

MASTER

Social-organizational performance aspects in developing breakthrough innovations in an industrial company

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Eindhoven, August 2013

**Social-Organizational Performance
Aspects in Developing Breakthrough
Innovations in an Industrial Company**

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in partial fulfilment of the requirements for the degree of

**Master of Science
in Innovation Management**

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Social-Organizational Performance Aspects in Developing Breakthrough Innovations in
an Industrial Company

Master Thesis (1JM96)

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Abstract

An exploratory research into social-organizational performance aspects in the development of breakthrough innovations was conducted in an industrial company. The high-tech company serves food industries. The company feels that they are being insufficiently innovative in terms of the number of breakthrough innovations. In the diagnostic phase of the research a definition of breakthrough innovation for the company was developed to create clarity about the concept. Furthermore, innovation projects were compared to reveal indications of project success, and indications of the breakthrough level of projects. From the analysis it appeared that the perceived room for creativity, and a high product performance regarding original project objectives are indications for both success and a high breakthrough level. Furthermore, the company's identification phase in the product-development process was compared with relevant findings from literature. Employees of Company X do not create, share and use knowledge from outside the company's borders and industries. In the design phase of the research 10 suggestions to stimulate the development of breakthrough innovations were developed. The suggestions were divided over three categories of different organizational aspects of innovation, namely: 1) Communication/connection; 2) Resources; and 3) Development/training. Also, it was evaluated which theoretical and practical aspects are covered by the suggestions.

Management Summary

A research into social-organizational performance aspects in developing breakthrough innovations was conducted in an industrial company, for confidentiality reasons called Company X. Below the research is briefly summarized.

Introduction

Company X is a global provider of equipment, systems and services to food industries. The research was conducted in one of the subsidiaries of Company X, located in the Netherlands. Therefore, the scope of the research is the subsidiary of Company X. (N.B.: this subsidiary will also be called Company X). Within Company X the feeling exists that they are not sufficiently innovative anymore in terms of the number of developments of so-called breakthrough innovations. Furthermore, an environment in which creativity can flourish is lacking at Company X, because there is a high need for structure among the employees.

The research had two main goals. The first goal was to conduct a diagnosis to create both a better understanding of the concept of breakthrough innovation, and a better understanding of the social-organizational performance aspects involved in the development of breakthrough innovations. Social-organizational performance aspects are a combination of human aspects and process aspects in innovation. An example of a human aspect is considered human behavior, and an example of a process aspect is the product-development process structure. Because these two kinds of aspects are very closely related, they are combined, and examined together in this research. In the diagnostic phase of the research two research questions were involved, namely:

1. *What does breakthrough innovation mean for Company X?*
2. *Which social-organizational aspects are indications for innovation-project success, and for the development of breakthrough innovations?*

These research questions were answered in the diagnostic phase of the research.

The second research goal was to develop a design in which the development of breakthrough innovations is stimulated. It is believed that this can be achieved by breaking through existing work patterns and organizational routines within Company X. The research question here was:

3. *In which way can the development of breakthrough innovations be stimulated within Company X?*

This question was answered in the design phase of the research, in which suggestions to stimulate the development of breakthrough innovation were proposed.

Theoretical background

The theoretical perspective of the research was the Complexity approach. More specifically, the Chaordic Systems Thinking approach was used. In this approach organizations are seen as a whole of interacting parts and the organization in its turn is part of a bigger whole. This is also the case for all organizational aspects. Besides, interaction between (organizational) aspects plays a main role in this approach because interaction is crucial for understanding the whole.

Furthermore, the componential theory of Creativity (Amabile, 1997) played a prominent role in this research. According to Amabile (1997), individual creativity consists of *intrinsic*

motivation, expertise and creative thinking. Creativity feeds innovation, which arises in a work environment consisting of high levels of available *resources, organizational motivation and management practices.* Besides creativity, also theoretical aspects regarding the product-development process and open innovation were covered in the innovation part of the theoretical background of this research.

Because knowledge and leadership were seen as important aspects in the development of breakthrough innovations, some theoretical aspects regarding both concepts were also covered in the theoretical background.

Research Methodology

With regards to research question 1 – what does breakthrough innovation mean for Company X? – the researcher created three descriptions of breakthrough innovation based on literature. The three descriptions covered three important elements of innovation: people; product; and process. These descriptions were shared and discussed with a network group consisting of Company X employees, who were creating a vision for innovation for the company. Based on their responses, the researcher created a definition of breakthrough innovation.

With regards to research question 2 – which social-organizational aspects are indications for innovation-project success, and for the development of breakthrough innovation? – the researcher compared innovation projects of Company X with each other by conducting surveys, and acquiring indications of the successfulness of the projects and the breakthrough level of the projects. Furthermore, the first phase of the product-development process, in which ideas are generated, is analyzed by comparing practice with findings from literature.

With regards to research question 3 – in which way can the development of breakthrough innovations be stimulated within Company X? – the researcher created suggestions, which can be implemented at Company X to boost the development of breakthrough innovations. The suggestions were directed by the results of the diagnostic phase of the research, and were based on literature findings and field examples. A guideline for the design phase was the so-called CIMO-logic, which is used to create a design proposition.

Results diagnostic phase

In the diagnostic phase, research questions 1 and 2 were answered. The answer to research question 1 is a definition of breakthrough innovation for Company X:

“A breakthrough innovation is an innovation that leads to a new-to-the-customer product that creates significantly more or new value for the customer, as well as for Company X, and it changes the competitor’s landscape.”

Next, the answer to research question 2 is summarized. Based on the comparison of innovation projects of Company X, the following can be stated: *Room for creativity during innovation projects,* and an eventual achieved *high product performance compared to original project objectives* are perceived as the dimensions that form indications of project success, as well as the successful development of breakthrough innovations. Furthermore, both the perception of project success, and the breakthrough level of products at company X, are mostly influenced by technological performance aspects, especially those performance aspects that are product related.

Based on the comparison between literature and practice regarding the innovation process of Company X, it can be stated that it is acknowledged that the level of knowledge creation,

knowledge use, and knowledge sharing outside the company's borders in the identification phase of the innovation process is low. This should be improved because it is believed that it can really contribute to the development of successful innovations with a high breakthrough level.

Results design phase

In the design phase of the research 10 suggestions were proposed to answer research question 3, so, to stimulate the development of breakthrough innovation. The suggestions were divided over three categories of different organizational aspects (of innovation), namely: 1) Communication/connection; 2) Resources; and 3) Development/training.

All suggestions vary in the theoretical aspects they cover, and the practical consequences of the implementation of those suggestions, i.e. costs and time involved. The suggestions stimulate the development of breakthrough innovation by: a high level of communication and interaction; open innovation; facilitating intrinsic motivation; knowledge creation; creativity; allocating sufficient resources to the development of breakthrough innovation; and the development of the (leadership) skills of Company X's employees.

Conclusion and reflection

All three research questions were answered, and now it is discretionary to the management of Company X, which of the proposed suggestions will be implemented to boost the development of breakthrough innovations. Although the outcomes of the suggestions are not documented in great detail, they seem promising, based in literature, and used in other fields of practice.

Reflecting on the research, it can be stated that both research objectives – conducting a diagnosis and creating a design for improvement - were met. Perhaps, a greater level of detail could have been achieved when more focus had been laid on either human aspects of innovation, or process aspects of innovation.

Regarding the theoretical reflection on the research it can be stated that the researcher tried to find a balance between the Complexity approach, in which interaction is crucial for understanding the whole, and the variable-based approach, in which separate parts and their relationships are examined. The Complexity approach is used in the design phase of the research and the variable-based approach is used in the diagnostic phase of the research.

The generalizability of the answers to the research questions is limited because only Company X was the subject of the study. Furthermore, a deeper investigation of, especially, the consequences of the proposed suggestions, offer directions for future research.

Preface

This thesis is the result of my final graduation project of the master study in Innovation Management at University of Technology, Eindhoven.

This graduation project was conducted within Company X and offered me the opportunity, to bring the acquired knowledge during my study, regarding social and organizational aspects of innovation, into practice.

The graduation project could not have been executed without the help of my supervisors and the participants in this research. Therefore, I would like to thank them for their great advice, feedback and contributions.

I would particularly thank my first university supervisor, Frans van Eijnatten, for his great filling in of the role of mentor. Thanks to his inspiring talks and useful feedback, I was able to conduct a very interesting project into the fields of innovation and human performance. Especially, our meetings, in which we discussed the progress of the project, always worked energizing for me to continue with the project and to pursue good results.

Moreover, I would like to thank my second university supervisor, Isabelle Reymen, for her feedback on the proceedings of the project. Especially, her comments on the argumentation within the report helped me very much.

Next, I am very grateful to my company supervisor. With both, her years of experience within Company X and, her knowledge of relevant theory and people, she provided my great guidance during the project. I have experienced her continuous willingness to help me in all possible ways as very helpful, and I am very grateful for that. Furthermore, for the contributions of all employees of Company X, who participated in the project in any way, I am very thankful.

Finally, I would like to thank my parents, girlfriend, and friends, who have supported me, not only during this final graduation project, but during all my college years at the university. Your support is much appreciated.

Jorin van de Laar

August 2013

Due to confidentiality reasons the name of the company, in which the research is conducted, is not mentioned in this report. Furthermore, the corresponding appendices of this report are confidential and will not be made public.

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1. Introduction

This chapter introduces the research by providing a description of the company in which the research is conducted, a description of the research context including the problem statement, a description of the research objectives including the research questions and a description of the report structure.

1.1. Company Description

In this section the organization in which the research is conducted will be briefly described. For confidentiality reasons this organization is called Company X.

Company X is a global provider of equipment, systems and services to food industries. Company X operates in a high-tech environment. Company X has offices and subsidiaries over 30 countries all over the world and about 4000 employees are working at company X and most of them are working in the Netherlands.

The scope of the research is a subsidiary of Company X, located in the Netherlands, from this point on also called Company X. At the moment, this subsidiary is the global leader in their industry. With a strong focus on innovation, it is tried to deliver the best solutions for the customer. At Company X it is believed that innovation is crucial for retaining the leading position in the market. Therefore, the amount of investment in innovation efforts is relatively high opposed to competitors. Furthermore, it is believed that human beings play a crucial role in innovation success.

1.2. Research Context

At Company X, people try to continuously improve and develop new products and services. Because of merging and integration of many companies and businesses, becoming one company is very important for Company X. To become one company, and to be the best in their industries, it is believed at Company X that they should be innovative. In their view, being innovative, requires creativity, rapid commercialization of new products, proper knowledge management practices, and the encouragement of experimentation, individual thinking and initiative.

The problem owners of Company X experience a feeling that the company is being insufficiently innovative in terms of an insufficient development of innovations with a high level of novelty. These innovations are so-called breakthrough innovations. According to the problem owners, symptoms of the experienced problem are; insufficient effort in terms of time and money is put into new product development; insufficient effort in terms of resources is put into knowledge creation practices; employees are not able to go after good opportunities; and the number of patents is diminishing.

Based on exploratory interviews with the problem owners of Company X, possible causes of the problem of being insufficiently innovative, can be intuitively divided into two categories, namely a category regarding people that are involved in innovation at Company X and a category regarding the innovation process. Regarding the people category, possible indications of the problem of an insufficient development of breakthrough innovations are: 'fixed' innovation-project-team composition; immaturity of innovation project leaders; short-term thinking; low motivation of innovative entrepreneurship; insufficient presence of market intelligence; and insufficient out-of-the-box thinking that leads to an insufficient creation of new knowledge. Regarding the innovation process category, possible indications of problems or improvement issues are: misinterpretation of the product development process; low degree of

knowledge sharing possibilities; changing management structures; and changing organizational structures.

Taking the research context into account it can be stated that the general research question is in which way the development of breakthrough innovations can be stimulated in a high-tech company as Company X.

1.3. Research Objectives

The first research goal is to make a diagnosis of the experiences of the problem owners. This will be done by answering research questions, which are presented below. The second research goal is to create a design to improve the current situation at Company X. Also with the design a research question will be answered. Both, the diagnostic phase and the design phase of the research are briefly described below and will be elaborated on in chapter 3 of this report.

Diagnostic phase

The diagnostic phase of the research can actually be divided into two parts.

The first part includes creating clarity on what breakthrough innovation actually means for company X. Therefore, the research question for this part is:

1. What does breakthrough innovation mean for Company X?

This question implies that breakthrough innovation should be defined. This definition can be used to create clarity about breakthrough innovation within Company X.

The second part of the diagnostic phase includes an analysis of 'best practices' and 'not so best practices' with respect to innovation *projects* of Company X to reveal the differences between those projects. A special focus will lie on social-organizational aspects. In this research, social aspects are seen as human aspects like human behavior and interaction and organizational aspects are aimed at organizational processes. Because people are part of the organizational processes, these two categories of aspects are very closely related and, therefore, the combination of these categories, i.e. the so-called social-organizational aspects of innovation projects, will be investigated in the second part of the diagnostic phase. The social-organizational aspects will be investigated in relation with the level of project success and the development of breakthrough innovations. Therefore, the research question is:

2. Which social-organizational aspects are indications for innovation-project success, and for the development of breakthrough innovations?

To answer this question, already completed innovation projects of Company X will be compared. This implies an investigation of innovation projects in retrospect. Furthermore, the current innovation *process* at Company X will be analyzed to determine the process aspects that can contribute to the successfulness of projects and the development of breakthrough innovations. The focus regarding the process aspects will lie on the first phase of the complete innovation process, i.e. the identification phase, because it is believed at Company X that breakthrough innovations arise in that very first phase of the complete innovation process.

Based on the results of the diagnostic phase, it will be determined which social aspects and which organizational aspects are indications for the development of successful (breakthrough) innovations at Company X.

Design phase

The results of the diagnostic phase will be used to direct the design phase of the research. In the design phase suggestions will be created, based on results from literature and example in fields of practice to stimulate breakthrough innovation development. The research question here is:

3. *In which way can the development of breakthrough innovations be stimulated within Company X?*

The design contains suggestions for human behavior, interaction and role distribution within innovation projects. The design should focus on breaking through existing patterns and developing new role patterns for the involved employees, including more open modes of behavior and interaction, because this might enhance the probability of success regarding the development of breakthrough innovations.

Furthermore, the design consists of creating suggestions for the innovation process, regarding aspects that will probably stimulate the development of successful breakthrough innovations. As mentioned before, social and organizational aspects are very closely related and therefore, the suggestions contain both social and organizational aspects of the development of breakthrough innovations.

Both, the diagnostic and design phases will eventually lead to an action plan for: 1) implementing a more open way of human behavior, interaction and role distribution within innovation projects in order to enhance the probability of developing successful breakthrough innovations; and 2) adapting the current innovation process in order to stimulate the successful development of breakthrough innovations.

1.4. Report Structure

The remainder of the report is as follows. Chapter 2 summarizes main theoretical findings in the fields of Chaordic Systems Thinking, innovation, knowledge creation and leadership. In chapter 3 the research methodology is explained including the methods used in both the diagnostic and design phase of the research. Chapter 4 contains the results of the diagnostic phase of the research, and chapter 5 contains the results of the design phase of the research. In chapter 6 conclusions of the research are provided. Reflections on the research, on theory and on individual performance are provided in chapter 7, together with a discussion about the research limitations and directions for further research. The report structure is graphically presented in figure 1 below.

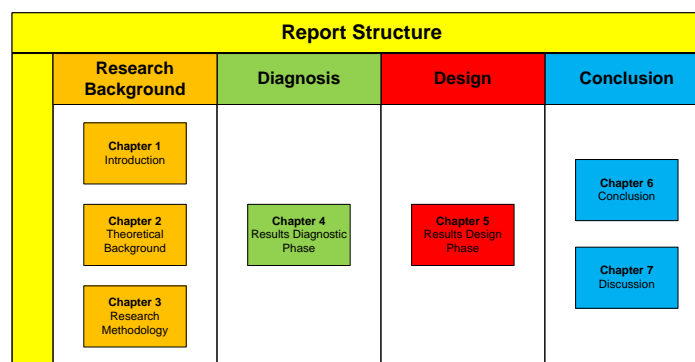


Figure 1 Report structure

2. Theoretical Background

This chapter presents main theoretical findings regarding Chaordic Systems Thinking, Innovation, Knowledge Creation and Leadership. These literature findings form the theoretical background of the research. This theoretical background will be used in the diagnostic phase and the design phase of the research. This chapter starts with an introduction, in which it is explained why particular theoretical aspects are included in this research.

2.1. Introduction of Theoretical Background

The research is performed from the perspective of Chaordic Systems Thinking, because multiple organizational aspects can be explained with help of this approach and it is believed that interaction plays a main role within the development of breakthrough innovations. Examples of such organizational aspects are organizational growth and organizational processes like product development processes. Moreover, interaction is crucial for understanding the bigger whole. Furthermore, human aspects like behavior and interaction can be viewed and characterized with help of the approach of Chaordic Systems Thinking.

Innovation is the main subject of the research, and therefore this will be part of the theoretical background. In this part human creativity, as being a source of innovation, will be explained. Then, innovation processes will be discussed with a focus on the first part of the process, the fuzzy front-end. Because of the fact that the focus of the research is on breakthrough innovation, this type of innovation will be introduced. Then, the innovation model of so-called open innovation will be described because at the start of the research it is believed that this model can be very helpful in stimulating the development of breakthrough innovation.

Besides creativity, knowledge is a source of innovation. With the eye on breakthrough innovation, knowledge creation is an important aspect, and therefore it will be described here. The focus will lie on the environment that is enabling knowledge creation. A new theory of knowledge creation will be introduced, namely C-K theory.

Because also leadership is an important aspect in innovation, this will also be introduced. Two forms of leadership are explained, namely Complex Adaptive Leadership and Shared Leadership. For both forms it is believed that they might be interesting options to implement in Company X.

2.2. Chaordic Systems Thinking

First of all, the theoretical perspective of the research is presented. The theoretical perspective is the Chaos & Complexity paradigm. A part of that paradigm is Chaordic Systems Thinking, which will be used throughout this research.

Van Eijnatten (2002) defined Chaos as a new way of thinking or metaphor to look to reality, and he defined Complexity as the characteristic of every whole consisting of a lot of interacting parts. Some other concepts are developed by Hock (1996, p.3). One of these concepts is Chaord. Chaord is formed by the two concepts of chaos and order. Chaord is behavior that blends characteristics of both chaos and order and can be applied to any self-organizing, adaptive, non-linear, complex organism, organization or community. Anything which is chaotic and orderly simultaneously is called Chaordic. A Chaordic System is an arrangement of connections between elements that form a whole containing both unpredictable and patterned behavior. Chaordic Systems Thinking is a way of thinking to design complex organizational systems.

When an organization is considered as a complex, non-linear, dynamic system, i.e. a Chaordic System, five characteristics of such systems can be identified. Those characteristics are presented in the text box 1 and will come back in the design phase of the research.

- **Consciousness**
Simply said this means that ideas are more important than the material executions of it. It is not about those executions but about the inner potency of it. So, organizations can develop themselves independently of their material executions to deeper levels of consciousness. However, organizations can not change when the mindset has not been changed.
- **Connectivity**
Nothing can be seen as a separate part of the whole. So, systems are part of a bigger system, which in its turn is again part of a bigger system, and so on. For organizations this means that every aspect is related to each other and therefore you have to apply a 'think globally, act globally' strategy.
- **Indeterminacy**
This stands for the fact that every link between cause and effect in complex systems like organizations, is insufficient or unclear. Therefore, it is very hard to predict the future.
- **Dissipation**
Complex systems sometimes fall apart and after a while they form a new combination. This falling apart is caused by the lack of inner potency of complex systems. This characteristic implies that you have to change before it is time.
- **Emergence**
The whole has unique characteristics emerging from the interactions of the parts. New combinations of parts can develop new characteristics of the whole. These new combinations can lead to higher levels of complexity. For organizations this means that they should make possible self-organization, self-reference and self-replication so that managers can let go of control.

Text box 1 Chaordic System characteristics (Van Eijnatten, 2002, p. 12)

As can be concluded from the above, a Chaordic System has to do with *wholes* and *parts*. Wilber (1996) defined holons as entities that are a whole and part of a bigger whole, at the same time. Furthermore, Wilber (1996) stated that holons consist of four domains: an intentional domain, a behavior domain, a culture domain, and a social domain. The intentional domain of a holon represents the intention of the holon, for example, the reflexes and thoughts of a holon. The behavior domain represents the behavior of a holon, so what kind of actions a holon makes. The cultural domain represents the norms and values of a holon, and the social domain represents the role of a holon in a social context. Furthermore, Wilber (1996) described two dimensions in which holons can appear. The first dimension is the individual vs. the collective dimension. In this dimension the focus is either on the holon itself (individual) or on the holon as a collection (collective). The second dimension is the interior vs. exterior dimension. This dimension represents the non-observable characteristics of a holon (interior) and the observable characteristics of a holon (exterior). Note that these domains and dimensions of holons only are representations of characteristics. The domains and dimensions together form Wilber's quadrants (1996), shown in figure 2.

Edwards (2005) adapted the quadrants by changing the individual vs. collective dimension into the agency vs. communion dimension. This results in the quadrants shown in figure 3. Both two-by-two tables can be used to describe human aspects.

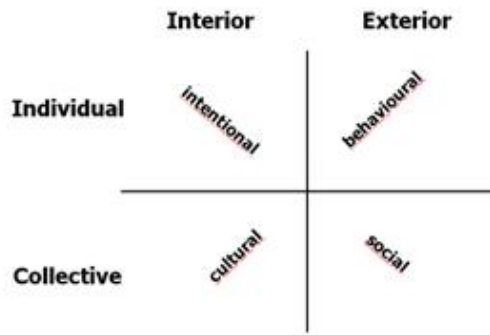


Figure 2 Wilber's quadrants (1996)

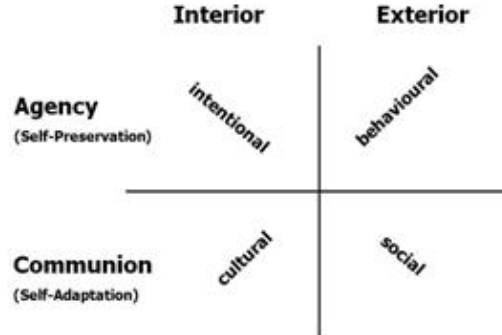


Figure 3 Wilber's quadrants adapted by Edwards (2005)

The difference between the two approaches is that in case of Wilber's quadrants, the lower part of the quadrants represents the larger whole. In that case you can speak of a collective holon, besides the individual holon, which characterizes the upper part of the quadrants. In case of Edwards' quadrants, the lower part of the quadrants represents a *system* as a part of a bigger system, as a part of a communion. The holon, which characterizes the lower part of the quadrants is the *same* holon, which characterizes the upper part of the quadrants. So, in case of Edwards' quadrants, all dimensions belong to one and the same holon and therefore, Edwards' quadrants are preferred.

Two mechanisms of development are distinguished in literature (Edwards, 2007). The first mechanism is development diffusing into other domains. This is called translation. Translation means rendering of interior aspects into exterior aspects and the other way around, and translation also means rendering of agency aspects into communion aspects and the other way around (Kira & Van Eijnatten, 2008). The development in one part of the quadrant is translated into another part of the quadrant. Translation can go in all directions. Often, the development in one of the quadrants is triggered by the representations of another quadrant. A graphical representation of translation is provided in figure 4.

The second mechanism of development is called transcendence, and this means that a holon transcends into higher levels of complexity. A holon is assumed to jump to a next level of complexity when all separate domains are developed equally. A graphical representation of transcendence is provided in figure 5.

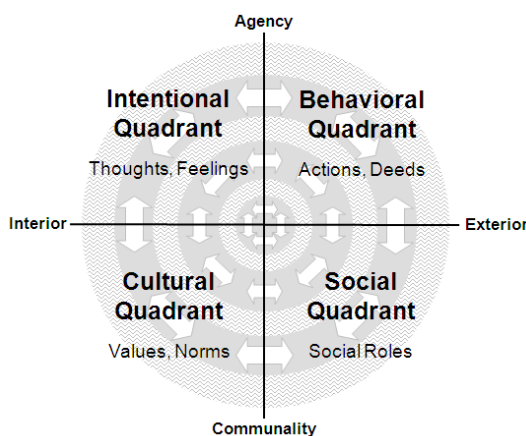


Figure 4 Translation (Kira & Van Eijnatten, 2008, p. 5)

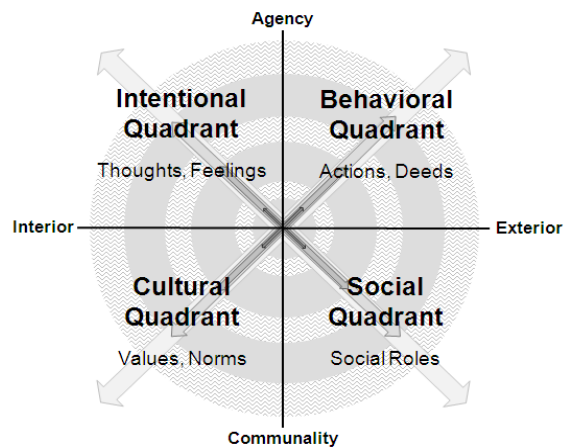


Figure 5 Transcendence (Kira & Van Eijnatten, 2008, p. 5)

2.3. Innovation

In this section, several issues related to innovation are presented. First, creativity as an important input source of innovation will be discussed. Second, the concept of breakthrough innovation is presented, as being an important part of the research. Third, the process of innovation is described including a focus on the first part of an innovation process, the Fuzzy Front End. Fourth, the model of open innovation is presented.

2.3.1. Creativity

The first step of innovation is creativity (Amabile, 1997). Creativity is referred to as “the production of novel appropriate ideas in any realm of human activity” and innovation is referred to as “the successful implementation of those novel, appropriate ideas” (Amabile, 1997, p. 40). Subsequently, Amabile (1997) distinguishes between two types of creativity, namely individual creativity and organizational creativity. Individual creativity consists of three major components, which are all necessary for creativity. The three components are: expertise; creativity skills; and (intrinsic) task motivation. Expertise and creativity skills, for instance taking new perspectives, determine what people are capable of. Intrinsic task motivation determines what people will do.

Organizational creativity is seen as the work environment within an organization that influences the level of innovativeness. The work environment consists of three important elements. Those elements are: organizational motivation to innovate, management practices and resources. Together, these components determine the level of innovativeness of an organization (Amabile 1997). The more the components are present, the higher the level of innovativeness is. Furthermore, Amabile (1997) states that the work environment impacts individual creativity and that individual creativity is a primary source for innovation within the organization. This is graphically presented in figure 6.

In appendix A, an overview of the components of individual creativity and the work environment, including their corresponding aspects and the relationship with creativity, is presented.

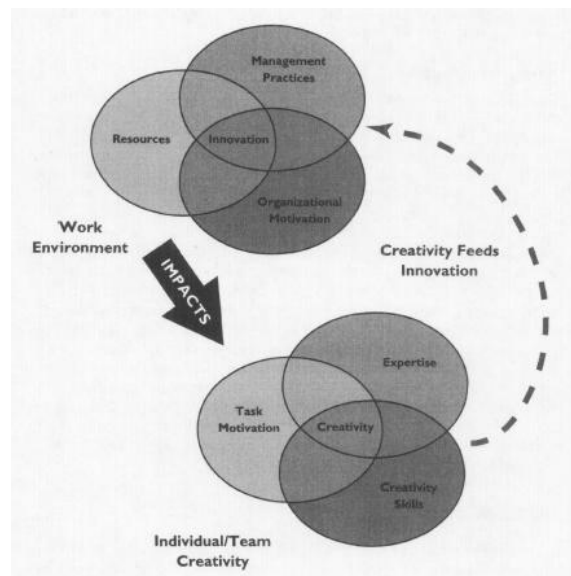


Figure 6 Relationship work environment and individual creativity (Amabile, 1997, p. 53)

Intrinsic motivation and rewards

Intrinsic motivation is part of creativity (Amabile, 1997). Intrinsic motivation is “the motivation to work on something because it is interesting, involving, exciting, satisfying, or personally challenging” (Amabile, 1997, p. 39).

Cognitive Evaluation Theory (CET) is a theory which examines external factors that influence intrinsic motivation (Deci, 1975). It is proposed that intrinsic motivation is facilitated by feelings of competence, i.e. self-efficacy, and feelings of autonomy. So, when both levels of feelings are high, the level of intrinsic motivation is also high.

Closely related to motivation and creativity are rewards, because rewards can motivate individuals to behave creatively. Examples of such rewards are: providing money, awards, praise, recognition and extra resources. Creativity is stimulated in the following manners by offering rewards. One option is that management should make clear that creativity will be rewarded. Providing this kind of information increases the probability of individuals being more creative. Another option is to increase choice. This means that employees are able to self-organize their work and that close monitoring and time pressure should be avoided (Byron & Khazanchi, 2012). In CET (Deci & Ryan, 1985) it was stated that providing an extrinsic reward like salary raises and promotions, for behavior that was previously rewarded with an intrinsic reward like autonomy, *decreases* the motivational level of employees. Therefore, providing intrinsic rewards is important to maintain a high level of motivation and creativity.

Kill The Company

Kill The Company is the title of a book written by Bodell (2012). In the book it is described that companies are struggling with their innovative environment. A toolkit is proposed to disrupt the status quo, in which a company can be in, and to start an innovation revolution. This can be done by developing five individual skills and five organizational behaviors, with the help of a toolkit. These skills and behaviors, with a brief explanation are provided in table 1. The toolkit will be presented in the design phase of the research.

Table 1 Individual skills and organizational behaviors (Bodell, 2012)

Category	Name	Explanation
Individual skill	Strategic imagination	Recognize the driving forces of change
	Provocative inquiry	Ask smart, disturbing questions
	Creative problem-solving	Use wide range of resources to go beyond the quick and obvious solutions
	Agility	Be able to deal with change
	Resilience	Encourage in overcoming obstacles and pushing the undeterred
Organizational behavior	Focus on the future	Pay attention to future trends and smaller shifts
	Challenge the status quo	Encourage a culture in which the accepted way is challenged
	Identify/invest in smart risks	Be smart about risks
	Active collaboration	Foster a culture of openness and sharing
	Continuous learning	Contain a learning attitude and encourage experimentation

2.3.2. Breakthrough innovation

Next, the concept of breakthrough innovation is presented. In general, breakthrough innovations can contribute significantly to firm's profitability (Wind & Mahajan, 1997). This is caused by the fact that "breakthrough innovations have a potential to create markets, shape consumers' preferences and change consumers' behavior" (Zhou, Yim & Tse, 2005, p. 47). Breakthrough innovations are positively related to *firm* performance in terms of sales growth and return of investments and they are positively related to *product* performance in terms of quality and customer value (Zhou et al., 2005). Furthermore, breakthrough innovation is essential to survive in turbulent markets (Hamel & Prahalad, 1994). Next, breakthrough innovation is presented on the basis of three important elements of innovation; people, product and process.

People

Breakthrough innovation in terms of people concerns breaking through existing patterns of thinking, i.e. creating new patterns of thinking. Especially in the idea generation phase of innovation these new patterns of thinking can lead to new thoughts, insights and opinions. Breaking through the existing patterns of thinking can be done by adapting, changing or removing the present assumptions in peoples' thinking (Bohm, 1990). Breakthrough innovations arise from invention or new insights based on new combinations of technologies and processes. From a pool of knowledge, a phenomenon called 'opportunity recognition' takes place (Colarelli O'Connor & Rice, 2001). This opportunity recognition is the step between idea generation and the actual translation of an idea into a business case and the latter development of a breakthrough innovation. Important aspects of people to conduct opportunity recognition are creativity and motivation. Both aspects should be present to a very high extent to conduct opportunity recognition and to come to breakthrough innovations (Colarelli O'Connor & Rice, 2001). Besides, breakthrough innovations result from harnessing tacit knowledge possessed by individuals and project teams (Mascitelli, 2000, p.179). Harnessing tacit knowledge can be achieved by fostering emotional commitment and involvement of team members, early and frequent prototyping and face-to-face interaction. In general, it can be stated that knowledge is an important aspect of people to manage in order to create breakthrough innovations (Mascitelli, 2000).

Product

Breakthrough innovations contain a high level of novelty to the firm but also a high level of novelty to the customer. Breakthrough innovations are unique, novel and change technologies that significantly, that they alter the consumption patterns of a market (Wind & Mahajan, 1997). However, they are risky to invest in, because of the high level of novelty.

Two types of breakthrough innovations regarding the product category are distinguished in literature: technology-based breakthrough innovations and market-based breakthrough innovations (Zhou et al., 2005). Technology-based breakthrough innovations adopt new technologies and improve customer benefits. Furthermore, they represent state-of-the-art technological advances (Benner & Tushman, 2003), and address the needs of existing markets (Zhou et al., 2005). In literature, these kinds of breakthrough innovations are also called radical innovations (Benner & Tushman, 2003).

Market-based breakthrough innovations involve new technologies and create new customer values for emerging markets (Benner & Tushman, 2003). Besides, market-based breakthrough innovations break through the existing customer-preference structure by

providing new benefit dimensions (Zhou et al., 2005). Compared to technology-based breakthrough innovations, market-based ones use more simple technologies.

In general, both types of breakthrough innovations are beneficial to both firm and product performance. Although, technology-based ones have a greater impact on performance (Zhou et al., 2005). The difference in impact is caused by the fact that technology-based innovations improve the benefits of mainstream customers.

Process

Breakthrough innovation in terms of processes has to do with fundamentally organizing business processes in another way. A business process is “a set of related tasks to be performed to achieve a particular business outcome” (Davenport & Short, 1990, p. 12). This other manner of organizing can be done by applying smarter organizing principles. Closely related to the process category of breakthrough innovation is the work environment of creativity and innovation, because management practices and resources are the basis of structuring processes. So, people and process are, of course, closely related regarding innovation.

2.3.3. Innovation process

An innovation process is a process, which brings new products and services to the market (Hauser, Tellis & Griffin, 2006). Because it is believed that (breakthrough) innovations arise in the first part of the innovation process, this part is elaborated on below.

Fuzzy Front-End

A prominent role in an innovation process is played by the so-called fuzzy front-end (FFE), which is defined as “the period between when an opportunity is first considered and when an idea is judged ready for development” (Kim & Wilemon, 2002, p. 269), so, the first stage of an innovation process. Effectively managing the FFE is important because it contributes to new product success (Cooper, 1998). The period in the above-mentioned definition consists of the following steps in the innovation process: product strategy formulation and communication; opportunity identification and assessment; idea generation, product definition; project planning; and early executive reviews (Khurana & Rosenthal, 1998).

Considering the subject of the thesis project, breakthrough innovation, Reid and De Brentani (2004) developed a theoretical model for the FFE in case of discontinuous innovation. Discontinuous innovation can be seen as breakthrough innovation (Colarelli O'Connor & Rice, 2001). Reid and De Brentani (2004) argue that discontinuous innovations originate in the environment when information flows from organizational individuals toward the corporate level of decision making and that “process of identifying, understanding and acting on the emerging patterns in the environment is the essence of the fuzzy front end” (Reid & De Brentani, 2004, p. 182). The theory suggests that the FFE consists of three interfaces, namely the boundary interface, the gatekeeping interface and the project interface. In the boundary interface, an organizational individual, i.e. the boundary spanner, interacts with the environment. In the gatekeeping interface, the information from the boundary spanner is evaluated on their relevance to the organization. In the project interface, the information shared with the organization in the gatekeeping interface now moves to the project level. In all three interfaces, the information flow effectiveness, which is the speed and quality of the information flow, depends on 1) the attributes of the innovation itself, 2) social system variables, and 3) attributes of the individuals involved (De Brentani & Reid, 2012). The propositions concerning information flow effectiveness per interface, is summarized in table 2 below.

Table 2 Summary propositions FFE of discontinuous innovation (De Brentani & Reid, 2012)

Interface	Dependence category	Attribute/Variable (relationship with speed, quality)
Boundary	Innovation attributes	Level of discontinuity (-,-)
	Social system variables	Broad network of relationships (+,+)
		Central role in network (+,+)
		Number of non-redundant contacts (+,+)
	Involved individual attributes	Need for cognition (-,+)
		Technical integration capability (+,+)
		Female compared to male (-,+)
Engagement level in search efforts (+,+)		
Gatekeeping	Innovation attributes	Amount of cost and risk (-,+)
		Strategic value of innovation (+,?)
	Social system variables	Authority, experience and expertise through formal roles (+,+)
		Informal roles (+,+)
		Size of organization (-,+)
		Lack of corporate structure (-,-)
	Involved individual attributes	Lack of value construction of context (-,-)
		Extraversion (+,+)
		Risk avoidance (-,-)
	Project	Innovation attributes
Social system variables		Active involvement senior managers (+,+)
		Experience and expertise of senior managers (+,+)
Involved individual attributes		Extraversion of senior managers (+,+)
		Organizational political sophistication of senior managers (+,+)

2.3.4. Open Innovation

Open innovation, first described by Chesbrough (2003a), is defined as: “the use of inflows and outflows of knowledge to accelerate internal innovation and to expand the markets for external innovation. Firms should use internal and external ideas by breaking the boundaries of the organization” (Chesbrough, 2006, p. 1). Open innovation can be seen as a model for innovation, illustrated in figure 7.

Two kinds of open innovation exist, namely Outside-in and Inside-out (Chesbrough, 2012). “Outside-in open innovation is the phenomenon that companies open up their own innovation processes to external inputs and contributions and Inside-out open innovation is the phenomenon that companies allow unused and underutilized ideas to go out of the company into other companies” (Chesbrough, 2012, p. 21).

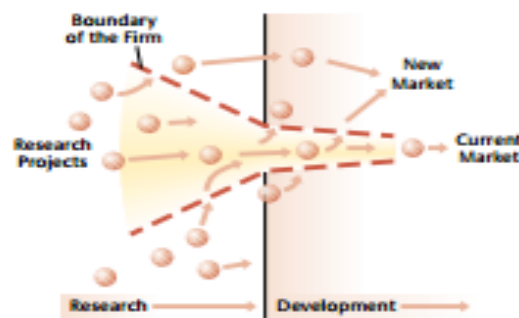


Figure 7 Open innovation model (Chesbrough, 2003a, p. 37)

2.4. Knowledge Creation

Knowledge is widely seen as an important source of firm's competitive advantage and an important source of innovation (Nonaka, Toyama & Konno, 2000). Knowledge is defined as a "justified true belief" (Nonaka, 1994, p. 15). Nonaka (1994) distinguishes between two types of knowledge, namely tacit knowledge and explicit knowledge. "Tacit knowledge is hard to formalize and contains subjective insights and intuitions. Explicit knowledge is expressible in formal language and can be shared in forms of data, reports, etc. (Nonaka et al, 2000, p. 7).

Ba

Ba is a concept from the knowledge creation theory developed by Nonaka (1994). Ba is defined as "a shared context in which knowledge is shared, created and utilized" (Nonaka et al., 2000, p. 14). Interaction is an important aspect of the shared context because interaction is key to knowledge creation. (Nonaka et al., 2000).

Four types of Ba exist. The first type is the originating Ba, in which individuals interact face-to-face. The second type is the dialoguing Ba, in which collective interaction takes place on a face-to face basis. The third type is the systemizing Ba, in which collective interaction takes place in a virtual context. The fourth type is the exercising Ba, in which individual interaction takes place in a virtual context.

C-K Theory

Hatchuel and Weil (2003) present an approach of innovative design, which is called C-K Theory. In this theory, knowledge plays an important role. C-K Theory is a unified design theory that offers a formalization of design, independent of any design domain.

C-K Theory is based on the premise of the existence of two distinct spaces: the Knowledge space (K-space) and the Concept space (C-space). The K-space is defined as "the space of propositions that have a logical status for a designer" (Hatchuel & Weil, 2003, p. 5). Examples of logical states are: true, false, undecidable, etc. The C-space is defined as "a space of concepts, which are propositions, which have no logical status in the K-space" (Hatchuel & Weil, 2003, p. 6).

A design process is defined as the expansion of the K-space and the C-space by the following four operators: $C \rightarrow C$, $C \rightarrow K$, $K \rightarrow C$ and $K \rightarrow K$. The design process starts with a undecidable proposition, i.e. a concept. Then, the concept is partitioned using propositions from K ($K \rightarrow C$). These partitions add new attributes to the concept and therefore, create new concepts. This is called the expansion of C ($C \rightarrow C$). This expansion of C provokes the expansion of K ($K \rightarrow K$) by conjunction ($C \rightarrow K$). However, the expansion of K also occurs by experimentation etcetera. See, figure 8. In this way, C-K theory shows that creative design is the interplay between the expansion of C and the expansion of K and can be used in innovation.

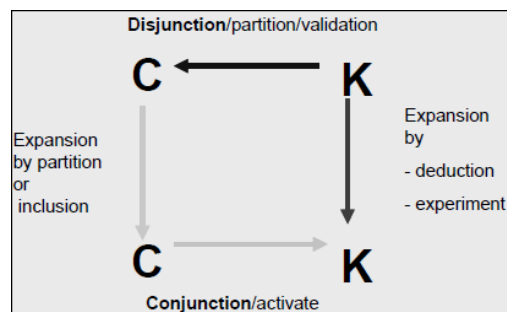


Figure 8 Design square (Hatchuel & Weil, 2003, p. 10)

2.5. Leadership

As stated in the introduction of the theoretical background chapter, leadership plays an important role in the development of (breakthrough) and therefore, two models of leadership, complex adaptive leadership and shared leadership, are explained here.

Complex Adaptive Leadership

Complex adaptive leadership (Obolensky, 2010) is based on the fact that leadership is best executed when leaders are capable of adapting their strategies towards the needs of their followers. Leadership can be divided into people and goal focused behavior. “People focused behavior means that there is an opportunity or need to develop peoples abilities and the relationships with them” (Obolensky, 2010, p. 160). “Goal focused behavior means that there is a need or opportunity to make a difference to the achievement of the goal through other people” (Obolensky, 2010, p. 161).

Four possible leadership strategies are: tell, sell, involve and devolve (Obolensky, 2010). Taking into account a complexity-science perspective, the goal is to let the followers themselves develop into the state of devolvement. This should lead to self-organization, which is a source of emergence of novel ideas. Furthermore, you have to keep working on the skills of the followers and, more importantly, on the will of the followers. There are many possible flows throughout the four strategies. In table 3 it is presented when to apply the proper leadership strategy.

Table 3 Complex Adaptive Leadership strategies (Obolensky, 2010, p. 161–162)

Strategy	When	Means
Tell	Low people focus, high goal focus. Leader knows the solution. Low skill and high will of follower.	Show what to do and how to do something.
Sell	High people focus, high goal focus. Leader knows the solution. Low skill and low will of follower.	Explain why something needs to be done. SPIN.
Involve	High people focus, low goal focus. Leader does not know the solution or holds it back. High skill and low will of follower.	Let the followers participate in discussion and decision making.
Devolve	Low people focus, low goal focus. Leader does not know the solution or holds it back. High skill and high will of follower.	Only keep finger on the pulse. (When need for change, apply sell or involve).

Shared Leadership

Shared leadership can be performed in organizational teams. When organizational teams are performing shared leadership, leadership is shared by every single team member (Pearce, 2004). So, every single team member is responsible for team performance at every moment. Shared leadership can be applied in teams that execute tasks that are highly interdependent, that are complex and require a high level of creativity (Pearce, 2004). So, shared leadership can be applied in innovation teams to a high extent because innovation is complex and requires a high level of creativity.

3. Research Methodology

This chapter describes the research methodology as performed in this research. First, the research approach will be presented. Second, the diagnostic phase methodology will be described. Third, the design phase methodology will be described. Finally, research quality aspects will be discussed.

3.1. Research Approach

The research at Company X is conducted following the regulative cycle approach by Van Aken (1994), see figure 9. This cycle forms the research approach.

The regulative cycle works as follows. From the problem mess, obtained in the orientation phase at Company X and with help of the problem owners, problems will be defined. The problem definition will be based on the problems experienced by the managers at Company X. In the diagnosis step of the cycle, the analysis of the problem of the research is conducted. An analysis of the collected data, concerning the problems defined in the problem definition step, will be conducted. This diagnostic part of the research methodology will be explained in section 3.2. The following step of the regulative cycle is the design step. A design is created in order to improve the current situation at Company X. The methodology regarding this phase will be elaborated on in section 3.3. The intervention and evaluation steps of the regulative cycle will not be conducted in this master-thesis project, due to time limits.

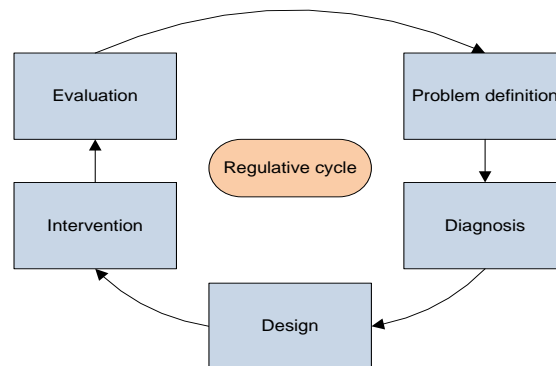


Figure 9 Regulative cycle (Van Aken, 1994)

3.2. Methodology of Diagnostic Phase

This section describes the methodology of the diagnostic phase of the research. As mentioned in chapter 1 of this report, the diagnostic phase of the research consisted of two parts. First, it is examined what breakthrough innovation actually means for Company X (research question 1). Second, it is investigated which social-organizational aspects are related to innovation-project success and are possible indicators for breakthrough innovation (research question 2). However, before the research questions are answered, the feelings of the problem owners were verified by presenting findings from multiple semi-structured interviews in order to get a deeper understanding of the problem(s) of Company X.

This section now continues with describing the methodologies of data collection and data analysis used in order to answer the two research questions.

3.2.1. Methodology for research question 1

To answer the research question what breakthrough innovation actually means for Company X, it was decided, in consultation with the problem owners, that it was needed to define

breakthrough innovation. For this purpose, multiple insights from literature and multiple company-wide perspectives are explored.

Based on literature, three descriptions of breakthrough innovation are developed by the researcher, see chapter 2. Those three descriptions are based on three important elements that are involved in innovation; people, product and process. Nine members of a network group regarding global innovation of Company X were requested to provide feedback on the descriptions of breakthrough innovation via an answer form. The feedback is categorized by the researcher based on common subjects in the responses. Based on the responses, the researcher composed a proposal for the definition of breakthrough innovation.

Subsequently, in an online meeting with the involved network-group members, together with the CEO and the Non-executive director of Innovation, Technology and Strategy, and Product Development of Company X, the responses were discussed. Based on the discussions the researcher composed a definition of breakthrough innovation for Company X.

3.2.2. Methodology for research question 2

To answer the research question which social-organizational aspects are possible indications for innovation-project success and which aspects are possible indications for the development of breakthrough innovations, innovation projects at company X were compared with each other and the current innovation process was investigated.

However, the social-organizational performance aspects that were searched for are closely related to some technological performance aspects and therefore, technological performance aspects are also taken into account when answering research question 2. The social-organizational performance aspects considered in the research were: knowledge practices, behavior, creativity, communication and organizational processes. The technological performance aspects considered in this research were: product performance and operational performance.

The steps conducted to answer research question 2 were: project selection, surveys, project ranking, measuring the breakthrough level of projects and an analysis of the current innovation process. These steps were necessary to conduct a comparison between innovation projects and to acquire an indication of project success and an indication of the breakthrough level.

Project selection

In consultation with the problem owners, selection criteria to select already completed innovation projects of Company X were determined. The selection criteria are based on practical aspects as availability of information to compare the projects and the selection criteria are composed to ensure a high level of comparability between the projects in terms of project size and a comparable manner of executing the project. The selection criteria are presented in text box 2. Based on these selection criteria, nine innovation projects were selected. An overview of the nine selected projects, including the relevant project leader, is presented in appendix B. Due to confidentiality reasons the projects will be called project 1, project 2, etc., in this report.

- The project is conducted at the subsidiary of company X in the Netherlands;
- The involved project leader is still working at the subsidiary of company X in the Netherlands;
- The project has at least covered all stages of the innovation process before the launch stage;
- The throughput time of the project is longer than 1 year;
- The project is conducted with a cross-functional team of at least 10 members;
- The group of selected involved project leaders should consist of a mix of different hierarchical functions within company X;
- Regarding the complete selection of projects, a project leader is allowed to evaluate only one project;

Text box 2 Project selection criteria

Surveys

A survey is developed to acquire data about several social-organizational performance aspects involved in innovation projects. The social-organizational performance aspects covered in the survey were: knowledge practices, behavior, communication, creativity and leadership. The statements in the survey were based on literature findings about social-organizational aspects and their relationship to innovation. The most prominent theory used for the composition of the survey statements is the theory of Amabile (1997), which considers creativity and innovation, as explained in chapter 2 of this report. Subsequently, the survey statements were translated into 'company language' in order to ensure the clearness of the statements.

The survey contains 82 statements and responses can be provided on a 7-point Likert scale. The survey is presented in appendix C. The nine project leaders of the nine selected projects were requested to participate in the survey.

Furthermore, innovation projects were also compared by using a part of the empirical results of a prior research with regard to innovation projects within Company X (Van Eersel, 2011). In that research of Van Eersel (2011), the technological performance of innovation projects at Company X was examined. Van Eersel (2011) identified two types of performance categories regarding new product performance, namely product performance and operational performance. Product performance is referred to as "the evaluation of the commercial outcome of an innovation project" and operational performance is referred to as "the reflection of how the innovation project was executed" (Blindenbach-Driessen, Van Dalen & Van den Ende, 2010, p. 574). The combination of both product performance and operational performance can be seen as project performance of an innovation project (Blindenbach-Driessen et al., 2010). Besides, Van Eersel (2011) split the product performance category into two parts, namely product performance compared to the original project objectives and product performance compared to similar products from the own company or from competitors.

However, the selection of innovation projects in the research of Van Eersel (2011) differed from the selection of innovation projects in this research. Therefore, data was not complete. In total, only three projects in the selection of Van Eersel (2011), e.g. project 1, project 3 and project 4, were also present in the selection of projects in this research. Therefore, the project leaders of the remaining six innovation projects, from which no data was collected regarding technological performance aspects, were requested to complete the results by completing the relevant part of the survey of Van Eersel (2011). That relevant part of the survey consists of 17 statements and responses can be provided on a 7-point Likert scale. The relevant part of the survey is presented in appendix D.

Project ranking

To be able to reveal what is seen as a successful project at Company X, it was needed to rank the innovation projects with respect to each other, on their level of success. The ranking of innovation projects was conducted by management representatives, who were not included in the survey. The management representatives were requested to rank the selected innovation projects based on their own chosen success criteria. The researcher developed a form on which the management representatives can conduct the ranking. The ranking form is presented in Appendix E.

Breakthrough-level indication

In order to be able to reveal which social-organizational and technological aspects are indications for the development of breakthrough innovations, the selected innovation projects were evaluated on the aspects of the definition of breakthrough innovation, which is developed in an earlier stage of the research. This evaluation of aspects of the definition is executed to get insight into the level of breakthrough of the selected projects. The management representatives who ranked the innovation projects on their success level were also requested to evaluate the 'breakthrough level' of the projects. The breakthrough level scoring form is presented in appendix F.

Analysis of current innovation process

To reveal which process aspects are related to innovation-project success and the development of breakthrough innovations within Company X, it was needed to describe the current innovation process at Company X, and to compare it with relevant literature findings regarding the successful development of breakthrough innovations. Because the problem owners felt room for improvement in the identification phase of the innovation process, which is generally the start of the innovation process, the focus, regarding this part of the diagnostic phase, was on the identification phase of the innovation process.

Describing the current innovation process of Company X was done based on semi-structured interviews with involved employees and based on a manual containing a description of the product development part of the complete innovation process of Company X.

Simultaneously, literature about innovation process aspects and their relationship with the development of breakthrough innovations were researched. Subsequently, these findings were compared to the current innovation process at Company X. From this comparison it became clear which aspects of the current innovation process at Company X stimulate or hinder the development of breakthrough innovations.

The mutual comparison of the innovation projects on social-organizational and technological performance aspects, together with the analysis of the current innovation process, indicated which social-organizational aspects are related to innovation project success and to the development of breakthrough innovations.

3.3. Methodology of Design Phase

This section describes the methodology of the design phase. As mentioned in chapter 1 of this report, the design contains suggestions to stimulate the development of breakthrough innovations. The suggestions contain aspects as human behavior, human interaction, human roles and innovation process aspects.

3.3.1. Methodology for research question 3

Based on the results of the diagnostic phase suggestions were developed to stimulate the development of breakthrough innovations within Company X.

First, a gross list of possible improvement suggestions was composed by the researcher. Next, based on the theoretical background of the research, a list of theoretical aspects that might be covered by the suggestions was composed. Besides, a list of practical aspects like costs and time was composed. For the suggestions on the gross list it was indicated by the researcher whether they covered or not the theoretical and practical aspects and to what extent. The theoretical and practical aspects vary per suggestion and therefore, multiple suggestions were developed.

Based on the indication, the researcher decided which suggestions were elaborated on. This further elaboration of the selected suggestions was based on interviews with the problem owners of Company X and based on literature research.

The design phase was directed by so-called CIMO-logic. CIMO-logic is a method to create design propositions (Denyer, Tranfield & Van Aken, 2008). Design propositions can be used to create a proposal for change(s) in an organization. The *C* of CIMO represents Context or Condition, the *I* represents Intervention, the *M* represents mechanism, and the *O* represents outcome. To create a design proposition, the CIMO-logic is used as follows: “in this class of problematic Contexts, use this Intervention type to invoke these generative Mechanisms, to deliver these Outcomes” (Denyer, Tranfield & Van Aken, 2008, p. 395-396).

In case of this research in Company X, the *C* is the insufficient number of breakthrough innovation developments and the insufficient innovative performance regarding the budget spent in innovation at Company X. The *I* is the group of suggestions developed in the design phase of the research to stimulate the development of breakthrough innovations within Company X. The *M* is the group of underlying mechanisms that are triggered by the suggestions. The *O* is the outcome of the suggestions, and in case of Company x, a higher number of breakthrough innovations.

3.4. Research Quality

This section examines the quality of the research in terms of validity and reliability.

3.4.1. Validity

Validity is about justification (Van Aken, Berends & Van der Bij, 2007), which means that valid research results are justified by the way it is generated. Van Aken et al. (2007) describe three types of validity: construct validity, internal validity and external validity.

Construct validity is “to what extent the measuring instruments measure what is intended to measure” (Van Aken et al., 2007, p. 163). Regarding this research, three measurement instruments were developed by the researcher: the survey, the indication of project success form and the indication of breakthrough level form. Because none of them are tested whether they cover concepts completely, it cannot be determined what the level of construct validity is in this research.

Internal validity concerns conclusions about relationships between phenomena (Van Aken et al., 2007). Regarding the indication of project success, multiple people will provide reasons whether they see a particular project as a success. From this it should be possible to draw valid conclusions about relationships between phenomena. Therefore, the level of internal validity will be high.

External validity concerns the generalizability of the research results. The research is really aimed at the situation of Company X and therefore, the results will have most value for Company X. So, generalizability is limited. However, particular aspects of the proposed suggestions in the design phase will also be able to be implemented in other companies. Innovation is context-specific and therefore, it is hard to determine to what extent the research results will also have value in other companies, industries, etc.

So, because of the exploratory nature of the research and context-specific results it is hard to determine whether the total level of validity is sufficient. Nevertheless, all possible was done to boost validity.

3.4.2. Reliability

Reliability is about the reproducibility of the research in other context (Yin, 1994). A research is reliable when another researcher can yield the same research results when using different research instruments with different respondents in different contexts. The level of reliability can be increased by repeating the measurements (Van Aken et al., 2007).

In this research multiple respondents were interviewed to get an understanding of the problems of Company X. From this, only comparable answers of the respondents were taken into account. This should lead to a reliable view of the problems of Company X.

Regarding the survey, the level of reliability is low because a single innovation project was only scored by one single project leader. Therefore, the answers are very subjective. However, per survey dimension, mean results are used, which should increase the level of reliability. Regarding the indication of project success and the breakthrough level of projects the level of reliability is high because multiple management representatives provided their indications and from this, the common results are taken into account. The analysis of the innovation process of Company X was based on interviews and company documentation. Because multiple resources were used and only the comparable answers, statements and findings were taken into account, the level of reliability should be high.

As mentioned in the previous section about validity, the research is very context-specific and therefore, it is hard to determine whether the same research results will be yielded in other contexts.

So, assuming that the respondents provided reliable answers, the total level of reliability of the research was sufficient because of the inclusion of multiple respondents and resources to perform measurements.

4. Results Diagnostic Phase

This chapter describes the results of the diagnostic phase of the research. First, the results of semi-structured interviews, held during the diagnostic phase, are presented. The main objective of these interviews was to create a deeper understanding of the problems of Company X. Subsequently, this chapter presents the results of the analyses of the collected data, and simultaneously, the answers on research questions 1 and 2. The chapter ends with a conclusion.

4.1. Deeper Understanding of Problems

To get a deeper understanding of the problems at Company X, and to verify the feelings of the problem owners as presented in chapter 1 of this report – the feeling of being insufficiently innovative in terms of the development of breakthrough innovations - this chapter starts with an overview of general findings based on semi-structured interviews, which were held during the diagnostic phase.

In total, 25 semi-structured interviews were held with 18 involved employees (e.g. several people were interviewed more than once). The interviews consisted in most cases of: the personal backgrounds of the employee, their views on innovation in general at Company X, their views on breakthrough innovation, their views on the resource allocation at Company X, and their views on leadership in innovation.

The statement made in the interviews that makes the problem of Company X most clear was: “Regarding the relatively high percentage of the budget that is spent in innovation, Company X is not achieving the desired results in that area”. This statement means that although Company X is spending a relatively big share of its budget to innovation compared to its competitors, the quality of the output of innovation is not sufficient. This problem is caused by the fact that an environment in which creativity can flourish is lacking at Company X because ‘control’ is dominantly present in innovation at Company X, or at least the need for control is too high for developing breakthrough innovations. This implies that the work of employees is too structured and the belief is that this hinders the development of breakthrough innovations. Related to this is, the lack of financial awareness among employees, which means that employees involved in innovation just assume that resources will be made available despite of the unknown potential of the development. The belief at Company X is that this may hinder the development of (breakthrough) innovations because employees are not challenged to become more creative, which would be the case if they experience a sense of scarcity regarding the available resources.

The interviews confirm the feelings of the problem owners of Company X being insufficient innovative in terms of the development of breakthrough innovations, to a great extent. Furthermore, the interviews confirm the feeling that causes of this problem lay in both people issues as well as in process issues.

However, to be able to get a deeper understanding of the causes, symptoms and consequences of the problem, it is needed, at first, to define breakthrough innovation as a concept, and subsequently, examine the related issues regarding (breakthrough) innovation at Company X.

4.2. Results Research Question 1

This section describes the process that was gone through in order to answer research question 1; what does breakthrough innovation mean for Company X. Together with the problem owners it was decided that the creation of a definition of breakthrough innovation is the way to make clear what breakthrough innovation means for Company X.

First, the researcher developed descriptions of breakthrough innovation based on literature findings (Benner & Tushman, 2003; Bohm, 1990; Davenport & Short, 1990; Wind & Mahajan, 1997; Zhou et al., 2005). A single description of breakthrough innovation is based on an important element of innovation. The three relevant elements of innovation involved in this research are: people, product and process. Therefore, three descriptions of breakthrough innovation are created. Key parts of the descriptions are presented in table 4 and the full descriptions are presented in appendix G.

Table 4 Key parts of breakthrough descriptions

Breakthrough Innovation		
<i>People element</i>	<i>Product element</i>	<i>Process element</i>
<ul style="list-style-type: none"> • New patterns of thinking • New expanded boundaries 	<ul style="list-style-type: none"> • New advanced technologies • New customer values 	<ul style="list-style-type: none"> • New smarter organizing principles

The descriptions were provided to nine members of a network group, which is responsible for creating a global innovation vision for Company X. Those members were asked to provide their feedback on the descriptions and to provide their view on breakthrough innovation. Eight of the nine members responded to this request. The researcher categorized the responses of the members into relevant aspects of breakthrough innovation, mentioned by the network group members. Those categories are: general, people, product, process/methods, customer, time, knowledge and results. An overview of the responses per category is presented in table 5.

Based on the responses, the researcher created a proposal for a definition of breakthrough innovation for Company X, by including the most frequently mentioned answers of the members into one statement. The eventual proposal was as follows.

Proposed definition of breakthrough innovation:

A breakthrough innovation is a new product based on new-for-us technologies that creates significantly more or new value for the customer and changes the competitor's landscape.

Table 5 Overview responses network group members

Category	Should be included	Should not be included
General	Something new, not seen before	
People	New ways of thinking Encouraging big thinking results in big results Passion, creativity and room	How to achieve breakthrough regarding people Contribution of people's values to definition
Product	New advanced technologies Products/services that change the competitor's landscape Breakthrough innovation is a breakthrough product	
Process/Methods	Open innovation (in- and outside company) Build a platform for people/employees to cooperate in projects Inter-company and inter-departmental participation Dynamics between product and process aspects Good identification processes Ideas are never bad and always have to be evaluated New way or technology that radically changes the way we solve an application problem	Business process Cutting-edge IT technology Emphasis on opinions in evaluation
Customer	New customer values Create certain image with customers Reflection to customer needs	Consumer examples
Time		Time frame (short vs. long term)
Knowledge	Market knowledge is required for breakthrough innovation Knowledge about today's equipment and processes used by customer	
Results	Spreading innovations in industries outside our core markets Contribution to our business / creates new value to our business Changes customer's business by simplifying it or creating new value Combinations of existing things in other industries and lead to unique market propositions Being the carrier for complete systems/lines Breakthrough innovation has significant impact on our own company Breakthrough innovation changes market approach to given problems or improvement points Patents should be filed, and are indications of breakthrough innovation	

Discussion Meeting

After the definition proposal was set up, the nine members of the network group, the CEO of Company X and the Non-Executive Director of Innovation, Technology and Strategy, and Product Development were invited to participate in a discussion meeting in which the definition proposal is presented and discussed. Eight of the eleven invited people were present during this meeting. Besides, one participant left the meeting earlier due to another appointment. A summary of the content of the meeting and an overview of the statements made in the meeting are provided in Appendix H.

Table 6 presents the total number of statements made, and the total number of agreements or additions made per participant. As can be seen from this table, participant 4 was the most active participant in the meeting. He made most statements, as well as most agreements/additions. Furthermore, participant 8 was relatively active in the meeting. Participants 6 and 7 were the relatively less active participants. Regarding participant 7, the reason could be that he had to leave earlier.

Table 6 Total numbers of statements and agreements/additions made per participant

Participant	1	2	3	4	5	6	7	8	Total
Number of statements	2	3	3	12	3	2	2	8	35
Number of agreements/additions	7	7	6	8	5	3	2	7	45
Total	9	10	9	20	8	5	4	15	80

The researcher categorized the content of the meeting into the following themes:

- Why a definition of breakthrough innovation?
- What is breakthrough innovation?
- What is the result of breakthrough innovation?
- How to achieve breakthrough innovation?
- What is the role of success in breakthrough innovation?
- What is the role of time in breakthrough innovation?

This categorization was based on the earlier responses of the network-group members on the descriptions of breakthrough as well as on the content of the meeting itself. In table 7 it is represented which participants made statements and agreements/additions per theme of the discussion.

Table 7 Contributions per theme per participant

Participant	1	2	3	4	5	6	7	8
Number of contributions in category why	0	1	1	2	0	1	0	2
Number of contributions in category what	2	3	2	5	2	2	-	3
Number of contributions in category result	4	2	3	5	3	2	-	5
Number of contributions in category how	0	2	1	3	1	0	-	3
Number of contributions in category success	1	0	0	2	2	0	1	1
Number of contributions in category time	2	2	2	3	0	0	3	1

The objective of the meeting was to agree upon a definition of breakthrough innovation. As can be seen from table 7, all present people contributed to the themes of what breakthrough innovation is and what the result of breakthrough innovation is. A brief summary of those parts, focusing on the definition proposal, is presented next.

During the meeting the proposal of the definition of breakthrough innovation was discussed. The proposal was: A breakthrough innovation is: 1) a new product; 2) based on new-for-us technologies; 3) that creates significantly more or new customer value; and 4) changes the competitor's landscape. All participants agreed upon that part 1, 3 and 4 should be part of the definition. Part 2 should be removed from the proposal because breakthrough is not only based on new-for-us technologies, but can be achieved in multiple ways. Furthermore, it was agreed upon that the impact for Company X also should be included in the definition. As for the customer, the impact for Company X is also the generation of significantly more or new value.

So, the answer on research question 1, what does breakthrough innovation mean for Company X, is answered by creating a definition of breakthrough innovation. Based on the statements and agreements in the discussion meeting the following definition is created.

Defintion of breakthrough innovation:

“A breakthrough innovation is an innovation that leads to a new-to-the-customer product that creates significantly more or new value for the customer, as well as for Company X, and it changes the competitor's landscape.”

4.3. Results Research Question 2

This section describes the research results in order to answer research question 2: Which social-organizational aspects are indications for innovation project success, and the development of breakthrough innovations at Company X. As mentioned in chapter 3, because of the fact that people (i.e. social) and processes (organizational) are closely related, the corresponding aspects will be examined, together. The data presented here are: the results of the surveys, the results of the project ranking, the results of the indication of the breakthrough level of projects, and the results of the analysis of the current innovation process.

Results surveys

Project leaders of the nine selected innovation projects completed two surveys. One survey covered social-organizational performance aspects (appendix C) and was completed by all project leaders in this research. The second survey covered technological performance aspects (appendix D) and was completed by six project leaders in this research and by three project leaders in a prior research (Van Eersel, 2011). The results of the social-organizational performance aspects survey will be presented first, followed by the results of the technical performance aspects survey.

The social-organizational aspects survey originally consisted of 82 statements distributed over 8 social-organizational performance dimensions. The dimensions in the survey are: knowledge creation (KC); knowledge use (KU); knowledge sharing (KS); knowledge storage (KO); behavior (BE); communication (CO); creativity (CR); and leadership (LE). However, statement 38 in the behavior dimension was almost the same as statement 79 in the leadership dimension. Because the statement better fits in the leadership (LE) dimension, statement 38 was deleted from the analysis.

For 75 of the remaining 81 statements the scores can be interpreted as the higher the score on the statement is, the higher the level of creativity/innovativeness is. This relationship is

based on the theory of Amabile (1997) about creativity and innovation, as explained in chapter 2 of this report. The remaining six statements, numbers 65, 66, 71, 76, 77 and 78, were posed in the opposite direction and therefore had to be reverse coded, before analysis could be executed. Furthermore, 9 of the 82 statements, e.g. numbers 34, 35, 36, 37, 47, 48, 58, 63 and 64, could not be directly linked to the concepts of the theory of Amabile (1997), therefore, those 9 statements were deleted from the analysis. So, in total, 72 statements, from which 6 statements were reverse coded, were analyzed.

The data of the social-organizational performance aspects survey is presented in appendix I, including the statements which were not taken into account in the analysis. The focus of this research is on the social-organizational performance aspects of (breakthrough) innovation, therefore, the results concerning the social-organizational performance aspects survey will be examined now.

As explained in chapter 2 of this report, Amabile (1997) distinguishes between individual creativity and organizational creativity. Considering the survey statements, 9 of the 72 statements are aimed at individual creativity, 58 statements are aimed at organizational creativity, i.e. the work environment in which innovation can occur, and the remaining 5 statements are outcomes of either individual creativity or organizational creativity. In appendix J a list of the three 'categories' regarding creativity and the corresponding statements are presented. Because of the relative big amount of statements aimed at organizational creativity and the fact that organizational creativity is closely related to the process aspects that are also examined with regard to research question 2, the 58 statements of the social-organizational performance aspects survey concerning organizational creativity, are analyzed.

The average scores per dimension of the remaining 58 statements concerning organizational creativity are provided in table 8. The number in brackets represents the number of statements per corresponding dimension.

Project 6 has the highest total average score and project 8 has the lowest total average score. So, regarding organizational creativity (Amabile, 1997), project 6 scores best on average.

Table 8 Average results of the social-organizational aspects survey

	KC (2)	KU (9)	KS (15)	KO (2)	CO (9)	CR (3)	LE (18)	Total (58)
Project 1	2,50	3,22	4,93	4,00	6,11	6,00	4,00	4,50
Project 2	5,00	4,67	4,33	5,50	4,44	5,67	4,28	4,52
Project 3	4,00	4,00	3,60	5,00	3,22	4,67	4,33	3,95
Project 4	5,50	5,67	5,87	5,50	5,11	5,33	4,22	5,16
Project 5	5,00	4,11	4,07	6,50	4,00	5,33	4,78	4,47
Project 6	5,00	4,89	5,60	5,00	5,56	4,67	4,94	5,19
Project 7	6,00	5,44	3,87	6,00	3,89	5,00	3,78	4,29
Project 8	3,00	3,67	3,33	6,50	4,78	4,33	3,67	3,86
Project 9	6,50	5,33	5,47	2,50	5,00	5,67	4,00	4,88

(Legend: KC = Knowledge Creation; KU = Knowledge Use; KS = Knowledge Sharing; KO = Knowledge storage; CO = Communication; CR = Creativity; LE = Leadership)

Next, the results of the survey data on the technological performance aspects of innovation projects are presented. The survey consisted of 17 statements distributed over 3 dimensions, namely product performance compared to the original project objectives (PP); product performance compared to similar products (PPG); and operational performance (OP). The total results are provided in appendix K. The average results of the dimensions are provided in table 9. Again, the number in brackets is the number of statements per dimension.

Project 3 has the highest total average score and project 6 has the lowest total average score, regarding the technological performance aspects survey. So, project 3 scores best at technological performance.

Table 9 Average results technological performance aspects survey

	PP (7)	PPG (4)	OP (6)	Total (17)
Project 1	5,71	5,00	4,83	5,24
Project 2	5,43	5,75	4,50	5,18
Project 3	6,57	6,00	3,67	5,41
Project 4	5,43	3,75	4,50	4,71
Project 5	5,57	3,25	4,67	4,71
Project 6	4,29	3,75	3,67	3,94
Project 7	5,43	5,00	3,33	4,59
Project 8	5,00	5,00	5,33	5,12
Project 9	5,43	4,75	4,83	5,06

(Legend: PP = product performance compared to original project objectives; PPG = product performance compared to similar products; OP = operational performance)

Because a high performance on social-organizational aspects (Amabile, 1997) as well as a high performance on technological aspects (Blindenbach-Driessen et al., 2010) can increase the probability of project success and the development of breakthrough innovations, the results of both surveys are combined. This is done by multiplying both total average scores. The scores are put into a scatter plot, see figure 10. The higher the point corresponding to the project number is in the scatter plot, the better it scores on the technological performance aspects. The more to the right the point corresponding to the project number is, the better it scores on the social-organizational aspects.

The best performing project in case of the combination of both categories of aspects is project 9 and the least performing project is project 7. So, project 9 had a high probability of project success and the development of a breakthrough innovation.

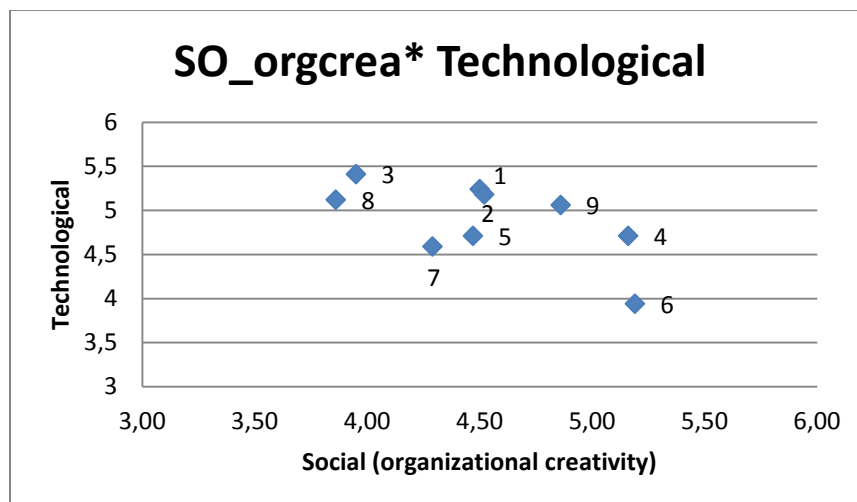


Figure 10 Combined results organizational creativity survey and technological performance aspects survey

Next, the combined survey results scores are plotted on a line to discover the relative distances between the projects. As can be seen in figure 11 below, the projects can be roughly divided into two groups. One group consisting of projects 7, 8, 6, 5 and 3, which are the less successful projects compared to the group consisting of projects 2, 1, 4 and 9, which are the more successful projects. The scale in figure 11 goes from a combined score of 19 to 25. However, in reality the range goes from 1 (total average result of 1 on SO_orgcrea survey * total average result of 1 on T survey) to 49 (total average result of 7 on SO_orgcrea survey * total average result of 7 on T survey). Therefore, figure 11 might be misleading, although, the relative distances between the projects stay the same and therefore, the projects can still be divided over two groups.

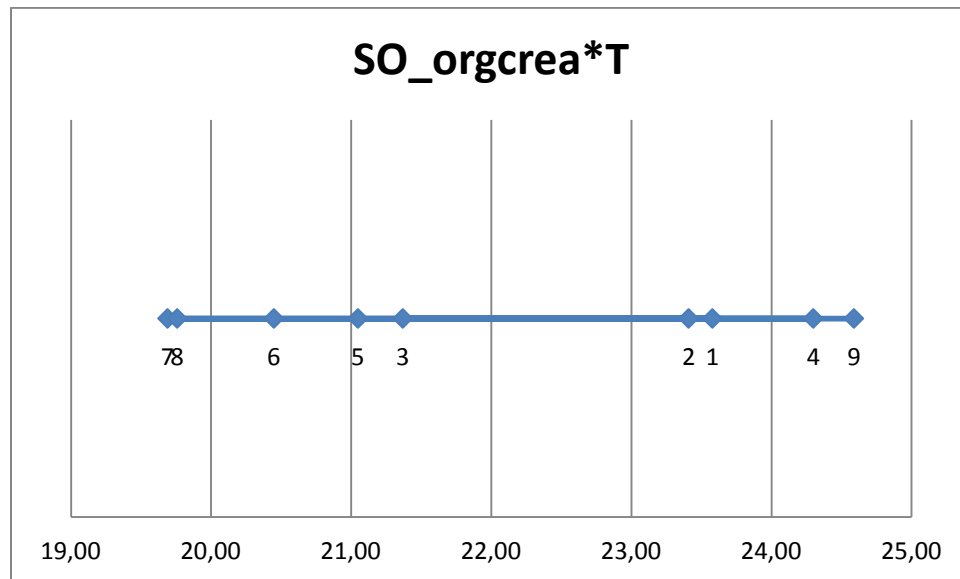


Figure 11 Project rankings based on combined survey results

Now, the differences between (the groups of) innovation projects will be determined. In figure 12, the projects are ranked per dimension of both surveys based on their average scores in a dimension.

As a group, the more successful projects are scoring high on the dimensions of knowledge sharing (KS), communication (CO), creativity (CR), product performance compared to original project objectives (PP) and operational performance (OP). The results of the group of the less successful projects, i.e. project 3, 5, 6, 7 and 8, are more distributed over the dimensions. The less successful projects are scoring worst on the dimension of knowledge sharing (KS).

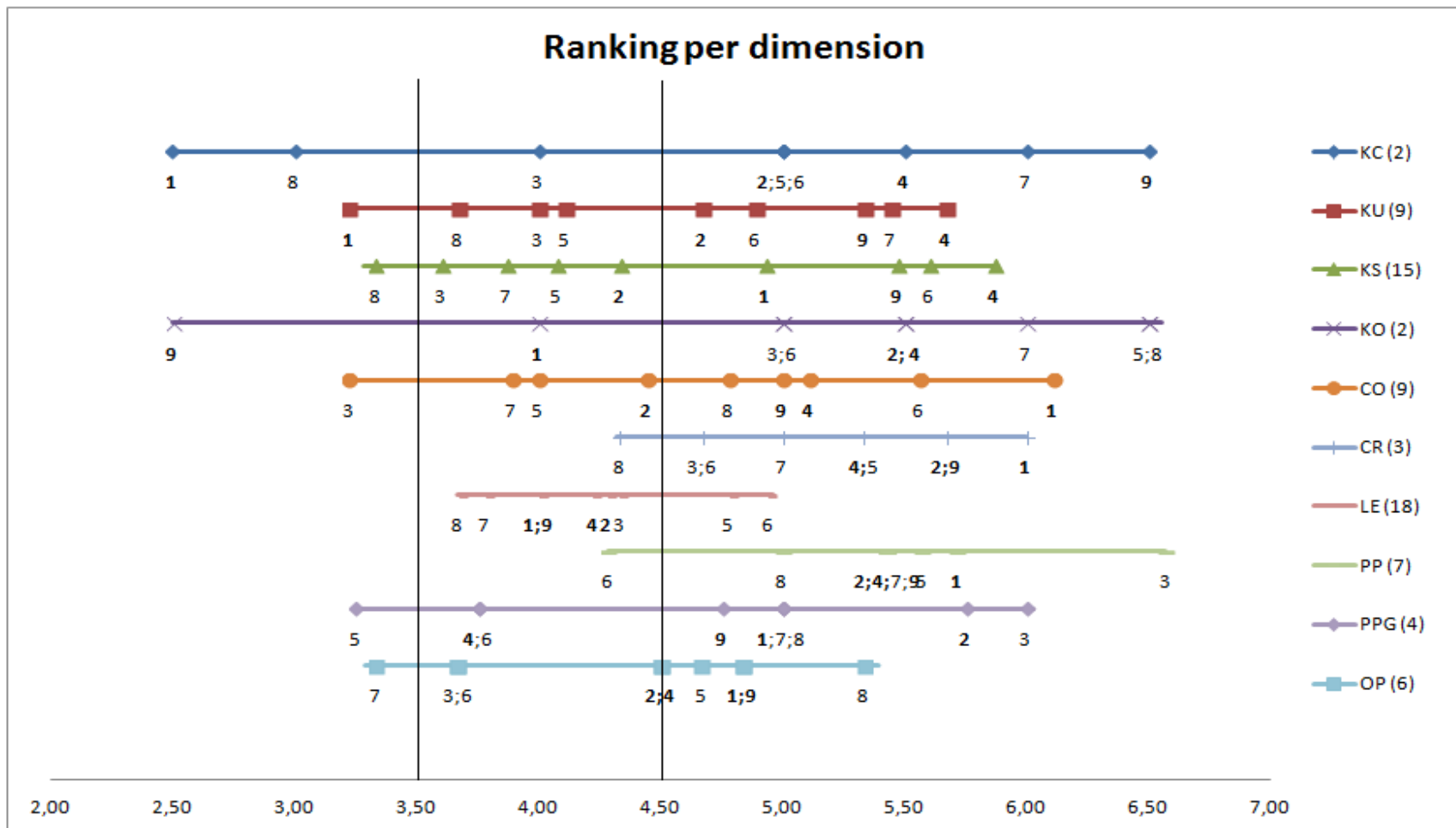


Figure 12 Project rankings per dimension of the organizational creativity survey and the technological performance aspects survey. Numbers in the figure are project numbers, numbers between brackets are the numbers of statements in the survey (Legend: KC = knowledge creation; KU = knowledge use; KS = knowledge sharing; KO = knowledge storage; CO = communication; CR = creativity; LE= leadership; PP = product performance compared to original project objectives; PPG = product performance compared to similar products; OP = operational performance).

Results project ranking

Next, the project-ranking results are presented. Five management representatives have ranked the nine selected innovation projects with respect to each other, using their own success criteria. Those management representatives are: Coach Structural Group Sales; Engineering & Development Manager; Manager Production & Assembly; Non-Executive Director of Innovation; Technology and Strategy and Product Development; and the Service Manager. The aggregated results are presented in table 10. A score in table 10 indicates the number of times a project was ranked in a certain position. So, project 1 was ranked third once; ranked fourth twice; ranked sixth once; and ranked ninth once.

The project, which is most often ranked on position 1 is perceived as the most successful project by management. In this case that is project 3. Subsequently, the project, which is most often ranked on position 1 after project 3, is the second most successful project, in this case project 5. This process continues for every position. The total result of the ranking of the innovation projects is provided in table 11. As can be seen, in total, project 3 is ranked as most successful and project 6 is ranked as least successful.

Reconsidering the dimensions of the surveys (figure 12), it can be seen that the top 3 of the ranking based on project success perception, i.e. projects 3, 5 and 2, are scoring high on the dimensions of knowledge storage (KO), creativity (CR) and product performance compared to original project objectives (PP).

Table 10 Aggregated results of project ranking by management

	Ranking								
	1	2	3	4	5	6	7	8	9
Project 1			1	2		1			1
Project 2		1	1	1			2		
Project 3	3	1						1	
Project 4		1			1	1		1	1
Project 5	2	1	1		1				
Project 6				1		1	1	1	1
Project 7			2	1			2		
Project 8		1			1	2			1
Project 9					2			2	1

Table 11 Ranking of projects based on indication of project success

Rank	Project
1	Project 3
2	Project 5
3	Project 2
4	Project 8
5	Project 4
6	Project 7
7	Project 1
8	Project 9
9	Project 6

Results breakthrough-level indication

The five management representatives who ranked the selected projects on their successfulness also indicated the breakthrough level of the projects by indicating to what extent the projects suit into the definition of breakthrough innovation, which was developed in an earlier stage of the research.

The developed definition of breakthrough innovation for Company X is:

A breakthrough innovation is an innovation that leads to a new-to-the-customer product that creates significantly more or new value for the customer as well as for Company X and it changes the competitor’s landscape.

In line with this definition, the management representatives evaluated the selected projects on three important aspects of the definition, namely: 1) the level of value creation for the customer; 2), the level of value creation for company X; and 3) the level of change of the competitor’s landscape. Evaluation was done by indicating whether the amount of value created for the customer was high (H); moderate (M); or low (L); by indicating whether the amount of value created for company X was high, moderate or low and by indicating whether the level of change of the competitor’s landscape was high, moderate or low. The higher the levels of value creation and change of competitor’s landscape are, the higher the level of breakthrough is. Because it is not determined which aspect of the breakthrough innovation definition is the most important one, all three aspects have an equal weight in the evaluation of the breakthrough level. Therefore, the project which was indicated with the highest number of high levels (H) of value creation and high levels of change of competitor’s landscape is perceived as the project with the highest breakthrough level.

The aggregated results are provided in table 12. Table 12 should be interpreted as follows. Project 1 is evaluated by four management representatives as scoring *high* on one aspect of the breakthrough innovation definition, and scoring *moderate* on the remaining two aspects of the breakthrough innovation definition (HMM). In case of project 1, one management representative evaluated one aspect of the definition as *moderate* and the two remaining aspects as *low* (MLL). This is done for all nine projects.

Table 12 Aggregated results indication of breakthrough level

	Indication of breakthrough level									
	HHH	HHM	HHL	HMM	HML	HLL	MMM	MML	MLL	LLL
Project 1				4					1	
Project 2		1		2				1		1
Project 3	4	1								
Project 4		1		1			1		2	
Project 5	3	1		1						
Project 6				2			2	1		
Project 7		2		1	1		1			
Project 8							1	2	2	
Project 9		1		1			2	1		

Table 13 Project ranking based on breakthrough-level evaluations

Rank	Project
1	Project 3
2	Project 5
3	Project 7
4	Project 2
5	Project 9
6	Project 4
7	Project 1
8	Project 6
9	Project 8

Like in the case of the project-success ranking, a ranking of the indications of the breakthrough level can be composed. Ranking is done in the same manner as the ranking of project success. So, the project which is evaluated with the most aspects indicated as *high* (H) is ranked to position 1, etc. The ranking of projects based on the indication of the breakthrough level is presented in table 13.

As can be seen, the management representatives indicated project 3 as the project with the highest breakthrough innovation level, according to the definition. Project 8 was indicated as the project with the lowest breakthrough-innovation level. If it is assumed that all aspects of the definition have to be evaluated *high* to consider a project as a breakthrough-innovation project, only projects 3 and 5 are perceived as breakthrough-innovation projects, according to the management representatives.

Reconsidering figure 12, containing the survey results per dimension, it can be seen that the top 3 of projects with the highest indicated breakthrough level, i.e. projects 3, 5 and 7 are scoring best at the dimensions of knowledge storage (KO), creativity (CR) and product performance compared to original project objectives (PP).

Analysis of current innovation process

This section describes the results of the analysis of the current innovation process aspects to reveal process aspects, as a part of social-organizational aspects, which stimulate or hinder the development of breakthrough innovations. Based on semi-structured interviews with relevant employees, and based on documentation of Company X, a description of the innovation process, which is the product development process, on how it is executed at the moment of the research is provided in appendix L.

As mentioned earlier in this report, the focus of the comparison will lie on the first phase of the innovation process: the identification phase. At the moment of this research, a small group of employees of Company X is considering the organization of this identification phase.

One interviewee stated that the reason to organize the identification phase in more detail is that the identification phase was not performed well, until now. Symptoms of this phenomenon were: Company X was more short-term driven, the vision of identification was not organized to a great extent, there is too much discussion between Sales and R&D afterwards and in earlier days, the identification of opportunities and solution directions occurred on the basis of coincidence.

Comparison of theory and practice regarding innovation process

In chapter 2 of this report, main theoretical findings regarding creativity and innovation (processes) are presented. Especially the studies concerning the fuzzy front end (FFE) of discontinuous innovation processes are interesting here, because they focus on the start of the innovation process which corresponds with the focus on the identification phase of the innovation process in this research.

Considering the theory of De Brentani and Reid (2004; 2012), about the fuzzy front end of discontinuous innovation it is possible to evaluate the social system variables and the involved individual attributes, as mentioned in table 2 in chapter 2, in case of Company X. The evaluation is provided in table 14 and is based on interview data.

The main deviation of Company X with the theory of De Brentani and Reid (2004; 2012) is the fact that although Company X is part of a big network, the feeling exists that not all the available information in the network is acquired or used in a proper way. One interviewee indicated that too often a solution is searched within the company borders, while, perhaps, the solution can be better found outside the company or even outside the company's industry.

Table 14 Company X performance on variables and attributes of theory of De Brentani and Reid (2004; 2012)

Category	Variables/attributes	Company X performance	Present in company X
Social system variables	Broad network	Company X has a big network containing many suppliers, customers, scientific institutions, etcetera. However, involved employees doubt about the fact that all the nodes of the network are used properly, i.e. the information from the complete network is not used to a high extent.	Yes
	Central role in network	For the customer company X plays a central role.	Yes
	Presence of formal roles	Not yet present in identification phase because the formalization of this phase is still in progress.	No
	Presence of informal roles	Before the process of organizing the identification phase, the identification of opportunities and solution directions was performed in a more informal way, based on coincidence and the capabilities of a good R&D manager.	No
	Involvement senior management	Involvement of senior management in identification phase is high because they are included in the team that is organizing the identification phase and they are performing decision making in the identification phase.	Yes
	Experience/expertise senior management	Because of the fact that company X is market leader for many years in their industries and the given that senior management was responsible and making decisions for that purpose, it can be stated that the level of experience and expertise is high.	Yes
Involved individual attributes	Technical integration capability	Most of the people involved in the identification phase of innovation have a technical educational background. The technical integration capability is therefore high.	Yes
	Engagement level in search efforts	Engagement level is high because people in the identification phase are really involved in finding new innovations. However, the number of really engaged people is perhaps not sufficient.	Yes/No
	Extraversion	'Technical people' are often more introvert than extravert. This is also the case at company X.	No

Because the organization of the identification phase is still in development, it is hard to conclude whether Company X is performing well or not regarding the identification phase of the innovation process.

A remarkable point is that employees are actually self-organizing the identification phase, while it was stated by some people that the level of 'control' and 'structure' is too high in Company X. This sounds conflicting. The feeling that it is needed to organize the identification phase is caused by the experience that the identification phase is not performed well now. However, some people doubt about the contribution of organizing the identification phase in terms of describing what has to happen. They prefer a more open identification phase in which interaction and creativity is stimulated. The researcher agrees with the latter and is convinced that over-structuring can kill the creativity needed to develop breakthrough innovations.

Answer research question 2

Now, section 4.2 is summarized by providing the answer on research question 2, which social-organizational performance aspects are indications of project success at company X and which social-organizational performance aspects are indications for the development of breakthrough innovations at Company X.

According to literature, the higher the level of the social-organizational performance aspects of knowledge creation, knowledge use, knowledge sharing, knowledge storage, communication and creativity is, the higher the level of innovativeness is, including a higher probability of innovation project success (Amabile, 1997). Furthermore, the higher the level of the technological performance aspects of product performance and operational performance is, the higher the probability of innovation project success is (Blindenbach-Driessen et al., 2010).

Considering the results of the two surveys, the successful innovation projects of Company X are scoring well on the dimensions of knowledge sharing (KS), communication (CO), creativity (CR), product performance compared to original project objectives (PP) and operational performance (OP). So, these dimensions might be indications for innovation project success at company X.

Combining the results of the indication of project success and the survey dimensions, it can be stated that projects, perceived as successful, are scoring high on the dimensions of knowledge storage (KO), creativity (CR) and product performance compared to original objectives (PP). So, these dimensions might be indications of project success at company X.

Considering the results of the indication of the breakthrough level of innovation projects, the scores on the dimensions of knowledge storage (KO), creativity (CR) and product performance compared to original project objectives (PP) are highest for the projects, which were indicated as containing the highest breakthrough level.

In table 15 an overview is presented on which dimensions the 'best' projects scored well per research part. As can be seen, the dimensions of *creativity (CR)* and *product performance compared to original project objectives (PP)* are present in all of these parts of the research and therefore, these might be the dimensions that form indications of project success as well as the successful development of breakthrough innovations.

Regarding the dimension of creativity (CR), it must be stated that it appeared from the surveys that there was sufficient room to generate and share new ideas, thoughts and opinions in the development phase of the innovation process. However, from interviews it appeared that time pressure was high. These results seem contradicting. Furthermore, it was stated by interviewees that the environment in which creativity can flourish, is lacking. Especially, the room for creativity was too limited. This is also somewhat contradicting with the survey results.

However, this latter statement was aimed at the identification phase of the innovation process. A possible explanation might be that there is sufficient room for creativity in the development phase of the innovation process but not in the identification phase of the innovation process. Nevertheless, time pressure severely limits this room.

Table 15 High scoring dimensions per research part

Research part	High scoring dimension
Surveys	Knowledge sharing
	Communication
	Creativity
	Product performance compared to original project objectives
	Operational performance
Indication of project success	Knowledge storage
	Creativity
	Product performance compared to original project objectives
Indication of breakthrough level	Knowledge storage
	Creativity
	Product performance compared to original project objectives

Furthermore, it is possible to compare the results of the surveys, the result of the project rankings, and the result of the breakthrough-level indication with each other. Table 16 provides the rankings of projects based on those results. It appears that the result on the organizational creativity survey differs to a high extent from the results on the other parts of the research. This might be an indication that the perception of project success and the breakthrough level of projects are mainly based on *technological* performance aspects. Besides, the projects, which were indicated as most successful and containing the highest breakthrough level, scored high on the similar dimensions of the surveys, namely knowledge storage (KO), creativity (CR) and product performance compared to original project objectives (PP). This might be an indication that a successful project and a project with a high breakthrough level are perceived is seen as the same.

Table 16 Project rankings based on survey results, indication of project success, and indication of breakthrough level of projects

Rank	Results survey organizational creativity (SO_orgcrea)	Results survey technological performance aspects (T)	Results project ranking on their success	Results indication breakthrough level of projects
1	Project 6	Project 3	Project 3	Project 3
2	Project 4	Project 1	Project 5	Project 5
3	Project 9	Project 2	Project 2	Project 7
4	Project 2	Project 8	Project 8	Project 2
5	Project 1	Project 9	Project 4	Project 9
6	Project 5	Project 4/5	Project 7	Project 4
7	Project 7	Project 4/5	Project 1	Project 1
8	Project 3	Project 7	Project 9	Project 6
9	Project 8	Project 6	Project 6	Project 8

4.4. Conclusion Diagnostic Phase

This section concludes the diagnostic phase by integrating the answers on research questions 1 and 2 and providing the main findings of the diagnostic phase.

Integration research question 1 and 2

Table 17 provides an overview of the findings concerning research question 1 and 2. In the table, the three earlier mentioned categories of breakthrough innovation, namely: people; product; and process are presented. It is reflected in which way those categories appeared in different parts of this research, i.e. the definition part, the surveys part, the project success indication part, and the breakthrough level indication part.

As can be seen in table 17, in case of participants using their own insights and criteria, i.e. in the breakthrough-innovation definition part and in the part of the indication of project success, the emphasis is on the *product* category of breakthrough innovation. That is because the three chosen aspects of the breakthrough-innovation definition are product related, and most of the criteria used to indicate project success are product related. This emphasis on the product category might be an indication that, at Company X, employees are less aware of both people and process aspects of breakthrough innovation, or that they do not acknowledge the importance of those aspects at this moment.

If it is assumed that the *people* category of breakthrough innovation corresponds to social-organizational performance aspects, that the *product* category corresponds to technological performance aspects and that the *process* category corresponds to both the social-organizational performance aspects, as well as the technological performance aspects, then it can be stated that:

The perception of project success and the breakthrough level of products at Company X, is mostly influenced by technological performance aspects, especially those performance aspects that are product related.

Main findings diagnostic phase

The list in text box 3 provides an overview of the main findings from the complete diagnostic phase of the research. These main findings will be used as input for the design phase of the research.

- Regarding the relatively high percentage of the budget that is spent in innovation, company X is not achieving the desired results in that area.
- An environment in which creativity can flourish is lacking because of the presence of too much 'control', or at least the need for control.
- The 'financial awareness' of people involved in development is low because they assume that no matter what, sufficient financial resources will be made available despite of the unknown potential of a development.
- Project success and the breakthrough level of a product highly depends on the room for creativity and the product performance compared to original project objectives.
- The focus of (breakthrough) innovation is mostly aimed on products and not on people and processes, while all three aspects are important in innovation.
- Employees of company X are not fully using the available knowledge outside the company's borders and industries.

Text box 3 Main findings diagnostic phase

Table 17 Breakthrough innovation categories and the corresponding research results

Breakthrough innovation research							
Category	Breakthrough innovation descriptions	Breakthrough innovation definition	Social-organizational performance survey	Technological performance survey	Indication project success (used criteria)	Indication breakthrough level	Analysis process (theory vs. practice)
People	<ul style="list-style-type: none"> • New patterns of thinking • New expanded boundaries 		<ul style="list-style-type: none"> • Knowledge practices • Behavior • Communication • Creativity • Leadership 		<ul style="list-style-type: none"> • Cooperation of people • People open for other perspectives • Address each other's responsibilities 		
Product	<ul style="list-style-type: none"> • New advanced technologies • New customer value 	<ul style="list-style-type: none"> • New or more customer value • New or more company X value • Change of competitors landscape 		<ul style="list-style-type: none"> • Product performance 	<ul style="list-style-type: none"> • Uniqueness • Consolidation market leadership • Change in market position • Distinctive power of product • Market potential • Market volume • Turnover • New technology • Extension product portfolio • Core product 	<ul style="list-style-type: none"> • New or more customer value • New or more company X value • Change of competitors landscape 	
Process	<ul style="list-style-type: none"> • New smarter organizing principles 		<ul style="list-style-type: none"> • Knowledge practices • Behavior • Communication • Creativity • Leadership 	<ul style="list-style-type: none"> • Operational performance 	<ul style="list-style-type: none"> • Time to market 		<ul style="list-style-type: none"> • Process aspects regarding the identification of opportunities and solution directions.

5. Results Design Phase

In this chapter the results of the design phase of the research project are presented. The design phase results are design suggestions to implement at Company X to stimulate the development of breakthrough innovations. First, it will be described what the requirements of the design are and what the involved theoretical and practical aspects of the design suggestions are. Second, the developed suggestions are presented. An explanation of the proposed suggestions and their corresponding practical and theoretical aspects are provided in that sense. Third, the design phase results are concluded.

5.1. Design Requirements and Aspects

The research question involved in the design phase of the research is: In which way can the development of breakthrough innovations be stimulated within Company X? To answer this question, it is needed to develop manners to stimulate the development of breakthrough innovations. This will be done in the form of suggestions regarding both human and process aspects of innovation, which can be implemented in Company X.

The suggestions are meant to improve the current situation at Company X. Considering the results of the diagnostic phase, it can be stated that the main design objective is to create an environment in which creativity can flourish, in order to increase the probability of developing breakthrough innovations.

With regards to design requirements, Roozenburg and Eekels (1995) identified four 'categories' of design specifications, namely: functional requirements; user requirements; prerequisites; and limitations. Functional requirements are the technical requirements of the design. In case of Company X, the main functional requirement is that the suggestions have to be implementable within the involved departments in innovation in Company X. So, the suggestions should 'fit' within the work of the involved departments. User requirements are requirements of the design from the eye of the user. In case of Company X, user requirements are: employees should be allowed to execute the suggestions in terms of time; employees should be able to implement the suggestions easily; and the suggestions should contribute positively to the work performance of the employees. Prerequisites of the design that should be satisfied in general are as follows. The main prerequisite in case of Company X is that the suggestions should stimulate the development of breakthrough innovations. Limitations are the organizational boundaries of the design. Regarding Company X, the limitations are: involved costs and time of the implementation and execution of the suggestions because, as in most commercial organizations today, money and time is limited. So, the developed suggestions have to satisfy all four of the above mentioned 'categories' of requirements to ensure that the suggestions are implementable from any point of view.

The design suggestions are created in such way that the impact on innovation at Company X, i.e. the enhancement of innovative performance of Company X, might be substantial. However, the level of this impact on innovation depends on how intense, how frequently and how well the suggestions are implemented at Company X.

The reason to develop multiple suggestions is, that they all vary by which theoretical and practical aspects they covered. The concerned theoretical and practical aspects are provided in appendix M. These differences in theoretical and practical aspects per design suggestion allows management of Company X to decide what they think is the most proper suggestion to implement in a situation at Company X.

The starting point of the design was the awareness that the suggestions should make it possible to break through existing behavioral patterns of employees, and organizational routines, because this will lead to a higher probability of developing breakthrough innovations. The creation of the suggestions was inspired by searching literature and exploring examples of relevant improvement designs.

As mentioned in chapter 3 - the research methodology - the guideline for the design was the CIMO-logic. The context (C) is already provided in chapter 1 and chapter 4, namely the insufficient number of breakthrough innovations and the insufficient innovative performance regarding budget spent in innovation within Company X. The interventions (I) and mechanisms (M) will be provided in the next section, in which the suggestions are presented. The outcome (O) of the suggestions is a higher number of breakthrough innovations.

5.2. Results Research Question 3

This section describes 10 design suggestions that are proposed to implement at company X, to make a start with creating an environment in which creativity can flourish, in order to develop more breakthrough innovations. These suggestions include suggestions for behavior, interaction and role distribution within innovation at Company X and they contain suggestions for applications that can be used during the innovation process, as was proposed in chapter 3 of this report.

An overview of the proposed suggestions is provided in table 18. Based on their content, the suggestions can be divided over three categories: 1) connection/communication; 2) resources; and 3) development/training.

Table 18 Overview suggestions per category

Category	Connection/Communication	Resources	Development/Training
Suggestions	1. Visualize Your Network 2. Open Innovation Café 3. Virtual Platforms 4. Connect Employees	5. Intrinsically Motivated Team Members 6. Change Resource Allocation 7. Rewarding with Autonomy	8. Kill The Company Exercises 9. Complex Adaptive Leadership Development 10. Shared Leadership

The suggestions will be described below. In the descriptions it is made clear what the practical aspects of the suggestions are. In the included boxes it is made clear what the amount of implementation/execution costs are (euro sign image), what the amount of implementation/execution time is (clock image) and what the amount of (long-term) investment is in terms of money and time, taking into account the consequences of the proposed suggestion (horizon image). The levels of these practical aspects are estimated based on experiences of project supervisors and examples from practice. After the descriptions of the suggestions, the theoretical aspects of the suggestions are explained.

5.2.1. Connection/Communication category

The suggestions in the connection/communication category are aimed at connecting employees with each other and the external organizational environment and aimed at stimulating communication because this is contributive to creativity and innovative performance.

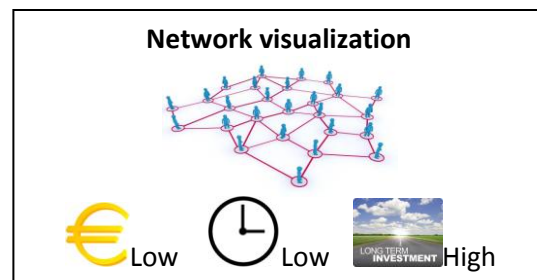
Suggestion 1: Visualize your network

To get more insight from where company X is gathering information, which is important input for innovation, it is suggested to visualize the personal networks of employees. Every employee concerned

with innovation at Company X should perform such network visualization to make clear what their sources of information are. This can be done relatively simple by just drawing links among you and the persons you are in contact with, regarding your working activities. This network visualization should make clear which of your relationships are developed well, which relationships are developed not well enough and, perhaps more importantly, which required relationships are missing. In appendix N a guide to visualize personal networks is presented.

The overview of not well enough developed relationships can trigger employees to give more attention to these relationships because this may lead to better performance of both involved persons. Missing relationships are relationships among the innovation employees of Company X with other persons, inside and outside the company, which can deliver a high contribution to the performance of the Company X employee, but apparently do not exist yet. Company X should make time available for innovation employees to work on these non-existing connections because a big network can improve innovative performance.

The execution costs of this suggestion are low, because visualizing personal networks can be done in simple forms and furthermore, the investment in time, i.e. the time it will take to visualize the network is relatively low per person. However, working on the results of the network visualization, for instance, improving relationships and creating new relationships, can take big amounts of time. So, the level of investment to create a broad network is high.



The impact on innovation of the network visualization itself is limited because it only creates insight in the relationships of a particular employee. However, the results of the visualization and the actions taken upon might have a big impact on innovation because developing new relationships and enhancing the network of possible information sources can contribute to innovation to a high extent. New relationships can contribute to innovative performance by combining different perspectives in order to create knowledge.

Suggestion 2: Open Innovation Café

The suggestion is to create an open innovation café. The goal of this café is to create and share knowledge together from multiple perspectives. Besides, it is a networking possibility. The open innovation café should be held frequently, for instance, once per yearly quarter. Perhaps, it is wise to only consider one subject per event, to make sure that the subject is handled with in great depth. The duration of a single event can differ from several hours to two days. Next, a first brief draft of how this café should look like is provided.

Participants: Various parties should be participating in the open innovation cafe. Possible participants are provided in text box 4. The number of participants and the composition of the group of participants varies per event, depending on the subject of the particular event. Perhaps, a number of 25 participants is ideal to make sure that everyone will be involved to a high extent during an event.

Location: The location of the event should be inspiring and energizing. Therefore, it is a good idea to held the events at

- Possible participants:
- Marel employees
 - Customers
 - Governments
 - Scientists
 - Students
 - Consultants
 - Suppliers
 - Etc.

Text box 4 Possible participants Open Innovation Cafe

locations, which are not familiar for the participants.

Content: The subjects of the café might differ per event. Subjects can be human-related, product-related, process-related, but other subjects can also be handled with of course, as long as it is connected to innovation.

A very important aspect of the open innovation café is that interaction among participants is stimulated because in that case creativity arises. Interaction can be stimulated by performing several exercises, as provided in text box 5. Furthermore, there should be sufficient room left for just informal interaction because too much structure in the events might kill the rise of creativity.

- Possible exercises:
- Open-ended conversations
 - Workshops
 - Games
 - Dialogue/Multilogue
 - Brainstorm sessions
 - Q&A
 - Exercises
 - Presentations
 - Etc.

Facilitation: Company X employees are responsible for facilitating the open innovation café, but this can happen in consultation with other participants.

Text box 5 Possible exercises Open Innovation Cafe

The costs of this open innovation cafe are very high because about 25 participants have to be invited and put their time into it. Furthermore, locations and, for instance, invited speakers have to be paid. Perhaps, to reduce costs, it is wise to facilitate the open innovation café, in case of several participants already being 'on tour' for other purposes like, committee meetings and customer visitations. Also the required time is high, for both company X employees and external participants as well. Therefore, this suggestion is a very expensive one in terms of money and time.



However, the impact on innovation might be big because you are developing an open innovation network, in which multiple perspectives are combined and in which a high amount of information is shared, which eventually enhances the probability of creating new knowledge. This creation of new knowledge contributes to innovative performance because the more knowledge is created and shared, the higher the probability is to develop real novel products.

Suggestion 3: Use Virtual Platforms

Nowadays, not only face-to-face meetings are valuable in information gathering, but also virtual platforms can contribute to this to a high extent. Especially, the use of social media platforms can be valuable because in that case Company X is able to reach a huge amount of people from everywhere around the world. This can be very valuable for Company X because in that way it is possible to use multiple perspectives in innovation related issues and besides, you increase the recognition of Company X on a worldwide scale.

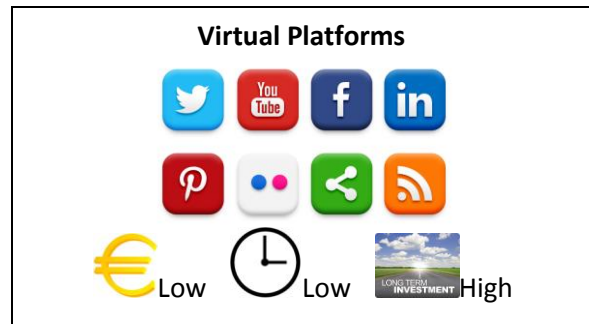
An example of using social media platforms for gathering information is by creating a virtual place where other people can post their ideas for new products and services, a so-called idea pool. These new products and services ideas can be considered by Company X employees, and valuable parts of the ideas might be used within Company X.

Another example of virtual information gathering is to start up online conversations by posting statements and blogs related to innovation and give other people space to react on those statements

and blogs. This might lead to inspiring new insights on all kind of innovation issues. Also it might answer questions that are present within Company X.

Probably the hardest issue regarding the use of virtual platforms is to get the people involved from the outside world. Company X should really trigger people to share their ideas, insights and opinions. This can be done by providing statements which are perceived as interesting by many people, because this enhance the probability that people are motivated to contribute to the virtual platforms. Furthermore, providing acknowledgement to the people who have contributed to the virtual platforms can be useful because that is perceived as energizing in general.

The development costs of the virtual platforms will be relatively low because creating virtual idea pools and forums is not expensive. The required time to develop the virtual platforms will be short. However, seeking the most proper virtual platform can take long. Furthermore, when a virtual platform is eventually used, considering and evaluating the contributions of others will take a big amount of time. You have to put time in going through the contributions in order to perform good evaluations. So, the investment is high.



The impact on innovation might be big because multiple perspectives will be used to come up with new propositions. But eventually it depends on the level of involvement of possible contributors. When the level of involvement is high, the probability that new knowledge will be created is high, but it also goes the other way around. So, when the level of involvement is low, the probability of new knowledge creation is low. Therefore, keeping the involvement high is crucial for this suggestion. Starting an internal as well as external advertising campaign might be useful in achieving a high involvement level because in that case people become aware of the virtual platforms.

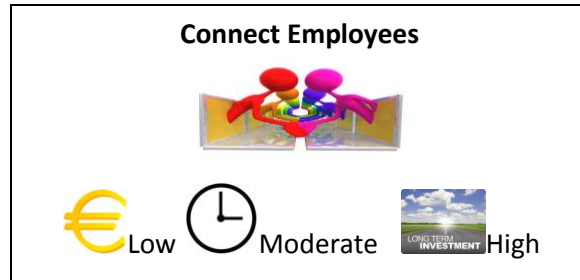
Suggestion 4: Connect Field Employees to Innovation Employees

About 300 employees of Company X are working in the field. They are supposed to transfer the information they gather in the field into the company. To ensure that every relevant piece of information finds its way into Company X, it is advised to formally connect groups of ‘field-employees’ to an employee of innovation. At Company X about 60 employees are concerned with innovation. So, every innovation employee will be connected to about five field employees.

The groups of field-employees should have regularly contact with their corresponding innovation employee. It is advised to have a meeting once a week. This can be a face-to-face meeting or an online meeting, depending on the location of the field employees. In this meeting the field employees are supposed to present issues of what they have ran into during their work. Think of problems they have encountered, suggestions of customers, suppliers, etc. When group members discuss these kinds of issues, perhaps, input for new ideas might arise. The meetings can also be held during a running innovation project to ensure that as less as possible information regarding the particular project is missed. This might increase the quality of the end product because you are more frequently and earlier talking about potential problems or bottlenecks, which makes it possible to tackle these problems early.

After the weekly meetings, the innovation employee should collect the discussed information and store it in the information system of Company X. Of course, it is necessary to store the information at a logical place in the information system, in order to ensure that other employees of Company X are able to find the new information quickly.

The implementation costs of this suggestion are low because you only have to formally connect people to each other. The weekly meetings should only take about an hour, so, the amount of time this alternative costs per person is moderate. However, if you consider the high number of field employees, this will take much time in total per week, and also storing the information takes much time. So, the total investment, considering the consequences of the meetings, is high.



The impact on innovation might be big, because the amount of information shared increases, which enhances the probability of the creation of new knowledge, ideas and solution directions. However, setting up a properly classified information system is crucial to make this suggestion a successful one. So, first the information has to be set up and, finally, the new information might contribute to the innovative performance of Company X.

5.2.2. Resource category

The suggestions in the resource category contain suggestions on how to select and motivate employees for innovation projects and how to allocate resources within innovation. These suggestions should lead to a higher level of creativity and a higher level of financial awareness.

Suggestion 5: Select Intrinsically Motivated Team Members

As mentioned in the theoretical background of this research, intrinsic motivation is very contributive to creativity (Amabile, 1997). Therefore, it is suggested to select team members for innovation projects who possess a high level of intrinsic motivation. This can be tested by examining perceived feelings of competence and perceived feelings of autonomy among the project team members, because these two factors facilitate the enhancement of intrinsic motivation.

One method to test the perceived feelings of competence and autonomy is a questionnaire, which is called the Intrinsic Motivation Inventory (IMI) (Ryan, 1982). Besides, this questionnaire examines the perceived level of satisfaction, importance and usefulness. This test can be a helpful means when selecting team members for innovation projects. An adapted version of the IMI is provided in appendix O. The advice is to select the team members with the highest level of intrinsic motivation in order to increase the probability of creativity level enhancement.

The costs of this suggestion are relatively low because the questionnaire can be composed relatively simple and it will not take much time to take the test and evaluate the results. So, this suggestion is a cheap, helpful means in selecting the most intrinsically motivated team members for your project. Furthermore, the total investment in money and time, considering the consequences of selecting intrinsically motivated team members, is low.



The impact on innovation might be big because you are probably enhancing the level of creativity within the project team by selecting intrinsically motivated people. This creativity level enhancement might eventually feeds innovation, leading to more ideas for new products and services.

Suggestion 6: Change Resource Allocation

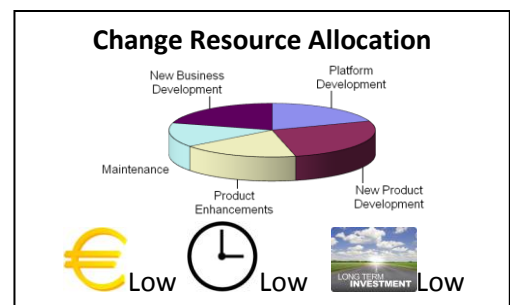
From the diagnostic phase of the research it appeared that the financial awareness among the employees of Company X involved in innovation is low. This means that employees just assume that money will be allocated no matter what the end result of the innovation projects will be. Eventually, this leads to the phenomenon of performing relatively not good enough regarding the amount of money that is spent in innovation. An advice for management is briefly described now.

One possibility to enhance the financial awareness is by only allocating big amounts of money to those ideas that really will lead to new products. So, only provide a big amount of budget to ideas for products that do not exist yet or radically change the way of how customers work. This form of resource allocation should enhance the probability of developing real novel products, because more resources will now be available for the radical innovations. On the other hand, this also leads to the fact that less budget will be available for incremental innovations. This should not be considered as negative per se, because limiting budget can force employees to find more efficient (product-) solutions and more efficient ways of working. Both require a higher level of creativity and eventually this will lead to a more efficient utilization of resources.

Nowadays, a little more than 20% of the available budget is put into research and long-term developments at Company X. Long-term developments are seen as radical developments at Company X. The rest of the budget is put into short-term developments, i.e. incremental innovations, and sustainment of developments. So, the proposed suggestion is to increase the percentage of available budget for long term-developments, which implies a decrease in available budget in the other forms of innovation. Furthermore, top management should 'control' the factual budget allocation by evaluating whether the budget indeed was allocated as proposed and whether it delivered the proposed results.

The costs of this suggestion are relatively low because only the balance of allocating resources is changed and not the amount of budget. The required time of the implementation of this suggestion is low because, again, only the balance in resource allocation will be formally changed. Considering the consequences of the implementation of this suggestion, the total investment is low.

The impact on innovation might be big because employees are triggered to come up with more radical ideas to receive sufficient resources and therefore, they are forced to come up with more creative ideas. Furthermore, when more resources are allocated to the radical innovations, it is possible to perform more extensive research into the idea or solution. This will eventually increase the probability of creating well-performing breakthrough innovations.



Suggestion 7: Rewarding with Providing Autonomy

To trigger employees of Company X to come up with ideas with a high level of novelty, for which a high level of creativity is required, it is suggested to 'reward' those initiatives, because rewards can motivate individuals to behave creatively. Management can offer rewards in different ways. Examples of such rewards are: providing money, awards, praise, recognition and extra resources.

However, as mentioned earlier, to become more creative, employees should be intrinsically motivated. The advice is to offer rewards that facilitate intrinsic motivation. Therefore, rewards that increase the feelings of competence and autonomy of the employees are suitable here. Examples of such rewards are providing more responsibility to team members and allow them to self-organize their

work. So, providing more autonomy is key in this suggestion. The advice is to let members of innovation project teams plan their own activities and let them participate in decision-making within the team.

The implementation costs of this suggestion are low because providing more autonomy is not expensive; you only have to allow employees to self-organize their work and, for instance, let them participate in decision-making to a high extent. Besides, the amount of time involved is low. Looking at the consequences of this suggestion, i.e. employees having more autonomy, it can be stated that the total investment, regarding the long-term consequences, is low because having more autonomy does not cost much from the perspective of Company X.



The impact on innovation might be big because the level of creativity might be enhanced by offering rewards that are positively related with intrinsic motivation. This enhancement of the creativity level eventually might lead to more novel ideas and insights, which are needed to create novel products.

5.2.3. Training/development category

The suggestions in the training/development category are aimed at training and developing the skills and abilities of employees of company X to achieve a high level of creativity with help of leadership and self-organization.

Suggestion 8: Kill The Company Exercises

Based on the book of Bodell (2012) a set of exercises is proposed to break out of the regular behavioral patterns and organizational routines that exist within Company X. This breaking out of patterns and routines should lead to a higher level of creativity and eventually to a higher amount of real novel innovations. With help of the exercises the creativity level of employees can be enhanced and therefore, these exercises are highly recommended.

An overview of the exercises and a brief explanation is provided in appendix P.

The costs of these exercises are low because they are easy to conduct and to facilitate. The required time to execute the exercises really depends on the frequency and length of the selected exercises. It is preferred to apply the exercises on a frequent basis because this will enhance mastering of new techniques and methodologies to increase creativity. So, the time required is moderate. Considering the consequences of executing the exercises, it can be stated that the total investment is low.



The impact on innovation might be big because the exercises are aimed at increasing the level of creativity and eventually the development of real novel ideas.

Suggestion 9: Develop Complex Adaptive Leadership strategies

This is a suggestion concerning behavior of leaders. As mentioned in the theoretical background of this research, complex adaptive leadership is about adapting your leadership strategies towards the abilities and willingness levels of your followers.

Adaptation of your leadership strategies implies that the leader has to be capable of recognizing the situations in which the proper strategy has to be applied. This can be done by training the leaders. A suitable training here is role playing because in that case different situations can be presented to the leader. Then, the leader is able to learn to identify what the situation is and what leadership strategy is required. An overview of the strategies and an indication of when to apply these, is provided in table 3 in chapter 2.

The costs of this role playing exercises are moderate because you have to assign a good trainer to it and it takes some moderate amount of time before the leaders will develop their skills in applying adaptive leadership strategies. Furthermore, it will take much longer before your followers, i.e. innovation project team members, are performing better because the effects of adaptive leadership strategies appear only after an amount of time when adaptation is applied. So, taking into account the consequences, the total investment is high.



The impact on innovation might be big because eventually, adaptive leadership strategies should lead to the emergence of real novel ideas by developing the skills of the innovation project leaders as well as the skills of the innovation project team members.

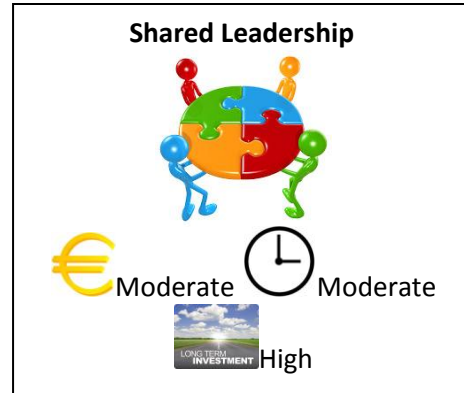
Suggestion 10: Shared leadership

Another suggestion related to leadership behavior is conducting shared leadership within innovation project teams. Shared leadership should ensure that every single team member feels responsible for the results of the team and that team members are leading each other to great results. Furthermore, shared leadership contributes to the development of the leadership skills of an employee.

As mentioned in the theoretical background of this research, shared leadership is positively related to innovative behavior in terms of higher levels of creativity. Shared leadership can be facilitated by conducting vertical transformational leadership, empowering leadership and selecting team members with a high level of integrity.

The advice is to apply shared leadership in innovation project teams in the development phase of the innovation process. So, after the team has been composed by the 'former' project leader, the leadership role will be shared among all core team members, which implies that there will no longer be a single project leader in the development phase of innovation. Guidelines on how to stimulate shared leadership are provided in text box 6.

The implementation costs for this suggestion are moderate because you have to allow that leadership is shared by team members, but in order to do so you have to stimulate this by training former project leaders and senior management. Because of that training, the amount of time required is moderate. The long-term consequences, i.e. development of leadership skills and good innovative performance, might take long time to occur. So, the investment is high. The impact on innovation might be high because shared leadership enhances creativity and increases innovative behavior, which in its turn is crucial for the development of breakthrough innovations.



- Stimulation of shared leadership:
- Train team members to take responsibility and participate in decision-making. This can be achieved by including team members in meetings where decisions are discussed and made. It is important to let them participate in such meetings. So, invite them to (evaluation-) meetings and ask about their opinions, thoughts and insights.
 - Train 'former project leaders' or senior management to conduct vertical transformational leadership. This means that they should be trained in motivating people and letting team members focus on team goals. Reviewing the literature on intrinsic motivation, it is important, in that sense, to emphasize team members' feelings of competence and feelings of autonomy. So, providing positive feedback is advised.
 - Train 'former project leaders' and senior management to conduct empowering leadership. This means that they should be trained in creating possibilities that team members develop their self-leadership skills as planning and decision-making. So, allow team members to self-organize their work.
 - For an innovation project, select team members with a high level of integrity, i.e. employees that are highly reliable, have a high level of trust in fellow team members and show an ethical, fair and transparent behavior. This facilitates shared leadership and eventually, innovative behavior.

Text box 6 Manners to stimulate shared leadership

Next, the suggestions are reviewed considering the theoretical aspects mentioned in the theoretical background of the research. This is done in the matrix in table 19. An 'x' in the matrix means that the theoretical aspect is covered by the proposed suggestion. The way in which the theoretical aspects are covered is provided in appendix Q. It should be taken into account that only the implementation/execution itself of a single suggestion is considered.

Table 19 Theoretical and practical aspects per design suggestion

		Suggestions									
		Connection				Resources			Training		
		Network Visualization	Open Innovation Cafe	Virtual Platforms	Connect Employees	Select Intrinsically Motivated People	Change Resource Allocation	Rewarding with Autonomy	Kill The Company Exercises	Comp. Adapt. Leadersh. Development	Shared Leadership
Theoretical aspects											
Chaordic Systems Thinking											
	Consciousness		x	x					x	x	x
	Connectivity		x	x	x				x	x	x
	Indeterminacy		x	x					x	x	x
	Dissipation		x	x					x	x	x
	Emergence		x	x	x				x	x	x
	Translation		x	x	x				x	x	x
	Transcendence		x	x	x				x	x	x
Creativity											
	Intrinsic motivation		x	x		x		x	x	x	x
	Expertise		x	x	x	x	x	x	x	x	x
	Creative thinking		x	x	x	x	x	x	x	x	x
	Organizational motivation		x	x	x		x		x	x	x
	Resources	x	x	x	x	x	x	x	x	x	x
	Management practices				x	x	x	x	x	x	x
Open Innovation											
	Outside-in		x	x	x						
	Inside-out		x	x							
Ba											
	Originating		x		x				x	x	x
	Dialoguing		x		x				x	x	x
	Systemising	x		x	x						x
	Exercising			x	x						x
C-K Theory											
	Disjunction (K-->C)		x	x	x		x		x		
	Expansion of C (C-->C)		x	x	x		x		x		
	Conjunction (C-->K)				x		x		x		
	Expansion of K (K-->K)						x		x		
Complex Adaptive Leadership											
	People focus	x	x	x	x	x	x	x	x	x	x
	Goal focus	x	x	x	x	x	x	x	x	x	x
Practical Aspects											
	Costs	L	H	L	L	L	L	L	L	M	M
	Required time	L	H	L	M	L	L	L	M	H	M
	Investment	H	H	H	H	L	L	L	L	H	H

5.3. Conclusion Design Phase

The design phase of the research will be concluded by reflecting on research question: in which way the development of breakthrough innovations can be stimulated within Company X? Besides, one general design proposition based on CIMO-logic will be provided.

Reflecting on the design requirements mentioned in section 5.1 the following can be stated. The suggestions are implementable (functional requirement), employees will be allowed to execute the suggestions in an easy way, and it probably contributes positively to their performance (user requirements), the suggestions stimulate the development of breakthrough innovations (prerequisite), and the suggestions differ in involved costs and time (limitations).

To summarize the design phase of the research, the following design proposition is created based on CIMO-logic, see figure 13. The context (C) is the insufficient number of breakthrough innovation developments and the insufficient innovative performance of Company X regarding the budget spent in innovation. The interventions (I) are the proposed suggestions. The underlying mechanisms (M) of the suggestions are: communication and interaction, open innovation, intrinsic motivation, knowledge creation, creativity, resource allocation, and leadership development. As can be seen from figure 13, multiple suggestions are related with multiple mechanisms. Furthermore, the mechanisms also interact with each other. As mentioned, interaction plays a main role in the complexity approach, so, the design is based on the complexity approach. The interventions and mechanisms should lead to the following outcome (O): a higher number of breakthrough innovations.

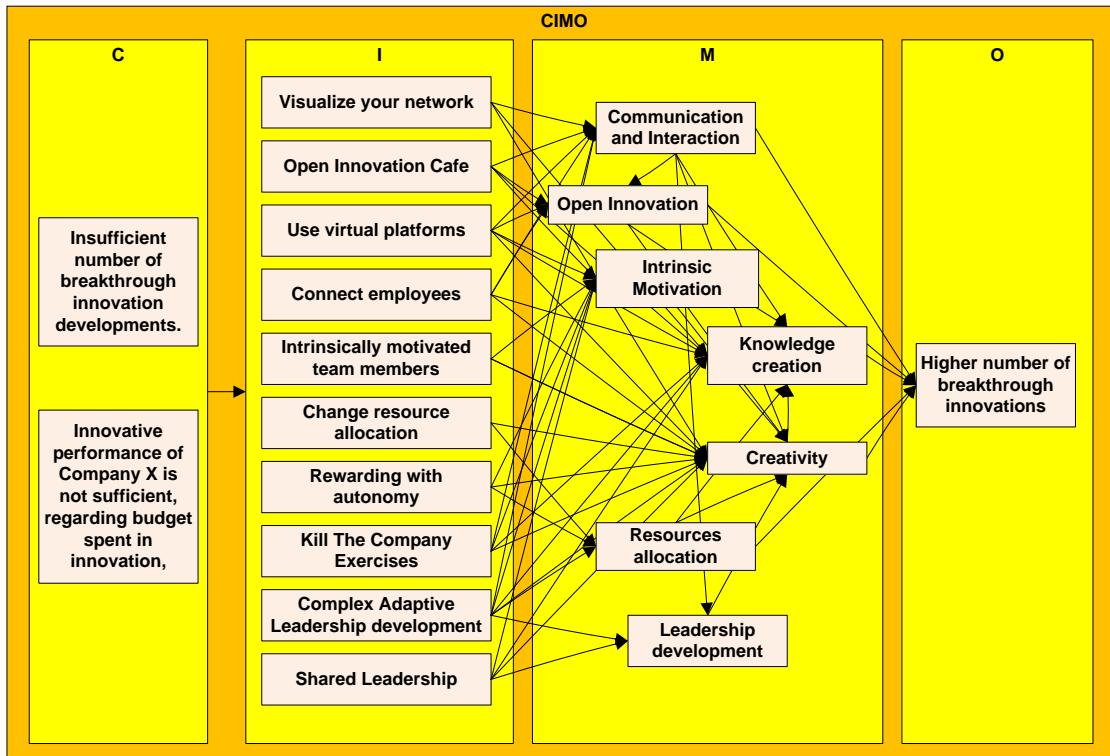


Figure 13 General design proposition of design phase

6. Conclusion

This chapter briefly concludes the research by reviewing the problem of Company X, the results of the diagnostic phase of the research, and the results of the design phase of the research.

Problem statement

Involved employees of Company X experience the feeling of a lack of an environment, in which creativity can flourish. This causes an insufficient number of breakthrough innovations. Therefore, Company X is not performing well, regarding the budget that is spent in innovation. It must be stated that this problem is based on subjective feelings of employees and is not objectively verified in this research with data of company records.

Results diagnostic phase

Two relevant research questions were developed to create a better understanding of the concept of breakthrough innovation, and a better understanding of the social-organizational performance aspects involved in the development of breakthrough innovation.

Research question 1 is: *What does breakthrough innovation mean for Company X?*

Based on descriptions from relevant literature and a meeting with involved employees, in which the definition of breakthrough innovation was discussed, the following definition of breakthrough innovation is created for Company X:

“A breakthrough innovation is an innovation that leads to a new-to-the-customer product that creates significantly more or new value for the customer, as well as for Company X, and it changes the competitor’s landscape.”

So, considering the above definition of breakthrough innovation, research question 1 is answered.

Research question 2 is: *Which social-organizational aspects are indications for innovation project success and the development of breakthrough innovations?*

Based on the comparison of innovation projects of Company X, the following can be stated: Room for creativity during the development phase of innovation projects and an eventual achieved high product performance compared to original project objectives are perceived as the dimensions that form indications of project success as well as the successful development of breakthrough innovations. Furthermore, the perception of project success and the breakthrough level of products at Company X, is mostly influenced by technological performance aspects, especially those performance aspects that are product related.

Based on the comparison between literature and practice regarding the innovation process of Company X, it is acknowledged that the level of knowledge creation, knowledge use and knowledge sharing outside the company’s borders in the identification phase of the innovation process is low, and that this should be improved because it is believed that it can really contribute to the development of successful innovations with a high breakthrough level. So, research question 2 is answered. However, the answer could have been more detailed if more focus had been laid on either the personal characteristics of involved employees in innovation or the innovation process itself.

Results design phase

One relevant research question was developed to examine in which way the development of breakthrough innovations can be stimulated.

Research question 3 is: *In which way can the development of breakthrough innovations be stimulated within Company X?*

A total number of 10 suggestions to stimulate breakthrough innovation development within Company X were developed. The suggestions were divided over three categories of different organizational aspects (of innovation), namely: 1) Communication/connection; 2) Resources; and 3) Development/training.

All suggestions vary in the theoretical aspects they cover, and the practical consequences of the implementation of those suggestions, i.e. costs and time involved. It is to the discretion of the relevant stakeholders of Company X to determine which suggestion is needed in which situation and to what extent it should be implemented. Perhaps some suggestions can be combined, or implemented simultaneously. The actual effects of the suggestions on the innovative performance of Company X will become clear after a suggestion is implemented. Its actual success will depend on multiple factors, which are not fully evaluated, yet. Although the outcomes of the suggestions are not documented in great detail, they seem promising, based in literature, and used in other fields of practice. Therefore, the effects of the suggestions are believed to be promising in terms of a positive impact on the innovative performance of Company X.

So, the 10 developed suggestions are the answer on research question 3.

7. Discussion

In this chapter, first, a reflection on the research will be provided. Second, a reflection on theory will be provided. Third, the limitations of the research will be discussed together with the directions for further research. Fourth, a personal reflection of the researcher on the research is provided.

7.1. Research Reflection

This section provides a reflection on the research itself. So, how does the research fit into the master program of Innovation Management, how did the research proceed and were the research objectives met, will be reflected on here.

The main subject of the research was breakthrough-innovation development. This subject fits perfectly with the master program of Innovation Management because it not only handles with new product development but also with human aspects as well as process aspects of innovation. Both, human and process aspects are an important part of the master study program and therefore the research fitted well in the educational program.

The complete research took a few weeks longer than planned at forehand. This extension was caused by a longer time needed for a deeper understanding of the problem(s) of Company X, and an extensive diagnostic phase of the research. The great willingness of the employees of Company X made it possible to conduct an extensive research and made it possible to acquire all the relevant and required information to conduct a proper research. So, in general, unless the longer time period, the research proceeded well.

The first research objective was to conduct a diagnosis of the feelings of the problem owners of Company X being insufficiently innovative in terms of the number of breakthrough-innovation projects. With help of a newly created definition of breakthrough innovation it was possible to conclude that Company X is very aimed at technological performance aspects only and that knowledge is created, shared and used outside the company's borders, to a very low extent. Furthermore, an environment in which creativity can flourish, is lacking.

The second research objective was to develop manners to stimulate the development of breakthrough innovations. The suggestions were aimed at both human and process aspects of innovation. The developed suggestions all have the potential to boost the innovative performance of Company X.

In general, all research questions were answered, and the two research objectives were met.

7.2. Theoretical Reflection

The Chaordic Systems Thinking approach was the perspective of this research. In this approach organizations are seen as a whole of interacting parts and the organization in its turn is part of a bigger whole. This is also the case for all organizational aspects. So, interaction is crucial for understanding the bigger whole. This Chaordic Systems Thinking can be seen as a complexity approach. Another approach is a variable-based approach. In a variable-based approach, theoretical concepts are seen as separate issues and the relationships between the concepts are examined.

During the research in company X the researcher was struggling with sticking to either the complexity approach or the variable-based approach. The researcher tried to find a balance in both approaches during the research. For instance, the diagnostic phase is more like a variable-based approach in which theoretical concepts and their relationships are examined, e.g. knowledge creation and innovative performance. The design phase is more like a Complexity

approach in which suggestions are developed that cover multiple interacting theoretical aspects simultaneously to stimulate the development of breakthrough innovations.

Next, it is reflected on whether or not the theories presented in the theoretical background in chapter 2 of this report, were usable in the research.

Regarding the diagnostic phase, the next theories were used in the following way. When the definition of breakthrough innovation was composed, only the theories regarding breakthrough products were taken into account by the employees of company X. Especially, the aspect of increasing customer value (Benner & Tushman, 2003) and the aspect of breakthrough products change markets (Wind & Mahajan, 2007) were involved in the final definition of breakthrough innovation.

In the survey - covering social-organizational performance aspects – different concepts of the theories of creativity (Amabile, 1997), knowledge creation (Nonaka, 1994) and open innovation (Chesbrough, 2003a) were used to compose the survey. Because the above theories include concepts that are applicable in multiple contexts, the concepts were also usable in this research.

In the comparison between literature and practice regarding the innovation process, the theory of Reid and De Brentani (2004; 2012) was used to examine how the innovation process of Company X scored according to the proposed theoretical concepts. The theory of Reid and De Brentani (2004; 2012) focused on the fuzzy front-end of a process in which discontinuous innovations were created, which is comparable to the identification phase of the innovation process of Company X, which is also applied in the development of breakthrough innovations at Company X. Therefore, the theory seemed usable, to a high extent.

In general, the theoretical aspects described in chapter 2 of the report were in that sense useful in the diagnostic phase of the research in composing research instruments and scoring Company X's performance.

Regarding the design phase of the research, it was provided in appendix Q in which way the theoretical concepts were covered in the developed suggestions. The main finding here is, that regarding the three suggestions in the resource category (i.e. select intrinsically motivated people, change resource allocation and rewarding with autonomy), only a few theoretical aspects were covered, compared to the other two suggestion categories. Only some aspects of creativity, C-K theory and Complex Adaptive Leadership were covered in this suggestion category of resources, while in the other categories of suggestions clearly more theoretical aspects were covered, as for instance, Chaordic System characteristics and open-innovation concepts.

Because the outcomes of the proposed suggestions are not visible yet in the specific context of Company X, because they have not been implemented, it cannot be determined, which theoretical aspects were eventually most usable regarding the suggestions for Company X.

7.3. Research Limitations and Further Research

As mentioned in the previous section, the outcomes and consequences of the proposed suggestions are not clear because the suggestions are not implemented yet. This is due to time limitations of the research. Simultaneously, this limitation provides a direction for further research. So, when one or some of the suggestions are implemented at Company X, it should be further examined what the effects of the suggestions are on multiple aspects of Company X.

Because, it is not known whether or not the implementation of one single suggestion is sufficient to increase the number of breakthrough innovations, it should be further examined in which way the suggestions can be combined, if needed, and what their corresponding

consequences are. Moreover, the interaction between the underlying mechanisms of the suggestions should be further explored. For this, a possible research direction is provided in the research of Mulder (2012), in which the CIMO-logic is used from a complexity approach.

Another limitation of the research is the unknown level of generalizability of the research results. Because the research was limited to Company X, it cannot be determined what will be the results of the research in case of other contexts, i.e. other companies. Again, regarding the results of the design phase of the research, it is unknown what the effects of the suggestions will be in other contexts. However, because in the design phase of the research, concepts were used from known, established theories as of creativity (Amabile, 1997), knowledge creation (Nonaka, 1994) and open innovation (Chesbrough, 2003), the expectation is that the suggestions might also be useful in other companies. For some suggestions, for instance the suggestions aimed at open-innovation concepts, multiple real-life examples exist of the suggestions having a positive effect on organization's innovative performance (Chesbrough, 2006). So, although not proven, the proposed suggestions seem promising.

A more practical limitation of the research are the small sample sizes used in the diagnostic phase of the research. In the composition of the definition of breakthrough innovation, in comparing the innovation projects of Company X and in revealing the indications of project success and the breakthrough level, only a limited number of employees and projects were involved. This might have influenced the reliability of the research.

Another limitation of the research is the focus on the social-organizational performance aspects, i.e. the combination of human performance aspects and innovation process aspects, and therefore, the lack of focus on personal characteristics of human beings involved in breakthrough innovation. Amabile (1997) mentioned that creativity is build on three components, i.e. creative thinking, expertise and intrinsic motivation, which can be seen as personal characteristics. Considering the major role creativity plays in developing breakthrough innovations, a direction for further research is to examine the personal characteristics of the people involved in the development of breakthrough innovations. Especially, expertise can be an interesting direction for further research, because from this investigation it might become clear, whether or not creativity increases when the level of expertise of employees is high.

7.4. Personal Reflection

I was delighted to start this master-thesis project, because I was very curious about how to apply the things I have learned during my educational years into practice. In the end, I can say that I have experienced the research project as a great learning adventure, especially regarding how employees work and interact in an innovative organization as Company X.

Looking back at the research itself, I think it could have been improved when at the start of the project, I conducted more interviews with more employees to get a deeper understanding of what actually was the problem for Company X. Still during the diagnostic phase of the research, I experienced that new problems or improvement points became clear for me. Furthermore, the diagnostic phase took more time than I had planned beforehand. Perhaps, being more focused on one particular issue of the development of breakthrough innovation, for instance on success indicators or innovation process aspects instead of both, would have provided research results with a higher level of detail. Personally, I think the developed suggestions in the design phase are promising and can have much value for Company X.

Regarding my academic attitude, I think I overemphasized this aspect a bit during the research project. I have the feeling that I should have gone more 'into-the-company' by conducting more interviews and receiving more time of involved employees of Company X.

References

- Aken, J.E. van (1994). De Bedrijfskunde als Ontwerpwetenschap. *Bedrijfskunde*, 66 (1), 16-26.
- Aken, J.E. van, Berends, H. & Bij, H. van der. (2007). *Problem Solving in Organizations*. New York: Cambridge University Press.
- Amabile, T.M. (1997). Motivating Creativity in Organizations: On Doing What You Love And Loving What You Do. *California Management Review*, 40 (1), 39-58.
- Benner, M.J. & Tushman, M.L. (2003). Exploitation, Exploration and Process Management: The Productivity Dilemma Revisited. *Academy of Management Review*, 28 (2), 238-256.
- Blindenbach-Driesen, F., Dalen, J. van & Ende, J. van den (2010). Subjective Performance Assessment of Innovation Projects. *Journal of Product Innovation Management*, 27 (4), 572-592.
- Bodell, L. (2012) *Kill The Company*. Brooklyn: Bibliomotion, Inc.
- Bohm, D. (1990). *On Dialogue*. Ojai, CA: David Bohm Seminars.
- Brentani, U. de & Reid, S.E. (2012). The Fuzzy Front-End of Discontinuous Innovation: Insights for Research and Management. *Journal of Product Innovation Management*, 29 (1), 70-87.
- Byron, K. & Khazanchi, S. (2012). Rewards and Creative Performance: A Meta-Analytic Test of Theoretically Derived Hypotheses. *Psychological Bulletin*, 138 (4), 1-22.
- Chesbrough, H. W. (2003a). The Era of Open Innovation. *MIT Sloan Management Review*, 44 (3), 35-41.
- Chesbrough, H. W. (2006). New Puzzles and New Findings. In H. W. Chesbrough & W. Vanhaverbeke & J. West (Eds.), *Open innovation: Researching a New Paradigm* (pp. 15-33). Oxford: Oxford University Press.
- Chesbrough, H.W. (2012). Open Innovation Past and Present: An Exclusive Interview with Henry Chesbrough. Retrieved from: <https://www.innovationmanagement.se/2013/07/17/open-innovation-past-and-present-an-exclusive-interview-with-henry-chesbrough/> Date accessed: 06-08-2013.
- Colarelli O'Connor, G.C. & Rise, M.P. (2001). Opportunity Recognition and Breakthrough Innovation in Large Established Firms. *California Management Review*, 43 (2), 95-116.
- Cooper, R.G. (1998). Benchmarking New Product Performance: Results of the Best Practice Study. *European Management Journal*, 16 (1), 1-17.
- Davenport, T.H. & Short, J.E. (1990). The New Industrial Engineering: Information Technology and Business Process Redesign. *Sloan Management Review*, 31 (4), 11-27.
- Deci, E.L. (1975). *Intrinsic Motivation*. New York: Plenum.

Deci, E.L., & Ryan, R.M. (1985). *Intrinsic Motivation and Self-Determination in Human Behavior*. New York: Plenum.

Denyer, D., Tranfield, D. & Aken, J.E. van (2008). Developing Design Propositions through Research Synthesis. *Organization Studies*, 29 (3), 393-413.

Edwards, M.G. (2005). The Integral Holon: A Holonic Approach to Organisational Change and Transformation. *Journal of Organizational Change Management*, 18 (3), 269-288.

Edwards, M.G. (2007). "It's just a phase I'm going through": Integral Lenses and Phase Transitions in Organizational Transformation. Annual Meeting of ECCON.

Eersel, K.H.J. van (2011). Evaluation Criteria over Stages in the New Product Development Process: A Qualitative Comparative Analysis at a High-tech Organization. Master Thesis. University of Technology, Eindhoven, The Netherlands.

Eijnatten, F.M. van (2002). Een Introductie in Concepten van het Chaosdenken. In Eijnatten, F.M. van, Poorthuis, A-M. & Peters, J. (Ed.). *Inleiding in Chaosdenken Theorie en Praktijk* (pp. 7-21). Assen: Van Gorcum.

Hamel, G. & Prahalad, C.K. (1994). *Competing for the Future*. Boston: Harvard Business School Press.

Hatchuel, A. & Weil, B. (2003). A new approach of innovative design: an introduction to C-K theory. Proceedings of the international conference on engineering design (ICED'03), Stockholm, Sweden, 109-124.

Hauser, J., Tellis, J.G. & Griffin, A. (2006). Research on Innovation: A Review and Agenda for Marketing Science. *Marketing Science*, 25 (6), 687-717.

Hock, D.W. (1996). *The Chaordic Organization: Out of Control and Into Order*. 21st Century Learning Initiative.

Kira, M. & Eijnatten, F.M. van (2008). Socially Sustainable Work Organizations: A Chaordic Systems Approach. *Systems Research and Behavioral Science*, 25 (6), 743-756.

Khurana, A. & Rosenthal, S.R. (1998). Towards Holistic "Front-Ends" in New Product Development. *Journal of Product Innovation Management*, 15 (1), 57-74.

Kim, J. & Wilemon, D. (2002). Focusing the Fuzzy-Front End in New Product Development. *R&D Management*, 32 (4), 269-279.

Mascitelli, R. (2000). From Experience: Harnessing Tacit Knowledge to Achieve Breakthrough Innovation. *Journal of Product Innovation Management*, 17 (3), 179-193.

- Mulder, N.T. (2012). *Value-based project management: Een aanpak voor chaordische projecten vanuit het perspectief van het complexiteitsdenken*. Eindhoven: University of Technology, dissertation.
- Nonaka, I. (1994). A Dynamic Theory of Organizational Knowledge Creation. *Organization Science*, 5 (1), 14-37.
- Nonaka, I., Toyama, R. & Konno, N. (2000). SECI, Ba and Leadership: a Unified Model of Dynamic Knowledge Creation. *Long Range Planning*, 33 (1), 5-34.
- Obolensky, N. (2010). *Complex Adaptive Leadership*. Surrey: Gower Publishing Limited.
- Pearce, C.L. (2004). The Future of Leadership: Combining Vertical and Shared Leadership to Transform Knowledge Work. *Academy of Management Executive*, 18 (1), 47-57.
- Reid, S.E. & Brentani U. de (2004). The Fuzzy Front End of New Product Development for Discontinuous Innovations: A Theoretical Model. *Journal of product innovation management*, 21 (3), 170-184.
- Roozenburg, N.F.M., & Eekels, J. (1995). *Productontwerpen, structuur en methoden*. Utrecht: Lemma.
- Ryan, R.M. (1982). Control and Information in the Intrapersonal Sphere: An Extension of Cognitive Evaluation Theory. *Journal of Personality and Social Psychology*, 43 (3), 450-461.
- Wilber, K. (1996). *A brief history of everything*. Dublin: Newleaf.
- Wind, J. & Mahajan, V. (1997). Issues and Opportunities in New Product Development: An Introduction to the Special Issue. *Journal of Marketing Research*, 34 (1), 1-12.
- Yin, R.K. (1994). *Case Study Research: Design and methods*. Thousand Oaks: Sage Publications.
- Zhou, K.Z., Yim, C.K.B. & Tse, D.K. (2005). The Effects of Strategic Orientations on Technology- and Market-based Breakthrough Innovations. *Journal of Marketing*, 69 (2), 42-60.