Network evolvement in innovation projects: the case of the construction industry

The influence of network evolvement on the innovation performance in the construction industry

Master thesis - Michiel Wolbers

University of Twente
Business Administration

UNIVERSITY OF TWENTE.

Ballast Nedam

COLOPHON

Title	**Network evolvement in innovation projects: the case of the construction industry**
	The influence of network evolvement on the performance of systemic product innovation in the construction industry
Place and date	Enschede, 22 September 2012
Research period	January 2012 till September 2012
Author	M.C. (Michiel) Wolbers Bsc.
Student number	S0112534
E-mail	m.c.wolbers@student.utwente.nl
University	University of Twente
Program	Business Administration
Track	Innovation & Entrepreneurship
Graduation committee	Dr. ir. E. (Erwin) Hofman *University of Twente* *Business Administration*
	Dr. J.B. (Judith) Timmer *University of Twente* *Stochastic Operations Research*
	Prof. dr. ir. J.I.M. (Joop) Halman *University of Twente* *Construction Management & Engineering*
	Ir. M.F. de Jonge MBA *Ballast Nedam N.V.* *Innovation Management*

Educational institution
University of Twente
Faculty of School of Management and Governance
Program of Business Administration
P.O. Box 217
7500 AE Enschede
www.utwente.nl/ba

Principal institution
Ballast Nedam
Department of Innovation Management
P.O. Box 1339
3430 BH Nieuwegein
www.ballast-nedam.com

“Only the curious will learn and only the resolute overcome the obstacles to learning. The quest quotient has always excited me more than the intelligence quotient.”

EUGENE S. WILSON

SUMMARY

Introduction

Successful innovations can offer firms various competitive advantages: lowering of the production costs, improving of the quality of products, entering of new markets or increasing the share in existing markets. These competitive advantages might lead to an improved position of the firm compared to its competitors and also Ballast Nedam is aiming to improve its position. However, before an innovation becomes successful a process of development and implementation activities precedes. In this process of development and implementation various organizations are involved and the relations between these organizations change during the innovation process and ultimately the network structure of these relations changes. It is likely that the evolvements in the relations and structure influence the results of the innovation process and the innovation performance. This research aims to understand the evolvement of the networks in these innovation processes and the effect of the network evolvement on the innovation performance.

Research design

Ballast Nedam wishes to improve its innovation management by creating a better understanding of the network dynamics in its innovation projects and the effect of the network dynamics on the innovation performance. The aim of this thesis is to obtain insight in the evolvement of networks in innovation projects of Ballast Nedam and the effect of the network evolvement on the innovation performance. This leads to the following research question:

How does the evolvement of an innovation network affect the performance of a systemic product innovation of Ballast Nedam?

Methodology

This thesis required a theoretical and a practical research: a theoretical research is conducted to determine the variables of an evolving innovation network and the variables to determine the innovation performance of a systemic product innovation. The practical research is conducted in the form of a multiple case study. Three innovation projects of Ballast Nedam are selected as cases for this research. For each case first the data is collected and analyzed. Second, the within case analyses are compared to each other in a cross case analysis to determine similarities and differences between the three cases. Finally, the results of the cross case analysis leads to conclusions and recommendations.

Theory

The theoretical research is conducted to determine the performance of a product innovation and the variables of an evolving innovation network. The definition of an innovation that is used in this research is as follows: *"an innovation is an idea, practice or object that is perceived as new by an individual or other unit of adoption"*. The type of innovation that is studied in this research is a systemic product innovation, which means that there is a complete configuration of components and interfaces of the product. The performance of the innovation and the innovation project is measured on four dimensions: technical performance, project performance, market performance and rate of satisfaction.

In the innovation process of a systemic product innovation four phases can be distinguished: (1) idea generation and selection, (2) pilot project, (3) development and testing and (4) implementation and diffusion. However, in the construction industry a true pilot project is not distinguished, because an innovation is mostly tested and implemented at the same time. The reason for the absence of a true pilot project is because the construction industry described as a complex products and systems industry, which is an industry in which products are developed that have an architectural structure and are produced in small batches.

In the open innovation paradigm external knowledge is used to developed innovations and to use external paths to expand the markets. The access to external knowledge and paths can be required through strategic alliances. There is a wide range of motives to form a strategic alliance. The motives are related to risk sharing, economies of scale, knowledge and skills transfer, shaping of the competition, access to new markets and consolidating of the market position. The strategic alliance can differ on the structure of the strategic alliance and the type of alliance partner, which depends on the relation between the organizations. The structure and the selection of the type of alliance partner determine partly the success of the strategic alliance and ultimately the success of the innovation.

The network in an innovation project is the set of strategic alliances and alliance partners. An innovation network can be characterized by the actors in the network, the ties between the actors and the structure of the direct and indirect ties. Both the network structure and the relations in the network affect the performance of an innovation project and an innovation. Also the dynamics of the network structure and relations affect the innovation performance. The dynamics are the changes in the structure and the relations. However, each change is embedded in the relations and the network structure and the other way around.

The embeddedness of networks consists of several dimensions. In this study a combination of three dimensions are studied: the structural, relational and cognitive embeddedness. The structural embeddedness refers to the configuration of the structure and the ties. To measure the structural embeddedness the measurements frequency of interaction and closeness of the relationship are used. The relational embeddedness, which describes the content of the relation between actors, is measured by making use of the items reliability and promise keeping. The cognitive embeddedness describes the similarity of interpretations among the actors and is measured by using the items shared vision and enthusiasm.

Data collection and analysis

A multiple case study is chosen as a research strategy to collect and analyze the data in this research. In this multiple case study three innovation projects are selected as cases: Duurzaam Speelbad, ModuPark® and iQwoning®. The first two projects are market-pull innovation projects, while the latter is a technology-push innovation project.

The data in this research is collected through document study, questionnaires and semi-structured interviews. Questionnaires are used to collect the data about the network evolvement and the innovation performance, while the document study and the semi-structured interviews are used to collect supporting data about the network evolvement and the innovation project.

The collected data is analyzed in a two-step analysis. Firstly, the data about the network evolvement and the innovation performance is analyzed in a within case analysis, which concerns the separately analysis of the innovation projects. Secondly, a cross case analysis is conducted to compare the three cases on the network evolvement and the innovation performance. Also the effect of the network evolvement on the innovation performance is analyzed in the cross case analysis.

Conclusion

All three innovation projects are described as successful innovation projects, although the projects score differently on the four dimensions of innovation performance. Based on the definition of 'innovation' in this research, the measurement market performance is chosen to compare the innovation projects on their success. This measurement measures the success of the implementation and the diffusion of the innovation. Based on this performance measurement the innovation project iQwoning® is determined as the most successful innovation of the three, followed by the innovation project ModuPark®. The innovation project Duurzaam Speelbad is the last in row; however, this innovation is in the middle of its diffusion and adoption process.

The three dimensions of embeddedness that are determined in the theory are used to measure the evolvement of the network in the three innovation projects. The level of network embeddedness is measured for each of the four phases that were identified in the theoretical framework. The evolvements of the innovation projects are compared on the level of embeddedness and the patterns of evolvement. All three innovation projects have high scores for all six network characteristics during the entire process, although there are differences in the evolvement. The projects iQwoning® and ModuPark® have similar evolvements for several of their network characteristics in contrast with the network evolvements in the innovation project Duurzaam Speelbad. The project iQwoning® has in general higher scores than the project ModuPark®, except for the scores in the first phase. Remarkable for all three innovation projects is the extremely high score on enthusiasm during the entire project.

The effect of the network evolvement on the innovation performance is descriptive determined. There are two reasons that this effect is not statistically determined. The first reason is that the evolvement is described as a pattern and the second reason is the small number of cases. Nevertheless, similarities are found in the network evolvements of the two innovation projects iQwoning® and ModuPark®. The two innovation projects show similar patterns of evolvement of the items close relationship, reliability and enthusiasm, although the levels of these items might differ during the process. These three items describe the involvement of the parties and this involvement, which evolves during the process, affects the innovation performance.

Recommendations

This research offers various directions of future research, because in the field of network dynamics there is a lack of knowledge about the causes and effects of network dynamics. The first type of future research is about the execution of this type of research. In this research a post-hoc analysis is used, but in future research the network evolvement and the innovation performance should be measured while the project is executed. Further, at the start of an innovation project it is not clear whether the project will be a success and therefore, future research might contain successful and unsuccessful innovation projects, which increase the insight of success factors regarding the network dynamics. Also other dimensions of embeddedness could be studied. The second type of future

research is about the environment of networks. In this research the networks of systemic product innovation projects are studied, but in future research network in other types of projects or industries could be studied to increase the insight in network dynamics.

Practical recommendations are mainly about creating the right conditions for the network evolvement. Each innovation projects should start with a meeting or a workshop to make people enthusiastic about the innovation project. The studied innovation projects showed that an extremely high level of enthusiasm might affect the innovation performance in a positive manner. Further, to manage and to control the network evolvement a process manager should be assign to guide the network during the innovation projects. In case it is not possible or desirable to invest in new relationships, it is recommended to cooperate in innovation projects with organizations that are well-known to the firm. A last practical recommendation is to measure the performance of the innovation and the innovation project during the executing of the project and to use these results for other future innovation projects.

PREFACE

This thesis marks the end of my short period as a master student Business Administration. After completing the bachelor Civil Engineering and finishing the courses of the master Construction Management I still had the idea that I missed something. In the courses of my bachelor and master the civil engineering is approached from a project perspective, while I was also interested in the businesses and their processes. The master program Business Administration seemed a logical choice to fil this gap of knowledge. Based on my own experience as an entrepreneur and my interest in innovation I choose to follow the track 'Innovation & Entrepreneurship' and to conduct my master thesis in the field of innovation.

After a period of trial and error in finding the right topic for my master thesis I finally saw possibilities to conduct a research in the field of network dynamics. Fortunately Ballast Nedam in the person of Menno de Jonge saw the same possibilities of this research and the practical relevance for the company. The design of the thesis changed several times during the research period, and although the combination with my other master thesis offered me new opportunities, I finally found the right research topic in my opinion: the effect of network evolvement on the innovation performance. A topic that offered me the opportunity not only to study the theory regarding this topic, but also the opportunity to experience of working in a company, to perceive the different business processes and to explore my interests.

First I would like to thank the members of my graduation committee. Erwin Hofman, Joop Halman, Judith Timmer and Menno de Jonge guided me during the execution of my thesis, but more they challanged me in a pleasant way to continually reconsider my choices and argumentation to improve the research. Of course I am also grateful for the support of the employees of Ballast Nedam and the partners of Ballast Nedam. Second I would like to thank my fellow graduates from A131a and A133 for supporting me, for discussing all kinds of topics and for the appropriate atmosphere. And of course thanks for the innumerable games of table tennis that we played together. Third I would to thank my friends for just being my friends. Fourth I would like to thank Sean Straatman and Eva Kunst personally for their insight and patience in answering my questions. Fifth I would like to say "thank you" to my family for their support during the execution of my research, but also for their support in the years before to realize my objectives and dreams. Finally I would like to thank my girlfriend Nienke for her support, patience, trust and love. Thank you my dear!

This preface, and especially the section with all the thanks, shows that this research could not be conducted without the support of other persons. That is also one of the conclusions of this research that you need other to realize your objectives. And did I fill the gap with my choice for the study Business Administration? Yes I did, but at the same time new gaps of knowledge arised.

Enschede, 22 September 2012,
Michiel Wolbers

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1 INTRODUCTION

This chapter introduces the topic of this thesis that is conducted as part of the master Business Administration at the University of Twente. First the motive of this research is discussed. Secondly the location were the research is conducted is described. Subsequently the relevance of this research is described and finally the outline of the report is given.

This master thesis describes the influence of network evolvement in innovation projects on the innovation performance. This thesis is part of a larger research that studied the network evolvement and decision making in innovation projects in the construction industry. The master thesis 'Decision making in innovation projects: the case of the construction industry', which is conduced by order of the master Construction Management and Engineering of the faculty Engineering Technology, describes the influence of decision making on innovation performance in innovation projects.

1.1 Research motive

Successful innovations can offer firms forms of competitive advantage that can be used to enhance the firm's position compared to its competitors (Teece, Pisano, & Shuen, 1997; Eisenhardt & Martin, 2000). Forms of competitive advantage that can be achieved through innovations are lowering the production costs, improving the quality of products and entering new markets or increasing shares in existing markets (Hagedoorn, 1993; Varadarajan & Cunningham, 1995; Glaister & Buckley, 1996).

Innovation management at Ballast Nedam was before 2009 an ad hoc process that was arranged according to the decentralized organization of Ballast Nedam. Since 2009 is the innovation management of the firm arranged in a centralized routine. In the centralized approach the ideas and innovations are linked to the different decentralized business lines of the firm. But the ideas and innovations are not exclusively linked to a specific business line: other business lines and external parties can be involved in the management of ideas and innovations. The involvement of other business lines and external parties in the development of innovations is in line with the ideas of open innovation (Chesbrough, 2003a). According to Chesbrough's open innovation paradigm (2003a; 2003b) innovations are often developed in collaboration with other parties: competitors, suppliers, buyers, research institutes, universities and governments.

A majority of nowadays successful innovations are the result of a process in which various parties are involved (Ahuja, 2000). The relationships between these parties change over time, and consequently the network structure of these parties follows suit (Lazer, 2001; Zaheer & Soda, 2009). Thus it seems likely to assume that network evolvement influences the innovation process. However, there is a lack of knowledge in the literature and at Ballast Nedam to confirm these assumption due to a lack of longitudinal data on this topic (Burt, 2000). Therefore, more research is needed to understand the network dynamics and the influence of these dynamics on innovation performance (Zaheer & Soda, 2009).

1.2 Company: Ballast Nedam

The research is conducted at Ballast Nedam N.V. by order of the master Business Administration of the faculty School of Management and Governance at the University of Twente. Ballast Nedam is a Dutch-based construction and engineering company that is headquartered in Nieuwegein. Ballast

Nedam builds houses and other buildings, develops infrastructures and provides services and products that are linked to these activities (BallastNedam, 2011a). Ballast Nedam is one on the largest companies in the construction industry with a turnover of € 1.4 billion and a profit of € 9 million in 2011 (PropertyNL, 2011; BallastNedam, 2012).

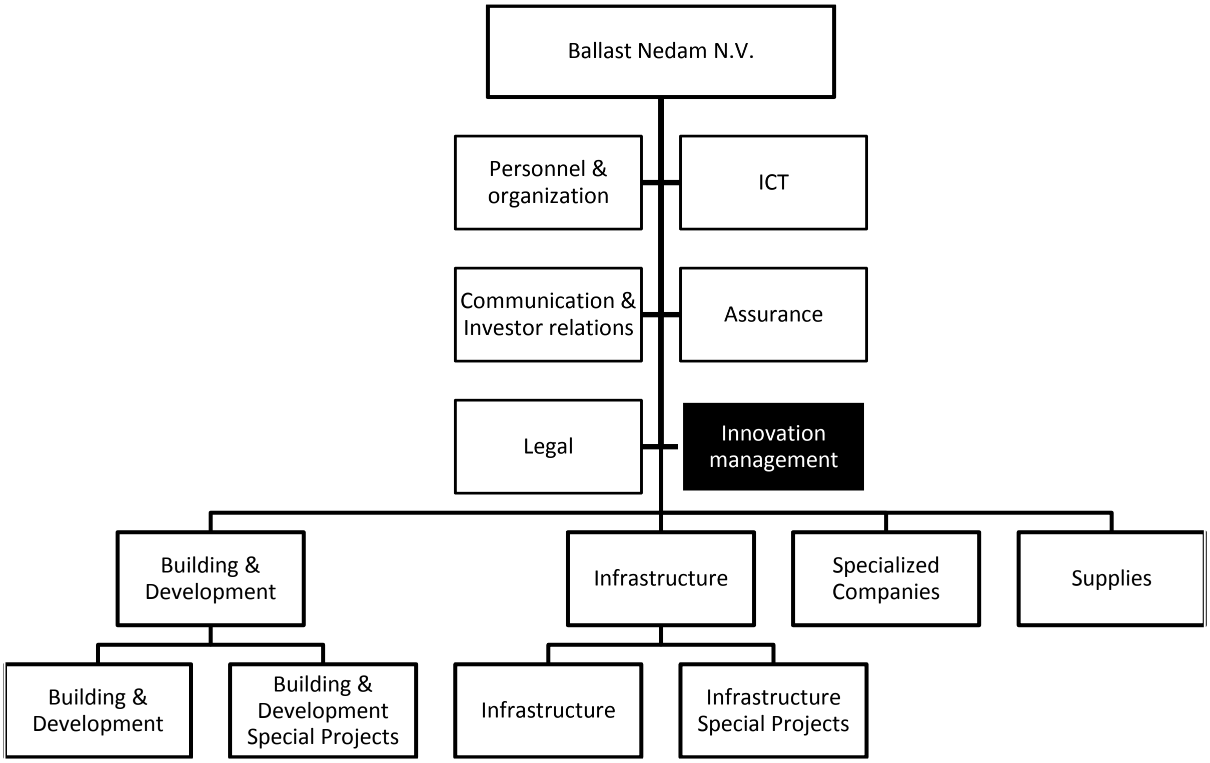


Figure 1.1: Organizational structure Ballast Nedam N.V.

The organizational structure of Ballast Nedam is situated in Figure 1.1 (BallastNedam, 2011b). The organization structure of Ballast Nedam consists of four divisions (Building & Development, Infrastructure, Specialized Companies & Supplies) and six clusters (BallastNedam, 2012). The segment Building & Development comprises the clusters Building & Development and Building & Development Special Projects, while the division Infrastructure comprises the cluster Infrastructure and Infrastructure Special Projects.

Innovation is considered to be an important part in Ballast Nedam's strategy, because innovation is "the actual application of knowledge that is new for the organization in the fields of products, materials, processes, markets, systems, and social and organizational change" (BallastNedam, 2011c). The importance of innovation is shown in the establishment of a department innovation management in 2009 and this department supports the segments and the clusters on a corporate level (BallastNedam, 2010). The department Innovation Management is highlighted in Figure 1.1.

1.3 Relevance of the research

1.3.1 Theoretical relevance

This research contributes to the theoretical development in the field of collaboration in innovation projects (Kogut, 1988; Varadarajan & Cunningham, 1995; Vyas, Shelburn, & Rogers, 1995), network dynamics (Doreian & Stokman, 1997; Zaheer & Soda, 2009) and the effect of network dynamics on the innovation performance (Dhanaraj & Parkhe, 2006).

1.3.2 Practical relevance

The pratical contribution of the research is to create insight in the processes of the innovation projects of Ballast Nedam and the performance of these projects. This research describes the development of the processes of three innovation projects, the parties that were involved, how the networks evolved over time and the effect of the network evolvement on the innovaton performance.

1.4 Outline

In this chapter the problem definition, research motive, research objective and research questions discussed. In chapter 2 the methodology that is used in this research is discussed. Chapter 3 discusses the theoretical framework that concentrates on the innovation process, inter-firm collaborations and decision making. Chapter 4 contains the within case analyses, which is followed by the cross case analysis that is presented in chapter 5. In chapter 6 the results and the research are discussed in the discussion, while in chapter 7 the reflection is presented. Chapter 8 contains the conclusions, limitations of the research and relevance of the research. In chapter 9 theoretical and practical recommendations are given.

2 RESEARCH DESIGN & METHODOLGY

This chapter describes the research design and the methodology. First the problem definition is given, followed by the research objective and the research questions. Subsequently the research strategy is discussed, which is followed by the sections about the data collection, the data analysis and the quality of the research. This chapter is concluded with the research model.

2.1 Problem definition

In the literature the relationship between the networks and the innovation performance has been the subject of many studies (Tsai, 2001; Pittaway, Robertson, Munir, Denyer, & Neely, 2004; Rodan & Galunic, 2004; Padula, 2008). However, these studies perceived networks as static entities. Various scholars have therefore suggested studying networks over time to create insight in the network dynamics and their effect on the innovation performance (Gulati, 1995; Dhanaraj & Parkhe, 2006; Zaheer & Soda, 2009). Firms are not able to fully control the changes in the network and subsequently the innovation performance that results from the network evolvement. There is a lack of insight in literature and at Ballast Nedam how the network evolvement affects the innovation performance.

The paradigm of Chesbrough´s open innovation (Chesbrough, 2003a) draws upon various network theories (e.g. Coleman, 1988; Burt, 1992) and is combined with the development of innovations. Many studies have been conducted to study the effects of network characteristics in the innovation process (e.g. Elfring & Hulsink, 2003; Rogers, 2003; Zaheer & Bell, 2005; Dhanaraj & Parkhe, 2006; Bjork & Magnusson, 2009; Hofman, 2010; Partanen, Chetty, & Rajala, 2011). The studies have focused on the effect of network structures and relations on the creation of ideas (Bjork & Magnusson, 2009), the development of innovations (Reid & de Brentani, 2004; Schilling & Phelps, 2007), the diffusion of innovations (Dewar & Dutton, 1986; Cooper, 1997) and also on the different types of innovations (Elfring & Hulsink, 2003; Partanen *et al.*, 2011). Although these studies show the dynamic character of the innovation process that consists of various phases, and networks are considered to be dynamic structures (Doreian & Stokman, 1997), however most of the network studies are cross-sectional instead of longitudinal (Burt, 2000).

Ballast Nedam wishes to improve its innovation management by understanding better the dynamics in innovation projects. This should ultimately lead to more ideas that turned into successful innovations. However, since there is a lack of insight, both in the literature as at Ballast Nedam, on network dynamics in innovation projects the following problem statement is formulated:

> *Ballast Nedam wishes to improve its innovation management by creating a better understanding of the network dynamics in innovation projects, since by creating a better understanding of the network dynamics more ideas can be turned into successful innovations.*

2.2 Research objective

Based on the defined problem statement in the previous paragraph the objective of this master thesis and the objective in the research are formulated.

The objective of the research is formulated as follows:

> *Obtaining insight in the evolvement of networks in innovation projects of Ballast Nedam and the effect of network evolvement on the performance of systemic product innovations*

The objective in the research is formulated as follows:

> *Capturing the network evolvement in three innovation projects of Ballast Nedam and determining how the network evolvement of these projects affects the performance of systemic product innovations of Ballast Nedam*

2.3 Research questions

The central research question is derived from the research objective:

Central research questions

> *How does the evolvement of an innovation network affect the performance of a systemic product innovation of Ballast Nedam?*

Sub questions

1.1. What are performance indicators of a systemic product innovation?
1.2. Which variables determine an inter-firm network?
1.3. How does an inter-firm network evolve during a product innovation project?
1.4. Which variables of an evolving innovation network affect the innovation performance of a product innovation?

2.4 Research strategy

This paragraph discusses the decisions in selecting a research strategy, the selection of the case study method as research strategy and the reasons to choose for a multiple case study design in this research.

2.4.1 Selecting research strategy

The choice for a research strategy is the outcome of a set of interrelated key decisions about the way the research has to be conducted (Verschuren & Doorewaard, 2007). According to Verschuren and Doorewaard (2007) the research strategy is based on the following decisions:

- Breadth versus depth of the research
- Quantitative versus qualitative research
- Empirical versus desk research

Although the theoretical framework addresses topics that are thoroughly discussed in various studies, there has been not much research done on the relationships between these topics and further the longitudinal perspective on innovation projects is a novelty in the literature. A more in-depth approach is desirable to study these relationships and the longitudinal character of the innovation projects (Verschuren & Doorewaard, 2007). Dul and Hak (2008) state that to specify the relation between independent and dependent concept an experimental research can be used if it is useful and feasible. If it is not, a theory-building comparative case study can be conducted to specify the relation (Dul & Hak, 2008).

Based on the research objective, the formulated research questions and the descriptive literature on research strategies, the choice for a research strategy is a case study (Verschuren & Doorewaard, 2007; Dul & Hak, 2008). An experimental research is not feasible in this research since it is not possible to manipulate the data (Dul & Hak, 2008). Three projects will be studied; each of these projects contains four smaller components that have to be studied, namely the four identified phases of an innovation project. The case study is preceded by a desk research to gather and analyze the available literature.

2.4.2 Case study

The case study method is a research strategy that is used to study an object in a real-life context where there is no manipulation (Yin, 2003; Dul & Hak, 2008). This is in contrast with the experiment, since this research strategy manipulates instances. The case study method gives researchers the possibility to study the processes, changes and relations in cases and the holistic characteristics of cases (Yin, 2003). A case study can be defined as follows:

DEFINITION 1

- ♦ *"A case study is an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident" (Yin, 2003, p. 13).*

Two types of case studies can be distinguished: the single case study and the multiple case study, also mentioned as the comparative case study (Yin, 2003; Dul & Hak, 2008). In a single case study one case is studied, while in a multiple case study studies a small number of instances are studied (Yin, 2003; Dul & Hak, 2008). However, in both types of case studies one or more units of analysis can be studied (Yin, 2003; Dul & Hak, 2008). For this research three cases are studied and each case contains 4 units of analysis (phases in innovation process). Therefore a multiple case study method is used in this research.

2.4.3 Multiple case study

The case study can be used based upon three purposes: exploratory, descriptive and explanatory (Yin, 2003). The central research questions of this research are of an explanatory nature, since the objective of the research is to create insight in the decision making and network evolvement in inter-firm innovation projects. Although Yin (2003) stated that a single case study can be used if it serves a longitudinal purpose, at the same time he stated that a single case study is vulnerable, since the research depends on the data of only one single case.

A multiple case study can therefore be more valuable since data is collected from multiple cases, which contributes to the reliability (Yin, 2003). Although the analysis of multiple cases requires more resources and time, the differences and similarities in the cases raise the generalizability of the results (Miles & Huberman, 1994; Yin, 2003). According to Eisenhardt (1989) a multiple case study consists of 4 till 10 cases. With more than 10 cases, it can be difficult to cope with the amount and complexity of data and with less than 4 cases it is difficult to generate theory. An exception is if the case consists of various mini-cases, which is the case in this research, because each phase in a project represents a case (Eisenhardt, 1989). Since 3 innovation projects are studied that each consists of 4 phases a total of 12 mini-cases are studied.

2.5 Data collection

This section describes which cases are selected, which unit and level of analysis is chosen and which research instruments are used to collect the data.

2.5.1 Case selection

To build theory from cases, cases have to be selected (Eisenhardt, 1989). The cases in this research are strategically selected and not at random, since the cases are used to build theory and further only a limited number of cases can be studied in this research due to the available time and resources (Eisenhardt, 1989). The cases in this research are selected based upon a small list of criteria. The first criterion in the selection of cases is that the project is a systemic innovation. The second criterion is based upon the stage of the innovation. Only cases that have reached the implementation and diffusion-phase are selected. The third creation in the selection is that multiple parties are involved in the innovation process. The fourth criterion refers to the availability of data. This means that only projects are selected that in 2012 are still commercialized, since otherwise it was not guaranteed that data was available and the responsible people for the innovation could be contacted. Based upon the four criteria the following cases within Ballast Nedam are selected:

- Duurzaam Speelbad
- iQwoning
- ModuPark

Duurzaam Speelbad

The Duurzaam Speelbad (Sustainable Swimming Pool) is a prefabricated swimming pool that is able to purify the swimming water itself. The swimming pools are designed for children in the age of 0-4 years and are placed in the public space. This concept is developed by Ballast Nedam in cooperation with Van Dorp and Waco Lingen. The first swimming pools are placed in the municipality of Amstelveen and more municipalities in the provinces Noord-Holland, Utrecht and Zuid-Holland should follow this example. Further the market potential in the recreational sector is examined.

iQwoning

The iQwoning is a modular housing concept that consists of 6 stackable concrete structures. The prefab concrete structures, that can contain stairs, interior walls, windows, tiles or sanitary, are produced in the factory in Weert. Thereafter, the structures are transported to the building site and in one day the whole house is assembled. Afterwards, only the facade and the roof tiles have to be placed. In the innovation process of the iQwoning various Ballast Nedam divisions, subsidiary companies and public authorities were involved. The first units of this housing concept were placed in Eindhoven in September 2009.

ModuPark

The ModuPark is a modular parking garage that consists of prefabricated elements. This building concept is developed by Ballast Nedam, Grontmij Parkconsult and Oosting Staalbouw. The construction contains steel columns and concrete panels that are used for the driveway and the parking lots. The ModuPark is demountable, which means that this parking concept can have a temporary and a permanent character. Further, the prefab elements can be recycled, which increases the sustainability of the concept. The first ModuPark parking garage was realized in August 2006 and was demounted in June 2010.

2.5.2 Unit and level of analysis

The unit and level of analysis are important considerations in determining the scope of the research (Yin, 2003). The unit of analysis is the major entity that is studied and is based upon the research questions defined in section 2.3. In this research the unit of analysis is the innovation network of systemic product innovation projects. The embedded units of analysis are the evolvement of the network structure and the innovation performance. In an embedded case study different data collection techniques can be used, which depends on the type of unit (Yin, 2003).

The level of analysis is primarily, but not exclusively, the project management of the innovation networks. The choice for this level of analysis is based upon the assumptions that the project management has the most insight in the evolvement of the innovation network and the decision making in the systemic innovation projects. Only in the case if the project management has insufficient insight in the embedded units of analysis other individuals were contacted to cooperate in the research.

2.5.3 Research instruments

One of the principles according to Yin (2003) in properly doing case studies is the use of a case study protocol. A case study protocol increases the reliability of the research and guides the investigator in carrying out the data collection from a case study (Yin, 2003). Another principle is the use of multiple source of evidence (Yin, 2003). In this research the necessary data is collected through documentation in combination with postal questionnaires, structured interviews and semi-structured interviews. For each research instrument a procedure is established on how to collect and to report the data (Yin, 2003).

Documentation study

The documentation study can be split into a literature study and a study of the project documentation. The literature study is used to create a theoretical framework and to determine the variables in the research, while the project documentation is used to create insights and overviews of the innovation projects. The project documentation is further used as input for the development of the questionnaires and semi-structured interviews (Yin, 2003; Saunders, Lewis, & Thornhill, 2009).

Questionnaires

In this research questionnaires are used to obtain data about the evolvement of network characteristics, the level of modular and architectural knowledge, and the internal and external performance of the innovation project. The reasons to use questionnaires to obtain this type of data are the sample size and the type of data (quantitative data) that has to be collected (Saunders *et al.*, 2009). The questionnaires are divided into the following modules:

- Network characteristics in the phase ‘idea generation and selection’
- Network characteristics in the phase ‘business case analysis’
- Network characteristics in the phase ‘development and testing’
- Network characteristics in the phase ‘implementation and diffusion’

- Modular and architectural knowledge
- Technical performance of the innovation
- Project performance of the innovation project
- Market performance of the innovation
- Satisfaction about the innovation

The technique of module routing is used within these questionnaires to avert that the respondents answer questions of modules that are not relevant to them when completing the questionnaire. The routings differ for each involved organization, because the organizations can be involved in different phases of the innovation process or might have not the necessary knowledge about the design or the performance of the innovation. In Appendix A the design of the questionnaire is presented.

Semi-structured interviews

Semi-structured interviews are in the first place used to collect data about the decision-making processes in the selected cases that is used in the master thesis about decision making in innovation projects. The data is mainly used in the report about decision making; the semi-structured interviews are also used to collect data about the innovation process. Although the respondents are given the opportunity to talk freely about the decision-making processes a framework for decision-making processes (Mintzberg, Raisinghani, & Theoret, 1976) is used to structure the questions and the order of questions (Saunders *et al.*, 2009).

Three to seven semi-structured interviews per case are conducted with employees of Ballast Nedam that are representatives of each group of decision actors. The interviewees were involved in the decision-making processes of the innovation projects and therefore can be described as highly knowledgeable informants. To enrich the reliability of the data the identified decision-making processes are submitted to other involved employees of Ballast Nedam. The interviews ranged from 30 minutes to 90 minutes. The average interview lasted 60 minutes. The list of interviewees is presented in appendix X and the identified decision-making processes are summarised in Appendix B. The researcher took notes during the interview and then transcribed the interviews. The interviews are recorded in case of authorization for recording the interview and these recordings supplemented the transcripts.

2.6 Data analysis

The data analysis is first conducted at case level, i.e. within case analysis, and subsequently the cases are compared in a cross case analysis.

2.6.1 Within case analysis

The within case analysis concerns the separate analysis of the selected cases (Eisenhardt, 1989; Yin, 2003). According to Eisenhardt (1989) "analyzing data is the heart of building theory from case studies" (Eisenhardt, 1989, p. 539). The idea of the within case analysis is to become familiar with each case and identify the case-specific patterns (Eisenhardt, 1989; Miles & Huberman, 1994; Yin, 2003). The within case analysis correspond with chapter 4:

1. A short introduction of the selected innovation and the corresponding project is given by using project documentation and the semi-structured interviews.

2. The innovation process of the innovation projects is described by using the framework of an innovation process determined in the theoretical framework. The analysis of the innovation process is based on project documentation and the semi-structured interviews.
3. The involved organizations in the innovation are classified by making use of the typology of alliance partners. This analysis is based on the semi-structured interviews and the project documentation.r
4. The innovation performance of the innovations is analyzed for fou performance indicators: the technical performance, the project performance (of the innovation project), the market performance and the rate of satisfaction. The results of the four types of indicators are shown by making use of boxplots (Vogt, 1993). The analysis of the innovation performance is based on the questionnaires. An interpretation of the boxplot is given in Appendix C.
5. The network evolvement of the networks in the innovation projects is analyzed per variable. In the questionnaire six variables are used to describe the network evolvement: frequency of interaction, close relationship, reliability, promise keeping, shared vision and enthusiasm. The analyzed data is based on the questionnaires and is presented by using boxplots.

2.6.2 Cross case analysis

The second step in analyzing the data of multiple cases is the cross case analysis (Eisenhardt, 1989; Miles & Huberman, 1994). After the case-specific patterns are identified, these patterns are compared to each other. In the cross case analysis the context of each case is eliminated, which means that the results of the cases can be generalized and theory can be built (Eisenhardt, 1989). The cross case analysis correspond with chapter 5:

1. The innovation performance of the three innovation projects are analyzed and compared to each other per performance indicator. The data is presented by making use of boxplots and matrixes (Vogt, 1993).
2. The network evolvement in the three innovation projects is analyzed per variable. The data is analyzed by using boxplots and matrixes (Vogt, 1993).
3. The effect of the network evolvement on the innovation performance is analyzed by using a case-ordered predictor matrix (Miles & Huberman, 1994). This technique is suitable to clarify and explain if variables cause a certain effect.

2.7 Quality criteria

Quality criteria are important to the monitor and control the quality of the research (Yin, 2003; Van Aken, Berends, & Van der Bij, 2007). The quality criteria that are taken into account in this research are: controllability, validity and reliability (Swanborn, 1996; Braster, 2000; Yin, 2003; Van Aken *et al.*, 2007). First the criteria will be described and subsequently the quality of this research will be discussed.

2.7.1 Controllability

Controllability is the first prerequisite of the validity and the reliability of the research (Swanborn, 1996; Braster, 2000; Van Aken *et al.*, 2007). Controllability means that the context in which the research is conducted should enable others to replicate it and to check whether the outcomes of both studies are the same. The researcher’s choices and the argumentation of it have to be properly documented to replicate the research.

2.7.2 Reliability

A study is reliable if the results are independent of the particular characteristics of the study (Van Aken *et al.*, 2007). This means that the same results are obtained if the research is replicated. The objective of reliability is to minimize the errors and biases in the research (Yin, 2003). In the literature four potential sources of bias are recognized: the researcher, the instrument, the respondents and the time and circumstances of the measurement (Swanborn, 1996; Van Aken *et al.*, 2007). Repetition of the research, but under different circumstances (e.g. another researcher, different situation, other measurement instruments and other respondents) should yield the same results (Van Aken *et al.*, 2007). In the case of case studies, a case study protocol is used to describe the execution of the case studies, while a case study database can be checked how data is obtained (Braster, 2000; Yin, 2003).

2.7.3 Validity

Validity describes the relationship between the obtained result and the way it has been generated (Van Aken *et al.*, 2007). The obtained results should been free of random and systemic errors (Swanborn, 1996). Three different types of validity are discussed: construct validity, internal validity and external validity. The discussion of these types is based on Swanborn (1996) and Yin (2003).

Construct validity

Construct validity refers to the extent the correct operational measures are established to measure what is intended to measure (Yin, 2003; Van Aken *et al.*, 2007). This type of validity describes the quality of the operationalisation of the concepts in the research. A concept should be covered completely by the measuring instrument and the measurement should not have elements that not fit within the meaning of the concept (Van Aken *et al.*, 2007). According to Yin (2003) the construct validity in case studies can be increased through: use of multiple sources of evidence, establish a chain of evidence and to have key informants review the draft case study report.

Internal validity

Internal validity refers to extent conclusions can be made about causal relationship between concepts based on the used research design (Swanborn, 1996; Verschuren & Doorewaard, 2007). Research results are internally valid when the conclusions about the relationships are complete, justified and there are no plausible competing explanations (Van Aken *et al.*, 2007). Yin (2003) mentions four possible techniques to increase the internal validity of case studies: pattern matching, explanation building, addressing rival explanations and using logic models.

External validity

External validity is about the generalizability of the obtained research results and the conclusions of the research (Swanborn, 1996; Van Aken *et al.*, 2007). External validity is in theory-oriented research more important than in practical research since theory-oriented research is aimed to contribute to the development of theory and is not focused on a specific problem (Van Aken *et al.*, 2007). External validity is also a major barrier in doing case studies since single cases are a poor basis for generalizing the research results (Yin, 2003). However, case studies rely on analytical generalization that means that the researcher strives to generalize a particular set of results to theory. To increase the external validity a cross case analysis is conducted (Yin, 2003).

2.7.4 Quality of the research

To guarantee the controllability of this research a case study protocol and case database are used to document how the research is conducted and how conclusions are made. Paragraph 2.5 describes

the data collection, while in paragraph 2.6 the data analysis is discussed. The obtained data is analyzed in the chapters 4 and 5, based on the described data analysis in paragraph 2.6. The conclusions are subsequently based on the within case analyses and the cross case analysis. On basis of the detailed description it is possible to reproduce the research.
The research is reliable because the results in this research are not dependable of the researcher, the instrument, the respondents or the time and circumstances of the measurement. To increase the reliaibilty of the researcher a case study protocol is used and for example the transcripts of the interviews are fed back to the interviewees. The reliability of the research instrument is increased to use multiple sources of information. In case of the respondents the reliability is increased by using multiple respondents and by using three case studies.

The construct validity is guaranteed by using multiple sources of evidence (project documentation, questionnaires and semi-structured interviews) and establishing a chain of evidence. Further the key informants reviewed the transcripts of the interviews and the draft versions of the report. The internal validity is guarnated by using the technique of explanation building. Explanation building is used to explain the causal links between concepts. Ultimately the external validity is increased by using three cases in the case study. However, three case studies might be not enough to generalize the research results. The research results can then be used as a starting point for developing theory about network dynamics in innovation projects.

2.8 Research model

The research is divided into four phases, which will be described shortly. In Figure 2.1 the research model is shown and the relations between the four phases are represented. In Appendix D the research model is presented at full size.

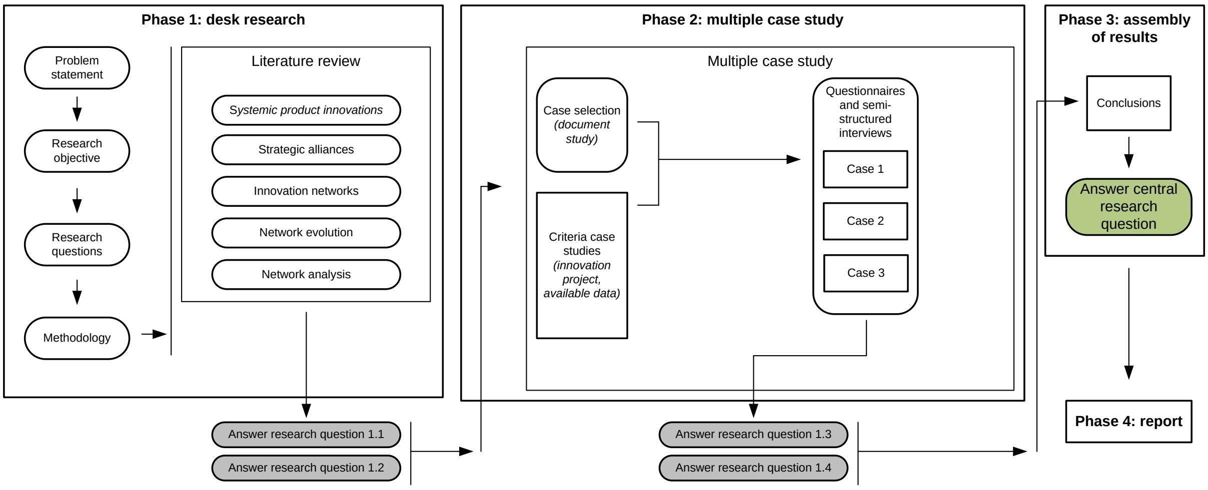


Figure 2.1: Research model master thesis

2.8.1 Desk research

The research started with a desk research in which the problem statement, the research objective, the corresponding research questions and methodology are described. Subsequently, a literature review is conducted on the following topics: systemic product innovation, strategic alliances, innovation networks, network evolution and network analysis. The literature review gave answer to the research questions 1.1 and 1.2. These answers acted as input for the case selection in next phase.

2.8.2 Multiple case study

Based on the outcomes of the desk research a selection of the available cases is made. In the multiple case study the cases are selected on a list of four criteria. During the multiple case data about the network evolution and innovation performance in innovation projects is collected, analyzed and compared. Data about the cases is collected through documentation, questionnaires, structured interviews and semi-structured interviews. The multiple case study is used to answer the research questions 1.3 and 1.4.

2.8.3 Assembly of results

In this phase of the research the conclusion will be formulated based on the outcomes of the desk research and the multiple case study. The conclusion will be used to answer the central research question and to generalize the outcomes about network evolvement in systemic innovation projects.

2.8.4 Report

In the last phase of the research the findings of the previous phases are combined into one report.

3 THEORETICAL FRAMEWORK

In this chapter the relevant literature regarding the central research question will be discussed. First the concept of product innovation is discussed (paragraph 3.1). Furthermore the theory behind strategic alliance (paragraph 3.2) and network in innovation projects (paragraph 3.3) is discussed. In paragraph 3.4 the embeddedness of networks is discussed and in paragraph 3.5 the level of analysis is described. Finally a concluded paragraph (paragraph 3.6) is presented that highlights the most important outcomes of the theoretical background.

3.1 Product innovation

3.1.1 Definition

Innovation has been the subject of many studies, but the definitions that are used in these studies to describe innovation differ largely (Garcia & Calantone, 2002; Crossan & Apaydin, 2010). Although the studies agree that innovation is an important source of competitive advantage (Teece *et al.*, 1997), there is no shared definition of innovation. Garcia and Calantone (2002) describe in their literature review innovation as an iterative process in which an technology-based invention is commercialized, initiated by the opportunity to introduce the invention to the market. However, in this research the definition of Rogers (2003) is used:

DEFINITION 2

- *“An innovation is an idea, practice or object that is perceived as new by an individual or other unit of adoption.” (Rogers, 2003, p. 11)*

This definition captures the internal and external sources of innovations (production and adoption), the different type of innovations, the relative novelty of an innovation and the entire process of an innovation.

3.1.2 Drivers of innovation

The reasons for a firm to innovate are vary widely and are a combination of internal and external drivers (Tidd & Bessant, 2009).

Internal drivers

The internal drivers to innovate are largely based on improving the strategic position of the firm through proactive development and achieving competitive advantage over its competitors (Teece *et al.*, 1997; Chesbrough, 2003a; Tidd & Bessant, 2009). Innovation can contribute in several ways in achieving competitive advantage. The introduction of an innovative product can help to create a new demand and in turn a new market, to enter an existing market or to increase its share in a market which the firm is already active (Hagedoorn, 1993; Varadarajan & Cunningham, 1995; Glaister & Buckley, 1996). Innovation can also lead to improvements in terms of quality, design and customization of the existing products (Tidd & Bessant, 2009). Innovations can further help in lowering the production costs and subsequently increasing the firm’s profit (Mowery, Oxley, & Silverman, 1996; Chesbrough, 2003a).

External drivers

The decision of a firm to innovate can also be based on changes in the external environment (Chesbrough, 2003a; van de Vrande, de Jong, Vanhaverbeke, & de Rochemont, 2009). A reason for a firm to innovate can be based on the identification of an inadequate satisfaction of a customer's need, which can lead to the development of an innovation that adequately fulfils the customer's need. This strategy is known as the market-pull strategy (Martin, 1994; Brem & Voigt, 2009). The opposite of a market pull innovation is the technological push innovation (Martin, 1994). The stimulus for this type of innovation is based upon new knowledge that became available. Other drivers of innovation can be based on changes in the external conditions, such as changed laws and regulations, increasing scarcity of resources and or changes in the market conditions (Geels & Schot, 2007).

3.1.3 Product architecture approach

There are two types of innovation: process innovation and product innovation (Tushman & Nadler, 1986). The first describes a change in the way a product is made, while the latter is about the changes in the product that is made by a firm. The product architecture approach is used to understand both the innovative processes and productions (Henderson & Clark, 1990; Ulrich, 1995; Sanchez & Mahoney, 1996). This approach defines an innovation as a system, which is composed of sub systems and interfaces (Henderson & Clark, 1990; Ulrich, 1995; Chen & Liu, 2005), and regards an innovative process or product as having two major levels. The degree of technological discontinuousness determines whether an innovation is incremental or radical, while the impact of the changes on the system level defines whether an innovation is identified as modular or architectural (Ettlie, Bridges, & Okeefe, 1984; Henderson & Clark, 1990; Ulrich, 1995; Sanchez & Mahoney, 1996; Chen & Liu, 2005). Henderson and Clark (1990) proposed a model (Figure 3.1) that contains two dimensions of knowledge: component knowledge and architectural knowledge.

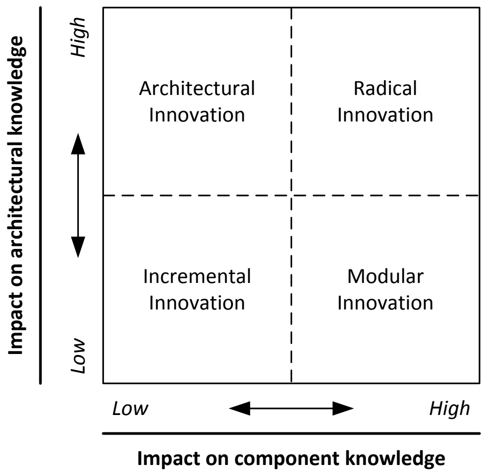


Figure 3.1: Framework for defining innovations (Henderson & Clark, 1990)

Component knowledge is about the knowledge of the core concepts and the components, while architectural knowledge refers to the knowledge how the components are integrated and linked together in a product (i.e. interfaces between sub systems and components) (Henderson & Clark, 1990; Afuah & Bahram, 1995; Chen & Liu, 2005). The concept of a systemic product innovation refers to the complete configuration of components and interfaces of a product (Henderson & Clark, 1990; Chen & Liu, 2005).

The model distinguishes the four types of innovation that can occur: incremental, modular, architectural and radical (Henderson & Clark, 1990; Sanchez & Mahoney, 1996).

- *Incremental innovation* refers to minor improvements on the component level and leaving the architecture and the links between the components unchanged (Henderson & Clark, 1990; Chen & Liu, 2005). Incremental innovations are used to refine and extend established designs.
- *Modular innovation* is an innovation where the core components are overturned, while the interfaces of the product keep unchanged (Henderson & Clark, 1990; Afuah & Bahram, 1995). The modules in the product can be developed autonomously, which in turn results in lower task interdependencies among the involved firms (Baldwin & Clark, 1997; Hofman, 2010).
- *Architectural innovation* leaves the core components unchanged, while the interfaces between the modules are changed (Henderson & Clark, 1990; Afuah & Bahram, 1995). The introduction of a new architecture can reveal unknown interfaces between modules (Hofman, 2010).
- *Radical innovation* establishes a new dominant design in both dimensions of knowledge in Henderson and Clark's model (1990), i.e. a new architecture that consists of new components (Henderson & Clark, 1990). Radical innovations can result in new demands that previously were not recognized by the users (Dewar & Dutton, 1986; Garcia & Calantone, 2002).

3.1.4 Innovation process

The innovation process encloses the process from the moment that ideas are generated to the diffusion of the innovation (Kline & Rosenberg, 1986; Kanter, 1988; Koen *et al.*, 2002; Brem & Voigt, 2009). Various models are developed to describe the innovation process and although the models use different phases, four phases can be distinguished that cover the innovation process in a broad sense: the idea generation and selection, the pilot project, the development and testing of the innovation and finally the implementation and diffusion of the innovation (Kanter, 1988; Koen *et al.*, 2002; Flynn, Dooley, O'Sullivan, & Cormican, 2003; Rogers, 2003; Brem & Voigt, 2009). The innovation process is shown in Figure 3.2.

Figure 3.2: Innovation process (Kanter, 1988)

Idea generation and selection

The idea generation and selection phase starts with the recognition of an opportunity. An opportunity for an innovation can be an inadequate satisfaction of a need or the creation of new knowledge, which can be used to solve a future problem (Kanter, 1988; Rogers, 2003; Trott, 2008; Brem & Voigt, 2009). Based on the identified opportunities ideas will be generated to seize the opportunity, which is an evolutionary process (Koen *et al.*, 2002; Brem & Voigt, 2009). The idea generation is followed by the enrichment of these ideas (Koen *et al.*, 2002). An idea can be enriched inside the organization, but also external parties are able to enrich the ideas if the parties have access to the ideas. The last step of this phase is selecting the ideas that should be pursued to achieve the most business value for the firm (Koen *et al.*, 2002; Brem & Voigt, 2009). Most idea selections follow a formal process that consists of several selection criteria, but it is also possible that an idea is selected based on an individual's preference (Koen *et al.*, 2001).

Pilot project

The next step in the innovation process is to realize a pilot project or business case to analyze the feasibility of the selected ideas (Cooper, 1990; Brem & Voigt, 2009). In this phase studies are undertaken to determine the fit with the firm's strategy, the competitive advantage of the idea, the market attractiveness, the technical feasibility and the expected financial results (Cooper, 1990, 2008). The pilot project further shows the resources that are necessary to develop the product, which could be an indication for a firm to seek potential partners to form a strategic alliance (Van de Ven, 1986; Kanter, 1988; Cooper, 2008). A firm needs in this case to sell the idea to other firms to acquire the necessary power. Power can be in the form of information, resources and support: the supplies that are necessary to realize the idea and produce an innovation (Kanter, 1988). Tushman (1977) stated however that the innovation process in the construction industry has no true pilot project, since innovations are mostly tested and implemented on the same moment in time.

Development and testing

The third phase of the innovation process involves the physical development of the product (Kline & Rosenberg, 1986; Kanter, 1988; Cooper, 1990; Rogers, 2003), which can be described as "the process of putting a new idea in a form that is expected to meet the needs of an audience of potential adopters" (Rogers, 2003, p. 146). This phase not only includes the technical development of the innovation, but concurrently also the development of marketing and operations plans (Cooper, 1990; Veryzer, 1998). As the prototype of the product is developed, there is the opportunity to test it and to provide validation for the entire project (Cooper, 1990, 2008). Areas that are tested are the product, the production process, the customers' satisfaction and the financial expectations (Cooper, 1990; Veryzer, 1998).

Implementation and diffusion

The last phase of the innovation process contains the implementation and diffusion of the innovation (Kanter, 1988; Cooper, 1990; Veryzer, 1998). In this phase of the innovation process the product is ready to be adopted by the users (Rogers, 2003). Further the firm's activities and structures, e.g. production, manufacturing, packaging, marketing and the distribution, are adjusted to the implementation and diffusion of the innovation to ensure the innovation becomes a success (Cooper, 1990; Veryzer, 1998; Rogers, 2003). The decision to diffuse the innovation is one of the most critical choices in the innovation process (Kanter, 1988; Rogers, 2003). Nevertheless, in the literature there is no consensus regarding the degree of centralization and formalization of the diffusion (Ettlie *et al.*, 1984; Dewar & Dutton, 1986; Kanter, 1988; Rogers, 2003).

3.1.5 Innovation in construction industry

The construction industry differs from other industries on various aspects: the type of products, the operations, the technology and also the industry itself (Nam & Tatum, 1989; Tatum, 1989). The construction industry is described as project-based, highly fragmented, geographically focused and highly competitive (Nam & Tatum, 1989; Tatum, 1989). The characteristics of construction products are "immobility, complexity, durability, costliness, and high risk of failure" (Tatum, 1989, p. 602), while the operations in the construction industry are described as design-oriented and site-depended and the activities on site are performed under highly variable environmental conditions (Nam & Tatum, 1989; Tatum, 1989). These characteristics suggest differences in the innovation development in the construction industry (Tatum, 1989; Blayse & K., 2009; Rutten, Dorée, & Halman, 2009).

Motives

The reasons to innovate differ in the construction industry compared to other industries. In other industries market-pull and technology-push innovations are distinguished (Saeden & Manseau, 2001), but innovations in the construction industry are mainly the result of regulations or a function of productivity considerations (Pries & Dorée, 2005; Blayse & K., 2009). The regulations that affect the development of innovations are mainly regulations that concern safety and environmental, although regulations regarding labour conditions become more a motive of innovations. Market needs are rarely recognized in the construction industry (Saeden & Manseau, 2001; Pries & Dorée, 2005) and in the same time there are almost no investments made regarding R&D, which could lead to technology-push innovation (Saeden & Manseau, 2001).

Construction innovations

The majority of the innovations in the construction industry can be described as incremental innovations and process innovations (Pries & Dorée, 2005). The reason for this can be found in the motives, which are mainly interal or dictated by the government through regulations (Pries & Dorée, 2005; Blayse & K., 2009). Another reason that product innovations are rarely developed in the construction industry is that the construction products can be described as complex product systems (Winch, 1998). Complex product systems are characterized based on many interconnected and customized elements, architectural structure and high degree of user involvement (Winch, 1998; Seaden & Manseau, 2001). Because minor changes one of the elements of these complex product systems could lead to large changes in the system or other components, organizations are not willing to make these changes and therefore product innovations are rare (Winch, 1998).

3.1.6 Innovation performance

Innovation performance can be measured in terms of innovation input (e.g. R&D expenditures, number of employees employed) and innovation output (e.g. patents frequency, sales) (Ahuja & Katila, 2001; Parthasarthy & Hammond, 2002; Lööf & Heshmati, 2006). However, to measure the success of an innovation, the focus is usually on the output measurements (Cooper & Kleinschmidt, 1987; Tatikonda & Montoya-Weiss, 2001). The success of product innovations can be measured from an internal and external perspective (Tatikonda & Montoya-Weiss, 2001). Internal innovation performance measurements measure the technical performance of the innovation and the performance of the innovation project (Montoya-Weiss & Calantone, 1994; Lee & Chen, 2007). From an external perspective the market performance is measured (Olson, Walker, Ruekert, & Bonner, 2001; Gatignon, Tushman, Smith, & Anderson, 2002).

Technical performance

The technical performance measurements are used to measure the quality of an innovation on different levels (Henderson & Clark, 1990; Hansen, 1999; Tatikonda & Montoya-Weiss, 2001). On a system level the performance of the entire product innovation is measured, while on the level of subsystems and components specific parts of the innovation are measured (Tatikonda & Montoya-Weiss, 2001). The technical performance of the interfaces between components and subsystems measures the quality of the interaction between the elements (Henderson & Clark, 1990; Hansen, 1999).

Project performance

The project performance measurements have an internal perspective and focus on how the work is executed, which includes the quality of the product innovation, the developments costs that are involved with the development of the innovation and the development time, which describes the duration of the innovation project compared to the planned duration of the innovation project (Montoya-Weiss & Calantone, 1994; Tatikonda & Montoya-Weiss, 2001; Lee & Chen, 2007). Table 3.1 shows the project performance measures.

Table 3.1: Project performance measures

	Description performance measure	Scale	Adopted from
1.	Innovation quality: *extent to which the product quality exceeded or fell short the original product quality objectives*	Scale 1 – 7	Tatikonda & Montoya-Weiss, 2001; Lee & Chen, 2007
2.	Development costs: *extent to which the development costs exceeded or fell short the planned development costs objectives*	Scale 1 – 7	Lee & Chen, 2007
3.	Development time: *extent to which the development time exceeded or fell short the planned development time objectives*	Scale 1 – 7	Lee & Chen, 2007
4.	Satisfaction technical design	Scale 1 – 7	Olson, Walker, Ruekert & Bonner, 2001
5.	Satistfaction functional performance	Scale 1 – 7	Olson, Walker, Ruekert & Bonner, 2001

Market performance

The market measure has an external focus and measures the market outcomes such as product sales, customer satisfaction, profit and market share (Cooper & Kleinschmidt, 1987; Griffin & Page, 1993, 1996; Tatikonda & Montoya-Weiss, 2001). The market measurements however are only used to measure the performance of a complete system and not the components separately due to the fact that only the complete system is brought to the market (Carlsson, Jacobsson, Holmen, & Rickne, 2002; Neely, Gregory, & Platts, 2005). Further the satisfaction about the technical design and the functional performance is measured. Table 3.2 contains the market performance measures.

Table 3.2: Market performance measures

	Description performance measure	Scale	Adopted from
1.	Sales volume	# of products sold per period	Griffin & Page, 1993
2.	Customer satisfaction	Scale 1 – 7	Olson, Walker, Ruekert & Bonner, 2001
3.	Return on investment	Years	Cooper & Kleinschmidt, 1987; Griffin & Page, 1993
4.	Market share	% share	Cooper & Kleinschmidt, 1987; Griffin & Page, 1993

3.2 Strategic alliances

3.2.1 Forms of strategic alliances

The open innovation paradigm (Chesbrough, 2003a) emphasizes the use of external knowledge to accelerate the development of innovations and external paths to expand the markets (Chesbrough, 2003a; Chesbrough, 2006). The need to have access to the external knowledge and external paths requires firms to form strategic alliances with other firms to be able to develop innovations. Strategic alliances are inter-firm collaborations over a given period in which resources and skills are shared to achieve common goals as well as firm specific goals (Varadarajan & Cunningham, 1995; Glaister & Buckley, 1996). Parkhe (1993) defines strategic alliances as follows:

DEFINITION 3

- *"Strategic alliances are the relatively enduring interfirm cooperative arrangements, involving flows and linkages that utilize resources and/or governance structures from autonomous organizations, for the joint accomplishment of individual goals linked to the corporate mission of each sponsoring firm" (Parkhe, 1993, p. 795).*

Strategic alliances can have different forms, depending on the goal of the cooperation and the risks that are associated with the alliance (Varadarajan & Cunningham, 1995; Vyas *et al.*, 1995; Das & Teng, 2001). The alliances vary from unilateral contracts (e.g. licensing agreements and R&D contracts), through bilateral contracts (e.g. joint R&D and joint production) to equity alliances (e.g. minority equity alliances and joint ventures) (Mowery *et al.*, 1996; Gulati, 1998; Das & Teng, 2001).

In Table 3.3 the characteristics of the four strategic alliances structures are shown (based on Das & Teng, 2001).

Table 3.3: Characteristics of four strategic alliances structures

	Unilateral contract-based alliances	**Bilateral contract-based alliances**	**Minority equity alliances**	**Equity joint ventures**
Ownership structure	Contractual	Contractual	One-way or cross-equity ownership	Joint equity
Performance risk	High	High	Low	Low
Relational risk	High	Low	High	Low
Degree of inter-firm integration	Low	Moderate	Substantial	High
Control mechanism	Contract law	Reciprocity	Equity stake	Hierarchical
Duration of alliance	Short- to medium-term	Short- to medium-term	Medium- to long-term	Medium- to long-term

3.2.2 Theoretical perspectives on strategic alliances

Four perspectives are distinguished in the literature to explain the forming of strategic alliances: transaction cost economics, strategic behaviour theory, organization knowledge and learning theory and dynamic capabilities theory (Kogut, 1988; Varadarajan & Cunningham, 1995; Eisenhardt & Schoonhoven, 1996; Eisenhardt & Martin, 2000; Teece, 2007).

Transaction cost economics

The transaction cost economics was developed by Williamson (as cited in Kogut, 1988) who stated that firms choose to transact based on the criterion to minimize the sum of production and transaction costs (Kogut, 1988; Varadarajan & Cunningham, 1995). Transaction costs is mostly used in routine and static efficient situations, however the logic of this theory does not capture the strategic and social advantages of an alliance (Eisenhardt & Schoonhoven, 1996).

Strategic behaviour theory

The theory of strategic behaviour has in contrast with the transaction costs economics a long-term character and discusses the firm's attempt to enhance its competitive position by improving its knowledge and skills or its market capabilities (Porter, 1985; Kogut, 1988; Hagedoorn, 1993; Eisenhardt & Schoonhoven, 1996). The propensity to enter a strategic alliance is a combination of a firm's characteristics, industry characteristics and environmental characteristics (Kogut, 1988; Varadarajan & Cunningham, 1995). Based on the three types of sets of characteristics three generic competitive strategies can be distinguished to receive or sustain competitive advantage: cost leadership, differentiation and focus (Porter, 1985; Varadarajan & Cunningham, 1995).

Organization knowledge and learning theory

The organization and learning theory addresses a firm's attempt to transfer organizational knowledge, which is in most cases knowledge that is tacit, experiential and embedded in the organization, or to retain capabilities and skills by learning from the partner (Kogut, 1988; Varadarajan & Cunningham, 1995; Eisenhardt & Schoonhoven, 1996). This theory is based on the resource- and knowledge based views (Eisenhardt & Schoonhoven, 1996; Grant, 1996) and emphasizes the difficulty of transferring knowledge and shows that few firms are self-sufficient and are depending on the resources of other firms to achieve their goals (Varadarajan & Cunningham, 1995; Eisenhardt & Schoonhoven, 1996; Mowery *et al.*, 1996).

Dynamic capabilities theory

The dynamic capabilities theory (Teece *et al.*, 1997; Eisenhardt & Martin, 2000; Teece, 2007) describes "the organizational and strategic routines by which firms achieve new resource configuration as markets emerge, collide, split, evolve, and die" (Eisenhardt & Martin, 2000, p. 1107). The theory is an extension on the resource- and knowledge-based views, since this theory takes into account the changing business environment and states that sustainable competitive advantage can only be achieved if the use of firm's resources is adapted to the dynamic environment (Eisenhardt & Martin, 2000; Teece, 2007).

3.2.3 Formation of strategic alliances

The life cycle of a strategic alliance consists of three main stages: the process of formation, operation and outcome (Das & Teng, 2002). Irrespective the form of the alliance, each formation process follows a pattern, which consists of the following stages: formulating a strategy, selecting potential partners, negotiating the alliance and setting up the alliance (Kanter, 1994; Spekman, Forbes, Isabella, & MacAvoy, 1998; Das & Teng, 2002). In Figure 3.3 the process is shown.

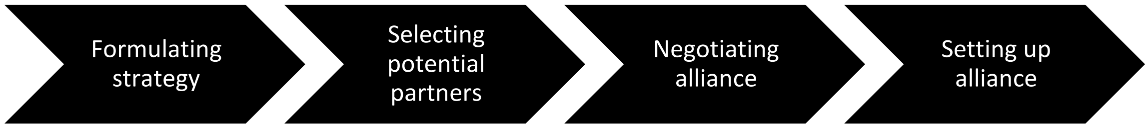


Figure 3.3: Stages of the formation process (based on Das & Teng, 2002)

Formulating strategy

In the first stage the firm formulates a strategy and decides whether a strategic alliance is the proper way to achieve the formulated goals (Spekman *et al.*, 1998). Other options can be horizontal and vertical integration or market transactions. In this stage the industry is analyzed and areas are identified where the firm can collaborate (Spekman *et al.*, 1998). The last step in this stage before the process can be continued is estimating the costs and benefits of the alliance (Das & Teng, 1997; Spekman *et al.*, 1998).

Selecting potential partners

The second stage of the formation process is selecting the potential partners for the alliance (Das & Teng, 1997; Spekman *et al.*, 1998; Das & Teng, 2002). This stage starts with formulating selection criteria and identifying potential alliance partners (Spekman *et al.*, 1998). The selection of an alliance partner can have a major impact on the sustainability of the alliance (Das & Teng, 1997).

Negotiating alliance

The third stage involves the negotiation of the alliance (Spekman *et al.*, 1998). The alliance partners have to negotiate the governance structure of the alliance, the contractual clauses, other legal and contractual parameters and the allocation of the resources and knowledge (Kanter, 1994; Spekman, Isabella, MacAvoy, & Forbes, 1996; Das & Teng, 1997).

Setting up alliance

The last stage of the formation process is sealing the deal (Das & Teng, 1997). There is however a difference between the forms of alliance: contractual alliances can be executed directly after sealing the deal, equity alliances however require a more extensive set up (Kanter, 1994; Das & Teng, 1997). In this case setting up an alliance includes aligning the structures of both firms, informing and convincing personnel and staffing the alliance (Kanter, 1994; Spekman *et al.*, 1996; Das & Teng, 1997).

3.2.4 Motives for collaboration

The literature on strategic alliances generates a wide range of motives to form a strategic alliance, varying from cost related argumentation to the objective to access new markets (Kogut, 1988; Hagedoorn, 1993; Varadarajan & Cunningham, 1995; Vyas *et al.*, 1995; Glaister & Buckley, 1996; Mowery *et al.*, 1996). In this paragraph the most frequently mentioned motives will be mentioned.

Risk sharing

Strategic alliance can be used to share the risks in projects that require large capital formation or have a high level of uncertainty (Hagedoorn, 1993; Glaister & Buckley, 1996). Hagedoorn (1993) stated that especially in the research stage firms enter strategic alliance to reduce, minimize and share the uncertainties in R&D and also to reduce and share the costs that are associated with the research and development activities. Firms could also decide to reduce the market risks by enabling product diversification by forming strategic alliances (Glaister & Buckley, 1996).

Product rationalization and economies of scale

The rationalization of products and achieving economies of scale in the production are strategic motives for firms to enter a strategic alliance (Glaister & Buckley, 1996). Entering an alliance provides the opportunity for firms to reduce the costs and to produce larger volumes of products (Glaister & Buckley, 1996). An alliance can also help firms to fill gaps in the existing product line of a firm (Varadarajan & Cunningham, 1995), to shortening the product life cycle, the period between invention and the introduction to the market (Hagedoorn, 1993) or to create vertical linkages in the production and distribution chain (Glaister & Buckley, 1996).

Knowledge / skills transfer

The transfer of knowledge and skills between firms can be a motive for firms to enter a strategic alliance (Glaister & Buckley, 1996). Alliances may be used to bring complementary capabilities together and the firms in the alliance can have the intent to learn from each other (Varadarajan & Cunningham, 1995). Innovations are often the result of the fusion of these complementary resources (Hagedoorn, 1993; Glaister & Buckley, 1996). The difficulty however of transferring organizational knowledge is that this knowledge is tacit, experiential and embedded (Varadarajan & Cunningham, 1995). Another option to acquire knowledge is the exchange of patents. Not only offers the exchange of patents the required knowledge, but also the entrance to a market (Glaister & Buckley, 1996). Not always it is necessary to transfer or share the knowledge. This is the case if a firm is able to produce and use knowledge independently from the other firm in the alliance (Brusoni & Prencipe, 2001; Langlais, Janasik, & Bruun, 2004).

Shaping competition

A firm can choose to enter a strategic alliance to shape the competition in the market the firm is operating (Glaister & Buckley, 1996; Mowery *et al.*, 1996). Potential enemies can be turned into allies by binding them in a strategic alliance (Varadarajan & Cunningham, 1995; Glaister & Buckley, 1996). A strategic alliance can also be used to combine the internal resource of the involved firms to become more effective competitors or as an offensive strategy to put pressure on the profits and market shares of other competitors (Glaister & Buckley, 1996). A firm can also decide to enter an alliance to raise entry barriers by denying other competitors to create the necessary volume to enter the market (Hagedoorn, 1993; Varadarajan & Cunningham, 1995).

Access to new markets / new products

In the quest for growth and profitability firms can decide to enter strategic alliances to have access to markets and products that are unknown to the firm (Hagedoorn, 1993; Varadarajan & Cunningham, 1995). Firms can form an alliance with foreign firms to penetrate an international market, since these firms have the knowledge of the foreign market (Glaister & Buckley, 1996). Another reason to form alliances with other firms is to overcome the entry barriers of a market (Hagedoorn, 1993; Varadarajan & Cunningham, 1995). Firms can also enter a strategic alliance to jointly develop new products or to have access to the leading edge of new technologies (Varadarajan & Cunningham, 1995; Vyas *et al.*, 1995; Mowery *et al.*, 1996).

Consolidate market position

Strategic alliances can not only be used to enhance the competitive advantage of a firm, but also to defend and consolidate its market position (Varadarajan & Cunningham, 1995; Vyas *et al.*, 1995). Strategic alliances can be used by firms to attack foreign competitors in their home market and to protect one’s market position in its own home market (Varadarajan & Cunningham, 1995). Further strategic alliances can be entered to enable Porter's competitive strategies: differentiation, focus and cost leadership (Kogut, 1988).

3.2.5 Alliance partners

Firms can form alliances with different types of partners depending on the common goal of the alliance, the motives to collaborate and the structure of the alliance (Rothaermel & Deeds, 2006; Nieto & Santamaria, 2007; Li, Eden, Hitt, & Ireland, 2008; Tsai & Hsieh, 2009). The differences between the potential partners are based on the relative position in the chain compared to the firm (Rothaermel & Deeds, 2006; Tsai & Hsieh, 2009) and the prior interactions between the potential partner and the firm (Dyer & Singh, 1998; Li *et al.*, 2008). In Table 3.4 the type of alliance partners are summarized.

Table 3.4: Type of alliance partners (based on Li, Ede, Hitt and Ireland, 2008; Tsai and Hsieh, 2009)

Position in chain (vertical)	Position in chain (horizontal)	Prior interactions
Suppliers	Competitors	Friends
Clients	Complementary firms	Acquaintances
Academia		Strangers
Government		

Position in the chain

The literature on strategic alliances distinguishes horizontal alliances and vertical alliances (Silverman & Baum, 2002; Rothaermel & Deeds, 2006; Tsai & Hsieh, 2009). The latter can be divided into upstream alliances and downstream alliances (Silverman & Baum, 2002; Rothaermel & Deeds, 2006). Upstream alliances are entered with *governments*, *academia* and *suppliers*. With the first two partners alliances are formed to have access to specific knowledge, while alliances with suppliers help a firm to improve the product and the production process (Chan & Heide, 1993; Dorée & Van der Veen, 1999; Silverman & Baum, 2002; Tsai & Hsieh, 2009). Downstream alliances are entered with *clients* to help a firm identifying market opportunities and understanding the needs and demands of its clients (Silverman & Baum, 2002; Nieto & Santamaria, 2007; Tsai & Hsieh, 2009). A horizontal alliance involves the collaboration between two potential *competitors* or collaboration with a *complementary firm*. Although in the case of an alliance between two competitors the potential partners are rivals of each other, the firms can help each other by combining complementary knowledge and resources (Silverman & Baum, 2002; Rothaermel & Deeds, 2006; Tsai & Hsieh, 2009). This is the same with complementary alliances, except that the firms are no rivals of each other (Chan & Heide, 1993; Dorée & Van der Veen, 1999).

Prior interactions

Potential partners can also be characterized based on their relation with the firm (Dyer & Singh, 1998; Li *et al.*, 2008). Li, Eden, Hitt and Ireland (2008) distinguish three types of potential partners: friends, acquaintances and strangers. The distinction is based on the trust that is developed in prior relations (Dyer & Singh, 1998; Li *et al.*, 2008). *Friends* are potential partners with whom a firm has developed a high level of trust. *Acquaintances* are potential partners with whom a firm has prior interactions, but not in the recent past. *Strangers* are potential partners with whom a firm has no prior interactions and consequently are unknown to each other (Li *et al.*, 2008).

3.2.6 Selection of partners

The selection of the partner is a critical factor for the success of a strategic alliance (Douma, Bilderbeek, Idenburg, & Looise, 2000; Hitt, Dacin, Levitas, Arregle, & Borza, 2000; Shah & Swaminathan, 2008; Wu, Shih, & Chan, 2009).

Partner characteristics

A first criterion is based on the partner characteristics. Shah and Swaminathan (2008) distinguished based on a literature review four key factors that influence partner selection and subsequent the strategic alliance performance: trust, commitment, complementarity and financial payoff. The second criterion for the formation of an alliance is that there is fit between the two potential partners (Hoozemans, 2005; Shah & Swaminathan, 2008).

Alliance alignment

Four areas of alliance alignment can be distinguished: strategic fit, operational fit, organizational fit and cultural fit (Varadarajan & Cunningham, 1995; Vyas *et al.*, 1995; Douma, 1997; Medcof, 1997; Saxton, 1997; Das & Teng, 2000; Douma *et al.*, 2000; Das & Teng, 2002; Hoozemans, 2005). An addition to the four areas is the project type of the alliance, which is defined through two dimensions: the process manageability and the outcome interpretability (Shah & Swaminathan, 2008). The alliance project type determines the partner attractiveness and subsequently also the partner selection.

Network context

The choice for a new partner is further embedded in a network context (Gulati, 1995; Gulati & Gargiulo, 1999; Li & Rowley, 2002; Hoozemans, 2005; Shah & Swaminathan, 2008). Studies show that prior alliances, the number of past ties, common third parties, the centrality in a network and the type of market the firm is operating influence firms' selection of partners (Gulati, 1995; Gulati & Gargiulo, 1999; Hitt *et al.*, 2000; Li & Rowley, 2002). Figure 3.4 (Based on Hoozemans, 2005) shows the selection criteria in a chart.

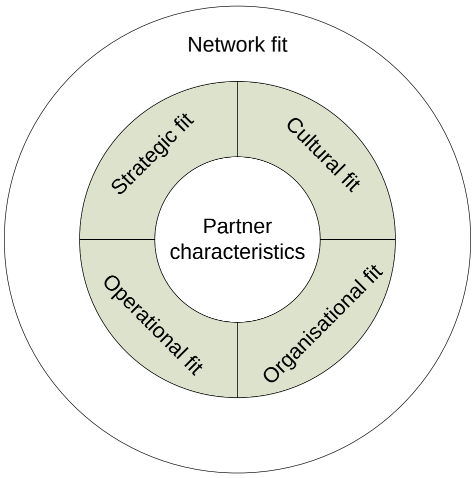


Figure 3.4: Selection chart (based on Hoozemans, 2005)

3.3 Networks in innovation projects

3.3.1 Networks in a business context

The literature agrees that networks and its characteristics affect the innovation process and the outcome of this process (Elfring & Hulsink, 2003; Rogers, 2003; Zaheer & Bell, 2005; Dhanaraj & Parkhe, 2006; Bjork & Magnusson, 2009; Hofman, 2010; Partanen *et al.*, 2011). Fomburn (1982) describes a network as a set of nodes and ties that are connected to each other.

Actors in a network

In the business context the nodes are actors which can be persons, teams, firms, etc. (Borgatti & Foster, 2003; Hagedoorn, 2006). An actor in a network can be classified based upon its position in the value chain, e.g. suppliers, clients, competitors, research institutes, etc.; however the type of actor in a network can also be based upon its position in a network. Three types of roles can be distinguished: the *central hub* or *orchestrator*, the *intermediary* and the *group member* (Burt, 1992; Ibarra, 1993; Burt, 2001; Barabasi & Bonabeau, 2003; Dhanaraj & Parkhe, 2006). The orchestrator is the most central actor in a network and has the power to coordinate the network (Ibarra, 1993; Dhanaraj & Parkhe, 2006). The intermediary is the actor who connects two other actors with each other which otherwise keep unconnected (i.e. structural hole), while the group member does not hold a specific position (Burt, 1992; Burt, 2001). In Figure 3.5 the three actor roles are shown.

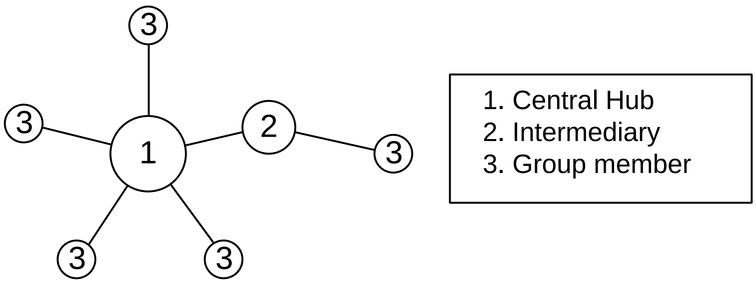


Figure 3.5: Actor roles in a network

Ties and tie strength

The ties in a network are the relationships that connect the actors with each other and have the potential to facilitate and constrain the flow of information and resources (Kimberly & Evanisko, 1981; Borgatti & Foster, 2003; Balkundi & Harrison, 2006; Hagedoorn, 2006). Ties between actors can be direct, which means that the actors are directly connected with each other. An indirect tie indicates that two actors in a network are connected through one or more actors (Burt, 1992). Ties can also be valued by using the strength of the tie (Borgatti & Foster, 2003; Balkundi & Harrison, 2006). The tie strength, which is deducted from the intensity between actors, is used to make a distinction between weak and strong ties (Reagans & McEvily, 2003a). Granovetter (1973a) defines the tie strength as a combination of “the amount of time, the emotional intensity, the intimacy and the reciprocal services” (Granovetter, 1973a; Granovetter, 1973b, p. 1361). Strong ties require a great investment of these characteristics, while weak ties need less investment (Reagans & McEvily, 2003a).

Structure and density of a network

The configuration of direct and indirect ties a network determines the structure and density of a network (Coleman, 1988; Burt, 1992). Burt (1992) underpins the importance of the advantages that are offered through indirect ties and loosely coupled networks in his theory of structural holes.

Coleman (1988) on the other hand the advantages of direct ties and tightly coupled networks emphasizes (Coleman, 1988; Burt, 1992; Sanchez & Mahoney, 1996). According to Burt (1992) a loosely coupled network offers a wide variety of knowledge, while Coleman (1988) states that network cohesion enables trust among the actors. Both theories show nevertheless the importance of the type of ties within a network and the as a result the position in it.

3.3.2 Influence of networks on performance

Influence of network structures on performance

Burt (1992) and Coleman (1988) describe two different perspectives with respect to the influence of network structures on the innovation performance. Burt (1992) describes the positive influence of a structural hole, which is the separation between non-redundant actors, on innovation performance. In his theory actors in a network act as brokers to bridge two other actors that otherwise keep unconnected. These structural holes that are created offer actors new connections, diverse experiences and novel ideas which can lead to new opportunities for the actors (Zheng, 2010). Coleman (1988) introduced an opposing view of the structural holes theory: the network closure theory. A dense network, which consists of cohesive ties, facilitates trust and cooperation between the actors (Coleman, 1988; Gargiulo & Benassi, 2000). Trust and cooperation makes actors more willing to share tacit knowledge which subsequently enhances the innovativeness of the actors.

Influence of network relations on performance

Other studies focused on the impact of network relations on innovation performance (Granovetter, 1973a; Granovetter, 1973b; Ahuja, 2000; Etzkowitz & Leydesdorff, 2000; Tsai, 2001). The connection between actors can, besides based on its presence, also be measured on its strength. The tie strength, which is deducted from the intensity between actors, is used to make a distinction between weak and strong ties (Reagans & McEvily, 2003a). Granovetter (1973b) defines the tie strength as a combination of "the amount of time, the emotional intensity, the intimacy and the reciprocal services". Strong ties require a great investment of these characteristics, while weak ties need less investment (Reagans & McEvily, 2003a). Both types of ties can be valuable for an organization, but also has its disadvantages. Strong ties facilitate the formation of trust which eases the transfer of tacit knowledge between actors; however the information that is transferred between the actors is likely to be highly redundant (Nelson, 1989). Weak ties can offer more diverse and novel information when acting as a bridge with other actors. Although weak ties require low investments, the influence on weak ties is also low which could affect the access and timing to information (Burt, 1992). Elfring and Hulsink (2003) state therefore that firms continuously searching for the optimal mix of strong and weak ties.

3.3.3 Dynamics of networks

Network process

A network process is according to Doreian and Stokman (1997) a *"series of events that create, sustain and dissolve social structures" (Doreian & Stokman, 1997, p. 3)*. Doreian and Stokman (1997) distinguish in the theory about network processes the difference between "network dynamics" and "the evolution of a network". Network dynamics is the more general term that is used to describe the changes in network structures over time, while the term evolution of a network refers to a process of changes that are understood by the actors (Stokman & Doreian, 1997). The evolution of a network is a complex process since a network attempts to approach an equilibrium state while multiple actors are involved with possible conflicting goals (Stokman & Doreian, 1997; Kossinets & Watts, 2006).

Changes in network

A network is described as a set of actors that are connected to each other through ties (Fombrun, 1982; Borgatti & Foster, 2003; Hagedoorn, 2006). This definition implies that three types of changes are possible in a network: the formation of a network tie, the dissolution of a network tie and the reconfiguration of network tie (Hoang & Antoncic, 2003; Powell, White, Koput, & Owen-Smith, 2005; Koka, Madhavan, & Prescott, 2006). A network tie can be formed with an existing network member, but an actor can also decide to form a relation with an actor that is unknown to the network (Barabasi *et al.*, 2002; Hoang & Antoncic, 2003). In the latter the network is expanded, while if a tie is created with an existing network member the network becomes tighter (Koka *et al.*, 2006). Tie dissolution means that the relationship between two actors is ended (Hoang & Antoncic, 2003; Powell *et al.*, 2005). It is possible that as a result an actor leaves the network. The last possible change in a network is the reconfiguration of a network tie. This change means that the relation content between two actors has changed (Borgatti & Foster, 2003; Powell *et al.*, 2005). The rate of reconfiguration is reflected in the change of the tie strength (Borgatti & Foster, 2003; Reagans & McEvily, 2003b). In Table 3.5 the changes and effects on the network structure are summarized.

Table 3.5: Changes in a network

	Tie with other network member	**Network size**	**Network density**
Tie formation	Yes	N/A	Increase
Tie formation	No	Increase	Decrease
Tie dissolution	Yes	N/A	Decrease
Tie dissolution	No	Decrease	Increase
Tie reconfiguration	N/A	N/A	N/A

Factors for network evolution

Network evolution is influenced by exogenous and endogenous factors (Oliver, 1990; Gulati, 1998; Koka *et al.*, 2006). Exogenous factors drive the changes in a network, while the endogenous factors influence the content of the changes, e.g. with whom to form an alliance or to strengthen a network tie (Gulati, 1998). Exogenous drivers of network evolution are uncertainty in the environment, legal or regulatory requirements, the nature of competition, the munificence of resources and the occurrence of critical industry events (Oliver, 1990; Gulati, 1998; Madhavan, Koka, & Prescott, 1998). The endogenous factors describe the embeddedness of a firm's strategic position in a network, e.g. goal compatibility, asymmetry in resources, the history of an actor's prior ties and reciprocity between actors (Oliver, 1990; Gulati & Gargiulo, 1999).

Effects of network evolution

Network evolution, i.e. tie formation, dissolution and reconfiguration, affects the network structure and the actor's attributes (Stokman & Doreian, 1997; Burk, Steglich, & Snijders, 2007). Both types of characteristics evolve over time as a result of the interaction between selection processes and contagion processes (Stokman & Doreian, 1997; Kamann & Bakker, 2004). Figure 3.6 models the two processes in a network evolution.

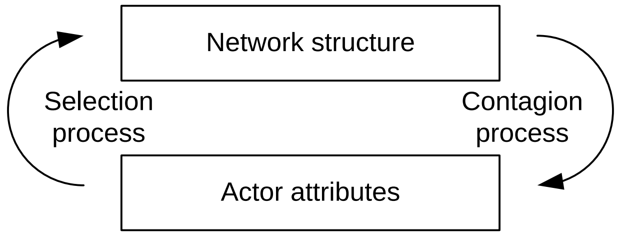


Figure 3.6: The selection and contagion model in network evolution (based on Stokman & Doreian, 1997)

The selection of actors is determined by the attributes of actors (Stokman & Doreian, 1997; Kamann & Bakker, 2004). Actors are selected that have the required or desired attributes (Barabasi *et al.*, 2002; Kamann & Bakker, 2004; Burk *et al.*, 2007). The actors in the network have a tendency to select actors with similar attributes which results in 'homogenous' network of actors (Kamann & Bakker, 2004; Burk *et al.*, 2007). The homogeneity of the network is reinforced through contagion processes (Stokman & Doreian, 1997). The network structure influences the actors' characteristics, which means that an actor adapts its behaviour to the behaviour of the other actors in the network (Stokman & Doreian, 1997; Kamann & Bakker, 2004). The ability to resist these influences declines when an actor becomes more embedded in a network (Kamann & Bakker, 2004).

3.4 Embeddedness of innovation projects

3.4.1 Embeddedness of networks

In the concept of embeddedness each tie with a firm is considered as a resource since it can provide access to benefits that are available within the network (Granovetter, 1985; Uzzi, 1996). The idea of this concept is that each economical action of a firm is embedded within the network and therefore cannot be considered independent, but is influenced by the ties and the structure of the network (Gulati, 1999; Gulati, Nohria, & Zaheer, 2000). Due to the fact that the economical actions of a firm are embedded in a larger social context, the actions are also constrained by the ties with other firms (Granovetter, 1985). This means that the denser a network of inter-firm alliances is, the higher the network embeddedness is. If a network is sparse, the economical actions of a firm are slightly embedded within the social context.

3.4.2 Dimensions of embeddedness

Embeddedness is an overarching concept which consists of several dimensions. Numerous scholars have identified and studied the various dimensions of embeddedness, namely: cognitive, cultural, political, relational, structural and positional embeddedness (Gulati, 1998; Tsai, 2001; Badry, 2009). The first three dimensions are social perspectives on the embeddedness of a network (Uzzi, 1997). Cognitive embeddedness captures the similarity in mental models, the cultural dimension deals with the management culture between firms (Dacin, Ventresca, & Beal, 1999) and the political embeddedness is about the power positions in a network (Halinen & Törnroos, 1998). The last three dimensions describe are the relationships within a network and the configuration of a network. (Shipilov, 2005). Relational embeddedness refers to the dyadic ties between firms (Gulati, 1998) and structural embeddedness discusses the structure of relations between firms (Baum, Shipilov, & Rowley, 2003). Positional embeddedness, which describes the impact of a firm's position in a network, is however in studies also seen as a sub component of structural embeddedness (Gulati, 1998; Dacin *et al.*, 1999; Shipilov, 2005).

3.4.3 Combination of dimensions

The identified dimensions of embeddedness can be used separately to explain the actions of actors. However, a single dimension explains partly the economic action, while a combination of dimensions can complement each other. On the same time, if the conceptualism of embeddedness is too broad, it becomes impossible to come to thorough conclusions (Powell, 1990). Simsek, Lubatkin and Floyd (2003) introduced conditions for the conceptualism of the dimensions of embeddedness. First, the social context of embeddedness should not be exaggerated since the actors are not a complete product of the social environment. Second, the proposed conceptualism should be sufficiently developed in the literature to reach valid conclusions.

3.4.4 Conceptualization of embeddedness

Conceptualization in literature

A combination of structural and relational embeddedness is a widely used combination in the literature about embeddedness (Granovetter, 1985; Gulati, 1998; Rowley, Behrens, & Krackhardt, 2000). Granovetter (1992) introduced the combination of relational and structural embeddedness with his statement that an economical action is affected through the dyadic relation between actors and the overall network of relations. In inter-firm networks often a third dimension is added to structural and relational embeddedness, namely cognitive embeddedness (Tsai & Ghoshal, 1998; Simsek *et al.*, 2003). Cognitive embeddedness refers to a shared goal among firms in a network to create intellectual capital, e.g. the development of an innovation (Nahapiet & Ghoshal, 1998).

Relational embeddedness

Relational embeddedness describes the direct ties between two actors and the assets that are developed within this relationship, like trust and trustworthiness (Gulati, 1998; Tsai & Ghoshal, 1998). This dimension of embeddedness therefore focuses on the dyadic level of a network and the quality and characteristics of the relationship. Granovetter (1973b) used ‘tie strength’ to stress the quality of a relationship and distinguished strong and weak ties. The strength of a tie can be determined based on the amount of time spent on maintaining the tie, the reciprocity, the emotional intensity and the intimacy between the actors (Granovetter, 1973b). The frequency of interaction between the actors is also often used in determining the tie strength (Scott, 2000; Hite, 2003). A strong tie indicates a high frequency of interaction, high degree of trustworthiness and shared norms, while a weak tie is associated with a low number of interactions and low intimacy. Nevertheless, both types of ties, strong and weak, provide distinct advantages for a firm. Strong ties promote trust and develop a shared understanding between the actors which enables the exchange of specific information (Krackhardt, 1992), while weak ties provide access to novel and unique information (Granovetter, 1973b).

Structural embeddedness

Structural embeddedness refers to the impersonal configuration of ties between actors and describes the impact of the structure of relations on the economical actions of actors in this network (Nahapiet & Ghoshal, 1998). This type of embeddedness goes beyond the direct ties of a focal actor and focuses on the informational value of the structural position an actor has in a network (Gulati, 1998). In contrast to relational embeddedness, which is focused on the benefits of a dyadic relationship between actors, structural embeddedness focuses on the information that is received through a beneficial position in the network (Gnyawali & Madhavan, 2001). The structural embeddedness is determined through the number of actors that are interacting with each other, the potential interactions in the network and the diffusion of information over a network (Granovetter, 1985; Gulati & Gargiulo, 1999). Density and centrality of a network are important complementary measures to measure the structural embeddedness of a network (Gulati & Gargiulo, 1999; Scott, 2000). Density describes the level of cohesion in a network, while centrality refers to the extent to which the cohesion is organized around the focal actor (Wasserman & Faust, 1994; Scott, 2000). A dense network, which consists of highly interconnected actors, provides shared norms and cooperation (Coleman, 1988). On the other hand, the benefit of a sparse network configuration, which is characterized by a low level of connectedness, is the access to non-redundant information (Burt, 1992).

Cognitive embeddedness

Cognitive embeddedness is about “the ways in which the structured regularities of mental processes limit the exercise of economic reasoning” (Zukin & DiMaggio, 1990, p. 15-16). This dimension of embeddedness refers to the similarity of representations, interpretations and systems of meaning among parties, e.g. shared language and shared codes (Nahapiet & Ghoshal, 1998). Cognitive embeddedness of a network is shaped by, and in turn is shaping, the interactions among the actors (Simsek *et al.*, 2003). A shared vision, which is in innovation studies deemed as a significant construct of this dimension (Zheng, 2010), can help to facilitate the actions of an individual actor or a group of actors (Tsai & Ghoshal, 1998). Although shared vision is widely used as a construct in innovation studies, studies show different outcomes with respect to the influence of shared vision on innovation. Pearce and Ensley’s (2004) study revealed a positive and reciprocal relationship between innovation and shared vision, while Tsai and Ghoshal’s (1998) study showed no significant relationship between shared vision and innovation, although shared vision was in this study significantly related to the constructs of relational embeddedness. Zheng (2010) argued that shared vision can have a positive influence on innovation when other constructs of embeddedness are not present.

3.5 Network analysis of innovation projects

3.5.1 Level of network analysis

Defining the level of analysis

Networks can be formed at different levels: individual level, team level and organizational level (Kimberly & Evanisko, 1981; Friedkin, 1982; Scott, 2000; Borgatti & Foster, 2003; Provan, Fish, & Sydow, 2007; Borgatti, Mehra, Brass, & Labianca, 2009). Although the network level is simple to define, defining the level of network analysis needs more subtlety (Borgatti & Foster, 2003; Balkundi & Harrison, 2006; Hagedoorn, 2006). Kogut and Zander (1992) state for example that knowledge is held on individual level, but in inter-firm collaborations the knowledge is exchanged on organization level. Borgatti and Foster (2003) describe three levels that are often used in network analysis: dyadic, actor and network. At the dyadic level the tie between two actors is analyzed, but is often part of an analysis at a higher level.

Actor-level versus network-level

The two other levels, the actor level and the network level, are more often used in network analysis. Other studies make this distinction in the form of micro level versus macro level (Wasserman & Galaskiewicz, 1994), an egocentric network versus a whole network (Kilduff & Tsai, 2003) or the form egocentric level versus sociocentric level (Marsden, 2002; Mizruchi & Marquis, 2006). Although these studies use different terminology, the common notion is that an actor analysis focuses on the ties of an organization and how an organization affects other organizations or an entire network. Network analysis on the other hand studies the effects of a network on organizations or the impact on the network outcomes (Provan *et al.*, 2007).

Actor-level analysis

An actor-level analysis is centred on one individual actor or organization (Mizruchi & Marquis, 2006) and focuses on the direct ties, indirect ties and structural holes of the organization (Ahuja, 2000). The focus in an actor-level approach is on how an organization is embedded in a network from the organization's perspective (Kim, Choi, Yan, & Dooley, 2011), and occasionally on how an organization structural and positional is embedded in the network (Provan *et al.*, 2007). An actor-level analysis focuses on the type of organizations in the whole network, the properties of the ties between organizations (frequency, duration and intensity) and the centrality (degree and betweenness) of the organization in the network (Marsden, 1990; Provan *et al.*, 2007; Kim *et al.*, 2011).

Network-level analysis

A network-level approach focuses on the overall structure of a network, the processes within a network and the properties of the network as a whole while a bird's eye view is used to observe the network (Provan *et al.*, 2007). At a network level, data is obtained about the network size, the network structure, the centralization of the entire network or the network density (Marsden, 1990; Scott, 2000; Provan *et al.*, 2007; Kim *et al.*, 2011). A network-level approach is preferred above the actor-level approach if full understanding of larger social network is necessary. Nevertheless, actor-level data is considered as a reliable substitute when network-level data is not available (Marsden, 2002; Mizruchi & Marquis, 2006; Kim *et al.*, 2011). In Table 3.6 the network measurement on an actor-level and a network-level can be found.

Table 3.6: Network measurements on actor-level and network level

	Actor level	Network level
Structure	Betweenness centrality	Betweenness centrality
	Closeness centrality	Centralization
	Degree centrality	Closeness centrality
	Density	Degree centrality
	Ego network size	Density
		Full network size
Relation	Norms	Norms
	Tie strength	Tie strength
	Trust	Trust

3.5.2 A longitudinal perspective

Longitudinal network analysis

Analyses of networks can be used to model the dynamics of a network of social entities and to create a better understanding of networks (Wasserman & Faust, 1994; Scott, 2000). Also in the economics, network analyses are in the last decades often used to model and analyze business networks (Madhavan *et al.*, 1998; Reagans, Zuckerman, & McEvily, 2004; Zouhaier, 2007; Kim *et al.*, 2011). Although these studies support the idea that networks are dynamic, most studies on network structures are cross-sectional (Burt, 2000). In the literature there is therefore a lack in studies that use a longitudinal perspective in the study of network structures.

Tools and techniques for longitudinal network analysis

The complexity in longitudinal network analyses is that it is assumed that time flows continuously, while the observations of a network structure occur at discrete points in time (Snijders, 2001). Nevertheless, the discrete longitudinal data can be used in discrete-time models (Powell *et al.*, 2005) and continuous-time models (Snijders, 2001). A reason to choose for a continuous-time model is based on the assumption that changes in the network structure are the result of series of small changes at random moments between the observations (Snijders, 2001, 2005). A proposed model to use is a continuous-time Markov chain actor-oriented model (Snijders, 2005). This model uses an actor-oriented process which means that for each change the perspective is chosen of the actor whose ties is changing. Arguments to choose for a discrete-time model is that the data is observed in discrete units and if the observed units are too large compared to the rate of the event occurs, the time is not considered as continuously (Allison, 1982). In this type of model the network structure of social entities can be displayed for each observed unit or to choose a period in time.

3.6 Conclusion theoretical background

The theoretical background provides the information to answer the following sub questions:

- What are performance indicators of a systemic product innovation?
- Which variables determine an inter-firm network?

These sub questions will be answered in this paragraph.

Performance indicators of a systemic product innovation

A systemic product innovation consists of smaller sub systems that are linked together through interfaces. This type of innovation is composed from component and architectural knowledge. Component knowledge refers to the knowledge of the sub systems, i.e. core concepts and components, while architectural knowledge is about how the sub systems are linked to each other. The success of a systemic product innovation can be measured by making use of internal or external performance measurements. The internal performance measurements are used to measure the technical performance of the innovation and the project performance of the innovation project. The external performance measurements measure the market performance of an innovation and the rate of satisfaction about the innovation. In Table 3.7 the market and operational performance measures are shown.

Table 3.7: Internal and external performance measurements

Technical performance	Project performance	Market performance	Satisfaction
System performance	Innovation quality	Succes of implementation	Technical design
Component performance	Unit costs	Commercial success	Functional performance
Interface performance	Development time	Influence on sales	

Variables of an inter-firm network

An inter-firm network is a group of firms that are connected to each other in the form of strategic alliances and cooperate with each other in order to achieve common goals as well as firm specific goals. The size of an inter-firm network depends on the number of firms involved and the number of relations. The firms in an inter-firm network can be classified based on the position in the value chain (e.g. suppliers, clients, competitors, research institutes, etc.) or on the position in a network (e.g. the central hub or orchestrator, the intermediary and the group member). The strategic alliances in a network are the relationships between the firms and have the potential to facilitate and constrain the flow of information and resources. The content and strength of the tie between two firms is based on the closeness and trust between the firms, the frequency of interaction and the time spent. The structure of a network is based on the configuration of direct and indirect ties in a network. An indirect tie in a network indicates that two firms in a network are not directly connected, but mutually with a third firm. The variables that determine an inter-firm network are the involved firms, the direct and indirect ties in the network, the role and position of the actors and the interaction, trustworthiness and shared vision of the direct ties (Table 3.8).

Table 3.8: Variables of an inter-firm network

Network	Actors	Ties
Actors	Position in a network	Interaction
Direct ties	Role in a value chain	Trustworthiness
Indirect ties		Shared vision

4 WITHIN CASE ANALYSIS

4.1 Duurzaam Speelbad

In the individual case analysis of the innovation project Duurzaam Speelbad first the project description is given and the innovation is described. The descriptions of the project and process are followed by an analysis of the innovation performance and the amount of knowledge about the innovation among the involved organizations. Subsequently the evolvement of the innovation network and the effect of the evolvement on the innovation performance are analyzed.

4.1.1 Innovation project

Project description

Duurzaam Speelbad is a modular children’s pool that classified as a swimming pool of category A and is developed by Ballast Nedam Infra Noord West, Waco Lingen Beton and Van Dorp Zwembaden. The system of the Duurzaam Speelbad is composed of two prefabricated elements of concrete of 3.5x7.0 square meters and a plant for the purification of the water. It is however possible to extent the design by using connecting pieces of 2.5 meters. The top view of the design is shown in Figure 4.1.

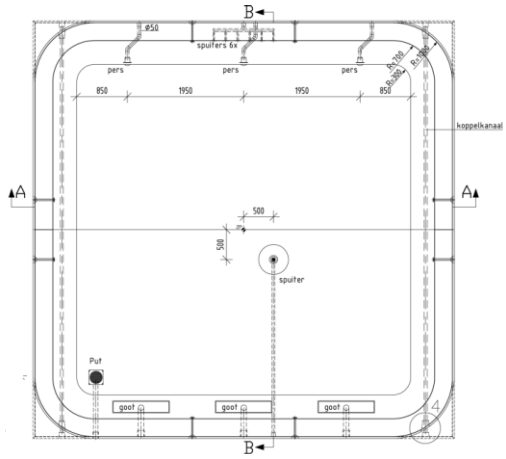


Figure 4.1: Top view of the design of Duurzaam Speelbad

Duurzaam Speelbad is a prefabricated version of the normal children’s pools that can be found in the neighbourhoods and therefore the prefabricated children’s pools can be produced in mass production, which lower the production costs and consequently the price of the children’s pools. Also the production time of the children’s pools is reduced because of the mass production. The children’s pool can be built within 12 weeks from the moment the order is confirmed.

Besides the ability of mass production also the quality of the water is improved. Although the water quality of most of the children’s pools does not meet the requirements, for years this level of water quality is allowed. In the design of the Duurzaam Speelbad a new purification plant is used that purifies the water according to the required level of water quality. Further in the new design the maintenance is taken into account. In other children’s pools the water had to be pumped out for each maintenance service. In case of the Duurzaam Speelbad the water is automatically pumped out every evening to be purified and therefore the Duurzaam Speelbad is more user-friendly to carry out maintenance.

Innovation process

The innovation process of the Duurzaam Speelbad started in February 2006 and at the moment of research (June 2012) the innovation was still improved and diffused into the market. In Figure 4.2 the timeline of the innovation process is shown. In contrast with the literature regarding innovation processes the development and testing of this innovation and the diffusion of it are not completely in series as stated in the literature, instead these phases run in parallel, although during the process there is a switch in the importance of the two phases.

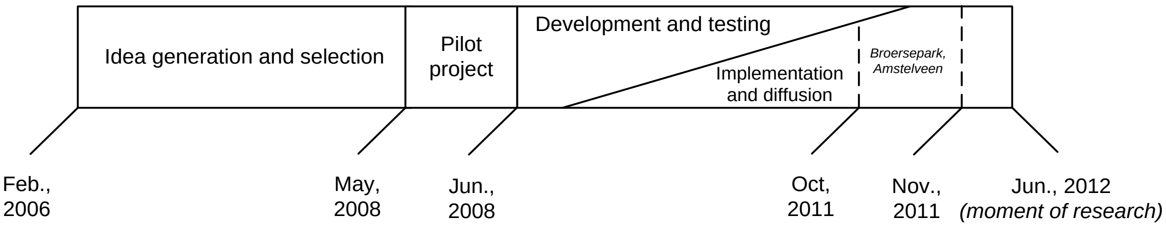


Figure 4.2: Timeline of the innovation project Duurzaam Speelbad

Idea generation and selection

Engineering agency Oranjewoud concluded in its report, which the agency in February 2006 presented to the municipality of Amstelveen that the children´s pools in the municipality of Amstelveen did not meet the statutory requirements and the pools had to be renovated. Based on this report the municipality approached the engineering agency Fehres with the order to renovate the children’s pools.

Fehres however concluded that it would cost too much money to renovate the children’s pools and that a better solution was to rebuild the pools. Consequently the municipality approached Ballast Nedam Infra Noord West to rebuild the children’s pool in cooperation with Fehres. Ballast Nedam Infra Noord West and Fehres both decided to accept the order to rebuild the children’s pools in cooperation with each other. The design of the first children’s pool that was renovated was based on a draft of the municipality.

Pilot project

The pilot project of the Duurzaam Speelbad was the children’s pool at Lucas van Leydenweg in Amstelveen. This children’s pool was the first of five children’s pool that had to be renovated. In the period that Fehres and Ballast Nedam Infra Noord West were approached the intention of the municipality of Amstelveen was to renovate 9 children’s pools. However, due to cuts in the budget the number of children’s pool was adjusted to 5 children’s pools.

The design of the first children’s pool that was renovated was based on a draft of the municipality and the concrete for the children’s pool was poured into the form on the site. However, in the same period Ballast Nedam Infra Noord West determined the market potential of renovating children’s pools and investigated the possibilities to produce prefabricated children’s pools.

Development and testing

In the development and testing phase Waco Lingen Beton was approached by Ballast Nedam Infra Noord West to transform the design of the first renovated children's pool into a design consisting of two prefabricated elements of concrete. After the new design was approved by the municipality of Amstelveen a mold was developed to produce the concrete elements for the other children's pool that had to be rebuilt.
Besides improving the frame of the children's pool Ballast Nedam Infra Noord West decided in this period that also the water quality had to meet the statutory regulations and to do this the purification plant had to be improved. However, Fehres decided that it was not willing to put effort in the development of a new purification plant. Therefore Ballast Nedam Infra Noord West approached Van Dorp Zwembaden to develop the new purification plant and to join forces in the development of an improved children's pool.

Implementation and diffusion

The second, third and fourth children's pool that had to be rebuilt were rebuilt based on the new design of using prefabricated elements. For these children's pools however the purification plants of Fehres were used instead of the new designed purification plant of Van Dorp Zwembaden, because of contractual agreements with the municipality of Amstelveen. The fifth children's pool that had to be rebuilt is rebuilt with the purification plant of Van Dorp Zwembaden.

Besides the rebuilding of the children's pool Ballast Nedam Infra Noord West determined the new market segments for the innovation Duurzaam Speelbad. In the pilot project Ballast Nedam Infra Noord West determined the municipalities in the provinces of Utrecht, North Holland and South Holland. In the implementation and diffusion phase recreation centres and large playgrounds are identified as new market segments.

Involved organizations

In the Table 4.1 the involved organizations in the innovation process of Duurzaam Speelbad per phase. The innovation process started with the proposal of the Municipality of Zaandam to Fehres and Ballast Nedam Infra Noord West to rebuild the children's pools in the municipality. After the proposal was accepted Ballast Nedam Infra Noord West approached Ballast Nedam Engineering to design the first children's pool.

In the next phase of the innovation process, the pilot project, the first children's pool was rebuilt. Ballast Nedam Infra Noord West and Fehres acted as contractor, while the municipality was besides as the principal of the project also as the involved government institution regarding the regulation and legalisation.

In the development and testing phase and the implementation and diffusion phase nearly the same organizations are involved. At the beginning of the development and testing phase Waco Lingen Beton is approached to design and develop a prefabricated children's pool. Later in this phase Van Dorp Zwembaden is approached as substitute for Fehres and to develop a new purification plant for the children's pool. Fehres is involved in the first part of the development and testing (development of the prefabricated children's pool), but was not involved in the development of a new purification plant. Ballast Nedam Engineering was only consulted in the development and testing phase.

Table 4.1: Involved organizations in the innovation project Duurzaam Speelbad

Type of organization	Idea generation and selection	Pilot project	Development and testing	Implementation and diffusion
Division Ballast Nedam	▪ BN Engineering ▪ BN Infra Noord West	▪ BN Infra Noord West	▪ BN Engineering ▪ BN Infra Noord West ▪ Waco Lingen Beton	▪ BN Infra Noord West ▪ Waco Lingen Beton
Competitor (constructor)				
Complementary firm	▪ Fehres	▪ Fehres	▪ Fehres ▪ Van Dorp Zwembaden	▪ Van Dorp Zwembaden
Supplier				
Client	▪ Municipality of Amstelveen	▪ Municipality of Amstelveen	▪ Municipality of Amstelveen	▪ Municipality of Amstelveen
Academia				
Government	▪ Municipality of Amstelveen	▪ Municipality of Amstelveen	▪ Municipality of Amstelveen	▪ Municipality of Amstelveen

4.1.2 Innovation performance

The performance of the innovation project is measured using four measurements: technical performance, project performance, market performance and satisfaction. The theses of the first three types of measurements are answered by 5 persons that were involved in the third phase (development and testing) and the latter measurement is answered by 5 persons that were either involved in the third phase or the fourth phase of the innovation process. The results are shown in Table 4.2.

Table 4.2: Innovation performance of the innovation Duurzaam Speelbad

Category	Variable	Mean	s.d.	N
Technical performance	Product	4,60	0,894	5
	Own components	3,75	0,500	4
	Components of others	4,60	1,075	10
	Own interfaces	4,00	0,000	4
	Interfaces of others	3,70	0,949	10
Project performance	Quality objective	5,00	1,871	5
	Cost objective	2,80	1,304	5
	Time objective	3,60	1,140	5
Market performance	Success of implementation	5,20	1,095	5
	Commercial success	3,50	1,000	4
	Influence on sales	3,00	1,155	4
Satisfaction	Technical design	5,80	1,095	5
	Functional performance	6,00	1,225	5

Technical performance

The technical performance of the innovation is measured on three levels: the system, the components and the interfaces. Regarding the components and the interfaces the distinction is made how the persons have assessed the technical performance of the components and interfaces for which they were responsible and the components and interfaces of which other parties were responsible for. The variation of the items that measured the technical performance is shown in Figure 4.3.a. The technical performance of the entire product is overall judged to be slightly better than expected. A remarkable outcome is the average score of the item 'own components', because the parties judged the performance of their own components to be not exactly as expected. On the other hand, on the item 'own interfaces' the average score shows that the performance of the interfaces is exactly on target. This in contrast to the interfaces of others, which is judged to be not exactly as expected. The item 'components of others' shows an average than indicates that the performance is slightly better than expected.

Project performance

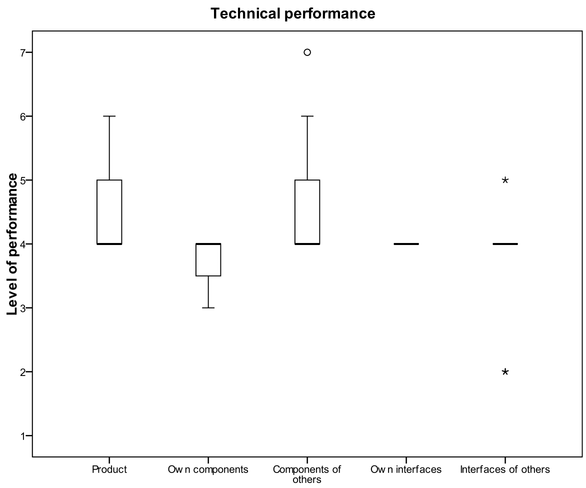
The project performance of the innovation project is measured using three items: the quality objective regarding the innovation, the costs objective of the innovation project and the time objective of the project. The scores of the project performance are shown in Figure 4.3.b. The quality of the innovation is on average slightly better than the objective, although the scores on this item vary between slightly better till far better, which indicates that the opinions on this item differ. The innovation project scores worse than expected on the cost objective and time objective. The costs were according to the respondents higher than the objective and also the duration of the project was slightly longer than expected.

Market performance

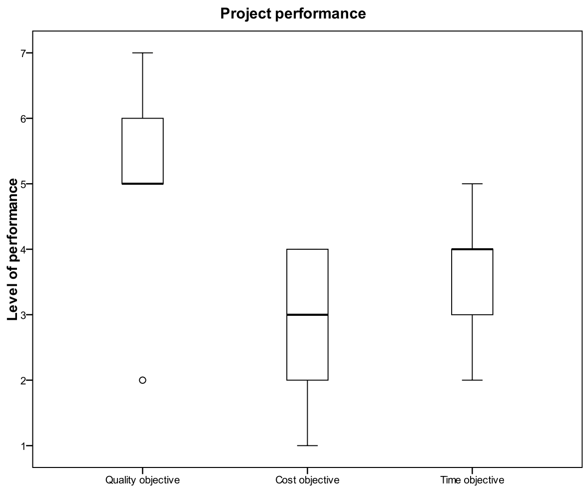
The market performance of the innovation project is measured using three items: the success of implementation, the commercial success and the influence on the firms' sales. The market performance is presented in Figure 4.3.c. According to the respondents the innovation was successful implemented, but this did not yet result in a commercial success according to the same respondents. Regarding the expectations of the influence of the innovation on the sales the innovation scores worse than expected, which indicates that the innovation did not yet had the influence on the sales that was expected.

Satisfaction

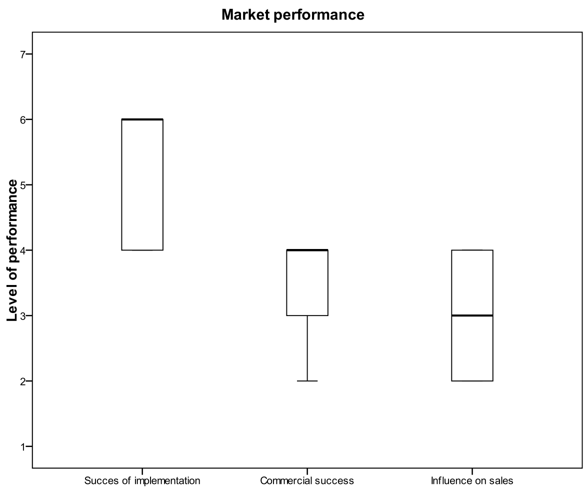
The satisfaction about the innovation is measured using two items: the satisfaction about the technical design of the innovation and about the functional performance of the innovation. The rate of satisfaction is shown in Figure 4.3.d. Both items score high on satisfaction, which means that the respondents are satisfied with both the technical design of the innovation and the functional performance of the developed product.



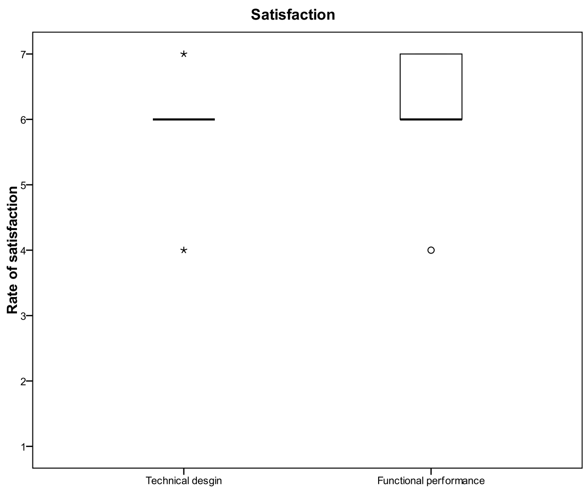
a. Technical performance



b. Project performance



c. Market performance



d. Satisfaction

Figure 4.3: Box plots of the innovation performance of the reference project (5th children's pool in Amstelveen)

The technical performance, project performance and market performance are assessed by respondents that were involved in the 3rd phase of the innovation process, while the satisfaction is assessed by respondents that were involved in the 3rd or 4th phase of the innovation process.

4.1.3 Network evolvement

The network evolvement is measured on the basis of a combination of three network embeddedness and six items: structural embeddedness (items: frequency of interaction and close relationship), relational embeddedness (items: reliability and promise keeping) and cognitive embeddedness (items: shared vision and enthusiasm). The first five items measure the evolvement of the ties, while the latter item (enthusiasm) measures the evolvement of the nodes. The means of the evolvement of the items are shown in Table 4.3 and the variation of the items is presented in Figure 4.4.

Table 4.3: Means of the evolvement per item per phase of the innovation process of Duurzaam Speelbad

	Phases in innovation process			
	Idea generation and selection	*Pilot project*	*Development and testing*	*Implementation and diffusion*
Frequency of interaction	6.55	6.33	5.57	5.63
Close relationship	6.27	6.50	5.33	5.88
Reliability	6.36	6.67	5.24	6.13
Promise keeping	5.82	5.50	5.43	6.00
Shared vision	6.27	6.67	5.90	6.50
Enthusiasm	6.25	6.33	6.40	6.33

Frequency of interaction

The frequency of interaction is during the entire innovation project high, only in the first phase of the project the frequency of interaction can be determined as extremely high. This is also shown in the presence of an outlier. Although it is an outlier, the outlier has still a score of 5. After the first phase the frequency of interaction slightly decreases in time. The frequencies of interaction in the third and fourth phase are almost the same, although at first sight there is a greater variance in the fourth phase. However, the third phase contains on the other hand extreme outliers that not fit the distribution. An explanation for the these extreme outliers might be the termination of the cooperation between Ballast Nedam Infra Noord West and Fehres. The evolvement of the frequency of interaction is shown in Figure 4.4.a.

Close relationship

The scores of close relationship in the first and second phase of the innovation project are almost the same. The mean of the first phase is slightly lower, which can be explained by the outlier in the data. In the third phase of the innovation project there is a dropdown in the level of close relationship. There is also a larger variance in this phase, similar to the variance regarding the frequency of interaction. In the last phase the level of close relationship increases and simultaneously the variation decreases. The evolvement of the closeness in the relationship is presented in Figure 4.4.b

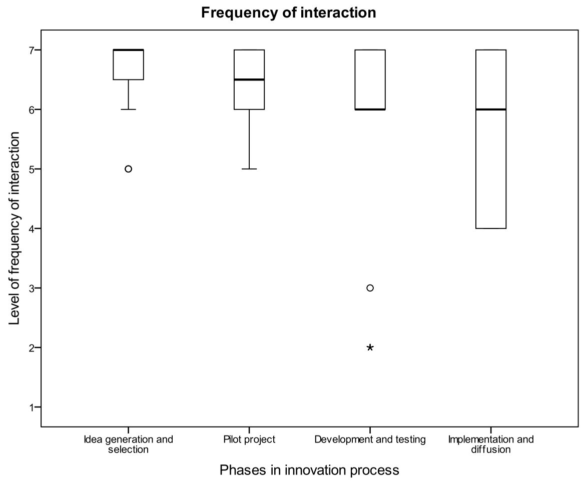
Reliability

The reliability in the first two phases is high, especially in the second phase, because in this phase all the respondents describe the reliability of the other involved parties as high as possible. In the first phase, the idea generation and selection-phase, there is a larger variance with even an outlier, although this is a weak outlier. In the last two phases, the development and testing-phase and the implementation and diffusion-phase, the scores regarding reliability are lower and the variance is larger compared to the first two phases. The expected reason for this dropdown might be the termination of the cooperation with Fehres. The evolvement of the reliability is presented in Figure 4.4.c.

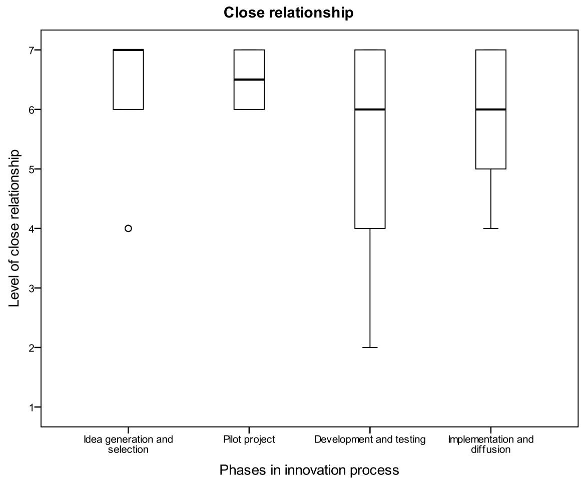
Promise keeping
In the first phase most of the promises are kept, except in one case, which is identified as an outlier. In the next three phases there is a decrease in the promises that are kept, with the lowest score in the third phase. This is the phase in which the cooperation between Ballast Nedam Infra Noord West and Fehres was terminated. In the fourth phase there is an increase regarding the promises that are kept, which resulted in the highest score during the entire innovation process. The variance is therefore also smaller compared to the third phase. The evolvement of the rate of ‘promise keeping’ is presented in Figure 4.4.d.

Shared vision
During the entire process the level of shared vision remains almost the same. Only in the first and third phase two outliers are present. The outlier in the first phase can be explained that the innovation project started as a regular project and perhaps therefore there was a difference in the visions. The outlier in the third phase might be explained with the termination of the cooperation between Ballast Nedam Infra Noord West and Fehres. The evolvement of the level of ‘shared vision’ is presented in Figure 4.4.e.

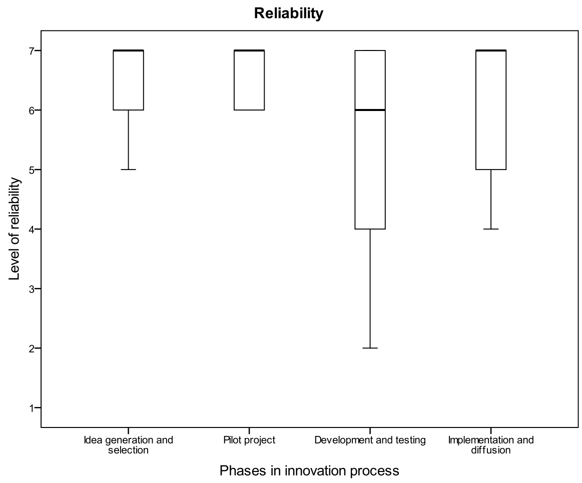
Enthusiasm
The item enthusiasm is in comparison with the other items not focused on the evolvement of the ties, but on the evolvement of the nodes. The rate of enthusiasm remains during the entire innovation high, although during the third phase the enthusiasm is slightly higher. A possible explanation for the small increase on this item is recognition of the possibilities to develop a prefabricated children’s pool and the actual development of it. The evolvement of the item ‘enthusiasm’ is shown in Figure 4.4.f.



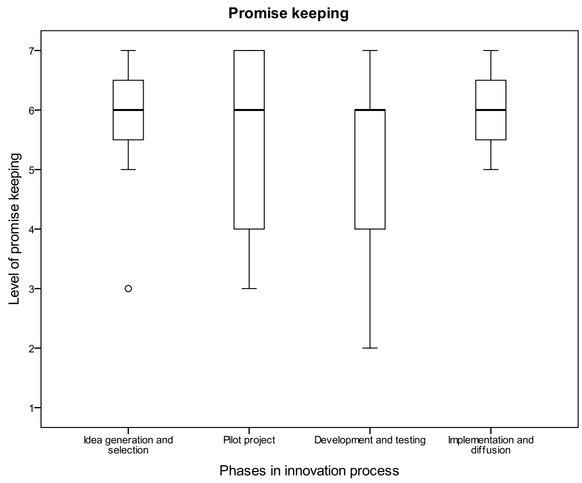
a. Frequency of interaction



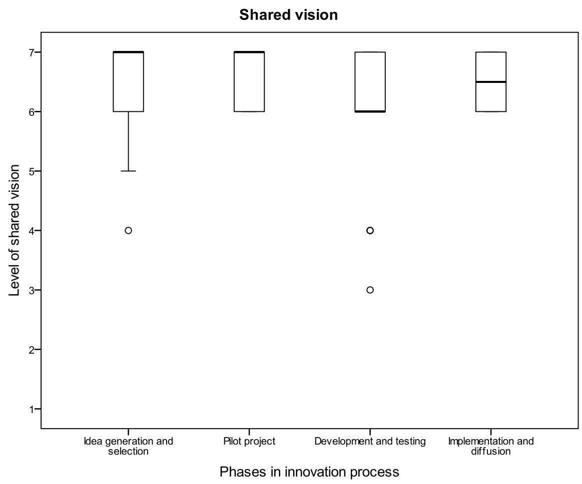
b. Close relationship



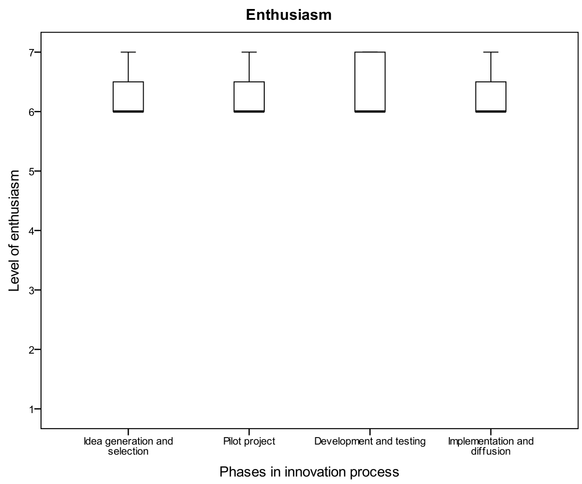
c. Reliability



d. Promise keeping



e. Shared vision



f. Enthusiasm

Figure 4.4: Network evolvement in the innovation process of Duurzaam Speelbad

4.1.4 Conclusion within case analysis

The innovation Duurzaam Speelbad is a market-pull innovation, since the innovation is developed after a need was identified in the market. The innovation process of the Duurzaam Speelbad can be split up into two parts: the first part is the development of the prefabricated children's pool in cooperation with Fehres and Waco Lingen Beton and the second part is the development of the Duurzaam Speelbad in cooperation with Van Dorp Zwembaden and Waco Lingen Beton.

The innovation scores on the technical performance are better than expected and also the quality of innovation is assessed to be better than the objective. However, the innovation is in the middle of its adoption and diffusion process and is not yet a commercial success, although the respondents are satisfied with the technical design and the functional performance. Nevertheless, the innovation project took more time than expected and also the involved costs are higher compared to the estimated costs.

The innovation project starts with high scores for the network characteristics in the first phase. In the second phase the levels are even higher, expect for the characteristic promise keeping. There is a decrease for five of the six network characteristics in the third phase. Only the characteristic enthusiasm shows a small increase. In the fourth phase there is for the same five characteristic an increase noticed, while there is a small decline in the level of enthusiasm, although this item remained during the entire process high.

4.2 iQwoning®

In the individual case analysis of the innovation project iQwoning® first the project description is given and the innovation is described. The descriptions of the project and process are followed by an analysis of the innovation performance and the amount of knowledge about the innovation among the involved organizations. Subsequently the evolvement of the innovation network and the effect of the evolvement on the innovation performance are analyzed.

4.2.1 Innovation project

Project description

The iQwoning® is a modular housing concept and is an internal development of Ballast Nedam. The iQwoning® consists of 6 modules of concrete: 3 modules on the ground and 3 modules on the first floor. The models are first produced and furnished in the factory and subsequently the models are transported to the site. On the site the models are assembled and the details of the house are completed. The cross section of an iQwoning® is shown in Figure 4.5.

Figure 4.5: Cross section of the design of the iQwoning®

The iQwoning® is initially developed as a solution for the increasing scarcity of craftsmanship in the construction industry and the different weather conditions in the Netherlands during the year. Based on experiences in Denmark (covered construction site) and Canada (production of elements in factory) Ballast Nedam developed a solution that combines both experiences and offers a solution to the two problems in the construction industry that are mentioned above.

The pilot project of the iQwoning® is executed as part of the urban development project Berckelbosch in Eindhoven. After the project was successful executed the decision was made to continue the innovation process and to build a factory for the production of elements for the iQwoning®. After several successful project in which iQwoning's® were realized the next step in the innovation process was to extent the production line with a new type of iQwoning®.
The first models of the iQwoning® that were developed consist of modules that had a width of 5.40 meters and a depth of 3.00 or 3.40 meters, while the new type of iQwoning® consists of modules

that have a width of 6.30 meters and a depth of 3.30 meters. With this new type of iQwoning®, which is larger than the original, it was possible to approach new markets like the market for life-proof homes.

Innovation process

The innovation process of the iQwoning® started in 2008 and at the moment of research (June 2012) the innovation was still improved and diffused into the market. In Figure 4.6 the timeline of the innovation process is shown. As the timeline shows, the development and testing of this innovation and the diffusion of it are not completely in series as stated in the literature, instead there is an overlap between the two phases.

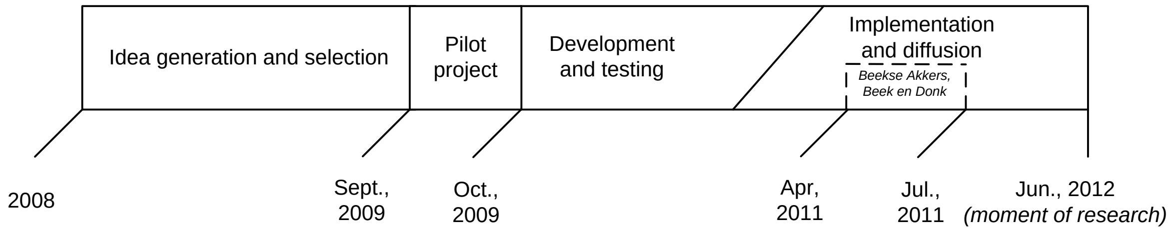


Figure 4.6: Timeline of the innovation project iQwoning®

Idea generation and selection

The innovation process started with the recognition of two problems: the increasing scarcity of craftsmanship in the construction industry and the problems with the different weather conditions in the Netherlands during the entire year. Two solutions for these problems were found abroad: in Canada the elements of houses were produced in factories and assembled on site which offered a solution to the scarcity of craftsmanship, while in Denmark buildings were constructed on a covered construction site.

With those two ideas in mind a project group was formed in 2008 to combine the solutions into one solution. The project group that consists of employees of different divisions of Ballast Nedam developed a modular housing concept. This modular housing concept consists of concrete elements that are produced in the factory and are assembled on the construction site.

Pilot project

The pilot project of the iQwoning® was executed in the period of September 2006 through October 2006 as part of the urban development project Berckelbosch in Eindhoven. The pilot project consisted of 5 iQwoning's® that were assembled on 5 different finish levels to show potential customers the structure of the iQwoning® and the opportunities.

During this stage the business model of the iQwoning® was designed and also the market for this concept was determined. In the pilot project was demonstrated that an iQwoning® within 6 weeks could be produced and assembled, which reduces the duration and nuisance compared to the building of regular houses. These advantages offered the opportunities to realize iQwoning's® in urban (re)development projects and therefore these types of projects are determined as the market of the iQwoning®.

Development and testing

In the development and testing phase Ballast Nedam has prepared itself for the next step in the innovation process, namely the production of iQwoning's® on a large scale. The first five iQwoning's® were produced in the factory of Hoco Beton, but for the production on a large scale a separate factory was necessary. This factory is built in Weert beside the factory of Hoco Beton and an entity was founded was to manage this factory.

Further there are changes implemented in the production process and improvements are made in the design of the iQwoning®. The changes in the production process are suggested by benchmarking the production process of the iQwoning to production processes of other companies and in other industries. Further an improvement was made regarding the product: the reinforcement of the concrete elements was improved.

Implementation and diffusion

After the pilot project in Eindhoven a factory was built for the production of the iQwoning® in Weert and an entity was founded to manage the production of it. From the moment the iQwoning® was implemented with some adjustments and further diffused into the market. At the moment of research 80 copies of the iQwoning® were realized of which 14 copies were realized in Beek en Donk which is the reference project in this case. For the near future more copies are on the schedule.

Major developments in this stage of the innovation process are changes in the organization regarding the commercialization of the iQwoning® and the introduction of a new type of iQwoning®, which has with a width of 6.30 meters a greater width than the original iQwoning® (width of 5.40 meters). With the introduction of a larger type Ballast Nedam is able to approach new market segments of the housing markets.

Involved organizations

In the Table 4.4 the involved organizations in the innovation process of iQwoning® per phase. During the entire innovation project only internal companies were involved in the development of the iQwoning. Only at the end of the innovation process in the implementation and diffusion phase an external party is involved, but as a client.

The innovation process started with a small project group that consisted of representatives of the 4 divisions of Ballast Nedam: Ballast Nedam Bouw & Ontwikkeling - Bouwtechniek, Ballast Nedam Engineering, Ballast Nedam Research & Development and Hoco Beton. In the next phase of the process, the pilot project, the division Ballast Nedam Bouw & Ontwikkeling Zuid became involved as the developer of the urban development project Berckelbosch, which became the location for the pilot project.

In the third phase of the process, which is the development and testing phase, IQ Woning B.V. was founded that had to manage the production process of the iQwoning® and also the further development of the innovation. Together with the divisions West and Zuid of Ballast Nedam Bouw & Ontwikkeling, Hoco Beton and Ballast Nedam Engineering the product is further developed and prepared to be implemented into the market.

In the last phase of the process IQ Woning B.V. operates more as a supplier of semi-finished products, which are the modules of concrete, while the regions of Ballast Nedam are responsible for the commercialization of the innovation. In the table also the region Ballast Nedam Bouw & Ontwikkeling Zuid is named separately, because of their involvement in the project Beekse Akkers.

Table 4.4: Involved organizations in the innovation project iQwoning®

Type of organization	Idea generation and selection	Pilot project	Development and testing	Implementation and diffusion
Division Ballast Nedam	▪ BN Bouw & Ontwikkeling - Bouwtechniek ▪ BN Engineering ▪ BN Research & Development ▪ Hoco Beton	▪ BN Bouw & Ontwikkeling – Bouwtechniek ▪ BN Bouw & Ontwikkeling Zuid ▪ BN Engineering ▪ BN Research & Development ▪ Hoco Beton	▪ IQ Woning B.V. ▪ BN Engineering ▪ BN Bouw & Ontwikkeling West ▪ BN Bouw & Ontwikkeling Zuid ▪ Hoco Beton	▪ IQ Woning B.V. ▪ BN Bouw & Ontwikkeling Zuid[1] ▪ (Regions of BN Bouw & Ontwikkeling)[2]
Competitor (constructor)				
Complementary firm				
Supplier				
Client				▪ Woningbouw-vereniging Bergopwaarts[1]
Academia				
Government				

[1] Both parties are highlighted because of their involvement in the project Beekse Akkers
[2] The regions are only involved in the diffusion of the innovation; they were not involved in the project Beekse Akkers

4.2.2 Innovation performance

The performance of the innovation project is measured using four measurements: technical performance, project performance, market performance and satisfaction. The theses of the first three types of measurements are answered by 5 persons that were involved in the third phase (development and testing) and the latter measurement is answered by 5 persons that were either involved in the third phase or the fourth phase of the innovation process. Extreme outliers regarding the project performance, market performance and satisfaction were detected, which were all derived from one respondent. Because of the relative high impact on the results due to the small number of respondents these extreme outliers are eliminated. The descriptive statics are shown in Table 4.5 and the distributions of the items are presented by making use of boxplots. The boxplots are shown in Figure 4.7.

Table 4.5: Innovation performance of the innovation iQwoning®

Category	Variable	Mean	s.d.	N
Technical performance	Product	4,60	1,140	5
	Own components	3,00	.	1
	Components of others	4,33	0,707	9
	Own interfaces	3,00	.	1
	Interfaces of others	4,56	1,130	9
Project performance	Quality objective	4,75	1,258	4
	Cost objective	3,00	0,816	4
	Time objective	4,00	1,414	4
Market performance	Success of implementation	5,00	1,155	4
	Commercial success	5,25	0,500	4
	Influence on sales	4,00	0,000	4
Satisfaction	Technical design	6,00	0,816	4
	Functional performance	5,75	0,500	4

Technical performance

The technical performance of the innovation is measured on three levels: the system, the components and the interfaces. Regarding the components and the interfaces the distinction is made how the persons have assessed the technical performance of the components and interfaces for which they were responsible and the components and interfaces of which other parties were responsible for. The variation of the items that measured the technical performance is shown in Figure 4.7.a.

The technical performance of the entire product is on average slightly better than expected, although the scores vary between slightly worse than expected and better than expected. A remarkable outcome regarding the technical performance is that components and interfaces are judged better by others than by the persons who are responsible for the components or interfaces. In the boxplot two extreme outliers are identified. However, these values are marked as extreme outliers due to fact that there is no variance expect for these outliers. Regarding the interfaces of which others are responsible an outlier is identified, but this outlier is within a range of three times the interquartile range.

Project performance

The project performance of the innovation project is measured using three items: the quality objective regarding the innovation, the costs objective of the innovation project and the time objective of the project. The scores of the project performance are shown in Figure 4.7.b.

The quality of the innovation is on average determined to be slightly better, compared to the quality objective. However, there is a wide variance in the scores, which indicates different opinions about the quality of the innovation. There were further more costs involved in the innovation project than was expected. The highest measured value is that the project meets the cost objective, while the other values state that more costs were involved than expected. Regarding the time objective the opinions differ, but overall the innovation project is on time.

Market performance

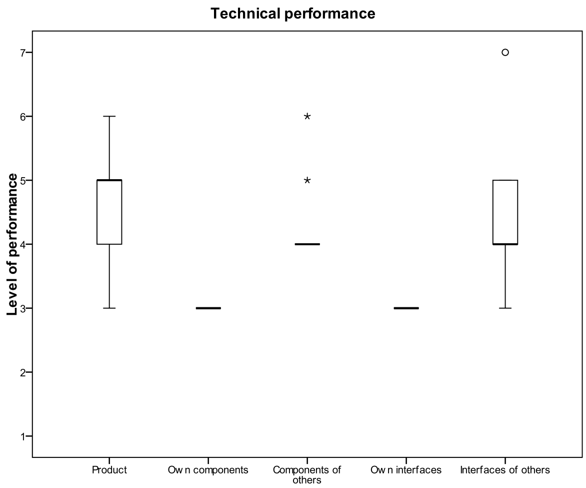
The market performance of the innovation project is measured using three items: the success of implementation, the commercial success and the influence on the firms' sales. The market performance is presented in Figure 4.7.c.

The implementation of the innovation and the commercial success of the innovation are according to the respondents on average slightly better than expected. For both items there are even respondents that state that the innovation scores on these items better than expected. Regarding the influence on the sales all the respondents state that the influence is exactly as expected.

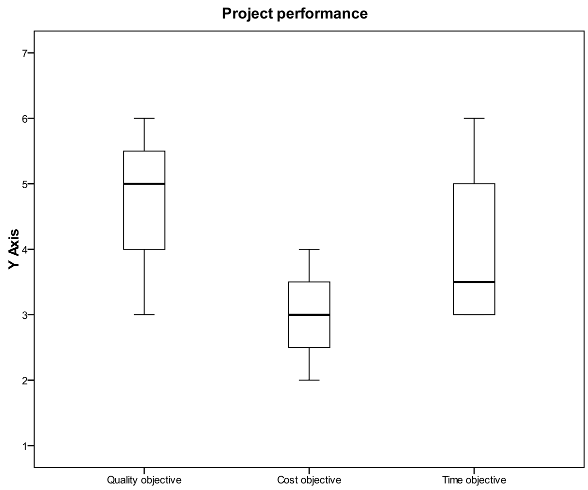
Satisfaction

The satisfaction about the innovation is measured using two items: the satisfaction about the technical design of the innovation and about the functional performance of the innovation. The rate of satisfaction is shown in Figure 4.7.d.

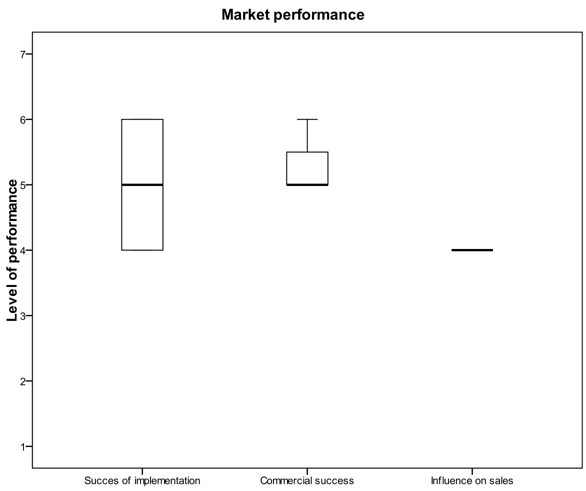
The respondents assess the satisfaction of the innovation on both items high, which indicates that the innovation scores on both the technical design and the functional performance better than expected. There is even a respondent who assess the technical design of the innovation far better than expected.



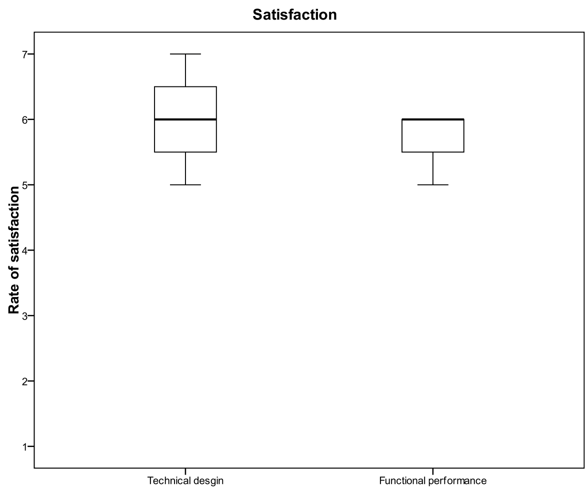
a. Technical performance



b. Project performance



c. Market performance



d. Satisfaction

Figure 4.7: Box plots of the innovation performance of the reference project (iQwoning's® in Beek en Donk)

The technical performance, project performance and market performance are assessed by respondents that were involved in the 3rd phase of the innovation process, while the satisfaction is assessed by respondents that were involved in the 3rd or 4th phase of the innovation process.

4.2.3 Network evolvement

The network evolvement is measured on the basis of a combination of three network embeddedness and six items: structural embeddedness (items: frequency of interaction and close relationship), relational embeddedness (items: reliability and promise keeping) and cognitive embeddedness (items: shared vision and enthusiasm). The first five items measure the evolvement of the ties, while the latter item (enthusiasm) measures the evolvement of the nodes. The means of the evolvement of the items are shown in Table 4.6 and the distributions of the items are presented by making use of boxplots. The boxplots are shown in Figure 4.8.

Table 4.6: Means of the evolvement per item per phase of the innovation process of iQwoning®

	Phases in innovation process			
	Idea generation and selection	*Pilot project*	*Development and testing*	*Implementation and diffusion*
Frequency of interaction	5.56	5.50	5.75	6.00
Close relationship	5.33	5.13	5.62	6.50
Reliability	5.89	5.25	5.38	6.50
Promise keeping	5.56	5.38	5.29	5.00
Shared vision	4.89	4.63	5.13	5.00
Enthusiasm	7.00	7.00	6.00	6.00

Frequency of interaction

The frequency of interaction is during the entire process almost the same if the means are compared. However, if the distributions for the four phases are compared some differences can be noticed. For the first three phases half of the values for the frequency of interaction have a score of 7. However, for the other half of the values the scores vary between 2 and 6. For the last phase, the implementation and diffusion phase, the frequency of interaction is scored 6. An explanation for this score is that, although only three parties are involved, there was only one respondent for this phase. The evolvement of the frequency of interaction is shown in Figure 4.7.a.

Close relationship

The average scores of the close relationship vary between the phases. In the second phase, the pilot project, the average score for this item is the lowest. In the last phase the close relationship scores the highest. An explanation for this score is small number of organizations that were involved in this phase, namely IQ Woning B.V., Ballast Nedam Bouw & Ontwikkeling and the client. Also the distributions of this item for the four phases shows that in the second phase the close relationship is the lowest and that the scores of the first and third phase are almost the same. The evolvement of the closeness in the relationship is presented in Figure 4.7.b.

Reliability

The reliability is relative high in the first and last phase and relative low in the second and third phase. In the first phase the reliability is high, but an outlier affects the average score of this item in the first phase. During the pilot project the score for the reliability drops, which is shown in the average score and the distribution of the values for this item. In the next phase, the development and testing phase, the average score increases slightly, but the variance remains almost the same. In the implementation and diffusion phase the reliability rises to a high level. The evolvement of the reliability is presented in Figure 4.7.c.

Promise keeping

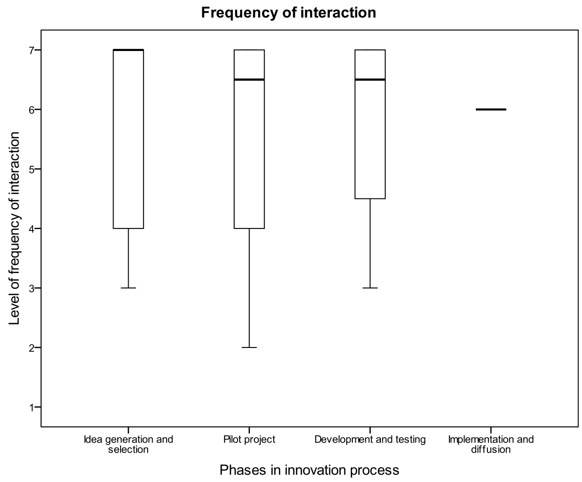
A wide variance regarding the item promise keeping can be noticed for all the four phases, although the variance is the slightest for the first phase. Although the average score remains almost the same for the four phases, if the means are compared there is continuous decrease noticeable during the entire process. The variance is the smallest during the pilot project, but due to extreme low scores in this phase the average is slightly lower. The evolvement of the rate of 'promise keeping' is presented in Figure 4.7.d

Shared vision

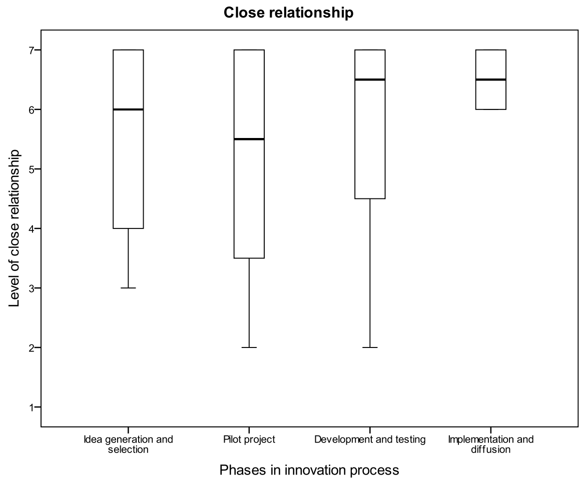
During the entire process the level of shared vision remains high, but this level is relatively low if considered the iQwoning® is an internal development. A striking fact is the large variance in the shared vision in the first and third phase, which can be described as internal-oriented phases, since in the first phase the iQwoning® is developed and in the third phase the organization is prepared to enter the market with the iQwoning®. In the second phase, the pilot project, an outlier is detected, but there was no reason to eliminate this outlier. However, the outlier affects the average score on this item in the second phase. The evolvement of the level of 'shared vision' is presented in Figure 4.7.e.

Enthusiasm

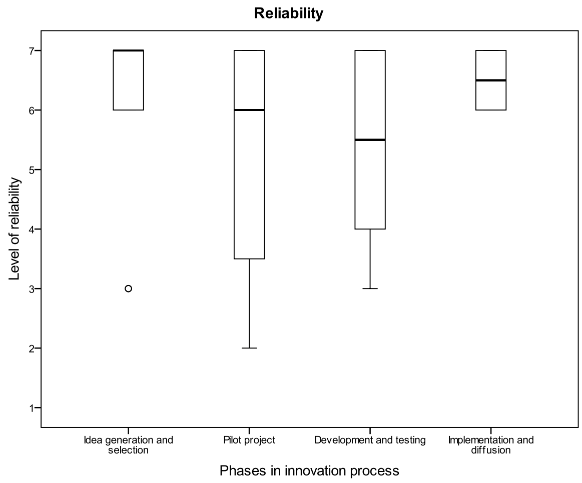
The item enthusiasm is in comparison with the other items not focused on the evolvement of the ties, but on the evolvement of the nodes. The rate of enthusiasm remains during the entire innovation high, although during the first and second phase the enthusiasm is slightly higher. A possible explanation for the small decrease on this item is the reduction of the novelty. The evolvement of the item 'enthusiasm' is shown in Figure 4.7.f.



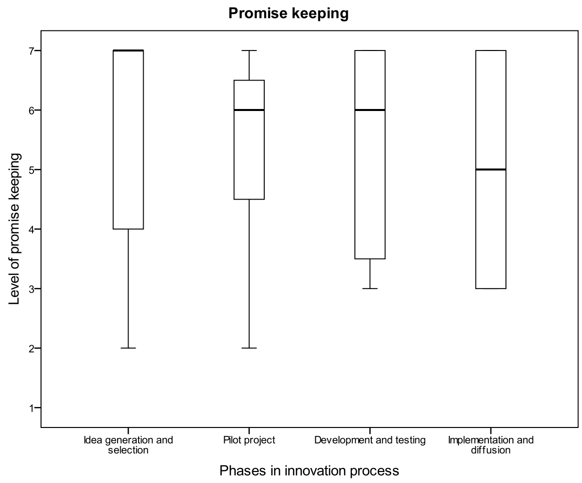
a. Frequency of interaction



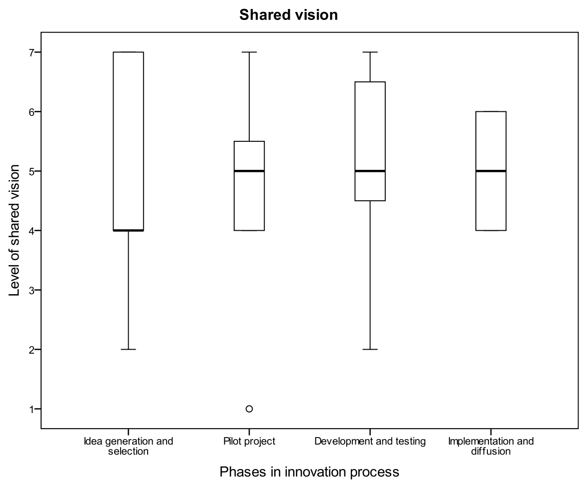
b. Close relationship



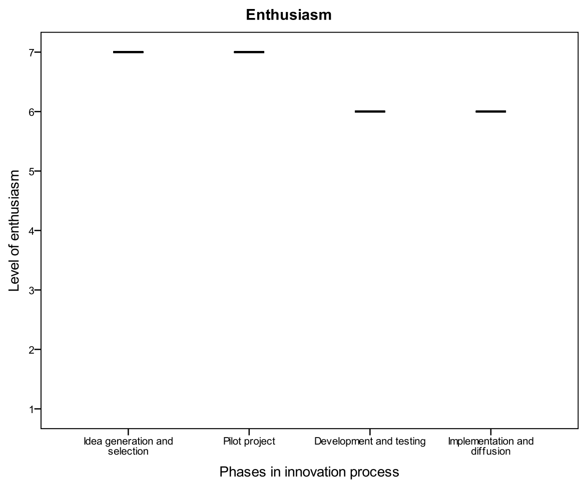
c. Reliability



d. Promise keeping



e. Shared vision



f. Enthusiasm

Figure 4.8: Network evolvement in the innovation process of iQwoning®

4.2.4 Conclusion within-case analysis

The innovation iQwoning® is a technology-push innovation, because opportunities are identified in the technologies and based on these opportunities a need in the market is identified. The project iQwoning® is an innovation project that is internal completed, which means that only subsidiaries of Ballast Nedam are involved in the development of the innovation.

The innovation scores on the technical performance are better than expected, although some respondents assessed their own input slightly worse than expected. The overall result is nevertheless better than expected. Regarding the market performance the innovation was successful implemented and is described as a commercial success. Further, the innovation met the expectations regarding the innovation's impact on sales and scored high with respect to the satisfaction about the technical design and the functional performance. The costs of the innovation project were higher than the estimated costs, but the respondents stated that the innovation project was developed within the time that was planned.

The innovation project starts with medium-high score for the network characteristics in the first phase with an exception for the level of enthusiasm that has a maximum score. In the second phase there is a small descrease noticed, except for the level of enthusiasm that remains the same. In the third phase there is small increase for four characteristics. In case of the item promise keeping there is a small decrease noticed and for the enthusiasm there is a decline of one point. For the fourth phase there is an increase for three characteristics, a small decrease for two items and the characteristic enthusiasm remains the same.

4.3 ModuPark®

In the individual case analysis of the innovation project ModuPark® first the project description is given and the innovation is described. The descriptions of the project and process are followed by an analysis of the innovation performance and the amount of knowledge about the innovation among the involved organizations. Subsequently the evolvement of the innovation network and the effect of the evolvement on the innovation performance are analyzed.

4.3.1 Innovation project

Project description

ModuPark® is a modular car park and is a development of Ballast Nedam Parking, Grontmij Parkconsult and Oostingh Staalbouw. The system of ModuPark® is composed of prefabricated elements: concrete panels and steel components. The standard design of the ModuPark® consists of 4 parking decks, a ramp and a staircase. The construction of an elevator is a feature in the design. A drawing of the ModuPark® car park is shown in Figure 4.9.

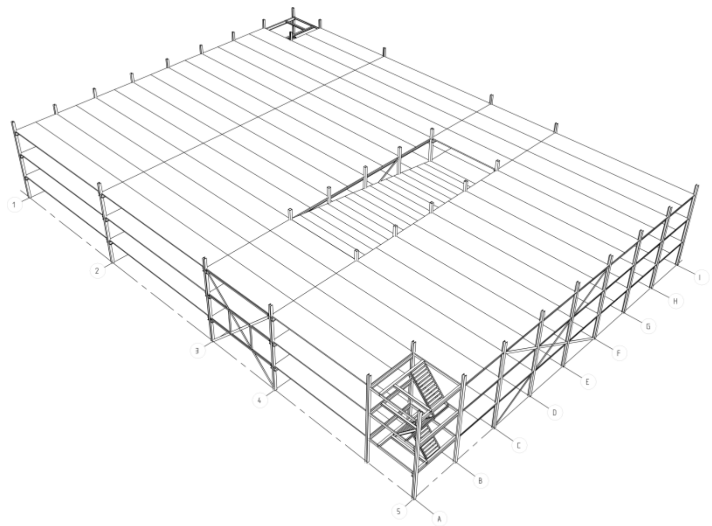


Figure 4.9: Drawing of of the ModuPark® car park

ModuPark® can be used as a temporary car park to create substitutional parking area during a (re)development project, although it is also possible to use ModuPark® as a permanent car park. Since a ModuPark® car park is demountable the materials can be reused at a new location if the development project has ended or when the presence of a ModuPark® car park is not necessary anymore.

The concept of ModuPark® offers various advantages regarding to the costs and the construction time. The standardized components that are used in the concept of ModuPark® are manufactured in series, which results in lower production costs. Further the design of ModuPark® is modular with the result that the construction time is shorter and the construction costs are lower in comparison with the construction of traditional car parks.

Innovation process

The innovation process of the ModuPark® car park started in November 2004 and at the moment of research (June 2012) the innovation was still improved and diffused into the market. In Figure 4.10 the timeline of the innovation process is shown. In contrast with the literature regarding innovation processes the development and testing of this innovation and the diffusion of it are not in series as stated in the literature, instead these phases run in parallel.

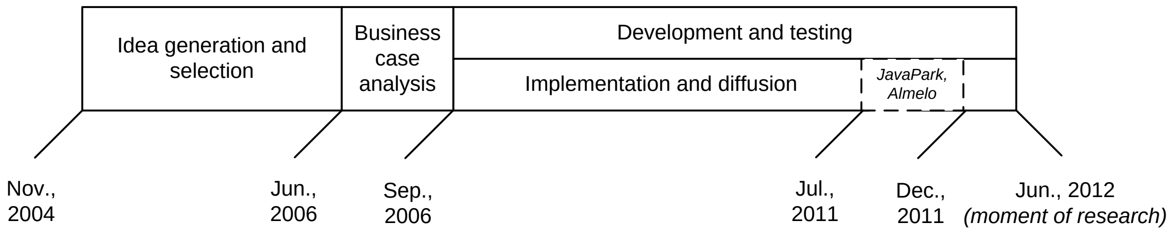


Figure 4.10: Timeline of the innovation project ModuPark®

Idea generation and selection

In 2004 Ballast Nedam Infra Projecten detected a business opportunity in the field of temporary parking. Urban (re)development projects and events that last several weeks or even months faced problems with their parking facilities since in 2004 there were no solutions for temporary parking problems. At the same time Grontmij Parkconsult contacted Ballast Nedam Infra Projecten for collaboration in the field of temporary parking. Subsequently ParkMasters joined this collaboration and together the organizations developed the concept of a modular car park.

The concept is then translated into a design that offers a solution for the parking problems in urban (re)development projects. The design was not applicable for the parking problems of the events, since the construction and the breaking off of the car park would take too long to be profitable. Therefore the collaboration of the three organizations decided to focus first on the parking problems in urban (re)development projects.

Pilot project

The pilot project of the innovation ModuPark® is the realisation of the car park Noordschebos in Zaandam. The municipality of Zaanstad was confronted with a temporary parking problem of almost 3 years due to an extensive urban redevelopment project in the inner city of Zaandam. In the period of June 2006 through August 2006 a modular car park with 3 parking decks was built and from September 2006 till December 2009 this car park was operational. In the spring of 2010 the car park was dismantled and afterwards it is rebuilt in Almelo.

In this stage of the process the department Ballast Nedam Parking was founded. The department Ballast Nedam Parking was 50% part of Ballast Nedam Infra and 50% part of Ballast Nedam Bouw & Ontwikkeling. In practice this partition meant that Ballast Nedam Infra was responsible for the underground car parks, while Ballast Nedam Bouw & Ontwikkeling was responsible for the other car parks.

Development and testing

In the development and testing phase the design of the ModuPark® car park is improved based upon the experience with the ModuPark® car park in Zaandam and later in the process improvements are also based upon experiences with other ModuPark® car parks. Major improvements during this stage of the innovation process are the expansion of the car park design to a 4-deck car park by adding a fourth parking deck, the improvement of the temporary fastening of the concrete elements and the improvement of the lateral load distribution.

Besides the improvements in the design in this phase of the innovation process also the entity ModuPark v.o.f. founded. ModuPark v.o.f. is a general partnership between the entity Ballast Nedam Parking and Oostingh Staalbouw. This general partnership was founded to share the risks and to improve the involvement of the two organizations in the development and implementation of the ModuPark® concept.

Implementation and diffusion

In total 8 ModuPark® car parks are produced and these car parks are used in 10 projects, which indicates that in 2 projects a ModuPark® car park is reused. This was also the case in the reference project JavaPark in Almelo. The JavaPark car park in Almelo was opened in January 2012, but before this ModuPark® car park was built in Almelo, the same ModuPark® car park was used in Zaandam. The Noordschebos car park, which was at that time the name of the car park, was used between September 2006 and December 2009. In 2010 the Noordschebos car park was dismantled and it was temporarily stored before it was rebuilt in Almelo.

The municipality of Almelo announced at the end of 2009 that there was a plan to build a car park with a capacity of 350 parking lots in the vicinity of the station. At that time the former Noorschebos car park, which had a capacity of 360 parking lots, was already stored and for fun this car park was placed on marktplaats.nl. However, Grontmij Parkconsult approached the municipality in 2010 with the offer to rebuild this car park in Almelo, since this car park had the necessity capacity and the costs would be lower compared to a normal car park, since the car park would be rented instead of be purchased.

At the start of the innovation process, which was in 2004, municipalities and hospitals were identified as potential customers of the innovation, since these types of customers are the principals in urban (re)development projects. In this stage of the process two other type of customers are identified: project developers and investors. Project developers and investors are also often the principals of urban development projects and therefore also the owner of the corresponding parking problems. However, these two types of principals are identified quietly late in the innovation process as potential customers.

Involved organizations

In the Table 4.7 the involved organizations in the innovation process of ModuPark® per phase. The innovation process started with the three organizations Ballast Nedam Infra Projecten, Grontmij Parkconsult and ParkMasters that developed the concept of ModuPark®. Ballast Nedam Engineering and Haitsma are consulted for the design of the ModuPark®.

In the next phase of the innovation process, the pilot project, Oostingh Staalbouw and Smit Elektra became involved as suppliers of respectively the steel construction and the electric installation. The municipality of Zaandstad is in this phase of the innovation process involved as client and also as government in case of legislation.

In the development and testing phase and the implementation and diffusion phase nearly the same organizations are involved, except for the municipality of Almelo that only is involved in the implementation and diffusion phase because of the realisation of the ModuPark® car park in Almelo. In contrast with the pilot project Spiering Installatietechniek became the preferred supplier regarding the electric installation in the ModuPark® car parks.

Table 4.7: Involved organizations in the innovation project ModuPark®

Type of organization	Idea generation and selection	Pilot project	Development and testing	Implementation and diffusion
Division Ballast Nedam	BN Engineering BN Infra Projecten Haitsma	BN Engineering BN Parking Haitsma	BN Parking Haitsma	BN Parking Haitsma
Competitor (constructor)				
Complementary firm	Grontmij Parkconsult ParkMasters	Grontmij Parkconsult ParkMasters	Grontmij Parkconsult	Grontmij Parkconsult
Supplier		Oostingh Staalbouw Smit Elektra	Oostingh Staalbouw Spiering Installatie-techniek	Oostingh Staalbouw Spiering Installatie-techniek
Client		Municipality of Zaandstad		Municipality of Almelo
Academia				
Government		Municipality of Zaandstad		Municipality of Almelo

4.3.2 Innovation performance

The performance of the innovation project is measured using four measurements: technical performance, project performance, market performance and satisfaction. The theses of the first three types of measurements are answered by 6 persons that were involved in the third phase (development and testing) and the latter measurement is answered by 6 persons that were either involved in the third phase or the fourth phase of the innovation process.

Table 4.8: Innovation performance of the innovation iQwoning®

Category	Variable	Mean	s.d.	N
Technical performance	Product	3,50	0,548	6
	Own components	4,17	0,983	6
	Components of others	3,50	0,632	16
	Own interfaces	3,00	0,632	6
	Interfaces of others	3,65	0,606	17
Project performance	Quality objective	3,67	1,366	6
	Cost objective	3,33	1,506	6
	Time objective	3,17	0,983	6
Market performance	Success of implementation	4,67	1,751	6
	Commercial success	4,50	1,049	6
	Influence on sales	4,17	0,753	6
Satisfaction	Technical design	4,17	1,602	6
	Functional performance	5,17	0,983	6

Technical performance
The technical performance of the innovation is measured on three levels: the system, the components and the interfaces. Regarding the components and the interfaces the distinction is made how the persons have assessed the technical performance of the components and interfaces for which they were responsible and the components and interfaces of which other parties were responsible for. The scores of the technical performance of the innovation are shown in Figure 4.11.a.

The technical performance of the entire system is judged to be at some extent worse than expectations. The parties that were responsible for components assess the performance of the components to some extent better than expected. This is in contrast with the judgements of other parties, since they state that the performances of the elements are somewhat worse than expected. The interfaces of are estimated to be a little bit worse than expected, both by the owners of the interfaces as by the non-responsible parties.

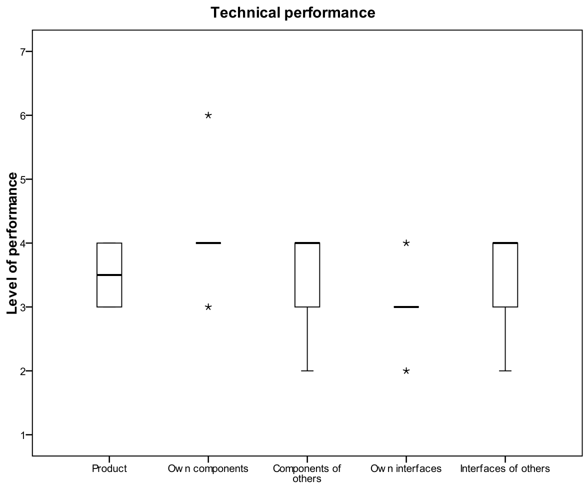
Project performance
The project performance of the innovation project is measured using three items: the quality objective regarding the innovation, the costs objective of the innovation project and the time objective of the project. The scores of the project performance are shown in Figure 4.11.b. The quality of the innovation is to some extent less than the objective, although an outlier shows that the quality of the innovation is also estimated to be better than expected. Regarding the costs objective and the time objective the innovation project scores worse than expected. There are more costs involved than expected and the innovation project took more time than expected.

Market performance
The market performance of the innovation project is measured using three items: the success of implementation, the commercial success and the influence on the firms’ sales. The market performance is presented in Figure 4.11.c. Both the implementation success of the innovation and

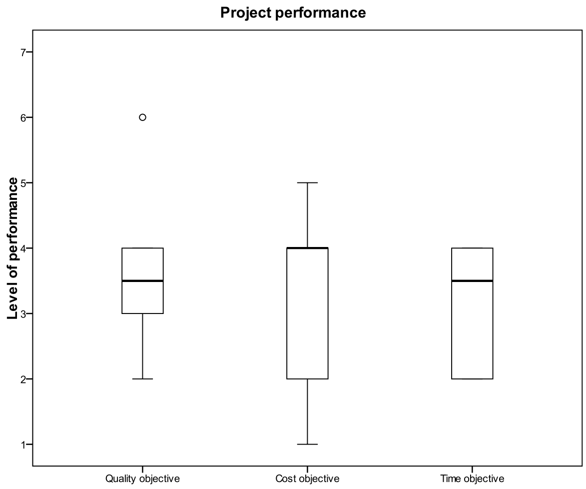
the commercial success of the innovation are slightly better than expected. The influence of the innovation on the firms' sales is to some extent better than expected, although the influence of the innovation on the sales is not for each firm better than expected.

Satisfaction

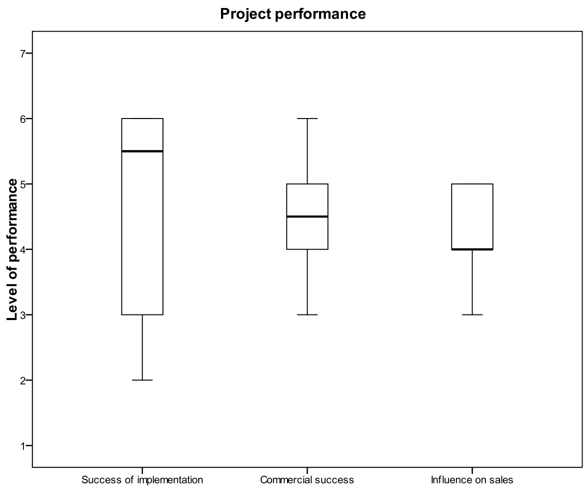
The satisfaction about the innovation is measured using two items: the satisfaction about the technical design of the innovation and about the functional performance of the innovation. The rate of satisfaction is shown in Figure 4.11.d. To some extent the respondents are satisfied with the technical design of innovation. This is in contrast to the functional performance of the innovation, which they were satisfied with.



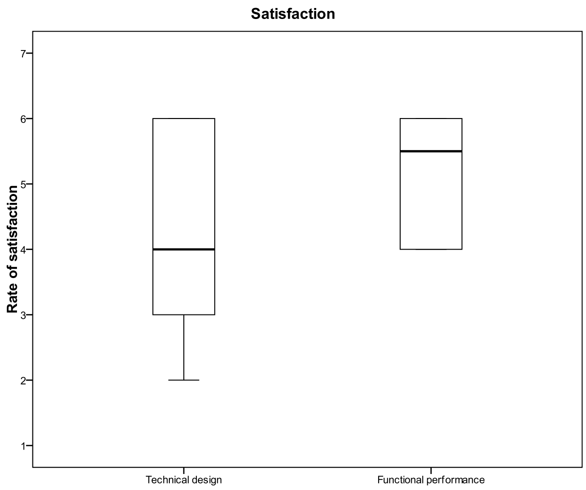
a. Technical performance



b. Project performance



c. Market performance



d. Satisfaction

Figure 4.11: Box plots of the innovation performance of the reference project (ModuPark® car park in Almelo)

The technical performance, project performance and market performance are assessed by respondents that were involved in the 3rd phase of the innovation process, while the satisfaction is assessed by respondents that were involved in the 3rd or 4th phase of the innovation process.

4.3.3 Network evolvement

The network evolvement is measured on the basis of a combination of three network embeddedness and six items: structural embeddedness (items: frequency of interaction and close relationship), relational embeddedness (items: reliability and promise keeping) and cognitive embeddedness (items: shared vision and enthusiasm). The first five items measure the evolvement of the ties, while the latter item (enthusiasm) measures the evolvement of the nodes. The means of the evolvement of the items are shown in Table 4.9 and the variation of the items is presented in Figure 4.12.

Table 4.9: Means of the evolvement per item per phase of the innovation process of ModuPark®

	Phases in innovation process			
	Idea generation and selection	*Pilot project*	*Development and testing*	*Implementation and diffusion*
Frequency of interaction	6.75	4.71	5.19	5.59
Close relationship	6.75	4.75	4.78	5.00
Reliability	7.00	5.21	4.81	5.35
Promise keeping	7.00	5.21	4.78	4.94
Shared vision	7.00	5.37	5.04	5.33
Enthusiasm	7.00	6.67	5.83	6.33

Frequency of interaction

The frequency of interaction is the highest in the first phase of the innovation project. In the next stage, the realisation of the first ModuPark® car park in Zaandam, the frequency of interaction is the lowest average in the entire innovation process. In the third phase of the process the frequency of interaction increases and in the fourth phase the frequency of interaction again increases slightly. The evolvement of the frequency of interaction is shown in Figure 4.12.a.

Close relationship

The closeness in the relationship is the highest during the idea generation and selection, the first phase of the innovation process. During the realisation of the pilot project in Zaandam the closeness in the relationship is the lowest in the entire process, similar to the frequency of contact. In the third phase, the further development of the innovation, the closeness in the relationship increases and in the fourth phase the closeness remains almost the same compared to the third phase. The evolvement of the closeness in the relationship is presented in Figure 4.12.b.

Reliability

The reliability among the involved organizations is the highest in the first phase. In the next phase the reliability decreases and there is even a lack of reliability with respect to one organization. In the following phase the reliability drops again, but in the fourth phase the reliability among the involved organizations increases somewhat. The evolvement of the closeness in the relationship is presented in Figure 4.12.c.

Promise keeping

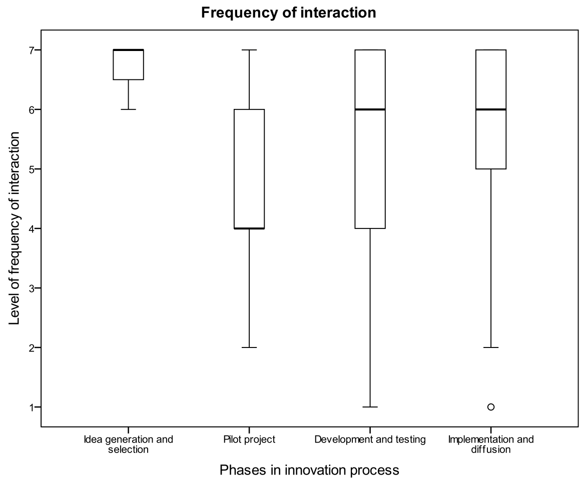
Promises between organizations are kept the most in the first phase, but the rate of promise keeping decreases during the pilot project. Nevertheless, the scores show that in most of the cases the promises are kept. In the third phase the rate of promise keeping drops again somewhat, although in more than three-quarter of the cases promises are kept. In the fourth phase the rate of promise keeping is increasing somewhat. The evolvement of the rate of ‘promise keeping’ is presented in Figure 4.12.d.

Shared vision

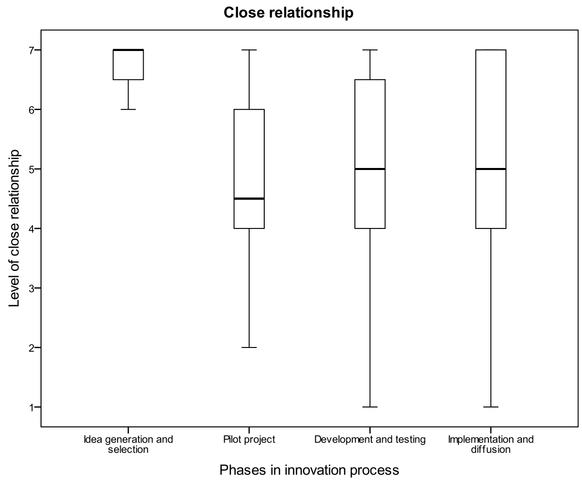
In the entire process the rate of shared vision is above average, although the highest rate of shared vision is in the beginning of the innovation project. During the realisation of the pilot project in Zaandam the rate of shared vision decreases and in the next stage, the further development of the innovation, the rate of shared vision remains the same, although there is a greater variation in the shared vision. The variation remains the same in the latest phase, but the average rate of shared vision increases.

Enthusiasm

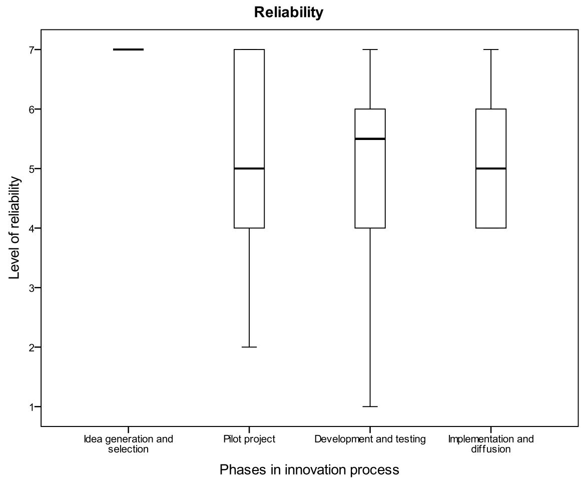
The item enthusiasm is in comparison with the other items not focused on the evolvement of the ties, but on the evolvement of the nodes. The rate of enthusiasm remains during the entire innovation high, although the first phase the rate of enthusiasm the highest. In the third phase there is a small drop in the rate of enthusiasm compared to the second phase. In the second and fourth phase of the innovation process the rate of enthusiasm remains high.



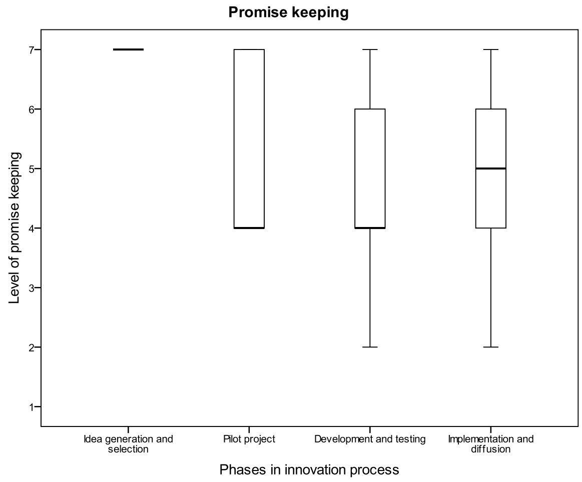
a. Frequency of interaction



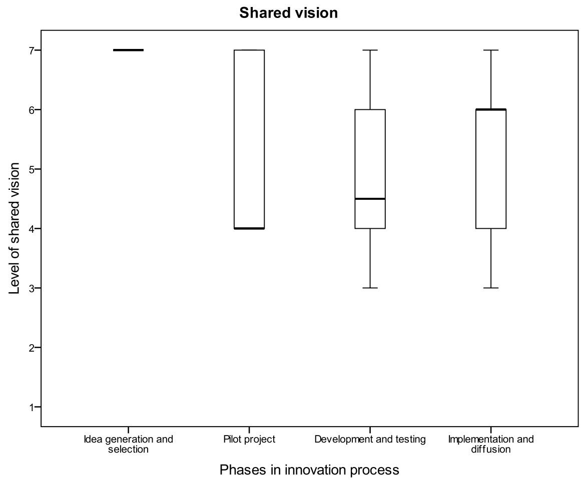
b. Close relationship



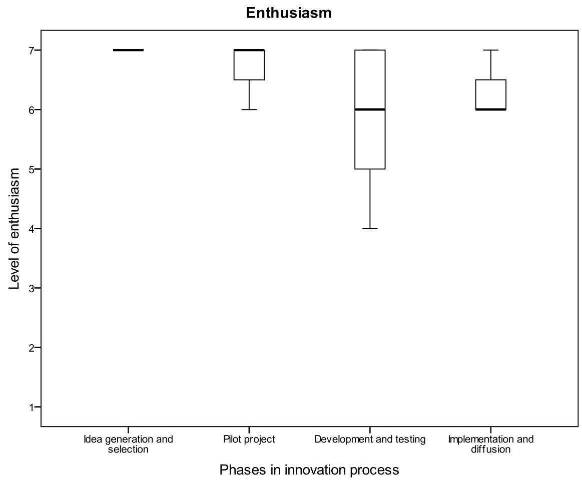
c. Reliability



d. Promise keeping



e. Shared vision



f. Enthusiasm

Figure 4.12: Network evolvement in the innovation process of ModuPark®

4.3.4 Conclusion within-case analysis

The innovation ModuPark® is a market-pull innovation, because Ballast Nedam identified an opportunity in the field of temporary parking and based on this identified opportunity the innovation ModuPark® was developed. Since the ModuPark® car park is a tempory car park a new business model is developed in which the ModuPark® car park is rented instead of sold to a customer.

The technical performance of the innovation is slightly worse than expected according to the respondents. This is also shown in the quality of the innovation, which is slightly worse than expected. However, the market performance of the innovation is slightly better than expected. The ModuPark® car park is successful implemented and is described as a commercial success that also has impact on the sales. However, the innovation satisfies not completey the satisfaction about the technical design and functional performance.

The innovation project starts with exteremly high scores for the network characteristics in the first phase with four items that have a maximum score. In the second phase there is a large descrease noticed, except for the level of enthusiasm for which a small decline is noticed. In the third phase there is a small increase for the characteristic frequency of interaction and the characteristic close relationship remains on a same level, but for the other four characteristics a decrease is noticed. In the fourth phase however there is an increase for all six network characteristics.

5 CROSS CASE ANALYSIS

In this chapter the cross-case analysis is performed to compare the three innovation projects Duurzaam Speelbad, iQwoning® and ModuPark® on the variables on which the cases are analyzed in the within-case analysis: the innovation performance and the network evolvement. Beside the comparison of the cases on these variables, the effect of the network evolvement on the innovation performance in the three cases is also compared. In this chapter the data is only analyzed and presented. The discussion about the results of the cross-case analysis is conducted in the next chapter.

5.1 Innovation performance

The innovation performance of the three innovation projects is measured on four types of performance: the technical performance, the project performance, the market performance and the satisfaction. In the with-in case analyses the technical performance is measured for the product, the components and the interfaces. In the cross-case analysis the innovation projects are compared on the product level, therefore only the technical performance of the three products are compared. In Table 5.1 the means on the four types of performance are presented and Figure 5.1 shows the distributions of these items. The results will be discussed per item.

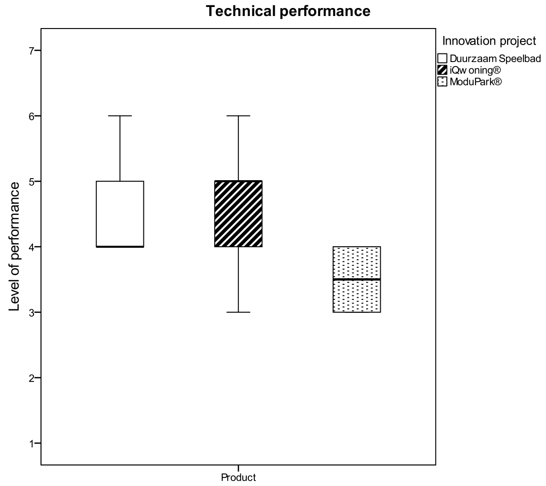
Table 5.1: Innovation performance of the three innovation projects

Innovation performance	Variable	Innovation project		
		Duurzaam Speelbad	iQwoning®	ModuPark®
Technical performance	Product	4.60	4.60	3.50
Project performance	Quality objective	5.00	4.75	3.67
	Cost objective	2.80	3.00	3.33
	Time objective	3.60	4.00	3.17
Market performance	Succes of implementation	5.20	5.00	4.67
	Commercial success	3.50	5.25	4.50
	Influence on sales	3.00	4.00	4.17
Satisfaction	Technical desgin	5.80	6.00	4.17
	Functional performance	6.00	5.75	5.17

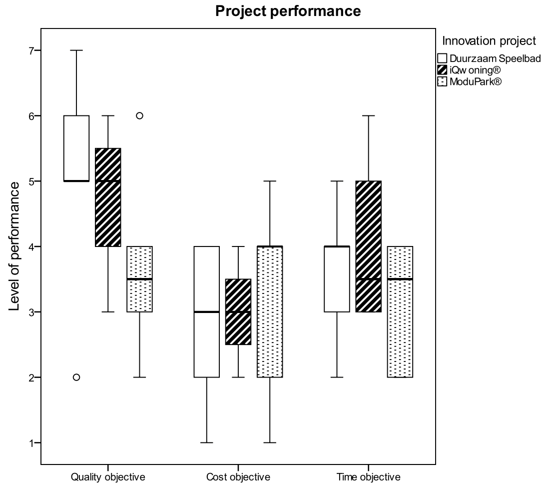
To compare the three innovation projects the means can be used, however for this cross-case analysis the scores are classified by making use of a classification system that consists of five components. The classification that is used is shown in Table 5.2. This classification is applied to the scores of the three innovation projects and is presented in Table 5.3. Only in cases of outliers an exception is with respect below classification. These exceptions will be marked in Table 5.3.

Table 5.2: Classification of innovation performance

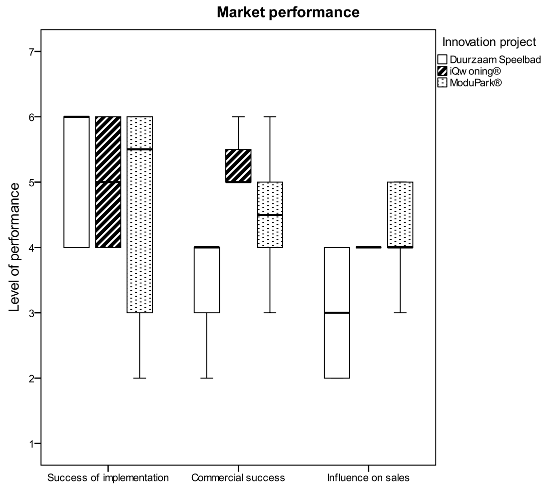
Score	1.00 – 2.20	2.21 – 3.40	3.41 – 4.60	4.61 – 5.80	5.81 – 7.00
Classification	Very low	Low	Moderate	High	Very high



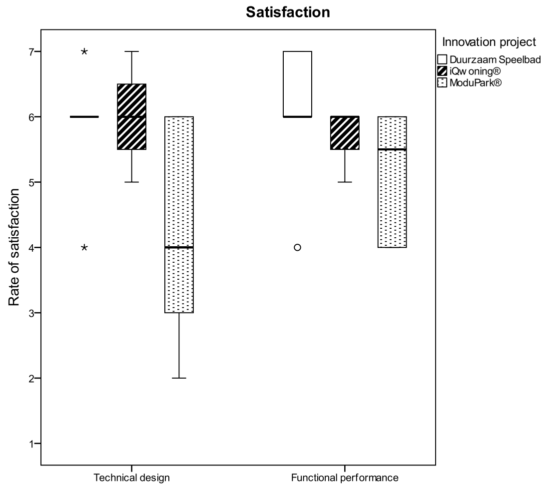
a. Technical performance



b. Project performance



c. Market performance



d. Satisfaction

Figure 5.1: Box plots of the innovation performance of the three innovation projects

The technical performance, project performance and market performance are assessed by respondents that were involved in the 3rd phase of the innovation process, while the satisfaction is assessed by respondents that were involved in the 3rd or 4th phase of the innovation process.

Table 5.3: Classification of the innovation performance of the three innovation project

Innovation performance	Variable	Innovation project		
		Duurzaam Speelbad	iQwoning®	ModuPark®
Technical performance	Product	M	M	M
Project performance	Quality objective	H	M	M
	Cost objective	L	L	L
	Time objective	M	M	L
Market performance	Succes of implementation	H	H	H
	Commercial success	M	H	H[1]
	Influence on sales	L	M	M
Satisfaction	Technical desgin	VH[2]	VH	M
	Functional performance	VH	H	H

[1] Adjusted from 'moderate' to 'high'

[2] Adjusted from 'high' to 'very high'

Same classification on 2 cases (light grey)
Same classification on 3 cases (dark grey)

1.00 – 2.20	2.21 – 3.40	3.41 – 4.60	4.61 – 5.80	5.81 – 7.00
Very Low (VL)	Low (L)	Moderate (M)	High (H)	Very High (VH)

5.1.1 Technical performance

The three innovation projects have the same classification for the technical performance of the product, namely moderate (see Table 5.3). However, if the means and the distributions of the three projects on this item are compared a difference is noticed between on one hand the projects Duurzaam Speelbad and iQwoning® and on the other hand the project ModuPark®. The first two projects are on the upper site of the classification, while the project ModuPark is on the downside of this classification. Nevertheless, this classification is justified, because for all of the three projects half of the values are within the range that is used for the classification of moderate.

5.1.2 Project performance

Regarding the quality objective the innovation projects iQwoning® and ModuPark® score moderate, while the project Duurzaam Speelbad scores high on this item. If the means and the distributions of this item for the three projects are compared this classification is justified, although the means of Duurzaam Speelbad and iQwoning® are in close proximity. However, the mean for Duurzaam Speelbad is affected by an outlier.

The innovation projects have all three the classification low for the performance regarding the cost objective. Also the means of the three projects are in close proximity. Only regarding the distributions differences are noticed. The distribution of the iQwoning® on this item is smaller than the distributions of the other two projects.

With respect to the time objective the innovation projects Duurzaam Speelbad and iQwoning® score the classification moderate, while the innovation project ModuPark® is classified as low. Although the means of Duurzaam Speelbad and ModuPark® on this item are in close proximity, Figure 5.1

shows nevertheless that the median of Duurzaam Speelbad is also higher compared to the median of ModuPark®.

5.1.3 Market performance

All three innovation projects score high regarding the success of implementation of the innovation. Also the means are in close proximity and the distribution of the three innovation projects are almost the same.

Regarding the commercial success of the innovation there is a large difference noticeable between the innovation Duurzaam Speelbad and the other two innovations. The innovation Duurzaam Speelbad scores moderate on this item, while the innovations iQwoning® and ModuPark® score high on this item. Also in the means and the distribution this difference is noticeable. To emphasize the difference between on one hand the innovation Duurzaam Speelbad and on the other hand the innovations iQwoning® and ModuPark® other classification should be used. However, based on the scores of the separate innovations there is no motive to change the classification.

Also on the influence on the sales the innovations iQwoning® and ModuPark® score better than the innovation Duurzaam Speelbad, respectively moderate and low. This difference is also noticed in the means and the distributions on this item.

5.1.4 Satisfaction

Regarding the satisfaction about the technical design the innovation projects Duurzaam Speelbad and iQwoning® score very high, while the innovation ModuPark® scores high. The classification of Duurzaam Speelbad is adjusted from high to very high. The reason for this adjustment is that the innovation has a mean of 5,80, which is on the edge of high-very high, but that this mean is affected by an outlier that is shown in Figure 5.1.

The innovation Duurzaam Speelbad scores very high on functional performance, while the other two innovations score high. The distribution of Duurzaam Speelbad on this item shows an outlier, but this outlier does not affect the classification for this innovation project. For the other two innovation projects the means and the distributions are within the range of the used classification.

5.2 Network evolvement

The network evolvement of the three innovation projects is measured by making use of six network characteristics, which can be classified into three types of network embeddedness: frequency of interaction and close relationship (structural embeddedness), reliability and promise keeping (relational embeddedness) and shared vision and enthusiasm (cognitive embeddedness). The first five items are used to measure the evolvement of the relations within the network, while the item enthusiasm measures the enthusiasm of the involved organizations in the innovations project. In Table 5.4 the means on the six items are presented per phase and Figure 5.2 shows the distributions of the items per phase. The results will be discussed per item.

To compare the three innovation projects the means can be used, however for this cross-case analysis the scores are classified by making use of a classification system that consists of ten components and for each component a range of 0.60. The reason to use ten components to classify the network evolvement is that the lowest mean is 4.63 (shared vision during the pilot project (2^{nd} phase) of the innovation project iQwoning® and the highest mean is 7.00. This means that there is a difference between the lowest and highest mean of 2.37. By making use of a component range of 0.60 at least 4 classes can be distinguished. This classification is applied to the network evolvement of the three innovation projects and is presented in Table 5.5. Only in cases of outliers an exception is with respect below classification. These exceptions will be marked in Table 5.5.

5.2.1 Frequency of contact

The frequency for two innovation projects, namely Duurzaam Speelbad and ModuPark®, the frequency of interaction is considerably higher in the first phase compared to the other phases. In case of ModuPark® the frequency of interaction drops during the pilot project, while the frequency of interaction of the innovation project Duurzaam Speelbad decrease after the pilot project.

The third innovation project, the iQwoning®, shows a different development of the frequency of interaction. In the pilot project there is similar to the innovation project ModuPark® a small decline in the frequency of interaction, but in contrast to the other two innovation projects a small increase in the third and fourth phase is noticeable.

In the first and fourth phase of the innovation process the frequency of interaction is similar for the innovation projects Duurzaam Speelbad and ModuPark®. In the development and testing phase the frequency of interaction is similar for the two innovation projects Duurzaam Speelbad and iQwoning®. As stated above, the frequency of interaction in the innovation project iQwoning® is less in the first phase compared to the other two innovation projects, but more in the implementation and diffusion phase.

Table 5.4: Network evolvement of the three innovation projects

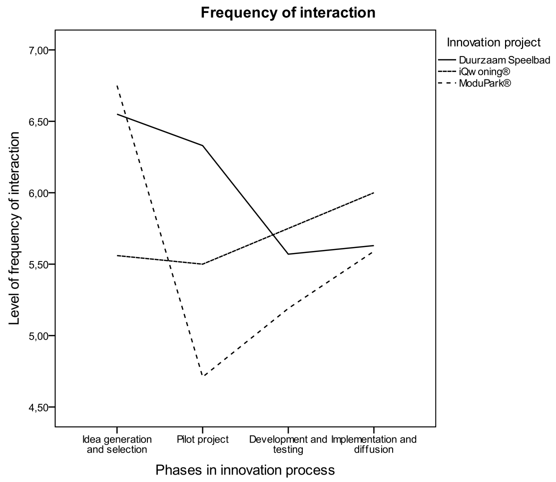
	Phases in innovation process											
	Idea generation and selection			Pilot project			Development and testing			Implementation and diffusion		
	DS	iQ	MP	DS	iQ	MP	DS	iQ	MP	DS	iQ	MP
Frequency of interaction	6.55	5.56	6.75	6.33	5.50	4.71	5.57	5.75	5.19	5.63	6.00	5.59
Close relationship	6.27	5.33	6.75	6.50	5.13	4.75	5.33	5.62	4.78	5.88	6.50	5.00
Reliability	6.36	5.89	7.00	6.67	5.25	5.21	5.24	5.38	4.81	6.13	6.50	5.35
Promise keeping	5.82	5.56	7.00	5.50	5.38	5.21	5.43	5.29	4.78	6.00	5.00	4.94
Shared vision	6.27	4.89	7.00	6.67	4.63	5.37	5.90	5.13	5.04	6.50	5.00	5.33
Enthusiasm	6.25	7.00	7.00	6.33	7.00	6.67	6.40	6.00	5.83	6.33	6.00	6.33

Table 5.5: Classification of the network evolvement of the three innovation projects

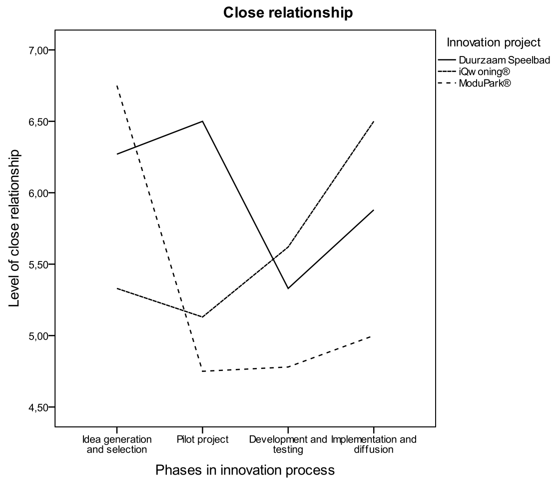
	Phases in innovation process											
	Idea generation and selection			Pilot project			Development and testing			Implementation and diffusion		
	DS	iQ	MP	DS	iQ	MP	DS	iQ	MP	DS	iQ	MP
Frequency of interaction	10	8	10	9	8	7	8	8	7	8	9	8
Close relationship	9	8	10	10	7	7	8	8	7	9	10	7
Reliability	9	9	10	10	8	8	8	8	7	9	10	8
Promise keeping	9	8	10	8	8	8	8	8	7	9	7	7
Shared vision	9	7	10	10	7	8	9	7	7	10	7	8
Enthusiasm	9	10	10	9	10	10	9	9	9	9	9	9

(light grey) Same classification on 2 cases
(dark grey) Same classification on 3 cases

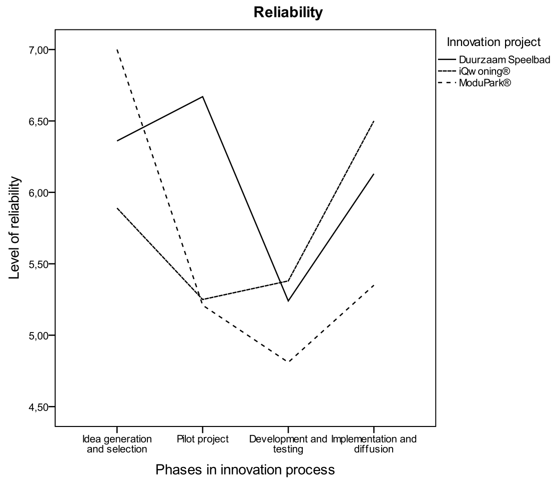
1.00 – 1.60	1.61 – 2.20	2.21 – 2.80	2.81 – 3.40	3.41 – 4.00	4.01 – 4.60	4.61 – 5.20	5.21 – 5.80	5.81 – 6.40	6.41 – 7.00
1	2	3	4	5	6	7	8	9	10



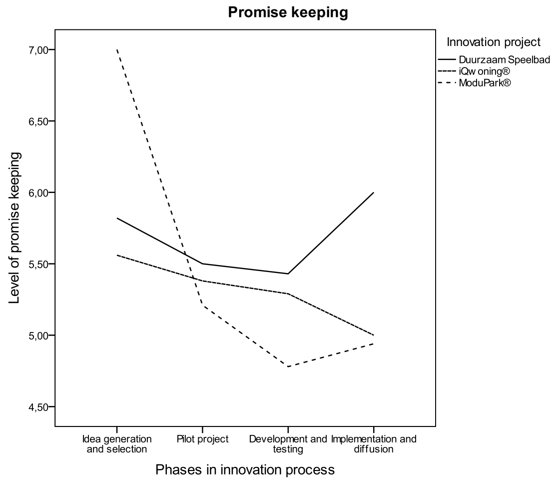
a. Frequency of interaction



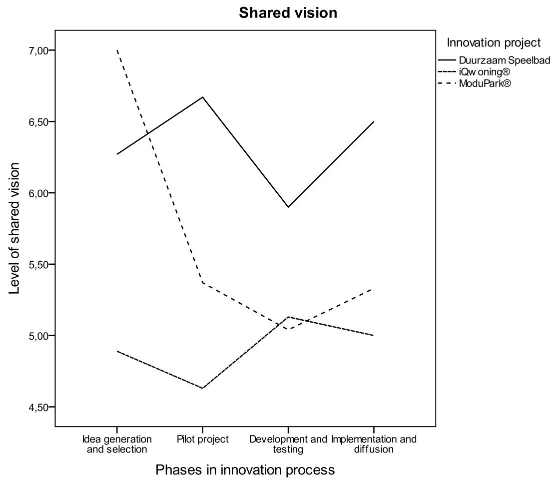
b. Close relationship



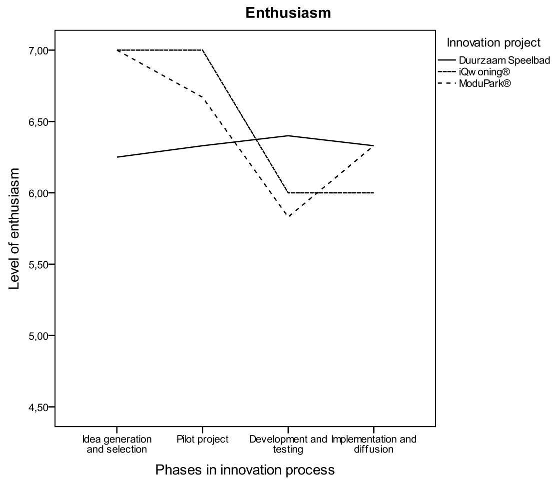
c. Reliability



d. Promise keeping



e. Shared vision



f. Enthusiasm

Figure 5.2: Network evolvement in the three innovation projects

5.2.2 Close relationship

In the first phase of the innovation process the three innovation projects score different on the item close relationship. The close relationship is the highest in the innovation project ModuPark® and the lowest in the innovation project iQwoning®, which is also shown in the Figure 5.2.b. The mean of the Duurzaam Speelbad is slightly lower compared to the mean of the ModuPark due to two outliers.

During the pilot project the level of close relationship is the same within the projects iQwoning® and ModuPark®. Especially the decline in the innovation project ModuPark® is remarkable. In the innovation project Duurzaam Speelbad on the other hand the level of close relationship even rises to a higher score.

In the third phase the innovation projects Duurzaam Speelbad and iQwoning® score the same classification, due to a decline in the level of close relationship in the first mentioned project and an increase in the project iQwoning®. The score on this item regarding the innovation project ModuPark® remains the same.

The level of close relationship in the fourth phase is the highest in the innovation project iQwoning®. Also an increase between the third and fourth phase is noticeable in the project Duurzaam Speelbad. The level of close relationship in the project ModuPark® has the same score as in the second and third phase of the process.

5.2.3 Reliability

The reliability in the innovation projects Duurzaam Speelbad and iQwoning® have the same score in the first phase of the innovation process. In the project ModuPark even a maximum score is observed regarding the reliability.

In the pilot project however a decrease is noticed regarding the reliability in the innovation projects iQwoning® and ModuPark®. Both projects score almost the same on this item in this phase of the process, which means that especially in the innovation project ModuPark® the decrease on this item is large. In the third innovation project, Duurzaam Speelbad, on the other hand an increase is noticeable on this item.

In the third phase of the project two projects score almost the same on reliability, namely the projects Duurzaam Speelbad and iQwoning®. The mean of the projects iQwoning® is slightly higher compared to the second phase, which means that there is a decline in the reliability of the project Duurzaam Speelbad. This is also clearly visible in the figure that shows the development ofthis item (Figure 5.2.c). A decline is also noticeable in the project ModuPark®.

For the projects Duurzaam Speelbad and the iQwoning® the reliability increases, while for the project ModuPark® the level of reliability remains the same. If the means of the third and fourth phase even are compared for the project ModuPark® a small decrease is noticeable.

5.2.4 Promise keeping

In the idea selection and generation phase a difference perceived between the three different innovation projects. The project ModuPark® scores a maximum value on this item and the innovation projects Duurzaam Speelbad and iQwoning® score almost the same, although there is a difference is in the classification, because in the project iQwoning® there are different opinions about the level of promise keeping in this phase of the process.

In the pilot project however the three innovation projects score nearly the same on promise keeping. The level of promise keeping in the innovation project iQwoning® remains the same, but for the other two projects a decrease in the level of promise keeping is noticed.

For the third phase the innovation projects Duurzaam Speelbad and iQwoning® have the same score regarding promise keeping. In the innovation project ModuPark® on the other hand the classification level of promise keeping decreases form a score 8 to a score 7.

In the implementation and diffusion phase the level of promise keeping in the project Duurzaam Speelbad increases, while in the project iQwoning® the level of promise keeping drops one level. The level of promise keeping in the project ModuPark® remains the same compared to the previous phase.

5.2.5 Shared vision

In the idea selection and generation phase of the innovation project ModuPark® the level of shared vision has a mean of 7.00. The project Duurzaam Speelbad scores slightly worse on this item, but far better than the innovation project iQwoning® with a mean of 4.89.

During the pilot project the level of shared vision in the project iQwoning® decreases slightly to a mean of 4.63. The score however remains a 7. The other two projects score better on this item, but a difference is noticed compared to the first phase: the shared vision in the innovation project Duurzaam Speelbad (classification of 10) is higher than the shared vision in the project ModuPark® (classification of 8).

The innovation projects iQwoning® and ModuPark® has the same classification with respect to the shared vision in the development and testing phase. Although the score of shared vision for the innovation project iQwoning® remains the same, there is a small increase noticeable if the means of the 2nd and 3rd level are compared. The project Duurzaam Speelbad has the highest classification of the three projects in this phase of the process.

In the fourth phase of the process the score of the innovation project iQwoning® remains the same. The scores of the shared vision in the innovation projects Duurzaam Speelbad and ModuPark® on the other hand increase, respectively from a classification 9 to a classification 10 and from a classification of 7 to a classification of 8.

5.2.6 Enthusiasm

The level of enthusiasm is during the entire innovation processes of all three innovation projects extremely high. This is also seen in the same classification that is used for the projects iQwoning® and ModuPark® in the first two phases and the same classification for all three innovation projects in the third and fourth phase. In the first two phases the enthusiasm is slightly less in the project Duurzaam Speelbad compared to the other two projects. However, it has to be stated that those two projects score almost the maximum score in both phases.

5.3 Effect of network evolvement on innovation performance

This section discusses the effect of the evolvement of the networks in the innovation projects on the innovation performance of the innovations and the projects. The innovation performances of the three projects are compared in paragraph 5.1 and the network evolvement of the three projects is analyzed in paragraph 5.2.

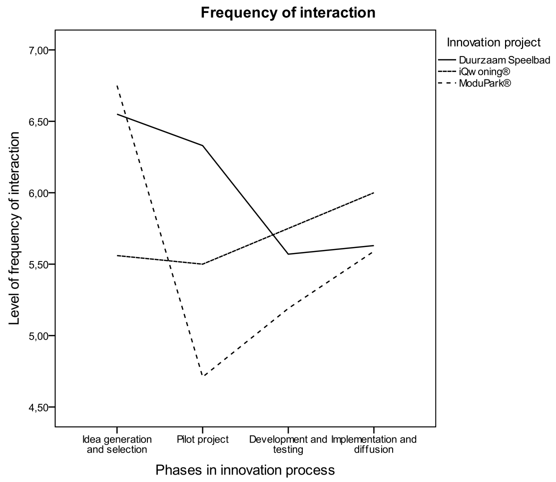
The effect of the network evolvement on the innovation performance is described per type of performance: technical performance, project performance, market performance and satisfaction. By making use of Table 5.6 a classification is made for each type of performance. These classifications are used to discuss the differences and similarities of the network evolvement of the three projects.

Table 5.6: Classification of the innovation performance of the three innovation projects

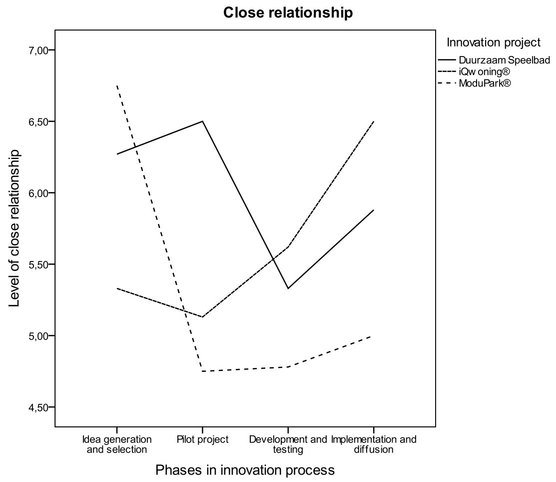
Innovation performance	Variable	Innovation project		
		Duurzaam Speelbad	iQwoning®	ModuPark®
Technical performance	Product	M	M	M
Project performance	Quality objective	H	M	M
	Cost objective	L	L	L
	Time objective	M	M	L
Market performance	Succes of implementation	H	H	H
	Commercial success	M	H	H
	Influence on sales	L	M	M
Satisfaction	Technical desgin	VH	VH	M
	Functional performance	VH	H	H

(dark grey)	Classified as 1st
(light grey)	Classified as 2nd
(white)	Classified as 3rd

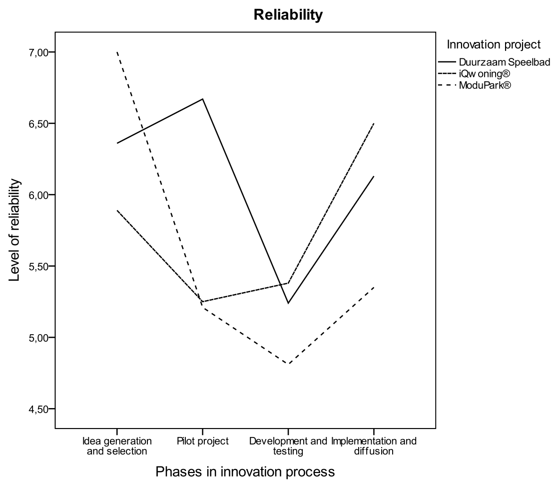
In the analyses of the network evolvement in paragraph 5.2 the score of a network characteristics per phase is considered to be one variable, while in this analysis the evolvement of a network characteristic during the entire process is considered to be one variable and this variable can be considered to be a composed variable. Because the effect of each phase on the innovation performance could not be statistically determined, it is also not possible to statistically determine the effect of the entire process on the innovation performance. Therefore the effect of the process on the innovation performance is descriptive described. The evolvement of the network characteristics of the three innovation projects are shown in Figure 5.3.



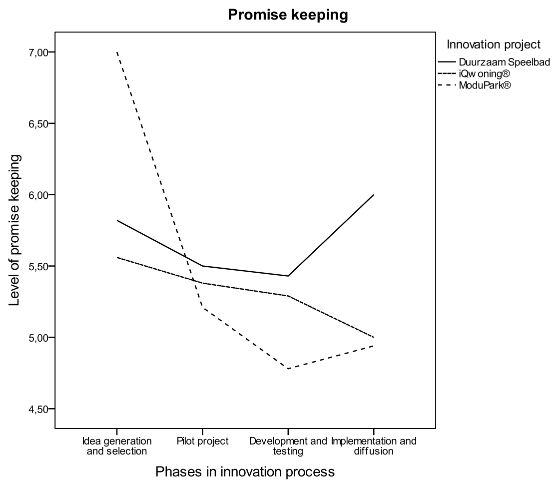
a. Frequency of interaction



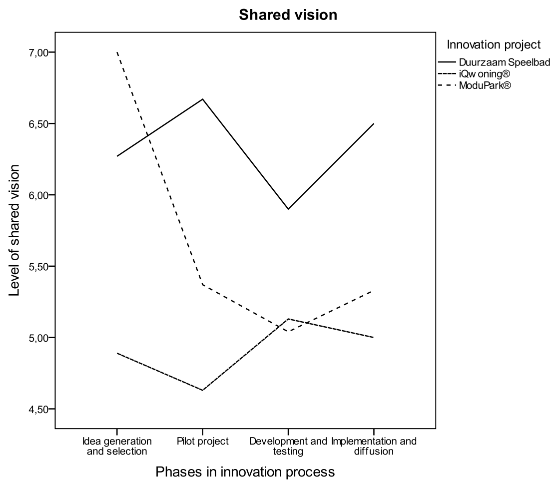
b. Close relationship



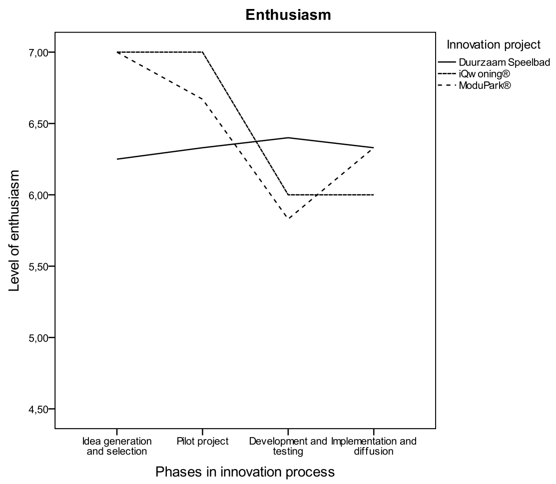
c. Reliability



d. Promise keeping



e. Shared vision



f. Enthusiasm

Figure 5.3: Network evolvement in the three innovation projects

5.3.1 Technical performance

The technical performance describes the technical performance of the system, components and interfaces and can be distinguished as an internal performance measurement, since the performance is assessed by persons that were involved in the development and testing phase. Therefore the implementation and diffusion phase is left out of the consideration.

Although the three projects have the same score regarding the technical performance, in the analysis of the innovation performance in paragraph 5.1 it was concluded that the technical performance of the innovations Duurzaam Speelbad and iQwoning® was slightly better compared to the innovation ModuPark®. Therefore the comparison will be between the projects Duurzaam Speelbad and iQwoning®.

The similarities between the projects are mainly based on the level of the network characteristics. For five of the six network characteristics in all the three phases of both projects score a level of 5.00 or higher. The discrepancy can be found regarding the shared vision. The project innovation iQwoning® scores a lower level compared to the Duurzaam Speelbad. The differences are mainly found in the developments of the network characteristics for both innovation projects. Only regarding the promise keeping a same development is noticed. For the other characteristics it can be roughly stated that the developments of both projects are opposites of each other.

5.3.2 Project performance

The project performance describes the performance of the innovation project. The items that are used to determine the performance of the project are the quality of the product that is developed, the duration of the project and the costs that were involved in the development of the innovation.

The innovation project Duurzaam Speelbad is assessed to be the best performing project. The project is assessed to be slightly better than the innovation project iQwoning® and the difference is based on the quality of the product, respectively the prefabricated children's pool and the prefabricated house. Therefore the comparison will be between the projects Duurzaam Speelbad and iQwoning®.

The similarities between the innovation projects iQwoning® and Duurzaam Speelbad are primarly found in the level of network characteristics and the development between the third and fourth phase of the process. For five of the six network characteristics the two projects score a level of 5.00 or higher. Only regarding the shared vision there is a difference noticeable between the levels of shared vision for both projects. The main difference between the projects is regarding the developments of the network characteristics between the first and third phase. As mentioned above the development between the third and fourth phase shows similarities.

5.3.3 Market performance

The market performance discusses the success of the innovation on the market. Three items are used to measure the market performance: the success of implementation of the innovation, the commercial success of the innovation and the influence of the innovation on the sales.

The innovations iQwoning® and ModuPark® are assessed to be the best performing innovations regarding the market performance. Although there are small differences between the two projects, on average the project score with respect to the market performance the same. Therefore the comparison will be made between the projects iQwoning® and ModuPark®.

The main differences are regarding the level of five of the six network characteristics. The execption is the level of enthusiasm that for both projects is high during the entire process. For the other five network characteristics the project ModuPark® scores higher in the first phase compared to the other project, but from the second phase the project iQwoning® has most of the time a higher level for its characteristics. The similarities between the two innovation projects are found in the development of the network characteristics, the level of enthusiasm during the entire process and the level of shared vision from the second phase till the fourth phase.

However, the developments of the characteristics are not similar during the entire process. Regarding the frequency of interaction, close relationship and reliability a similar development is noticed from the second phase till the fourth phase, wile for the promise keeping a similar development is seen from the first phase till the third phase. With respect to shared vision a decrease is noticed between the first and second phase for both projects, but after the second phase the developments of the two projects differ.

5.3.4 Satisfaction

The measurement satisfaction describes the satisfaction about the innovation. The satisfaction is measured on two items: the technical design of the innovation and the functional performance of the innovation.

The innovations Duurzaam Speelbad and iQwoning® are assessed to be the best performing innovations regarding the satisfaction. Both projects are however already compared to each other for the effect of the evolvement on the project performance. Therefore Table 5.6 can be used to determine the similarities and differences between the projects.

The two innovation projects show similarities regarding the high scores for five of the six characteristics. Only regarding the shared vision there is a difference noticeable between the scores of both projects. With respect to the evolvement of the network characteristics there are large differences noticeable, mainly regarding the evolvement between the first and second phase and the second and third phase. With respect to the evolvement between the third and fourth phase there are more mainly similarities noticed.

5.4 Conclusion cross-case analysis

The cross case analysis provides the information to answer the following sub questions:

- How does an inter-firm network evolve during a product innovation project?
- Which variables of an evolving innovation network affect the performance of a product innovation?

The sub questions will be answered in this paragraph.

Network evolvement in innovation projects

The network evolvements of the three innovation projects show that in all three projects high scores are distinghuished for the six network characteristics. However, there are differences in the evolvement of the three innovation networks. In the innovation project Duurzaam Speelbad high scores are noticed during the entire process (lowest score 5.24), this in contrast with the other two projects that show scores that are in some phases slightly lower (lowest score of iQwoning® is 4.63, lowest score of ModuPark® is 4.71). A remarkable result is that the project ModuPark® shows exteremly high scores in the first phase of the project, while in the second phase this project has for four characteristics the lowest score. With respect to the item enthusiasm all three innovation projects show high levels during the entire process.

Regarding the development of the scores similarities are noticed between the projects iQwoning® and ModuPark®, although the average levels of the network characteristics of iQwoning® is slightly higher compared to the average level of network characteristiscs of ModuPark® with the exception of the levels in the first phase. In the second phase a decrease is noticed for these two projects, while in the same time an increase is noticed in the project Duurzaam Speelbad. In the third phase the tables are turned: increases are noticed in the project iQwoning® and ModuPark®, while there is a decline in the project Duurzaam Speelbad. In the fourth phase all projects show either an increase in the levels or the network characteristics remain the same. The only exception for this phase is the characteristic promise keeping, since a decrease is noticed in the project iQwoning®.

Effect of network evolvement on innovation performance

The innovation performance is measured by making use of four items: technical performance, project performance, satisfaction and market performance. Only the last measurement measures the performance of the innovation on the market. Therefore the three innovation projects are compared by making use of this performance measurement and the comparison shows that the iQwoning® is the best performing innovation followed by the ModuPark®. The Duurzaam Speelbad is still in the middle of its implementation and diffusion process and therefore the market performance is less compared to the other two innovations.

Based on the comparison between the projects iQwoning® and ModuPark® similarities can be found in the network evolvement which might effect the innovation performance. The patterns of evolvement of the network characteristics of close relationship and reliaibility show similarities, although the increases in the project iQwoning® are sharper than the increases in the innovation project ModuPark®. Also similarities are distinguished regarding the development of the characteristic enthusiasm which is in both processes for all phases high with only a small decrease after the second phase. Regarding the levels of network characteristics there are almost the same levels of frequency of interaction and promise keeping in the fourth phase. Although this is not a pattern, it is a remarkable result.

6 DISCUSSION

This research started with the statement that there is a lack in the literature and the practice how the networks in innovations projects evolve and how the network evolvement affects the innovation performance of the projects. To obtain answers for these questions three innovation projects are analyzed and compared to each other. In this section the key findings of the analyses are presented.

The key findings of the within-case analyses and the cross-case analysis will be discussed according to the same outline that is used in the cross-case analysis:

- Innovation performance
- Network evolvement
- Effect of network evolvement on innovation performance

In the cross case analysis the three projects are separately compared with each other, but in this section the different types of innovation projects are also compared. The projects Duurzaam Speelbad and ModuPark® are identified as market-pull innovation (Martin, 1994; Brem & Voigt, 2009) of which the innovation ModuPark® is the more commercially successful innovation of the two. The innovation iQwoning® is determined as a technology-push innovation (Martin, 1994).

6.1 Innovation performance

The innovation performance of the three innovation projects is measured by making use of four measurements: technical performance, project performance, market performance and satisfaction. The first two measurements have an internal character, while the latter two measure the innovation performance from an external perspective. In the cross case analysis the measurement market performance is chosen as the main performance measurement, since it measures the success of an innovation.The other three performance measurements describe the success of the product, the success of the project or the satisfaction about the product. Although these measurements measure not the success of an innovation, the innovation and the innovation project might meet the minimum conditions to be successful.

The market performance measures the success of implementation, commercial success and the influence on the sales (Gatignon *et al.*, 2002). Based on the results of the analyses the innovations iQwoning® and ModuPark® are determined to be commercial successful innovations, since both are successful implemented and commercially successful. The innovation Duurzaam Speelbad is not yet determined as a commercially successful innovation, since this innovation is in the middle of its adoption and diffusion process. This is also shown in the score on the item commercial success, which is moderate. Regarding the influence on the sales all three innovation projects score below expectations.

The items implementation success and commercial success are indicators of the customers can be distinguished as customer acceptance measures (Griffin & Page, 1993; Gatignon *et al.*, 2002), while the item influence on the sales is a financial measure (Griffin & Page, 1993; Tatikonda & Montoya-Weiss, 2001; Gatignon *et al.*, 2002). Griffin and Page (1993) stated that the combination of these two types of measures provide a balanced outlook of the success of the innovation. However, if this statement is followed all the three innovation projects in this study can no be determined as successful, since the sales expectations for the three innovations are not met. A reason that the projects score below expectations regarding the influence on the sales is the type of industry in which the innovation projects are executed. The construction industry is described as an industry with high costs and low marges (Tatum, 1989) and that because of these characteristics the influence of the sales of an innovation are lower compared to other industries. The market performance of innovations in the construction industry should therefore be measured by using the measures the success of implementation and the commercial success and exclude the influence on the sales from this performance measurement (Griffin & Page, 1993; Tatikonda & Montoya-Weiss, 2001; Gatignon *et al.*, 2002).

The other three performance measurements (technical performance, project performance and satisfaction) can either be used as conditions that must be met be successful or as indicators of successful innovations. Tatikonda and Montoya-Weiss (2001) stated that the technical performance and the quality of the innovation are significantly positively associated with the relative sales of the innovation and the customer satisfaction. Customer satisfaction is according to Griffin and Page (1993) an item to measure the customer acceptance, which is in its turn a measure for the market performance. Tatikonda and Montoya-Weiss (2001) further found that there is positive relation between the involved costs and the relative sales. However, as stated above relative sales are not used to determine the innovation performance.

In all the three innovation projects the technical performance of the innovations is as expected and regarding the quality of the innovation in two projects (iQwoning® and ModuPark®) the actual quality is equal to the planned quality. Only in case of the Duurzaam Speelbad the quality of the innovation is better compared to the planned objective. Nevertheless, all three innovation projects score equal to or better than the expectations regarding the technical performance and quality of the innovation.

Based on Olson et al. (2001) the satisfaction about the innovation is divided into satisfaction about the technical design and satisfaction about the functional performance. In contrast to the studies of Tatikonda and Montoya-Weiss (2001) and Griffin and Page (1993) the satisfaction in this research is not only assessed by customers, but also by the involved employees in the innovation projects. Regarding the satisfaction about the technical design the three innovations score differently, but with respect to the satisfaction about the functional performance all the three innovations score high or very high on this item. Griffin and Page (1993) used the item customer satisfaction to predict the market performance, and although in this research the satisfaction is assessed not only by customers, but also by involved employees, the item satisfaction will be used as a predictor for the market performance of the innovation.

PROPOSITION 1

- *The satisfaction about the functional performance of innovations in the construction industry is a positive indicator for the market performance of innovations in the construction industry.*

6.2 Network evolvement

The evolvement of the networks in the three innovation projects is determined by measuring the evolvement of three dimensions of embeddedness and their corresponding network characteristics: structural embeddedness (frequency of interaction and close relationship), relational embeddedness (reliability and promise keeping) and cognitive embeddedness (shared vision and enthusiasm). The differences and similarities between the innovations are discussed per dimension of embeddedness.

6.2.1 Structural embeddedness

The structural embeddedness is determined by measuring the frequency of interaction and the closeness of the relationship (Tsai & Ghoshal, 1998). The frequency of interaction measures the amount of time spent in a tie (Granovetter, 1973b; Tsai & Ghoshal, 1998; Reagans & McEvily, 2003a), while the close relationship determines the intensity of the tie (Granovetter, 1973b; Tsai & Ghoshal, 1998; Reagans & McEvily, 2003a). In the study of Tsai and Ghoshal (1998) a positive correlation is found between the amount of time spent and the level of closeness in the relationship and the positive relationship is also found between these two items in this study, although this study measured the level of structural embeddedness over the entire process. However, the study of Tsai and Ghoshal (1998) studied an electronics company and used an intra-organizational perspective, while this study was focused on innovation projects in the construction industry from an inter-organizational perspective.

The evolvement of the frequency of interaction and the closeness of the relationships show similarities for all the three innovation projects and also the scores for both items show a correlation between the items, although it is not statistically determined. Further, the evolvement of the frequency of interaction in the project ModuPark® is sharper compared to the evolvement of the closeness of the relationships. In the project iQwoning® it is the other way around: the evolvement of the closeness of the relationships is sharper compared to the frequency of interaction.

The structural embeddedness is high during all three innovation process and in some phases the level of structural embeddedness can be called extremely high, especially in the first phase of the two market-pull innovation projects Duurzaam Speelbad and ModuPark®. In a market-pull innovation project a customer’s need is identified that is not properly fulfilled (Martin, 1994). Since the need is already identified, there is pressure from the market to develop a solution that fulfils the need. This pressure might result in the extremely high level of structural embeddedness in the first phase of this type of innovation projects, because the time is limited to come up with a solution. This results in the following proposition:

PROPOSITION 2

- ♦ *The structural embeddedness in the first phase of the innovation process of market-pull innovation projects in the construction industry is extremely high due to the pressure of the market to develop an innovation to fullfil the identified need.*

Regarding the evolvement of the network on this dimension of embeddedness a decrease is noticed after the first phase in the three innovation projects, with the exeception of the level of close relationship in the project Duurzaam Speelbad, which slightly increases. In the second phase the pilot projects are executed and compared to the first phase of the innovation process this phase is mainly executed by the leading form and as a result the structural embeddedness decreases.

The evolvement between the second and third phase however show different results. The level of structural embeddedness increases in the projects iQwoning® and ModuPark®, but in the project Duurzaam Speelbad a decrease is noticed. Regarding the market-pull innovation projects it is therefore not possible to make a statement about the evolvement, however with respect to the technology-push innovation project a proposition can be formulated. Compared to the second phase in which the pilot project is executed the structural embeddedness is higher in the development and testing phase. Rogers (2003) stated that in this phase the innovation is further developed to meet the needs of the potential adopters of the innovation. In market-pull innovation projects this part has already taken place in the first phase of the process.

The structural embeddedness increases between the third and fourth phase in all the three innovation projects, although the rate of increase differs between the projects. Regarding the frequency of interaction the scores are almost similar for the projects, but with respect to the closeness of relationship the scores are in a wider range, although the projects score at least high for this item. In the fourth phase of the innovation process the innovation is implemented in the market and further diffused. Where in the previous phases the interaction was mainly with the organizations that participated in the development of the innovation in this phase there is also interaction with the clients and especially in the construction industry the interaction with the client is high due to the unique characteristics of the construction industry (Tatum, 1989; Blayse & K., 2009; Rutten *et al.*, 2009). This results in the following proposition:

PROPOSITION 3

- *The structural embeddedness increases between the third and fourth phase of the innovation process of the innovation projects in the construction industry due to the interaction with the potential adopters of the innovation.*

6.2.2 Relational embeddedness

The relational embeddedness of the innovation networks is measured by using the level of reliability and the level of promise keeping (Tsai & Ghoshal, 1998). The reliability measures the level of trustworthiness, while the level of promise keeping is used to measure the level of trust (Gulati, 1998; Tsai & Ghoshal, 1998). Following the study of Tsai and Ghoshal (1998) there is a positive relation between the reliability level and the level of promise keeping. In the study of Tsai and Ghoshal (1998) the items are however measured for the entire network process, while this research measured these items for the four phases of the innovation process. A remark is that the study of Tsai and Ghoshal (1998) studied intrafirm network in a multinational electronics company, while this research studied the interfirm networks in the construction industry.

However, in contrast to the study of Tsai and Ghoshal (1998) the positive relation between the items reliability and promise keeping is not present in two of the three innovation projects. Only in the innovation project ModuPark® similar patterns are found for the items reliability and promise keeping, but in the other two projects different patterns are found for both items. Nevertheless, all three the innovation projects score still high on both items, only the evolvements differ. According to the theory a high level of trust and trustworthiness enables cooperation and cooperation enables in its turn trust and trustworthiness (Granovetter, 1973a; Granovetter, 1973b; Nahapiet & Ghoshal, 1998; Tsai & Ghoshal, 1998). In all the three innovation projects the involved organizations developed the innovation in close cooperation. Based on the observation and the corresponding theory the following proposition is formulated:

PROPOSITION 4

- *The relational embeddedness in innovation projects in the construction industry is during the entire innovation process high due to the close cooperation in the innovation projects.*

The evolvements of the two items reliability and promise keeping in the three innovation projects differ, even in the market-pull innovation projects different evolvements are noticed. However, the level of relational embeddedness increases between the third and fourth phase in the market-pull innovation projects. In the technology-push only the level of reliability increases between those two phases, while the level of promise keeping decreases in the same time. A reason that in the fourth phase of the market-pull innovation projects the relational embeddedness is higher in comparison with the third phase is that activities and structure are adjusted (Cooper, 1990; Veryzer, 1998; Rogers, 2003).

6.2.3 Cognitive embeddedness

The cognitive embeddedness of the networks in the innovation projects is measured by making use of the level of shared vision and the level of enthusiasm (Tsai & Ghoshal, 1998). The item shared vision is used to measure the "mental model of the future state shared by members of a unit" (Zheng, 2010, p. 173). The item enthusiasm measures on the other hand a network characteristic on an actor level, while the other item measures on a dyadic level (Tsai & Ghoshal, 1998). In the study of Tsai and Ghoshal (1998), which was conducted at a multinational electronics company, there is a significant positive relation between the two items. Similar to the results of this study, the mean of the item enthusiasm is higher than the item shared vision.

However, two differences compared with the study of Tsai and Ghoshal (1998) is firstly that this study measured the network characteristic for the entire network process, while in this study the items are measured for the four phases of the innovation process. Secondly, the research settings differ. Tsai and Ghoshal (1998) studied a multinational electronics compay from an intra-organizational perspective, while in this research the construction industry is studied from an inter-organizational perspective.

Compared to the study of Tsai and Ghoshal (1998) there is however no positive correlation found between the items shared vision and enthusiasm. The evolvements of the two items differ and also the scores on the items are different. The scores on the item shared vision differ between high and extremely high, while the scores on the item enthusiasm are extremely high. However, as mentioned above the perspectives of the two items differ. The item shared vision has a dyadic perspective on the cognitive embeddedness, while the item enthusiasm has an actor perspective on the cognitive embeddedness. Because the items focus on different elements of the cognitive embeddedness the following proposition is formulated:

PROPOSITION 5

- *There is no significant correlation between the items shared vision and enthusiasm in innovation projects in the construction industry.*

The evolvements of the shared vision in the three innovation projects, but a distinction can be made between the evolvement of this item in the market-pull innovation projects and the evolvement of the shared vision in the technology-push innovation project. The level of shared vision in the market-pull innovation projects is in general higher compared to the technology-push innovation projects. In the theory scholars have been conducted to study the effect of shared vision on innovations (Pearce & Ensley, 2004; Zheng, 2010) and the effects of market orientation and learning orientation on innovations (Baker & Sinkula, 1999a, 1999b). In the literature there has been found no scholars that have studied the shared vision in different types of innovation projects or the effect of these shared visions on the innovation performance. However, based on the motives of the market-pull (need in the market is identified) and technology-push innovation projects (innovation is based on new technologies) the following proposition is formulated:

PROPOSITION 6

- *The shared vision in market-pull innovation projects in the construction industry is higher compared to technology-push innovation projects in the construction industry, because the motive to develop an innovation is more clear in market-pull innovation projects than in technology-push innovation projects.*

The evolvement of the item enthusiasm differs in the three innovation projects that are studied, but in all the three innovation projects the level of enthusiasm remains extremely high despite the small evolvements. This extremely high level of enthusiasm can be explained by the type of respondents that full-in the questionnaires. The respondents of the questionnaire were individuals that were highly involved in the innovation project and are called 'champions' (Howell & Higgins, 1990; Howell & Shea, 2001). These champions contribute to the innovation by actively and enthustiaclly promoting the progress of the innovation. However, the respondents were employees of different organizations, which mean that various champions were involved in the innovation projects.

6.3 Effect of network evolvement on innovation performance

The research objective of this study was to determine how the network evolvement of the innovation projects affects the innovation performance. However, the effect of the network evolvement on the innovation is only described and not determined in this study. The reasons are firstly that the variable network evolvement describes a pattern and secondly that only three innovation projects are studied, which is too small to determine an effect. Although it was not possible to determine a direct relation between the network evolvement and the innovation performance, there are different patterns described for the three innovation projects and based on these identified patterns and the determined innovation performance of the three projects the effect can be described.

In other studies the effect of the innovation networks on the innovation performance is studied, but there are two main differences between this study and the other studies. First, this study measured the network evolvement, while the other studies considered networks as static entities. Second, this research is conducted in the construction industry, which is described as a complex product and systems (CoPS) industry (Rutten *et al.*, 2009). The other studies are conducted in other industries, which can not be determined as CoPS industries.

In the study of Tsai and Ghoshal (1998), which was conducted in an electronics company, the effect of the innovation network on the innovation performance is studied from three perspective: the structural, the relational and the cognitive perspective. Only regarding the cognitive dimension no positive effect was determined. Pearce and Ensley (2004) on the other hand determined a positive relation between the cognitive embeddedness of intrafirm networks in the automotive industry and the innovation performance. Further, the studies of Ahuja (2000) and Tsai (2001) studied the relation between the structural embeddedness of a network and the innovation performance in respectively the chemicals industry (Ahuja, 2000) and a petrochemical and food-manufacturing companies (Tsai, 2001). In both studies a positive relation was determined between the structural embeddedness of the networks and the innovation performance.

In this study the innovations iQwoning® and ModuPark® were determined as successful innovations, while the innovation Duurzaam Speelbad is in the middle of its adoption and diffusion process, and therefore it is hard to make a statement about the success of the innovation. However, the market-pull and technology-push innovation projects are present in this research by respectively the project ModuPark® and iQwoning®. The effect of the network evolvement on the innovation performance will be discussed per phase of the innovation process and propositions are defined. In some cases the propositions are defined per type of innovation project.

6.3.1 Idea generation and selection

In the first phase of the innovation process, which is the phase where the idea of the innovation is developed, the ties in the innovation network are strong all along the line regarding the technology-push innovation project and extremely strong with respect to the market-pull innovation project.

An explanation for the strong ties in the technology-push innovation project might be that the involved organizations were familiar to each other and worked earlier together with each other. In case of the project iQwoning® only units of Ballast Nedam were involved, which explains the strong ties. However, if this innovation project is regarded as a regular technology-push innovation project the strong ties might be the result of interaction with actors with familiar knowledge. The acquired knowledge is likely to be tacit knowledge, but might be also redundant knowledge (Nelson, 1989).

PROPOSITION 7

- ♦ *The strong ties in the first phase of the innovation process of technology-push innovation projects in the construction industry enable the actors in the network to share tacit knowledge that is used to develop a technology-push innovation.*

The extremely strong ties in the market-pull innovation project can be explained because of the need to develop an innovation that adequately fulfils an identified customer's need (Martin, 1994; Brem & Voigt, 2009). In contrast with the interactions in the technology-push innovation projects the organizations in market-pull innovation projects are not necessarily familiar to each other. The strength of these ties might indicate that the level of cooperation is speeded up to become familiar with each other and to share the tacit knowledge that is necessary to develop an innovation (Coleman, 1988; Gargiulo & Benassi, 2000).

PROPOSITION 8

- *The extremely strong ties in the first phase of the innovation process of market-pull innovation projects in the construction industry speed up the cooperation between the actors in the network, which ultimately leads to the sharing of tacit knowledge that is used to develop a technology-push innovation.*

6.3.2 Pilot project

In the second phase of the innovation process the developed idea is to analyze the feasibility of the innovation. The strength of the ties in this phase of the process is slightly weaker compared to the first phase of the process, both in the technology-push and market-pull innovation projects. A reason for the decrease in tie strength is that the pilot projects are executed in cooperation with less familiar units or organizations. Weaker ties require less investment and offer more diverse and novel information, although the influence is also less (Burt, 1992). The following proposition is formulated:

PROPOSITION 9

- *The decrease in the strength of the ties between the first phase and the second phase of the innovation process of innovation projects in the construction industry is the result of the execution of pilot projects with new units or organizations that are less familiar and ultimetaly the new units or organizations offers novel knowledge to the actors in the innovation projects.*

6.3.3 Development and testing

The third phase of the innovation process, which is the development and testing phase, different evolvements are noticed in the two types of innovation projects. In the technology-push innovation project the ties become stronger, while in the market-pull innovation projects the interaction increases, but the content (reliability, promise keeping and shared vision) decreases.

In the technology-push innovation project the ties become stronger, which can be traced back to the fact that the actors from the first phase start to cooperate again. Further the increase in the shared vision indicates that there is more agreement about the final innovation and to create the innovation there is more cooperation compared to second phase and ultimetately more tacit knowledge is shared. This leads to the following proposition:

PROPOSITION 10

- *The increase in the tie strength between the second phase and the third phase of the innovation process of technology-push innovation projects in the construction industry results in a closer cooperation and enables the sharing of tacit knowledge.*

The strength of ties in market-pull innovation projects decreases, although the interaction increases. This means that there is more contact between the involved actors, but that the level of trust and trustworthiness decreased. Due to the decrease of trust and trustworthiness less tacit knowledge is shared. However, the increase in interaction shows that still investments are made in the ties and that therefore less investment can be made in new ties.

6.3.4 Implementation and diffusion

The fourth phase is the phase in which the innovation is implemented and diffused in the market. All along the line an increase in the tie strength is noticed in both the technology-push and market-pull innovation projects. Only regarding the promise keeping and the shared vision in the technology-push innovation project a decrease is noticed. However, the evolvements of the item shared vision in both projects indicate the different types of effect that the network evolvement has.

In the technology-push project the tie strength increases, although on the items promise keeping and shared vision there is a small decrease. A reason for these evolvements is that in this phase there is interaction with the potential customer of the innovation, although it is not clear if it satisfies a customer's need (Martin, 1994). The discrepancy between the scores on these items in the third and fourth phases can be explained with it. However, on the same time the increase in tie strength shows a frequent contact between the involved actors, which might indicate that is tried to make the adoption of the innovation successful. The following proposition is formulated:

PROPOSITION 11

- *The increase in the tie strength between the third phase and the fourth phase of the innovation process of technology-push innovation projects in the construction industry results in a successful adoption of the innovation.*

The tie strength in market-pull innovation projects increases between the third phase and the fourth phase of the innovation process. In the market-pull innovation project the idea of the innovation is based on a need that was identified in the market and in previous phases there was more contact with the market about the innovation (Martin, 1994; Brem & Voigt, 2009). The combination of the character of this type of innovation project and an increasing shared vision might indicate that consensus is reached about the solution that satisfies the customer's need. This leads to the following proposition:

PROPOSITION 12

- *The increase in the tie strength between the third phase and the fourth phase of the innovation process of market-pull innovation projects in the construction industry results in an innovation that satisfies the identified customer's need.*

7 REFLECTIONS

In the previous chapter the results are discussed. In this chapter the research methodology will be discussed. First the research strategy is discussed, followed by the case studies that are chosen. Thereafter the data collection is reviewed and finally a reflection is made regarding the data analysis.

7.1 Research strategy

Based on the research objectives and the questions that were formulated based on the objectives the decision was made to use a cross case analysis as the research strategy. Another research strategy that theoretical could have been used in this research is an experimental research. However, due to pragmatic reasons this type of research was not selected. First, in an experimental research data of different cases are manipulated. This was however not possible in this research. Second, if an experimental research was chosen the possibility was present to observe the cases, but since these cases took several years, the duration of the research would be too long for this purpose. Therefore the choice for a case study is justified.

7.2 Case studies

In this research three innovation projects are studied. Three cases is a relatively low number of cases to generalize the results, but in the methodology section it was explained that each case consisted of four embedded units of analysis, which resulted in a total of twelve embedded units of analysis and that due to practical reasons, namely the duration of the research, no more projects are studied. However, also because of the explanatory purpose of this research the number of three innovation projects is justified.

The cases that were selected are innovation projects in which Ballast Nedam had a leading role. If the research was conducted a research institute the possibility was present to study innovation projects in which different contractors had a leading role. However, the choice was made to conduct the research at Ballast Nedam, since there was no opportunitiy to conduct the research at a research institute and further Ballast Nedam showed great interest in this research. Therefore the research was conducted at Ballast Nedam and innovation projects of Ballast Nedam were selected to be studied.

The three selected cases were assessed by Ballast Nedam as innovation projects, which indicated that the innovations were commercial successful. During the execution of the research it appeared that the Duurzaam Speelbad was not completely implemented and diffused in the market. However, the question may arise if this innovation would be more successful than the iQwoning®, since this innovation fulfil the need in a niche market, while the iQwoning® fulfils the need in a large market of Ballast Nedam.

7.3 Data collection

Besides the document study two other research instruments can be distinguished: the questionnaire to obtain data about the network evolvement and the semi-structured interviews to collect data about the decision-making in the network evolvement. For the collection of data about the network evolvement a structured interviews could have been used. The advantage of this research instrument is that it offers the opportunity to ask questions to the interviewee that are not directly related to the topic or questions that could clearify ambiguities. However, this research instrument is time-consuming and due to the large number of involved persons the questionnaire was preferred.

For the data collection about decision-making semi-structured interviews were used. Other research instruments that could have been used to collect the data were structured interviews, unstructured interviews and observations. However, structured interviews do not offer the opportunity to deviate of the subject or to change the order of questions, while an unstructured interview has no predetermined list of questions and themes. Therefore, both interview techniques do not fit the purpose of collecting data about decision-making. The third option was to observe the decision-making processes, but since the decision-making processes occurred in the past, this was not an option.

7.4 Data analysis

In the data analysis different techniques are used, because the research contains both qualitative and quantitative data. For each variable the proper technique is chosen to analyze the data as explained in the methodology section. Only regarding the network evolvement an extra technique could have been used, namely to determine the correlation. However, due to small N this technique is not used, because it offered no added value.

8 CONCLUSION

This research was conducted at Ballast Nedam to obtain insight in the network evolvement in innovation projects and the effect of it on the innovation performance. In the literature and at Ballast Nedam there was a lack of knowledge on these topics.

This chapter presents the conclusions, the limitations of the research and the theoretical and practical relevance of the research.

8.1 Conclusions

Based on the research objective a research question and four sub questions were formulated. The theoretical sub questions are answered in the conclusion of the theoretical framework, while the practical sub questions are answered in the conclusion of the cross case analysis. These answers are ultimately used to answer the two research questions.

> *How does the evolvement of an innovation network affect the performance of a systemic product innovation of Ballast Nedam?*

The performance of an innovation can be measured in different ways and from different perspectives. Perspectives that were identified in this research were the technical performance, project performance, market performance and satisfaction about the innovation. However, if the definition of innovation is followed, the market performance describes as best the success of an innovation, namely if the innovation is successful implemented and diffused in the market.

To determine how the evolvement of a network affects the performance it is important to determine the most important characteristics of a network. Based on the literature study that is conducted in this research six network characteristics are identified that determine a network: frequency of interaction, close relationship, reliability, promise keeping, shared vision and enthusiasm. The first five characteristics describe the relations in a network, while the latter describes the enthusiasm of an actor in a network.

The three studied innovation projects evolve in different ways, although there are for some network characteristics similar patterns found. The similarities and differences in these evolvements are based on the level of the network characteristics in each phase of the innovation process and the differences on the levels between the phases of the process. A similarity that is found during the research and can be applied for all the three projects is that all the three projects score during their entire process an above average level on all six network characteristics.

The network evolvements of the three innovation projects differ largely for most of the network characteristics. Either the level of a network characteristic in a phase differs compared to the other two innovation projects or the development of a network characteristic between two phases differs. However, there are also similarities identified apart from the similarity of the above average level on all the network characteristics. The most important similarities are between the network evolvement of the innovation project iQwoning® and the evolvement of the network in the project ModuPark®. The reason for the importance of these similarities is that both innovations score high on the market performance that earlier is identified as the performance measure that measures the success of the innovation on the market. The similarity in the evolvement of these characteristics might affect the innovation performance.

The similarities that are found in the evolvement are regarding the network characteristics close relationship, reliability and enthusiasm. The similarity is based on the relative development of the levels on these characteristics, since the levels of close relationship and reliability in the project iQwoning® are higher compared to the levels in the project ModuPark® for these network characteristics. Only regarding the characteristic enthusiasm there are similarities in the development of this item and the levels in the four phases, since this characteristic is high during the entire process.

The evolvement of the innovation networks affects the performance of innovations by tightening and loosening the involvement of the network members in the different phases of the innovation project. This involvement with the innovation project is described by the network characteristics close relationship, reliability and enthusiasm. A successful innovation network might be described as a group of friends: close relationship and reliability among the friends and a shared enthusiasm to bring the project to a successful end.

8.2 Limitations of the research

Within this research there were several limitations that could have affected the results.

First, in this research only three innovation projects were studied. Although each case consisted of four embedded units of analysis, which ultimately resulted in a total of twelve embedded units of analysis, the number of cases is too low to generalize the results of this research. However, due to practical limitations (duration of the research) it was not possible to study more innovation projects. Nevertheless, this research can be used as a start for future researches on this topic.

Second, the research is conducted by using a post-hoc analysis. This means that the data is analyzed after the innovation projects are concluded. This limitation has two implications. First, the data about the network evolvement is based on the memory of the involved persons in the innovation projects, the memories about the earlier stages of the innovation processes are flatted compared to the later stages of the process. Second, in this research it was not possible to manipulate the projects and to study the effect of these manipulations on the data.

Third, the research method of questionnaires is used to measure the evolvement of the networks and the innovation performance of the innovation projects and has advantages regarding the flexibility, anonymity, speed and reliability, but the questionnaire is also a standardized research instrument. This means that by making use of this research instrument it is not possible to obtain more insight in the innovation performance and the causes of the network evolvement. A qualitative research method has the possibility to clearify results in the quantitative data and to explain more in detail how the network evolves. Therefore, in future research qualitative research methods can be used to create more insight in the innovation performance and the network evolvement and to understand the performance and the evolvement.

Fourth, in this research it was not possible to determine the effect of the network evolvement on the innovation performance in the innovation projects. The network evolvement is described as a pattern and it is therefore not possible to statistically determine which part of the evolvement affects the innovation performance. To statistically determine the relation between the network evolvement and the innovation performance more innovation projects have to be studied.

8.3 Theoretical relevance

This research makes several contributions to the literature on network dynamics and decision making in innovation projects.

The research shows that there is a high level of cohesion among the network members of the three innovation projects that were studied, and in some phases the cohesion can be described as extremely high. Further the performance of the innovation projects is measured by making use of different performance measurements and the correlation between these measurements is determined. Also the effect of the network evolvement on the innovation performance is studied. Although it is not possible to determine the effect statistically, because the network evolvement is described as a pattern, the effect is described in this research.

First, in this research insight is obtained about the embeddedness of innovation networks. In the literature the combination of structural and relational ebmeddedness is widely studied (Granovetter, 1985; Gulati, 1998; Rowley *et al.*, 2000), but the combination of structural, relational and cognitive embeddedness is a combination that is less studied (Tsai & Ghoshal, 1998). The study showed that there is a correlation between the three dimensions of embeddedness, although there are small differences how the items that measured the embeddedness evolve.

Second, in this research insight is acquired about the network evolvement in innovation projects. The network evolvement is determined based on the evolvement of six network characteristics between the four phases of three innovation processes. Zaheer and Soda (2009) stated that more work was needed to explore the processes and conditions in which networks evolve. This research contributes to this point by exploring the processes and conditions in innovation projects to understand the evolvement of the innovation networks.

Third, this research studied the innovation performance by making use of four different performance measurements. In earlier studies the focus was mainly on the external measurements of innovation projects (Cooper, 1990; Tatikonda & Montoya-Weiss, 2001), while this study combined the internal measurements (project and technical performance) with the external measurements (market performance and satisfaction) and also studied the correlation between the different performance measurements.

Fourth, in this research relations are determined between the evolvement of particular network characteristics and the performance of the innovation. Patterns are found between innovation projects in the evolvement of network characteristics about the closeness of relationships, the level of reliability and the enthusiasm of network members during the project. This conclusion is a first step in answering the question that was stated by Dhanaraj and Parkhe (2006) how the network evolvement drives the innovation performance.

8.4 Practical relevance

This research shows several outcomes that have practical relevance regarding the organization of innovation projects and the innovation performance in innovation projects.

First, this research shows how the networks in three innovation projects are organized and developed over time. Since the three innovation projects can be considered to be successful innovation projects, the network structures and evolvements that are determined in these projects can be used as guidelines for future innovation projects. The three innovation projects showed that a high level for the six network characteristics is desired, but that it is not necessary to strive for an extreme high level. The only exception is the network characteristic enthusiasm for which an extreme high level is desired during the entire process.

Second, in this research four performance measurements are used to measure the innovation performance of the three innovation performance. To measure the innovation performance two internal and two external performance measurements are used, although the measurement market performance is used to determine the success of the innovation. The research further shows that a successful innovation has to have a specific level of technical performance and quality and that there is a positive correlation between the satisfaction with the functional performance and the market performance of the innovation.

Third, the results of the research show that the network characteristics close relationship, reliability and enthusiasm affect the market performance of the innovation, which is considered to be the indicator of the success of the innovation. These three network characteristics have to receive special attention in the formation and evolvement of the networks. However, the other three distinguished network characteristics should not be considered not to be important, but less attention have to be paid to bring these characteristics to a particular level.

9 RECOMMENDATIONS

Based on the discussion and the conclusions the recommendations could be determined. In this section recommendations are made about directions for future research and practical recommendations for Ballast Nedam.

9.1 Future research

Several directions for future research in the field of network dynamics and decision making emerge from the results and the limitations of this research.

First, it would be useful to study the network evolvement while the innovation project is executed. In this research a post-hoc analysis is conducted, but as mentioned in the limitations of the research some data might be flatted due to the period of time. If the network evolvement is studied while the project is executed not only the data might be less flatted, but it offers also the opportunities for the research to observe the network evolvement. Not only will the construct validity be improved if observartions are used as a measuring instrument, it also offers the opportunity to study the causes of network evolvement.

Second, it is interesting to conduct the same type of research in other industries. This research is conducted in the context of the construction industry, which is described as a complex product and system industry. It might be however interesting if the results of this research can be compared with similar research in other industries and compare the differences and similarties between the industries. The comparison will probably highlight the differences between the industries, but might offer also the opportunity to discover patterns that were not found in this research that are useful for innovation projects in the construction industry.

Third, a same type of research can be conducted in integral construction projects in which multiple organizations are involved. Although this direction of future research is not directly related to innovation management, integral construction projects and innovation projects show similarities in the formatizion of the organisation structure and the development process. Not only the network evolvement can be studied, also the decision making in integral construction projects is an interesting direction for research. In integral construction projects the decision-making processes are more structured and it is interesting if there are differences and similiraties in the decision-making processes of both types of projects.

Fourth, in this research the conclusions of this research are based on successful innovation projects and the effects of independent variables are determined based on the differences between the successful projects. It is however interesting if the same similarities and differences are determined if unsuccessful innovation projects are studied. A first step in this direction is to study innovations that are implemented, but are not commercial successful. A next step is to study innovation project that ended in one of three earlier phases. This way a successful innovation project can be compared for all phases of the innovation process.

Fifth, this research studied three dimensions of embeddedness: structural, relational and cognitive embeddedness. However, as mentiod in the theoretical framework three other dimensions are not used in this research: positional, cultural and political embeddedness. The first dimension is described as a sub component of the structural embeddedness, but the other two dimensions of embeddedness could be used in future research, especially if similar researches are conducted in different cultures.

Sixth, this research studied systemic product innovations in the construction industry. However, this type of innovations is rare in the construction industry; therefore it is interested to study other types of innovations. A first option is to study modular product innovations, which has a lower impact on the architectural knowledge compared to systemic innovations, but a higher impact on the component knowledge. A second option is to study process innovations instead of product innovations, which is a common type of innovation in the construction industry.

9.2 Practical recommendations

Based on the conclusions of the research and the observations of the researcher practical recommendations are made for Ballast Nedam regarding the execution of innovation project and innovation management in general.

First, in the conclusion it is stated that in successful innovation projects the level of enthusiasm is during the entire process extremely high, while the level of shared vision is relatively low during the innovation project. Further the conclusions show that also the levels of close relationship and reliability are factors that influence the innovation performance. In future project it is however the question if the involved persons in the innovation network notice the levels of these network characteristics. It is therefore recommended to assign a process manager in these innovation projects that guides the network evolvement in the innovation projects.

Second, the item enthusiasm scores during the entire innovation process in all three innovation projects extremely high. This might indicate that it is necessary that the involved organizations and people are enthusiastic if the innovation ultimately has to be successful. Because the level of enthusiasm is from the beginning extremely high, it might be necessary to create a workshop to stimulate the level of enthusiasm if it is not present yet.

Third, the levels of all five network characteristics regarding the relations between organizations (frequency of interaction, close relationship, reliability, promise keeping and shared vision) are high during all three innovation processes. However, to mimize the investment to bring the relations to a high level it is recommended to cooperate in innovation projects with well-known organizations and people. Only in case new knowledge is necessary not well-known organizations should be approached to participate.

Fourth, the innovation performance in this research is measured by making use of four performance indicators. Two performance indicators, namely the market performance and the rate of satisfaction, are measurements that are used at the end of the process, but the other two performance indicators, the technical performance and the project performance can be used during the entire process. If these performance indicators are used in during the entire process of new innovation projects, the results can be used to determine in earlier stages if the innovation project will become a success.

10 REFERENCES

Afuah, A.N., & Bahram, N. (1995). The Hypercube of Innovation. *Research Policy, 24*(1), 51-76.

Ahuja, G. (2000). Collaboration networks, structural holes, and innovation: A longitudinal study. *Administrative Science Quarterly, 45*(3), 425-455.

Ahuja, G., & Katila, R. (2001). Technological acquisitions and the innovation performance of acquiring firms: A longitudinal study. *Strategic Management Journal, 22*(3), 197-220.

Allison, P.D. (1982). Discrete-Time Methods for the Analysis of Event Histories. *Sociological Methodology, 13*, 61-98.

Badry, D. (2009). *Multinational companies in low-income markets: an analysis of social embeddedness in Southeast Asia*: Gabler.

Baker, W.E., & Sinkula, J.M. (1999a). Learning Orientation, Market Orientation, and Innovation: Integrating and Extending Models of Organizational Performance. *Journal of Market-Focused Management, 4*(4), 295-308.

Baker, W.E., & Sinkula, J.M. (1999b). The synergistic effect of market orientation and learning orientation on organizational performance. *Journal of the Academy of Marketing Science, 27*(4), 411-427.

Baldwin, C.Y., & Clark, K.B. (1997). Managing in an age of modularity. *Harvard Business Review, 75*(5), 84-&.

Balkundi, P., & Harrison, D.A. (2006). Ties, leaders, and time in teams: Strong inference about network structure's effects on team viability and performance. *Academy of Management Journal, 49*(1), 49-68.

Ballast Nedam. (2010). *Annual report - 2009*. Retrieved 26 April, 2012, from http://www.ballast-nedam.nl/content/files/SITE2/annualreports/BNannualreport_2009_EN_web.pdf

Ballast Nedam. (2011a). *Organisation, Profile*. Retrieved 19 December, 2011, from http://www.ballast-nedam.nl

Ballast Nedam. (2011b). *Organisation, Organisation structure*. Retrieved 19 December, 2011, from http://www.ballast-nedam.nl

Ballast Nedam. (2011c). *Organisation, Innovation*. Retrieved 19 December, 2011, from http://www.ballast-nedam.nl

Ballast Nedam. (2012). *Creating enduring quality: Annual report - 2011*. Retrieved 26 April, 2012, from http://www.ballast-nedam.nl/content/files/SITE2/annualreports/ar2011_lowress.pdf

Barabasi, A.L., & Bonabeau, E. (2003). Scale-free networks. *Scientific American, 288*(5), 60-69.

Barabasi, A.L., Jeong, H., Neda, Z., Ravasz, E., Schubert, A., & Vicsek, T. (2002). Evolution of the social network of scientific collaborations. *Physica a-Statistical Mechanics and Its Applications, 311*(3-4), 590-614.

Baum, J.A.C., Shipilov, A.V., & Rowley, T.J. (2003). Where do small worlds come from? *Industrial and Corporate Change, 12*(4), 697-725.

Bjork, J., & Magnusson, M. (2009). Where Do Good Innovation Ideas Come From? Exploring the Influence of Network Connectivity on Innovation Idea Quality. *Journal of Product Innovation Management, 26*(6), 662-670.

Blayse, A.M., & K., M. (2009). Key influences on construction innovation. *Construction Innovation, 4*(3), 143–154.

Borgatti, S.P., & Foster, P.C. (2003). The network paradigm in organizational research: A review and typology. *Journal of Management, 29*(6), 991-1013.

Borgatti, S.P., Mehra, A., Brass, D.J., & Labianca, G. (2009). Network Analysis in the Social Sciences. *Science, 323*(5916), 892-895.

Braster, J.F.A. (2000). *De kern van casestudy's*. Assen: Van Gorcum.

Brem, A., & Voigt, K.I. (2009). Integration of market pull and technology push in the corporate front end and innovation management-Insights from the German software industry. *Technovation, 29*(5), 351-367.

Brusoni, S., & Prencipe, A. (2001). Managing knowledge in loosely coupled networks: Exploring the links between product and knowledge dynamics. *Journal of Management Studies, 38*(7), 1019-1035.

Burk, W.J., Steglich, C.E.G., & Snijders, A.B. (2007). Beyond dyadic interdependence: Actor-oriented models for co-evolving social networks and individual behaviors. *International Journal of Behavioral Development, 31*(4), 397-404.

Burt, R.S. (1992). *Structural holes: the social structure of competition*. Cambridge, Mass.: Harvard University Press.

Burt, R.S. (2000). Decay functions. *Social Networks, 22*(1), 1-28.

Burt, R.S. (2001). Structural Holes versus Network Closure as Social Capital. In N. Lin, K. S. Cook & R. S. Burt (Eds.), *Social capital : theory and research* (pp. 31-56). New York: Aldine de Gruyter.

Carlsson, B., Jacobsson, S., Holmen, M., & Rickne, A. (2002). Innovation systems: analytical and methodological issues. *Research Policy, 31*(2), 233-245.

Chan, P.S., & Heide, D. (1993). Strategic alliances in technology: key competitive weapon. *Advanced Management Journal, 58*(4), 9-17.

Chen, K.M., & Liu, R.J. (2005). Interface strategies in modular product innovation. *Technovation, 25*(7), 771-782.

Chesbrough, H.W. (2003a). *Open innovation : the new imperative for creating and profiting from technology*. Boston, Mass.: Harvard Business School Press.

Chesbrough, H.W. (2003b). The era of open innovation. *Mit Sloan Management Review, 44*(3), 35-41.

Chesbrough, H.W. (2006). Open innovation: A New Paradigm for Understanding Industrial Innovation. In H. W. Chesbrough, W. Vanhaverbeke & J. West (Eds.), *Open Innovation: Researching a New Paradigm* (pp. 1-12). Oxford: Oxford University Press.

Coleman, J.S. (1988). Social Capital in the Creation of Human-Capital. *American Journal of Sociology, 94*, S95-S120.

Cooper, J.R. (1997). A multidimensional approach to the adoption of innovation. *Innovation in Technology Management - the Key to Global Leadership*, 183-183.

Cooper, R.G. (1990). Stage-Gate Systems - a New Tool for Managing New Products. *Business Horizons, 33*(3), 44-54.

Cooper, R.G. (2008). Perspective: The Stage-Gate (R) idea-to-launch process-update, what's new, and NexGen systems. *Journal of Product Innovation Management, 25*(3), 213-232.

Cooper, R.G., & Kleinschmidt, E.J. (1987). New Products - What Separates Winners from Losers. *Journal of Product Innovation Management, 4*(3), 169-184.

Crossan, M.M., & Apaydin, M. (2010). A Multi-Dimensional Framework of Organizational Innovation: A Systematic Review of the Literature. *Journal of Management Studies, 47*(6), 1154-1191.

Dacin, M.T., Ventresca, M.J., & Beal, B.D. (1999). The embeddedness of organizations: Dialogue & directions. *Journal of Management, 25*(3), 317-356.

Das, T.K., & Teng, B.S. (1997). Sustaining strategic alliances: options and guidelines. *Journal of General Management, 22*(4), 49-64.

Das, T.K., & Teng, B.S. (2000). A resource-based theory of strategic alliances. *Journal of Management, 26*(1), 31-61.

Das, T.K., & Teng, B.S. (2001). A risk perception model of alliance structuring. *Journal of International Management, 7*(1), 1-29.

Das, T.K., & Teng, B.S. (2002). The dynamics of alliance conditions in the alliance development process. *Journal of Management Studies, 39*(5), 725-746.

Dewar, R.D., & Dutton, J.E. (1986). The Adoption of Radical and Incremental Innovations - an Empirical-Analysis. *Management Science, 32*(11), 1422-1433.

Dhanaraj, C., & Parkhe, A. (2006). Orchestrating innovation networks. *Academy of Management Review, 31*(3), 659-669.

Dorée, A.G., & Van der Veen, B. (1999). *Strategische allianties in de bouw: Van hooggespannen verwachtingen naar concrete actie*. Enschede: University of Twente.

Doreian, P., & Stokman, F.N. (1997). The Dynamics and Evolution of Social Networks. In P. Doreian & F. Stokman (Eds.), *Evolution of social networks* (pp. 1-17). Amsterdam: Gordon and Breach Publishers.

Douma, M.U. (1997). *Strategic alliances : fit or failure.* Dissertation, University of Twente, Enschede.

Douma, M.U., Bilderbeek, J., Idenburg, P.J., & Looise, J.K. (2000). Strategic alliances - Managing the dynamics of fit. *Long Range Planning, 33*(4), 579-598.

Dul, J., & Hak, T. (2008). *Case study methodology in business research*. Boston, MA: Elsevier.

Dyer, J.H., & Singh, H. (1998). The relational view: Cooperative strategy and sources of interorganizational competitive advantage. *Academy of Management Review, 23*(4), 660-679.

Eisenhardt, K. (1989). Building Theories from Case Study Research. *The Academy of Management Review, 14*(4), 532-550.

Eisenhardt, K.M., & Martin, J.A. (2000). Dynamic capabilities: What are they? *Strategic Management Journal, 21*(10-11), 1105-1121.

Eisenhardt, K.M., & Schoonhoven, C.B. (1996). Resource-based view of strategic alliance formation: Strategic and social effects in entrepreneurial firms. *Organization Science, 7*(2), 136-150.

Elfring, T., & Hulsink, W. (2003). Networks in entrepreneurship: The case of high-technology firms. *Small Business Economics, 21*(4), 409-422.

Ettlie, J.E., Bridges, W.P., & Okeefe, R.D. (1984). Organization Strategy and Structural Differences for Radical Versus Incremental Innovation. *Management Science, 30*(6), 682-695.

Etzkowitz, H., & Leydesdorff, L. (2000). The dynamics of innovation: from National Systems and "Mode 2" to a Triple Helix of university-industry-government relations. *Research Policy, 29*(2), 109-123.

Flynn, M., Dooley, L., O'Sullivan, D., & Cormican, K. (2003). Idea management for organisational innovation. *International Journal of Innovation Management, 7*(4), 1-26.

Fombrun, C.J. (1982). Strategies for Network Research in Organizations. *Academy of Management Review, 7*(2), 280-291.

Friedkin, N.E. (1982). Information flow through strong and weak ties in intraorganizational social networks. *Social Networks, 3*(4), 273-285.

Garcia, R., & Calantone, R. (2002). A critical look at technological innovation typology and innovativeness terminology: a literature review. *Journal of Product Innovation Management, 19*(2), 110-132.

Gargiulo, M., & Benassi, M. (2000). Trapped in your own net? Network cohesion structural holes, and the adaptation of social capital. *Organization Science, 11*(2), 183-196.

Gatignon, H., Tushman, M.L., Smith, W., & Anderson, P. (2002). A structural approach to assessing innovation: Construct development of innovation locus, type, and characteristics. *Management Science, 48*(9), 1103-1122.

Geels, F.W., & Schot, J. (2007). Typology of sociotechnical transition pathways. *Research Policy, 36*(3), 399-417.

Glaister, K.W., & Buckley, P.J. (1996). Strategic motives for international alliance formation. *Journal of Management Studies, 33*(3), 301-332.

Gnyawali, D.R., & Madhavan, R. (2001). Cooperative networks and competitive dynamics: A structural embeddedness perspective. *Academy of Management Review, 26*(3), 431-445.

Granovetter, M. (1973a). The Strength of Weak Ties. *American Journal of Sociology, 78*(6), 1360-1380.

Granovetter, M. (1985). Economic-Action and Social-Structure - the Problem of Embeddedness. *American Journal of Sociology, 91*(3), 481-510.

Granovetter, M. (1992). Problems of explanation in economic sociology. In N. Nohria & R. Eccles (Eds.), *Networks and Organizations: Structure, Form, and Action* (pp. 25-56): Harvard University School Press.

Granovetter, M.S. (1973b). The Strength of Weak Ties. *American Journal of Sociology, 78*(6), 1360-1380.

Grant, R.M. (1996). Toward a knowledge-based theory of the firm. *Strategic Management Journal, 17*, 109-122.

Griffin, A., & Page, A.L. (1993). An Interim-Report on Measuring Product Development Success and Failure. *Journal of Product Innovation Management, 10*(4), 291-308.

Griffin, A., & Page, A.L. (1996). PDMA success measurement project: Recommended measures for product development success and failure. *Journal of Product Innovation Management, 13*(6), 478-496.

Gulati, R. (1995). Social structure and alliance formation patterns: A longitudinal analysis. *Administrative Science Quarterly, 40*(4), 619-652.

Gulati, R. (1998). Alliances and networks. *Strategic Management Journal, 19*(4), 293-317.

Gulati, R. (1999). Network location and learning: The influence of network resources and firm capabilities on alliance formation. *Strategic Management Journal, 20*(5), 397-420.

Gulati, R., & Gargiulo, M. (1999). Where do interorganizational networks come from? *American Journal of Sociology, 104*(5), 1439-1493.

Gulati, R., Nohria, N., & Zaheer, A. (2000). Strategic networks. *Strategic Management Journal, 21*(3), 203-215.

Hagedoorn, J. (1993). Understanding the Rationale of Strategic Technology Partnering - Interorganizational Modes of Cooperation and Sectoral Differences. *Strategic Management Journal, 14*(5), 371-385.

Hagedoorn, J. (2006). Understanding the cross-level embeddedness of interfirm partnership formation. *Academy of Management Review, 31*(3), 670-680.

Halinen, A., & Törnroos, J.Å. (1998). The role of embeddedness in the evolution of business networks. *Scandinavian Journal of Management, 14*(3), 187-205.

Hansen, M.T. (1999). The search-transfer problem: The role of weak ties in sharing knowledge across organization subunits. *Administrative Science Quarterly, 44*(1), 82-111.

Henderson, R.M., & Clark, K.B. (1990). Architectural Innovation - the Reconfiguration of Existing Product Technologies and the Failure of Established Firms. *Administrative Science Quarterly, 35*(1), 9-30.

Hite, J.M. (2003). Patterns of Multidimensionality among Embedded Network Ties: A Typology of Relational Embeddedness in Emerging Entrepreneurial Firms. *Strategic organization, 1*(1), 9-49.

Hitt, M.A., Dacin, M.T., Levitas, E., Arregle, J.L., & Borza, A. (2000). Partner selection in emerging and developed market contexts: Resource-based and organizational learning perspectives. *Academy of Management Journal, 43*(3), 449-467.

Hoang, H., & Antoncic, B. (2003). Network-based research in entrepreneurship - A critical review. *Journal of Business Venturing, 18*(2), 165-187.

Hofman, E. (2010). *Modular and architectural innovation in loosely coupled networks: matching customer requirements, product architecture, and supplier networks.* Dissertation, University of Twente, Enschede.

Hoozemans, S.S. (2005). *Successful Development of Innovation Networks: A Partner Selection Approach.* Master, Eindhoven University of Technology, Eindhoven.

Howell, J.M., & Higgins, C.A. (1990). Champions of Technological Innovation. *Administrative Science Quarterly, 35*(2), 317-341.

Howell, J.M., & Shea, C.M. (2001). Individual differences, environmental scanning, innovation framing, and champion behavior: key predictors of project performance. *Journal of Product Innovation Management, 18*(1), 15-27.

Ibarra, H. (1993). Network Centrality, Power, and Innovation Involvement - Determinants of Technical and Administrative Roles. *Academy of Management Journal, 36*(3), 471-501.

Kamann, D.-J.F., & Bakker, E.F. (2004). Changing supplier selection and relationship practices: a contagion process. *Journal of Purchasing and Supply Management, 10*(2), 55-64.

Kanter, R.M. (1988). When a 1000 Flowers Bloom - Structural, Collective, and Social Conditions for Innovation in Organization. *Research in Organizational Behavior, 10*, 169-211.

Kanter, R.M. (1994). Collaborative Advantage - the Art of Alliances. *Harvard Business Review, 72*(4), 96-108.

Kilduff, M., & Tsai, W. (2003). *Social networks and organizations*. London ; Thousand Oaks, Calif.: SAGE.

Kim, Y., Choi, T.Y., Yan, T.T., & Dooley, K. (2011). Structural investigation of supply networks: A social network analysis approach. *Journal of Operations Management, 29*(3), 194-211.

Kimberly, J.R., & Evanisko, M.J. (1981). Organizational Innovation - the Influence of Individual, Organizational, and Contextual Factors on Hospital Adoption of Technological and Administrative Innovations. *Academy of Management Journal, 24*(4), 689-713.

Kline, S.J., & Rosenberg, N. (1986). An overview of innovation. In R. Landau & N. Rosenberg (Eds.), *The Positive Sum Strategy: Harnessing Technology for Economic Growth* (pp. 275-305). Washington, D.C.: National Academy Press.

Koen, P., Ajamian, G., Burkart, R., Clamen, A., Davidson, J., D'Amore, R., . . . Wagner, K. (2001). Providing clarity and a common language to the "Fuzzy Front End". *Research-Technology Management, 44*(2), 46-55.

Koen, P.A., Ajamian, G.M., Boyce, S., Clamden, A., Fisher, E., Fountoulakis, S., . . . Seibert, R. (2002). Fuzzy Front End: effective methods, tools and techniques. In P. Belliveau, A. Griffin & S. Somermeyer (Eds.), *The PDMA toolbook for new product development* (pp. 5-36). New York: John Wiley & Sons.

Kogut, B. (1988). Joint Ventures - Theoretical and Empirical-Perspectives. *Strategic Management Journal, 9*(4), 319-332.

Kogut, B., & Zander, U. (1992). Knowledge of the Firm, Combinative Capabilities, and the Replication of Technology. *Organization Science, 3*(3), 383-397.

Koka, B.R., Madhavan, R., & Prescott, J.E. (2006). The evolution of interfirm networks: Environmental effects on patterns of network change. *Academy of Management Review, 31*(3), 721-737.

Kossinets, G., & Watts, D.J. (2006). Empirical analysis of an evolving social network. *Science, 311*(5757), 88-90.

Krackhardt, D. (1992). The Strength of Strong Ties - the Importance of Philos in Organizations. In N. Nohria & R. Eccles (Eds.), *Networks and Organizations: Structure, Form, and Action* (pp. 216-239): Harvard University School Press.

Langlais, R., Janasik, N., & Bruun, H. (2004). Managing Knowledge Network Processes In The Commercialization Of Science: Two Probiotica Discovery Processes In Finland And Sweden. *Science Studie, 17*(1), 34-56.

Lazer, D. (2001). The co-evolution of individual and network. *Journal of Mathematical Sociology, 25*(1), 69-108.

Lee, C., & Chen, W.J. (2007). Cross-functionality and charged behavior of the new product development teams in Taiwan's information technology industries. *Technovation, 27*(10), 605-615.

Li, D., Eden, L., Hitt, M., & Ireland, R. (2008). Friends, Acquaintances, or Strangers? Partner Selection in R&D Alliances. *The Academy of Management Journal ARCHIVE, 51*(2), 315-334.

Li, S.X., & Rowley, T.J. (2002). Inertia and evaluation mechanisms in interorganizational partner selection: Syndicate formation among US investment banks. *Academy of Management Journal, 45*(6), 1104-1119.

Lööf, H., & Heshmati, A. (2006). On the relationship between innovation and performance: A sensitivity analysis. *Economics of Innovation and New Technology, 15*(4-5), 317-344.

Madhavan, R., Koka, B.R., & Prescott, J.E. (1998). Networks in transition: How industry events (re)shape interfirm relationships. *Strategic Management Journal, 19*(5), 439-459.

Marsden, P.V. (1990). Network Data and Measurement. *Annual Review of Sociology, 16*, 435-463.

Marsden, P.V. (2002). Egocentric and sociocentric measures of network centrality. *Social Networks, 24*(4), 407-422.

Martin, M.J.C. (1994). *Managing innovation and entrepreneurship in technology-based firms*. New York: Wiley.

Medcof, J.W. (1997). Why too many alliances end in divorce. *Long Range Planning, 30*(5), 718-732.

Miles, M.B., & Huberman, A.M. (1994). *Qualitative data analysis: an expanded sourcebook* (2nd ed.). Thousand Oaks: Sage Publications.

Mintzberg, H., Raisinghani, D., & Theoret, A. (1976). The Structure of "Unstructured" Decision Processes. *Administrative Science Quarterly, 21*(2), 246-275.

Mizruchi, M.S., & Marquis, C. (2006). Egocentric, sociocentric, or dyadic? Identifying the appropriate level of analysis in the study of organizational networks. *Social Networks, 28*(3), 187-208.

Montoya-Weiss, M.M., & Calantone, R. (1994). Determinants of New Product Performance - a Review and Metaanalysis. *Journal of Product Innovation Management, 11*(5), 397-417.

Mowery, D.C., Oxley, J.E., & Silverman, B.S. (1996). Strategic alliances and interfirm knowledge transfer. *Strategic Management Journal, 17*, 77-91.

Nahapiet, J., & Ghoshal, S. (1998). Social capital, intellectual capital, and the organizational advantage. *Academy of Management Review, 23*(2), 242-266.

Nam, C.H., & Tatum, C.B. (1989). Toward Understanding of Product Innovation Process in Construction. *Journal of Construction Engineering and Management, 115*(4), 517-534.

Neely, A., Gregory, M., & Platts, K. (2005). Performance measurement system design - A literature review and research agenda. *International Journal of Operations & Production Management, 25*(12), 1228-1263.

Nelson, R.E. (1989). The Strength of Strong Ties - Social Networks and Intergroup Conflict in Organizations. *Academy of Management Journal, 32*(2), 377-401.

Nieto, M.J., & Santamaria, L. (2007). The importance of diverse collaborative networks for the novelty of product innovation. *Technovation, 27*(6-7), 367-377.

Oliver, C. (1990). Determinants of Interorganizational Relationships - Integration and Future-Directions. *Academy of Management Review, 15*(2), 241-265.

Olson, E.M., Walker, O.C., Ruekert, R.W., & Bonner, J.M. (2001). Patterns of cooperation during new product development among marketing, operations and R&D: Implications for project performance. *Journal of Product Innovation Management, 18*(4), 258-271.

Padula, G. (2008). Enhancing the innovation performance of firms by balancing cohesiveness and bridging ties. *Long Range Planning, 41*(4), 395-419.

Parkhe, A. (1993). Strategic Alliance Structuring - a Game-Theoretic and Transaction Cost Examination of Interfirm Cooperation. *Academy of Management Journal, 36*(4), 794-829.

Partanen, J., Chetty, S.K., & Rajala, A. (2011). Innovation Types and Network Relationships. *Entrepreneurship Theory and Practice*, no-no.

Parthasarthy, R., & Hammond, J. (2002). Product innovation input and outcome: moderating effects of the innovation process. *Journal of Engineering and Technology Management, 19*(1), 75-91.

Pearce, C.L., & Ensley, M.D. (2004). A reciprocal and longitudinal investigation of the innovation process: the central role of shared vision in product and process innovation teams (PPITs). *Journal of Organizational Behavior, 25*(2), 259-278.

Pittaway, L., Robertson, M., Munir, K., Denyer, D., & Neely, A. (2004). Networking and innovation: a systematic review of the evidence. *International Journal of Management Reviews, 5-6*(3-4), 137-168.

Porter, M.E. (1985). *Competitive advantage : creating and sustaining superior performance*. New York; London: Free Press; Collier Macmillan.

Powell, W.W. (1990). Neither Market nor Hierarchy - Network Forms of Organization. *Research in Organizational Behavior, 12*, 295-336.

Powell, W.W., White, D.R., Koput, K.W., & Owen-Smith, J. (2005). Network dynamics and field evolution: The growth of interorganizational collaboration in the life sciences. *American Journal of Sociology, 110*(4), 1132-1205.

Pries, F., & Dorée, A.G. (2005). A century of innovation in the Dutch construction industry. *Construction Management and Economics, 23*(6), 561-564.

PropertyNL. (2011). Winst en omzet 2010 Ballast Nedam vrijwel gelijk gebleven Retrieved 19 December, 2011, from http://www.propertynl.com/index-newsletter/winst-en-omzet-2010-ballast-nedam-vrijwel-gelijk-gebleven/

Provan, K.G., Fish, A., & Sydow, J. (2007). Interorganizational networks at the network level: A review of the empirical literature on whole networks. *Journal of Management, 33*(3), 479-516.

Reagans, R., & McEvily, B. (2003a). Network structure and knowledge transfer: The effects of cohesion and range. *Administrative Science Quarterly, 48*(2), 240-267.

Reagans, R., & McEvily, B. (2003b). Network structure and knowledge transfer: The effects of cohesion and range (vol 48, pg 251, 2004). *Administrative Science Quarterly, 48*(3), 554-554.

Reagans, R., Zuckerman, E., & McEvily, B. (2004). How to make the team: Social networks vs. demography as criteria for designing effective teams. *Administrative Science Quarterly, 49*(1), 101-133.

Reid, S.E., & de Brentani, U. (2004). The fuzzy front end of new product development for discontinuous innovations: A theoretical model. *Journal of Product Innovation Management, 21*(3), 170-184.

Rodan, S., & Galunic, C. (2004). More than network structure: How knowledge heterogeneity influences managerial performance and innovativeness. *Strategic Management Journal, 25*(6), 541-562.

Rogers, E.M. (2003). *Diffusion of innovations* (5th ed.). New York: Free Press.

Rothaermel, F.T., & Deeds, D.L. (2006). Alliance type, alliance experience and alliance management capability in high-technology ventures. *Journal of Business Venturing, 21*(4), 429-460.

Rowley, T., Behrens, D., & Krackhardt, D. (2000). Redundant governance structures: An analysis of structural and relational embeddedness in the steel and semiconductor industries. *Strategic Management Journal, 21*(3), 369-386.

Rutten, M.E.J., Dorée, A.G., & Halman, J.I.M. (2009). Innovation and interorganizational cooperation: a synthesis of literature. *Construction Innovation, 9*(3), 285-297.

Saeden, G., & Manseau, A. (2001). Public policy and construction innovation. *Building Research & Information, 29*(3), 182-196.

Sanchez, R., & Mahoney, J.T. (1996). Modularity, flexibility, and knowledge management in product and organization design. *Strategic Management Journal, 17*, 63-76.

Saunders, M., Lewis, P., & Thornhill, A. (2009). *Research methods for business students* (5th ed.). New York: Prentice Hall.

Saxton, T. (1997). The effects of partner and relationship characteristics on alliance outcomes. *Academy of Management Journal, 40*(2), 443-461.

Schilling, M.A., & Phelps, C.C. (2007). Interfirm collaboration networks: The impact of large-scale network structure on firm innovation. *Management Science, 53*(7), 1113-1126.

Scott, J. (2000). *Social network analysis : a handbook* (2nd ed.). London ; Thousands Oaks, Calif.: SAGE Publications.

Seaden, G., & Manseau, A. (2001). Public policy and construction innovation. *Building Research & Information, 29*(3), 182-196.

Shah, R.H., & Swaminathan, V. (2008). Factors influencing partner selection in strategic alliances: The moderating role of alliance context. *Strategic Management Journal, 29*(5), 471-494.

Shipilov, A.V. (2005). Should you bank on your network? relational and positional embeddedness in the making of financial capital. *Strategic organization, 3*(3), 279-309.

Silverman, B.S., & Baum, J.A.C. (2002). Alliance-based competitive dynamics. *Academy of Management Journal, 45*(4), 791-806.

Simsek, Z., Lubatkin, M.H., & Floyd, S.W. (2003). Inter-firm networks and entrepreneurial behavior: A structural embeddedness perspective. *Journal of Management, 29*(3), 427-442.

Snijders, T.A.B. (2001). The statistical evaluation of social network dynamics. *Sociological Methodology 2001, Vol 31, 31*, 361-395.

Snijders, T.A.B. (2005). Models for Longitudinal Network Data. In P. C. J. Scott & S. Wasserman (Eds.), *Models and methods in social network analysis* (pp. 215-247). New York: Cambridge University Press.

Spekman, R.E., Forbes, T.M., Isabella, L.A., & MacAvoy, T.C. (1998). Alliance management: A view from the past and a look to the future. *Journal of Management Studies, 35*(6), 747-772.

Spekman, R.E., Isabella, L.A., MacAvoy, T.C., & Forbes, T. (1996). Creating strategic alliances which endure. *Long Range Planning, 29*(3), 346-357.

Stokman, F.N., & Doreian, P. (1997). Evolution of Social Networks: Process and Principles. In P. Doreian & F. Stokman (Eds.), *Evolution of social networks* (pp. 233-250). Amsterdam: Gordon and Breach Publishers.

Swanborn, P.G. (1996). A common base for quality control criteria in quantitative and qualitative research. *Quality & Quantity, 30*(1), 19-35.

Tatikonda, M.V., & Montoya-Weiss, M.M. (2001). Integrating operations and marketing perspectives of product innovation: The influence of organizational process factors and capabilities on development performance. *Management Science, 47*(1), 151-172.

Tatum, C.B. (1989). Organizing to Increase Innovation in the Construction Firm. *Journal of Construction Engineering and Management, 115*(4), 602-617.

Teece, D.J. (2007). Explicating dynamic capabilities: The nature and microfoundations of (sustainable) enterprise performance. *Strategic Management Journal, 28*(13), 1319-1350.

Teece, D.J., Pisano, G., & Shuen, A. (1997). Dynamic capabilities and strategic management. *Strategic Management Journal, 18*(7), 509-533.

Tidd, J., & Bessant, J.R. (2009). *Managing innovation : integrating technological, market, and organizational change* (4th ed.). Hoboken, NJ: Wiley.

Trott, P. (2008). *Innovation management and new product development* (4th ed.). Harlow, England ; New York: Financial Times/Prentice Hall.

Tsai, K.H., & Hsieh, M.H. (2009). How different types of partners influence innovative product sales: Does technological capacity matter? *Journal of Business Research, 62*(12), 1321-1328.

Tsai, W.P. (2001). Knowledge transfer in intraorganizational networks: Effects of network position and absorptive capacity on business unit innovation and performance. *Academy of Management Journal, 44*(5), 996-1004.

Tsai, W.P., & Ghoshal, S. (1998). Social capital and value creation: The role of intrafirm networks. *Academy of Management Journal, 41*(4), 464-476.

Tushman, M., & Nadler, D. (1986). Organizing for Innovation. *California Management Review, 28*(3), 74-92.

Tushman, M.L. (1977). Special Boundary Roles in Innovation Process. *Administrative Science Quarterly, 22*(4), 587-605.

Ulrich, K. (1995). The Role of Product Architecture in the Manufacturing Firm. *Research Policy, 24*(3), 419-440.

Uzzi, B. (1996). The sources and consequences of embeddedness for the economic performance of organizations: The network effect. *American Sociological Review, 61*(4), 674-698.

Uzzi, B. (1997). Social structure and competition in interfirm networks: The paradox of embeddedness. *Administrative Science Quarterly, 42*(1), 35-67.

Van Aken, J.E., Berends, H., & Van der Bij, H. (2007). *Problem Solving in Organizations*. Cambridge: Cambridge University Press.

Van de Ven, A.H. (1986). Central Problems in the Management of Innovation. *Management Science, 32*(5), 590-607.

van de Vrande, V., de Jong, J.P.J., Vanhaverbeke, W., & de Rochemont, M. (2009). Open innovation in SMEs: Trends, motives and management challenges. *Technovation, 29*(6-7), 423-437.

Varadarajan, P.R., & Cunningham, M.P.H. (1995). Strategic alliances: A synthesis of conceptual foundations. *Journal of the Academy of Marketing Science, 23*(4), 282-296.

Verschuren, P., & Doorewaard, H. (2007). *Het ontwerpen van een onderzoek*. Den Haag: Lemma.

Veryzer, R.W. (1998). Discontinuous innovation and the new product development process. *Journal of Product Innovation Management, 15*(4), 304-321.

Vogt, W.P. (1993). *Dictionary of statistics and methodology : a nontechnical guide for the social sciences*. Newbury Park, Calif.: Sage Publications.

Vyas, N.M., Shelburn, W.L., & Rogers, D.C. (1995). An analysis of strategic alliances: forms, functions and framework. *Journal of Business Industrial Marketing, 10*(3), 47-60.

Wasserman, S., & Faust, K. (1994). *Social network analysis: methods and applications*. Cambridge ; New York: Cambridge University Press.

Wasserman, S., & Galaskiewicz, J. (1994). *Advances in social network analysis : research in the social and behavioral sciences*. Thousand Oaks, Calif.: Sage Publications.

Winch, G. (1998). Zephyrs of creative destruction: understanding the management of innovation in construction. *Building Research & Information, 26*(5), 268-279.

Wu, W.Y., Shih, H.A., & Chan, H.C. (2009). The analytic network process for partner selection criteria in strategic alliances. *Expert Systems with Applications, 36*(3), 4646-4653.

Yin, R.K. (2003). *Case study research: design and methods* (3rd ed.). Thousand Oaks, Calif.: Sage Publications.

Zaheer, A., & Bell, G.G. (2005). Benefiting from network position: Firm capabilities, structural holes, and performance. *Strategic Management Journal, 26*(9), 809-825.

Zaheer, A., & Soda, G. (2009). Network Evolution: The Origins of Structural Holes. *Administrative Science Quarterly, 54*(1), 1-31.

Zheng, W. (2010). A Social Capital Perspective of Innovation from Individuals to Nations: Where is Empirical Literature Directing Us? *International Journal of Management Reviews, 12*(2), 151-183.

Zouhaier, M.C. (2007). The Smart Card Firms' Network Positions:: A Social Network Analysis. *European Management Journal, 25*(1), 36-49.

Zukin, S., & DiMaggio, P. (1990). *Structures of capital: the social organization of the economy*. Cambridge England ; New York: Cambridge University Press.

11 APPENDICES

11.1 Appendix A: Questionnaire

11.1.1 Network characteristics

Strongly disagree	Disagree	Slightly disagree	Neutral	Slightly agree	Agree	Strongly agree
1	2	3	4	5	6	7

	Frequency of interaction	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**NA**
FRQ01	We had frequent contact with COMPANY A	O	O	O	O	O	O	O	O
FRQ02	We had frequent contact with COMPANY B	O	O	O	O	O	O	O	O
FRQ03	We had frequent contact with COMPANY C	O	O	O	O	O	O	O	O
FRQ04	We had frequent contact with COMPANY D	O	O	O	O	O	O	O	O

	Close relationship	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**NA**
CLS01	We maintained close relationships with COMPANY A	O	O	O	O	O	O	O	O
CLS02	We maintained close relationships with COMPANY B	O	O	O	O	O	O	O	O
CLS03	We maintained close relationships with COMPANY C	O	O	O	O	O	O	O	O
CLS04	We maintained close relationships with COMPANY D	O	O	O	O	O	O	O	O

	Reliability	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**NA**
REL01	We could rely on COMPANY A without any fear that they will take advantage of us even if the opportunity arises	O	O	O	O	O	O	O	O
REL02	We could rely on COMPANY B without any fear that they will take advantage of us even if the opportunity arises	O	O	O	O	O	O	O	O
REL03	We could rely on COMPANY C without any fear that they will take advantage of us even if the opportunity arises	O	O	O	O	O	O	O	O
REL04	We could rely on COMPANY D without any fear that they will take advantage of us even if the opportunity arises	O	O	O	O	O	O	O	O

	Promise keeping	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**NA**
PRM01	COMPANY A kept the promises they made to us	O	O	O	O	O	O	O	O
PRM02	COMPANY B kept the promises they made to us	O	O	O	O	O	O	O	O
PRM03	COMPANY C kept the promises they made to us	O	O	O	O	O	O	O	O
PRM04	COMPANY D kept the promises they made to us	O	O	O	O	O	O	O	O

Strongly disagree	Disagree	Slightly disagree	Neutral	Slightly agree	Agree	Strongly agree
1	2	3	4	5	6	7

	Shared vision	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**NA**
SHR01	We shared the same ambitions and vision with COMPANY A	O	O	O	O	O	O	O	O
SHR02	We shared the same ambitions and vision with COMPANY B	O	O	O	O	O	O	O	O
SHR03	We shared the same ambitions and vision with COMPANY C	O	O	O	O	O	O	O	O
SHR04	We shared the same ambitions and vision with COMPANY D	O	O	O	O	O	O	O	O

	Enthusiasm	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**NA**
ENT01	People in our firm were enthusiastic about pursuing the collective goals and missions of the project	O	O	O	O	O	O	O	O

11.1.2 Modular and architectural knowledge

Modular knowledge

Strongly disagree	Disagree	Slightly disagree	Neutral	Slightly agree	Agree	Strongly agree
1	2	3	4	5	6	7

	Modular Knowledge	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**NA**
MOD01	We thoroughly understood the basic knowledge of our components	O	O	O	O	O	O	O	O
MOD02	We thoroughly understood the basic knowledge of the underlying components of COMPANY A	O	O	O	O	O	O	O	O
MOD03	We thoroughly understood the basic knowledge of the underlying components of COMPANY B	O	O	O	O	O	O	O	O
MOD04	We thoroughly understood the basic knowledge of the underlying components of FIXED FOUNDATION	O	O	O	O	O	O	O	O
MOD05	We thoroughly understood the basic knowledge of the underlying components of COMPANY D	O	O	O	O	O	O	O	O

Architectural knowledge

Strongly disagree	Disagree	Slightly disagree	Neutral	Slightly agree	Agree	Strongly agree
1	2	3	4	5	6	7

	Architectural Knowledge	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**NA**
ARC01	We thoroughly understood the basic knowledge of how our components were linked with the components of COMPANY A	O	O	O	O	O	O	O	O
ARC02	We thoroughly understood the basic knowledge of how our components were linked with the components of COMPANY B	O	O	O	O	O	O	O	O
ARC03	We thoroughly understood the basic knowledge of how our components were linked with the components of COMPANY C	O	O	O	O	O	O	O	O
ARC04	We thoroughly understood the basic knowledge of how our components were linked with the components of COMPANY D	O	O	O	O	O	O	O	O

11.1.3 Innovation performance

Technical performance

Far worse than expected	Worse than expected	Slightly worse than expected	Exactly On Target	Slightly better than expected	Better than expected	Far better than expected
1	2	3	4	5	6	7

	Technical performance of system	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**NA**
TEC01	The technical performance of the entire system is	O	O	O	O	O	O	O	O	O	O

	Technical performance of components	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**NA**
TEC02	The technical performance of our component(s) is	O	O	O	O	O	O	O	O	O	O
TEC03	The technical performance of the component(s) of COMPANY A is	O	O	O	O	O	O	O	O	O	O
TEC04	The technical performance of the component(s) of COMPANY B is	O	O	O	O	O	O	O	O	O	O
TEC05	The technical performance of the component(s) of COMPANY C is	O	O	O	O	O	O	O	O	O	O
TEC06	The technical performance of the component(s) of COMPANY D is	O	O	O	O	O	O	O	O	O	O

Far worse than expected	Worse than expected	Slightly worse than expected	Exactly On Target	Slightly better than expected	Better than expected	Far better than expected
1	2	3	4	5	6	7

	Technical performance of interfaces	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**NA**
TEC07	The technical performance of the physical interactions between our components is	O	O	O	O	O	O	O	O	O	O
TEC08	The technical performance of the physical interactions of our component(s) with the component(s) of others is	O	O	O	O	O	O	O	O	O	O
TEC09	The technical performance of the physical interactions of our components with the component(s) of COMPANY A is	O	O	O	O	O	O	O	O	O	O
TEC10	The technical performance of the physical interactions of our components with the component(s) of COMPANY B is	O	O	O	O	O	O	O	O	O	O
TEC11	The technical performance of the physical interactions of our components with the component(s) of COMPANY C is	O	O	O	O	O	O	O	O	O	O
TEC12	The technical performance of the physical interactions of our components with the component(s) of COMPANY D is	O	O	O	O	O	O	O	O	O	O

Project performance

Strongly disagree	Disagree	Slightly disagree	Neutral	Slightly agree	Agree	Strongly agree
1	2	3	4	5	6	7

	Project performance	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**NA**
PRJ01	The quality of the innovation is higher in comparison with the planned objective	O	O	O	O	O	O	O	O
PRJ02	The total development costs of the innovation are lower in comparison with the planned objective	O	O	O	O	O	O	O	O
PRJ03	The total development time of the innovation is less in comparison with the planned objective	O	O	O	O	O	O	O	O

Market performance

Strongly disagree	Disagree	Slightly disagree	Neutral	Slightly agree	Agree	Strongly agree
1	2	3	4	5	6	7

	Market performance	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**NA**
MAR01	The innovation was successfully implemented	O	O	O	O	O	O	O	O
MAR02	The innovation has been commercially successful	O	O	O	O	O	O	O	O
MAR03	The Innovation has met the expectations regarding the innovation's impact on sales	O	O	O	O	O	O	O	O

	Sales performance	**Number**	**Scale**
SLV01	Sales volume of the entire system		# of systems sold
SLV02	Sales volume of our components		# of components sold

Satisfaction

Strongly disagree	Disagree	Slightly disagree	Neutral	Slightly agree	Agree	Strongly agree
1	2	3	4	5	6	7

	Satisfaction	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**NA**
SAT01	The innovation's technical design is satisfactory	O	O	O	O	O	O	O	O
SAT02	The innovation's functional performance is satisfactory	O	O	O	O	O	O	O	O

11.1.4 References

	Variable	Source	Adopted / Based
FRQ	Frequency of interaction	Tsai & Ghoshal (1998)	Adopted
CLS	Close relationship	Tsai & Ghoshal (1998)	Adopted
REL	Reliability	Tsai & Ghoshal (1998)	Adopted
PRM	Promise keeping	Tsai & Ghoshal (1998)	Adopted
SHR	Shared vision	Tsai & Ghoshal (1998)	Adopted
ENT	Enthusiasm	Tsai & Ghoshal (1998)	Adopted
MOD	Modular knowledge	Henderson & Clarck (1990)	Based
ARC	Architectural knowledge	Henderson & Clarck (1990)	Based
TEC	Technical performance	Tatikonda & Montoya-Weiss (2001)	Based
PRJ	Project performance	Lee & Chen (2007)	Based
MAR	Market performance	Gatignon, Tushman, Smith & Anderson (2002)	Adopted
SLV	Sales volume	Cooper & Kleinschmidt (1987); Griffin & Page (1993)	Adopted
MRS	Market share	Cooper & Kleinschmidt (1987); Griffin & Page (1993)	Adopted
SAT	Satisfaction	Olson, Walker, Ruekert & Bonner (2001)	Based

11.2 Appendix B: List of interviews

Duurzaam Speelbad

Function	Time	Date
Project leader	1 hrs	02-05-2012
Project leader	¾ hrs	30-05-2012
Head Development and Commerce	¾ hrs	12-06-2012

iQwoning

Function	Time	Date
Commercial manager	1 hrs	13-03-2012
Plan developer	1½ hrs	23-03-2012
Director	1½ hrs	29-05-2012
Head of business office	½ hrs	05-06-2012
Commercial manager	1 hrs	18-06-2012
Senior proces manager	1¼ hrs	20-06-2012
Plan developer	1½ hrs	16-07-2012

ModuPark

Function	Time	Date
Commercial manager	1 hrs	20-03-2012
Commercial manager	1 hrs	08-05-2012
Business development manager	1½ hrs	16-05-2012
Commercial manager	1 hrs	16-05-2012
Business development manager & commercial manger	1½ hrs	26-06-2012

11.3 Appendix C: Interpretation of boxplots

Vogt (Vogt, 1993) describes a boxplot, also known as a Box-and-Whisker Diagram as follows in the example below:

Box-and-Whisker Diagram – A type of graph in which boxes and lines show a distribution's shape, centreal tendency, and variability. The "boxplot," as it is often called, gives a highly informative picture of the values of a single variable and is especially helpful for indicating wether a distribution is skewed and has outliers.

In the following example, tow box-and-whisker diagrams are used for comparing distributions. The grade point averages (GPAs) of individual students in two groups are diagrammed. Here is some of the information necessary to interpret the diagram. (Terms and symbols vary, but the following conventions are fairly common and illustrate the main concepts.)

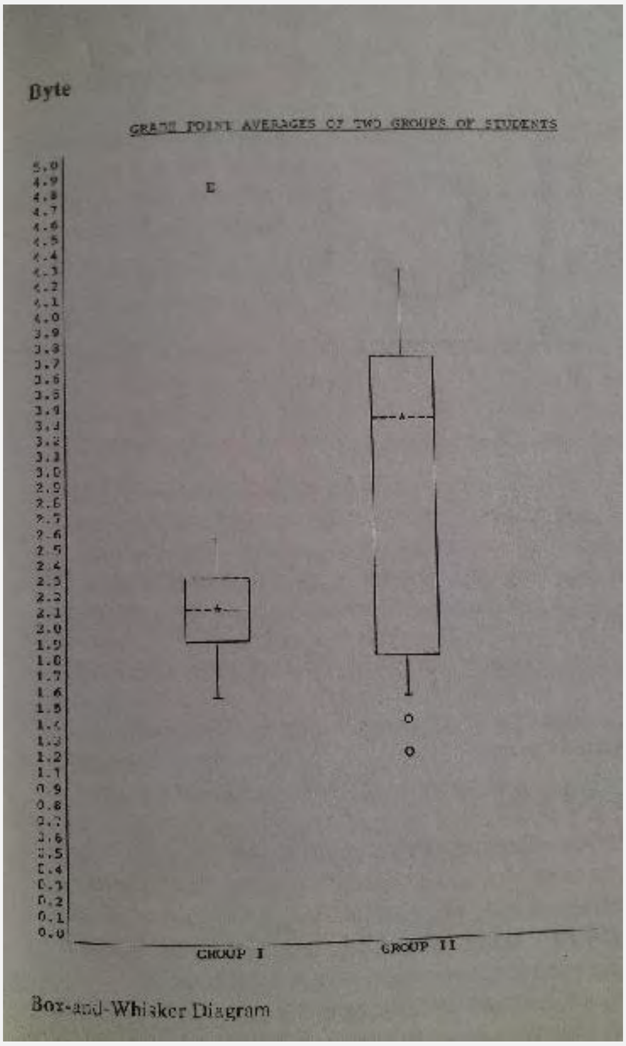


Figure 11.1: Box-and-Whisker Diagram

1. The upper and lower boundaries of each box (called hinges) are drawn at the 75th and 25th percentiles; this means that the box represents the interquartile range (IQR), that is, the middle 50% of the values in the distribution.
2. The line marked with the asterisk, --*--, shows the distribution's median.

3. The “whiskers” are the lines extending from the boxes. They reach to the largest and smallest GPAs that are less than 1 interquartile range (IQR) from the ends of the boxes.
4. Any points beyond the gigh and low points of the whiskers are outliers (if they are less than 1.5 iQRs from the end of the box) and are marked with an “O”. If tey are more than 1.5 IQRs from the end, they are extreme outliers and are indicated by an “E”.
5. Comparing the two boxplots, we can see that the variability in Group II is much greater than it is in Group I. Also, Group I’s median GPA is much lower than Group II’s. This is true dispite the fact that the highest single GPA was earned by a student in Group I (the extreme outlier, E) and even though the lowest GPAs were earned by students in Group II (the outliers marked by the Os).

11.4 Appendix D: Research model