1), it still seems that spending the time and money on new research in this company is perceived as an important criterion.

5A.2 Criteria's relative importance in selection

Figure 5A. 5 shows the percentage of interviewees in case 1 (SK) which explained these criteria. When comparing the importance of these criteria with the synthesis, the synthesis situation for case 1-4 (only Iranian cases) and case 1-5 (all cases) was also drawn in this Figure. Based on Figure 5A. 5, it is possible to explain the difference between the importance (or perceived importance) of these criteria in this case when compared with synthesis cases.

As Figure 5A. 5 suggests in case 1 (SK) the "implementation capability" is perceived as one of the top important criteria in this stage. This might be because in this industry (bus and truck manufacturing) current technology is not flexible enough for any kind of new project and preparing new technology, and skill, requires a large investment of time and capital.

"Culture" is useful to consider in a competitive market in order to achieve more customers. As discussed before (Section 5.1.1), large and specific clients make up the main customer base in this industry. Thus case 1 (SK) does not need to consider their competitors as their market share is guaranteed. It seems this criterion is not perceived as an important criterion based on this company's point of view in this stage. In addition, because of the lack of competition the role of "competitors" is not usually perceived as an important one in this stage. Since the length of the production is usually long in this industry, it seems the "time of achieving the result" is also not perceived as a significant criterion when selecting a new idea at this stage.

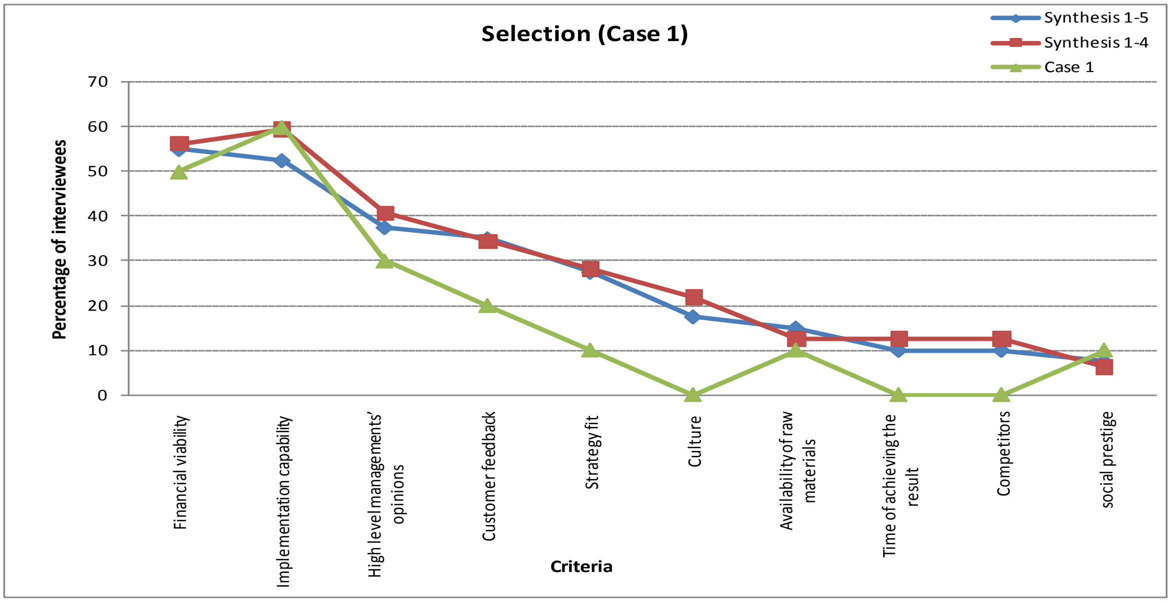


Figure 5A. 5 - Interviewees (*n*=10) referring to selection criteria in case 1 (SK)

Figure 5A. 6 shows the percentage of interviewees in case 3 (RDPC) who mentioned these criteria. As this figure suggests the general pattern of the case 3 profile is almost identical to the synthesis cases.

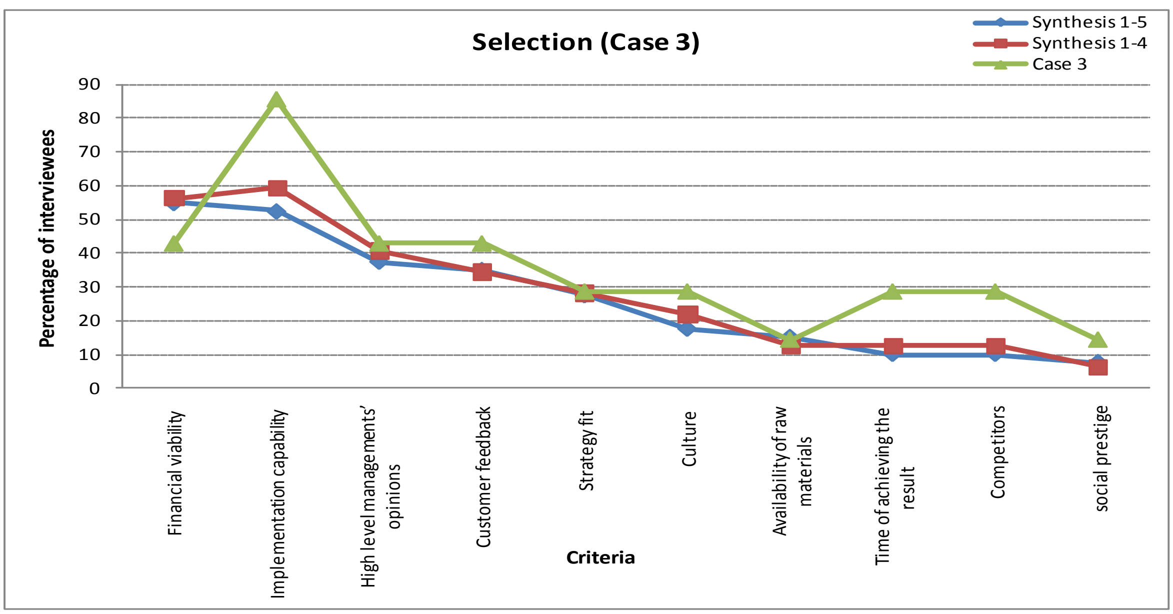


Figure 5A. 6 - Interviewees (*n*=7) referring to selection criteria in case 3 (RDPC)

Figure 5A. 6 suggests that the "implementation capability" is perceived as the first important criterion in case 3 in comparison with the synthesis cases. Since the technology in this company is older when compared with its competitors, the wide variety of products in this industry requests many different types of technology, so “implementation capability” is perceived as the most important criterion in the selection stage for this company. For instance special technology for packaging is needed for producing the milk with different flavour (Section 7.1.2). With current technology the risk of production of this product is so high since the time of their expiry is short.

Based on detailed texts of interviews market competition in case 3’s industry is high (Section 6.1), so “competitors” and “time of achieving the result” (sometimes the long time causes the new product miss the novelty in the market) are therefore perceived as important criteria by this company.

Percentage of interviewees who explained these criteria in case 4 (SJT) are shown in Figure 5A. 7. This figure suggests that the “financial viability” and “strategy fit” are perceived as most the important criterion in this company when compared with synthesis.

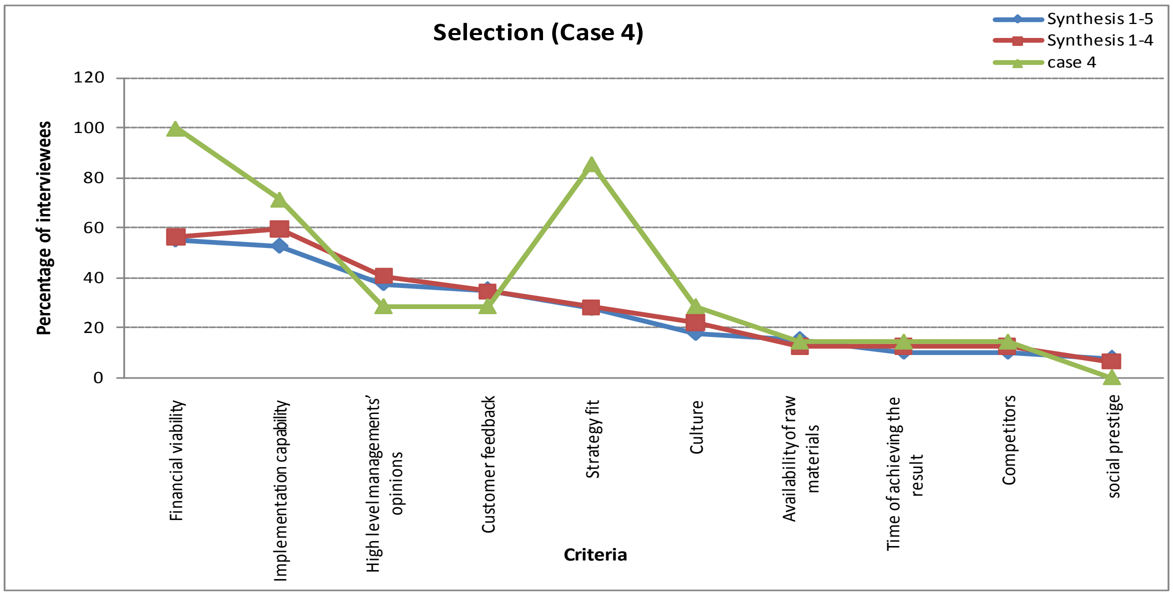


Figure 5A. 7 - Interviewees (*n*=7) referring to selection criteria in case 4 (SJT)

Since SJT company is one of the most modern companies in this industry, their management is looking for development during their process; therefore following the “strategy” has played an important role for the company. For instance some interviewees explained that in this company “goals” and “strategy” (Section 8.1.2) play a significant role when selecting the new idea (the company will only consider ideas which it feels are consistent with its long term strategies and goals). They also stated that one of the most important goals for this company is to achieve more profit. Usually the company will considers their financial ability, the amount of investment, required number of employees, the final cost and profit of each new idea before making a final decision and selecting appropriate ones. Therefore “financial viability” and “strategy fit” are perceived as important criteria in this stage.

Figure 5A. 7 suggests that employees do not perceive “social prestige” as an important criterion in SJT company. In case 2 (Tile Co, Chapter 6) this criterion is also not perceived as an important one, it is most likely that the nature of this industry (ceramic industry) leads the company not to consider this criterion at this stage. In addition, should be noted that “social prestige” is a relatively new concept in Iran and the situation of each industry and company has an effect on this criterion.

Figure 5A. 8 shows the percentage of interviewees in case 5 (SSE) who mentioned these criteria. Based on this figure it is possible to explain the difference between the importance (or perceived importance) of these criteria in this case when compared with synthesis cases.

As Figure 5A. 8 suggests seven criteria (“financial viability,” “implementation capability,” “high level managements’ opinion,” “customers,” “strategy fit,” “availability of raw materials” and “social prestige”) are perceived as important criteria when SSE is selecting new ideas. For instance one of the criteria that must be considered at this stage is “availability of raw materials”. As discussed in Section 9.1.2, in one of SSE’s projects a question was posed: how can SSE get biomass crops into London cheaply? These issues suggest that raw material can play an important role in the selection stage.

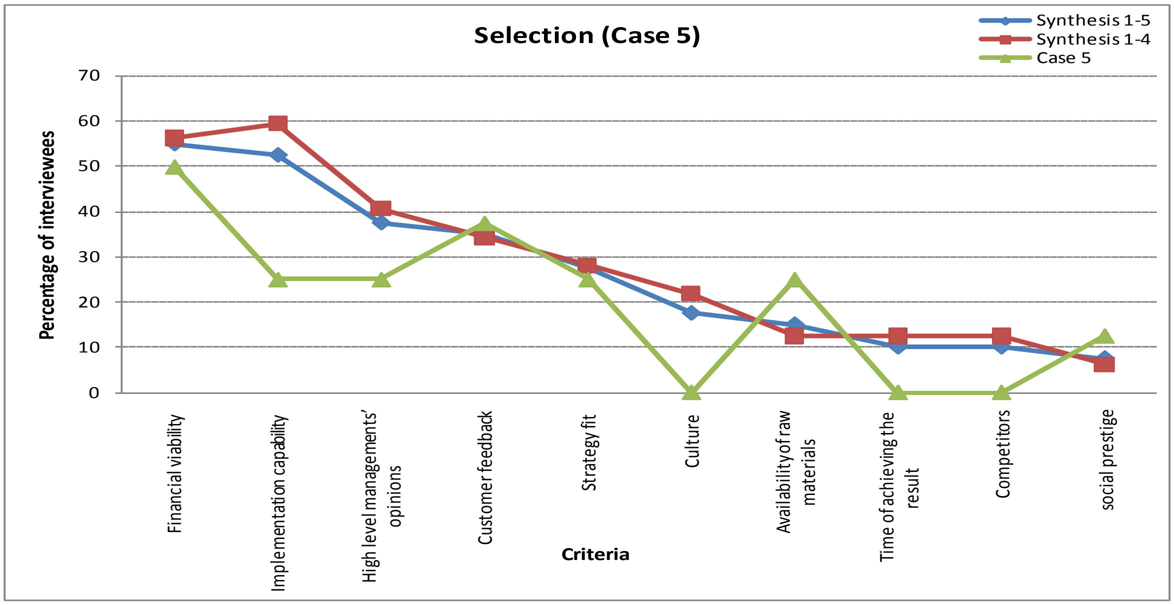


Figure 5A. 8 - Interviewees (*n*=8) referring to selection criteria in case 5 (SSE)

It seems, since in SSE “competitors” and “culture” were considered in the previous stage (Section 10.2.3), there is no need to consider these criteria again at this point.

As Figure 5A. 8 suggests the “time of achieving the result” is not perceived as an important criteria by interviewees in this stage as some interviewees believed that a short-term return is not expected from the portfolio of interests of SSE. Also it might be because of the fact that most of the projects in this company need a long time process.

5A.3 Criteria’s relative importance in incubation

Figure 5A. 9 shows the percentage of interviewees in case 1 (SK) which explained these criteria. In order to comparing the importance of these criteria with the synthesis, the synthesis situation for case 1-4 (only Iranian cases) and case 1-5 (all cases) was also drawn in this Figure.

As Figure 5A. 9 suggests, the role of “high level management’s opinion” in case 1 is not an important (or is not of perceived importance) criterion in this stage. This is because of the nature of products this company produces (different kinds of bus and truck): high level management has more impact into the earlier stages, such as selection. The cost of starting a new project and producing a prototype in this industry is high, so the company tries to elicit the opinion of high level management and make decisions in earlier stages before spending more money in later stages. Since large clients make up the main customer base in case 1’s industry and the market share is guaranteed (see Section 5.1.1), it seems that the importance of “customer’s opinions” is less for for this company, in this stage, than in the Iranian synthesis case.

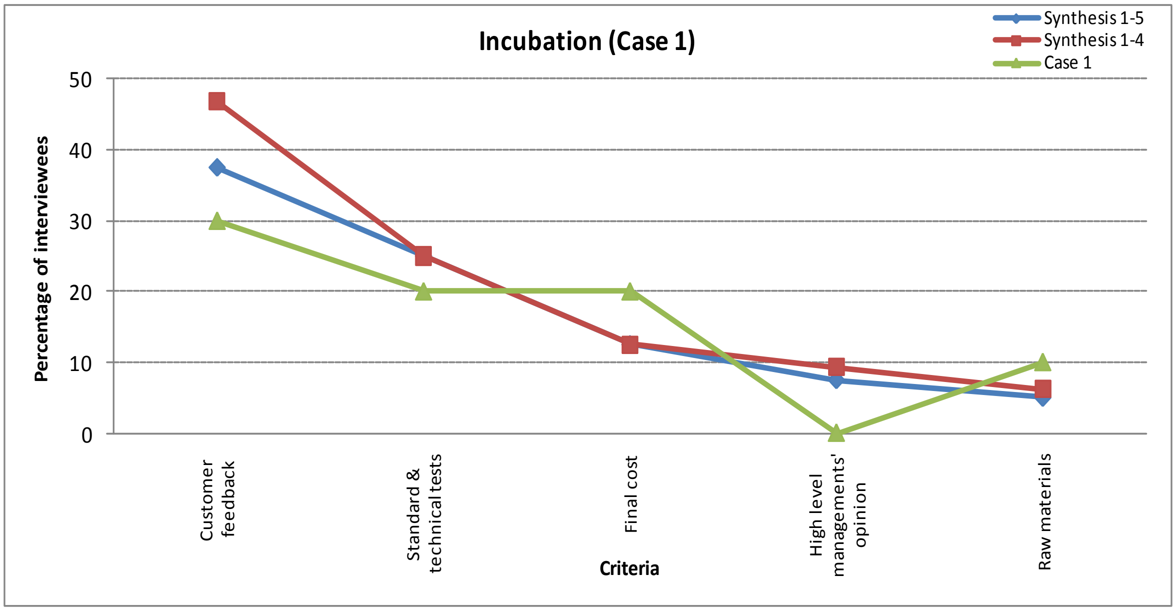


Figure 5A. 9 - Interviewees (*n*=10) referring to incubation criteria in case 1 (SK)

The percentage of interviewees who mentioned these criteria in case 2 (FT) are shown in Figure 5A. 10. As this figure suggests, the general pattern of the case 2 profile is similar to the synthesis cases. It seems that the importance (or perceived importance) of "customer feedback" in this case is more than in synthesis cases. Since the diversity of culture in Iran is high and the interest of the customer plays an important role in achieving success, the company needs to get customers' opinion about new products before going to mass production.

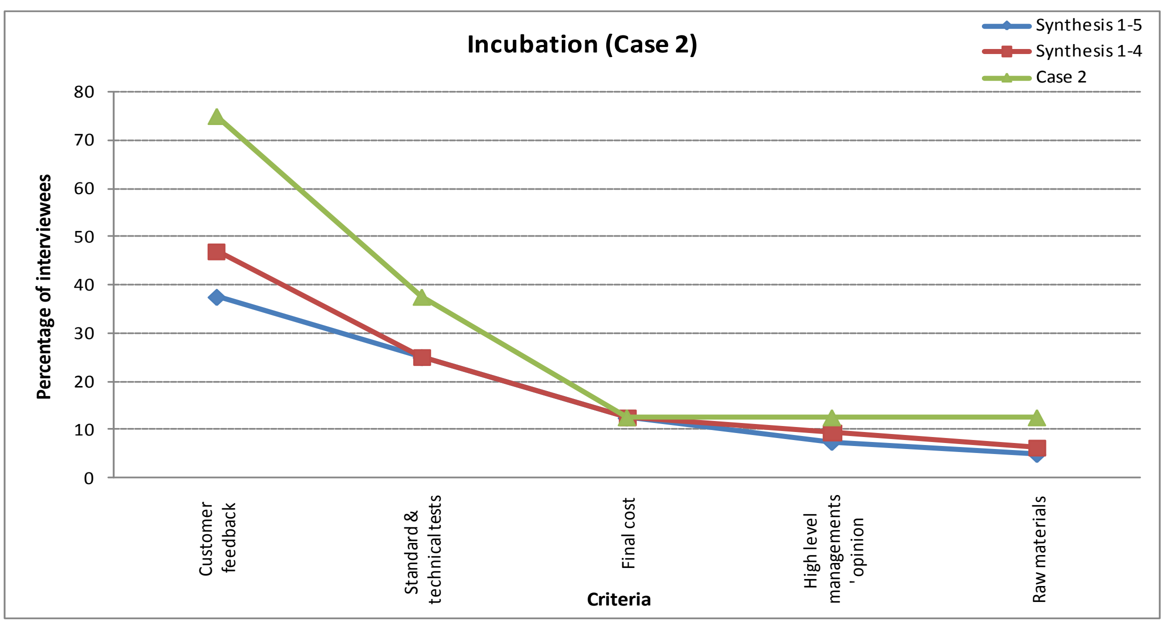


Figure 5A. 10 - Interviewees (*n*=8) referring to incubation criteria in case 2 (FT)

Figure 5A. 10 suggests that FT company is putting stress on "standard and technical test" in this stage. Based on some interviewees' opinions in this case, the company respect their customers and want to provide them with a product that is of a high quality and condition. To achieve this, the

company applies many different technical and standard tests. For example, the tests for measuring the shock endurance of the tiles, the quality of enamel, firmness of the tiles and the colour quality (Section 6.1.3). Regarding this, interviewees claimed that this company's internal standards are tougher than rigid governmental standard tests.
Percentage of interviewees who explained these criteria in case 4 (SJT) are shown in Figure 5A. 11. Based on this figure it is possible to explain the difference between the importance (or perceived importance) of these criteria in this case when in comparison with synthesis cases.
Based on Figure 5A. 11 the role of "final cost" and "raw materials" in case 4 are not important (or is not of perceived importance) criteria in this stage. As it was shown in the selection section (Section 10.3.3); this company puts a lot of consideration into the "final cost" when in the selection stage. Probably the employees in this company are more professional, so it seems they can predict the final cost in selection stage more precisely than other companies.

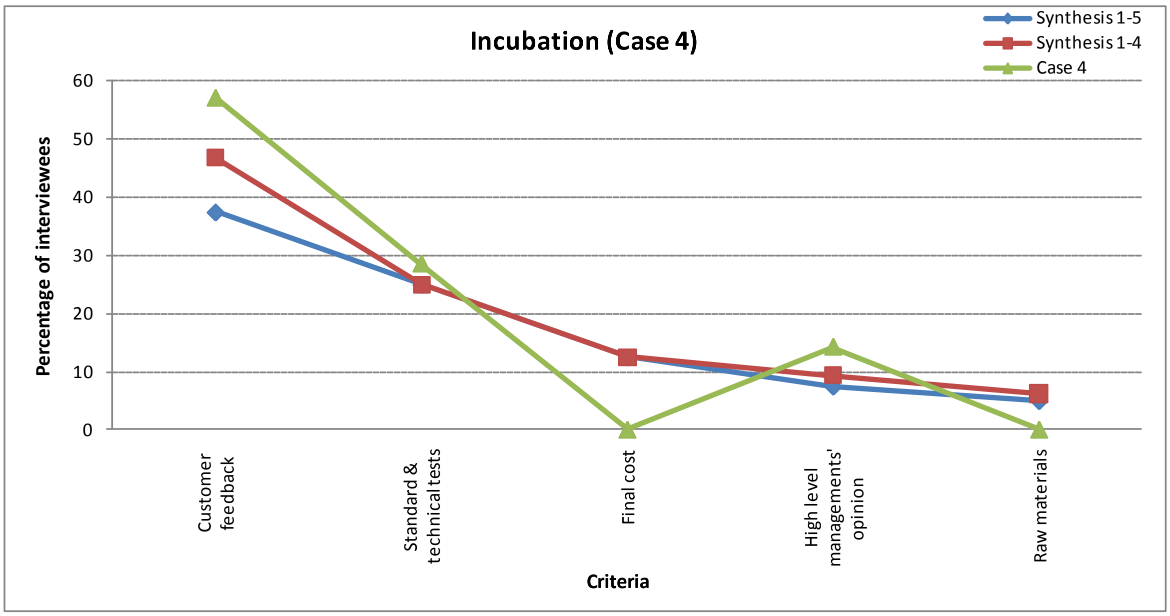


Figure 5A. 11 - Interviewees (*n*=7) referring to incubation criteria in case 4 (SJT)

Since SJT company considers the availability of raw materials in the previous stage, the employees did not deem the method of supplying raw material to be important (or of perceived importance) in this stage. However interviewees mentioned that raw material is one of the criteria which creates risk in this company (Section 8.2.1), so it is better to consider this criterion at this stage as well.

A5.4 Criteria's relative importance in implementation

Figure 5A. 12 shows the percentage of interviewees in case 1 (SK) which explained these criteria. When comparing the importance of these criteria with the synthesis, the synthesis situation for case 1-4 (only Iranian cases) and case 1-5 (all cases) was also drawn in this figure.
Figure 5A. 12 suggests that the role played by "market" in SK company is not important (or is not of perceived importance) criteria in this stage. As discussed in case 1, the market share is guaranteed in bus and truck manufacturing industry (see Section 5.1.1), so it seems that the company does not need to consider the "market" in this stage. In addition, although this company considers "profit" when continuing with the production of a new product; it seems that based on detailed texts of interviews (Section 5.1.1), since the market share is guaranteed in this industry, employees do not perceive this as a very important criterion at this stage.

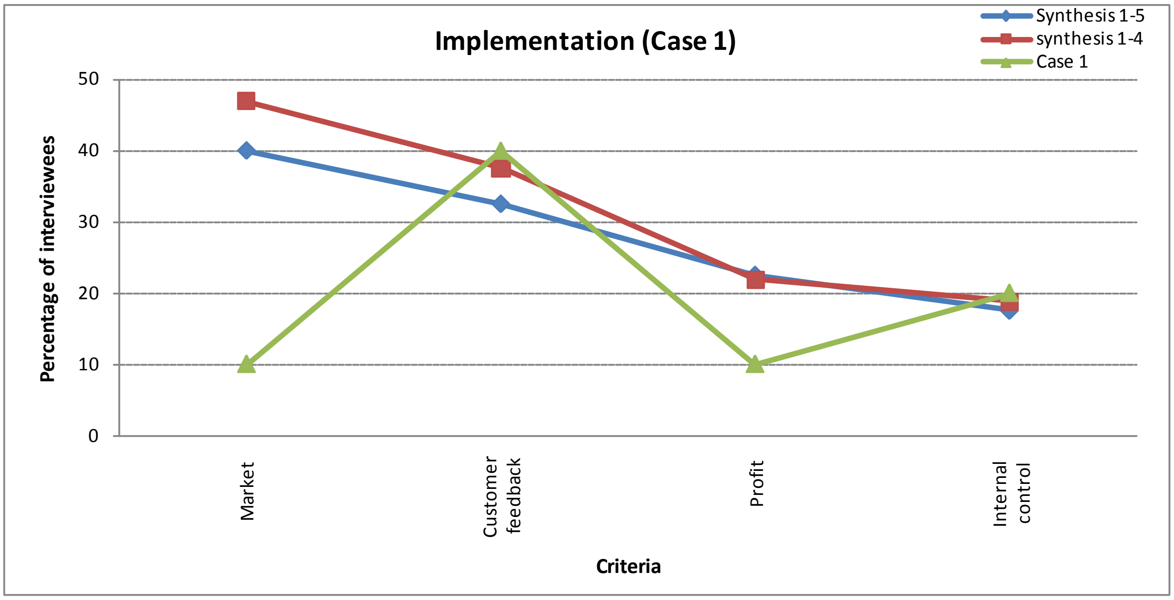


Figure 5A. 12 - Interviewees (*n*=10) referring to implementation criteria in case 1 (SK)

Percentage of interviewees who explained these criteria in case 2 (FT) are shown in Figure 5A. 13. This figure suggests that the role of "customer feedback" in this case is less than the Iranian synthesis cases. This company considered this criterion in full at previous stages (creativity, selection and incubation), so there is no need to return to these questions again in this stage. In addition, since the importance of interest of customers in this stage is usually mirrored in market feedback and profit, this company, consequently, considers market feedback and profit when deciding to continue with mass production.

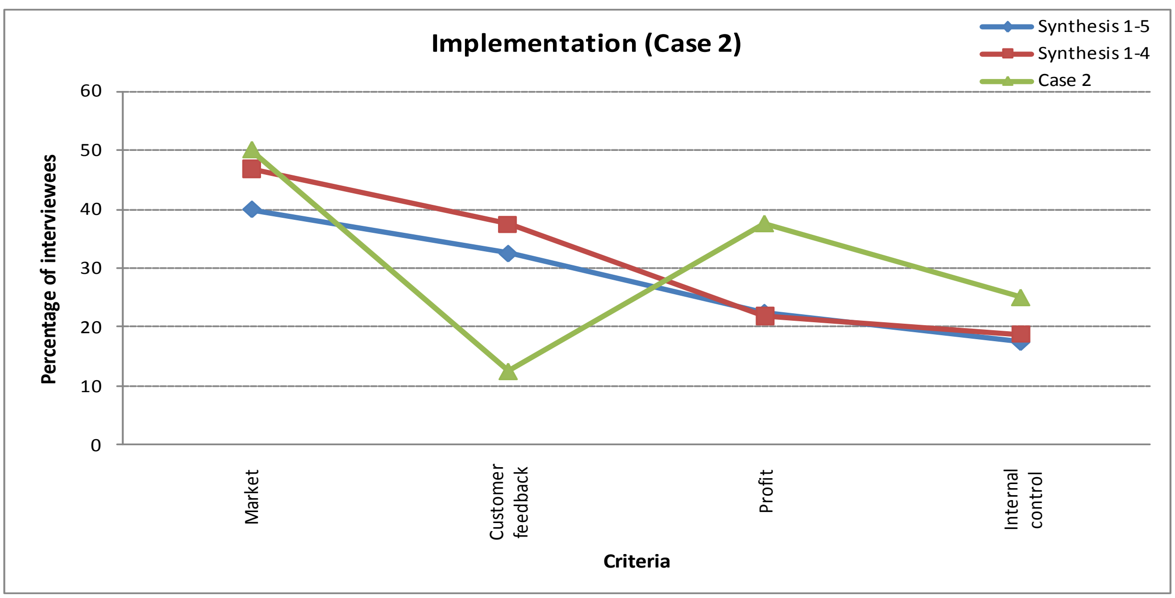


Figure 5A. 13 - Interviewees (*n*=8) referring to implementation criteria in case 2 (FT)

FT company wants to provide a high quality product in good condition (see Section 6.1.3), so in order to achieve this they apply many technical and standard tests as "internal controls". As Figure

5A. 13 suggests since FT is a private company, employees perceive the role of "profit" as one of the important criteria in this stage.
The percentage of interviewees who mentioned these criteria in case 3 (RDPC) are shown in Figure 5A. 14. Although the general pattern of the case 3 profile is similar to the synthesis cases, this figure suggests that "market" and "customer feedback" are perceived as most the important criteria in this company.
As discussed in the incubation stage (Section 10.4.1), some interviewees in case 3 said that the predicted market situation of this industry in earlier stages is very difficult. Creating contact with their customers in order to get feedback is usually considered in the implementation stage rather than the incubation stage. Therefore, dairy companies enter the market with a wide variety of products (but in limited numbers) and after receiving feedback, will choose to continue products which have become popular.

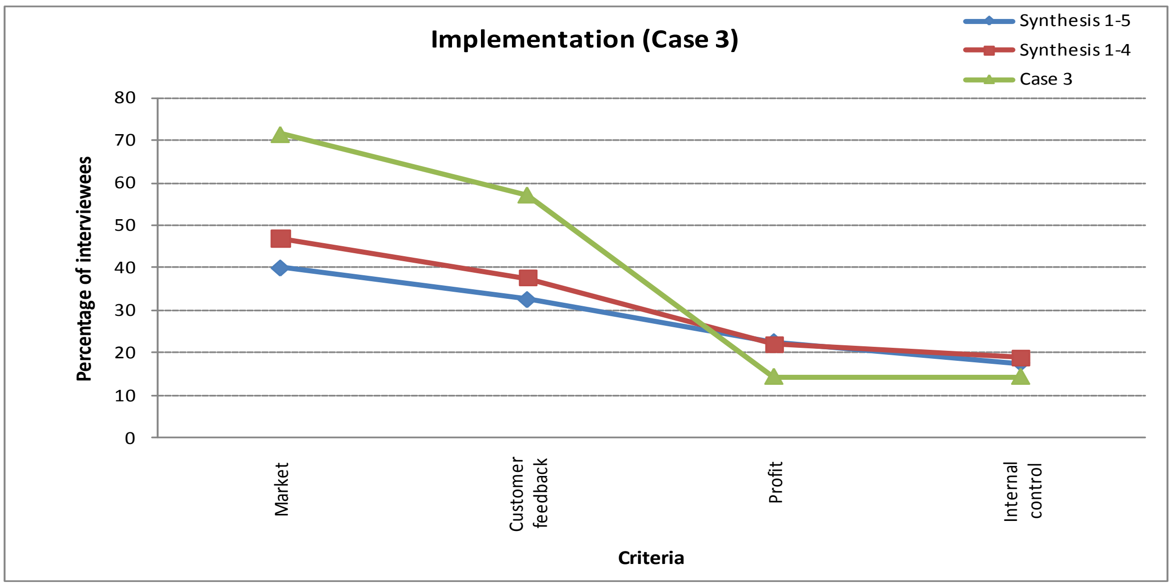


Figure 5A. 14 - Interviewees (*n*=7) referring to implementation criteria in case 3 (RDPC)

The percentage of interviewees who explained these criteria in case 5 (SSE) are shown in Figure 5A. 15. Based on this figure, it is possible to explain the difference between the importance (or perceived importance) of these criteria in this case when compared with synthesis cases.
Although Figure 5A. 15 indicates that "market" and "customer feedback" are not perceived as the most important criteria for SSE when compared with Iranian synthesis cases (this is reasonable by considering the disciplined management in this company as discussed in Section 10.4.1), however this figure suggests that the difference between the importance of all criteria in case 5 is not large in this stage. Therefore it seems that based on employees' opinion in detailed texts of interviews (Section 9.1.4), considering all criteria have an important role for this company in order to decide to continue with a new project.

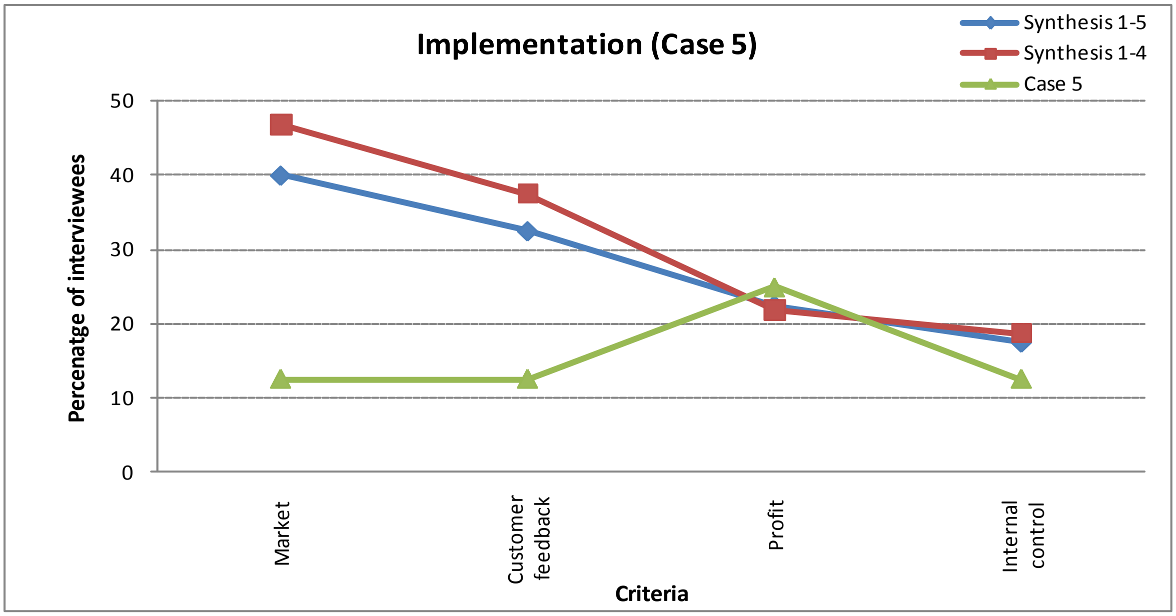


Figure 5A. 15 - Interviewees (*n*=8) referring to implementation criteria in case 5 (SSE)

A5.5 Identifying Potential Risk Factors

Figure 5A. 16 shows the percentage of interviewees in case 1 (SK) which explained these risk areas. Comparing the importance of these areas with the synthesis, the synthesis situation for case 1-4 (only Iranian cases) and case 1-5 (all cases) was drawn in this figure.

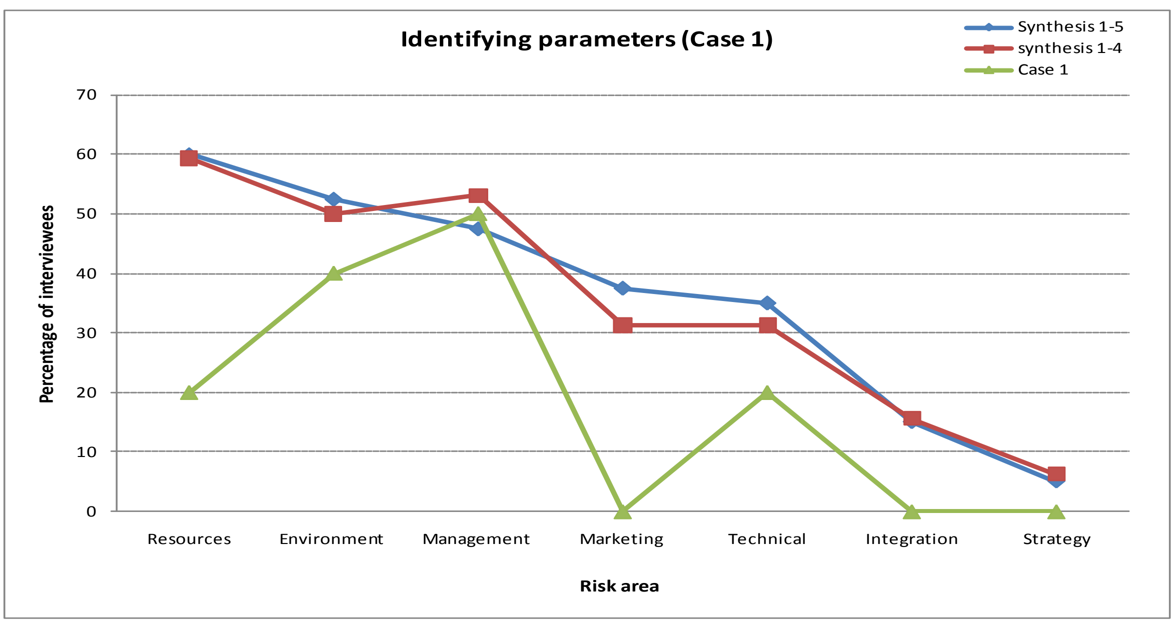


Figure 5A. 16 - Interviewees (*n*=10) referring to risk areas in case 1 (SK)

Figure 5A. 16 suggests that the "marketing," "integration" and "strategy" are not perceived as important areas in case 1 (SK). As discussed in case 1 (e.g. see: Section 5.1.1), the market share is guaranteed in this industry (bus and truck manufacturing industry), so it seems that the company does not have any specific problems in this area in terms of risk factors. Although the company considers "customer feedback" in the implementation stage, the role of market and competitors are not specific to the stages of innovation.

Although interviewees believed that new technology is one of the factors which creates risk during the implementation stage (Section 5.2.1), the technology push (generally related to developed countries, see Chandra and Neelankavil, 2008) is not usually perceived as an important factor for car manufacturing companies in Iran (the bus and truck manufacturing industry is limited to domestic companies as the tariff on importing foreign cars is high and the market share is guaranteed for the companies; Section 5.2.1), therefore SK company does not perceive "integration" (usually related to old and new technology) as an area of risk.

Interviewees in case 1 mentioned different factors in the "management" area as risk factors (Section 5.2.1), these included: co-ordination between different parts of the company and also between the company and customers, a lack of harmony between job specification and expectation, lack of motivation, plan of sale division and traditional structure of management (there is a strict hierarchy). They also stated that the opinion and attitude of high level management is another factor which can sometimes create risk in this area.

"Resources" and "environment" area are two other areas which case 1 considers as sources of risk. Although Figure 5A. 16 suggests that there is difference between the importance of "resources" in case 1 and synthesis cases, based on detailed texts of interviews, it can be said that "resources" is an important area which creates risk for this company. For instance, as discussed in Section 5.2.1, the availability of funding for the purchase of raw material is a parameter that the company should consider as a risk factor in the innovation process. Some factors in "environment" area explained by employees which can create risk in the innovation process include: government laws (which are not fixed) and political and economic issues (e.g. inflation).

Percentage of interviewees who explained these risk areas in case 2 (FT) are shown in Figure 5A. 17. As this figure suggests, the general pattern of case 2 is similar to the synthesis cases.

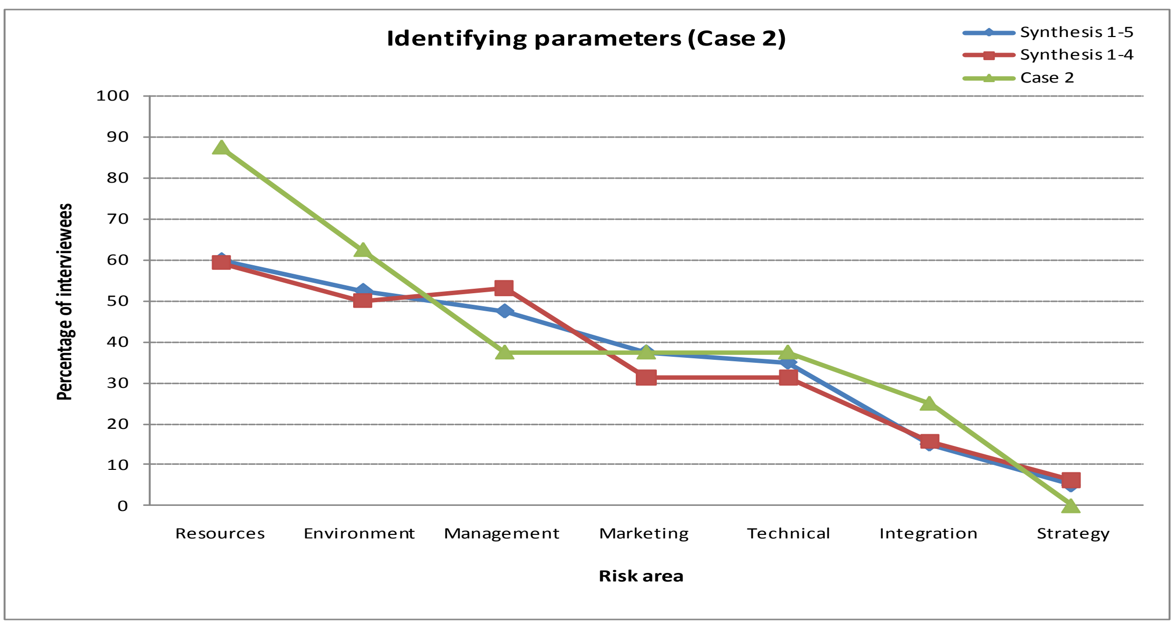


Figure 5A. 17 - Interviewees (*n*=8) referring to risk areas in case 2 (FT)

Interviewees case 2 (FT) mentioned factors such as raw materials, finance, energy and a lack of skilled and experienced labour as issues which can create risk in the "resources" area. Based on some interviewees' opinions, as the company only uses one type of energy in their production line, this individual source has the potential to create risk should the company fail to meet their minimum energy requirements. They also added that because of the instability in raw material sources (Section 6.2.1), which are often affected by political issues, sometimes the quality of raw materials can create risk within the company.

Figure 5A. 17 suggests that the potential risk role posed by the "environment" is the second high risk area in case 2. Based on respondents' opinions, factors such as government policy and culture are two important factors which can create risk in this area. As discussed in the selection stage (Section 10.3), because of the varying tastes and cultures of different regions in Iran, this company considers culture to be an important factor at this stage of innovation. So culture is the main factor which can create risk if the company does not consider it carefully.

As Figure 5A. 17 suggests, "strategy" is not perceived as an important risk area for FT company. Since the interviewees did not mention the importance of strategy in the creativity and selection stage of innovation (Section 10.2.3 and 10.3.3), it seems that this factor may not have any effect on this company. In other words, it is probable that the role of strategy is not significant for the interviewees in this company.

The percentage of interviewees who explained these risk areas in case 4 (SJT) are shown in Figure 5A. 18. Based on this figure "integration" is not perceived as an important risk area in this company. Since this company is one of the most developed companies in this industry, the company does not need to consider the integration of new and old technology.

Based on the interviewee's opinions in case 4 (Section 8.2.1), raw material, a lack of skilled labour and energy are factors which can create risk in "resources" area. As discussed in Section 8.1.1, international trade sanctions currently imposed on Iran cause an increase in expense and an increase in the length of time it takes to receive raw materials, therefore it can create risk within the company.

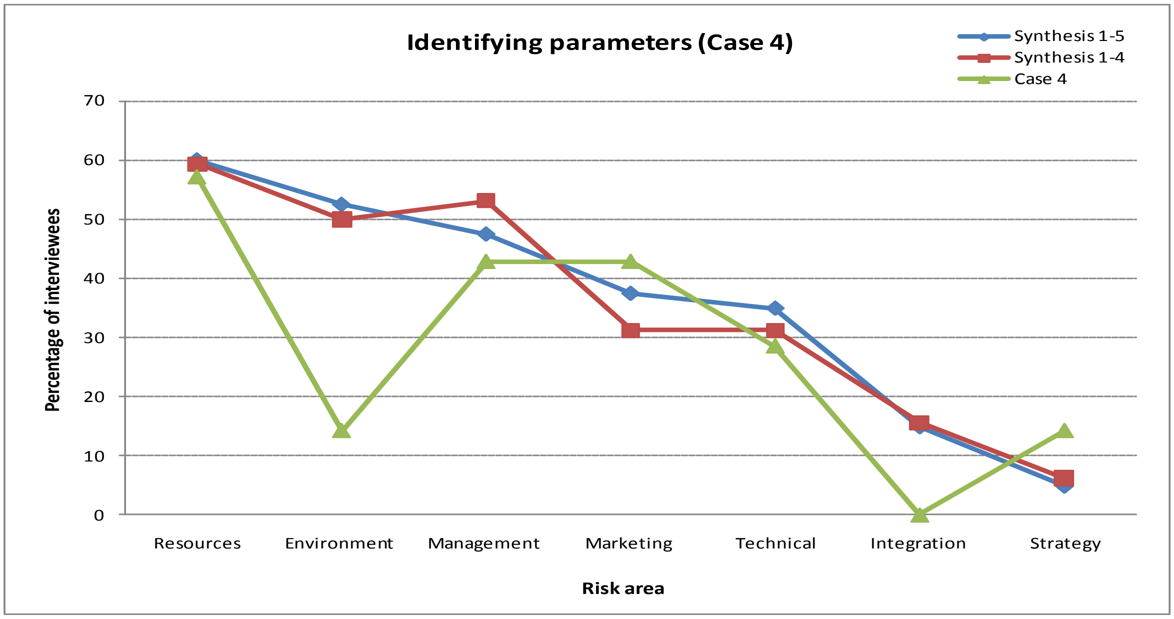


Figure 5A. 18 - Interviewees (*n*=7) referring to risk areas in case 4 (SJT)

Figure 5A. 18 suggests that the "environment" is not perceived as an important area for case 4 (SJT) in comparison with synthesis cases. But as mentioned, political issues (e.g. international trade sanctions) can create risks in raw material. Therefore it seems that the effect of political issues are mirrored in the "resources" area more than "environment" area. In other words, although employees consider raw materials as one of the factors which create risk, they did not acknowledge that political issues may be the cause of this risk.

The percentage of interviewees who explained these risk areas in case 5 (SSE) are shown in Figure 5A. 19. Based on this figure, it is possible to explain the difference between the importance (or perceived importance) of these areas in this case when compared with synthesis cases.
As Figure 5A. 19 suggests, the risk posed by "management" area is perceived to be less in SSE than in Iranian synthesis cases. Since this company is more developed, it seems that the role played by this area when creating risk is less than in the other cases. In other words, the method of management, high level management's opinion and structure of the company causes this area to become less risky when compared with other companies.

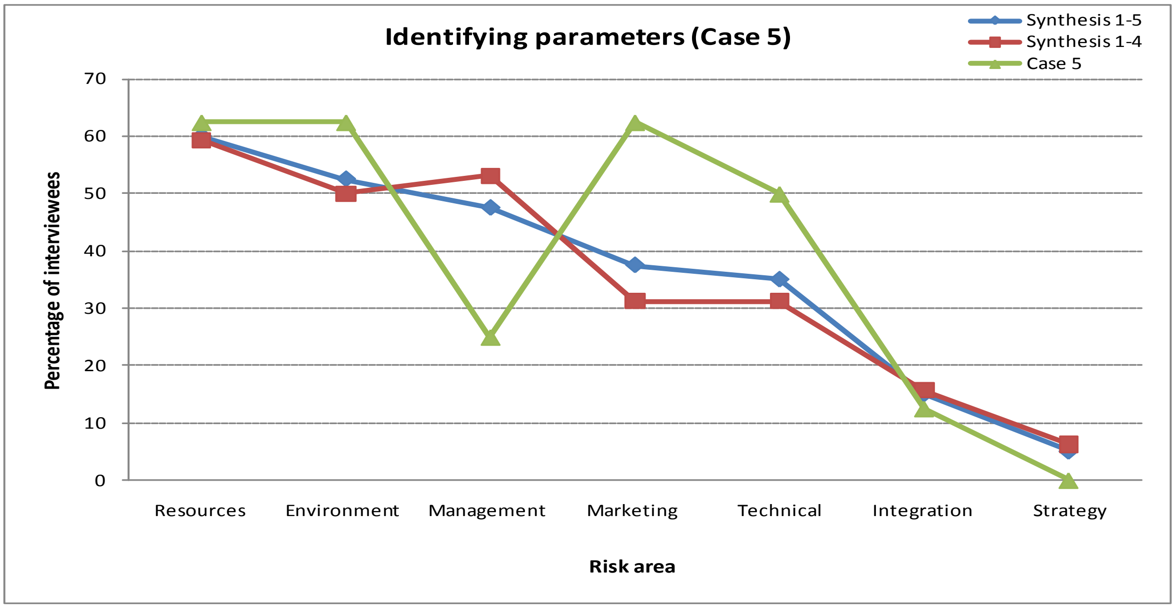
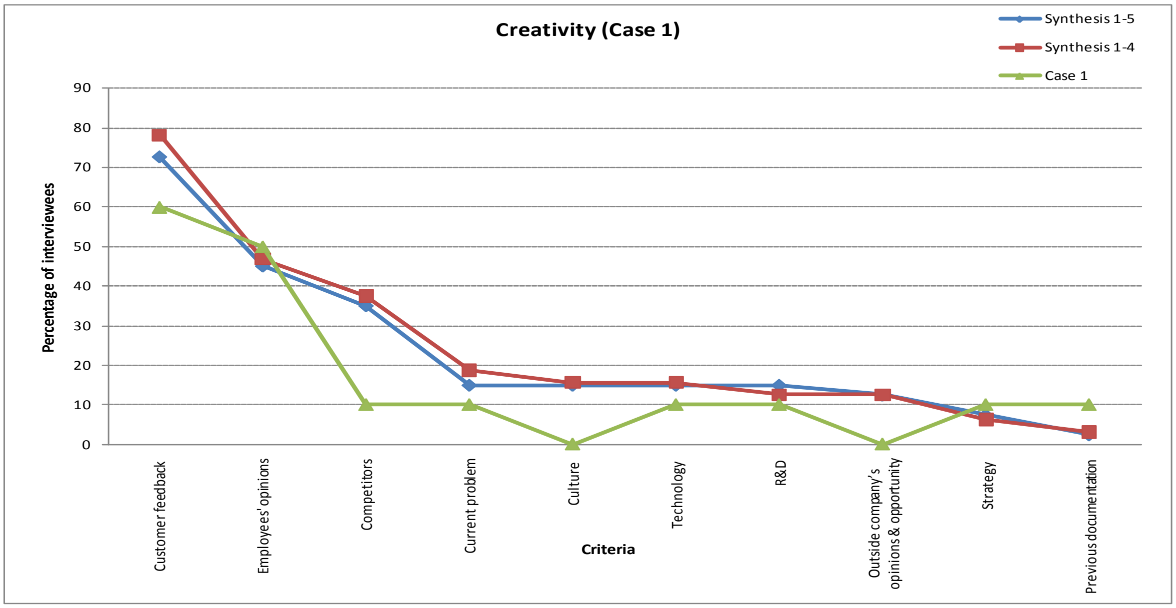


Figure 5A. 19 - Interviewees (*n*=8) referring to risk areas in case 5 (SSE)

Interviewees explained different factors such as the transferring of technology to the site, delivering technology on a small scale, and shipping and re-gas at the market end, as factors which create risk in SSE's "technical" area (Section 9.2.1). Since the Figure 5A. 19 suggests that "strategy" is not perceived as an important risk area in case 5, it seems that the company has a clear strategy and employees could perceive it completely.

Appendix 6 – Statistical tests of the content analysis

The figures based on the content analysis which were shown in Chapter 10 provide a summary of the apparent importance of each factor. These profiles illustrate the initial impression of the relative importance of various factors in the analysis of this study. For example, based on the following figure from Section 10.2.3, "competitors" do not seem to have a role in creativity in case 1: only 1 of 10 interviewees mentioned "competitors" as a source of creativity for this company, even though it seems to be significant in the other case study companies. As stated in case 1, within the bus and truck manufacturing industry in Iran there are a few large and specific customers (e.g. Ministry of Interior); although some other small customers exist in this market, they do not have a large share of the market, so the company does not need to consider competitors as their market share is guaranteed. Given the relatively low number of interviews (40) there was limited scope for any analysis of the statistical significance of the results. This appendix illustrates some of the difficulties. Instead the objective of the content analysis and the profiles, such as the figure below, was to provide a structure for comparison using the detail of the interview text: the text provides substance which may confirm or disprove the impression created by the profiles.



Interviewees (*n*=10) referring to creativity criteria in case 1 (Chapter 10, Figure 10.5)

Table 6A. 1describes a Chi-Squared test that illustrates a potential approach if more data were available; it also illustrates the difficulties of such an approach given the relatively small sample. A major problem is the requirement that in Chi-Square, the expected count should not be less than five in more than 20% of cells or less than one in any cell. The example examines the factors in the creativity stage in Case 1 (SK). As the following table indicates, the Chi-Square test suggests that the low number of interviewees mentioning "competitors" as a factor in creativity, compared to the cases 2-4, is significant (while is not significant in compared to cases 2-5); the apparent difference in the importance of "customer feedback" is not significant (at 5% level). Therefore a Chi-Squared test would not be useful in determining whether the difference in the numbers of references to a factor in a specific case is significantly different from the typical case in current study. This does not imply that the profiles are of no use but that they are tentative evidence which has to be considered in conjunction with the detailed examination of the interview texts.

Table 6A. 1- Chi-Square test for criteria in creativity stages in case 1

Criteria	**Asymp. Sig.**	
	Case 2-4	Case 2-5
Customers’ feedback	.094	.307
Employees’ opinions	.811	.714
Competitors	.030	.079
Current problem	.393	.609
Culture	.101	.125
Technology	.555	.609
R&D	.773	1.00
Outside company’s opinions & opportunity	.149	.168
Strategy	.555 †	.442 †
Previous documentation	.132†	.079†

† The expected count is less than 1

Appendix 7 – A brief summary of two case studies from the literature

A7.1 Case 1 - Hewlett-Packard: Kittyhawk (HP)

In June of 1992, Hewlett-Packard (HP) introduced the smallest hard disk-drive in the world, the Kittyhawk (Christensen, 2003). The drive's disks were 1.3 inches in diameter. The first version of the Kittyhawk supplied 20 megabytes of storage and had unique componentry enabling the drive to withstand a three-foot drop without any data loss. The possible applications of the drive in the mobile computing market seem endless, and the team at HP responsible for launching the Kittyhawk eagerly anticipated the take-off of their newest innovation. Hard drives were storage for magnetic information used by computers. It was first invented in 1956 by engineers in IBM's San Jose, California laboratories, and was the size of two large refrigerators placed side by side. It could store 5 megabytes (MB) of information drivers as reading and writing information were in the same sort of binary code that computers used.

How did HP decide to select this new product? The HP culture deeply valued technical innovation and believed it a key to success. The General Manager of the disk memory division (Spenner) who was widely viewed as a visionary and risk taker often asked: ‘‘How can we make HP a major player in the disk-drive industry? Why don't we have 20% of market share? How can DMD (Disk Memory Division) become the next printer business for HP?’’ Questions like this sparked Spenner's entrepreneurial spirit. By 1991 he was convinced that new disk drive architecture, with an innovative design, could take the computing market by storm, and that HP was the company to create it.

This case indicates that HP follows the general stages of the innovation process, which was discussed in the theoretical model of the innovation process (Figure 2.7). It means that the process started with ideas that came from the manager of one division (creativity stage), progressed to incubation and implementation. In the selection stage, in order to receive approval to initiate the project, Spenner presented the idea to the executive vice president.

However, on September 7, 1994, HP announced that it would discontinue its 20 and 40 megabyte Kittyhawk disk drives. Its production levels were far below those initially forecasted. “We're disappointed to have to cancel our market-leading HP Kittyhawk”, said Bruce Spenner in a press release. “HP keeps its individual business units tightly focused on key market segments with good to excellent prospects. When those markets don't yield as expected, HP minimizes its exposure to additional risk and makes difficult decisions such as this one.”

By considering the process of innovation in this case, some factors which created risk during this process, and also factors which have an effect on innovation process, are identified. If the company had considered these factors during the process of innovation it might have been more successful. These factors support the risk management system and factors which have an effect on the process of innovation in the theoretical model, such as Market (lost its first major potential customer), Management (set tight goals) and Technical (new methods and material). In one action plan, in order to reduce the probable risk of investment for new technology, the company used outsourcing. In addition, the case explains that learning is fundamental for HP and failure is an important source of improvement for future projects.

A7.2 Case 2 - The 3M Cochlear Implant Program (3M)

This case describes the efforts by the Cochlear Implant Program (CIP) at 3M Corporation in St. Paul, Minnesota, to develop single-channel and multiple-channel cochlear implant devices (van de Ven *et al.*, 1999).

Cochlear implants are implanted electronic devices. The device provides a sensation of sound for the deaf. By amplifying sound, hearing aids make hearing a little possible in less severe deaf patients. A cochlear implant is very different from a hearing aid. Hearing aids make sounds long so they may be recognised by damaged ears. Cochlear implants bypass damaged portions of the ear and move the auditory nerve. Signals produced by the implant are sent by means of the auditory nerve to the brain, which recognises the signals as sound. Hearing through a cochlear implant is unlike natural hearing and will take some time to learn. It allows many people to recognise warning signals, understand other sounds in the environment, and enjoy a conversation by telephone or in person. The implant consists of an external portion that sits behind the ear and a second portion that is surgically located under the skin. It consists of the following parts: A microphone, that picks up sound from the environment; A speech processor, which selects and arranges sounds picked up by the microphone; A transmitter and receiver/stimulator, which receive signals from the speech processor and convert them into electric impulses; An electrode array, which is a group of electrodes that collects the impulses from the stimulator and sends them to different areas of the auditory nerve.

By 1978, the idea of an “electronic ear” had gain sufficient credibility to persuade 3M’s technical director and his supervisor to allocate resources. This case indicates that 3M began innovation by finding a new idea, although this idea came from outside the company. After this, the company attempted to select the most appropriate ideas from those which has been gathered. In the incubation stage, 3M used both internal and external R&D to develop the product. Before progressing to the implementation stage, the company tried to gather more information about market size in order to make decisions regarding the investment in the new technology. Therefore, it seems that 3M followed the general stages of the innovation process in the theoretical model (Figure 2.7).

In September 1988, 3M made the decision to exit formally from cochlear implants, because maintaining even minimal cochlear implant operations required substantial resources. By considering the process of innovation in this case, a number of factors which can create risk during the process of innovation and have an effect on the process can be identified. For instance, obtaining FDA (Food and Drug Administration) approval took three to five years, so this issue sometimes caused the company to lose market share. Product transition management is another issue that has an effect on the success of innovation. In this company, after promoting the second generation product and introducing it too quickly, patients were reluctant to undergo surgery to implant existing cochlear devices when a multichannel implant would soon be available. Other issues such as strategy, limited resources, requiring different specific skills and knowledge for unrelated innovation, coordination problems between different manufacturing sites and market all had an effect on the process of innovation in this company. The case mentions that 3M apply the ‘hurdle rate’ in order to consider and evaluate the innovation.