Decision making in innovation projects: the case of the construction industry

The influence of decision making on the innovation performance in the construction industry

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Ballast Nedam

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“If a man does not keep pace with his companions, perhaps it is because he hears a different drummer. Let him step to the music which he hears, however measured or far away.”

HENRY DAVID THOREAU

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 decisions are made about the product, but also about the cooperation between organizations that are involved in the innovation process. It is likely that these decisions influence the results of the innovation process and the innovation performance. This research aims to understand the decision making in innovation projects and the effect of the decision making on the innovation performance.

Research design

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

How does the decision making in an innovation project 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 characteristics of a decision-making process, to establish the decisions in an innovation projects 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, the characteristics of a decision-making process and the decisions in an innovation project. 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 multiple organizations can be involved in innovation projects. Strategic alliances between the organizations are formed to have access to external knowledge that is used to develop innovations and external paths to expand the markets. 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.

During the innovation process various decisions are made that are related to the development of the innovation. The decisions in innovation projects differ in level and in type. This research focuses on strategic decisions, which are decisions that are complex, political and uncertain and important for the innovation project. The different types of decisions that can be distinguished are organizations decisions, operations decisions, product decisions and marketing decisions. The decision-making process of a decision consists of four phases and seven routines. However, it is not necessary that all phases and routines are completed in a decision-making process. Further, the decision can be made in different phases of the innovation process and also the decision makers can differ, especially if multiple organizations are involved in the innovation project.

Game theory is the study of mathematical models that can be applied to describe the decision-making processes in innovation projects in which multiple decision makers are involved. The basic assumptions of game theory are that decision makers are rational and think strategically. This means that the decision makers are taking into account the knowledge and expectations of other decision makers. Three game types can be distinguished that can be applied in innovation projects. The first type is the strategic game, which is a non-cooperative game and decision makers make their decision independently of each other. The second game type is an extensive game with imperfect information, which is also a non-cooperative game, but in this game the decision makers take into account the decisions of other decision makers. The third type is a coalitional game, which is a cooperative game and decisions are made in a coalition of decision makers.

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 innovation performance, while the

document study and the semi-structured interviews are used to collect supporting data about the innovation project and the decision making in the innovation project.

The collected data is analyzed in a two-step analysis. Firstly, the data about the decision making 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 decision making and the innovation performance. Also the effect of the decision making 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.

In the three innovation projects four types of decisions are distinguished: organizations decisions, operations decisions, product decisions and marketing decisions. The organizations decisions are made in all four phases of the innovation process, although the most decisions of this type are made in the internal-oriented phases 'idea generation and selection' and 'development and testing'. Operations decisions are also mainly made in these two phases, although some decisions of this type are also made during the pilot project. Decisions about the product are made in the phases 'idea generation and selection', 'development and testing' and 'implementation and diffusion'. Marketing decisions are mainly made in the external-oriented phases: 'pilot project' and 'implementation and diffusion'.

Three game types are distinguished in the innovation projects that are studied: strategic games, extensive games with imperfect information and coalitional games. Strategic games are not played in the first phase, but this game type is played in the other three phases. The other two game types are observed in all four phases of the innovation process. An explanation that these two game types are present in all phases is that in most of the cases an extensive game with imperfect information is followed by a game of the same type or a coalitional game, or the other way around.

The effect of the decision making on the innovation performance is descriptive determined. If the most successful innovation projects are perceived based on its characteristics differences are noticed regarding the distribution of decisions and the games that are played. In the technology-push innovation project iQwoning® a large percentage of operations decisions are determined, while in the market-pull innovation project ModuPark® the product decisions represent the largest share of the decisions. With respect to the games that are played in the two innovation projects there is a difference between the number of decision makers in the decision-making processes. In the innovation project iQwoning® in most of the decision-making process multiple decision makers are involved, while in the project ModuPark® a third of the decisions is made by a single decision maker.

Recommendations

This research offers various directions of future research, because in the field of decision making there is a lack of knowledge about the dynamics of decision making. 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 decision making 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 the consequences of decisions. Also the effect of decision making on the network evolvement could be studied. The second type of future research is about the environment of decision making. In this research the decision making in systemic product innovation projects are studied, but in future research decision making in other types of projects or industries could be studied to increase the insight in decision making.

Practical recommendations are mainly related to the start of the innovation process. At the start of the process the potential market of the innovation should be determined instead of during the innovation process the potential market is determined or adjusted, which can save time and money. Besides determining the market earlier in the process it is recommended to determine the possibilities of the innovation and which needs in other markets or market segments can be fulfilled with the innovation. Regarding the marketing of the innovation an alliance can be formed with a marketing firm to improve the implementation and diffusion of the innovation. 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 master thesis is the final assignment that I made as a student Civil Engineering. Seven years ago I started with the bachelor Civil Engineering, which was not a strange choice. As a child I wrote reports about The Netherlands and their relation with water and held a public speech about the Delta Works. Although during my time as a student my interest moved from the discipline water management to the discipline construction management, I kept my interest in civil engineering as a broad discipline. Even the second master program in the field of Business Administration that I followed did not change my interest in this discipline. The contrary, this second master program enhanced my insight and increased my interest in civil engineering.

The topic of this thesis, the decision making in innovation projects, is the result of the other master thesis that I also conducted at Ballast Nedam. The presence of a mathematician in my graduation committee of my master thesis Business Administration offered the link to game theory and subsequently to decision making. Game theory is a study of decision making by making use of mathematical models. However, in this thesis the practical application of these models is studied. Although I was not familiar with this topic, from the first moment it had my interest and it was interesting to see how the mathematical models could be applied in the studied innovation projects.

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 to thank the friends that I made during my student days. Together with the activities that I conducted during my time at the university my friends formed me to the person I am today. Third 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!

One of the conclusions of this research is that playing coalitional games in innovation projects leads to success and the same is applicable in real life. By finishing my master Construction Management & Engineering I can state that together with the help of my family and friends I ended my study successful, but more important is that I can state that my entire period as a student was a success thanks to my family and friends.

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 Consturction Management and Engineering 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 decision making on the innovation performance in innovation projects. 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 'Network evolvement in innovation projects: the case of the construction industry', which is conduced by order of the master Business Administration of the faculty School of Management and Governance, describes the influence of network evolvement in innovation projects on the innovation performance.

1.1 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 was before 2009 an ad hoc process that was arranged according to the decentralized organization of Ballast Nedam N.V. 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. The innovation processes in which these firms collaborate can be described as a "series of steps, activities, decisions and goals" (Song, Dyer, & Thieme, 2006).

The goals in an innovation process can be common goals that are shared by various parties, but also individual goals that are allocated to specific parties. In case the common goals and the individual goals of the involved parties are not aligned, parties have to make decisions to align the common and individual goals. These decisions can have effect on the goals that previously were set, the outcomes of the innovation project, the innovation process and the innovation performance (Mintzberg, Raisinghani, & Theoret, 1976; Eisenhardt & Zbaracki, 1992; Song *et al.*, 2006).

1.2 Company: Ballast Nedam

The research is conducted at Ballast Nedam N.V. by order of the master Construction Management & Engineering of the faculty Engineering Technology 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).

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.

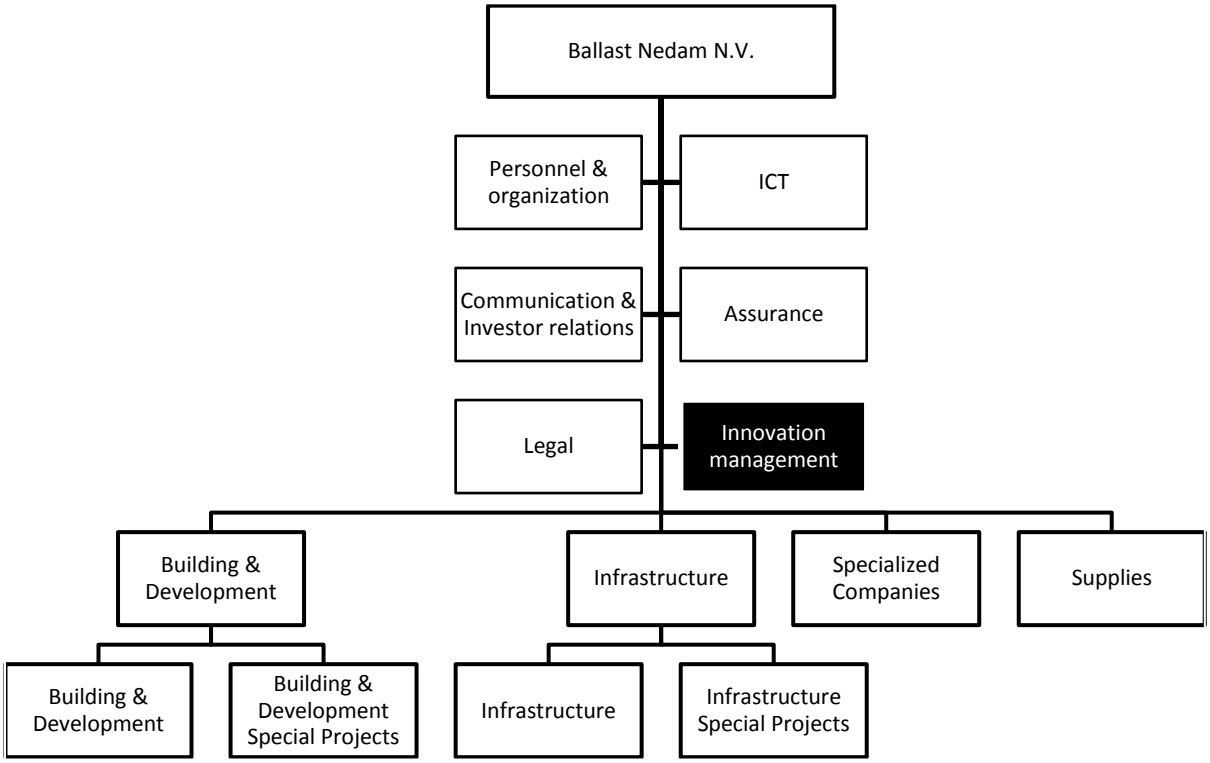


Figure 1.1: Organizational structure Ballast Nedam N.V.

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 theoretical development in the field of collaboration in innovation projects (Kogut, 1988; Varadarajan & Cunningham, 1995; Vyas, Shelburn, & Rogers, 1995), strategic

decision making in innovations projects (Mintzberg *et al.*, 1976; Eisenhardt & Zbaracki, 1992) and game theory in practice (Nash, 1950; Shapley, 1953; Osborne, 2004; Peters, 2008).

1.3.2 Practical relevance

The practical contribution of the research is to create insight in the decisions made in systemic product innovation projects, the processes of decision making in the innovation projects, the games played in thsee decision-making processes and the effect of the decision making on the innovation performance of systemic product innovation projects.

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

Scholars have conducted studies on cooperative innovations between firms (Walters & Rainbird, 2007; Bosch-Sijtsema & Postma, 2009), the decision making regarding the adoption and diffusion of innovations (Rogers, 2003; Kennedy & Fiss, 2009; Peres, Muller, & Mahajan, 2010) and the causal relationship between the decisions in the innovation process (Galanakis, 2006), but still there is a lack of insight how the decision making in inter-firm innovation processes occur and how the decisions that are made affect future decisions, the innovation process and the outcome of the innovation process.

Eisenhardt and Zbaracki (1992) described that decision making is an interweaving of bounded rationality and political processes. Decision making is boundedly rational since decision makers are cognitively limited and political since decisions makers engage in politics and use their powers to influence decisions. Decision makers in innovation processes use their powers and form coalitions to pursue their goals which have affect on the composition of the networks and the relationships in these networks (Fredrickson, 1986; Eisenhardt & Zbaracki, 1992). Nevertheless, it is unclear how the decision making in innovation projects occurs and how it affects the innovation performance.

Ballast Nedam wishes to improve its innovation management by understanding better the decision making 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 and decision making in innovation projects the following problem statement is formulated:

> *Ballast Nedam wishes to improve its innovation management by creating a better understanding of the decision making in innovation projects and the effect of decision making on the innovation performance, since by creating a better understanding of the decision making 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 decision making in the innovation projects of Ballast Nedam and its effect on the innovation performance*

The objective in the research is formulated as follows:

> *Capturing the decision-making processes in three innovation projects of Ballast Nedam and determining how the decision making in these projects affects the performance of systemic product innovation of Ballast Nedam*

2.3 Research questions

The central research question is derived from the research objective and the sub-objectives:

Central research question

> *How does the decision making in an innovation project affect the performance of a systemic product innovation of Ballast Nedam?*

Sub questions

1.1. How can the decision-making process be characterized?
1.2. Which models of decision making can be distinguished in an innovation process?
1.3. How can the decision-making processes in the different phases of an innovation process be characterized?
1.4. How are the decision-making processes in an innovation project linked to each other?
1.5. Which factors of the decision making in an innovation project have effect on 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, what 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 decision-making processes 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 decision making in the systemic innovation projects and the innovation performance. 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

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). However, in this research only data about the innovation performance is used. 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 used within this research to collect data about the decision-making processes in the selected cases. The choice to use semi-structured interviews is based upon the explanatory character of this research (Yin, 2003; Dul & Hak, 2008; Saunders *et al.*, 2009). Although the respondents are given the opportunity to talk freely about the decision-making processes a framework for decision-making processes (Mintzberg *et al.*, 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 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.
4. The innovation performance of the innovations is analyzed for four 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 strategic decisions in the innovation projects are described on basis of the moment the strategic decisions were made and by using the typology of decisions in innovation processes as determined in the theoretical framework. A time-ordered matrix is used to present the analyzed date (Miles & Huberman, 1994). The analysis is based on the semi-structured interviews.
6. The strategic decision-making processes are described by using a model based on the framework of Mintzberg et al. (1976) and a checklist matrix (Miles & Huberman, 1994). For each decision-making processes the completed phases and routines are described. The analysis is based on the semi-structured interviews.
7. The linkage of strategic decisions is described by making use of the decision context and the decision-making process. The analysis is based on the semi-structured interviews.

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 matrices (Vogt, 1993).
2. The strategic decisions of the 3 innovation projects are analyzed by making use of a time-ordered matrix (Miles & Huberman, 1994).
3. The strategic decision-making processes are analyzed by using a model based on the framework of Mintzberg et al. (1976) and thematic conceptual matrix (Miles & Huberman, 1994).
4. The linkage of the strategic decisions is analyzed by making use of the causal chain technique (Miles & Huberman, 1994).

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, by verifying the descriptions of decision-making processes and by using three case studies. Finally, the reliability of the time and circumstances of the measurements are increased by interviewing the representatives of the innovation network at their own offices to make them feel comfortable.

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.

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 decision making, game theory and strategic alliances. 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. The multiple case study is conducted in two steps. In the first step data about the innovation performance and decision making in innovation projects is collected, analyzed and compared. During the second step the data about decision making and innovation performance is discussed to determine the effect of decision making on the innovation performance. 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, 1.4 and 1.5.

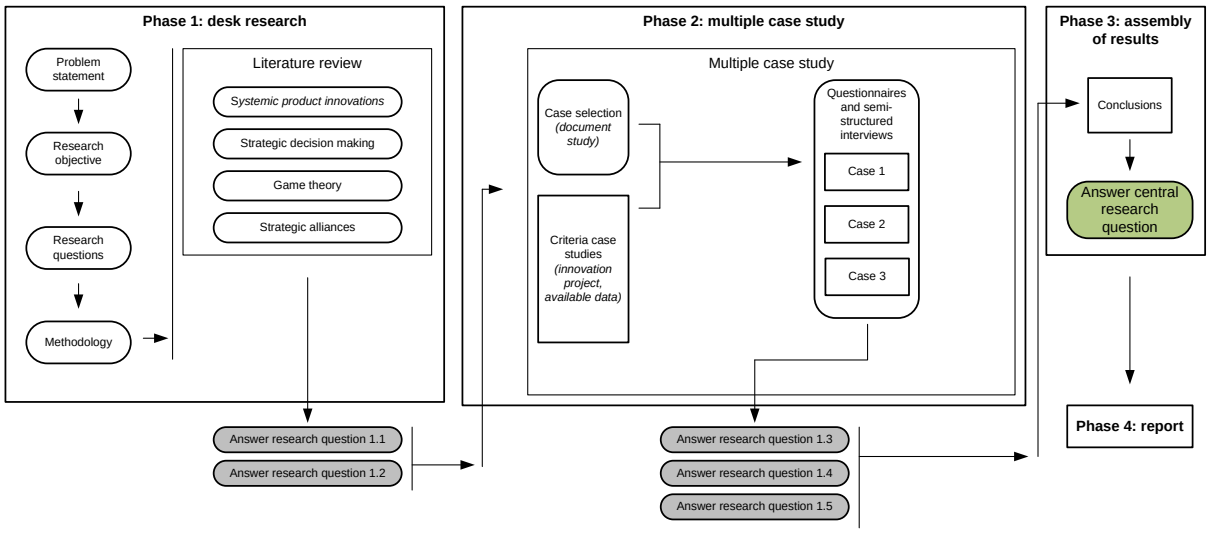


Figure 2.1: Research model master thesis

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 questions and to generalize the outcomes about decision making and innovation performance 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), followed by the theory behind strategic alliance (paragraph 3.2). Furthermore the theories about strategic decision making (paragraph 3.3) and game theory (paragraph 3.4) are discussed. Finally a concluded paragraph (paragraph 3.5) 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.

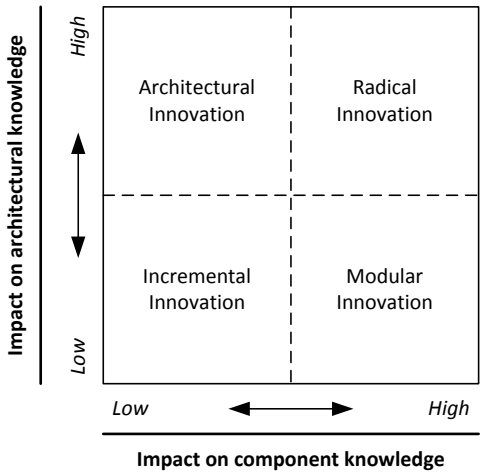


Figure 3.1: Framework for defining innovations (Henderson & Clark, 1990)

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 business case analysis, 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.

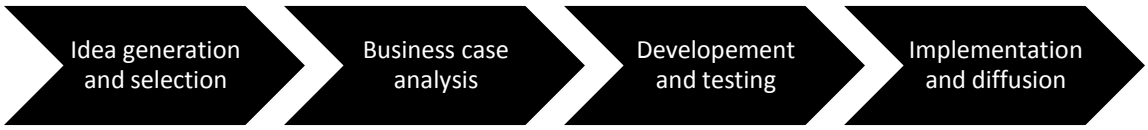


Figure 3.2: Innovation process (Kanter, 1988)

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.

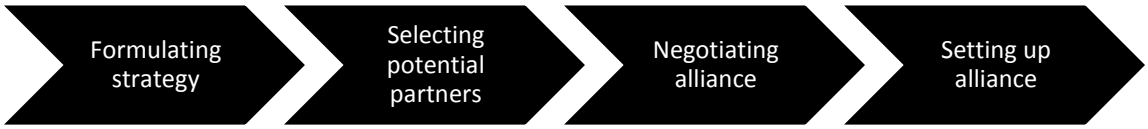


Figure 3.3: Stages of the formation process (based on Das & Teng, 2002)

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.

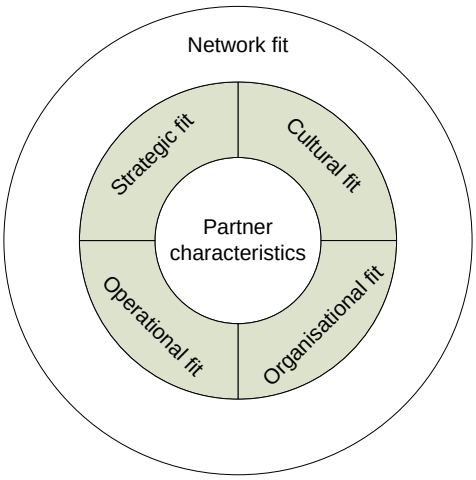


Figure 3.4: Selection chart (based on Hoozemans, 2005)

3.3 Strategic decision making

3.3.1 Decisions in innovation projects

During the entire innovation process decisions are made that are directly or indirectly related to the development of an innovation (Kanter, 1988; Cooper, 1990; Rogers, 2003). The decisions in an innovation process differ in the moment that a decision is made (Cooper, 1990), the level of decision making (Schmidt & Wilhelm, 2000), the decision perspective (Krishnan & Ulrich, 2001) and the type of decision (Rogers, 2003). Decisions in an innovation process will be categorized based on the level a decision is made, the decision perspective that is used how the decision is made and whom makes the decision (Schmidt & Wilhelm, 2000; Krishnan & Ulrich, 2001; Rogers, 2003).

Decision level

The hierarchy in decision making distinguishes three levels: strategic, tactical and operational (Schmidt & Wilhelm, 2000; Gunasekaran, Patel, & McGaughey, 2004). According to the literature on decision making, decisions at a strategic level refer to the decisions that influence an entire organization and are made by the top management (Gunasekaran *et al.*, 2004). However, in case of innovation projects strategic decisions concern the selection of firms to cooperate with, the type of alliances and the organisation of the innovation project in outline (Ortt & Van der Duin, 2008). Tactical decisions deals with the resource allocation, the process flows and the quality of the innovation (Gunasekaran *et al.*, 2004; Ortt & Van der Duin, 2008). The operational decisions are the daily decisions in an innovation project, i.e. the scheduling of tasks (Schmidt & Wilhelm, 2000).

Decision perspective

Decisions in an innovation project can be perceived from different perspectives. Krishnan & Ulrich (2001) distinguished four perspectives: engineering design, marketing, operations management and organizations (Krishnan & Ulrich, 2001). The engineering design perspective concerns the decisions about the characteristics and quality of the product innovation (Krishnan & Ulrich, 2001) and is the main decision perspective in the stage-gate model developed by Cooper (1990). The marketing perspective focuses on the decisions regarding the marketplace and therefore has a more external perspective (Krishnan & Ulrich, 2001; Tatikonda & Montoya-Weiss, 2001). The operations management perspective on the other hand has an internal perspective and is about the processes in an innovation project (Krishnan & Ulrich, 2001; Tatikonda & Montoya-Weiss, 2001). The organizations perspetive is about the decisions regarding the organization of the innovation project (Krishnan & Ulrich, 2001).

Types of decisions

Rogers (2003) mentioned in his book *Diffusions of Innovations* three types of innovation decisions: optional, collective and authority innovation-decisions. Although these types refer to the decision to adopt or reject an innovation, the classification designed by Rogers can be used to classify decisions during the entire innovation process (Rogers, 2003). Optional innovation-decisions are decisions that are made by an individual independent of other actors. A collective innovation-decision is made by consensus among the actors involved in the innovation process, while an authority innovation-decision is made by a few individuals with the necessary power. A fourth type innovation-decision is the contingent innovation-decision that only can be made after a prior innovation-decision. This type of decision is a sequential combination of two or more of the three innovation-decisions.

3.3.2 Strategic decision making

Strategic decision making has been the topic of various scholars, although there is no consensus about the definition of "strategic decision" (Mintzberg *et al.*, 1976; Eisenhardt & Zbaracki, 1992; Saxton, 1995; Schwenk, 1995; Papadakis, Lioukas, & Chambers, 1998; Nutt, 2008). This research follows the definitions of a strategic decision that are used by Mintzberg et al. (1976) and Nutt (2008). The definition of a strategic decision-making process is adopted form Mintzberg et al. (1976).

DEFINITION 4

- A **strategic decision** is important, in terms of the actions taken, the resources committed, or the precedents set, and has long term effects (Mintzberg *et al.*, 1976; Nutt, 2008).

DEFINITION 5

- A **strategic decision-making process** is "a set of actions and dynamic factors that begins with the identification of a stimulus for action and ends with the specific commitment to action" (Mintzberg *et al.*, 1976, p. 246).

Strategic decisions can be characterized based upon decision-specific factors (Eisenhardt & Zbaracki, 1992; Rajagopalan, Rasheed, & Datta, 1993; Papadakis *et al.*, 1998). The most frequently distinguished factors are the complexity, politicality and uncertainty of the decision (Butler, Davies, Pike, & Sharp, 1991; Cray, Mallory, Butler, Hickson, & Wilson, 1991; Eisenhardt & Zbaracki, 1992; Rajagopalan *et al.*, 1993). The complexity of a decision refers to the interests of the involved organizations, the consequences of the decision and familiarity of the type of decision (Butler *et al.*, 1991; Cray *et al.*, 1991; Eisenhardt & Zbaracki, 1992). Politicality is about the internal and external influences of actors and the balance in the different interests of the involved organizations (Butler *et al.*, 1991; Cray *et al.*, 1991). The level of decision uncertainty is based upon the risks associated with the decision, the collection of the necessary information, the actions to be taken and the outcome of the decision (Butler *et al.*, 1991; Rajagopalan *et al.*, 1993; Papadakis *et al.*, 1998). Other decision-specific factors that are mentioned in the literature are the impetus of the decision (Rajagopalan *et al.*, 1993), the pressure to make a decision (Papadakis *et al.*, 1998) and the importance or urgency of the decision (Rajagopalan *et al.*, 1993; Nutt, 2008), although the concept of a strategic decision comprehends these factors (Mintzberg *et al.*, 1976).

Also a strategic decision-making process can be characterized based upon determined factors (Rajagopalan *et al.*, 1993). The literature distinguishes the following factors that are frequently used to describe a strategic decision-making process: comprehensiveness, sources of information, interaction, process flow, duration, centralization and formalization (Cray, Mallory, Butler, Hickson, & Wilson, 1988; Rajagopalan *et al.*, 1993; Papadakis *et al.*, 1998). Comprehensiveness is a measure of rationality and is about *"the extent to which organizations attempt to be exhaustive or inclusive in making and integrating strategic decisions"* (Fredrickson, 1984, p. 445). The sources of information refers to the internal and external sources of information and views in the decision-making process (Cray *et al.*, 1988). Interaction concerns the informal and formal interaction between decision-makers and the scope of negotiations (Cray *et al.*, 1988; Papadakis *et al.*, 1998). The process flow refers to the reasons, occurrence and length of disruptions in the decision-making process (Cray *et al.*, 1988). The duration is about the length and duration to finish the decision-making process (Cray

et al., 1988; Rajagopalan *et al.*, 1993). Centralization refers to the level of centrality the decision was authorized (Cray *et al.*, 1988; Papadakis *et al.*, 1998). Formalization concerns the level of standardization of the decision-making process (Papadakis *et al.*, 1998).

3.3.3 Paradigms in strategic decision making

The literature on strategic decision making consists of various approaches and models to understand strategic decision making (Eisenhardt & Zbaracki, 1992; Schoemaker, 1993; Elbanna, 2006; Gehner, 2008). The approaches and models are in turn based upon various paradigms. The most dominant paradigms that can be distinguished in the literature and are discussed in this paragraph are rationality and bounded rationality, politics and power and the contextual view (Eisenhardt & Zbaracki, 1992; Schoemaker, 1993; Elbanna, 2006; Gehner, 2008).

Rationality and bounded rationality

The rational model in strategic decision making assumes that a decision-maker enters a decision situation with clear objectives and purposes and further has all the information about the situation and possible solution to come to a decision (Eisenhardt & Zbaracki, 1992). Simon (1955) introduced a more accurate representation of the actual decision-making process. In the concept of bounded rationality Simon states that decision-makers have cognitive limitations and lack complete information to make a decision (Simon, 1955; Eisenhardt & Zbaracki, 1992). Decision-makers move along the continuum of rationality versus bounded rationality (Eisenhardt & Zbaracki, 1992). In the literature on organisational decision making two streams can be identified to describe the moving along the continuum: procedural rationality and rule following behaviour (Schoemaker, 1993; Gehner, 2008). Procedural rationality is the extent to which decision-makers collect in the decision-making process relevant information about alternatives and analyze this information to come to a decision (Dean & Sharfman, 1993; Elbanna, 2006). Rule following behaviour in decision-making processes refers to standard patterns of behaviour in an organization to make decisions based on rules and programs (Mazzolini, 1981; Elbanna, 2006).

Politics and power

Strategic decision-making processes are considered to be political due to uncertain outcomes, actors that have conflicting goals and the role of power in decision making (Eisenhardt & Zbaracki, 1992; Gehner, 2008). Similar to the boundedly relational model, the political model is a more accurate description of the actual decision processes (Eisenhardt & Zbaracki, 1992). According to Eisenhardt and Bourgeois (1988) “politics are the observable, but often covert, actions by which executives enhance their power to influence a decision. These actions include behind-the-scenes coalition formation, offline lobbying and cooptation attempts, withholding information, and controlling agendas” (Eisenhardt & Bourgeois, 1988, pp. 737-738). A first feature of the political model is that actors might use these powers due to conflicting goals or views and are determined to achieve these goals (Eisenhardt & Zbaracki, 1992). A second feature is that the decision reflects the preferences of the most powerful actors in the process (Eisenhardt & Bourgeois, 1988; Eisenhardt & Zbaracki, 1992). However, a third feature of the model is that actors, due to the power distribution, sometimes cooperate with other actors (Eisenhardt & Zbaracki, 1992; Schoemaker, 1993). Examples of cooperation are “coalition formation, lobbying, cooptation, withholding agendas, and control of agendas” (Eisenhardt & Zbaracki, 1992, p. 26).

Contextual view

The contextual model, also known as the garbage can model, is a reaction to the boundedly relational model and political model, since these models lacked the complex situation in which decisions are made (Cohen, March, & Olsen, 1972; Eisenhardt & Zbaracki, 1992; Schoemaker, 1993; Gehner, 2008). According to Schoemaker (1993) "organizational environments are so complex and human desires so varied, that each decision context becomes its own reality, with limited consistency across situations and goals" (Schoemaker, 1993, p. 110). These organizational environments are so called organization anarchies: organizations that not have a clear set of goals, are using unclear technology and are characterized by fluid participation (Cohen *et al.*, 1972; Eisenhardt & Zbaracki, 1992). The driving force for decisions is the context in which the decisions are made instead of established goals or a planning of the decision process (Schoemaker, 1993). This context changes constant due to changing problems, arising opportunities, choices that are made, suggested solutions and decision-makers that come and go from the decision-making process (Cohen *et al.*, 1972; Eisenhardt & Zbaracki, 1992; Gehner, 2008). The model becomes more applicable if "time frames become longer, deadlines are removed, and institutional forces are diminished" (Eisenhardt & Zbaracki, 1992, p. 31).

3.3.4 Process of strategic decision making

Various studies described the process of strategic decision making as a sequence and a repetition of steps, phases or routines (Mintzberg *et al.*, 1976; Fredrickson, 1984; Chapman & Ward, 2002; Gehner, 2008; Nutt, 2008). Mintzberg et al. (1976) described the decision-making process not as a linear model, but instead as a circular model in which some steps are repeated various times before going to the next step (Mintzberg *et al.*, 1976). Mintzberg et al. (1976) used the Simon trichotomy (intelligence-design-choice) for their central framework to describe the decision-making process, although they defined the trichotomy using the terms identification, development and selection (Mintzberg *et al.*, 1976). Based upon more recent literature a fourth phase is added to the trichotomy, namely the implementation phase (Fredrickson, 1984; Chapman & Ward, 2002; Nutt, 2008).

Identification

The identification phase concerns the recognition of necessity to make a decision, identify the causes that evoke the decisional activities and determine the direction for the development phase (Mintzberg *et al.*, 1976; Chapman & Ward, 2002; Nutt, 2008). The first step in this phase is to recognize the need or opportunity to make a decision (Mintzberg *et al.*, 1976; Nutt, 2008). The decision-maker decides based on the cumulative amplitude of stimuli to come in action (Mintzberg *et al.*, 1976). The next step is to determine the reasons and causes to come in action and to investigate the decision situation (Mintzberg *et al.*, 1976; Chapman & Ward, 2002).

Development

In the development phase the criteria for the decision are determined, is there are search for information and are courses of action identified, designed and analyzed (Mintzberg *et al.*, 1976; Chapman & Ward, 2002; Gehner, 2008; Nutt, 2008). Chapman & Ward (2002) and Gehner (2008) described the first step of the development phase, namely the determination of criteria to judge the decision. This step is followed by the search for information and alternatives (Mintzberg *et al.*, 1976; Chapman & Ward, 2002; Gehner, 2008; Nutt, 2008). The search can be distinguished in an internal, external, passive or active form of search. The next step of the development phase is the

identification, design and analyses of decisions and courses of action (Mintzberg *et al.*, 1976; Chapman & Ward, 2002; Gehner, 2008). Decisions can be divided into two groups: custom-made decisions and modified decisions (Mintzberg *et al.*, 1976). Custom-made decisions require a more complex and iterative procedure, while modified decisions are modified based on the form of application (Mintzberg *et al.*, 1976).

Selection

The selection phase concerns the screening and evaluating of alternative courses of actions and authorizing of the final selected decision (Mintzberg *et al.*, 1976; Chapman & Ward, 2002; Gehner, 2008; Nutt, 2008). The selection phase is typically a multistep and iterative process, since multiple alternatives are screened and evaluated (Mintzberg *et al.*, 1976). The screening routine is evoked when more alternative actions are generated than can be intensively evaluated (Mintzberg *et al.*, 1976). The evaluation of alternatives is more intensively than the screening them (Mintzberg *et al.*, 1976; Chapman & Ward, 2002; Gehner, 2008; Nutt, 2008). During the evaluation step the selected alternatives can be judged, bargained and analyzed. In judgement one individual makes a decision, while in bargaining multiple decision-makers discuss the alternative decisions and select a decision. In analysis a factual evaluation is conducted, which can be followed by choice by in judgement or in bargaining (Mintzberg *et al.*, 1976). The last step in the selection phase is the authorization of the decision (Mintzberg *et al.*, 1976; Gehner, 2008).

Implementation

The implementation phase is not considered to be part of the framework developed by Mintzberg et al. (1976), but Chapman & Ward (2002) and Nutt (2008) nevertheless decided that the implementation has to be considered part of the strategic decision-making process. Also Fredrickson (1984) noticed that the decision implementation is part of the decision-making process. The decision has to be integrated into the overall strategy and daily routines to *"conceptualize a decision in terms of its broad impact, incorporate it into financial projections, and purposely involve other departments and divisions to ensure that a decision's overall effect has not been underestimated."* (Fredrickson, 1984, p. 460)

Synthesis

The steps in the decision processes of Mintzberg et al. (1976), Chapman & Ward (2002), Nutt (2008) and Gehner (2008) are shown in Table 3.5. Also a synthesis is made based upon the four decision processes, which is presented in the final column of the table.

Table 3.5: Comparison and synthesis of decision processes

	Mintzberg et al. (1976)	Chapman & Ward (2002)	Nutt (2008)	Gehner (2008)	Synthesis
	–	Monitor the environment and current operations within the organisation	–	–	–
Identification	Recognition	Recognise an issue	Intelligence gathering	Recognition	Recognition
	Diagnosis	Scope the decision	Direction setting	–	Diagnosis of decision situation
Development	–	Determine the performance criteria	–	Determination of decision criteria	–
	Search	Identify alternative courses of action	Option identification	Search for information	Search for information and alternative decisions
	Design	Predict the outcomes of courses of action	–	Identification and analysis of courses of action	Design of alternative decisions
Selection	Screen	–	–	–	–
	Evaluation / choice	Choose a course of action	Evaluation	Evaluation	Evaluation of alternative decisions
	Authorisation		–	Authorisation	Authorisation of selected decision
Implementation	–	Implement the chosen alternative	Implementation	–	Implementation of selected decision
	–	Monitor and review performance	–		–

As mentioned above the framework of Mintzberg et al. (1976) is extended with the implementation phase. Further the 'monitoring' activities are excluded from the synthesis since these activities are considered not to be part of the strategic decision-making process. The identification phase consists of the steps 'recognition' and 'diagnosis of the decision situation' and can be compared to the identification phase of Mintzberg et al. (1976), Chapman & Ward (2002) and Nutt (2008). In the next phase, the development phase, the determination is not included since this step is incorporated into the step 'search for information and alternatives'. This step is followed by the 'identification and analysis of alternative decisions'. The selection phase consists of the steps 'evaluation' and 'authorisation'. The screen routine is excluded since it is considered to be part of the evaluation-step.

Finally the implementation consists of the step 'implementation of selected decision'. The synthesis is shown in Figure 3.5.

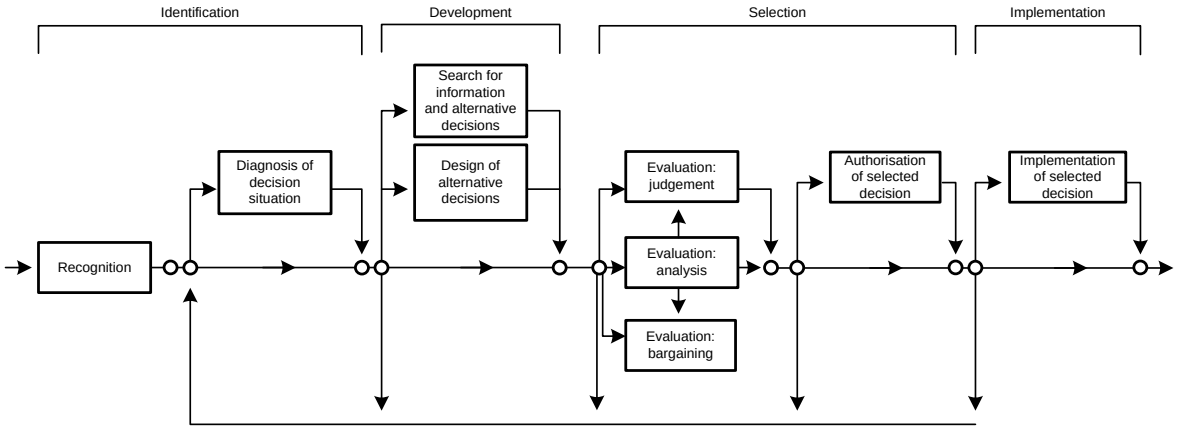


Figure 3.5: Synthesis of strategic decision-making process (based on Mintzberg, Raisinghani and Theoret, 1976)

3.4 Game theory

3.4.1 Introduction to game theory

Game theory is the study of mathematical models to describe interactive decision situations between the decision makers which can lead to cooperative or competitive behaviour between these players (Nash, 1950; Davis, 1997; Osborne, 2004; Peters, 2008). Game theory is used in a broad scale of fields: economics, politics, psychology and biology (Nash, 1950; Osborne, 2004; Peters, 2008). The basic assumptions that underlie game theory is that decision makers are firstly rational and will pursue well-defined objectives and secondly think strategically, which means that they take into account the knowledge and expectations of other players (Osborne & Rubinstein, 1994).

DEFINITION 6 A **game** according to game theory consists in its simplest form of the following features (Osborne & Rubinstein, 1994; Gilles, 2010):

- Set of players (two or more)
- For each decision maker, a set of actions (also mentioned as decisions)
- For each decision maker, preferences over the set of action profiles
- The actions of the decision makers can be interactive

The decision makers make their decisions not in isolation, instead their decisions are interdependently related (Carmichael, 2005). This means that each action of a decision maker can have an impact on the other players and that these players are aware of this impact. However, a decision maker needs also be aware that its decision can have consequences for him (Carmichael, 2005; Gilles, 2010).

Example: Prisoner's Dilemma

One of the most well-known examples that illustrates game theory is the *Prisoner's Dilemma*. It is well-known since it can be used in a high variety of situations.

Two suspects in a major crime are arrested for a minor crime. They are held in separate cells and are not able to communicate with each other. There is unfortunately not enough evidence to convict either of them of the major crime, unless one of the suspects confesses. If both suspects confess, both will be sentenced to 5 years in prison. If only one of them confesses, he will be freed, while the other suspect will be sentenced to 8 years in prison based on the confession of the first suspect. However, if both suspects decide to remain silent they will be convict of the minor crime and will be sentenced to 1 year in prison. Each suspect must choose to confess or to remain silent.

The situation is modelled as shown below:

		Suspect B	
		Remain silent	*Confess*
Suspect A	*Remain silent*	1,1	8,0
	Confess	0,8	5,5

The best outcome for both suspects is to remain silent, which means that both are sentenced to 1 year in prison. Both suspects however have the incentive to confess with the reward of being freed. They have to take in mind that the other suspect also has this incentive and if both will confess, they are both sentenced to 5 years in prison.

3.4.2 Theoretical models in game theory

Game theory distinguishes various types of theoretical models to describe decision situations that differ in the sequence of actions, amount of information and type of pay-off: strategic games, extensive games with perfect information, extensive games with imperfect information and coalitional games (Osborne & Rubinstein, 1994; Peters, 2008). These types of theoretical models require different strategies since these models differ in the set of players, set of actions, the moment of deciding, amount of information and consequences for the players (Osborne & Rubinstein, 1994; Osborne, 2004; Rasmusen, 2007).

Strategic games

A first distinction in the theoretical models in game theory is based on the sequence of decisions that are made by the players in the game (Von Neumann & Morgenstern, 1953). In a strategic game, also called a game in a normal form, each decision maker makes a permanent decision and chooses his plan of action, and all of the players in the game make their decision simultaneously and independently of each other (Osborne & Rubinstein, 1994; Leyton-Brown & Shoham, 2008).

DEFINITION 7 A **strategic game** consists of

- Set of players
- Set of action sets (for each player)
- Preferences over set of actions (for each player)

Strategic games can be categorized based on the symmetry of the game and the payoff function of the game (Leyton-Brown & Shoham, 2008; Peters, 2008). The literature distinguishes symmetric versus asymmetric games and zero-sum versus non-zero-sum games (Rasmusen, 2007; Leyton-Brown & Shoham, 2008; Peters, 2008). A symmetric game is a game where the outcome of playing a particular strategy depends on which strategy is played by the other player, and not on who the other player is. In an asymmetric game the roles of the players are not interchangeable, which means that it depends on who is playing which strategy and that the payoff depends on the strategy that is played by the other player (Rasmusen, 2007). A zero-sum game is a game where the total sum of gains and losses of all players in the game adds to zero, while in a non-zero-game the total benefits of all the players is more or less than zero (Davis, 1997; Leyton-Brown & Shoham, 2008; Peters, 2008).

Strategic games distinguish two types of strategies: pure strategies and mixed strategies. In case of a pure strategy, a player assigns the probability 1 to a single action, while a mixed strategy means that a player randomises its choices based on the probability distribution over its available actions (Rasmusen, 2007; Leyton-Brown & Shoham, 2008). Pure strategies are seen as extremes of the mixed strategies, since the probability distribution leads to one specific action (Osborne, 2004). A pure strategy indicates that it dominates the other strategies of the player. These other strategies are also mentioned as dominated strategies (Leyton-Brown & Shoham, 2008; Jehle & Reny, 2011). The other side of the spectrum describes the dominant strategies in the game. A dominant strategy is strictly superior to all other strategies of a player (Leyton-Brown & Shoham, 2008; Jehle & Reny, 2011). It is possible that the pure strategy of a player is dominated by a mixed strategy (Rasmusen, 2007). A strategy can also be characterized based on the principals of the player. The principal to maximize the minimum gain is called the maximin rule (Leyton-Brown & Shoham, 2008; Peters, 2008). The opposite of this principal is to minimize the maximum losses. This rule is also known as the minimax (regret) rule (Leyton-Brown & Shoham, 2008; Peters, 2008).

The most commonly used outcome in game theory is that of the Nash equilibrium (Osborne & Rubinstein, 1994; Leyton-Brown & Shoham, 2008). A Nash equilibrium is a stable strategy profile where for no player has an incentive to deviate from its strategy given that the other players do not deviate. This means that in a Nash equilibrium, "each player's strategy is a best reply to the other player's strategy" (Peters, 2008, p. 32). Nash equilibria can be divided into two categories: strict and weak. A strict Nash equilibrium means that none of the players has a better reply to the other player's strategies, while a weak Nash equilibrium indicates that at least one other reply is as good the current reply (Leyton-Brown & Shoham, 2008).

Extensive games

In an extensive game the decision makers make their decisions sequentially: they observe the decisions of the other decision makers and make their choice based on the available information (Osborne & Rubinstein, 1994; Peters, 2008). Instead to the outcome in a strategic game the outcome

in an extensive game is not necessarily definitive, since in an extensive game it can be possible to react on earlier made decisions (Osborne & Rubinstein, 1994). Extensive games can be divided into extensive games with perfect information and extensive games with imperfect information. Perfect information means that all the players in the game know the moves that are previously made by the players. A strategic game can therefore be characterized as a game with imperfect information since in simultaneous games as strategic games players do not know the actions of the other players. Extensive games with perfect and imperfect information can be defined as follows:

DEFINITION 8 An **extensive game with perfect information** consists of

- Set of players
- Complete set of sequences (each action of a player is a component of the set)
- Player function (for each player)
- Preferences over set of actions (for each player)

DEFINITION 9 An **extensive game with imperfect information** consists of

- Set of players
- Complete set of sequences (each action of a player is a component of the set)
- Player function (for each player)
- Probability distribution over played actions (for each player)
- Information partition (for each player)
- Preferences over set of actions (for each player)

A way to graphically represent an extensive game is to use a game tree diagram (Jehle & Reny, 2011). In Figure 3.6 and Figure 3.7 two game tree diagrams are shown: Figure 3.6 shows an extensive game with perfect information, while Figure 3.7 represents an extensive game with imperfect information (Osborne & Rubinstein, 1994; Jehle & Reny, 2011). The circles represent the decision nodes and the black lines described the corresponding actions of the two players. The dashed line in Figure 3.7 represents player 2's incomplete information set. Player 2 does not know whether player 1 chose L or R.

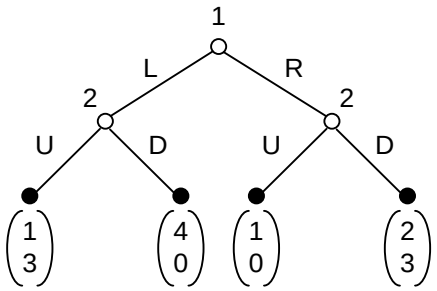


Figure 3.6: Extensive games with perfect information

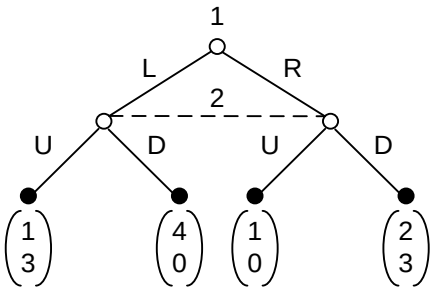


Figure 3.7: Extensive games with imperfect information

In an extensive game with perfect information it is possible with the backward induction technique to solve this type of games. If this technique is applied on the extensive game with perfect information in Figure 3.6, the first step is to analyze the end nodes. All four end nodes belong to player 2. At the left part of the game player 2 does best to choose U, and at the right part of the game he does best to choose D. The game can be reduced to the game shown in Figure 3.8. The next

step is to analyze the previous nodes in the reduced game. Based on the outcomes that are shown in Figure 3.8, player 1 does best to choose R, since this will result in a payoff of 2 instead of 1. The outcome of the game is shown in Figure 3.9.

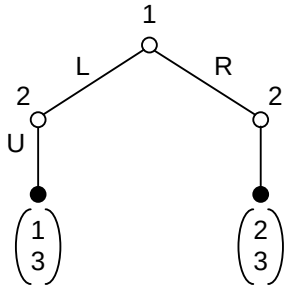


Figure 3.8: Reducing end nodes in extensive game with perfect information

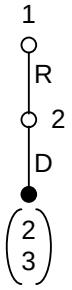


Figure 3.9: Final result of the backward induction technique

Although the backward induction technique is not immediately extend to extensive games with imperfect information, this technique can be used to find subgame perfect equilibria and sequentially to solve the extensive game with imperfect information. A subgame can in this case be defined as a subset of an extensive game and a subgame perfect equilibrium is then a "strategy combination that induces a Nash equilibrium in every subgame" (Peters, 2008, p. 49). If the replies in a subgame represent a Nash equilibrium, then there is a subgame perfect equilibrium in the larger game (Leyton-Brown & Shoham, 2008; Peters, 2008; Jehle & Reny, 2011).

Coalitional games

The previous discussed games can be described as non-cooperative games where the players in the game decide autonomously. Despite that the decisions are made autonomously, a player's preferences can still be to reach an outcome that is beneficial for not only the player itself, but also for one or more other players (*see Prisoner's Dilemma*) (Osborne & Rubinstein, 1994; Carmichael, 2005). A coalitional game, also mentioned as a cooperative game, describes a model in which a group of players (coalition) takes a joint action to reach an outcome (Osborne & Rubinstein, 1994; Leyton-Brown & Shoham, 2008). A coalitional game can be defined as follows:

DEFINITION 10 A **coalitional game** consists of

- Set of players
- Set of coalitions
- Set of actions (for each coalition)
- Coalition's payoff function (for each coalition)

Besides that the players in a coalitional game have a mutuality of interests, namely the payoff of the game, cooperation also emerges due to the fact that players in the game can meet again in the future and might need each other (Axelrod, 1984; Axelrod & Keohane, 1985; Parkhe, 1993). However, an important condition to this reasoning is that the numbers of interactions is indefinite, otherwise the players have no incentive to cooperate (Axelrod & Hamilton, 1981; Axelrod, 1984). A third reason that influences the emergence of cooperation is the number of players in the game and the structures of the players' relationships (Axelrod, 1984; Axelrod & Keohane, 1985; Parkhe, 1993).

Various scholars about cooperation described the importance of reciprocity in a relationship (Gouldner, 1960; Axelrod, 1984; Axelrod & Keohane, 1985; Kogut, 1989; Parkhe, 1993; Nowak, 2006). Reciprocity is the mechanism behind the exchange of privileges between players favoured by the probability of future interactions and the probability of consequences for the reputation in a society (Axelrod, 1984; Axelrod & Keohane, 1985; Nowak, 2006). Reciprocity is mainly categorized in 3 types: direct reciprocity, indirect reciprocity and network reciprocity (Nowak, 2006). Direct reciprocity describes the immediate collaborative exchange of benefits, while indirect reciprocity is the separation of contributing and gaining benefits in an exchange: the return of a benefit for contributing a benefit comes from someone else than the receiver of the benefit (Nowak & Sigmund, 2005; Nowak, 2006). The third type of reciprocity, network reciprocity, describes the mechanism that players help other players that are in their network (Nowak, 2006).

The outcome of a coalitional game is stable as long as no other coalition in the game can obtain the payoffs that exceed the total sum of the coalition members' current payoffs (Osborne & Rubinstein, 1994; Leyton-Brown & Shoham, 2008; Gilles, 2010). Thus the coalition members do not speculate about the behaviour of the players outside the coalition, only about the behaviour of the coalition members and their possible payoffs (Osborne, 2004). The core of a coalition can be seen as an analog of strong Nash equilibrium in non-cooperative games, since it is required that the payoffs of the coalition are the best possible payoffs for all the coalition members (Leyton-Brown & Shoham, 2008).

The most well-known solution in coalitional games is the Shapley Value (Shapley, 1953; Osborne & Rubinstein, 1994; Leyton-Brown & Shoham, 2008; Peters, 2008). The Shapley Value assigns to each player of the coalition a part of the worth (the coalition payoff) that is generated by the coalition (Leyton-Brown & Shoham, 2008). The basic criterion behind the concept of the Shapley Value is to determine the relative importance of each player in the coalition and the corresponding distribution of the payoff (Osborne & Rubinstein, 1994). Although the Shapley Value is described as a fair, balanced and efficient solution to divide the coalition payoffs, players in coalitions still can decide to bargain about the outcomes of the game and the distribution of the payoff (Osborne & Rubinstein, 1994; Leyton-Brown & Shoham, 2008; Peters, 2008).

Players in a coalition can negotiate with each other about the distribution of the payoff since it is possible in their perspective that the suggested distribution according to the Shapley Value is not fair and balanced (Carmichael, 2005). Nash (1950) described in his paper the bargaining problem between two players and introduced the bargaining solution for this problem, named after Nash: the Nash bargaining solution (Nash, 1950; Peters, 2008). A solution of this type should satisfy the following four conditions: Pareto optimality, symmetry, invariant to equivalent utility representations, and independence of irrelevant alternatives (Nash, 1950; Peters, 2008). Two reasons for a player to bargain is that a player is in the assumption that other players deserve a smaller part or that the player itself deservers a larger part of the payoff (Osborne & Rubinstein, 1994).

3.5 Conclusion theoretical background

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

- How can the decision-making process be characterized?
- Which models of decision making can be distinguished in an innovation process?

These sub questions will be answered in this paragraph.

Characteristics of a strategic decision-making process

Strategic decisions are considered to be complex, political and uncertain because of the parties involved in the decision making and the unfamiliarity with the decision. These characteristics of a strategic decision address at the same time the paradigms in strategic decision making literature: bounded rationality, powers in the decision-making process and the complexity of the process. Decision makers are boundedly rational due to their cognitive limitations and a lack of information. Further the amount of power of the decision makers and the continuously changing context in which decisions are made influence the decision-making process. A strategic decision-making process is considered to be iterative and consists of four phases:

- identification phase;
- development phase;
- selection phase;
- implementation phase;

A phase consists of one or more steps and a step can be several times repeated before going to the next step. Due to the iterative character of the process it is even possible to return to earlier steps in the process. Strategic decision-making processes can be characterized based upon their comprehensiveness, internal and external sources of information, interaction between decision makers, the process flow, the duration of the process, the centrality of the decision making and the formalization of the process.

Models of strategic decision making in innovation process

An innovation process consists of four phases: idea generation and selection-phase, business case analysis-phase, development and testing-phase and implementation and diffusion-phase. Each phase in this process contains different parties, although in the first three phases it is expected that the same parties are involved since in these phases an idea is turn into a product. In the last phase the product is commercialized, which may require different parties than in the first three phases.

Game theory distinguishes four games that are frequently used: strategic games, extensive games with perfect information, extensive games with imperfect information and coalitional games. The first three games are non-cooperative games in contrast to the coalitional game that is a cooperative game. In Table 3.6 the games are linked to each phase of the innovation process perceived from the perspective of the leading firm in the innovation process.

Table 3.6: Decision-making models in innovation process

	Idea generation and selection	Pilot project	Development and testing	Implementation and diffusion
Strategic game	X			X
Extensive game with perfect information				
Extensive game with imperfect information	X	X	X	X
Coalitional game		X	X	X

In none of the phases the extensive game with perfect information is played, since in none of these phases the leading firm has a complete set of information (Osborne & Rubinstein, 1994). In the first phase the strategic game is combined with the extensive game with imperfect information, because in this phase ideas are generated, which can be with employees inside the organization or with external parties. However, it is the question if this is real cooperation or that the parties decide to work together to serve their own objectives (Osborne & Rubinstein, 1994; Peters, 2008). Therefore it is stated that in the first game either a strategic game is played or an extensive game with imperfect information.

In the second and third phase the leading firm has decided to cooperate with one or more firms to develop the innovation, which explains the coalitional game in these phases (Osborne & Rubinstein, 1994; Carmichael, 2005). Nevertheless, it is possible that the leading firm works together with a party that has different goals and interests, but that at the same time the parties need each other. In this case an extensive game with imperfect information is played (Peters, 2008).

In the last phase of the innovation process the innovation is implemented and diffused in the market (Kanter, 1988; Veryzer, 1998; Rogers, 2003). However, the earlier phases of the innovation process focused on the development of a prodct, this phase focuses on the commercialization of a product. It is therefore possible that other parties are involved in the commercialization compared to the development phases. This might explain the presence of strategic games and extensive games with imperfect information in this phase, since it shows similarities with the first phase of the process. However, if the leading firm decides to continue the cooperation with the firms from the development phases either the coalitional game and extensive game with imperfect information will be played.

An addition to the allocation of the games in the innovation process is that the game that is played may differ based on the decisions that have to be made, since these decisions differ in the level, the perspective and the type of decision makers.

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. Subsequently the strategic decisions that are made in the innovation process 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.

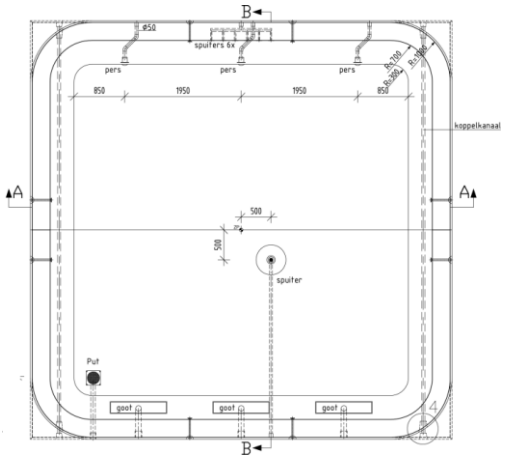


Figure 4.1: Top view of the design of Duurzaam Speelbad

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.

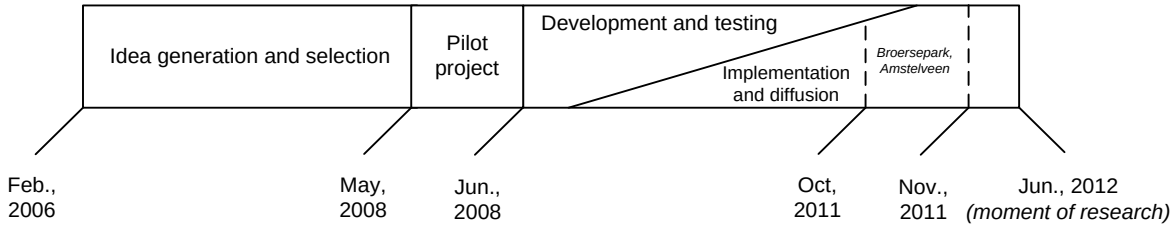


Figure 4.2: Timeline of the innovation project Duurzaam Speelbad

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

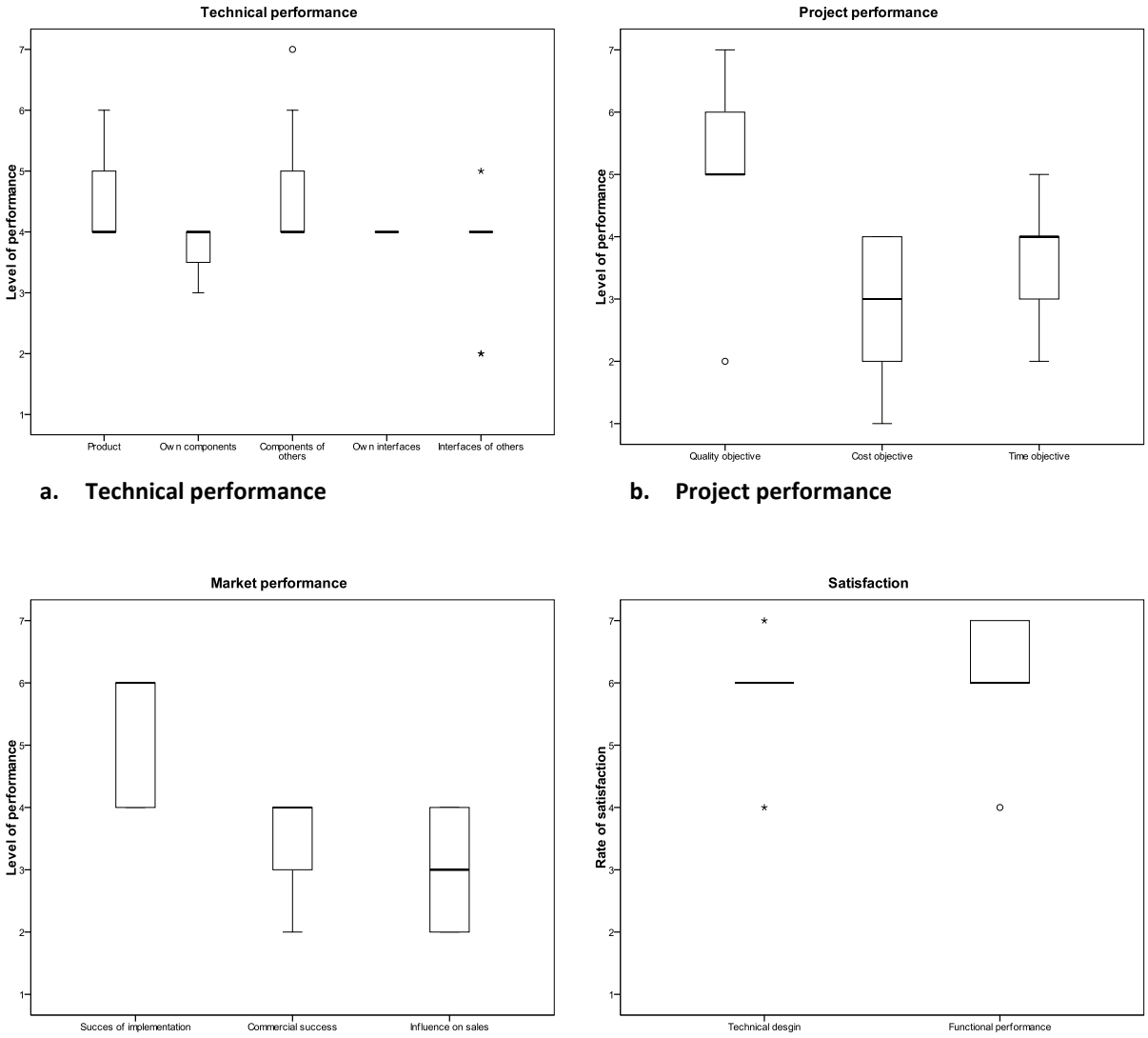
The project performance of the innovation project is measured using three items: the quality objective regarding the innovation, the costs objective of the innovation project and the time objective of the project. The scores of the project performance are shown in Figure 4.3.b. The quality of the innovation 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 Strategic decision making

In this section first the identified strategic decisions in the innovation project are discussed, thereafter the decision-making processes are analyzed and finally the linkages between strategic decisions are determined and discussed. The strategic decisions that will be discussed are from the perspective of Ballast Nedam Infra Noord West.

Strategic decisions

For the innovation project Duurzaam Speelbad 11 strategic decisions are identified, which were identified and described by two employees that were involved in this innovation project. These decisions are shown in Table 4.3. The decisions are numbered on chronological order. The detailed description of the decisions can be found in Appendix E.

Table 4.3: Decisions in the innovation project Duurzaam Speelbad

	Idea generation and selection	**Pilot project**	**Development and testing**	**Implementation and diffusion**
Organizations	01. Rebuilding of children's pools in Amstelveen		05. Cooperation with Waco Lingen Beton 07. Cooperation with Van Dorp Zwembaden	
Operations	01. Rebuilding of children's pools in Amstelveen		09. Design of production process	
Product	02. Design of children's pool		06. Design of Duurzaam Speelbad 08. Improved design of Duurzaam Speelbad	10. Roughening of the floor
Marketing		03. Design of business model 04. Determination of the market		11. Determination of new types of customers

Organizations decisions

In the innovation project three organizations decisions can be distinguished:

- Rebuilding of children's pools in Amstelveen (decision 01)
- Cooperation with Waco Lingen Beton (decision 05)
- Cooperation with Van Dorp Zwembaden (decision 07)

In the first phase of the innovation process the decision is made to rebuild the children´s pools in Amstelveen (decision 01), which can be described as an organizations and operations decision, since on one hand respectively the cooperation between the municipality, Fehres and Ballast Nedam infra Noord West started and on other hand the development of the children's pool was started. In the development and testing phase two decision regarding cooperation can be distinguished: the decision to start to cooperate with Waco Lingen Beton (decision 05) and the decision to start the collaboration with Van Dorp Zwembaden (decision 07).

Operations decisions

Two operations decisions can be distinguished in this innovation process:

- Rebuilding of children's pools in Amstelveen (decision 01)
- Design of production process (decision 09)

In the first phase the first operations decision is made, namely the decision to rebuild the children's pool in Amstelveen (decision 01). This decision is also described as an organizations decision, since this decision is the reason to start the innovation process and to form the cooperation between the municipality, Fehres and Ballast Nedam Infra Noord West. The other operations decision is about the design of the production process regarding the production of the Duurzaam Speelbad (decision 09)

Product decisions

In the innovation project Duurzaam Speelbad four product decisions can be distinguished:

- Design of children's pool (decision 03)
- Design of Duurzaam Speelbad (decision 06)
- Improved design of Duurzaam Speelbad ((decision 08)
- Roughening of the floor (decision 10)

The first product decision, which is the design of a children's pool, is related to the decision of the municipality of Amstelveen to rebuild the children's pools in the municipality (decision 03). However, the most important decisions regarding the final product are made in the third phase of the innovation process: the development and testing phase. In this stage of the process the design of the children's pool that was used in the pilot project is transformed into a design consisting of prefabricated elements of concrete (decision 06). Later in this stage the design is improved by the implementation of a new type of plant purification in the design (decision 08). The last product decision in the process is an improvement of the design, namely roughening the floor of the product (decision 10). This decision however does not change the design of the children's pool significantly.

Marketing decisions

Regarding the marketing decisions four decisions can be distinguished:

- Design of business model (decision 03)
- Determination of the market (decision 04)
- Determination of new types of customers (decision 11)

Regarding the marketing decisions 2 types of decisions can be distinguished in this innovation process: decisions regarding the profit mechanism and decisions with respect to the market presentation. The decision about the design of the business model (decision 03) is made during the pilot project, which seems late, however the innovation process started as a regular construction project, but during the pilot project it turned out that in this type of construction projects a market could be distinguished. Based on this recognition a business model is developed for this type of projects. Decisions about the market presentation are related to the type of potential customers of the innovation. In the first instance municipalities are determined as potential customers (decision 04). However, in the implementation and diffusion phase recreation centres and large play grounds are also determined as potential customers (decision 11). This might indicate that the innovation has developed during the process, that the market in the beginning of the process was not completely defined or that the environment in which the innovation is diffused has changed during the process.

Decision-making processes

In this paragraph the decision-making processes of the 11 strategic decisions in the innovation project Duurzaam Speelbad are discussed. The detailed descriptions of the decision-making processes are presented in Appendix E. Table 4.4 shows an overview of the decision-making processes and the game characteristics of these processes. The steps in the decision-making processes are scored according to the model developed in the theoretical framework. The decision-making processes are categorized based on the form of the process, the level of cooperation and the level of information.

For each decision first the context of the decision is determined, secondly the decision-making process is analyzed by making use of the the model developed in the theoretical framework and finally the type of game that is played in the process is determined. Two decisions are described as an example how the context, process and type of game is determined.

Rebuilding of children's pools in Amstelveen (decision 01)

This decision described the start of the innovation process and two types of decisions can be distinguished in this decision: an organizations decision, since it is the start of the cooperation between the municipality, Fehres and Ballast Nedam Infra Noord West and an operations decision, because this decision marks the start of the development of the children's pool. The process of the decision making is shown in Figure 4.4 and these steps in the process are also described in Table 4.4.

This decision-making process is determined as an extensive game with imperfect information. First the form of the game is determined, which is extensive since multiple organizations can be described as decision-makers. Secondly, there was however no cooperation between these organizations, although the goal of the decision-making process was to start to cooperate. Therefore the game is described as a non-cooperative game. The last step of determining the game is regarding the set of information. In this process the information set is imperfect; therefore the process is determined as an extensive game with imperfect information.

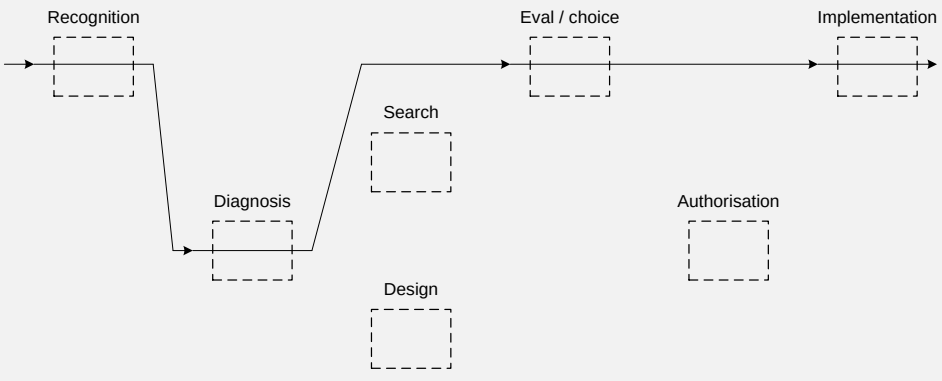


Figure 4.4: Decision-making process of decision 01 in innovation project Duurzaam Speelbad

Design of the children's pool (decision 02)

This decision is named a product decision, because it describes the design process of the first children's pool and the decision to use this design for the construction of the children's pool. The process of the decision making is shown in Figure 4.5 and these steps in the process are also described in Table 4.4. A remarkable routine that is completed in this decision-making process is the authorization routine. The reason that this routine is completed is that the municipality had to give authorization before the design could be used.

This decision-making process is determined as a coalitional game. First the form of the game is determined, which is extensive since both Ballast Nedam Infra Noord West and Fehres were involved in design the children's pool and the municipality had to give permission to implement the decision. Secondly, the game is a cooperative game since Ballast Nedam Infra Noord West and Fehres designed the children's pool as a coalition. The last step to determine the type of game is by determining the set of information, which is in this process imperfect. Therefore the determined game is a coalitional game.

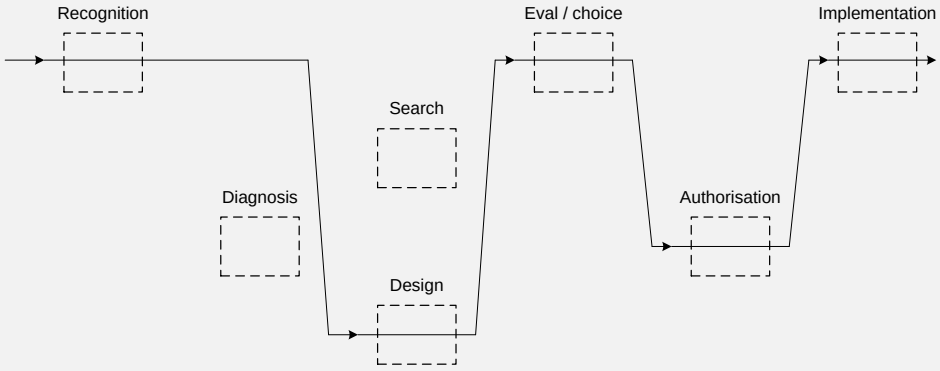


Figure 4.5: Decision-making process of decision 02 in innovation project Duurzaam Speelbad

Organizations decisions

In the innovation project three organizations decisions are distinguished:

- Rebuilding of children's pools in Amstelveen (decision 01)
- Cooperation with Waco Lingen Beton (decision 05)
- Cooperation with Van Dorp Zwembaden (decision 07)

All three organizations decisions can be described as straightforward with no interruptions. In case of two decisions, namely the decision to rebuild the children's pool (decision 01) that initiates the innovation process and the decision to cooperate with Van Dorp Zwembaden (decision 07), the diagnosis routine is used. In both decisions more information was necessary for the decision makers to identify potential partners, which were at the end respectively Ballast Nedam Infra Noord West and Van Dorp Zwembaden. In case of the decision to cooperate with Waco Lingen Beton (decision 05) this routine was not necessary, since this company was a subsidiary of Ballast Nedam. All three decision-making processes are named as extensive games with imperfect information, since multiple parties were involved, but these parties did not form a coalition during the process.

Operations decisions

Two operations decisions are distinguished in this innovation process:

- Rebuilding of children's pools in Amstelveen (decision 01)
- Design of production process (decision 09)

The first operations decision is the decision to rebuild the children's pools in Amstelveen (decision 01), which is determined as the start of the innovation process. The other operations decision is about the production process of the innovation. The design of the production process (decision 09) was made in cooperation with Waco Lingen Beton and therefore there was a search routine used instead of a design routine. The reason for this is that Waco Lingen Beton already had experiences in the production of prefabricated elements and that an existing production process had to be adjusted to the production process of prefabricated elements for a children's pool. The first decision (decision 01) is described as an extensive game with imperfect information, since multiple parties were involved, but did not yet cooperate. The decision about the design of the production process (decision 09) is a coalitional game, because the decision was made by a coalition of parties.

Product decisions

In the innovation project Duurzaam Speelbad four product decisions can be distinguished:

- Design of children's pool (decision 03)
- Design of Duurzaam Speelbad (decision 06)
- Improved design of Duurzaam Speelbad (decision 08)
- Roughening of the floor (decision 10)

The product decisions are related to the designs of the products and the improvement of these products. This type of decisions has the only decision in the innovation project with an interruption, namely the improved design of the Duurzaam Speelbad (decision 08). The reason for the interruption is that the frame of the children's pool had to be adjusted to the new purification plant that was developed by Van Dorp Zwembaden. Regarding the decision to use the design of Duurzaam Speelbad (decision 06) authorization of the municipality was necessary before the design could be used. For the design of the children's pool (decision 03) and the roughening of the floor (decision 10) the search routine is used instead of the design routine, since in the first case the design was based on a draft of the municipality and in the second case the solution for the problem was based on earlier experiences with this type of problem.

All the four decision-making processes of the production decisions can be named as coalitional games. The reason for this is that in all four cases the decision is made by a coalition. Regarding the design of the children's pool (decision 03) two divisions of Ballast Nedam, Fehres and the municipality were involved and with respect to the improved design of the Duurzaam Speelbad (decision 08) the organizations Ballast Nedam Infra Noord West, Waco Lingen Beton and Van Dorp Zwembaden were involved. Regarding the design of the Duurzaam Speelbad (decision 06) and the roughening of the floor (decision 10) the coalition Ballast Nedam Infra Noord West/Waco Lingen Beton made the decisions.

Marketing decisions

Regarding the marketing decisions three decisions are distinguished:

- Design of business model (decision 03)
- Determination of the market (decision 04)
- Determination of new types of customers (decision 11)

The decision-making processes regarding marketing decisions are all described as strategic games. The reason for this is that Ballast Nedam Infra Noord West was the only party involved in these decision-making processes and consequently the only decision-maker in the processes.

Regarding the routines that are completed in these decision-making processes there are similarities that can be found. The decision-making processes about the determination of the market (decision 04) and determining new types of customers (decision 11) both consist of an extensive identification phase. In both processes more information was necessary before a decision could be made. The decision-making process with respect to the business model (decision 03) is the exception of three processes, since this process has no extensive identification phase, but instead to the other two processes a search routine.

Table 4.4: Decision-making processes in the innovation project Duurzaam Speelbad

Decision		Decision context		Decision process										Game			
	Decision	Phase	Type of decision	Steps of decision-making process							Evaluation			Form	Coop.	Info.	Game
				Rec.	*Diag.*	*Search*	*Design*	*Eval. / choice*	*Auth.*	*Impl.*	*Anal.*	*Judge.*	*Barg.*				
01	Rebuilding of children's pools in Amstelveen	1	Op/Or	1	1	-	-	1	-	1	-	1	-	E	NG	II	3
02	Design of the children's pool	1	P	1	-	-	1	1	1	1	1	-	1	E	CG	-	4
03	Design of business model	2	M	1	-	1	-	1	-	1	-	1	-	N	-	-	1
04	Determination of the market	2	M	1	1	-	-	1	-	1	-	1	-	N	-	-	1
05	Cooperation with Waco Lingen Beton	3	Or	1	-	-	-	1	-	1	-	-	1	E	CG	II	3
06	Design of Duurzaam Speelbad	3	P	1	-	-	1	1	1	1	1	-	1	E	CG	-	4
07	Cooperation with Van Dorp Zwembaden	3	Or	1	-	1	-	1	-	1	-	-	1	E	NG	II	3
08	Improved design of Duurzaam Speelbad	3	P	1	1	-	2	2	-	1	2	2	-	E	CG	-	4
09	Design of production process	3	Op	1	-	-	1	1	-	1	-	-	1	E	CG	-	4
10	Roughening of the floor	4	P	1	-	-	1	1	-	1	-	-	1	E	CG	-	4
11	Determination of new types of customers	4	M	1	1	-	-	1	-	1	-	1	-	N	-	-	1

Phase
1. Idea generation
2. Pilot project
3. Development
4. Implementation

Type of decision
Or Organizations
Op Operations
P Product
M Marketing

Form
E Extensive
N Normal

Cooperation
CG Cooperative
NG Non-cooperative

Information
II Imperfect information
PI Perfect information

Game
1. Strategic
2. Extensive, perfect information
3. Extensive, imperfect information
4. Coalitional

Groups of decisions

Although the 15 strategic decisions in this innovation project can all be linked to each other through the innovation itself and its development process, there can be groups of decisions be distinguished. A linkage of decisions consists of 2 or more decisions that are directly linked to each other, because the outcome of a decision-making process is the cause to start a new decision-making process. An overview of the links between the decisions is shown in Figure 4.9. The following groups of decisions are distinguished:

- Preparation for construction project (group DS.A)
- Development of innovation project (group DS.B)
- New market segmentation (group DS.C)

Preparation for construction project

This group of decisions describes the preparation for the construction project (group DS.A). The linkage started with the decision to rebuild the children's pools in the municipality of Amstelveen (decision 01). For this project Fehres and Ballast Nedam Infra Noord West were approached. The next step in the preparation for the project was to design the first children's pool that had to be constructed (decision 02). The design of this children's pool was based on a draft that was made by the municipality. The group of decision is shown in Figure 4.6.

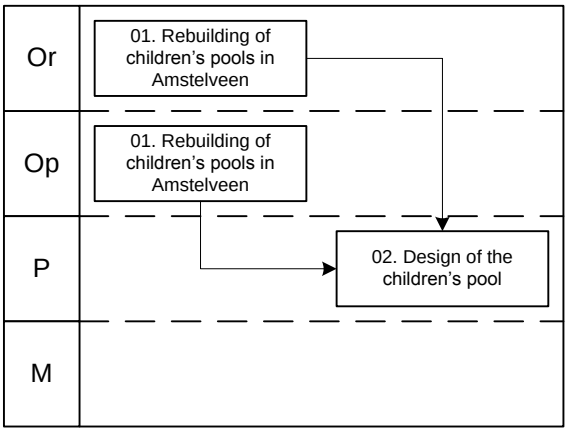


Figure 4.6: Group of decisions 'preperation for construction project' (group DS.A)

Development of innovation project

The next group of decisions that can be distinguished in the innovation process is the development of the innovation project (group DS.B), which can be described as the core of the innovation process. The linkage started with determination of the market and the possibilities of marketing prefabricated children's pools (decision 04). The next four decisions can be described in two pairs: the development of a prefabricated children's pool and the development of an improved purification plant. The first pair of decisions consists of the decision to approach Waco Lingen Beton (decision 05) and the design of the prefabricated children's pool (decision 06). The other pair consists of the approach of Van Dorp Zwembaden (decision 07) and the decision to improve the design of the prefabricated children's pool (decision 08). The group of decisions is presented in Figure 4.7.

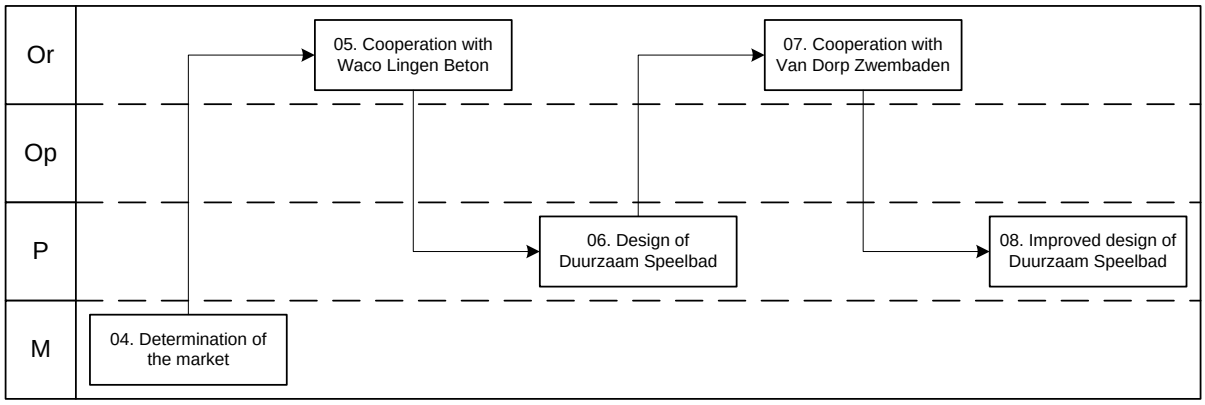


Figure 4.7: Group of decisions 'development of innovation project' (group DS.B)

New market segmentation

The group of decisions (group DS.C) that is named new market segmentation consists of two decisions of which the second decision can be described as an extension of the first decision. The first decision is about the determination of the market (decision 04), which was made in the first phase of the innovation process. The second decision was made in the fourth phase and is about the determination of new types of customers (decision 11), which is an extension of the original market that was determined. The group of decisions is shown in Figure 4.8.

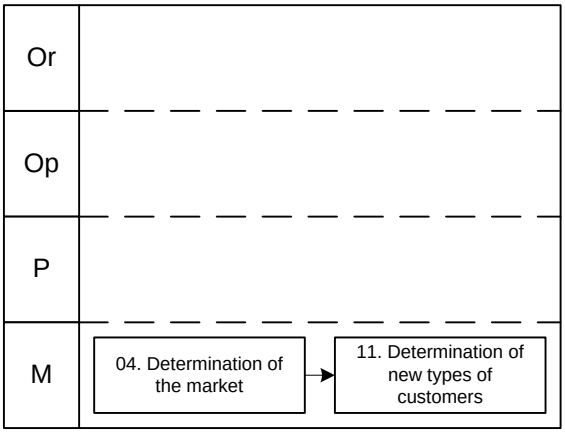


Figure 4.8: Group of decisions 'new market segmentation' (group DS.C)

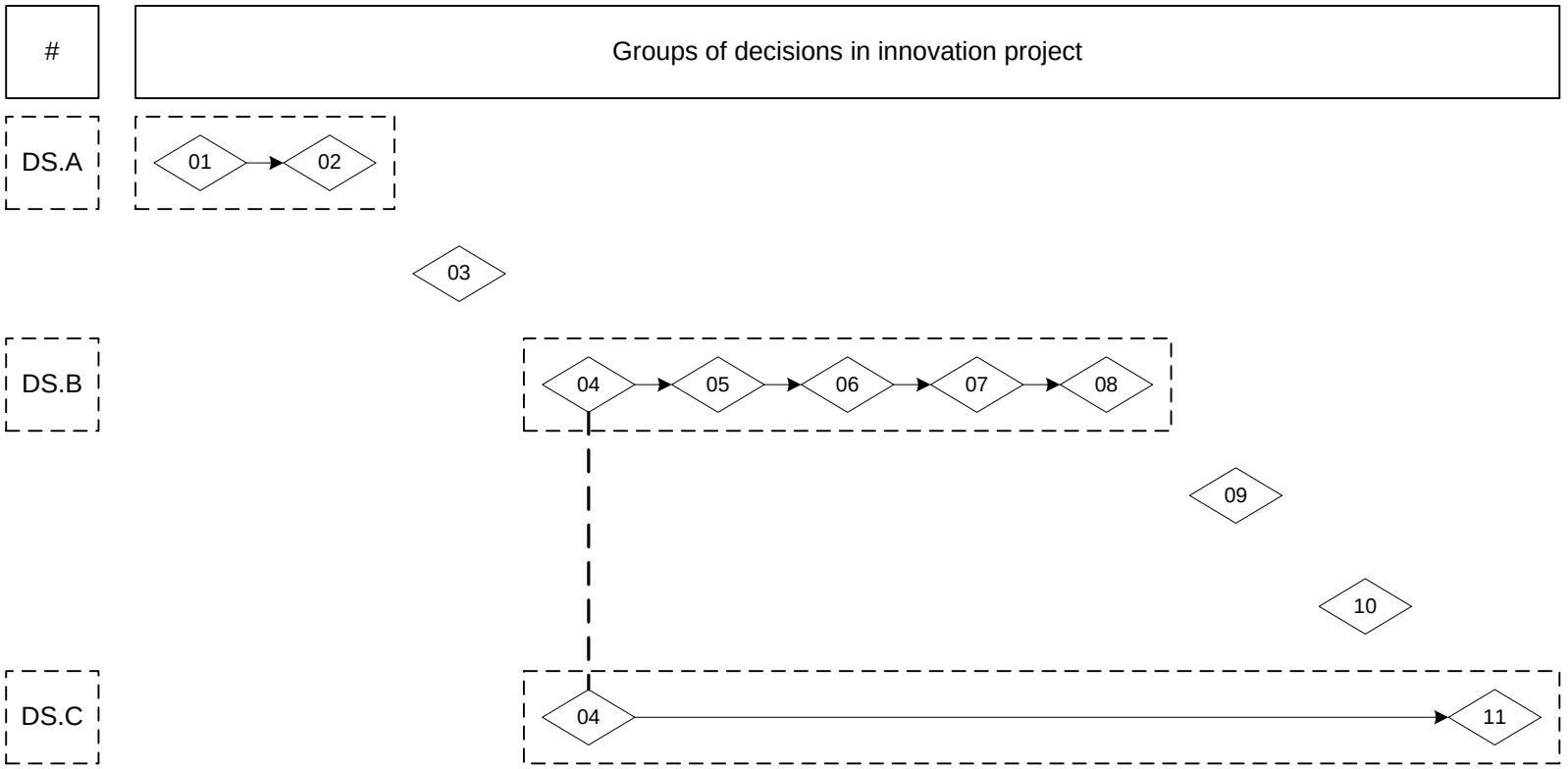


Figure 4.9: Overview of linked decisions in innovation project Duurzaam Speelbad

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.

In the innovation process 11 strategic decisions are identified of which six decisions are equally divided in the first, second and fourth phase of the process. The five remaining decisions are made in the third phase of the process. It is remarkable that all the organizations decisions are made by making use of an extensive game with imperfect information, that all the marketing decisions are made by playing a strategic game and that the product decisions are made by using a coalitional game. The two operations decisions are made by using for one decision an extensive game and one decision by playing a coalitional game.

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. Subsequently the strategic decisions that are made in the innovation process 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 4.10.

Figure 4.10: 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 4.11 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.

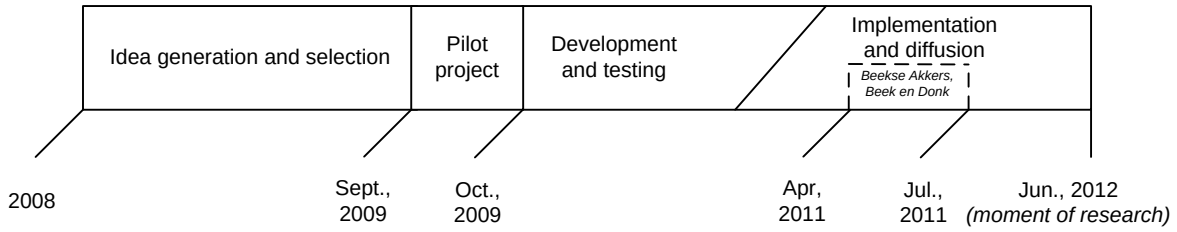


Figure 4.11: Timeline of the innovation project iQwoning®

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 4.5 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 4.5: 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 4.6 and the distributions of the items are presented by making use of boxplots. The boxplots are shown in Figure 4.12.

Table 4.6: 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 4.12.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 4.12.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

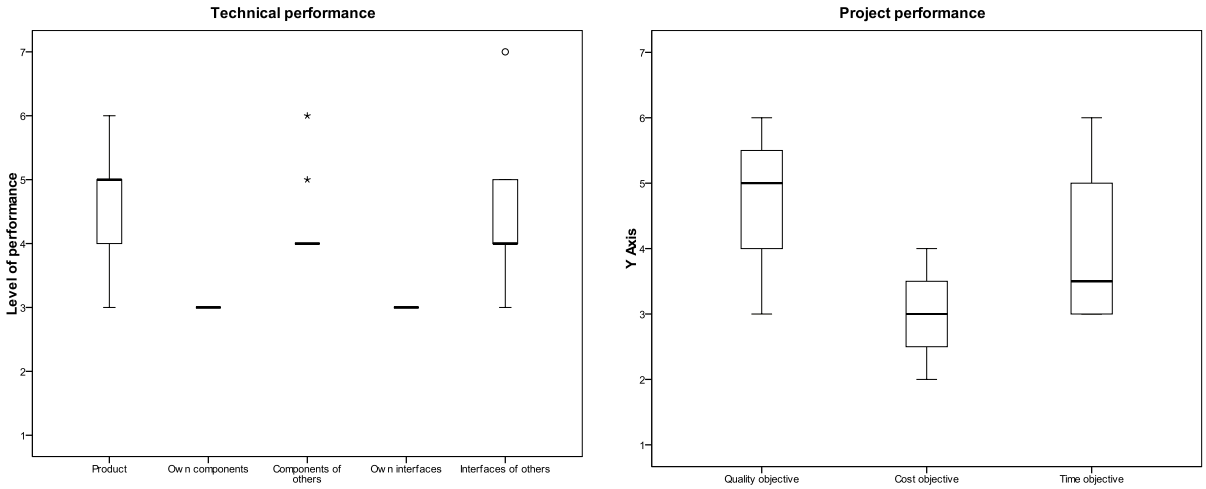
The market performance of the innovation project is measured using three items: the success of implementation, the commercial success and the influence on the firms' sales. The market performance is presented in Figure 4.12.c.

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.

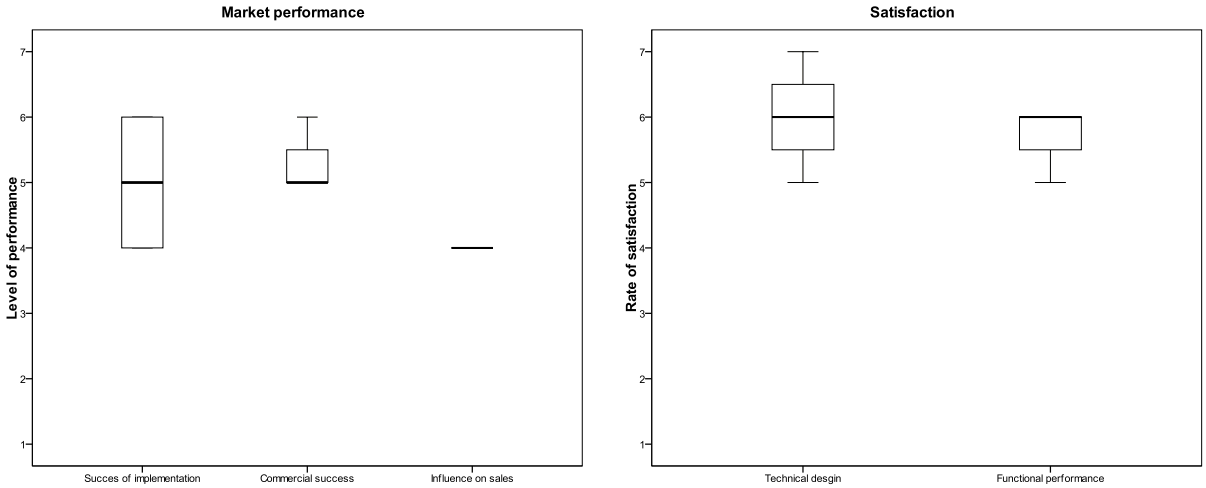
Satisfaction

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 4.12.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 4.12: 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 Strategic decision making

In this section first the 15 identified strategic decisions in the innovation project are discussed, which are identified and described by the interviewees. Thereafter the decision-making processes are analyzed and finally the linkages between strategic decisions are determined and discussed. The strategic decisions that are made will be discussed for the first two phases from the perspective of the project group that was found in the first phase of the innovation process and from the third phase from the perspective of IQ Woning B.V.

Strategic decisions

For the innovation project iQwoning® 15 strategic decisions are identified, which were identified and described by four employees that were involved in this innovation project. These decisions are shown in Table 4.7. The decisions are numbered on chronological order. The detailed description of the decisions can be found in Appendix F.

Table 4.7: Decisions in the innovation project iQwoning®

	Idea generation and selection	Pilot project	Development and testing	Implementation and diffusion
Organizations	01. Development of concept of modular housing		08. Founding of IQ Woning B.V.	11. Start of iQteam 13. Adjustment of responsibilities of iQteam
Operations	01. Development of concept of modular housing 03. Design of production process	06. Pilot project Berckelbosch	07. Factory for production iQwoning® 09. Improvements in production process	
Product	02. Design of iQwoning®		10. Improvement of reinforcement	14. Addition of new type of iQwoning®
Marketing		04. Design of business model 05. Determination of market		12. Adjustment in performing acquisition 15. Development of iQconcept

Organizations decisions

In the innovation project four organizations decisions can be distinguished:

- Development of concept of modular housing (decision 01)
- Founding of IQ Woning B.V. (decision 08)
- Start of iQteam (decision 11)
- Adjustment of responsibilities of iQteam (decision 13)

In the first phase of the process the decision is made to start the innovation process (decision 01), which can be described as an organizations and operations decision, since on one hand respectively

the project group was founded and on other hand the development was started. The other organizations decisions are made in the last two phases of the innovation project. In the development and testing phase the entity IQ Woning B.V. is founded (decision 08), which became responsible for the production of the iQwoning®. In the last phase the iQteam was started (decision 11), which is the team that is responsible for the commercialization of the iQwoning®, and later in this phase adjustments are made regarding the responsibilities of this same iQteam (decision 13).

Operations decisions

Five operations decisions can be distinguished in this innovation process:

- Development of concept of modular housing (decision 01)
- Design of production process (decision 03)
- Pilot project Berckelbosch (decision 06)
- Factory for production iQwoning® (decision 07)
- Improvements in production process (decision 09)

In the first phase two operations decisions are made: the decision to start the development process (decision 01) that can be seen as the start of the innovation process and the design of the production process of the iQwoning® (decision 03). In the next stage the location of the pilot project was chosen, which was the urban development project Berckelbosch (decision 06). The decision to build a factory for the production of the iQwoning® (decision 07) can be described as the go/no-go-decision in the innovation process. This decision is based on the enthusiasm of potential customers and the estimated demand for this innovation. The last operations decision is about the improvements in the production process (decision 09). The improvements that are made in the production process are based on production process of other competitors and in other industries.

Product decisions

In the innovation project iQwoning® three product decisions can be distinguished:

- Design of iQwoning® (decision 02)
- Improvement of reinforcement (decision 10)
- Addition of new type of iQwoning® (decision 14)

The first product decision is about the design of the iQwoning® (decision 02). Although the table shows only one decision regarding the design, this decision contains various sub-decisions focusing on elements of the design: the dimensions of the product, the number of elements the product consists of, the materials used in the product and the look of the innovation. The second product decision is about the improvement in the reinforcement of the concrete elements (decision 10), since it turned out that the designed reinforcement did not functioned according to the calculations. The third product decision is about the development of a larger type of the iQwoning® (decision 14). With this larger type IQ Woning B.V. and Ballast Nedam Bouw & Ontwikkeling want to approach other market segments.

Marketing decisions

Regarding the marketing decisions four decisions can be distinguished:

- Design of business model (decision 04)
- Determination of market (decision 05)
- Adjustment in performing acquisition (decision 12)
- Development of iQconcept (decision 15)

The first two marketing decisions are made in the phase the pilot project was executed. The first marketing decision was about which business model to use for this innovation (decision 04) and the second marketing decision was regarding the determination of the market of the iQwoning® (decision 05). The market that was determined at that time was the medium-priced market for homes for rent and for sale. In the last phase of the process the manner of performing acquisition was adjusted to the iQwoning® (decision 12) and the decision was made to further develop the concept of the iQwoning® (decision 15).

Decision-making processes

In this paragraph the decision-making processes of the 15 strategic decisions in the innovation project iQwoning® are discussed. The detailed descriptions of the decision-making processes are presented in Appendix F. Table 4.8 shows an overview of the decision-making processes and the game characteristics of these processes. The steps in the decision-making processes are scored according to the model developed in the theoretical framework. The decision-making processes are categorized based on the form of the process, the level of cooperation and the level of information.

For each decision first the context of the decision is determined, secondly the decision-making process is analyzed by making use of the model developed in the theoretical framework and finally the type of game that is played in the process is determined. Two decisions are described as an example how the context, process and type of game is determined.

Development of concept of modular housing (decision 01)

This decision describes the start of the development of the idea of a modular house, which can be distinguished as both an organizations decision since as a result the project group was founded that developed the iQwoning® and as an operations decision, because this decision marks the start of the innovation process. The process of the decision making is shown in Figure 4.13 and these steps in the process are also described in Table 4.8.

This process of decision making is determined as an extensive game with imperfect information. First is the form of the game determined, which is extensive since multiple employees were involved, which influenced the ultimate decision. Secondly, while only employees of Ballast Nedam were involved there was no true cooperation between the employees, although the employees shared the same goal. Therefore the game is described as a non-cooperative game. The last step to determine the type of game is by determining the set of information, which is in this process imperfect. Therefore the determined game is an extensive game with imperfect information.

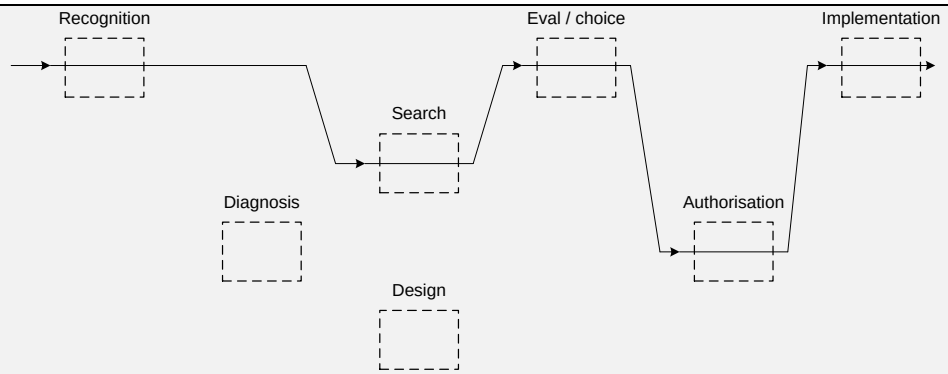


Figure 4.13: Decision-making process of decision 01 in innovation project iQwoning®

Improvement of reinforcement (decision 10)

This decision, which is a product decision, is about the improvements that are made in the reinforcement in the concrete elements of the iQwoning®. The process of the decision making is shown in Figure 4.14 and these steps in the process are also described in Table 4.8.

This process of decision making is determined as a strategic game. First is the form of the game determined, which is normal, since the decision to improve the reinforcement is made independently of other actors. The next steps in the determination are therefore not necessary, since in a strategic game there is no cooperation and the set of information in these types of games is imperfect.

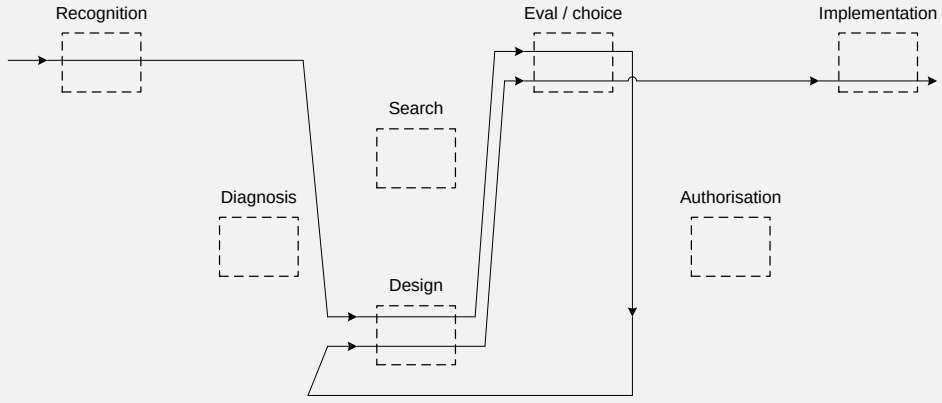


Figure 4.14: Decision-making process of decision 10 in innovation project iQwoning®

Organizations decisions

In the innovation project four organizations decisions are distinguished:

- Development of concept of modular housing (decision 1)
- Founding of IQ Woning B.V. (decision 8)
- Start of iQteam (decision 11)
- Adjustment of responsibilities of iQteam (decision 13)

All four organizations decisions can be described as straightforward with no interruptions. Two of the four decisions needed authorization, because respectively a project group was formed (decisions 1)

and an entity was founded (decision 8). Regarding the start of iQteam (decision 11) there was no authorization necessary since the involved parties found each other in the formation of a team. These three decisions are determined as extensive games with imperfect information, since all three had the goal to form a coalition or entity (project group, entity IQ Woning B.V. and iQteam). The last organizations decision (adjustment of responsibilities of the iQteam (decision 13)) is determined as a coalitional game, because the parties formed in an earlier stage a team and in this decision-making process fine-tuned the responsibilities.

Operations decisions

Five operations decisions are distinguished in this innovation process:

- Development of concept of modular housing (decision 01)
- Design of production process (decision 03)
- Pilot project Berckelbosch (decision 06)
- Factory for production iQwoning® (decision 07)
- Improvements in production process (decision 09)

Two operations decisions are about milestones in the innovation process (start of the innovation process (decision 01) and the pilot project in Berckelbosch (decision 06)), while the other three operations decisions are about the production process of the innovation (decisions 03, 07 and 09). The decisions about the milestones are process with no interruptions, while the decisions about the design of the production process (decisions 03 and 09) have both two interruptions, which indicate that the first plans were adjusted or changed. The decision to start the innovation process (decision 01) is in the previous paragraph determined as an extensive game with imperfect information. Also the decision 06 and 07 are determined as extensive games with imperfect information, since both decisions are made by multiple parties that are not yet in a coalition. The design of the production process (decision 03) is a coalitional game, since the design is made by the project group. The decision to make improvements in the production process (decision 09) is however described as a strategic game, since only IQ Woning B.V. is involved in this decision-making process.

Product decisions

In the innovation project iQwoning® three product decisions are distinguished:

- Design of iQwoning® (decision 02)
- Improvement of reinforcement (decision 10)
- Addition of new type of iQwoning® (decision 14)

The decision about the design of the iQwoning® (decision 02) is the decision with the most interruptions in this innovation project. Several adjustments are made regarding the design before was decided that the design met the requirements and wishes. The second product decision, which was about the improvement of the reinforcement (decision 10), has also an interruption. The reason for this interruption is that at first the solution to improve the reinforcement was not found). The last product decision, the addition of a new type of iQwoning® (decision 14), is made without interruptions. The design of the new type of iQwoning® is based on the design of the original iQwoning®. The design of the iQwoning® (decision 02) is determined as a coalitional game, since the design was made by the project group. The decision to improve the reinforcement (decision 10) is determined as strategic game, since only IQ Woning B.V. is involved in this decision-making process. The last decision (addition of new type of iQwoning® (decision 14)) is described as an extensive game

with imperfect information, since this decision was made by multiple decision-makers, but the decision-makers formed not a coalition.

Marketing decisions

Regarding the marketing decisions four decisions are distinguished:

- Design of business model (decision 04)
- Determination of market (decision 05)
- Adjustment in performing acquisition (decision 12)
- Development of iQconcept (decision 15)

All four marketing decisions can be described as straightforward with no interruptions. Also in the steps of the decision-making processes similarities are seen. In three of the four marketing decisions (decision 04, 05 and 15) the diagnosis routine is used. Further, regarding the decision to make adjustments in the performing of acquisition (decision 12) a new way of performing acquisition is suggested. Also with respect to the development of the iQconcept (decision 15) the decision is made by using the search routine. All four decision-making processes are determined as coalitional games, since the decisions are made by coalitions of decision-makers.

Table 4.8: Decision-making processes in the innovation project iQwoning®

Decision		Decision context		Decision process										Game			
	Decision	Phase	Type of decision	Steps of decision-making process							Evaluation			Form	Coop.	Info.	Game
				Rec.	*Diag.*	*Search*	*Design*	*Eval. / choice*	*Auth.*	*Impl.*	*Anal.*	*Judge.*	*Barg.*				
01	Development of concept of modular housing	1	Or/Op	1	-	1	-	1	1	1	-	1	-	E	NG	II	3
02	Design of iQwoning®	1	P	1	-	2	2	4	-	1	2	1	3	E	CG	-	4
03	Design of production process	1	Op	1	-	-	2	2	-	1	-	1	1	E	CG	-	4
04	Design of business model	2	M	1	-	1	-	1	-	1	-	-	1	E	CG	-	4
05	Determination of market	2	M	1	1	-	-	1	-	1	-	-	1	E	CG	-	4
06	Pilot project Berckelbosch	2	Op	1	1	-	-	1	-	1	1	-	1	E	NG	II	3
07	Factory for production iQwoning®	3	Op	1	1	-	1	1	1	1	1	-	-	E	NG	II	3
08	Founding of iQwoning B.V.	3	Or	1	-	-	-	1	1	1	-	-	1	E	NG	II	3
09	Improvements in production process	3	Op	1	-	1	1	2	-	1	1	2	-	N	-	-	1
10	Improvement of reinforcement	3	P	1	-	-	2	2	-	1	1	-	1	N	-	-	1
11	Start of iQteam	4	Or	1	1	-	-	1	-	1	-	-	1	E	NG	II	3
12	Adjustment in performing acquisition	4	M	1	-	1	-	1	-	1	-	-	1	E	CG	-	4
13	Adjustment of responsibilities of iQteam	4	Or	1	-	-	1	1	-	1	-	-	1	E	CG	-	4
14	Addition of new type of iQwoning®	4	P	1	-	-	1	1	-	1	1	-	1	E	NG	II	3
15	Development of iQconcept	4	M	1	1	1	-	1	-	1	-	-	1	E	NG	II	4

Phase
1. Idea generation
2. Pilot project
3. Development
4. Implementation

Type of decision
Or Organizations
Op Operations
P Product
M Marketing

Form
E Extensive
N Normal

Cooperation
CG Cooperative
NG Non-cooperative

Information
II Imperfect information
PI Perfect information

Game
1. Strategic
2. Extensive, perfect information
3. Extensive, imperfect information
4. Coalitional

Groups of decisions

Although the 15 strategic decisions in this innovation project can all be linked to each other through the innovation itself and its development process, there can be groups of decisions be distinguished. A linkage of decisions consists of 2 or more decisions that are directly linked to each other, because the outcome of a decision-making process is the cause to start a new decision-making process. An overview of the links between the decisions is shown in Figure 4.21. The following groups of decisions are distinguished:

- Determination of costs and prices (group iQ.A)
- Market determination (group iQ.B)
- Industrial production process (group iQ.C)
- Organization of production process (group iQ.D)
- Alignment in commercialization (group iQ.E)
- Addition of innovation (group iQ.F)

Determination of costs and prices

This group of decisions (group iQ.A) describes the decisions that led to the determination of the costs and prices of the iQwoning®. The innovation project started with the development of the concept of modular housing (decision 01) which ultimately turned out in the design of the iQwoning® (decision 02). Subsequently the production process of the iQwoning® (decision 03) is determined and finally the business model is designed (decision 04), which is based on the costs and efforts that are involved in the production process. This group of decisions is shown in Figure 4.15.

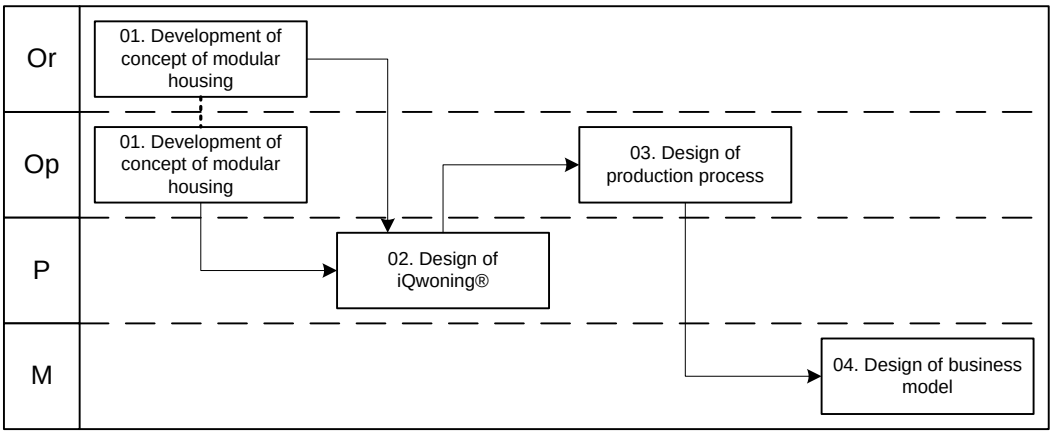


Figure 4.15: Group of decisions 'determination of costs and prices' (group iQ.A)

Market determination

The group of decisions that describes the market determinations (group iQ.B) consists of three decisions: the design of the iQwoning® (decision 02), the determination of the market of the iQwoning® (decision 05) and the decision to execute the pilot project in Berckelbosch (decision 06). First the iQwoning® is designed and based on the possibilities of the iQwoning® the market (medium-priced market) was determined. The pilot project Berckelbosch is chosen, since in this urban development project medium-priced houses were built. The group of decisions is presented in Figure 4.16.

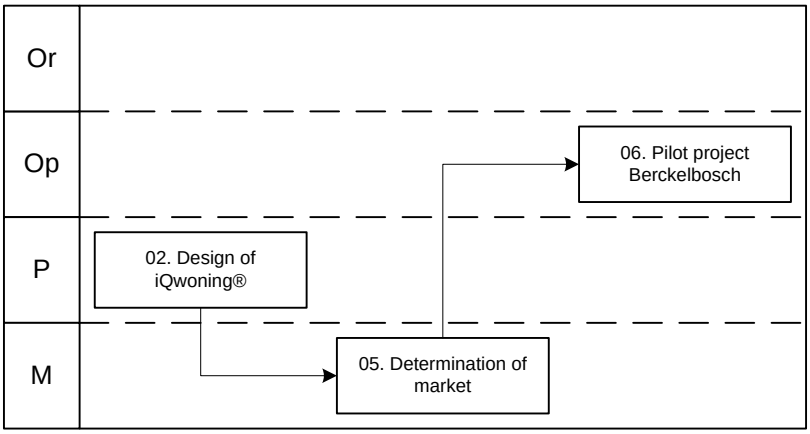


Figure 4.16: Group of decisions 'market determination' (group iQ.B)

Industrial production process

This group of decisions describes the industrialization of the production process. This process started with the design of the production process (decision 03). This process was used for the production of the iQwoning's® for the pilot project in Berckelbosch and the lay-out of this production process was used for the decision to build a factory for the production of the iQwoning® (decision 07). However, after the realization of the factory it seemed that the production process did not function optimally. Therefore improvements are made in the production process (decision 09). The group of decisions is shown in Figure 4.17.

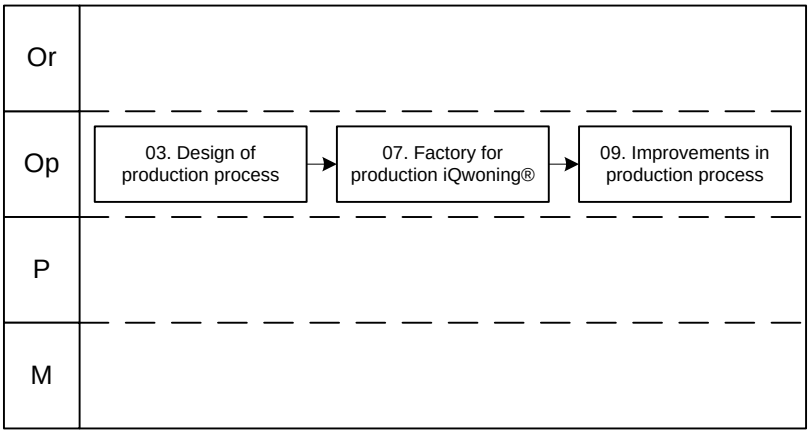


Figure 4.17: Group of decisions 'industrial production process' (group iQ.C)

Organization of production process

This group of decisions describes how the organization regarding the iQwoning® is determined. This group starts with the pilot project in Berckelbosch (decision 06) and the enthusiasm about the 5 iQwoning's® that were realized. Based on this enthusiasm and an estimated demand the decision was made to build a factory for the production of the iQwoning® (decision 07). After this decision it was decided that a new entity had to be founded that had to manage the production of the iQwoning®. This decision is the founding of IQ Woning B.V. (decision 08). The group of decisions is shown in Figure 4.18.

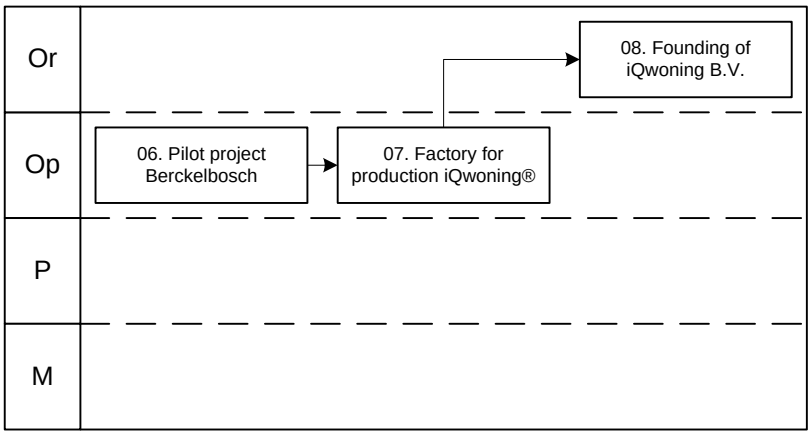


Figure 4.18: Group of decisions 'organization of production process' (group iQ.D)

Alignment in commercialization

This series of decisions described how the commercialization regarding the iQwoning® is aligned. The series starts with the start of the iQteam (decision 11), a team that consists of account managers of the regions of Ballast Nedam and representatives of IQ Woning B.V. and Ballast Nedam Bouw & Ontwikkeling. The iQteam decided after the start of it to make adjustment in the way of performing acquisition (decision 12) to generate more revenue through the iQwoning®. However, the first design of responsibilities did not function optimally; therefore adjustments are made in the responsibilities between the team members of the iQteam. The series of decisions is shown in Figure 4.19.

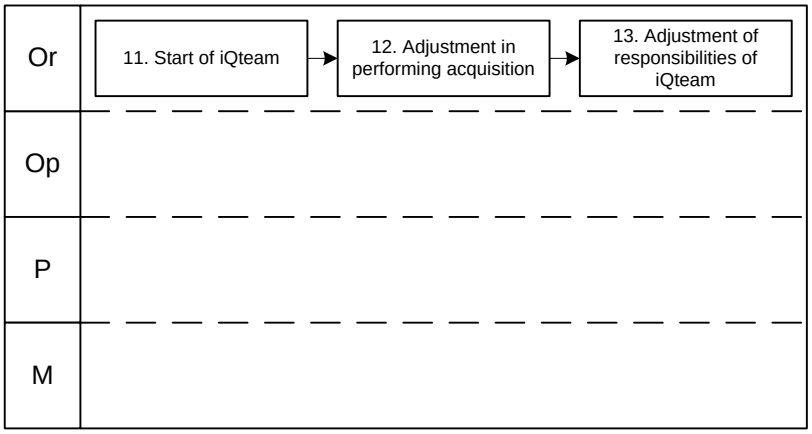


Figure 4.19: Group of decisions 'alignment in commercialization' (group iQ.E)

Addition of innovation

This group of decisions is the smallest group of decision in the innovation project, although it can be seen as a start of a larger group of decision. This group of decisions described the addition of the innovation in the form of a new version of the iQwoning®. This series starts with the decision to study the possibilities to enlarge the design of the iQwoning, which resulted in the addition of a new type of iQwoning® (decision 14). Consequently, this resulted in the possibilities to develop the concept of the iQwoning® further (decision 15). Next steps in this group of decision might be to adjust the iQteam based on the new markets than can be approached. However, these decisions are hypothetical and are not made. The group of decisions is shown in Figure 4.20.

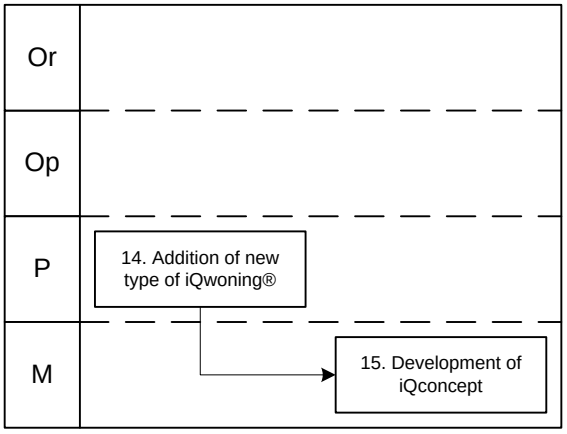


Figure 4.20: Group of decisions 'addition of innovation' (group iQ.F)

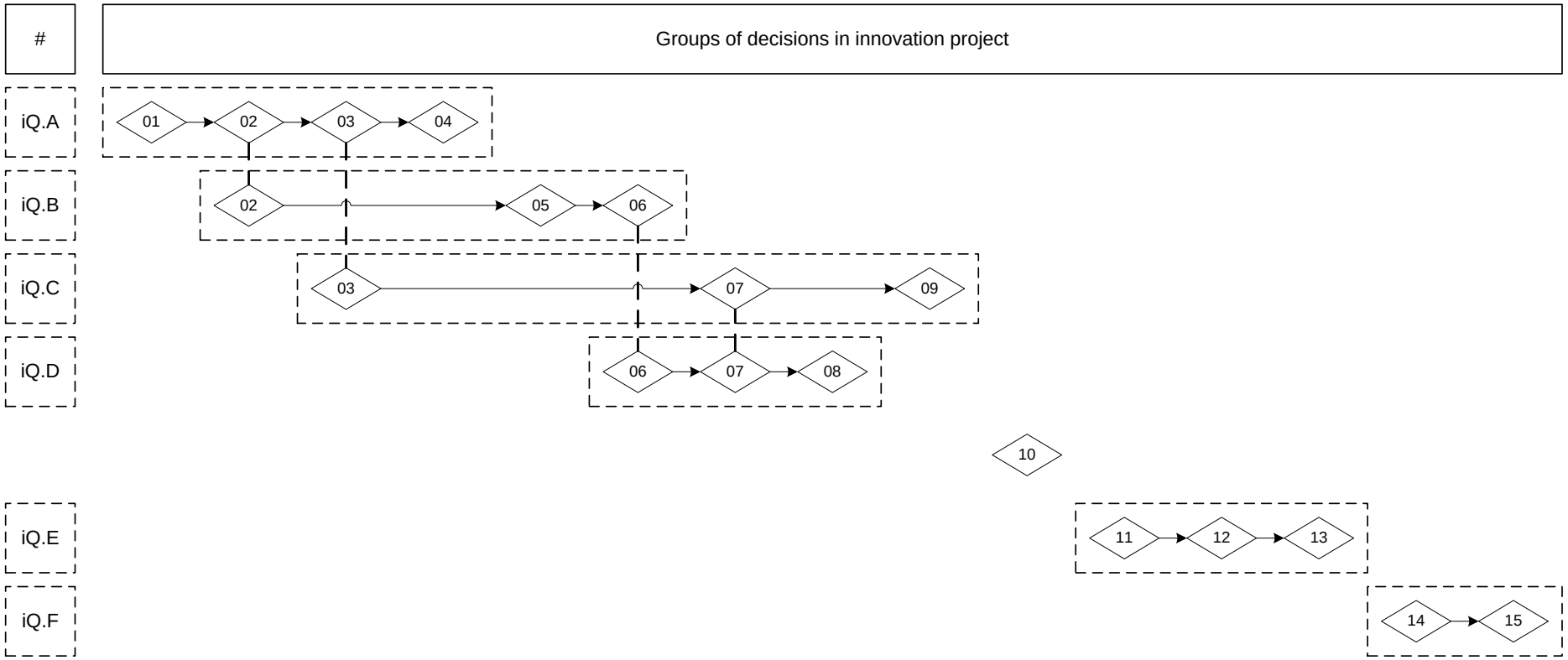


Figure 4.21: Overview of linked decisions in innovation project iQwoning®

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.

In this innovation process 15 strategic decisions are identified of which three decisions were made in the first phase, three decisions in the second phase, four decisions in the third phase and five decisions in the fourth phase of the process. Two decision-making processes are made by playing a strategic game. Both decisions are improvements in a design, respectively the design of the innovation and the design of the production process. The other decisions are made by playing either an extensive game with imperfect information or a coalitional game.

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. Subsequently the strategic decisions that are made in the innovation process 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 4.22.

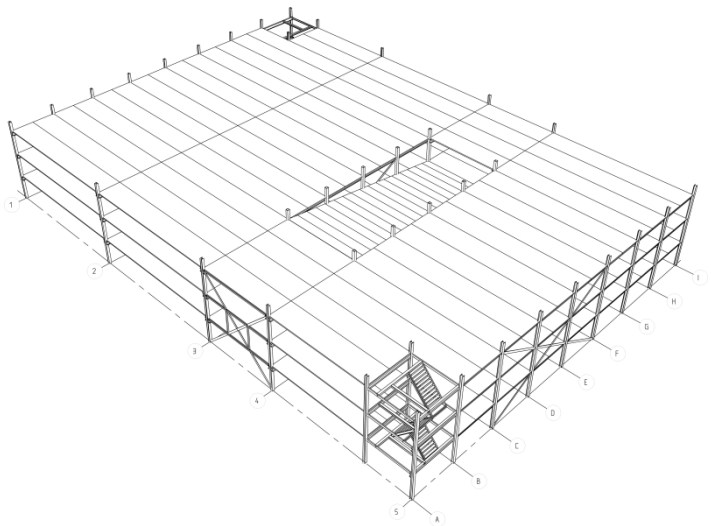


Figure 4.22: Drawing of of the ModuPark® car park

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 4.23

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.

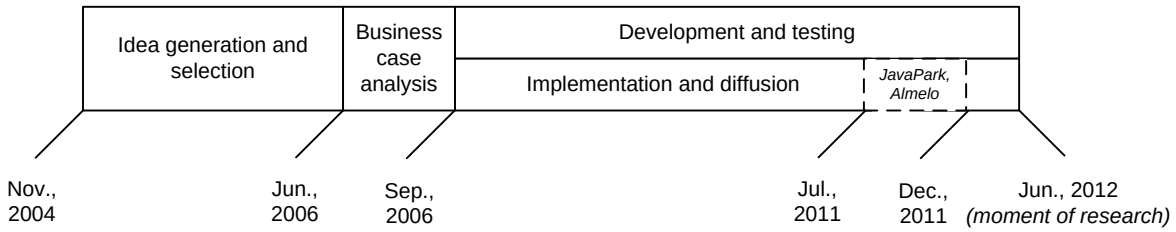


Figure 4.23: Timeline of the innovation project ModuPark®

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 4.9 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 4.9: 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.

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 4.24.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.

Table 4.10: 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

Project performance

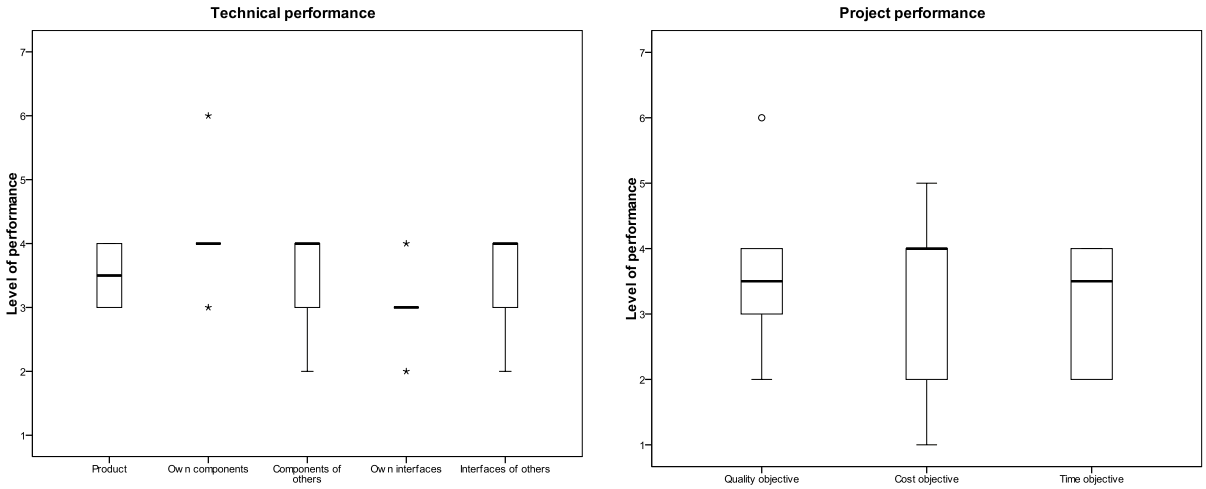
The project performance of the innovation project is measured using three items: the quality objective regarding the innovation, the costs objective of the innovation project and the time objective of the project. The scores of the project performance are shown in Figure 4.24.b. The quality of the innovation 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

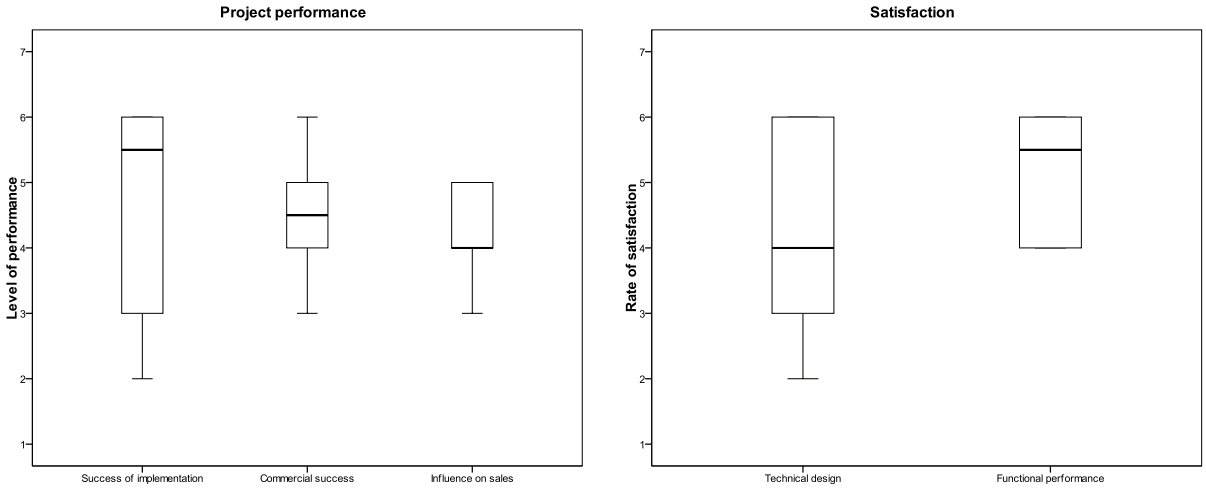
The market performance of the innovation project is measured using three items: the success of implementation, the commercial success and the influence on the firms' sales. The market performance is presented in Figure 4.24.c. Both the implementation success of the innovation and the commercial success 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 4.24.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 4.24: 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 Strategic decision making

In this section first the identified strategic decisions in the innovation project are discussed, thereafter the decision-making processes are analyzed and finally the linkages between strategic decisions are determined and discussed. The strategic decisions that will be discussed are from the perspective of Ballast Nedam Parking and Ballast Nedam Infra Projecten (the forerunner of Ballast Nedam Parking).

Strategic decisions

For the innovation project ModuPark® 12 strategic decisions are identified, which were identified and described by two employees that were involved in this innovation project. These decisions are

shown in Table 4.11. The decisions are numbered on chronological order. The detailed description of the decisions can be found in Appendix G.

Table 4.11: Decisions in the innovation project ModuPark®

	Idea generation and selection	Pilot project	Development and testing	Implementation and diffusion
Organizations	01. Cooperation between Ballast Nedam Infra Projecten, Grontmij Parkconsult and ParkMasters	05. Founding of Ballast Nedam Parking v.o.f.	07. Founding of ModuPark v.o.f.	
Operations	01. Cooperation between Ballast Nedam Infra Projecten, Grontmij Parkconsult and ParkMasters			
Product	02. Concept of the solution for temporary parking problems 03. Design of a modular car park		08. Expansion of the design with additional parking deck 09. Improvement of temporary fastening	10. Improvement of lateral load distribution
Marketing	04. Determination of the types of customers	05. Founding of Ballast Nedam Parking v.o.f. 06. Design of business model		11. Defining the types of end users 12. Determination of new types of customers

Organizations decisions

In the innovation project three organizations decisions can be distinguished:

- Cooperation between Ballast Nedam Infra Projecten, Grontmij Parkconsult and ParkMasters (decision 01)
- Founding of Ballast Nedam Parking v.o.f. (decision 05)
- Founding of ModuPark v.o.f. (decision 07)

The first organizations decision is the decision is to cooperate with Grontmij Parkconsult and ParkMasters (decision 01). The cooperation between the three firms is captured in a contract in contrast with the cooperation between Ballast Nedam Parking and Oostingh Staalbouw (decision 07) that is captured in a general partnership. The founding of the division Ballast Nedam Parking v.o.f. (decision 05) is besides an organizations decision also considered as a marketing decision, since the division emphasizes the expertise in the field of parking.

Operations decisions

One operations decision can be distinguished in this innovation process:

- Cooperation between Ballast Nedam Infra Projecten, Grontmij Parkconsult and ParkMasters (decision 01)

The decision to cooperate with Grontmij Parkconsult and ParkMasters is beside an organizations decision also an operations decision, because the determination of the demand in the market can be seen as the start of the innovation process.

Product decisions

In the innovation project ModuPark® five product decisions can be distinguished:

- Concept of the solution for temporary parking problems (decision 02)
- Design of a modular car park (decision 03)
- Expansion of the design with additional parking deck (decision 08)
- Improvement of temporary fastening (decision 09)
- Improvement of lateral load distribution (decision 10)

The most important product decisions are made in the first phase of the innovation process: the development of the concept solution for the temporary parking problems (decision 02) and the design of the modular car park (decision 03). Later in the innovation process adjustments are made in the design based on experiences with ModuPark® car parks that were realized. The first major adjustment was the expansion of the design with an additional parking deck (decision 08). This decision was made to increase the number of parking lots of a ModuPark® car park. Further, there are improvements made regarding the temporary fastening (decision 09) with the final goal to improve the demountability of the ModuPark and improvement with respect to the lateral load distribution (decision 10).

Marketing decisions

Regarding the marketing decisions four decisions can be distinguished:

- Determination of the types of customers (decision 04)
- Founding of Ballast Nedam Parking v.o.f. (decision 05)
- Design of business model (decision 06)
- Defining the types of end users (decision 11)
- Determination of new types of customers (decision 12)

As mentioned above the decision to found the division Ballast Nedam Parking v.o.f. (decision 05) can be considered as an operational decision, but also a decision with respect to the manner of presentation to the outside world. The decision about the design of the business model (decision 06) is made in the pilot project-phase, which seems late, however the preamble of the decision was in the first phase of the innovation process. The decisions about the market approach are made in the first and last phase of the process. In the first phase the market for the innovation is determined (decision 04), but in the last phase the potential market extended with new market segments (decision 12) after the types of end users were defined (decision 11). This might indicate that the innovation has developed during the process, that the market in the beginning of the process was not completely defined or that the environment in which the innovation is diffused has changed during the process.

Decision-making processes

In this paragraph the decision-making processes of the 12 strategic decisions in the innovation project ModuPark® are discussed. The detailed descriptions of the decision-making processes are presented in Appendix G. Table 4.12 shows an overview of the decision-making processes and the game characteristics of these processes. The steps in the decision-making processes are scored according to the model developed in the theoretical framework. The decision-making processes are categorized based on the form of the process, the level of cooperation and the level of information.

For each decision first the context of the decision is determined, secondly the decision-making process is analyzed by making use of the model developed in the theoretical framework and finally the type of game that is played in the process is determined. Two decisions are described as an example how the context, process and type of game is determined.

Concept of the solution for temporary parking problems (decision 02)

This decision is named a product decision, because during this decision- making process the concept of the ModuPark® was made. The outcome of this decision-making process is used for the final design of the ModuPark®. The process of the decision making is shown in Figure 4.25 and these steps in the process are also described in Table 4.12.

This decision-making process is determined as a coalitional game. Firstly, the form of the game is determined. In this case the form is extensive, since multiple decision-makers were involved with different interests. Secondly, the game is a cooperative game, since three parties (Ballast Nedam Infra Projecten, Grontmij Parkconsult and ParkMasters) were involved in this process. Thirdly, the set of information is determined. In practice it is almost impossible to have all the information, which is also the case in this project; therefore the set of information is defined as incomplete and the game is determined as a coalitional game.

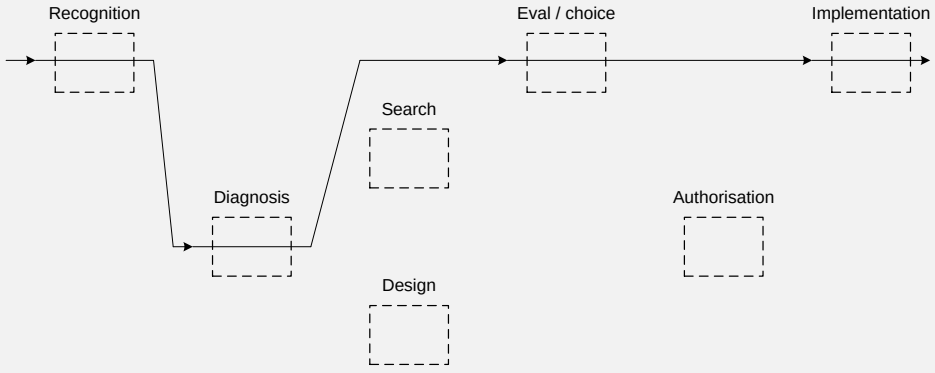


Figure 4.25: Decision-making process of decision 02 in innovation project ModuPark®

Founding of Ballast Nedam Parking v.o.f. (decision 05)

This decision is determined to be an organization decision, since the decision was to found an entity, and a marketing decision, because the entity was used to present itself to the outside world as an expert in the field of parking. For the founding of the entity authorization of the board of management was necessary. The process of the decision making is shown in Figure 4.26 and these steps in the process are also described in Table 4.12.

The decision-making process of the founding of Ballast Nedam Parking is described as a coalitional game. First, the game has an extensive form, since the directions of Ballast Nedam Bouw and Ballast Nedam Infra were involved in this process. Second, the game is determined to be cooperative. Although there is no legal coalition formed, both divisions are part of the same organization and therefore are bound to each other. Third, the set of information is incomplete, since in practice it is almost impossible to have a complete set of information. Therefore the game is determined as a coalitional game.

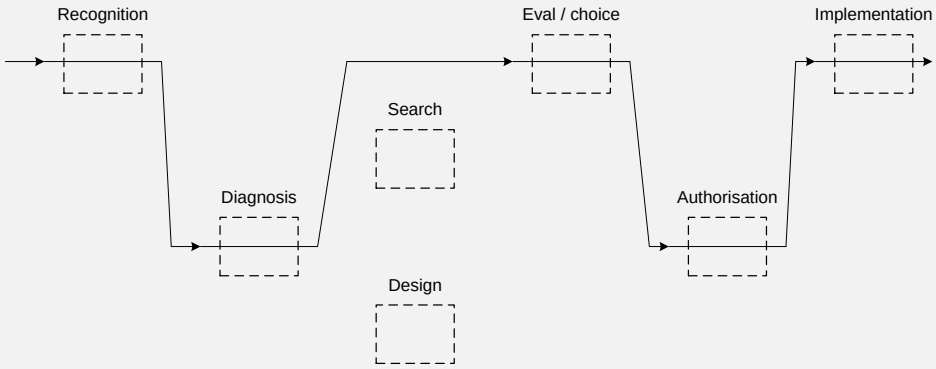


Figure 4.26: Decision-making process of decision 05 in innovation project ModuPark

Organizations decisions

In the innovation project three organizations decisions are distinguished:

- Cooperation between Ballast Nedam Infra Projecten, Grontmij Parkconsult and ParkMasters (decision 01)
- Founding of Ballast Nedam Parking v.o.f. (decision 05)
- Founding of ModuPark v.o.f. (decision 07)

The organizations decisions in this innovation project are the decision to cooperate with other firms and the founding of entities, of which the founding of one entity is the result of a decision to cooperate more closely (decision 07). All three operational decisions can be described as straightforward with few interruptions. Only in the case of the decision to cooperate with Grontmij Parkconsult and ParkMasters an interruption can be distinguished (decision 01). However, the interruption was made to approach ParkMasters for the collaboration. Further it is noticed that both the decisions to found an entity needed authorization (decisions 05 and 07). The reason that only those two decisions needed authorization is because these decisions exceed the innovation project.

Although two decisions are about cooperation, none of the operational decisions are considered to be coalitional games. The reason that the decisions about cooperation are described as extensive games with imperfect information is that the games are played to with the goal to form a coalition. The decision to found Ballast Nedam Parking (decision 05) is a decision that is made independently of other parties. Therefore this decision-making process is considered to be a strategic game.

Operations decisions

One operations decision is distinguished in this innovation process:

- Cooperation between Ballast Nedam Infra Projecten, Grontmij Parkconsult and ParkMasters (decision 01)

The decision to cooperate with Grontmij Parkconsult and ParkMasters is besides an organizations decision also an operations decision. To establish the cooperation an interruption was made, because in the second round ParkMasters was approach to participate in the collaboration. The game of this decision is determined as an extensive game with imperfect information. The reason is that the process has an extensive form, there is no coalition yet and the set of information is incomplete.

Product decisions

In the innovation project ModuPark® five product decisions are distinguished:

- Concept of the solution for temporary parking problems (decision 02)
- Design of a modular car park (decision 03)
- Expansion of the design with additional parking deck (decision 08)
- Improvement of temporary fastening (decision 09)
- Improvement of lateral load distribution (decision 10)

The product decisions are decisions about the concept, design and improvements in the design. This type of decisions contains the decision-making process with the most interruption, namely the design process of the modular car park (decision 03). In this decision-making process several examples for a modular carp park are compared before Ballast Nedam Infra Projecten decided to design a modular car park. This process is also the only decision-making process for this type of decisions that is classified as an extensive game with imperfect information. The reason for this classification is that various organizations are involved in the design process, but there was no coalition with these organizations.

Except for the decision regarding the improvement of the fastening (decision09), the other decision-making processes are described as coalitional games. The concept of the solution for the temporary parking problems is developed together with Grontmij Parkconsult and ParkMasters (decision 02), while the decisions to improve the lateral load distribution (decision 10) and to expand of the design with an additional parking deck (decision 08) is made in consultation with Oostingh Staalbouw.

Marketing decisions

Regarding the marketing decisions four decisions are distinguished:

- Determination of the types of customers (decision 04)
- Founding of Ballast Nedam Parking v.o.f. (decision 05)
- Design of business model (decision 06)
- Defining the types of end users (decision 11)
- Determination of new types of customers (decision 12)

The decision-making processes of marketing decisions are either strategic games or coalitional games. The determination of the types of customers (decision 04) that is done in the first phase in the innovation process is described as a coalitional game, since both Grontmij Parkconsult and

ParkMasters are involved. The other marketing decisions are however described as strategic games which can be explained because of the leading role Ballast Nedam Parking had and has in the marketing of the innovation. This leading role is reflected in the decision to found Ballast Nedam Parking v.o.f. (decision 05), because this entity emphasizes the expertise of Ballast Nedam in the field of parking.

The two marketing decisions in the last phase about defining the types of end users (decision 11) and determining the new types of customers (decision 12) are almost identical to each other. Both processes contain a search routine, which indicates that in both situations the final result is not designed, but is found in other situations and adjusted to the situation in the innovation project. The decision about the business model (decision 06) is an extensive decision-making process and the reason for the extensiveness is because there were no examples of business models for this unique type of product.

Table 4.12: Decision-making processes in the innovation project ModuPark

Decision		Decision context		Decision process										Game			
	Decision	Phase	Type of decision	Steps of decision-making process							Evaluation			Form	Coop.	Info.	Game
				Rec.	*Diag.*	*Search*	*Design*	*Eval. / choice*	*Auth.*	*Impl.*	*Anal.*	*Judge.*	*Barg.*				
01	Cooperation Ballast Nedam Grontmij and ParkMasters	1	Or/Op	1	-	2	-	2	-	1	-	-	2	E	NG	II	3
02	Concept of the solution for temporary parking problems	1	P	1	1	-	-	1	-	1	-	-	1	E	CG	-	4
03	Design modular car park	1	P	1	1	1	2	3	-	1	3	2	-	E	NG	II	3
04	Determination of the types of customers	1	M	1	1	-	-	1	-	1	-	-	1	E	CG	-	4
05	Founding of Ballast Nedam Parking v.o.f.	2	Or / M	1	1	-	-	1	1	1	-	1	-	E	CG	I-	4
06	Design of business model	2	M	1	-	1	1	2	-	1	-	-	2	N	-	-	1
07	Founding of ModuPark v.o.f.	3	Or	1	-	-	-	1	1	1	-	-	1	E	NG	II	3
08	Expansion of the design with additional parking deck	3	P	1	-	-	1	1	-	1	1	-	1	E	CG	-	4
09	Improvement of temporary fastening	3	P	1	1	-	1	1	-	1	1	-	-	N	-	-	1
10	Improvement of lateral load distribution	3	P	1	1	1	-	1	-	1	1	-	-	E	CG	-	4
11	Defining the types of end users	4	M	1	-	1	-	1	-	1	-	1	-	N	-	-	1
12	Determination of new types of customers	4	M	1	1	-	-	1	-	1	-	1	-	N	-	-	1

Phase
1. Idea generation
2. Pilot project
3. Development
4. Implementation

Type of decision
Or Organizations
Op Operations
P Product
M Marketing

Form
E Extensive
N Normal

Cooperation
CG Cooperative
NG Non-cooperative

Information
II Imperfect information
PI Perfect information

Game
1. Strategic
2. Extensive, perfect information
3. Extensive, imperfect information
4. Coalitional

Linkages of decisions

Although the 12 strategic decisions in this innovation project can all be linked to each other through the innovation itself and its development process, there can be groups of decisions be distinguished. A linkage of decisions consists of 2 or more decisions that are directly linked to each other, because the outcome of a decision-making process is the cause to start a new decision-making process. An overview of the links between the decisions is shown in Figure 4.31. The following groups of decisions are distinguished:

- Market entering (group MP.A)
- Profit mechanism (group MP.B)
- Consequences of business model (group MP.C)
- New market segmentation (group MP.D)

Market entering

This group of decisions describes is the market entering of the innovation (group MP.A). The group started with the decision of Ballast Nedam Infra Projecten to begin to cooperate with Grontmij Parkconsult and ParkMasters (decision 01) after a demand was identified in the field of temporary parking. The following decision was to develop a concept solution for this demand (decision 02), which was elaborated by Ballast Nedam Parking in the design of a modular car park (decision 03). The final decision of the linkage was the determination of the types of customers of the modular car park (decision 04). Although the determined types of customers were already earlier in the process identified, in this stage of the process the focus on the potential market was accentuated. The group of decision regarding the market entering is shown in Figure 4.27.

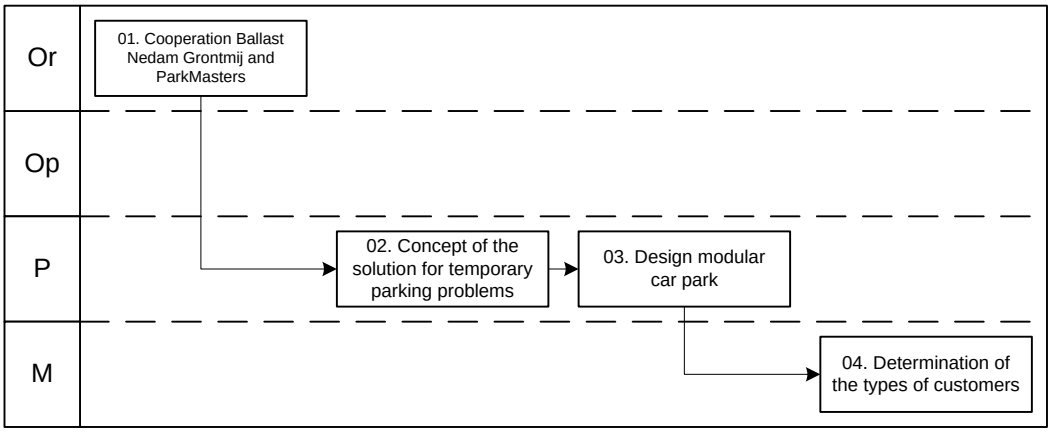


Figure 4.27: Group of decisions 'market entering' (group MP.A)

Profit mechanism

This group of decisions is about the profit mechanism (group MP.B). This group of decision began with the decision for the concept of the solution for the temporary parking problem (decision 02). The concept is subsequently developed into a design for a modular car park (decision 03) by Ballast Nedam Infra Projecten, since Ballast Nedam Infra Projecten was the only firm of the three firms in the cooperation that was a constructor and that had the knowledge to develop a modular car park. After the modular car park was designed the next step in the process was to develop a business model for the innovation (decision 06). In the chosen business model customers rent a modular car

park for a particular period of time and after this rental period the same modular car park is rented to another customer. The linkage 'profit mechanism' is shown in Figure 4.28.

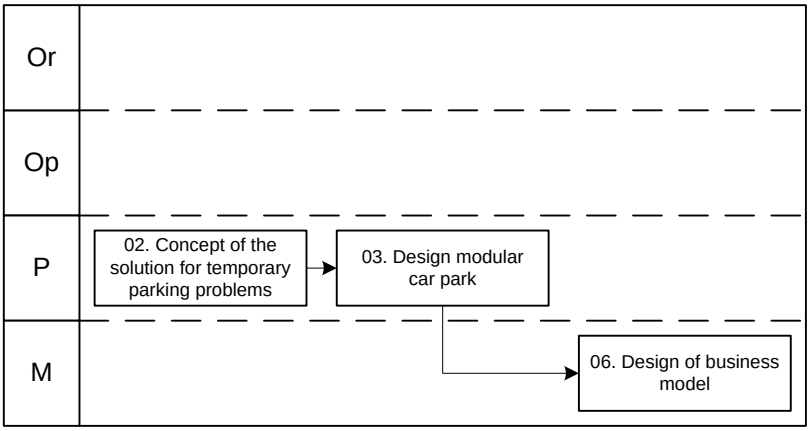


Figure 4.28: Group of decisions 'profit mechanism' (group MP.B)

Consequences of business model

This group of decision, regarding the consequences of the business model (group MP.C), consists of the design of the business model (decision 06) and the founding of the ModuPark v.o.f. (decision 07). In the chosen business model the ModuPark® car parks were rented to customers and if a ModuPark® car park was not rented the elements were stored at depositories of Ballast Nedam. However, with the storage of these elements high financial risks were involved, therefore Ballast Nedam Parking decided to collaborate with Oostingh Staalbouw and to found the general partnership ModuPark v.o.f. to share the risks and besides that to increase the commitment regarding the further development of the innovation. The group of decisions is presented in Figure 4.29.

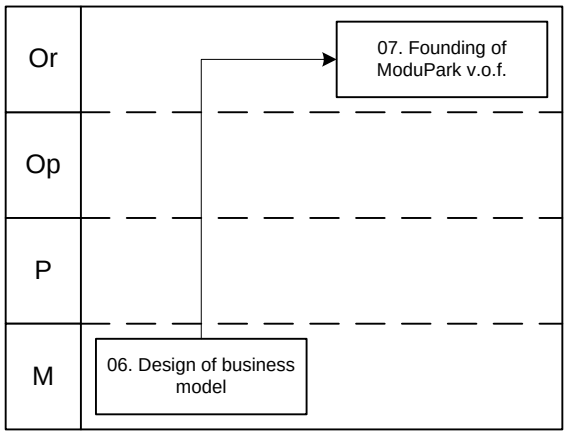


Figure 4.29: Group of decision 'consequences of business model' (group MP.C)

New market segmentation

The group of decisions with respect to the determination of new market segments (group MP.D) originates in the determination of the types of customers in the first phase of the innovation process (decision 04). In the fourth phase, the implementation and diffusion, new market segments are

determined. First the different types of end users of the ModuPark® are identified (decision 11) to better understand the wishes and demands of different types of end users and subsequently new types of customers are determined (decision 12), since these customers offer the opportunity for parking to the different types of end users. The group of decisions is shown in Figure 4.30.

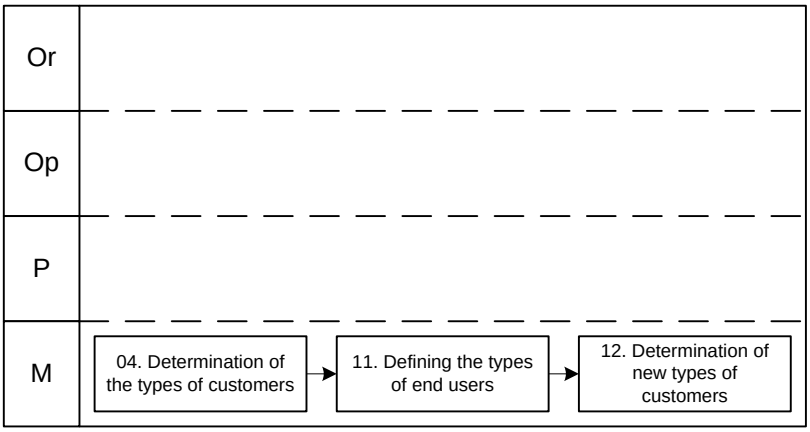


Figure 4.30: Group of decisions 'new market segmentation' (group MP.D)

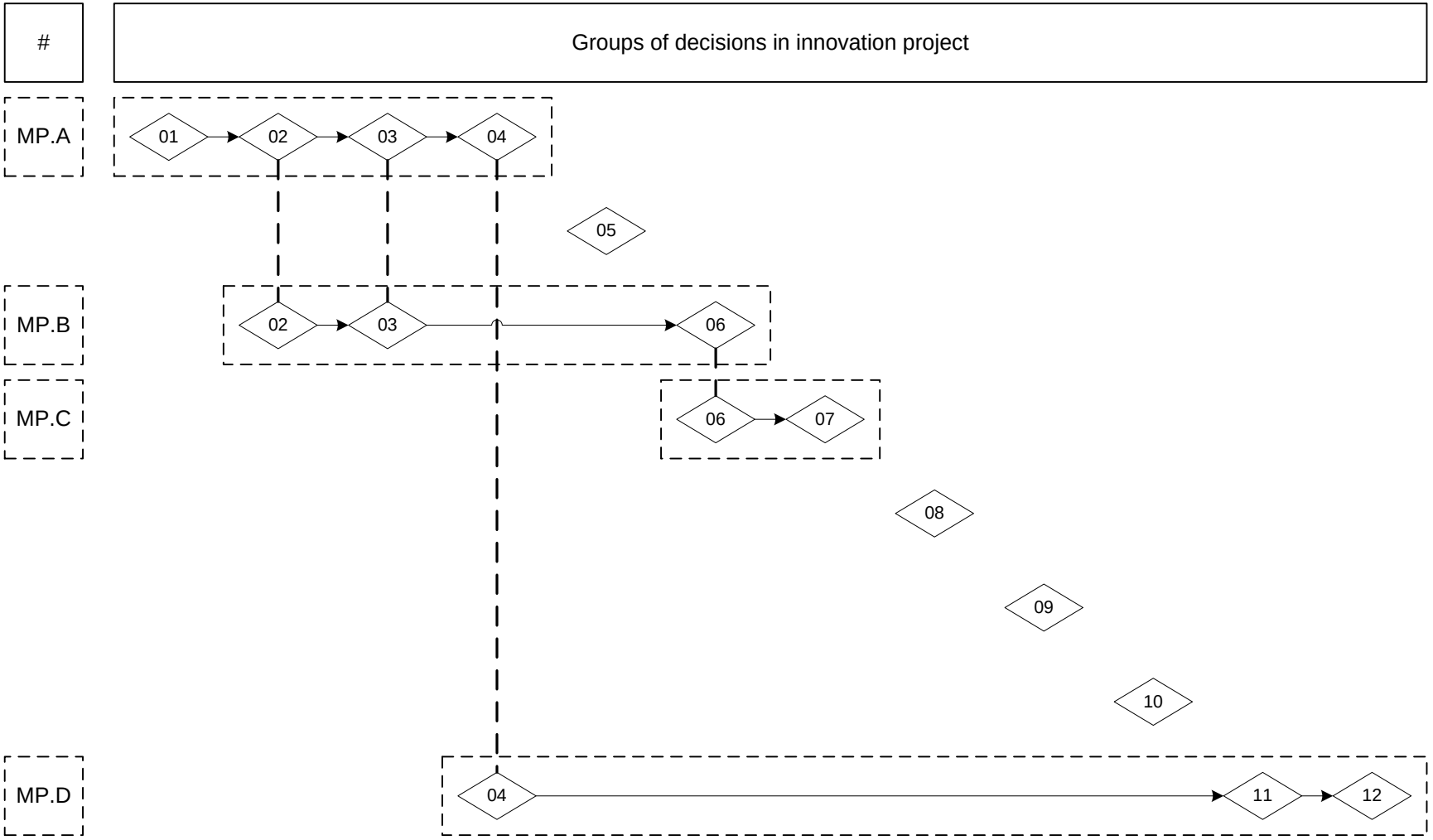


Figure 4.31: Overview of linked decisions in innovation project ModuPark®

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.

In this innovation process 12 strategic decisions are identified of which four decisions were made in the first phase, two decisions in the second phase, three decisions in the third phase and again three decisions in the fourth phase of the process. At the beginning of the project the decision-making processes are played by an extensive game with imperfect information or a coalitional phase. From the second phase processes are also played by a strategic game, especially the marketing decisions. Further, in this innovation projects two decisions were made to found a general partnership.

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, the decisions that were made, the decision-making processes that are executed and the links between the decisions. Beside the comparison of the cases on these variables, the effect of decision-making processes on the innovation performance is analyzed. 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.

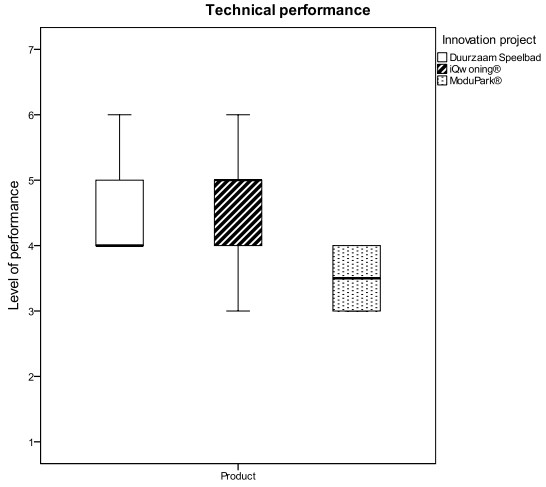
Table 5.1: Innovation performance of the three innovation projects

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

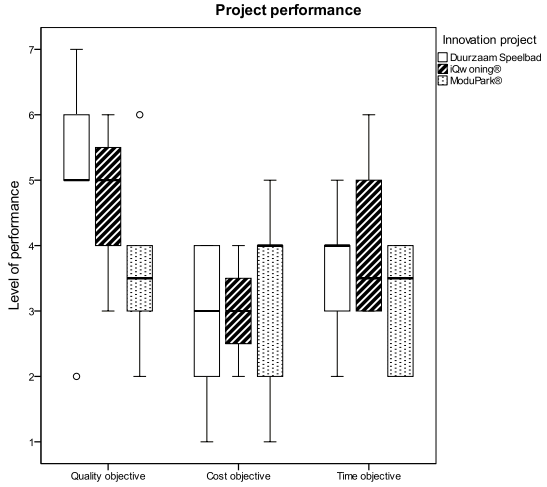
To compare the three innovation projects the means can be used, however for this cross-case analysis the scores are classified by making use of a classification system that consists of five components. The classification that is used is shown in Table 5.2. This classification is applied to the scores 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

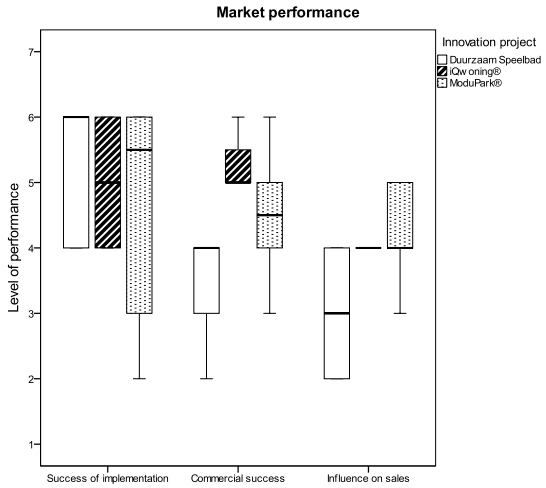
Score	1.00 – 2.20	2.21 – 3.40	3.41 – 4.60	4.61 – 5.80	5.81 – 7.00
Classification	Very low	Low	Moderate	High	Very high



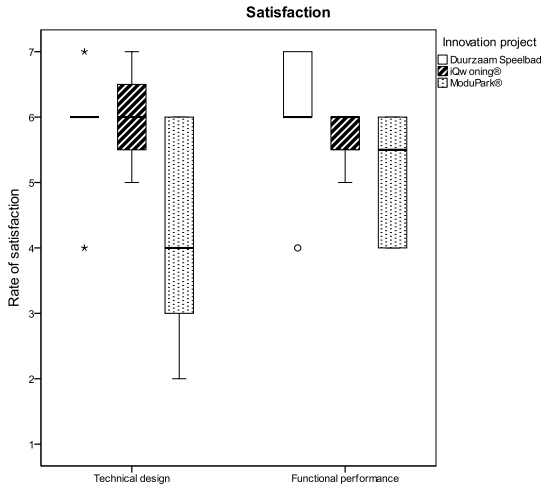
a. Technical performance



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
	Same classification on 3 cases

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 Strategic decision making

5.2.1 Strategic decisions

In this section the strategic decisions that are made in the three innovation projects are compared. In the innovation projects four types of decisions can be distinguished: organizations decisions, operations decisions, product decisions and marketing decisions. The number of decisions that were made per phase in the three projects is shown in Figure 5.2. The other figures show percentages of the decisions per phase and per innovation project. The decisions will be discussed per decision type.

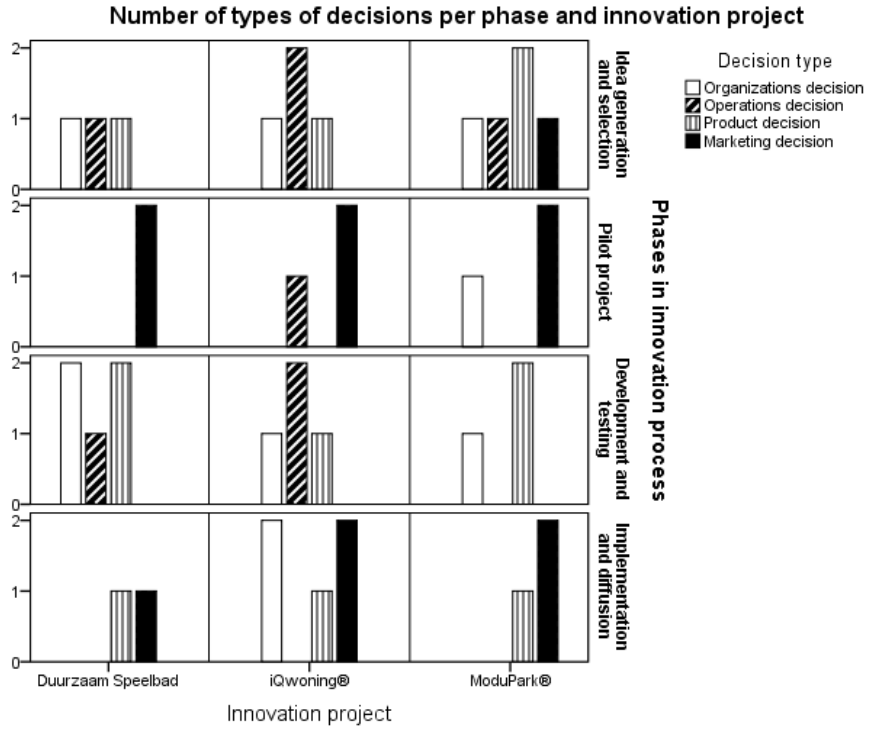


Figure 5.2: Number of types of decisions per innovation project

5.2.1.1 Organizations decisions

In total 10 organizations decisions can be distinguished in the three innovation projects. In the idea selection and generation phase the number of organizations decisions is the highest, while the percentage of organizations decisions compared to the other types of decisions is the highest in the development and testing phase. In the phase of the pilot project only one organization decisions was made and in the implementation and diffusion phase two decisions were made. These two decisions were both made in the innovation project iQwoning® and the reason for these decisions was to prepare the organization of Ballast Nedam for the diffusion of the iQwoning®. In all three innovation projects about a quarter of the made decisions was an organizations decision.

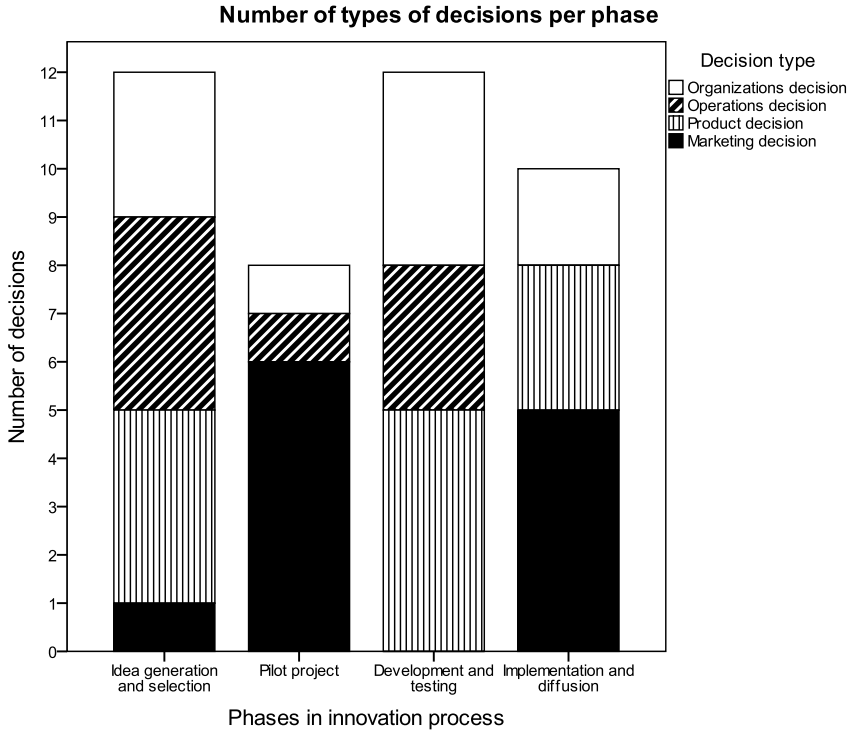


Figure 5.3: Number of types of decisions per phase

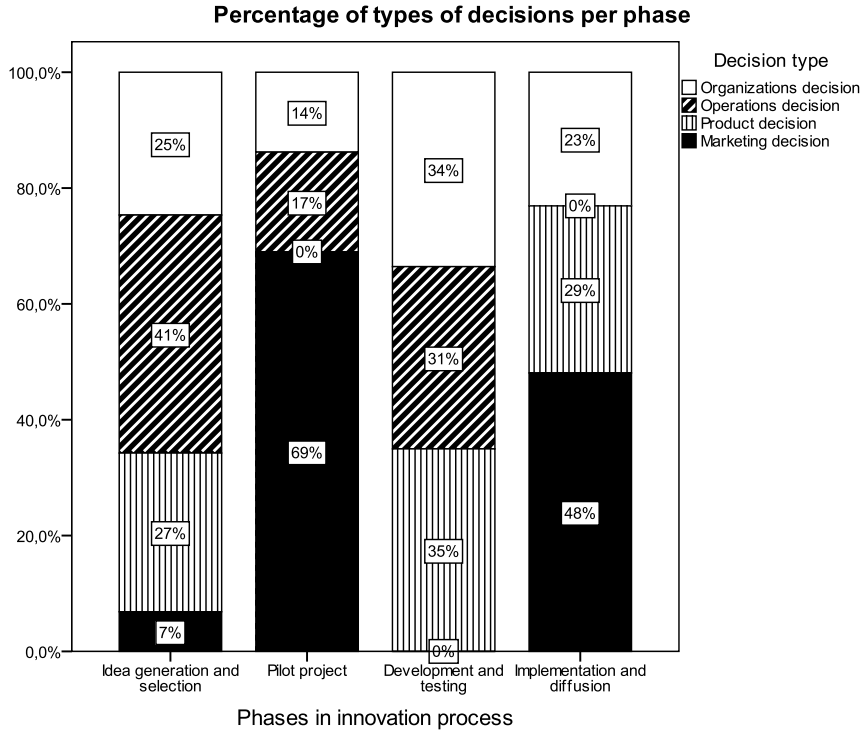


Figure 5.4: Percentage of types of decisions per phase

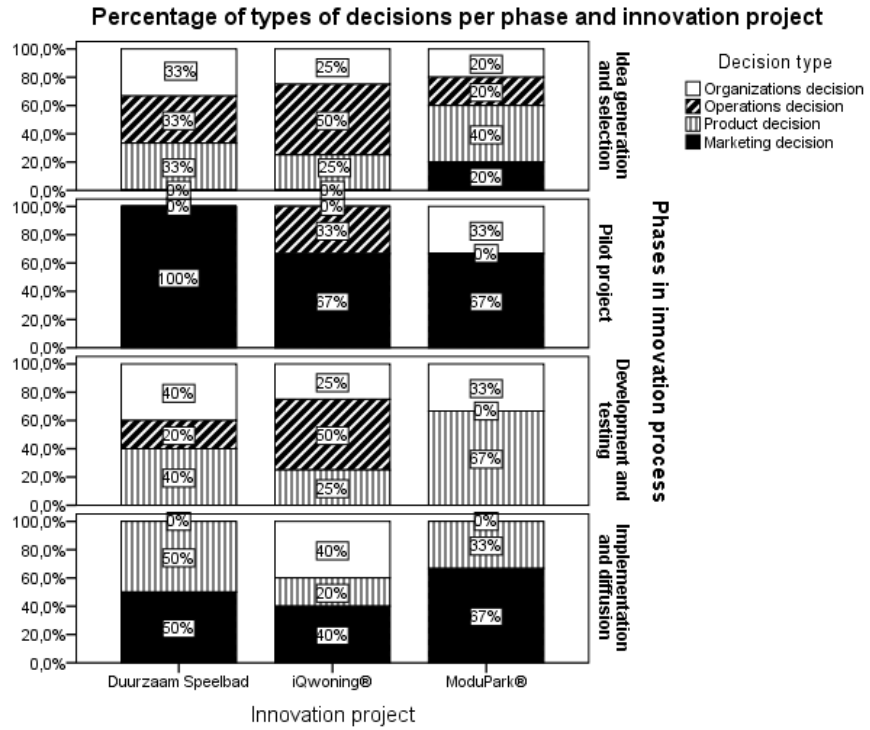


Figure 5.5: Percentage of types of decisions per phase and innovation project

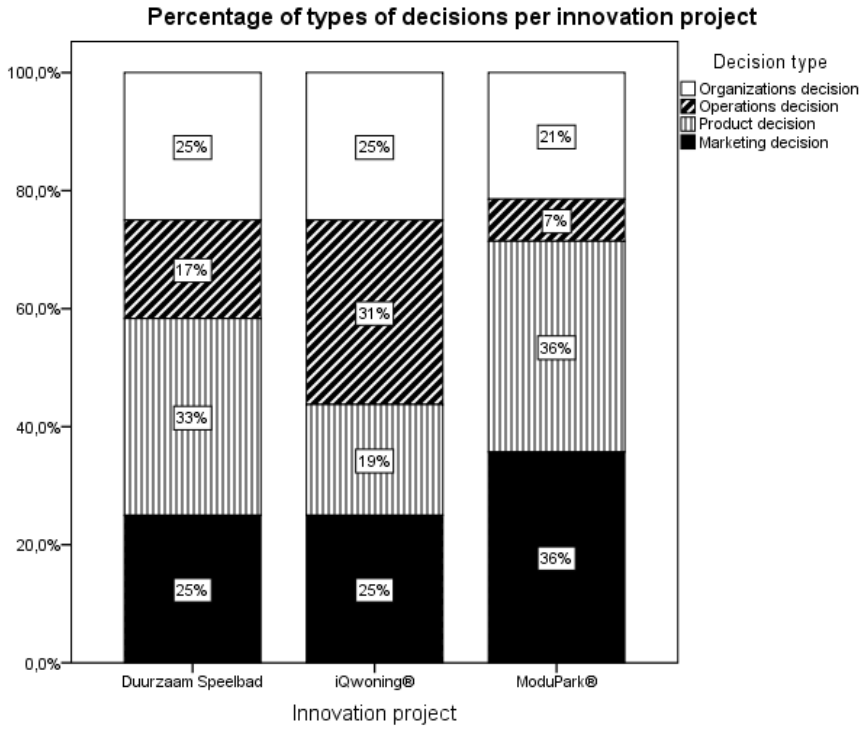


Figure 5.6: Percentage of types of decisions per innovation project

5.2.1.2 Operations decisions

In the three innovation projects eight operations are distinguished. These operations decisions are only made in the first three phases and not in the implementation and diffusion phase. The most operations decisions are made in the first phase, both the numbers and percentages. However, also in the development and testing phase several operations decisions are made. In the phase the pilot projects are conducted only one operations decision can be distinguished. This decision was made in the innovation project iQwoning® and was about the where and when the pilot project to conduct. This is remarkable, since this decision type is not made in the other two projects. The reason for this is that in those two projects a market party approached Ballast Nedam to conduct a pilot project, since those two innovations were market-pull innovations, while the iQwoning® is a technology-push innovation and therefore not demanded by the market. The largest part of decisions in the project iQwoning® were operations decisions (31%), while in the other two projects this percentage was 17% (Duurzaam Speelbad) and 7% (ModuPark®).

5.2.1.3 Product decisions

There can be 12 product decisions be distinguished in the three innovation projects. The most product decisions can be found in the development and testing phase, while no product decisions are made in the pilot project. The product decisions can be classified based on the phase in which they are made. In the idea and generation phase the product decisions are about the first design or draft of the innovation. In the development and testing phase the product decisions that are made are mainly improvements regarding the product, which are based on experiences in the pilot project. The product decisions in the last phase of the innovation process are adjustments in the design or the further development of an innovation. In the latter case, the further development can also be considered as the idea selection and generation phase of a new innovation process. About a third of the decisions in the market-pull innovation projects Duurzaam Speelbad (33%) and ModuPark® (36%) are characterized as a product decision, while in the project iQwoning® 19% is a product decision.

5.2.1.4 Marketing decisions

The 12 marketing decisions are mainly made during the pilot project or implementation phase. Only in the innovation project ModuPark® a marketing decision is made in the first phase of the process. Most of the marketing decisions are made in the second and fourth phase, because marketing decisions have an external perspective and those two phases are the two most external-oriented phases in the innovation process. During the pilot project, or in case of the project ModuPark® in the idea selection and generation, marketing decisions are made about the determination of the market and in the implementation and diffusion phase marketing decisions are made to adapt the market or to enter new markets. In the project ModuPark® a third of the decisions is named as a marketing decision, while the share in the projects Duurzaam Speelbad and iQwoning® is for both 25%.

5.2.2 Decision-making processes

In the within case analyses of the three innovation projects the processes of the 38 identified decisions are analyzed by making use of the the model developed in the theoretical framework. For each decision-making process the routines that were used in the process are determined, the types of used evaluations are determined and the type of game is determined. Based on similarities between the decisions that are made in the three innovation projects nine groups of decisions are distinguished by the researcher:

- Start of the innovation process (group 01)
- Design of the innovation (group 02)
- Design of business model (group 03)
- Determination of the market (group 04)
- Cooperation with other parties (group 05)
- New design of the innovation (group 06)
- Design of production process (group 07)
- Improvements in design (group 08)
- Determination of new types of customers (group 09)

In Table 5.4 the decision-making processes of the 24 selected decisions are shown. The 24 decision-making processes are compared on the phase the decision was made, the routines that were completed, the evaluations that were used and the type of game that was played.

5.2.2.1 Start of the innovation process

The three innovation projects had all three a different start of the innovation process (group 01), which is seen in the routines that were completed. The innovation project Duurzaam Speelbad was started (code 01.A), because of a direct demand out of the market, while the project ModuPark® was started (code 01.C), because an opportunity in the market was noticed by Ballast Nedam. However, both innovations can be classified as a market-pull innovation. The innovation project iQwoning® on the other hand was started (code 01.B) because opportunities were noticed in the technology. Therefore this innovation project can be described as a technology push innovation.

The differences in the starts can also be noticed based on the completed routines in the three decision-making processes. Regarding the start of the project Duurzaam Speelbad (01.A) no search or design routines were completed, while in the innovation project ModuPark® (01.C) the search routines was completed twice. In the innovation project iQwoning® (01.B) the opportunities of the technology were determined in the search routine. This routine was completed in one time.

Similarities between the processes that can be perceived are regarding the evaluation routine and the way the evaluation was conducted. In the projects Duurzaam Speelbad (01.A) and iQwoning® (01.B) the evaluation routine was conducted one time and the evaluation took place through judgement. In the project ModuPark® (01.C) the evaluation was conducted twice and the evaluation took place through bargaining. All three decision-making processes however are played by an extensive game with imperfect information.

Table 5.4: Similar decision-making processes in the three innovation projects

Type of process	Decision	Code	Decision context			Decision process										
	Decision		Project	Phase	Decision type	Steps of decision-making process							Evaluation			Game
						Rec.	*Diag.*	*Search*	*Design*	*Eval. / choice*	*Auth.*	*Impl.*	*Anal.*	*Judge.*	*Barg.*	
Start of the innovation process	Rebuilding of children's pools in Amstelveen	01.A	DS	1	Or/Op	1	1	-	-	1	-	1	-	1	-	3
	Development of concept of modular housing	01.B	iQ	1	Or/Op	1	-	1	-	1	1	1	-	1	-	3
	Cooperation Ballast Nedam Grontmij and ParkMasters	01.C	MP	1	Or/Op	1	-	2	-	2	-	1	-	-	2	3
Design of the innovation	Design of Duurzaam Speelbad	02.A	DS	3	P	1	-	-	1	1	1	1	1	-	1	4
	Design of iQwoning®	02.B	MP	1	P	1	-	2	2	4	-	1	2	1	3	4
	Design modular car park	02.C	MP	1	P	1	1	1	2	3	-	1	3	2	-	3
Design of business model	Design of business model	03.A	DS	2	M	1	-	1	-	1	-	1	-	1	-	1
	Design of business model	03.B	iQ	2	M	1	-	1	-	1	-	1	-	-	1	4
	Design of business model	03.C	MP	2	M	1	-	1	1	2	-	1	-	-	2	1
Determination of the market	Determination of the market	04.A	DS	2	M	1	1	-	-	1	-	1	-	1	-	1
	Determination of market	04.B	iQ	2	M	1	1	-	-	1	-	1	-	-	1	4
	Determination of the types of customers	04.C	MP	1	M	1	1	-	-	1	-	1	-	-	1	4

Same classification on 2 cases
Same classification on 3 or more cases

Type of process	Decision	Code	Decision context			Decision process										
	Decision		Project	Phase	Decision type	Steps of decision-making process							Evaluation			Game
						Rec.	*Diag.*	*Search*	*Design*	*Eval. / choice*	*Auth.*	*Impl.*	*Anal.*	*Judge.*	*Barg.*	
Cooperation with other parties	Cooperation with Waco Lingen Beton	05.A	DS	3	Or	1	-	-	-	1	-	1	-	-	1	3
	Cooperation with Van Dorp Zwembaden	05.B	DS	3	Or	1	-	1	-	1	-	1	-	-	1	3
	Cooperation Ballast Nedam Grontmij and ParkMasters	05.C	MP	1	Or/Op	1	-	2	-	2	-	1	-	-	2	3
New design of the innovation	Improved design of Duurzaam Speelbad	06.A	DS	3	P	1	1	-	2	2	-	1	2	2	-	4
	Addition of new type of iQwoning®	06.B	iQ	4	P	1	-	-	1	1	-	1	1	-	1	3
Design of production process	Design of production process	07.A	DS	3	Op	1	-	-	1	1	-	1	-	-	1	4
	Design of production process	07.B	iQ	1	Op	1	-	-	2	2	-	1	-	1	1	4
Improvements in design	Roughening of the floor	08.A	DS	4	P	1	-	-	1	1	-	1	-	-	1	4
	Improvement of reinforcement	08.B	iQ	3	P	1	-	-	2	2	-	1	1	-	1	1
	Improvement of temporary fastening	08.C	MP	3	P	1	1	-	1	1	-	1	1	-	-	1
	Improvement of lateral load distribution	08.D	MP	4	P	1	1	1	-	1	-	1	1	-	-	4
Determination of new types of customers	Determination of new types of customers	09.A	DS	4	M	1	1	-	-	1	-	1	-	1	-	1
	Determination of new types of customers	09.B	MP	4	M	1	1	-	-	1	-	1	-	1	-	1

Same classification on 2 cases
Same classification on 3 or more cases

5.2.2.2 Design of the innovation

The group regarding the design of the innovations contains three decisions (group 02). The first difference that can be noticed is that the actual innovation Duurzaam Speelbad (code 02.A) is designed in the development and testing phase, while the innovations iQwoning® (code 02.B) and ModuPark® (code 02.C) are developed in the idea generation and selection phase. The reason that the development process of the Duurzaam Speelbad is not named the idea selection and generation stage is that Ballast Nedam was unfamiliar with the design of children's pool and used the design of the children's pool that was poured on side as a starting point of the further design of the children's pool.

The differences in the design process can be noticed in the differences in the design phase of the decision-making process. Both the iQwoning® (02.B) and ModuPark® (02.C) completed the routines in the design phases several times, while in the design process of the Duurzaam Speelbad (02.A) this routine only one time was completed.

A difference between the innovation ModuPark® (02.C) and the other two innovations is that the decision-making process of the design of the innovation ModuPark is described as an extensive game with imperfect information, while the other two innovations are developed in a coalitional game. The reason for this is that in an earlier stage coalitions were made regarding the design of the Duurzaam Speelbad (02.A) and iQwoning® (02.B), while with respect to the innovation ModuPark® (02.A) a coalition was made about to solve the problem of temporary parking.

5.2.2.3 Design of business model

This group of decision-making processes describes the design of the three business models (group 03) that are used in the innovation projects. The decision-making processes on this item of Duurzaam Speelbad (code 03.A) and iQwoning® (code 03.B) show similarities. Only regarding the type of game that is conducted there is a difference. The reason for this difference is that regarding the iQwoning® departments of Ballast Nedam were involved, while in the project Duurzaam Speelbad Ballast Nedam Infra Noord West decided independently about the decision model.

The decision-making process of the business model of the ModuPark® contains more routines compared to the other two processes. The reason for this is that the concept of a modular car park did not fit the regular business models. Therefore the business model had to be developed. Similar to the decision-making process in the project Duurzaam Speelbad the game is a strategic game.

5.2.2.4 Determination of the market

The determination of the markets of the innovations (group 04) occurred either in the first phase of the innovation process or in the second phase. In all three innovation projects the same routines were completed. The processes started all three with an extensive identification phase (recognition and diagnosis routines), but in none of the process the routines of the development phase are completed.

Differences can be noticed in the way the evaluation is conducted. In the project Duurzaam Speelbad (code 04.A) the evaluation took place through judgement, while in the projects iQwoning® (code 04.B) and ModuPark® (code 04.C) the evaluation took place through bargaining. This difference can

also be seen in the games that are conducted, respectively a strategic game and twice a coalitional game.

5.2.2.5 Cooperation with other parties

Regarding the cooperation with other parties (group 05) three obvious decision-making processes can be distinguished. Although more collaborations can be distinguished in the three innovation projects, these collaborations are either not distinguished as a strategic decision or the collaboration is in cooperated in another decision (for example the founding of ModuPark v.o.f. which includes the collaboration between Ballast Nedam Parking and Oostingh Staalbouw).

Although at first sight the three decision-making processes differ from each other, there can be similarities be found between the decision-making processes to cooperate with Van Dorp Zwembaden (code 05.B) and to cooperate with Grontmij Parkconsult and ParkMasters (code 05.C). Both decision-making processes contains the search routine, because in both projects a partner had to be found that was not familiar to Ballast Nedam, this in contrast with the decision-making process regarding the collaboration with Waco Lingen Beton (code 05.A), which is a subsidiary of Ballast Nedam. The search routine in the project ModuPark (code 05.C) is conducted twice, because two partners had to be found.

5.2.2.6 New design of the innovation

In this group of decisions, regarding the developing a new design of the innovation (group 06), two decisions can be distinguished: the improved design of the Duurzaam Speelbad (code 06.A) and the addition of a new type of the iQwoning® (code 06.B). There are however mainly differences between the two decision-making processes. The reason is that the improved design of Duurzaam Speelbad is an improvement of the design, while the decision to design a new iQwoning® is an addition to the original design.

Two remarkable differences between the two decision-making processes are the way the evaluations took place in the two processes and the games that were played. In the process of the Duurzaam Speelbad the evaluation took place through analyses and judgements, while a coalitional game was played. In the project iQwoning® the game was an extensive game with imperfect information and the evaluation took place through bargaining.

5.2.2.7 Design of production process

Regarding the design of production processes (group 07) two decisions can be distinguished: the design of the production process of the Duurzaam Speelbad (code 07.A) and the design of the production process of the iQwoning® (code 07.B). Although the decisions are made in difference phases in the process, both decisions were almost directly made after the innovations were designed.

Both decision-making processes completed the design routine, although this routine is completed twice in the process regarding the iQwoning® (07.B), since the production process is further developed after a draft was made. This also indicates that the design of the production process of the Duurzaam Speelbad (07.A) is simpler than the design of the production process of the iQwoning® (07.B). A similarity between the two processes is that both are designed in cooperation and therefore both are played according coalitional game.

5.2.2.8 Improvements in design

In the group improvements in design (group 08) four decision-making processes can be distinguished: one improvement in the innovation Duurzaam Speelbad (code 08.A), one improvement regarding the innovation iQwoning® (code 08.B) and two improvements with respect to the innovation ModuPark® (codes 08.C and 08.D).

A distinction can be made between the decision-making processes based on the quantity of the knowledge in the recognition routine. In three processes (08.A, 08.B and 08.C) the decision situation was new for the involved organizations, which is reflected in the design routines that were completed in these processes. In the fourth process (08.D) the organizations faced a familiar problem and therefore executed a search routine instead of a design routine.

Two decision-making processes are determined as strategic games (08.B and 08.C), while the other two processes are determined as coalitional games (08.A and 08.D). In the coalitional games the improvements are designed in cooperation, while in the strategic games the improvements are made by one party and sometimes an external party is consulted for information.

5.2.2.9 Determination of new types of customers

Regarding the determination of new types of customers (group 09) two decision-making processes can be distinguished: new types of customers of the Duurzaam Speelbad (code 09.A) and of the ModuPark® (code 09.B). Based on the routines that are completed the two decision-making processes are identical and also the type of game that was played is similar. Both processes contain the diagnosis routine, which is the core in both processes.

5.2.3 Games in decision-making processes

This section discusses the games that are played in the 38 decision-making processes that were identified in the three innovation projects. In the innovation projects three types of games were distinguished: the strategic game, the extensive game with imperfect information and the coalitional game. Extensive games with perfect information were not played in the three studied innovation projects. The number of games that were played in the three innovation projects is shown in Figure 5.7. The other figures in the paragraph show the percentage of games per phase, per innovation project en per decision type. The games will be discussed per type of game.

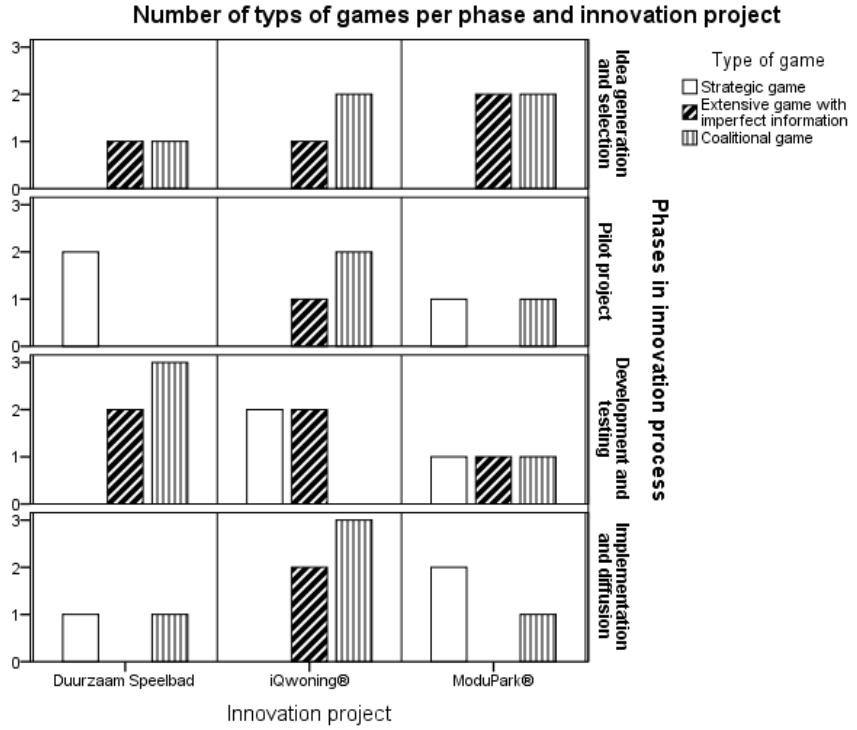


Figure 5.7: Number of types of games per innovation project

5.2.3.1 Strategic games

In total nine strategic games can be distinguished in the three innovation projects. However, none of these strategic games is played in the idea selection and generation phase, the first phase of the innovation process. In the innovation project ModuPark® the strategic games are played in all the three other phases. In the project Duurzaam Speelbad the strategic games are only played in the phase of the pilot project and implementation and diffusion phase. This is in contrast with the project iQwoning®, where the strategic games are only played in the third phase of the process.

Figure 5.8 and Figure 5.9 show that most strategic games are played within the processes of marketing decisions. In none of the organizations decisions a strategic game is played. The reason for this is probably, because organizations decisions about cooperation or the organization of new structure and in both types of organizations decisions multiple parties are involved. Further, if the three projects are compared the share of strategic game in the market-pull innovation projects Duurzaam Speelbad and ModuPark® is twice the share of strategic games in the technology-push innovation project iQwoning®.

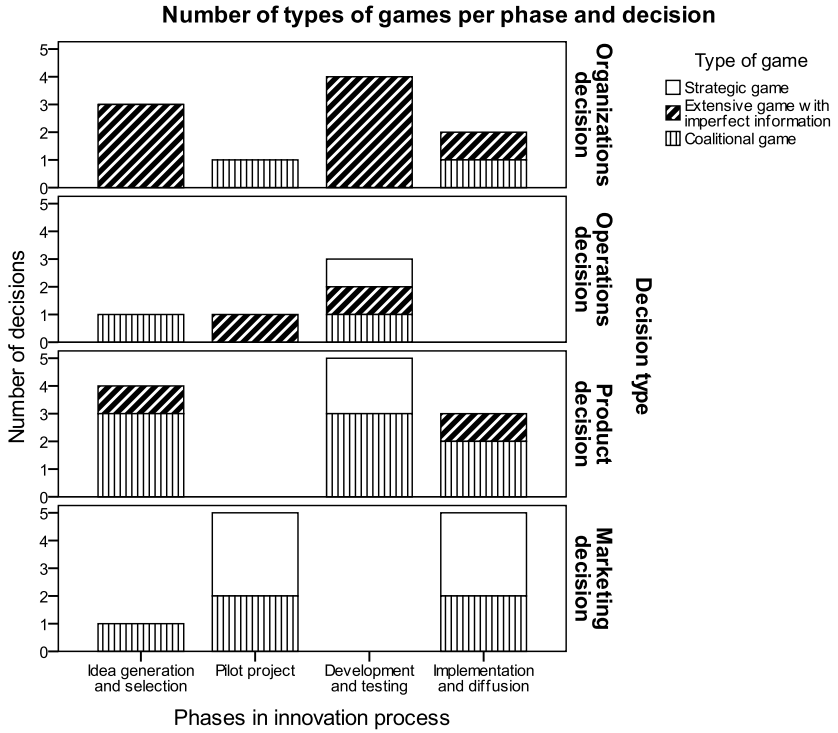


Figure 5.8: Number of games per phase and decision

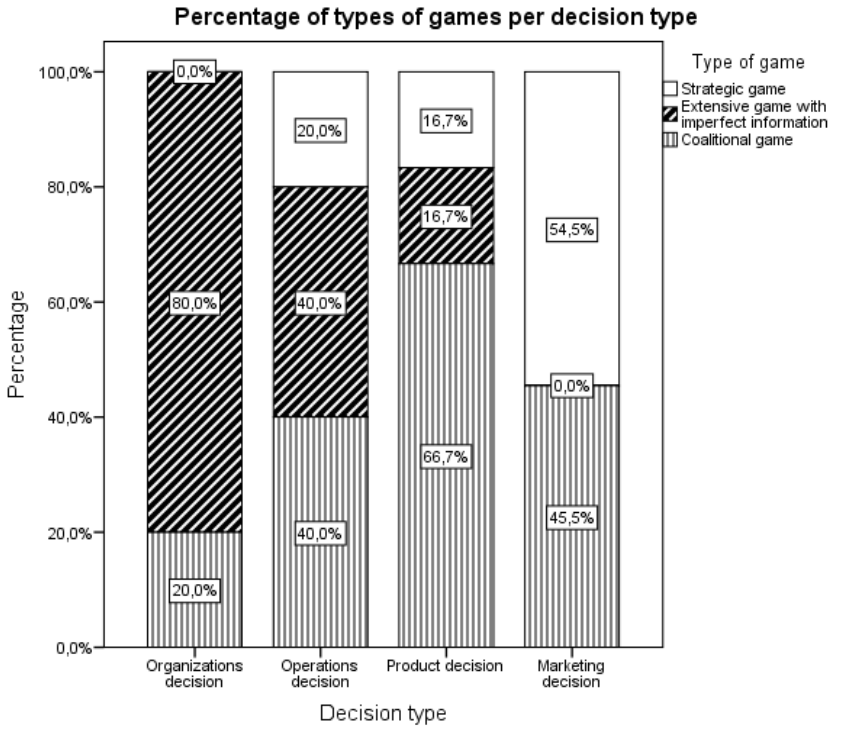


Figure 5.9: Percentage of types of games per decision type

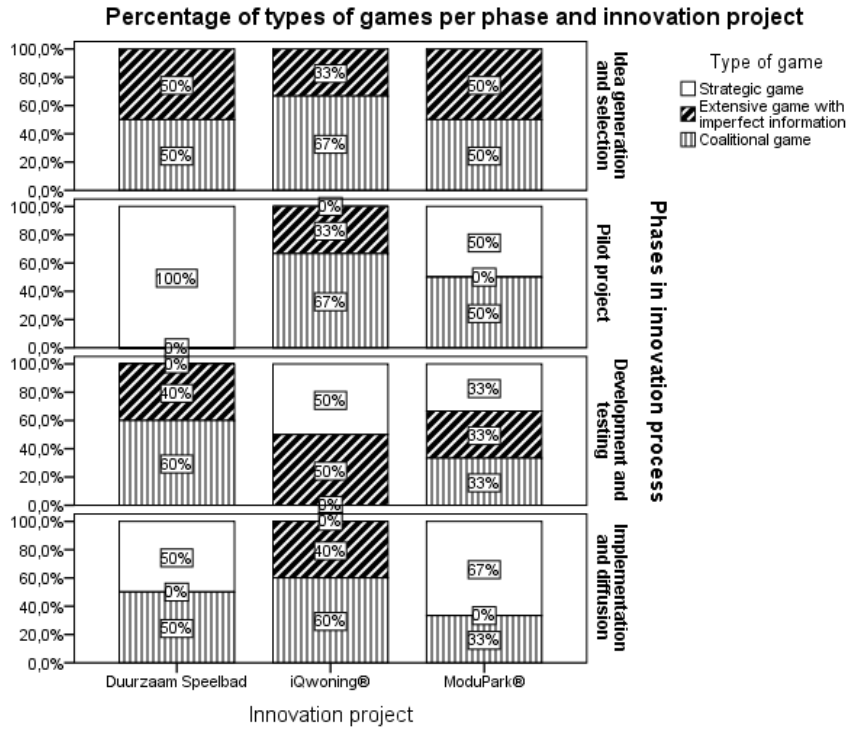


Figure 5.10: Percentage of types of games per phase and innovation project

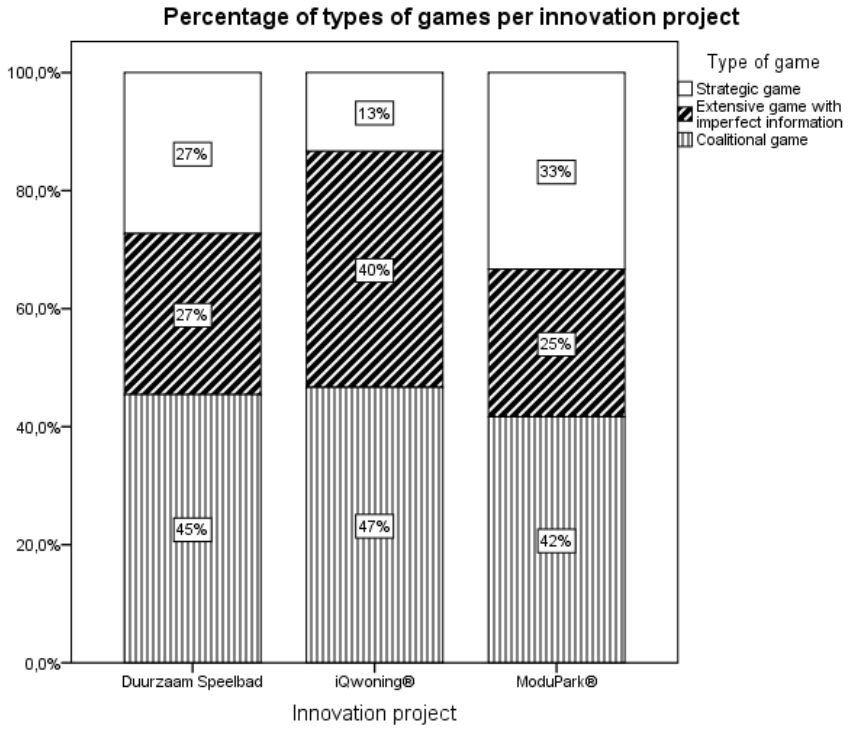


Figure 5.11: Percentage of types of games per innovation project

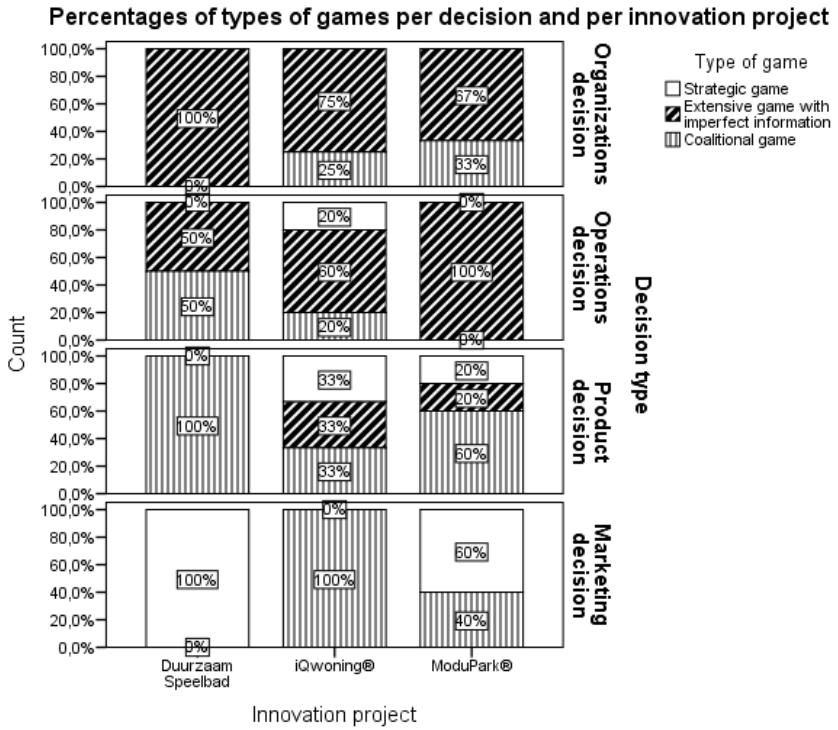


Figure 5.12: Percentages of types of games per decision and per innovation project

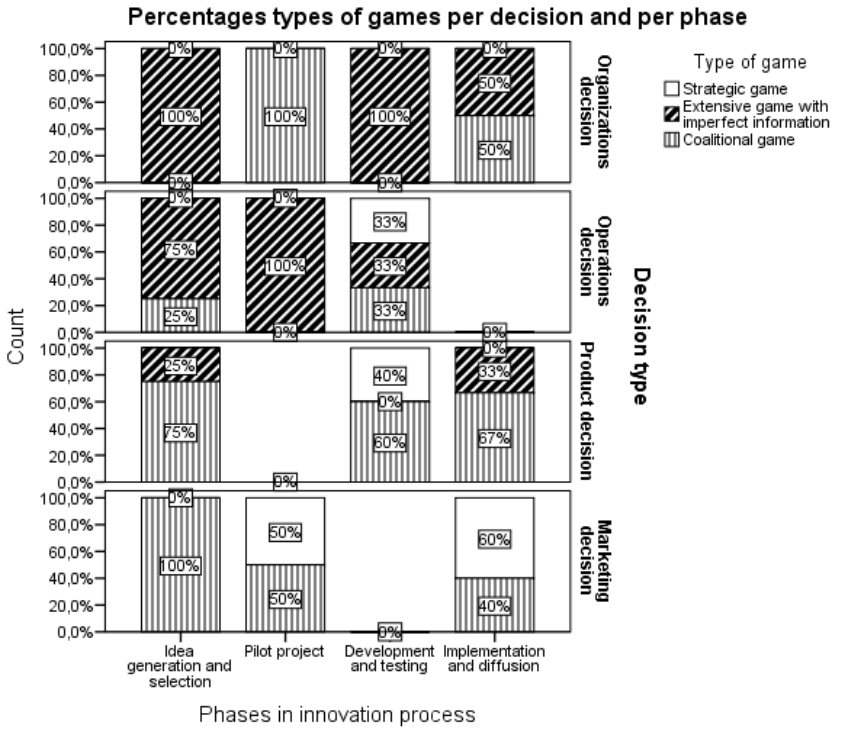


Figure 5.13: Percentages of types of games per decision and per phase

5.2.3.2 Extensive game with imperfect information

In the three innovation projects 12 extensive games with imperfect information can be distinguished. In the innovation project iQwoning® this type of game is played in each phase of the process. In the other two projects the extensive games with imperfect information are only played in the idea selection and generation phase and in the development and testing phase of the process. A reason for this difference might be that the other two phases, the pilot project and implementation and diffusion phase, are more external-oriented phases and that in these phase there is either cooperation or decisions are made independently.

Figure 5.8 and Figure 5.9 show that in a majority of the organizations decisions an extensive game with imperfect information is played and that in none of the marketing decisions this type of game is played. Also a large share of the operations decisions are played according to the extensive game with imperfect information. A reason might be that the operations decisions have similar to the organizations an internal-oriented perspective. Further, the extensive game with imperfect information is more often played in the technology-push innovation project iQwoning® than in the market-pull innovation projects Duurzaam Speelbad and ModuPark®. In the market-pull innovation projects the share of extensive games with imperfect information is about 25%, while in the project iQwoning® this percentage is 40%.

5.2.3.3 Coalitional game

17 of the 38 games can be described as a coalitional game. In the innovation project ModuPark® at least one coalitional game per phase is played. In the other two projects in three of the four phases a coalitional game is played. In the project Duurzaam Speelbad only in the pilot project a coalitional game is not played, while in the innovation project iQwoning® this type of game is not played in the development and testing phase.

In Figure 5.8 and Figure 5.9 it is showed that the coalitional game is played in the decision-making processes of all the four types of decisions. However, most of the product decisions are made by playing a coalitional game. A reason for this might be that the in an earlier stage of the innovation organizations decide to cooperate, because the organizations have the needed knowledge and expertise to develop an innovation. During the decision-making processes of product decisions the coupling of the knowledge is discussed to develop the innovations or to make improvements. The percentage of coalitional games is in all three innovation projects almost the same. In the project iQwoning® 47% of the games is a coalitional game, while in the market-pull innovation projects Duurzaam Speelbad and ModuPark this percentage is respectively 45% and 42%.

5.2.4 Groups of decisions

In the within-case analyses 13 groups of decisions are identified in the three innovation projects. Three groups of decisions in the innovation project Duurzaam Speelbad (DS.A, DS.B and DS.C), six groups are distinguished in the project iQwoning® (iQ.A, iQ.B, iQ.C, iQ.D, iQ.E and iQ.F) and four groups of decisions are determined in the innovation project ModuPark® (MP.A, MP.B, MP.C and MP.D). Based on the 13 groups of decisions there can be 26 links between the decisions distinguished. In Table 5.5 the groups of decisions are presented on basis of the decisions types and the game types.

Table 5.5: 13 groupds of decisions in the three innovation projects

Decision	Code	Decision type					Game type				
		#1	*#2*	#3	#4	#5	*#1*	*#2*	#3	#4	#5
Preparation for construction project	DS.A	OO	P	-	-	-	EGI	CG	-	-	-
Development of innovation project	DS.B	M	Or	P	Or	P	SG	EGI	CG	EGI	CG
New market segmentation	DS.C	M	M	-	-	-	SG	SG	-	-	-
Determination of costs and prices	iQ.A	OO	P	Or	M	-	EGI	CG	CG	CG	-
Market determination	iQ.B	P	M	Op	-	-	CG	CG	EGI	-	-
Industrial production process	iQ.C	Op	Op	Op	-	-	CG	EGI	SG	-	-
Organization of production process	iQ.D	Op	Op	Or	-	-	CG	EGI	EGI	-	-
Alignment in commercialization	iQ.E	Or	Or	Or	-	-	EGI	CG	CG	-	-
Addition of innovation	iQ.F	P	M	-	-	-	EGI	CG	-	-	-
Market entering	MP.A	OO	P	P	M	-	EGI	CG	EGI	CG	-
Profit mechanism	MP.B	P	P	M	-	-	CG	EGI	SG	-	-
Consequences of business model	MP.C	M	Or	-	-	-	SG	EGI	-	-	-
New market segmentation	MP.D	M	M	M	-	-	CG	SG	SG	-	-

Decision type

M	Marketing decision
Op	Operations decisions
Or	Organisations decision
P	Product decision
OO	Operations & organisations decision

Game type

CG	Coalitional game
EGI	Extensive game with imperfect information
SG	Strategic game

5.2.4.1 Decision types in decision links

Although 26 links are identified, there are 29 links based on the decision type. The reason for this is that in three links a decision was presented that was a combination of an organizations and operations decision. However, in these links only the first decision was a combined decision, therefore only three links have to be added. The 29 links between decisions based on decision type are presented in Table 5.6.

Table 5.6: Decisions links based on decision type

First decision in link	Second decision in link				Sub total
	Or	*Op*	*P*	*M*	
Organizations decision (Or)	2	-	5	1	**8**
Operations decision (Op)	1	3	3	-	**7**
Product decision (P)	2	-	2	4	**8**
Marketing decision (M)	2	1	-	3	**6**
Sub total	**7**	**4**	**10**	**7**	**29**

The table shows that there is no wide variety in the decision type of the first decision of the link. Organizations and product decisions are eight times distinguished as first decision of a link, organizations decisions seven times and marketing decisions six times. However, regarding the second decision of the link there is a wider variety in the decision types. In 10 of 29 cases a product decision is distinguished as second decision of a link, while in only four cases an operations decision is named as the second decision of a link. The organizations and marketing decisions are both named seven times as the second decision of a link.

Further it can be noticed that in the decision links an organization or product decision was never followed by an operations decisions and an operations decision was never followed by a marketing decision. Also the links operations-organizations, marketing-operations and organizations-marketing occur only once.

5.2.4.2 Game types in decision links

Regarding the game types there are no extra links added, because no decision-making process was played by making use of a combination of games. Therefore 26 links based on the game type are identified. An overview of the links is shown in Table 5.7.

Table 5.7: Decisions links based on game type

First game in link	Second game in link			Sub total
	SG	*EGI*	*CG*	
Strategic game (SG)	2	2	-	**4**
Extensive game with imperfect information (EGI)	2	1	8	**11**
Coalitional game (CG)	1	6	4	**11**
Subtotal	**5**	**9**	**12**	**26**

The table shows that only in four links a strategic game was named as the first game of a link and in only five links as the second game. This indicates that most of the links either an extensive game with imperfect information or a coalitional game is involved. This is also shown in the number of first game that is an extensive game with imperfect information or a coalitional game, which is in both cases 11 times and as a second game the extensive game with imperfect information is mentioned nine times and a coalitional game 12 times.

5.3 Effect of decision making on innovation performance

This section discusses the effect of the decision making 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 by making use of four innovation performance indicators. However, if the definition of innovation is followed, the performance indicator market performance describes the best the success of an innovation. The innovation projects iQwoning® and ModuPark®, which are respectively a technology-push innovation project and a market-pull innovation project, score the best on this performance indicator. Because these two types of innovation projects have different motives (Martin, 1994), the effect of the decision making in innovation projects on the innovation project is analyzed from these two types.

The effect of decision making on the innovation performance is analyzed from the perspective of the decisions that are made in the innovation project and from the perspective of the games that are played. In paragraph 5.2 the decisions and games are analyzed per phase, while in this paragraph the decisions and games are analyzed as a collection and the effect of this collection on the innovation performance. Figure 5.14 and Figure 5.15 describe the percentages of respectively the decisions and games in the innovation projects iQwoning® and ModuPark®.

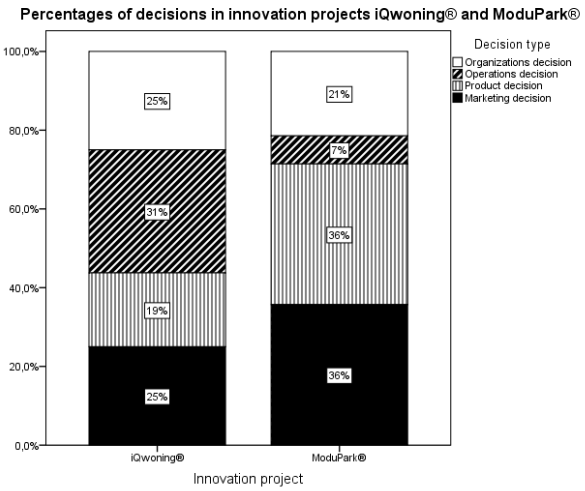


Figure 5.14: Percentages of decisions in innovation projects iQwoning® and ModuPark®

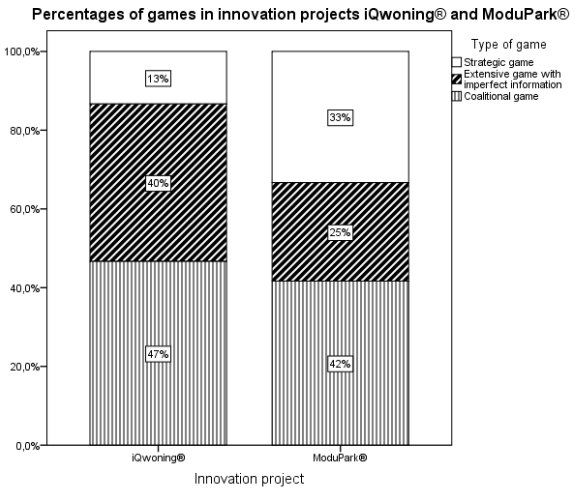


Figure 5.15: Percentages of games in innovation projects iQwoning® and ModuPark®

5.3.1 Technology-push innovation project

The innovation project iQwoning® is determined as a technology-push innovation project, because the process was started because technological opportunities were identified. Later in the process the need in the market is identified that could be satisfied with the developed innovation. The effect of the decision making in this technology-push innovation project on the innovation performance will be determined per type of decision and per type of game.

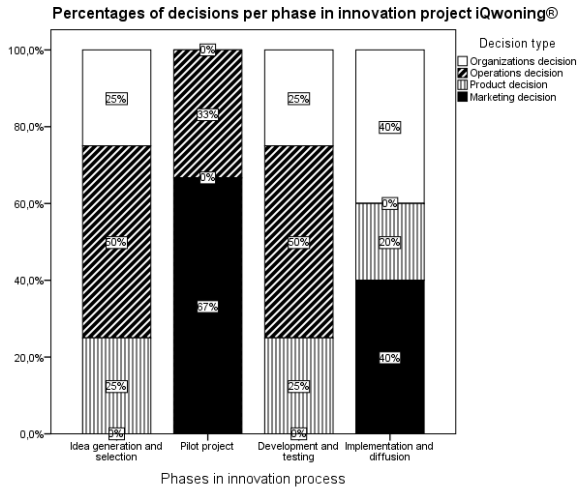


Figure 5.16: Percentages of decisions per phase in innovation project iQwoning®

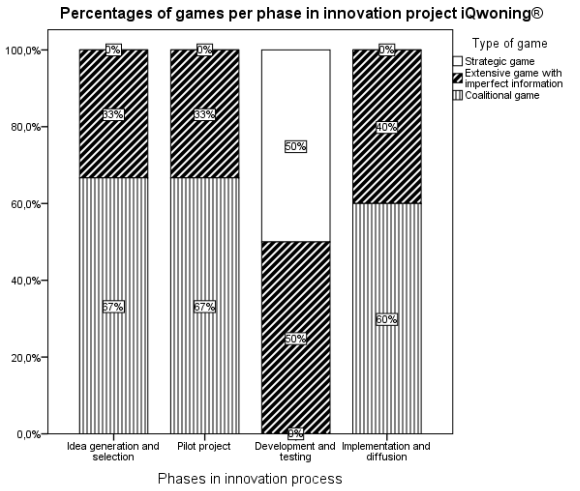


Figure 5.17: Percentages of games per phase in innovation project iQwoning®

5.3.1.1 Decisions

In the innovation project iQwoning® 15 decisions are identified, although 16 different types of decisions are determined, because one decision making process is determined by using two decision types. Figure 5.14 shows that the largest share of decisions is represented by the operations decisions (31%). The organizations and marketing decisions in this innovation project represent both 25% of the total decisions, while the product decisions represent only 19% of all decisions that were made.

Figure 5.16 presents the percentages of decisions per phase. In the first three phases the operations decisions are made and especially in the first phase and the third phase a majority of the decisions is an operations decisions. The marketing decisions in this project are only made in the second and fourth phase of the innovation process. The reason for this is that both phases are determined as external-oriented phases, which fits with the character of the marketing decisions. The organizations and product decisions are made in the same phases (first, third and fourt phase of the process), which fits with the observation that organizations decisions are mostly followed by product decisions (see paragraph 5.2.4.1).

5.3.1.2 Games

15 games were identified in the innovation project iQwoning®. Only two games were identified as strategic games. The other games were either extensive games with imperfect information or coalitional games. Figure 5.15 shows that 47% of the games in this innovation project is a coalitional game and 40% is an extensive game with imperfect information. Only 13% of the games is a strategic game.

Figure 5.17 shows the percentages of the games in the four phases of the innovation project iQwoning®. The figure shows that the strategic games are only played in the third phase of the process, which means that in the other three phases all the decision-making processes involve two or more decision makers. Further, it is remarkable that the distribution of extensive games with imperfect information and coaltional games is almost the same in these three phases. The fact that

extensive games with imperfect information and coalitional games are played within the same phases fits with the observation about the links between the different game types (see paragraph 5.2.4.2). Similar to this is the link between the strategic games and extensive games with imperfect information in the third phase of the process. In paragraph 5.2.4.2 strategic games are never followed by a coalitional game, while the other way around occurs only once.

5.3.2 Market-pull innovation project

The innovation project ModuPark® is defined as a market-pull innovation project, because the reason to start the development of the innovation was based on a need in the market that was not fully satisfied. The cause of the development of this innovation has influence on the strategic decision making and the effect of the decision making on the innovation performance will be analyzed per type of decision and per type of game.

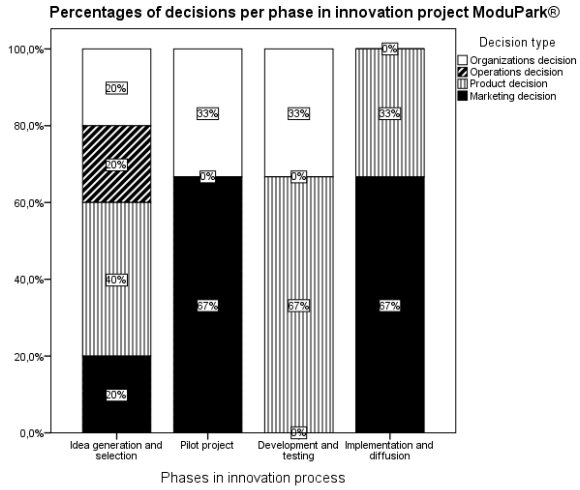


Figure 5.18: Percentages of decisions per phase in innovation project ModuPark®

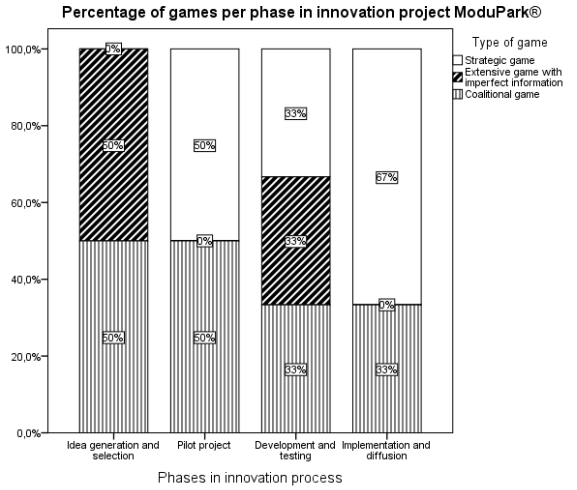


Figure 5.19: Percentages of games per phase in innovation project ModuPark®

5.3.2.1 Decisions

14 decision types are determined in the innovation project ModuPark®, although only 12 decisions were actually made. The reason for this is that two decision-making processes are defined by making use of two decision types. Figure 5.14 shows that the majority of the decisions in this project is either a marketing decision or a product decision (both 36% of the decisions). The organizations decisions in this project represent 21%, while the operations decisions have only a share of 7% in this project.

Figure 5.18 presents the decisions per phase in the innovation project ModuPark®. The only operation decision in this project is made in the first phase. The first phase shows further a balanced distribution of the different decision types. The organizations decisions represent a small share in the first three phases, but are not present in the last phase of the process. The product and marketing decisions are also present in only three phases, but represent a much larger share in these phases. The presence of the large share of marketing decisions can be explained by the presence of the product decisions and the marketing decisions itself, because a marketing decision is mostly the result of a product decision or a marketing decision (see paragraph 5.2.4.1). The presence of the product decisions is not to explain by the observations mentioned in paragraph 5.2.4.1.

5.3.2.2 Games

In the innovation project ModuPark® 12 games were played. A third of the games that is played is named as a strategic game. 25% of the games that were played in this innovation project is an extensive game with imperfect information, while 42% of the games in this project is a coalitional game. The distribution of the games is shown in Figure 5.15. These percentages indicate that in a majority of the decisions two or more decision makers are involved, but that in the same time 33% of the decisions is made by one decision maker.

In Figure 5.19 the percentage of games per phase are presented. The figure shows that the strategic game type is not played in the first phase of the project, but that it is presented in the other three phases. The extensive game with imperfect information is played only in the first and third phase of the process, but in these phases the game is as often played as other games. Further, the coalitional game is played in all phases, although in none of the phases this type of game represents a majority. The presence of extensive games with imperfect information and coalitional games in the first phase corresponds with the observation of the links between the games in paragraph 5.2.4.2. However, the presence of the strategic game and the other two types of games is harder to explain regarding the other three phases.

5.4 Conclusion cross-case analysis

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

- How can the decision-making processes in the different phases of an innovation process be characterized?
- How are the decision-making processes in an innovation project linked to each other?
- Which factors of the decision making in an innovation project have effect on the innovation performance of a product innovation?

The sub questions will be answered in this paragraph.

Strategic decision-making processes in innovation processes

The strategic decision-making processes in the different phases of the innovation processes can either be characterized based on the decision type or the game type. In the three innovation processes four decision types are distinguished: organizations decisions, operations decisions, product decisions and marketing decisions. The three game types that are played in the three innovation projects are the strategic game, the extensive game with imperfect information and the coalitional game.

Figure 5.20 shows the decision types in the different phases of the innovation process. The organizations decisions are made in each phases, although the share is the largest in the first and third phase of the process. The operations decisions are only identified in the first, second and third phase and its share in the second phase is quite small. The product decisions are made in the first, third and fourt phase. In the first phase the product decisions are mainly about the first design, while in the third and fourth phase decisions are made about improvements or improved designs.

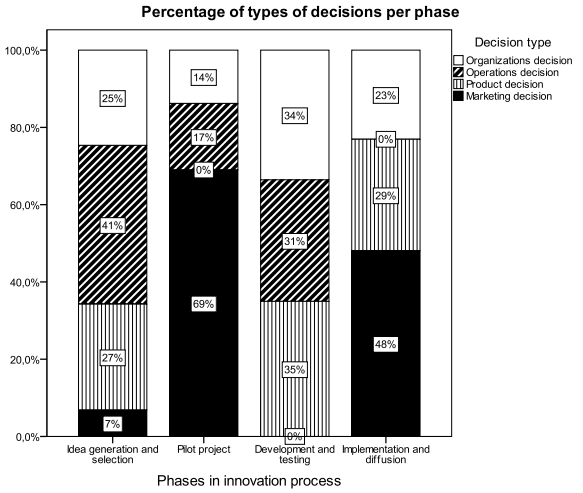


Figure 5.20: Decision types in the different phases of the innovation process

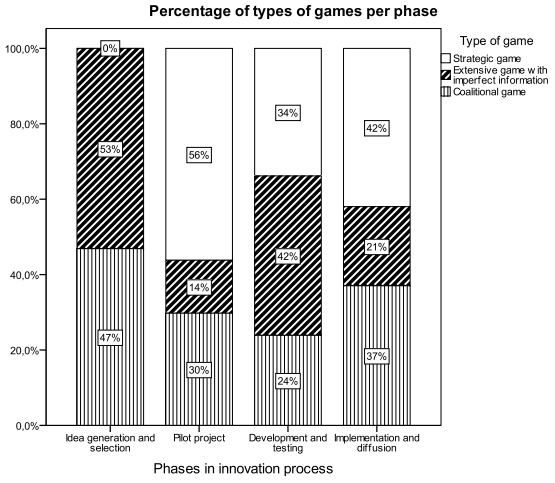


Figure 5.21: Game types in the different phases of the innovation process

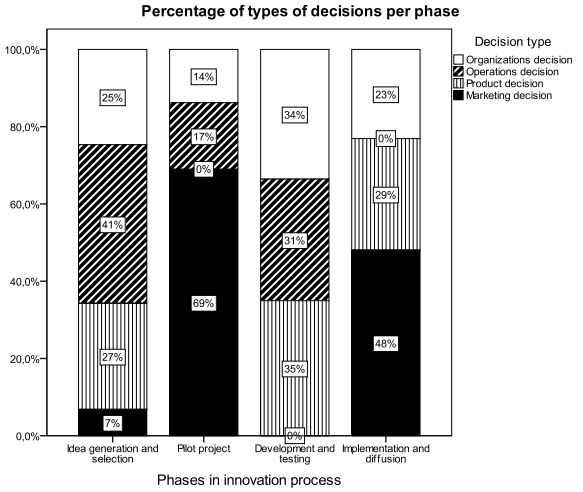


Figure 5.22: Decision types in the different phases of the innovation process

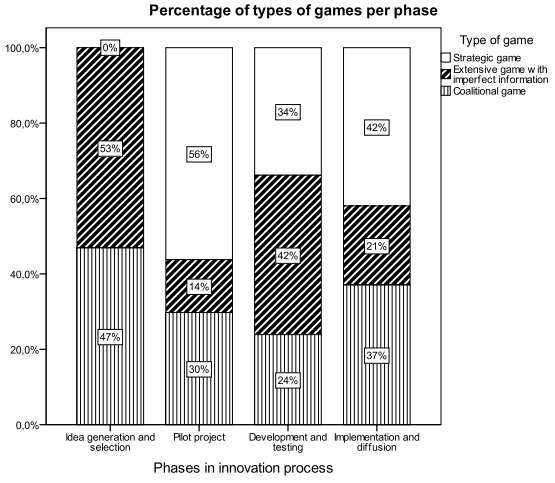


Figure 5.23: Game types in the different phases of the innovation process

In Figure 5.21 the game types are shown per phase of the innovation process. Strategic games are identified in the second, third and fourth phase of the innovation process, while based on the literature it was expected that this type of game only would be played in the first and fourth phase of the process. The extensive games with imperfect information are played in all phases of the process, although its share in the second phase is quite small. The coaltional game was played in all phases of the innovation process, while it was not expected that this game type was played in the first phase.

Linkage of strategic decision-making processes

Similar in the way the strategic decision-making processes are characterized, the links between the decisions can be categorized based on the decision type and the game type. In the three innovation projects in total 26 links are identified. If these links are characterized based on the decision type 29 links are identified, because three decisions have the the characteristics of both operations and organizations decisions. There are no significant differences in decision types that are the first

decision of a chain of decisions or a link of two decisions. However, if the second decision in a link is observed in ten of the 29 times the second decision is a product decisions, while the last decision in a chain of decisions is in six of the 13 times a marketing decision.

If the links are characterized based on the type of game 26 links are identified, because in a decision-making process no multiple games are played. There are mainly links between extensive games with imperfect information and coalitional games, which was already expected since of the 39 decisions 14 decisions are played as an extensive game with imperfect information and 17 decisions are played as a coalitional game. Also if the first decisions and second decisions in a link are observed the decisions are primarily extensive games with imperfect information or coalitional games.

Effect of decision making on innovation performance

The innovation performance of the three innovation projects is measured by using four performance indicators, although the performance indicator market performance is used to determine the success of the innovations. To determine the effect of decision making on innovation performance two types of innovation projects are distinguished: technology-push innovation project and market-pull innovation project. The innovation project iQwoning® is determined as the only technology-push innovation project in this study and the project ModuPark® is based on the market performance determined as the most successful market-pull innovation project. The decision making in both types of project might differ due to the different reason to start the project.

The decision making is determined by making use of the four decision types and the three game types that are identified in the three innovation projects. The four decision types are organizations, operations, product and marketing, while the three games differ namely in the form of the game, which can be normal or extensive, the degree of cooperation in the decision-making processes and the available set of information. Also the phases in which the decisions or games occurred differ between the innovation projects.

In the technology-push innovation project iQwoning® a large percentage of operations decisions is distinguished, which are played in the first three phases. Product decisions are made the least. This in contradiction with the market-pull innovation project ModuPark® in which the product decisions represent the largest share and operations decisions are made the least. Regarding the games that are played there is mainly a difference between the numbers of involved decision makers in a decision-making process. In the technology-push innovation project iQwoning® the decisions are mainly made by multiple decision makers, while in the project ModuPark® a third of the decisions is made by one decision maker.

6 DISCUSSION

This research started with the statement that there is a lack in the literature and the practice how the decisions are made within the innovation projects and how the decision making affects the innovation performance of the innovation 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
- Decision making
- Effect of decision making 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 these outcomes the following propositions are formulated:

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 Strategic decision making

The strategic decision making in innovation projects is described by determining the strategic decisions in the three innovation projects, the decision-making processes of these decisions and the game play in these processes and the groups of decisions that are identified in the projects. The differences and similarities between the innovation projects are discussed by making us of the above described aspects.

6.2.1 Strategic decisions

The four decision types that are distinguished in the three innovation projects are organizations, operations, product and marketing decisions (Krishnan & Ulrich, 2001; Tatikonda & Montoya-Weiss, 2001). Each decision type covers a part of the decisions in an innovation project. Although there are studies conducted that focused on the decisions in an innovation process (Cooper, 1990; Schmidt & Wilhelm, 2000; Rogers, 2003) or perceived the decisions from an perspective (Krishnan & Ulrich, 2001; Elbanna, 2006), there has been no research conducted regarding the type of decisions in an innovation process and at which phase of the innovation process these decisions are made. Based on the characteristics of the phases of an innovation process a notion has been given regarding the moment the decisions that are made in the process and which type of decisions.

The organizations decisions are about the organization of the project: cooperation between organization, termination of collaboration, changes in the organizational structure and founding of entities. A quarter of all decisions that are made in the three innovation projects are organizations decisions (Brown & Eisenhardt, 1995; Krishnan & Ulrich, 2001). Organizations decisions are mainly made in the first and third phase of the process: both phases have an internal perspective and focus more on the development on the innovation and the corresponding organization rather than the diffusion of the innovation. An expectation to this is the project iQwoning, since in this project the organizations decisions are also made in the fourth phase of the process. The reason for this might be that in technology-push innovation project a new organizational structure has to developed that will implement and diffuse the innovation, since the organizational structure that was used in the phases before was focused on the technological development of the innovation. Based on these observations and the corresponding literature the following propositions are formulated:

The operations decisions focus on the decisions regarding the execution of the innovation process (Krishnan & Ulrich, 2001). In the market-pull innovation projects Duurzaam Speelbad and ModuPark® the share of operations decisions is respectively 17% and 7%, but in the technology-push innovation project iQwoning® the percentage of operations decisions is quite larger with a percentage of 31%. The reason for this difference can be traced back to the start-up of both types of innovation projects: in the market-pull innovation projects the goal is clearer and therefore also the road to this goal, while a technology-push innovation project is started because of the technological opportunities that are offered, but meanwhile the final goal, which is the satisfaction a customer's need, is not clear yet (Martin, 1994; Walsh, Kirchhoff, & Newbert, 2002; Brem & Voigt, 2009). The following proposition is formulated based on the above:

PROPOSITION 2

- *Technology-push innovation projects in the construction industry need more operations decisions than the market-pull innovation projects in the construction industry, because the innovation process and the final goal of the technology-push innovation project are not clear.*

The product decisions are about the product that is being developed in the innovation project (Krishnan & Ulrich, 2001). The percentage of product decisions in the market-pull innovation projects Duurzaa Speelbad and ModuPark® is respectively 33% and 36%, while the percentage of product decisions in the technology-push innovation project is 19%. The reason for this difference can be the opposite of the reason for the difference regarding the operations decisions: in a technology-push innovation projects there is more consensus reached regarding the used technologies and the product, while in a market-pull innovation projects there is more vagueness about the final product and the technologies that have to be used (Walsh *et al.*, 2002; Brem & Voigt, 2009). Therefore the following proposition is formulated:

PROPOSITION 3

- *Market-pull innovation projects in the construction industry need more product decisions than the technology-push innovation projects in the construction industry, because the necessary technologies and the final product of the market-pull innovation project are not clear.*

The marketing decisions are about the implementation and diffusion of the product (Krishnan & Ulrich, 2001). The majority of the marketing decisions are made in the phases that have an external perspective, namely the phases in which the pilot project is executed and the phase in which the innovation is implemented and diffused in the market. The execption to this is the market-pull innovation project ModuPark®, since in this project a marketing decision is also made in the first phase of the innovation process. A reason that a marketing decisions is made in this phase of the process can be traced back to the motive of the innovation project, namely to satisfy a customer's need that was not properly satisfied. Therefore it is important in this type of innovation project to have it as fast as possible clear what the potential market is of the innovation. Perhaps this might also be the reason that the innovation ModuPark® is more successful compared to the project Duurzaam Speelbad (see other report for the innovation performance). However, based on the observations the following proposition is formulated:

PROPOSITION 4

- *The earlier marketing decisions are made in the innovation process of market-pull innovation projects, the more successful the market-pull innovation projects are in the construction industry.*

6.2.2 Decision-making process

The identified decisions in the three innovation projects are analyzed by making use of the model that was developed in the theoretical framework. In the cross case analysis decisions of the three projects that showed similarities are compared to each other, but in this section also the other decision-making processes are incorporated that were not analyzed in the cross case analysis.

The decision-making processes of organizations decisions are all quite straightforward. Only regarding one decision-making process a routine is executed is twice, but regarding the other decision-making processes the routines are only executed once. In combination with the types of evaluation that are used in these processes, namely bargaining and judgement, these decision-making processes can be named straightforward and obvious. A reason that these decision-making processes are straightforward and obvious is because the organizations understand they need each other and have to cooperate with each other to develop an innovation. This lead to the following proposition:

PROPOSITION 5

- *The decision-making processes of organizations decisions in innovation projects in the construction industry are obvious and straightforward, because the involved organizations understand that they need each other to develop a successful innovation.*

The decision-making process of operations decisions shows cycles between routines, and especially in the design phase the routines are executed more than once. The reason for this is that these decisions include the design of production processes, which are complex due to the number of involved parties and the corresponding responsibilities. Due to the cycles in the decision-making processes various evaluations are used in, although it is not necessary that only one type of evaluation is used in the decision-making process. Further it is noticed that except for one decision-making process the processes are executed together with multiple parties, although it is not necessary that the parties form a coalition.

The decision-making process of product decisions shows similiraties with the processes of operations decisions. Similar to the processes of operations decisions the decision-making process of product decisions the design phase is almost always executed and mainly in this phase the design routine is used. Only in two processes the design routine is not used: in one process the search routine used and in one process none of the two routines are used. Another similarity between the operations and product decisions is the combination of different types of evaluation, although compared to the operations decisions the evaluation method analysis is more often used. A reason that the evaluation method analysis is used is because product decisions involve the design or adjustments of a product, which can be quantified and evaluated by making use of an analysis.

PROPOSITION 6

- *The decision-making processes of product decisions in innovation projects in the construction industry are often evaluated by making use of analyses, because the results of the decision-making process can be quantified.*

The decision-making process of marketing decisions shows similarities with the processes of the organizations decisions: only one time a cycle between routines is used, while in the other decision-making processes of this type decision the processes are straightforward and obvious. A reason for the straightforwardness and the obviousness is that the decisions are made alone or with coalition parties. Another similarity is the use of judgement or bargaining as evaluation method. A reason for these evaluation methods is that the consequences of a marketing decision are hard to measure and

that therefore bargaining or judgement is more suitable. Based on the above observations the following propositions are formulated:

PROPOSITION 7

- *The decision-making processes of marketing decisions in innovation projects in the construction industry are evaluated by making use of bargaining or judgement, because the consequences of marketing decisions are mostly qualitative of nature.*

6.2.3 Games in decision-making processes

In this paragraph the games that are used in the decision-making process are discussed. In the literature the following games are identified: a strategic game, an extensive game with perfect information, an extensive game with imperfect information and a coalitional game (Osborne, 2004; Peters, 2008). However, in the three innovation projects the extensive game with perfect information was not identified, therefore the games in the decision-making processes will be discussed based on the three games that were identified: strategic games, extensive games with imperfect information and coalitional games. The differences and similarities between the innovation projects are discussed by making us of the identified games.

A strategic game is a game in which players make their decisions independently of each other (Osborne & Rubinstein, 1994; Osborne, 2004; Leyton-Brown & Shoham, 2008). Based on the theoretical framework it was stated that the strategic game would only be played in the first and fourth phase of the innovation process, because in the other phases the focus was on the development of the innovation and this would happen in cooperation with other parties. However, the strategic game is not played in the first phase of the innovation process, but it is played in the other three phases.

In the second and fourth phase strategic games are played in the market-pull innovation projects Duurzaam Speelbad and ModuPark®. In all of these cases the strategic game was played in a marketing decision-making process. A reason that this type is played is that the leading firm decided that the commercialization of the innovation could be best lead by one party. This leads to the following proposition:

PROPOSITION 8

- *Strategic games are played in the marketing decision-making processes in market-pull innovation projects in the construction industry, because the commercialization of the innovation is led by one organization.*

Although the strategic game is often played in marketing decision-making processes, both in the market-pull innovation projects as in the technology-push innovation project iQwoning®, the strategic game is also played in operations and product decision-making processes, although the percentage is lower compared to the marketing decision-making processes. A reason that the strategic game is played in these types of decision-making processes is because the decisions required the expertise or knowledge of one organization. Strategic games are not played in organizations decision-making processes, probably because in this type of decision-making process two or more organizations are involved. The following propositions is formulated:

PROPOSITION 9

- *Strategic games are played in the operations and product decision-making processes in innovation projects in the construction industry, because of the expertise and knowledge of single organizations.*

In an extensive game with imperfect information the players in the game make their decisions sequentially: the decisions are based on earlier decisions, but compared to the coalitional game there is no cooperation between the players, although there can be outcomes of the decision-making process that are beneficial for multiple players (Osborne & Rubinstein, 1994; Peters, 2008). According to the theoretical framework the extensive game with imperfect information is played in each phase of the innovation process.

The expectations are met in the technology-push innovation projects, but in the market-pull innovation projects the extensive game with imperfect information is only played in the first and third phase of the innovation process. This difference is also shown in the percentage of this type of games in the three innovation projects. In the technology-push innovation project iQwoning® this percentage is 40%, while in the projects Duurzaam Speelbad and ModuPark® these percentages are respectively 27% and 25%. A reason for this difference is that in market-pull innovation projects the innovation is commercialized either alone or in a coalition, while in the technology-push innovation project new organizations are approached in the development or commercialization of the innovation.

The extensive game with imperfect information is often played in organizations decision-making processes and also in operations decision-making process this type of game is played. In the product decisions this game type is also used, but to a lesser extent. The reason that this game type is often played in organizations decisions is because these decisions can be an overture to collaboration. The extensive game with imperfect information is however not played in marketing decision-making processes. A possibility that in marketing decisions this game type is not played is that this decision requires trust between the players and this is not offered in an extensive game with imperfect information. This leads to the following propositions:

PROPOSITION 10

- *Extensive games with imperfect information are played in organizations decision-making processes of innovation projects in the construction industry, because this type of decisions is the overture to collaboration.*

PROPOSITION 11

- *Extensive games with imperfect information are not played in marketing decision-making processes of innovation projects in the construction industry, because this type of decisions requires trust between the players.*

Coaltional games are games in which the players have their own interests and objectives, but also have shared objectives and decisions are made with these shared objectives in mind (Osborne & Rubinstein, 1994; Carmichael, 2005). In the theoretical framework it was stated that the coaltional game was played in the second, third and fourth phase of the innovation process, but not in the first

phase of the innovation process. The reason was that in this phase of the innovation process cooperation was not yet possible. However, the three innovation projects showed that the first phase show enough opportunities to cooperate.

The percentage of coalitional games in the three innovation projects is almost the same: in the project Duurzaam Speelbad the percentage is 45%, in the project iQwoning® the percentage is 47% and in the innovation project ModuPark® the percentage is 42%. Remarkable is the high percentage of coalitional games in the first phase of the innovation project, which is between 50% and 67%, and especially if you compared it with the statements in the theoretical framework. An explanation for the number of coalitional game is that only organizations participate in these decision-making processes that share the same vision regarding the innovation project.

Further, a majority of the product decision-making processes is played according to a coalitional game. 67% of the product decisions are played by a coalitional game, while the other 33% is played by either a strategic game or an extensive game with imperfect information. An explanation for the high number of coalitional games for this type of decisions is the complexity of the innovation. The participating organizations have to share the same ideas regarding the innovation and discuss the design of the product.

6.2.4 Groups of decisions

In the three innovation projects 13 groups are identified, which resulted in 26 links of decisions. Subsequently these links are analyzed based on the type of decision and the type of game. Because in three links decisions were involved that showed the characteristics of two types of decisions the number of links based on the type of decision is extended to 29 links. Regarding the type of game there were no links added.

The literature studied the processes or sequences of decisions (Cooper, 1990; Rogers, 2003), but there is a gap in the literature how specific decisions are related to each other. In the game theory literatute the concept of subgame is used to illustrate the position of a game in a larger view (Leyton-Brown & Shoham, 2008; Peters, 2008; Jehle & Reny, 2011), however the sequence of different types of games is not studied.

Regarding the links based on the decision type it is remarkable that in 10 of the 29 cases the follow-up decision is a product decision. In none of the cases however a marketing decisions was the prior decision. This might indicate that the organizations and operations decisions are decisions that prepare the product decision or create the conditions that the product decision can be made. The reason for this is that the organizations decisions shape organizational structures in which the product decisions can be made and the operations decisions create processes that are necessary to make a decision related to the product. Based on these observations the following proposition is formulated:

PROPOSITION 12

- *Organizations and operations decisions create the necessary conditions to make product decisions in innovation project in the construction industry can be made.*

In the links between games more interesting outcomes are found. First of all, in four links a strategic game is the prior game and of these four links it results in two strategic games and two extensive games with imperfect information. None of the links in which a strategic game is the prior game a coalitional game is the result. A possible reason is that a strategic game offers no cooperative environment in which a coalitional game can be played. This leads to the following proposition:

PROPOSITION 13

- *Strategic games in innovation projects in the construction industry are not followed by a coaltional game, because strategic games create no cooperative environment.*

Another remarkable aspect is the relationship between extensive games with imperfect information and coaltional games. If an extensive game with imperfect information is played in 8 of 11 times it is followed by a coaltional game, while in case if the coaltional game is played first it results in 6 of 11 times in an extensive game with imperfect information. On the same time, if an extensive game with imperfect information is played it only results one time in another extensive game with imperfect information. Regarding the coaltional games a prior coaltional game results in four cases in a new coaltional game. The fact that an extensive game with imperfect information often results in a coalitional game is probably because this type of game is considered as an overture for cooperative behavior. The possible reason that a coaltional game results either in an extensive game with imperfect information or a coaltional game is because multiple organizations are involved in the process of decisions. Based on the above the following proposition is formulated:

PROPOSITION 14

- *Extensive games with imperfect information are followed by coaltional games, because a cooperative environment is created if the extensive game with imperfect information is played.*

6.3 Effect of decision making on innovation performance

In this study the objective was to determine the effect of decision making on the innovation performance. As explained in the previous sections the effect of decision making on the innovation performance is not statistically determined, but is descriptive determined. The reason for this is that it was not possible to determine which decision has actual influence on the innovation performance. Therefore, the collection of decisions is analyzed per type of innovation project and the effect of this collection of decisions on the innovation performance is described.

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 decision making on the innovation performance will be discussed per the characteristics of decision making: types of decisions and types of games. In some cases the propositions are defined per type of innovation project.

6.3.1 Decisions

In the technology-push innovation project iQwoning® 31% of the decisions is determined as an operations decision compared to the market-pull innovation project ModuPark® in which only 7% is defined as an operations decision. As earlier described the operations decisions are about the execution of the innovation process (Krishnan & Ulrich, 2001). The high percentage of operations decisions in the technology-push innovation project might point at the necessity to control the process of developing an innovation, because involved organizations have to be confinced that the technology offer opportunities to enter a market. This is less the case in market-pull innovation projects, because the motive to start an innovation process is the identification of a customer's need that is not fully satisfied.

On the other hand, in the market-pull innovation project ModuPark® 36% of the decisions is a product decision, while in the technology-push innovation project iQwoning® this percentage is 19%. Product decisions are about the design and adjustments of the product (Krishnan & Ulrich, 2001). The high percentage of product decisions in this project, and also in the other market-pull innovation project Duurzaam Speelbad (33%), indicate that the design is continually adjusted. The reason for this might be that in market-pull innovation projects the customer's need is understood, but that it takes time and adjustment to develop a proper product that satisfies the need. In technology-push project this is less the case, because the product is developed from technological opportunities.

If the assumption is made that marketing decisions are similar related to market-pull innovation projects as are product decisions are related to technology-push innovation projects, than the high percentage of marketing decisions in the market-pull innovation project ModuPark® (36%) can be called remarkable. The marketing decisions are about the implementation and diffusion of the innovation (Krishnan & Ulrich, 2001) and the high percentage of marketing decisions in the project ModuPark® indicate that multiple decisions were necessary to implement and diffuse the innovation, while the project was initially started because of the identification of an inadequate satisfied need in the market. This might point at the fact that although the need was identified, the construction industry lacks the capabilities to implement and diffuse the innovation without delays, due to decisions that have to be made regarding the marketing.

Also in the literature about complex products it is indicated that organizations have to develop the capabilities regarding marketing to be successful (Davies & Brady, 2000; Gann & Salter, 2000). Successful firms develop capabilities that are able to respond to or to shape changes in the market (Davies & Brady, 2000). Wang and Von Tunzelmann (2000) indicated that although the markets of complex products are non-complex, since the products are developed for a small number of customers, firms have to understand the complexity of the market.

6.3.2 Games

The technology-push innovation project iQwoning® shows a high percentage of extensive games with imperfect information and coaltional games that are played in the project, namely respectively 40% and 47%, while the percentage of strategic games played only 13% is. These percentages show that an exteremly high percentage of the decisions are made by multiple decision makers and that almost the half of the decisions is made in a cooperative way. Remarkable is that the coalitional game is not played in the third phase of this innovation project, which means that none of the decisions is made

with a coalition. This might indicate that the coalitions in the previous phases are terminated or that these coalitions were not involved in particular decisions that were made in the third phase of the process.

In the market-pull innovation project ModuPark® the percentage strategic game is higher compared to the project iQwoning®: 33%. The extensive game with imperfect information and the coalitional game represent together two-third of the total decisions: 25% of the total decisions is an extensive game with imperfect information and 40% of all decisions is a coalitional game. In this type of innovation project the coalitional game is played in all the four phases, which indicate that during the entire process coalitions are present, although it is not necessary that these coalitions last the entire process and that the coalitions are only involved in one type of decisions.

A remarkable difference between the technology-push innovation project iQwoning® and the market-pull innovation project ModuPark® is the type of games that is played in the decision-making processes of marketing decisions. In the project iQwoning® all marketing decisions are played according to a coalitional game, while in the project ModuPark® 60% of the marketing decisions is played according to a strategic game and 40% is played by a coalitional game. In the other market-pull innovation project, the innovation project Duurzaam Speelbad, the percentage of strategic games is even higher: 100 percent. The differences in the games that are played might explain the differences in success between the three projects, because the project iQwoning® is the most successful project of the three projects.

In the literature about complex product systems it is stated that market inefficiency arises due to a lack of knowledge about the involved risks (Barlow, 2000). Firms tend to manage these risks by retaining knowledge instead of sharing knowledge with firms that are involved in the project coalition (Barlow, 2000; Gann & Salter, 2000). The firms in the project coalition can be fellow-developers, but in case marketing capabilities are missing (Davies & Brady, 2000; Gann & Salter, 2000), it might be necessary to involve firms that have these capabilities and to share the knowledge about the risks of the project.

7 REFLECTIONS

In the previous chapter the results are discussed. In this paragraph 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 innovation performance 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 and innovation performance 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 decision making 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 the topics network dynamics and decision making in innovation projects.

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 questions and five 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 research question about the decision making and the effect of the decision making on the network evolvement.

> *How does the decision making in an innovation project affect the performance of a systemic product innovation of Ballast Nedam?*

The strategic decision-making processes in the innovation projects can be described as unstructured decision processes, because these decision-making processes occur without predetermined and explicit procedures and responses. However, unconsciously the decisions are made following a set of routines and phases. In the decision-making processes four phases and seven routines are identified that can be used to structure a decision-making process.

The strategic decision-making processes can be distinguished based on the form of the process, the set of information that is available and whether there is cooperation or no cooperation between the decision-makers. Based on the literature the decision-making processes are classified by making use of game types: strategic games, extensive games with imperfect information, games with perfect information and coalitional games. However, in the theoretical framework the extensive game with perfect information is excluded, because in real life there is no complete set of information.

Besides the game type the strategic decision-making processes can also be distinguished based on the decision type. In the innovation projects four decision types are distinguished: organizations decisions, operations decisions, product decisions and marketing decisions. The distinction in the four decision types is based on the activities that are excuted in the decision-making process and the desired result of the process. Since in the different phases of the innovation process different decision-making processes are required, the decision types can be linked to specific phases in the innovation process. Organizations decisions are made during the entire process, but the other three decisions types are made within specific phases. Operations decisions are made in the first three decisions, the product decisions in the first, third and fourth phase and the marketing decisions are mainly made in the second and fourth phase of the process.

Although the decisions that are made in the three innovation projects can be linked to each other through the innovation process that is executed, there are decisions that are directly linked to each other, because the outcome of a decision-making process can be the motive to start a new decision-making process. Regarding the decision types there are no significant differences how the decisions are linked. However, with respect to the game type there are differences noticed. Strategic games stand alone in the innovation process and if there is a link it is often with another strategic game or the strategic game is the beginning or end of a chain. Coalitional games and extensive games with imperfect information on the other hand are often linked to each other and are overtures to start a new link of decisions.

The strategic decision-making processes in the innovation projects occur unstructured, but the processes can be distinguished based on the decision type and the type of game that is played within the process. It was not possible to statistically determine the effect of the strategic decision-making processes on the innovation performance, because multiple decisions were made in the four phases of the innovation process and in a post hoc analysis it is hard to separate the decision-making processes and to determine the effect of a single decision-making process on the innovation performance. Nevertheless, if the effect of a collection of decisions on the innovation performance is determined there are three elements that might affect the innovation performance: the type of decision, the type of game played in the decision-making process and in which phase the decision is made and the game is played, although the type of game depends on the decision that is made.

In successful technology-push innovation projects a high percentage of the strategic decisions are about the innovation process and only a few are about the product and the associated technologies. In successful market-pull innovation projects on the other hand a high number of decisions is about the product and less about the operations within the innovation project. Successful innovation projects further show that in a majority of the decision-making processes multiple decision makers are involved, although this not necessarily means that the decision makers form a coalition. The difference between the technology-push innovation project and the market-pull innovation project is that in the latter more strategic games are played, which means that more decisions are made by a single decision maker. The literature and the empirical data however show that a project become more successful if knowledge is shared within coalitions and decisions are made by coalitions.

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 decision making 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 data about decision making was collected after the decisions in the innovation projects were made and further the data was collected through semi-structured interviews with employees that were involved in the innovation projects. Because the decision-making processes are described as unstructured processes these processes are not completely documented and therefore the only form of data collection in this situation was by using interviews. Therefore, the data about decision making has a subjective character. For future research it is suggested to observe the decision-making processes, although it might be hard to distinguish the unstructured decision-making processes on time.

Fourth, the research method of questionnaires is used to measure the innovation performance of the innovation projects and the evolvement of the networks 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 performance of the innovation. 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.

Fifth, in this research it was not possible to determine the effect of the decision-making processes on the performance of the innovation projects. The decision-making processes occur during the entire innovation project, while the innovation performance is measured at the end of the process. Therefore it is not possible to determine which decisions affect the innovation performance and with which magnitude. To study this effect in the future an experimental research is suggested, although it can be hard to manipulate the decision making in innovation projects. Another possibility is to measure the technical and project performance after each decision to allocate the effect of decision making to the innovation performance.

8.3 Theoretical relevance

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

This research describes the performance of three innovation projects in the construction industry for four dimensions. The research describes further the decision-making processes of decisions that were made in three successful innovation projects. The results show that there are relations between the decision type, the phase in which the decision is made, the game type and the type of innovation project. Also the effect of the decision making on the innovation performance is studied, but it was not possible to determine this effect. On the other hand, factors that might influence the innovation performance are determined.

First, in this research the different types of decisions are studied in the innovation projects and how these decision types are linked to phases in the innovation process of the different types of innovation projects. In the study of Krishnan and Ulrich (2001) four types of decisions in the product

development are studied, but this study did not show when these decisions are made. In this research a contribution is made by determining the decisions in the innovation projects and in which phase these decisions are made.

Second, this research shows how decisions are made within innovation projects, that there are sequences of of decisions in innovation projects and further that particular decisions can be linked to particular phases of an innovation process. Galanakis (2006) identified the sequences of decisions in an innovation system, but did not capture the decision making in the innovation projects. This research contributes to the literature by explaining how decision-making processes are completed and how these processes are linked to each other.

Third, in this research game theory is applied to the decision-making processes in the three innovation projects. Three different game types are distinguished in the innovation projects and relations are determined between the decision type and the game type. The literature on game theory is mainly focused on the mathematical models of the game types (Nash, 1950; Shapley, 1953; Osborne & Rubinstein, 1994; Peters, 2008), while in this research the game theory is used in practical applications.

Fourth, in this research insight is acquired about the dynamics of decision making. In the master thesis about network evolvement the evolution of networks is studied, while in this thesis processes and conditions are studied. The decision making and network evolvement are connected with each other, because a change in one of the two items might affect the other item. Zaheer and Soda (2009) stated that more work was needed to explore the processes and conditions of network evolvement. This research contributes to this point by exploring the decision making in innovation networks.

Finally, the research further tried to describe the relation between the decision making and the innovation performance. Although the effect is not determined in this research, the research shows that the type of the innovation project, the decision type and the game type have effect on the innovation performance of innovation projects.

8.4 Practical relevance

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

First, the research acquired insight in the decisions that are made in the innovation projects. The two types of innovation projects, the market-pull and technology-push innovation projects, show different processes of decisions and also the distrubtion of decisions differ between the two types of innovation projects. In the technology-push innovation project the share of operations decisions is high, while in the market-pull innovation projects show a large share of product decisions.

Second, through this research insight is obtained about in the decision-making processes of the decisions in innovation projects. This research shows how the decision-making processes of the 38 identified decisions occurred and what the differences and similarities are between similar decisions in the three innovation projects. The research shows that the decisions-making processes of

organizations and marketing decisions are straightforward, while the processes of the operations and product decisions show more steps that have to be performed.

Third, by making use of game theory different strategies are identified in the three innovation projects. The research shows that multiple games are played in one innovation projects and that the type of game or strategy that is followed depends on the type of decision and in which phase of the innovation process the decision is made. The research showed that the majority of the decisions in the technology-push innovation project are made with multiple organizations, while in the market-pull innovation project also the strategic game is often played.

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, as mentioned in the discussion and conclusion it was in this research not possible to study the decision-making processes separately, since a post-hoc analysis was conducted. In a future research decision-making processes should be observed and studied while they are completed. This will result in a better understanding of the different phases in a decision-making process, how the phases are related to each other and especially how exactly the decisions are made and which actors act as decision makers.

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 decision making can be studied, also the network evolvement 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 thesis the relation is studied between the decision making and the innovation performance, while in the other thesis the effect is studied between the network evolvement and the innovation performance. However, in a future research is is interesting to study the effect of the decision making and the network evolvement. If multiple decisions are studied it is interesting how the relation is between the number of decisions and the effect on the network evolvement.

Fifth, 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.

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 two of the three innovation projects in a later stage of the process the potential market of the innovation is adjusted. This might indicate that either there are new opportunities for the innovation or at the start of the innovation process the market is not completely or correctly determined. If the market is not completely or correctly determined there is a chance that also the need is not completely or correctly determined and consequently the innovation is not desgined based on the actual need. More time should therefore be spent for determining the market in the first phase of the process, which might save time and costs later in the process.

Second, further on the above, the project iQwoning® distinguishes itself from the other two projects by developing the innovation further. In the fourth phase of this project new opportunities are determined that could be exploited if the innovation was further developed. For new innovation projects it is advisable to develop a same attitude as is used in the project iQwoning®. This means that on one hand an innovation is developed to fulfil a short-term purpose, but on the other hand that there are also ideas how innovations could be further developed and fulfil needs in new markets or new market segments.

Third, the marketing decisions that are made in the three innovation projects show that these decisions are made by playing a strategic game or a coalitional game. If a strategic game is played the decision is made independently by Ballast Nedam, while if a coalitional game is played the decision is most of the time made by the same coalition that developed the innovation. However, the organizations in these coalitions cooperate because of their product knowledge, not because of their knowledge regarding marketing. It might be therefore interesting to start to cooperate with marketing firms, since these firms have the necessary marketing knowledge and might place the innovation better in the market.

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.

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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

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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.)

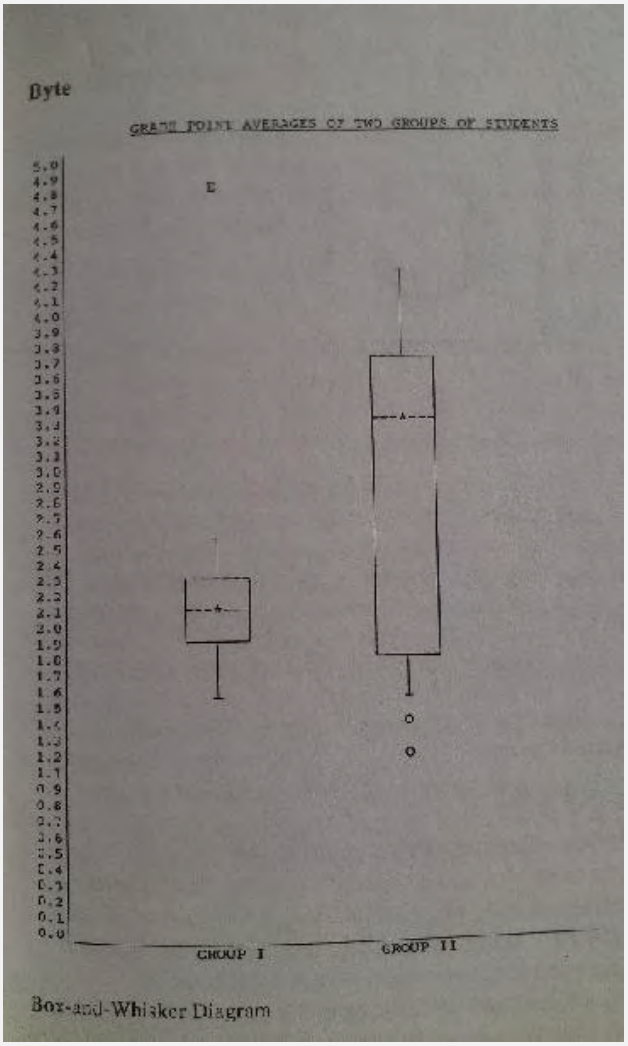
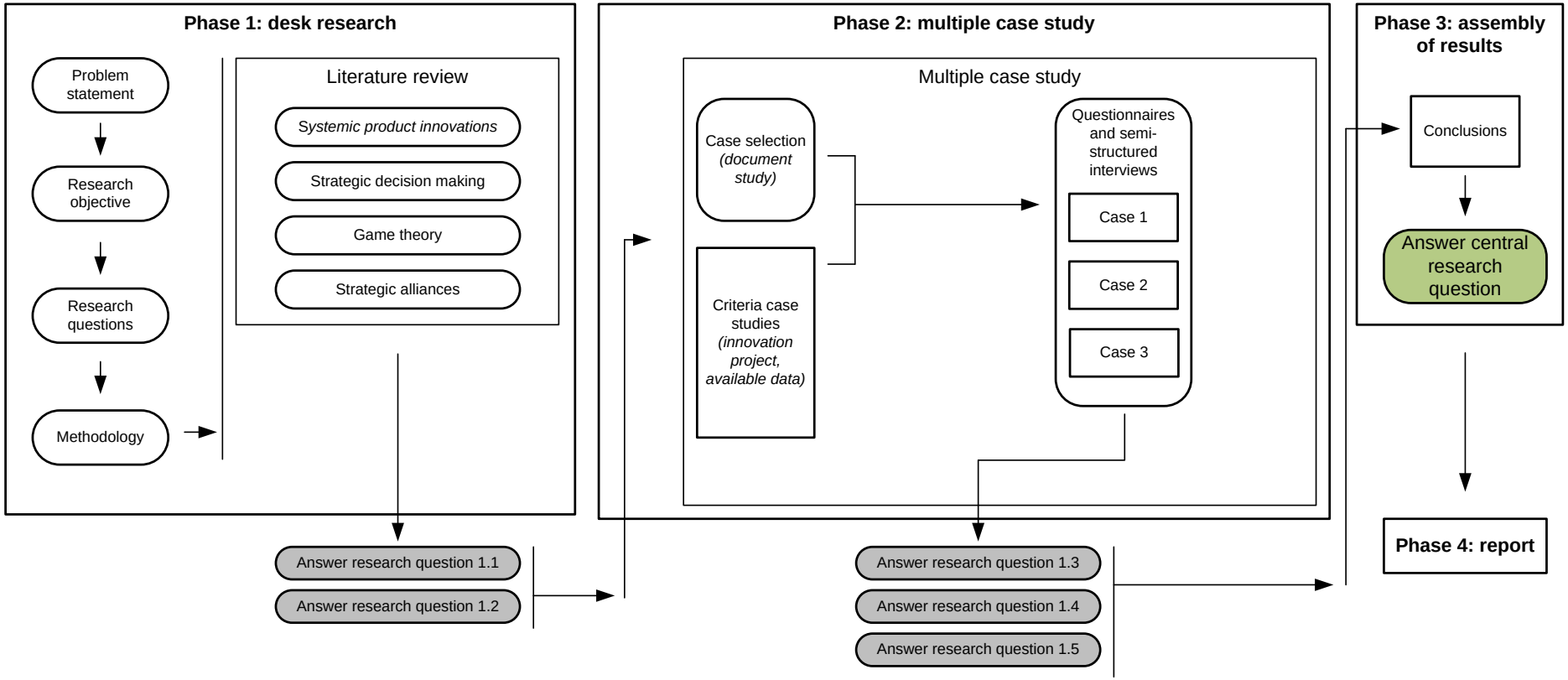


Figure 11.1: Box-and-Whisker Diagram

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



11.5 Appendix E: Decisions in Duurzaam Speelbad

11.5.1 Overview of decisions

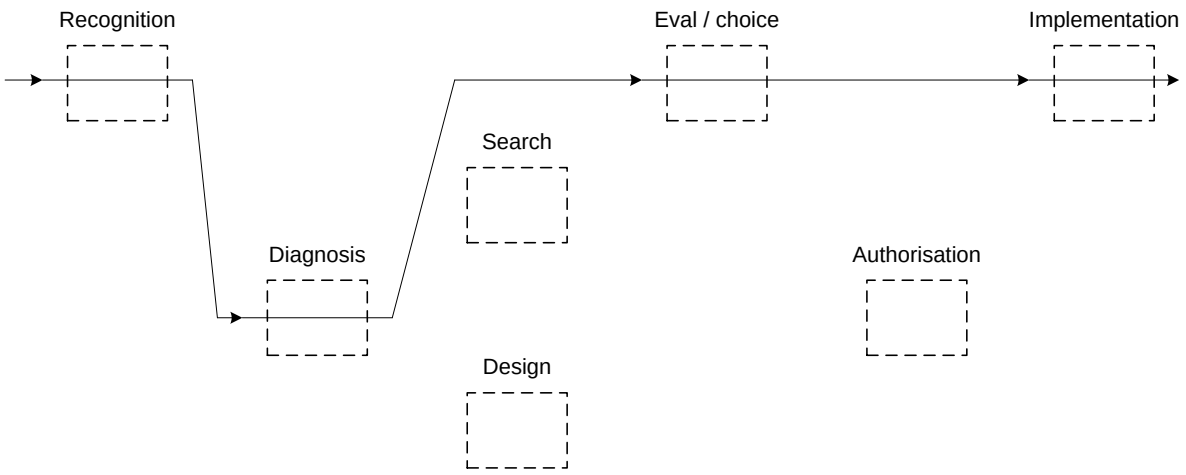
1. Rebuilding of children's pools in Amstelveen
2. Design of the children's pool
3. Design of business model
4. Determination of the market
5. Cooperation with Waco Lingen Beton
6. Design of Duurzaam Speelbad
7. Cooperation with Van Dorp Zwembaden
8. Improved design of Duurzaam Speelbad
9. Design of production process
10. Roughening of the floor
11. Determination of new types of customers

11.5.2 Description of decisions

1. Rebuilding of children's pools in Amstelveen

Description of decision	Based on a report of the engineering agency Oranjewoud the municipality of Amstelveen decided to approach Fehres for the renovation of the children's pool in the municipality. Fehres declared that it would advisable to rebuild the children's pool instead of renovate the pools. Consequently the municipality approached Ballast Nedam Infra Noord West to rebuild the children's pools in cooperation with Fehres.
Phase in innovation process	■ Idea generation and selection □ Pilot project □ Development and testing □ Implementation and diffusion
Type of decision	■ Organizations ■ Operations □ Product □ Marketing
Involved organizations	• Ballast Nedam Infra Noord West • Fehres • Municipality of Amstelveen
Decision making	□ Analysis ■ Judgement □ Bargaining
Form	■ Extensive form □ Normal form
Cooperation	□ Cooperative game ■ Non-cooperative game
Information	■ Imperfect information □ Perfect information
Game	□ Strategic game □ Extensive game with perfect information ■ Extensive game with imperfect information □ Coalitional game

Model of decision-making process

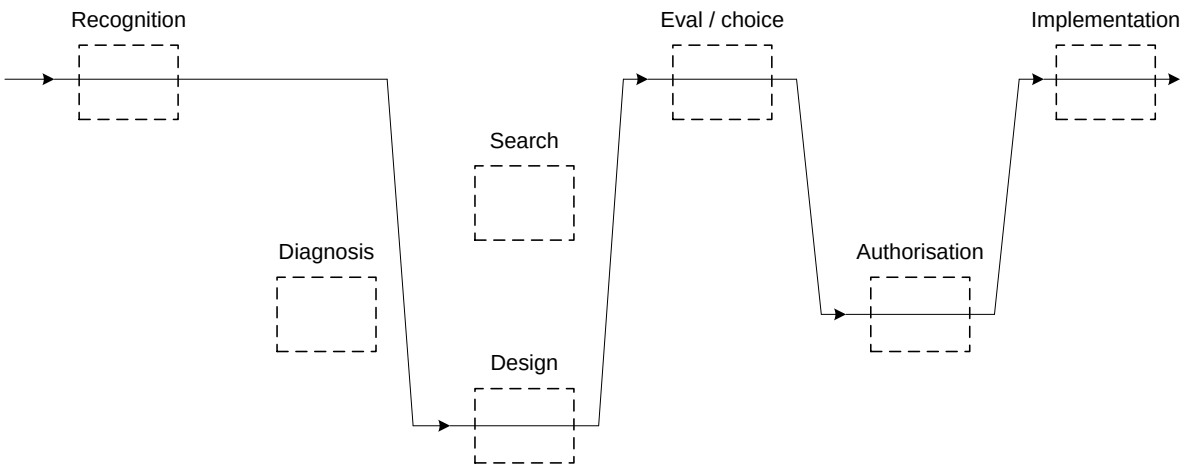


Routine in decision-making process	
Recognition	Based on a report of engineering agency Oranjewoud the municipality of Amstelveen decided to renovate the children's pools in the municipality. The municipality approached thereafter Fehres for the renovations of the children's pools.
Diagnosis	Fehres declared to the municipality that it would be advisable to rebuild the children's pools instead to renovate them. Consequently the municipality approached Ballast Nedam Infra Noord West to rebuild the children's pools in cooperation with Fehres. In the past Fehres and Ballast Nedam Infra Noord West had finished successfully a project in the municipality of Amstelveen.
Search	
Design	
Evaluation / choice	Fehres and Ballast Nedam Infra Noord West were approached by the municipality of Amstelveen to rebuild 3 children's pools. Both parties operated by order of the municipality, but had also contact with each other regarding the design. The decision to rebuild the children's pool was made by the municipality of Amstelveen and the evaluation took place through judgement.
Authorisation	
Implementation	In the end Fehres and Ballast Nedam Infra Noord West rebuilt 4 children's pool in the municipality of Amstelveen. The concrete of the first pool was poured on site, while the other 3 children's pools were made by using prefabricated elements.

2. Design of the children's pool

Description of decision	The design of the children's pools that had to be rebuilt was based on a draft that was made by the municipality of Amstelveen. The final design of the children's pool was made in cooperation between Ballast Nedam Infra Noord West, Ballast Nedam Engineering and Fehres. The municipality gave in the end authorization to rebuild the pools based on the design.
Phase in innovation process	■ Idea generation and selection □ Pilot project □ Development and testing □ Implementation and diffusion
Type of decision	□ Organizations □ Operations ■ Product □ Marketing
Involved organizations	• Ballast Nedam Engineering • Ballast Nedam Infra Noord West • Fehres • Municipality of Amstelveen
Decision making	■ Analysis □ Judgement ■ Bargaining
Form	■ Extensive form □ Normal form
Cooperation	■ Cooperative game □ Non-cooperative game
Information	■ Imperfect information □ Perfect information
Game	□ Strategic game □ Extensive game with perfect information □ Extensive game with imperfect information ■ Coalitional game

Model of decision-making process

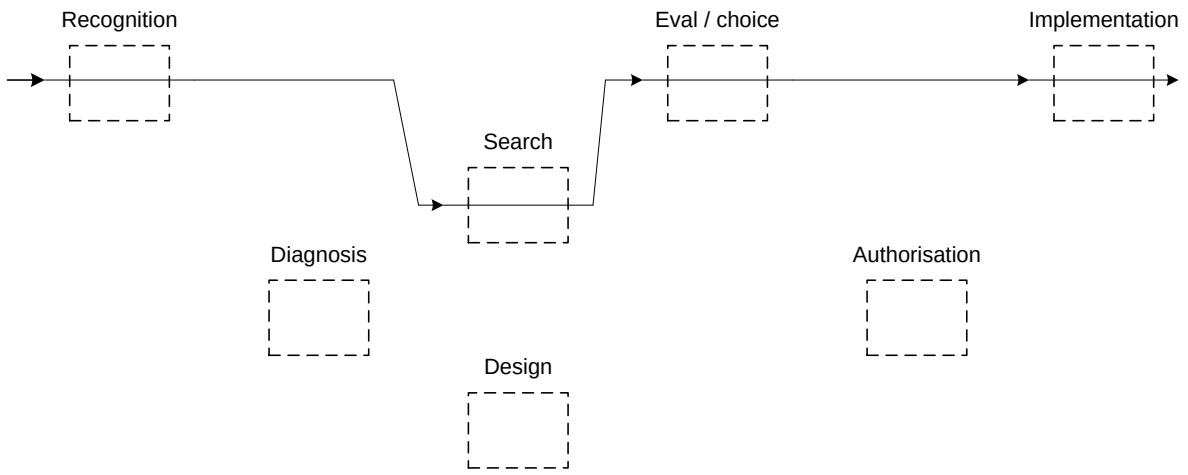


Routine in decision-making process	
Recognition	After the municipality of Amstelveen decided not to renovate the children's pools in the municipality, but to rebuild them. The municipality provided the draft for the design of the pool, but gave Ballast Nedam Infra Noord West the space to design the surroundings of the pool.
Diagnosis	
Search	
Design	Ballast Nedam Infra Noord West and Ballast Nedam Engineering designed the frame of the children's pool based on the draft that was provided by the municipality. In the meanwhile Fehres designed the purification plant for the children's pool.
Evaluation / choice	Fehres and Ballast Nedam Infra Noord West combined their design in a final design for the children's pool. The evaluation took place through analysis (calculations and designs) and bargaining.
Authorisation	The municipality of Amstelveen authorized the decision to rebuild the children's pool based on the proposed design.
Implementation	The first children's pool was rebuilt based on the basis of the design that was authorized by the municipality and the pool was poured on location. The following children's pools were however rebuilt by using prefabricated elements.

3. Design of business model

Description of decision	Ballast Nedam Infra Noord West was as contractor approached to rebuild several children's pool together with Fehres. As an extension of this assignment Ballast Nedam Infra Noord West was asked to renovate also the surroundings of the children's pool. As a result Ballast Nedam Infra Noord West decided to use this construction, the realisation of the children's pool and its surroundings, as a business model for future projects.
Phase in innovation process	☐ Idea generation and selection ■ Pilot project ☐ Development and testing ☐ Implementation and diffusion
Type of decision	☐ Organizations ☐ Operations ☐ Product ■ Marketing
Involved organizations	• Ballast Nedam Infra Noord West
Decision making	☐ Analysis ■ Judgement ☐ Bargaining
Form	☐ Extensive form ■ Normal form
Cooperation	☐ Cooperative game ■ Non-cooperative game
Information	■ Imperfect information ☐ Perfect information
Game	■ Strategic game ☐ Extensive game with perfect information ☐ Extensive game with imperfect information ☐ Coalitional game

Model of decision-making process

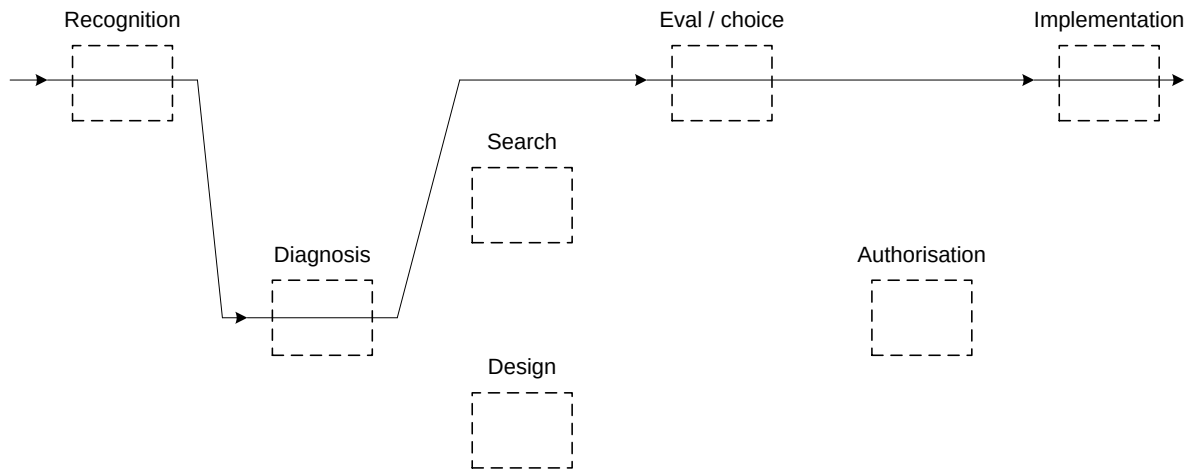


Routine in decision-making process	
Recognition	Ballast Nedam Infra Noord West was approached by the municipality of Amstelveen to rebuild several children's pool in cooperation with Fehres. As an extension to this assignment Ballast Nedam Infra Noord West was asked to also rebuild the surroundings of the children's pools.
Diagnosis	
Search	After calculation it seemed profitable to rebuild also the surroundings of the children's pools. Compared to the rebuilding of the children's pools the rebuilding of the surroundings was even more profitable.
Design	
Evaluation / choice	For future projects Ballast Nedam Infra Noord West would use the business model of building a children's pool and (re)building its surroundings. The evaluation took place through judgement.
Authorisation	
Implementation	Ballast Nedam Infra Noord West has rebuilt the surroundings of the 2nd, 3rd and 4th children's pool. It was however not possible to rebuild the surroundings of the 5th children´s pool due to a contract between the municipality and a local gardener. However, for future projects the business model is still valid.

4. Determination of the market

Description of decision	After the introduction of the idea to the municipality of Amstelveen to use prefabricated children´s pools for the remaining pools that had to be rebuilt Ballast Nedam Infra Noord West inventoried the demand for prefabricated children´s pools in the provinces of Utrecht, North Holland and South Holland. Ultimately Ballast Nedam Infra Noord West decided not to respond to the inventoried demand, but first to realize the prefabricated children's pools in the municipality of Amstelveen.
Phase in innovation process	☐ Idea generation and selection ■ Pilot project ☐ Development and testing ☐ Implementation and diffusion
Type of decision	☐ Organizations ☐ Operations ☐ Product ■ Marketing
Involved organizations	• Ballast Nedam Infra Noord West
Decision making	☐ Analysis ■ Judgement ☐ Bargaining
Form	☐ Extensive form ■ Normal form
Cooperation	☐ Cooperative game ■ Non-cooperative game
Information	■ Imperfect information ☐ Perfect information
Game	■ Strategic game ☐ Extensive game with perfect information ☐ Extensive game with imperfect information ☐ Coalitional game

Model of decision-making process

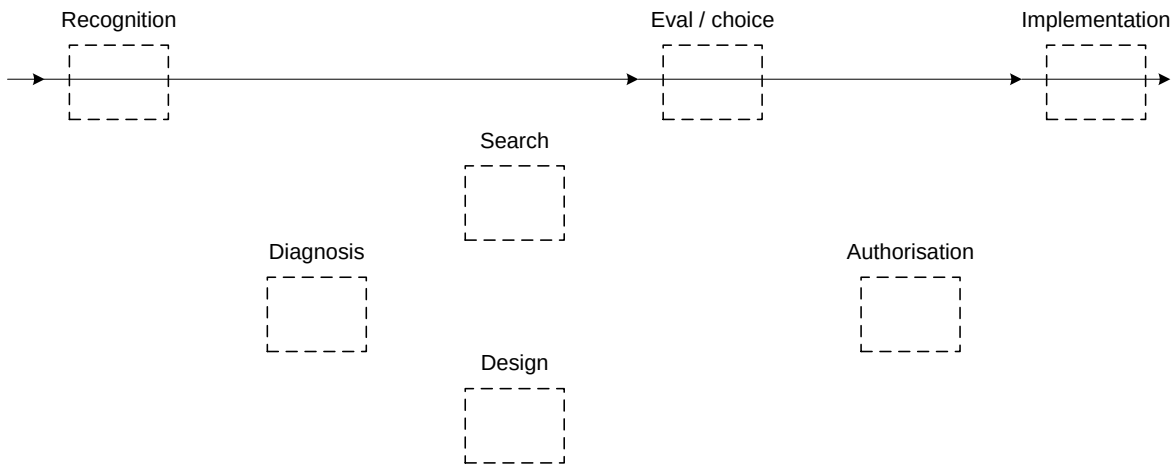


Routine in decision-making process	
Recognition	After the introduction of the idea to the municipality of Amstelveen to use prefabricated children´s pools for the remaining pools that had to be rebuilt Ballast Nedam Infra Noord West looked for other opportunities.
Diagnosis	Ballast Nedam Infra Noord West inventoried the demand for prefabricated children´s pools in the provinces of Utrecht, North Holland and South Holland. The reason to inventory the demand in these provinces is that the large cities are located in these provinces. Subsequently the number of children's pools in the three provinces was determined and the number of children's pool that had to be renovated.
Search	
Design	
Evaluation / choice	Ultimately Ballast Nedam Infra Noord West decided not to approach the municipalities in the provinces of Utrecht, North Holland and South Holland, but first to develop and to build the prefabricated children's pool in the municipality of Amstelveen. The evaluation took place through judgement.
Authorisation	
Implementation	The municipalities in the provinces of Utrecht, North Holland and South Holland will soon be approached to join a workshop about the Duurzaam Speelbad.

5. Cooperation with Waco Lingen Beton

Description of decision	For the development of prefabricated children's pool Waco Lingen Beton is approached to participate in the development process. The reasons to approach Waco Lingen Beton were that Waco Lingen Beton is specialized in developing prefabricated elements of concrete and is a subsidiary of Ballast Nedam N.V.
Phase in innovation process	□ Idea generation and selection □ Pilot project ■ Development and testing □ Implementation and diffusion
Type of decision	■ Organizations □ Operations □ Product □ Marketing
Involved organizations	• Ballast Nedam Infra Noord West • Waco Lingen Beton
Decision making	□ Analysis □ Judgement ■ Bargaining
Form	■ Extensive form □ Normal form
Cooperation	□ Cooperative game ■ Non-cooperative game
Information	■ Imperfect information □ Perfect information
Game	□ Strategic game □ Extensive game with perfect information ■ Extensive game with imperfect information □ Coalitional game

Model of decision-making process

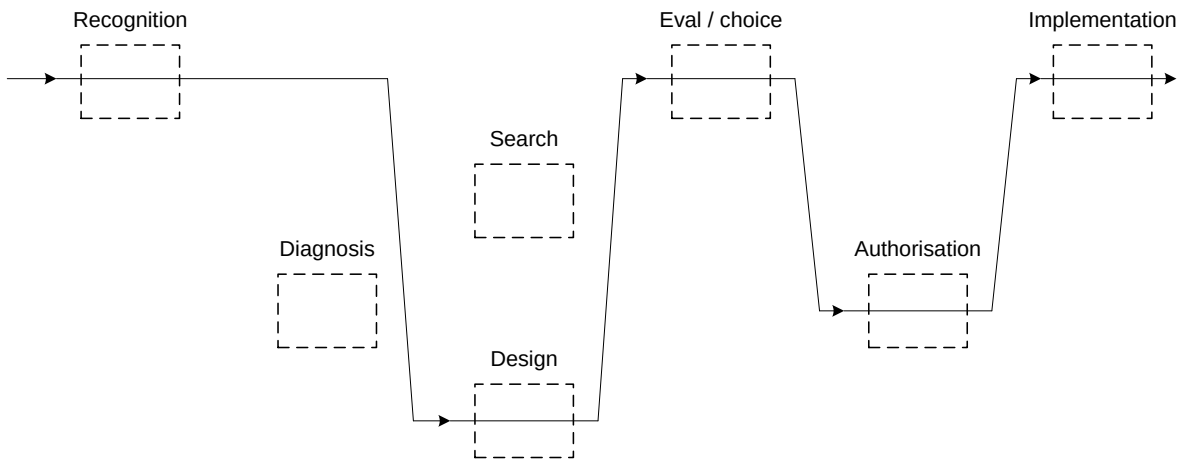


Routine in decision-making process	
Recognition	For designing and developing the prefabricated children's pools Ballast Nedam Infra Noord West approached Waco Lingen Beton to participate in the development process. The reasons to approach Waco Lingen Beton were that the company is specialized in the development and realization of prefabricated elements of concrete and that is a subsidiary of Ballast Nedam.
Diagnosis	
Search	
Design	
Evaluation / choice	Ballast Nedam Infra Noord West and Waco Lingen Beton decided to cooperate in the development process of the prefabricated children's pool. The evaluation took place through bargaining.
Authorisation	
Implementation	Waco Lingen Beton developed the first design of the prefabricated children's pool and was further involved in the further development of the product.

6. Design of Duurzaam Speelbad

Description of decision	The first children's pool in Amstelveen was poured on the site, but the other children's pools that had to be rebuilt would be prefabricated children´s pools. Although the initial agreement was to build 3 children´s pools, Ballast Nedam Infra Noord West agreed with the municipality to build a fourth children's pool so that the investment would be distributed over 3 children's pools instead of over 2 pools. Ultimately the design for a Duurzaam Speelbad was made.
Phase in innovation process	☐ Idea generation and selection ☐ Pilot project ■ Development and testing ☐ Implementation and diffusion
Type of decision	☐ Organizations ☐ Operations ■ Product ☐ Marketing
Involved organizations	• Ballast Nedam Infra Noord West • Fehres • Municipality of Amstelveen • Waco Lingen Beton
Decision making	☐ Analysis ☐ Judgement ■ Bargaining
Form	■ Extensive form ☐ Normal form
Cooperation	■ Cooperative game ☐ Non-cooperative game
Information	■ Imperfect information ☐ Perfect information
Game	☐ Strategic game ☐ Extensive game with perfect information ☐ Extensive game with imperfect information ■ Coalitional game

Model of decision-making process

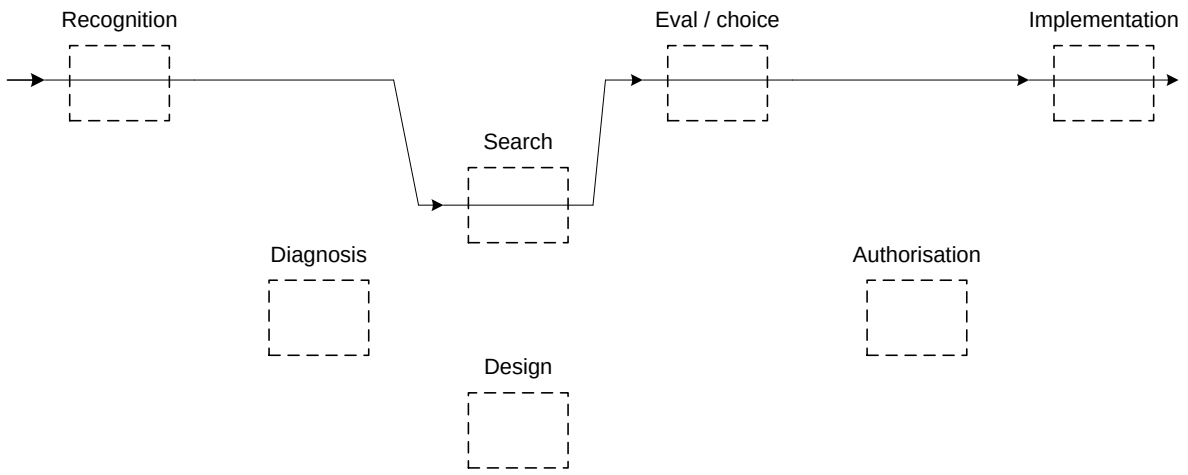


Routine in decision-making process	
Recognition	The first children's pool in Amstelveen was poured on site, but Ballast Nedam Infra Noord West thought that it would be better to build the next children's pools according to principle of prefabrication, since the quality would be better, the pools could be produced in a fixed time and the costs of the pools would be lower.
Diagnosis	
Search	
Design	Based on the design of the first children's pool that was poured on site a design was made for a prefabricated children's pool by Waco Lingen Beton. There were no major changes made compared to the original design, only some minor changes were made that were necessary to produce it in a mold.
Evaluation / choice	In consultation with Fehres and the municipality of Amstelveen it was decided to build the other children's pool according to use the design of the Duurzaam Speelbad. To lower the investments costs the municipality of Amstelveen decided to rebuild a fourth children's pool so that the investment could be distributed over 3 pools instead of over 2 pools.
Authorisation	The municipality of Amstelveen authorized the decision to use the design of the Duurzaam Speelbad for the remaining children's pools that had to be rebuilt.
Implementation	The 2^{nd}, 3^{rd} and 4^{th} children's pools were rebuilt according to the design of the Duurzaam Speelbad. The 5^{th} pool was rebuilt according to an improved design of the Duurzaam Speelbad.

7. Cooperation with Van Dorp Zwembaden

Description of decision	After Fehres had indicated that it would not cooperate in further developing the Duurzaam Speelbad Ballast Nedam Infra Noord West had to find a new partner to improve the purification plant of the children's pool. Ballast Nedam Infra Noord West decided to cooperate with Van Dorp Zwembaden, a company that had experiences in developing and building swimming pools.
Phase in innovation process	☐ Idea generation and selection ☐ Pilot project ■ Development and testing ☐ Implementation and diffusion
Type of decision	■ Organizations ☐ Operations ☐ Product ☐ Marketing
Involved organizations	• Ballast Nedam Infra Noord West • Van Dorp Zwembaden
Decision making	☐ Analysis ☐ Judgement ■ Bargaining
Form	■ Extensive form ☐ Normal form
Cooperation	☐ Cooperative game ■ Non-cooperative game
Information	■ Imperfect information ☐ Perfect information
Game	☐ Strategic game ☐ Extensive game with perfect information ■ Extensive game with imperfect information ☐ Coalitional game

Model of decision-making process

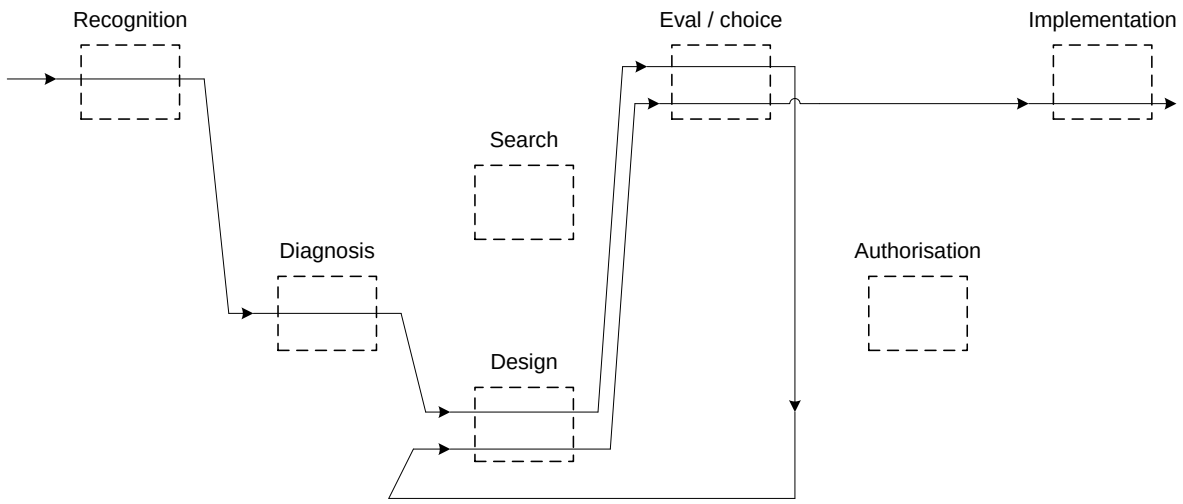


Routine in decision-making process	
Recognition	Ballast Nedam Infra Noord West wanted to further develop the Duurzaam Speelbad before it would enter the market of children's pools. In an earlier stage a design of a prefabricated children's pool was made. The next step was to improve the purification plant and consequently to improve the quality of the water. By improving the water quality the Duurzaam Speelbad would be classified as a swimming pool of category A. However, Fehres was not willing to develop an improved purification plant therefore Ballast Nedam had to find a new partner.
Diagnosis	
Search	Ballast Nedam Infra Noord West looked for possible candidates to participate in the further development of the Duurzaam Speelbad. Van Dorp Zwembaden was found after a short research on the internet. Based on the fact that it was part of a national operating company, it was specialized in building swimming pools and it had an entrepreneurial character Van Dorp Zwembaden was approached by Ballast Nedam Infra Noord West to participate in the development process.
Design	
Evaluation / choice	After consultation Ballast Nedam infra Noord West and Van Dorp Zwembaden agreed to cooperate in the further development of the Duurzaam Speelbad and also in the marketing of the Duurzaam Speelbad. Both parties would however operate independently on the market, but in case of future requests to realize a Duurzaam Speelbad both parties will cooperate.
Authorisation	
Implementation	Ballast Nedam Infra Noord West and Van Dorp Zwembaden signed a contract to cooperate in the development of the Duurzaam Speelbad and the building of children's pools.

8. Improved design of Duurzaam Speelbad

Description of decision	After the realization of the first three prefabricated children's pools Ballast Nedam Infra Noord West wanted to improve its design and especially the purification plant. To improve the purification plant Ballast Nedam Infra Noord West started to cooperate with Van Dorp Zwembaden, which resulted in an improved purification plant. Consequently the design of the Duurzaam Speelbad needed to be adjusted to fit in the purification plant.
Phase in innovation process	☐ Idea generation and selection ☐ Pilot project ■ Development and testing ☐ Implementation and diffusion
Type of decision	☐ Organizations ☐ Operations ■ Product ☐ Marketing
Involved organizations	• Ballast Nedam Infra Noord West • Van Dorp Zwembaden • Waco Lingen Beton
Decision making	■ Analysis ■ Judgement ☐ Bargaining
Form	■ Extensive form ☐ Normal form
Cooperation	■ Cooperative game ☐ Non-cooperative game
Information	■ Imperfect information ☐ Perfect information
Game	☐ Strategic game ☐ Extensive game with perfect information ☐ Extensive game with imperfect information ■ Coalitional game

Model of decision-making process



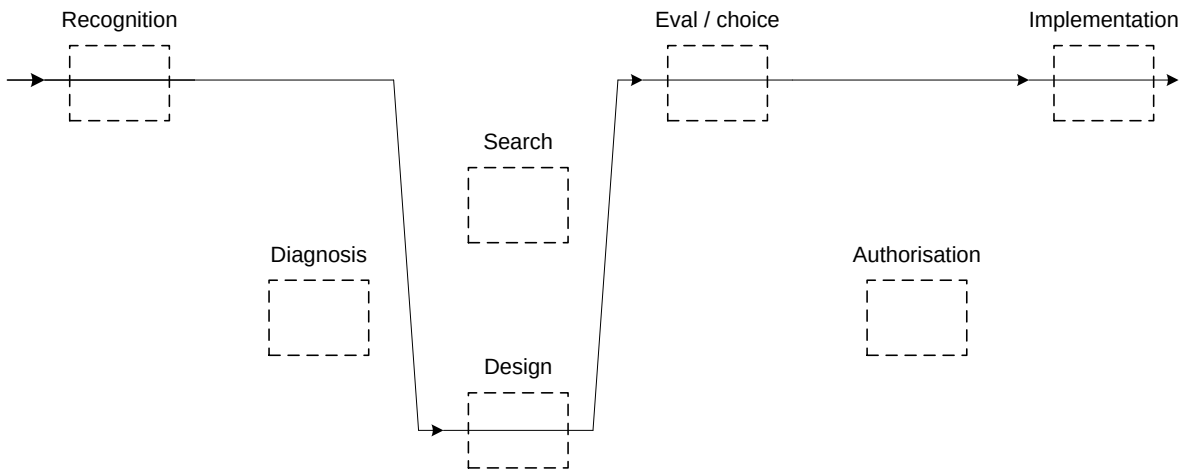
Routine in decision-making process	
Recognition	Ballast Nedam Infra Noord West distinguished opportunities regarding the market of children´s pools, but before entering this market Ballast Nedam Infra Noord West wanted a product that met the regulations regarding the water quality of children´s pools.
Diagnosis	After Fehres indicated that it would not further participate in the development of the Duurzaam Speelbad Van Dorp Zwembaden was approached in the development process. Together with Waco Lingen the two firms started the development process.
Search	
Design	Van Dorp Zwembaden started the process with the development of an improved purification plant that would purify the water according to the regulations for a swimming pool of category A. After the purification plant was improved the frame of the Duurzaam Speelbad had to be adjusted to fit in the purification plant. Because of the improved water quality of the Duurzaam Speelbad it was on basis of the regulations possible to enlarge the children´s pool. Therefore an extra mold is developed to increase the Duurzaam Speelbad with 2.5 meter by using an extra connecting-piece.
Evaluation / choice	The first analysis is regarding the purification plant. This purification plant is developed by Van Dorp Zwembaden and they are therefore also the organization that took the decision that the purification plant met the necessary requirements. The evaluation took place through analysis and judgement. The second analysis is regarding the changes in the frame of the Duurzaam Speelbad. Changes are made in the design to fit in the purification plant and also to be able to enlarge the Duurzaam Speelbad. The evaluation took place through analysis and judgement.

Routine in decision-making process	
Authorisation	
Implementation	In 2011 the fifth children's pool was built, which was the first version of the improved version of the Duurzaam Speelbad. Future children's pools will be built according to the design of the improved Duurzaam Speelbad.

9. Design of production process

Description of decision	The prefabricated children's pool was designed with the idea to produce more prefabricated children's pools in the near future. However, to produce more children's pools a production process had to be designed. This production process is designed by Ballast Nedam Infra Noord West and Waco Lingen Beton en the 5th children's pools is the first production of this production process.
Phase in innovation process	☐ Idea generation and selection ☐ Pilot project ■ Development and testing ☐ Implementation and diffusion
Type of decision	☐ Organizations ■ Operations ☐ Product ☐ Marketing
Involved organizations	• Ballast Nedam Infra Noord West • Waco Lingen Beton
Decision making	☐ Analysis ☐ Judgement ■ Bargaining
Form	■ Extensive form ☐ Normal form
Cooperation	■ Cooperative game ☐ Non-cooperative game
Information	■ Imperfect information ☐ Perfect information
Game	☐ Strategic game ☐ Extensive game with perfect information ☐ Extensive game with imperfect information ■ Coalitional game

Model of decision-making process

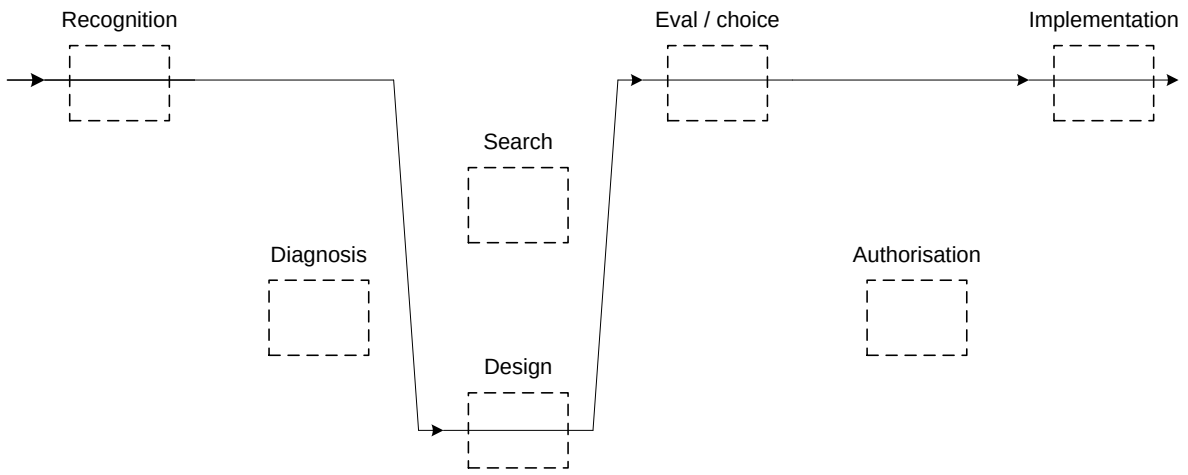


Routine in decision-making process	
Recognition	A prefabricated children's pool offers a certain level of quality, a set duration to produce it and the costs per children's pool would be lower compared to a children's pool that was poured on site. However, to produce prefabricated children's pool a production process had to be designed.
Diagnosis	
Search	
Design	Waco Lingen Beton had experiences with the production of prefabricated elements of concrete and used this experience to design the production process of the Duurzaam Speelbad in cooperation with Ballast Nedam Infra Noord West.
Evaluation / choice	Ballast Nedam Infra Noord West and Waco Lingen Beton decided in consultation to use the designed production process for the production of future children´s pools. The evaluation took place through bargaining.
Authorisation	
Implementation	For the production process of the improved Duurzaam Speelbad new molds were developed and these molds were use for the production of the first improved Duurzaam Speelbad, which was the 5th children´s pool in Amstelveen.

10. Roughening of the floor

Description of decision	After the 5th children´s pool was placed it turned out the floor of the children's pool was too slippery. Regarding this pool is decided to roughening the floor on site, for the Duurzaam Speelbaden that have to be realized in the future the design is adjusted with a rougher floor.
Phase in innovation process	☐ Idea generation and selection ☐ Pilot project ☐ Development and testing ■ Implementation and diffusion
Type of decision	☐ Organizations ☐ Operations ■ Product ☐ Marketing
Involved organizations	• Ballast Nedam Infra Noord West • Waco Lingen Beton
Decision making	☐ Analysis ☐ Judgement ■ Bargaining
Form	■ Extensive form ☐ Normal form
Cooperation	■ Cooperative game ☐ Non-cooperative game
Information	■ Imperfect information ☐ Perfect information
Game	☐ Strategic game ☐ Extensive game with perfect information ☐ Extensive game with imperfect information ■ Coalitional game

Model of decision-making process

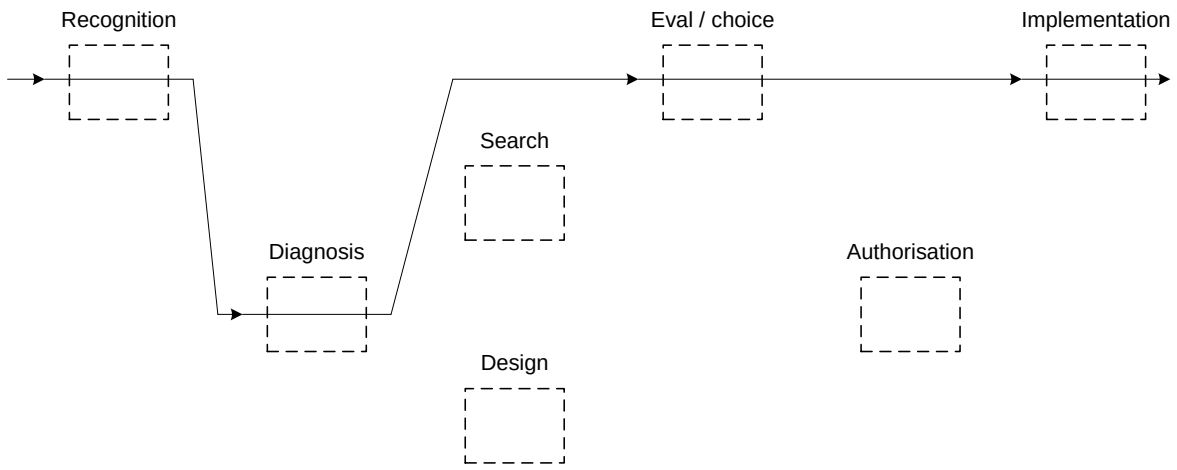


Routine in decision-making process	
Recognition	After the realization of the 5th children's pool, which was the first improved version of the Duurzaam Speelbad, the floor turned out to be too slippery. Normally the order is to produce polished concrete, but in combination with the water in the children's pool the concrete should not be too polished.
Diagnosis	
Search	
Design	Waco Lingen Beton adjusted the design of the improved Duurzaam Speelbad by roughening the floor of the elements.
Evaluation / choice	Waco Lingen Beton and Ballast Nedam Infra Noord West decided in consultation that the floors of the future children's pools had to be rougher. Regarding the 5th children's pool in Amstelveen that already was realized the floor had to be made rougher.
Authorisation	
Implementation	The design of the improved Duurzaam Speelbad is adjusted with a rougher floor and the floor of the 5th children's pool was made rougher on site.

11. Determination of new types of customers

Description of decision	Municipalities in the provinces of Utrecht, North Holland and South Holland were considered to be the potential market of the Duurzaam Speelbad. However, due to the economic crisis Ballast Nedam Infra Noord West decided to shift its attention to the private market. Recreation centres and large playgrounds are determined as new types of customers of the Duurzaam Speelbad. Municipalities remain potential customers of the Duurzaam Speelbad.
Phase in innovation process	☐ Idea generation and selection ☐ Pilot project ☐ Development and testing ■ Implementation and diffusion
Type of decision	☐ Organizations ☐ Operations ☐ Product ■ Marketing
Involved organizations	• Ballast Nedam Infra Noord West
Decision making	☐ Analysis ■ Judgement ☐ Bargaining
Form	☐ Extensive form ■ Normal form
Cooperation	☐ Cooperative game ■ Non-cooperative game
Information	■ Imperfect information ☐ Perfect information
Game	■ Strategic game ☐ Extensive game with perfect information ☐ Extensive game with imperfect information ☐ Coalitional game

Model of decision-making process



Routine in decision-making process	
Recognition	Partly because of the economic crisis municipalities often lack the financial capacity to renovate or replace the play pools in their municipalities. For this reason, Ballast Nedam Infra Noord West decided to shift its attention to other parts of the market for prefabricated children's pools.
Diagnosis	Before new market segments were determined and the attention was shifted towards these market segments Ballast Nedam Infra Noord West first identified the demand of children's pools. Beside the demand Ballast Nedam Infra Noord West looked also to the financial resources of potential customers of children's pools. This analysis showed that recreation centres and large playgrounds were potential customers of the children's pools. As private parties the recreation centres and large playgrounds have the opportunity to make the necessary investment to purchase children´s pool.
Search	
Design	
Evaluation / choice	Recreation centres and large playgrounds are often large companies and have, unlike government institutes, the ability to independently make investment decisions. The purchase of a Duurzaam Speelbad means a major investment decision and since recreation centres and large playgrounds have the freedom to make such investments, it was decided that recreation centres and large playgrounds Ballast Nedam Infra Noord West would shift its attention to these two types of customers.
Authorisation	
Implementation	Recreation centres and large playgrounds will be in the near future be invited for a workshop about the possibilities of the Duurzaam Speelbad. Municipalities will also be invited for this workshop, since municipalities remain to be seen as potential customers despite the economic crisis.

11.6 Appendix F: Decisions in iQwoning

11.6.1 Overview of decisions

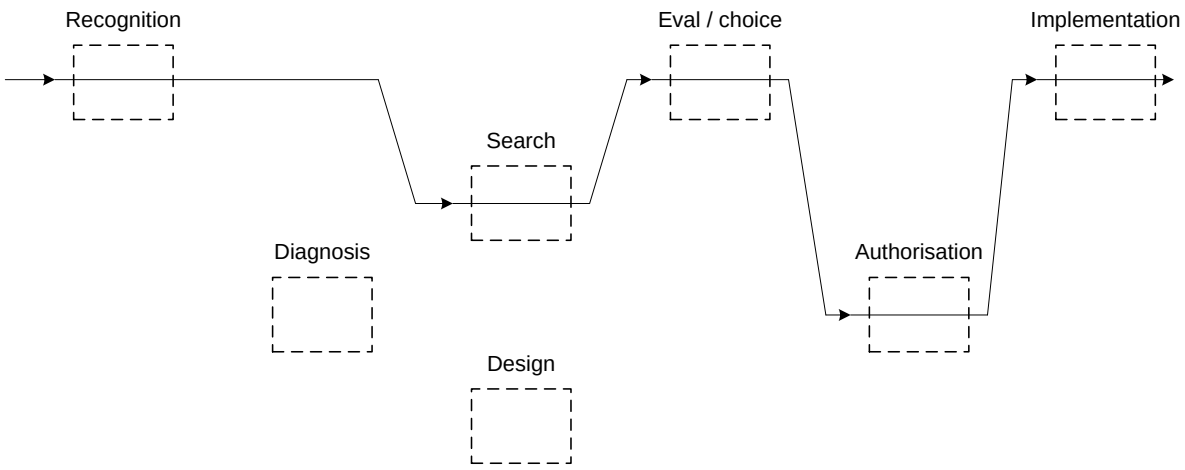
1. Development of concept of modular housing
2. Design of iQwoning®
3. Design of business model
4. Determination of market
5. Design of production process
6. Pilot project Berckelbosch
7. Factory for production IQwoning®
8. Founding of IQ Woning B.V.
9. Improvements in production process
10. Improvement of reinforcement
11. Start of iQteam
12. Adjustment of responsibilities of iQteam
13. Adjustment in performing acquisition
14. Addition of new type of iQwoning®
15. Development of iQconcept

11.6.2 Description of decisions

1. Development of concept of modular housing

Description of decision	Ballast Nedam faced two types of problems: the increasing scarcity of craftsmanship and the changing weather conditions during the year. A solution for these two problems was found in the concept of a modular housing that would consist of semi-fabricated elements. Based on this concept a project group was formed that would design the modular house.
Phase in innovation process	■ Idea generation and selection □ Pilot project □ Development and testing □ Implementation and diffusion
Type of decision	■ Organizations ■ Operations □ Product □ Marketing
Involved organizations	• Board of Management Ballast Nedam N.V. • Ballast Nedam Bouw West • Ballast Nedam Research & Development
Decision making	□ Analysis ■ Judgement □ Bargaining
Form	■ Extensive form □ Normal form
Cooperation	□ Cooperative game ■ Non-cooperative game
Information	■ Imperfect information □ Perfect information
Game	□ Strategic game □ Extensive game with perfect information ■ Extensive game with imperfect information □ Coalitional game

Model of decision-making process



Routine in decision-making process	
Recognition	Ballast Nedam faced two types of problems several years ago: the increasing scarcity of craftsmanship and the different weather conditions in the Netherlands during the entire year that influence the construction projects. To be able to face these two problems one or more solutions have to be found.
Diagnosis	
Search	Two types of construction projects abroad offered the solutions for the problems regarding the scarcity of craftsmanship and the changing weather conditions. In Canada timber houses were built by making use of elements that were produced in a factory and in Denmark the concrete constructions were built on covered construction sites. Ballast Nedam combined these two solutions in one solution: production of semi-fabricated concrete elements.
Design	
Evaluation / choice	The proposed solution was then developed in a concept of a modular housing. The evaluation of the concept took place through judgement.
Authorisation	The director of the division Ballast Nedam Bouw West authorized the decision to design a modular house.
Implementation	For designing the modular house a project group was formed that consisted of employees of different Ballast Nedam departments.

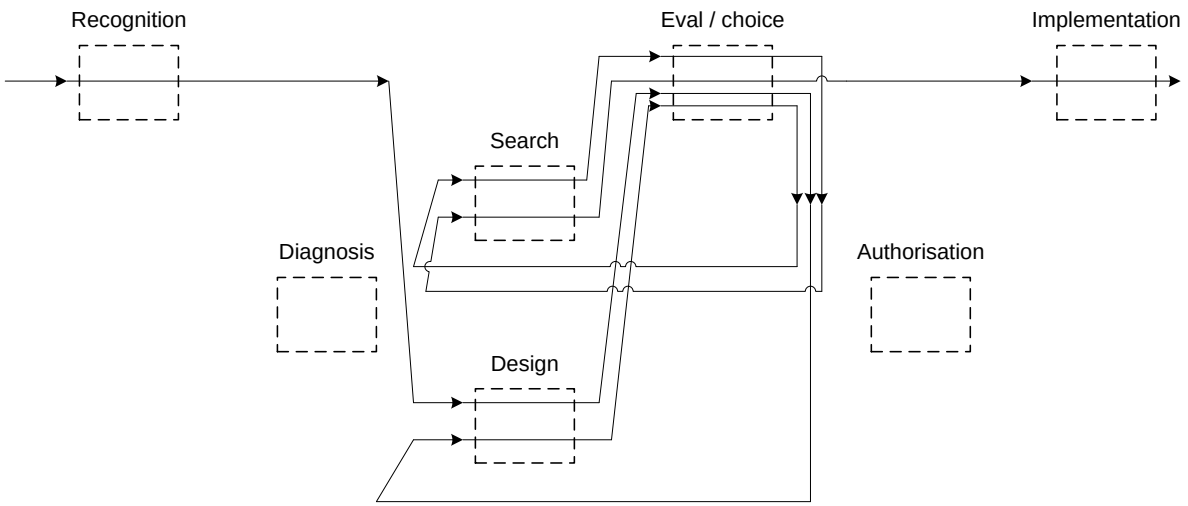
2. Design of iQwoning®

Description of decision	The conditions for the design of the iQwoning® were related to the transport of the elements on the road and the size of the house. Eventually it was decided that an iQwoning ® consists of 6 concrete elements with a beech size of 5.40 meters, so that the elements still could be transported on the road, but that at the same time the house would be large enough.
Phase in innovation process	■ Idea generation and selection □ Pilot project □ Development and testing □ Implementation and diffusion
Type of decision	□ Organizations □ Operations ■ Product □ Marketing

Involved organizations	• Projectgroep Red Bull
	  ○ Ballast Nedam Bouwtechniek
	  ○ Ballast Nedam Engineering
	  ○ Ballast Nedam Research & Development
	  ○ Hoco Beton

Decision making	■ Analysis ■ Judgement ■ Bargaining
Form	■ Extensive form □ Normal form
Cooperation	■ Cooperative game □ Non-cooperative game
Information	■ Imperfect information □ Perfect information
Game	□ Strategic game □ Extensive game with perfect information □ Extensive game with imperfect information ■ Coalitional game

Model of decision-making process



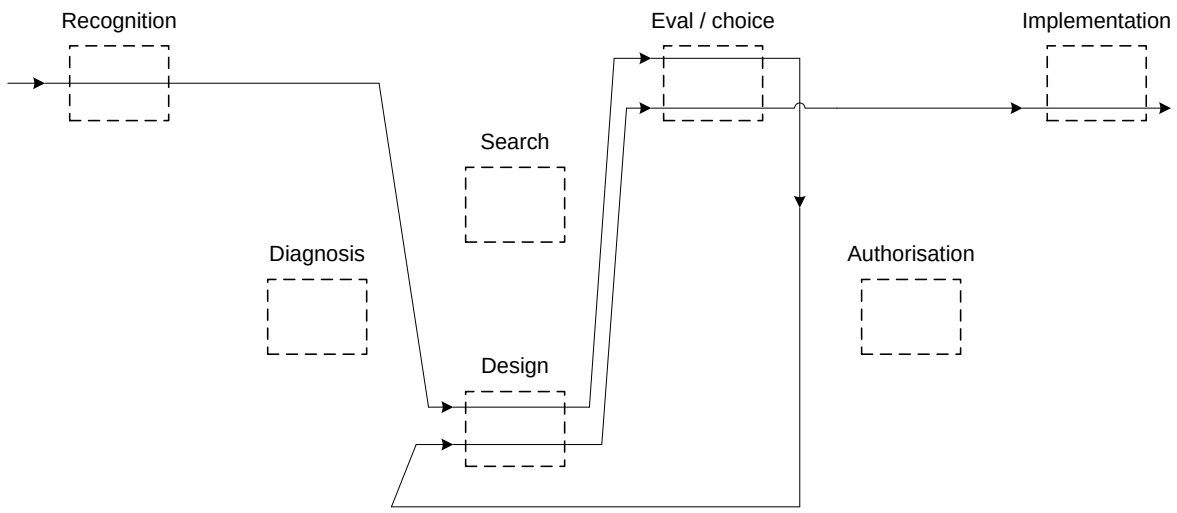
Routine in decision-making process	
Recognition	The idea of the modular house was to fabricate the elements in the factory and to assemble the semi-fabricated elements on the construction site. Based on this concept two requirements were formulated before designing the modular house: the semi-constructed elements had to be transported on roads and further the elements had to be easily assembled on the construction location.
Diagnosis	
Search	Firstly, the project group determined the dimensions of the modular house. The beech size of the house was first set at 4.80 meters. However, this beech size was too small; therefore the beech size was enlarged to 5.40 meters. After the determination of the beech size the next step was to determine the number of elements of the modular house. The project group designed two options: the first options consisted of 6 elements with a depth of 3 meters per element, while the second option consisted of 4 elements (depth of 4.50 meters).
Design	After the determination of the dimensions the material of the elements was determined. Because the materials could not be too heavy the project group decided to use thin concrete elements that were strengthened with small bars. The final step in the design process was the design of the roof of the modular house. In this phase it was suggested to use a triangular form and to build the outer leafs at the location.
Evaluation / choice	In this decision, several evaluations were applied to attain to the final design. In the first evaluation the beech size of the modular house was evaluated. After consultation between the group members it was decided not to opt for a beech size of 4.80 meters, but to use a beech size of 5.40 meters. The evaluation took place by making use of consultation and analysis.

	The second evaluation was focused on the layout of the modular house. The project group choose for the option that consisted of 6 elements, because these elements could be transported on the road. Again, the evaluation was carried out by using consultation and analysis. The third evaluation was used to evaluate the material of the elements. Ultimately, the choice was made to use thin concrete with small bars to provide extra strength. The evaluation took place through analysis and judgement. The fourth evaluation was related to the completion of the design. The choice was made to build a triagular roof in the factory and to build the outer leafs on the construction site. The evaluation took place by making use of bargaining.
Authorisation	
Implementation	The final design of the iQwoning® (name for the modular house) consists of 6 elements that have a beech size of 5.40 meters and a depth of 2.10 meters or 3.00 meters. The thickness of the walls is 120 mm and the thickness of the ceilings and floors is 85 mm.

3. Design of production process

Description of decision	The production of the iQwoning ® had to be designed differently compared to the traditional construction process, since iQwoning® is largely manufactured in the factory. The activities in the production process should be connected to each other to realize an efficient construction process. Eventually it was decided to fill the elements with self-compacting concrete and to inject the concrete from above. Further, the elements would be tilted after the injection of the concrete to be designed.
Phase in innovation process	■ Idea generation and selection □ Pilot project □ Development and testing □ Implementation and diffusion
Type of decision	□ Organizations ■ Operations □ Product □ Marketing
Involved organizations	• Projectgroep Red Bull o Ballast Nedam Bouwtechniek o Ballast Nedam Engineering o Ballast Nedam Research & Development o Hoco Beton
Decision making	□ Analysis ■ Judgement ■ Bargaining
Form	■ Extensive form □ Normal form
Cooperation	■ Cooperative game □ Non-cooperative game
Information	■ Imperfect information □ Perfect information
Game	□ Strategic game □ Extensive game with perfect information □ Extensive game with imperfect information ■ Coalitional game

Model of decision-making process



Routine in decision-making process	
Recognition	The concept of the iQwoning® is based on the idea that the elements of the house are manufactured in a factory. In comparison with a traditional building process, this means that a new type of production process had to be designed in order to produce the iQwoning®. The involved parties had to consider which activities are necessary in the production of the iQwoning® and also how these activities are connected with each other.
Diagnosis	
Search	
Design	The production process distinguished two types of activities: the production of the concrete elements and the assembly of these elements. In the design process it was proposed to pour the concrete elements lying instead of sanding. After the pouring the elements could be tilt, so that the elements could be designed. Regarding the pouring of the concrete elements, it was proposed to fill the elements with self-compacting concrete. The concrete could be injected from the top or from the bottom.
Evaluation / choice	It was decided by the parties to design a hydraulic system to tilt the concrete elements. The evaluation took place by using bargaining. Regarding the pouring of the concrete it was decided that the proposed self-compacting concrete would be used and that the concrete should be injected from above. Although it was considered to use an injection from the bottom, the injection from worked satisfactorily. The evaluation took place through judgement.
Authorisation	

Implementation	In the production process of the iQwoning® the concrete elements are poured lying and after the pouring the elements are tilted, so that the elements can be designed. In the further development of the production process it was decided to let the finishing of the the concrete elements occur in different parts of the factory. To do this the elements are transported through the factory. Previously, the elements were finished at a certain place in the factory, which meant that the employees continuously walked through the factory to finish the elements.

4. Design of business model

Description of decision	The concept of the iQwoning® is considered to be innovative, but price technically it was decided to approach the iQwoning® as a regular house. This means that the iQwoning® similar to a regular house can be sold or rent and that the prices are used as the prices of regular houses.
Phase in innovation process	☐ Idea generation and selection ■ Pilot project ☐ Development and testing ☐ Implementation and diffusion
Type of decision	☐ Organizations ☐ Operations ☐ Product ■ Marketing

Involved organizations	• Projectgroep Red Bull
	  o Ballast Nedam Bouwtechniek
	  o Ballast Nedam Engineering
	  o Ballast Nedam Research & Development
	  o Hoco Beton

Decision making	☐ Analysis ☐ Judgement ■ Bargaining
Form	■ Extensive form ■ Normal form
Cooperation	■ Cooperative game ☐ Non-cooperative game
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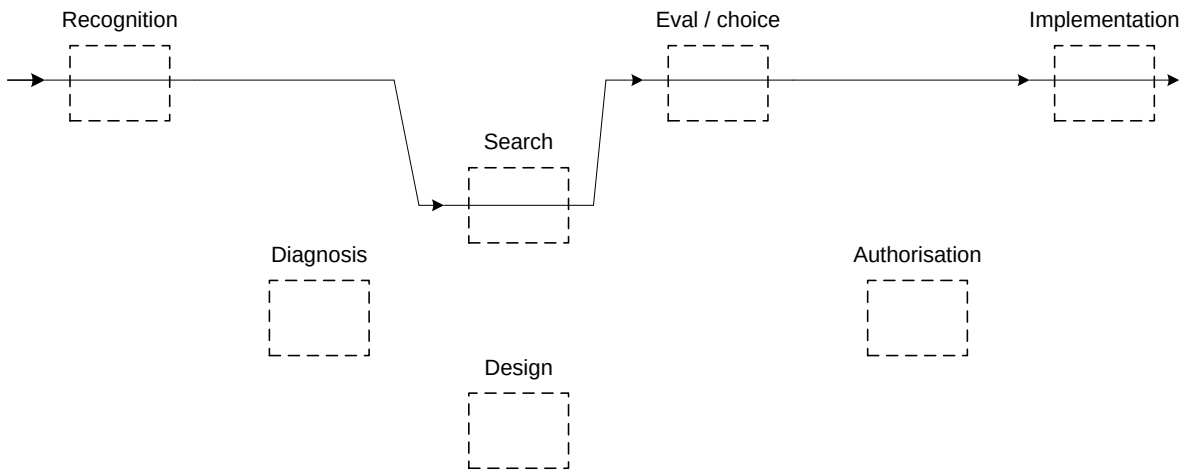
Model of decision-making process



Routine in decision-making process	
Recognition	The iQwoning® can be determined as an innovation concept due to the production method and the layout of the house. The concept provides benefits in terms of cost and time, since the iQwoning ® can be manufactured in the factory and it takes less time to assemble the house on the construction site.
Diagnosis	
Search	Although the iQwoning® is considered to be an innovative concept, the end user might see the iQwoning® as a regular house. Therefore it is important that the market regards the iQwoning as a regular house and that the business model of the iQwoning® is similar to the business models of regular houses.
Design	
Evaluation / choice	It was agreed to apply the same business model for the iQwoning® as for regular homes. The lower costs and the shorten construction time might affect the price, but will not affect the working of the model. The evaluation took place through bargaining.
Authorisation	
Implementation	The prices that are applicable for the iQwoning® are prices that are competitive with the prices of regular houses. Further, the same business model is used for the iQwoning® as for other houses.

5. Determination of market

Description of decision	A part of the production process of the iQwoning® occurs in the factory, which results in a reduction of construction time on the site and the costs that are involved. Due to the short construction time on the site and the relatively low market prices it was decided to focus on urban development projects, both new development as redevelopment projects, since this type of projects can use these advantages.
Phase in innovation process	☐ Idea generation and selection ■ Pilot project ☐ Development and testing ☐ Implementation and diffusion
Type of decision	☐ Organizations ☐ Operations ☐ Product ■ Marketing

Involved organizations	• Projectgroep Red Bull
	  ○ Ballast Nedam Bouwtechniek
	  ○ Ballast Nedam Engineering
	  ○ Ballast Nedam Research & Development
	  ○ Hoco Beton

Decision making	☐ Analysis ☐ Judgement ■ Bargaining
Form	■ Extensive form ☐ Normal form
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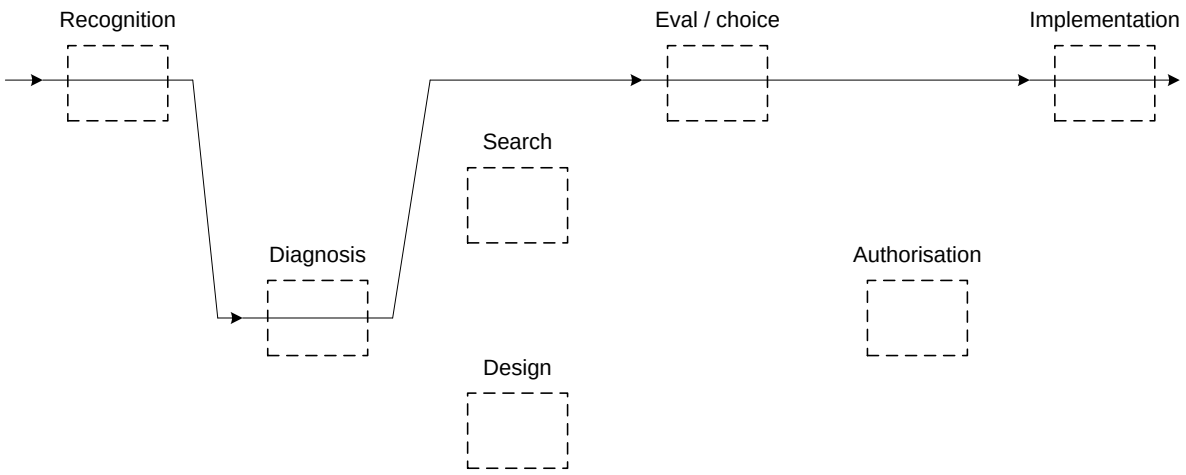
Model of decision-making process



Routine in decision-making process	
Recognition	Since a part of the production process of the iQwoning® occurs in the factory, it is possible to reduce the construction time on the site. Due to the construction time that is reduced, the nuisance is less, both in terms of the duration of the nuisance as the amount of nuisance.
Diagnosis	Further, it was noticed by the project group that there was a change in the purchase of houses. In the past houses were sold for more than € 500,000, but the change showed that houses were sold in a price range of € 200,000 and € 300,000. The price of the iQwoning® is within this price range, which makes it interesting for housing associations to purchase this type of houses for their development projects. The iQwoning® can be used in urban development projects as in redevelopment projects.
Search	
Design	
Evaluation / choice	Early in the decision-making process the focus regarding the determination was on the urban development projects, because in this type of projects the iQwoning ® could offer benefits in terms of a lower price and a reduced construction time. The evaluation was made based on bargaining.
Authorisation	
Implementation	Initially it was decided to focus first on urban development projects, but due to the economic crisis, the demand for new homes decreases, while the demand for rebuilding homes increased. This way the focus was from that moment also on redevelopment projects. Nevertheless, there was also the possibility to focus on both types of development projects.

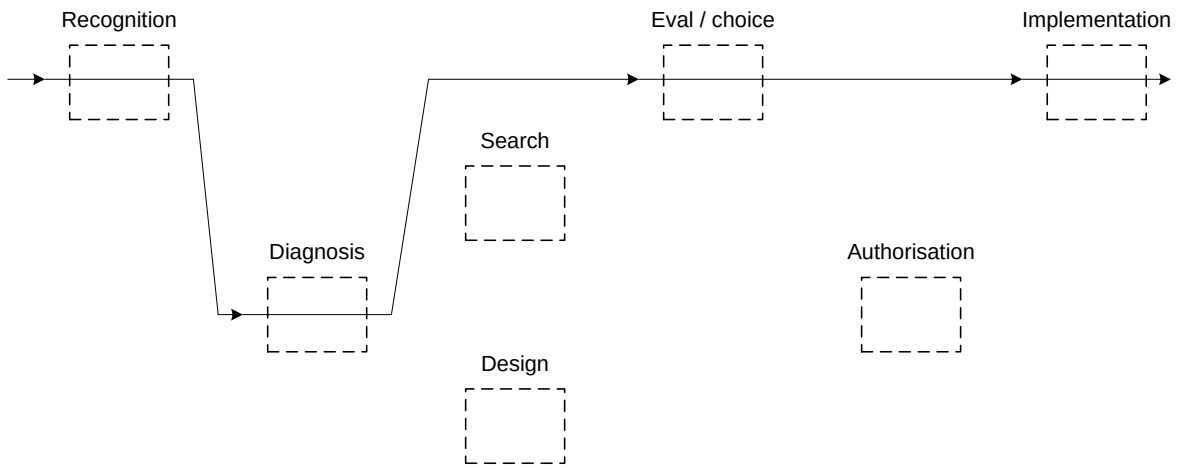
6. Pilot project Berckelbosch

Description of decision	After the concept of iQwoning ® was designed, the concept had to be tested in practice on the feasibility. It was then decided to perform the pilot project as part of the construction project Berckelbosch in Eindhoven. In this project, Ballast Nedam was involved as a developer to realize about 900 houses and due to its position in the construction project it was possible to realize the pilot project in this development project.
Phase in innovation process	☐ Idea generation and selection ■ Pilot project ☐ Development and testing ☐ Implementation and diffusion
Type of decision	☐ Organizations ■ Operations ☐ Product ☐ Marketing

Involved organizations	• Projectgroep Red Bull
	  ○ Ballast Nedam Bouwtechniek
	  ○ Ballast Nedam Engineering
	  ○ Ballast Nedam Research & Development
	  ○ Hoco Beton
	• Ballast Nedam Bouw & Ontwikkeling Zuid

Decision making	■ Analysis ☐ Judgement ■ Bargaining
Form	■ Extensive form ☐ Normal form
Cooperation	☐ Cooperative game ■ Non-cooperative game
Information	■ Imperfect information ☐ Perfect information
Game	☐ Strategic game ☐ Extensive game with perfect information ■ Extensive game with imperfect information ☐ Coalitional game

Model of decision-making process



Routine in decision-making process	
Recognition	After the design of the iQwoning® was realized the concept had to be tested in practice on the feasibility. The feasibility was in this case regarding the production of the elements and the assembly of the iQwoning® on the construction site.
Diagnosis	The project group analyzed the possibilities to execute the pilot project and based on this analysis the project Berckelbosch in Eindhoven was selected. The project Berckelbosch was a construction project of Ballast Nedam Bouw & Ontwikkeling Zuid to realize 900 houses. Since BNBO Zuid was the developer it was possible to realize several iQwoning's®.
Search	
Design	
Evaluation / choice	Eventually it was decided by the project group in consultation with Ballast Nedam Bouw & Ontwikkeling Zuid to perform the pilot project within the boundaries of the construction project Berckelbosch in Eindhoven. The pilot project would consist of the realization of five iQwoning's®. The evaluation regarding the choice of the pilot project within the project Berckelbosch occurred through analysis and bargaining.
Authorisation	
Implementation	In 2009 the concrete elements for the 5 iQwoning's® were produced and in October of that year the 5 houses were realized in Eindhoven. All five were sold quickly, although the 5th iQwoning® was used as a model home to show future customers the opportunities of the iQwoning®.

7. Factory for production iQwoning®

Description of decision	After the decision was made to proceed with the innovation process, the next decision was regarding the production of the iQwoning®. For the pilot project was still using the factory of Hoco Beton, but for a full-fledged production a new factory was necessary. Finally the decision was made to build a new factory for the production of the iQwoning®. The factory is built in Weert, in the vicinity of the factory of Hoco Beton, and is operational from April, 2010.
Phase in innovation process	☐ Idea generation and selection ☐ Pilot project ■ Development and testing ☐ Implementation and diffusion
Type of decision	☐ Organizations ■ Operations ☐ Product ☐ Marketing
Involved organizations	• Ballast Nedam Bouw & Ontwikkeling • Hoco Beton
Decision making	■ Analysis ☐ Judgement ☐ Bargaining
Form	■ Extensive form ☐ Normal form
Cooperation	☐ Cooperative game ■ Non-cooperative game
Information	■ Imperfect information ☐ Perfect information
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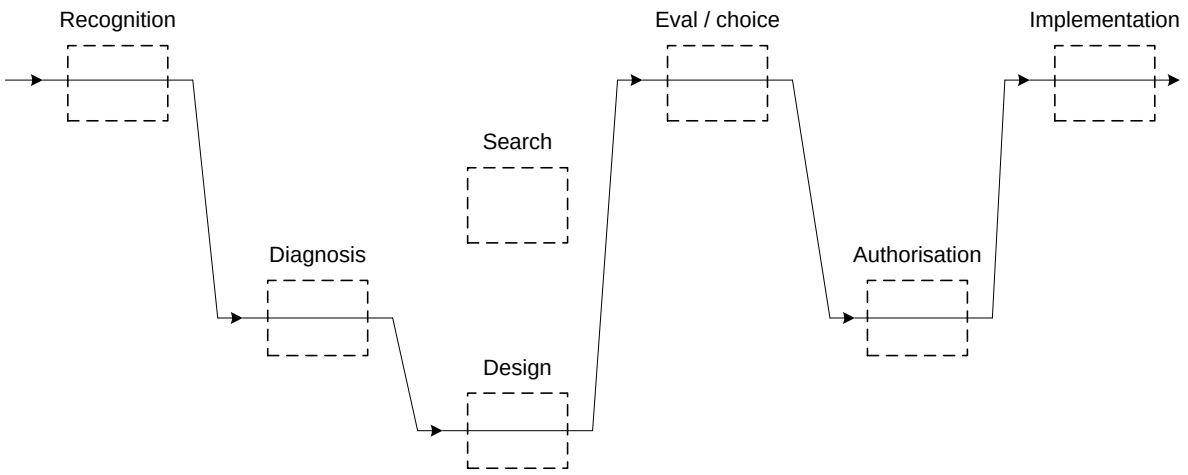
Model of decision-making process

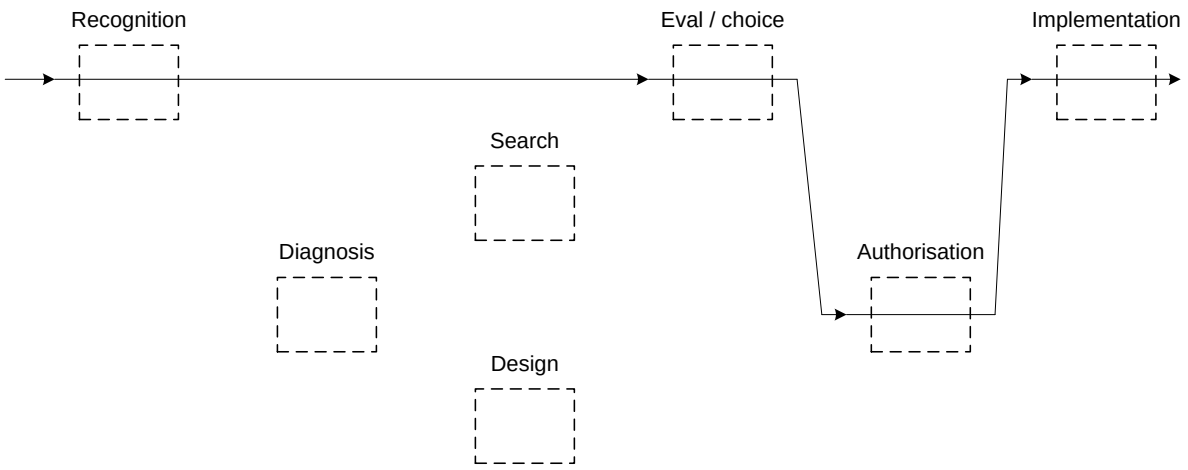


Routine in decision-making process	
Recognition	After the decision was made to proceed with the innovation process, the next decision was regarding the production of the iQwoning®.
Diagnosis	The concrete elements that were used in the pilot project in Berckelbosch were produced in the factory of Hoco Beton, but for a full production of concrete elements the factory of Hoco Beton could not be used. Therefore, Ballast Nedam had to look for a new location to produce the concrete elements of the iQwoning®.
Search	
Design	For the location of the factory for the production of the concrete elements of the iQwoning ® two options were developed. The first option was to expand the factory of Hoco Beton with an additional hall where the production of the iQwoning ® should occur. The second option was to build a new factory, possibly in the vicinity of the factory of Hoco Beton in Weert. This factory would be fully equipped to produce the iQwoning®.
Evaluation / choice	After consultation between the parties the decision was made to build a new factory, which would be built in the vicinity of the existing factory of Hoco Beton in Weert. Further, it was decided that the new factory would only be used for the production of elements of the iQwoning® to keep the production process separate of other production processes. The evaluation and selection has taken place through bargaining.
Authorisation	The decision was authorized by the Board of Ballast Nedam Bouw & Ontwikkeling.
Implementation	The new factory is built next to the existing factory Hoco Concrete in Weert. From 1 April 2011, the factory is operational and the concrete elements for the iQwoning® are produced. The concrete for the elements is provided by Hoco Beton.

8. Founding of IQ Woning B.V.

Description of decision	Parallel to the decision to build a new factory for the production of the iQwoning® the decision was made to found a new entity that is responsible for the production and supply of the iQwoning®. In 2010 the entity IQ Woning B.V. was founded and it is part of the division Ballast Nedam Toelevering.
Phase in innovation process	☐ Idea generation and selection ☐ Pilot project ■ Development and testing ☐ Implementation and diffusion
Type of decision	■ Organizations ☐ Operations ☐ Product ☐ Marketing
Involved organizations	• Ballast Nedam Bouw & Ontwikkeling • Ballast Nedam Toelevering
Decision making	☐ Analysis ☐ Judgement ■ Bargaining
Form	■ Extensive form ☐ Normal form
Cooperation	☐ Cooperative game ■ Non-cooperative game
Information	■ Imperfect information ☐ Perfect information
Game	☐ Strategic game ☐ Extensive game with perfect information ■ Extensive game with imperfect information ☐ Coalitional game

Model of decision-making process

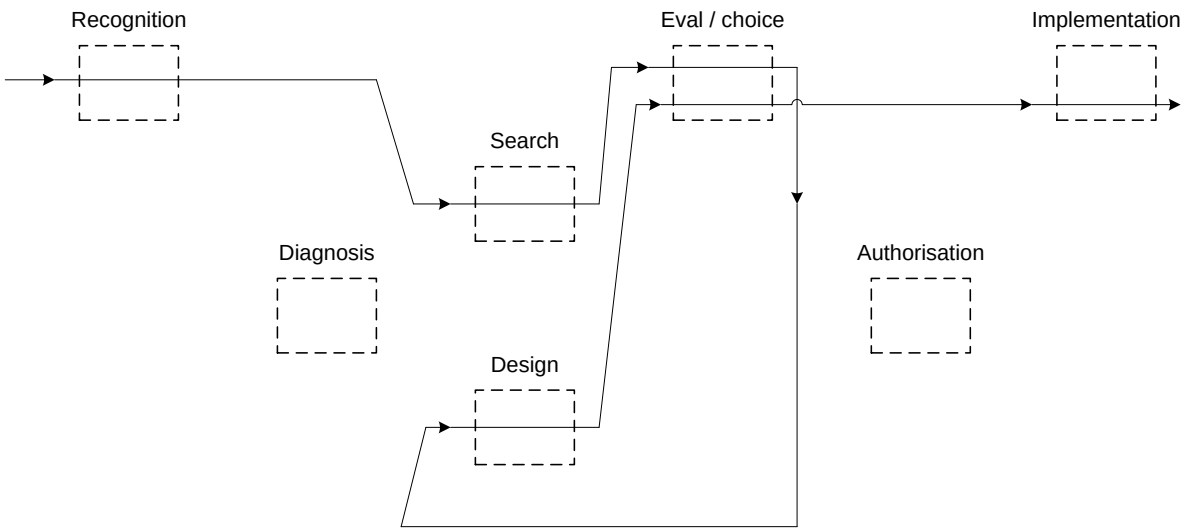


Routine in decision-making process	
Recognition	Parallel to the decision to build a new factory for the production of the iQwoning® the decision was made to found a new entity that is responsible for the production of the iQwoning®. One reason to found a new organization was that the production process was focused on the production of the iQwoning. Another reason was that the new organization was not directly related to Ballast Nedam. The idea behind this reason was that other players on the market would be less reluctant to buy elements of the iQwoning® if the name Ballast Nedam was associated with the iQwoning®.
Diagnosis	
Search	
Design	
Evaluation / choice	Finally, the decision was made to found the entity IQ Woning B.V. IQ Woning B.V. would be a subsidiary of the division Ballast Nedam Toelevering, since the entity would deliver concrete elements to divisions of Ballast Nedam, but also to external parties.
Authorisation	The decision was authorized by the Board of Ballast Nedam Bouw & Ontwikkeling.
Implementation	In 2010 the entity IQ Woning B.V. was founded and from that moment it is part of the division Ballast Nedam Toelevering. Koos Pijnenburg is from October 1, 2010 the director of the entity.

9. Improvement in production process

Description of decision	The iQwoning® is designed as a modular product. The production was initially arranged according to a traditional construction process. To be more efficient the production process is adjusted to a process that is more in line with the type of product that will be realized.
Phase in innovation process	☐ Idea generation and selection ☐ Pilot project ■ Development and testing ☐ Implementation and diffusion
Type of decision	☐ Organizations ■ Operations ☐ Product ☐ Marketing
Involved organizations	• IQ Woning B.V.
Decision making	■ Analysis ■ Judgement ☐ Bargaining
Form	☐ Extensive form ■ Normal form
Cooperation	☐ Cooperative game ■ Non-cooperative game
Information	■ Imperfect information ☐ Perfect information
Game	■ Strategic game ☐ Extensive game with perfect information ☐ Extensive game with imperfect information ☐ Coalitional game

Model of decision-making process

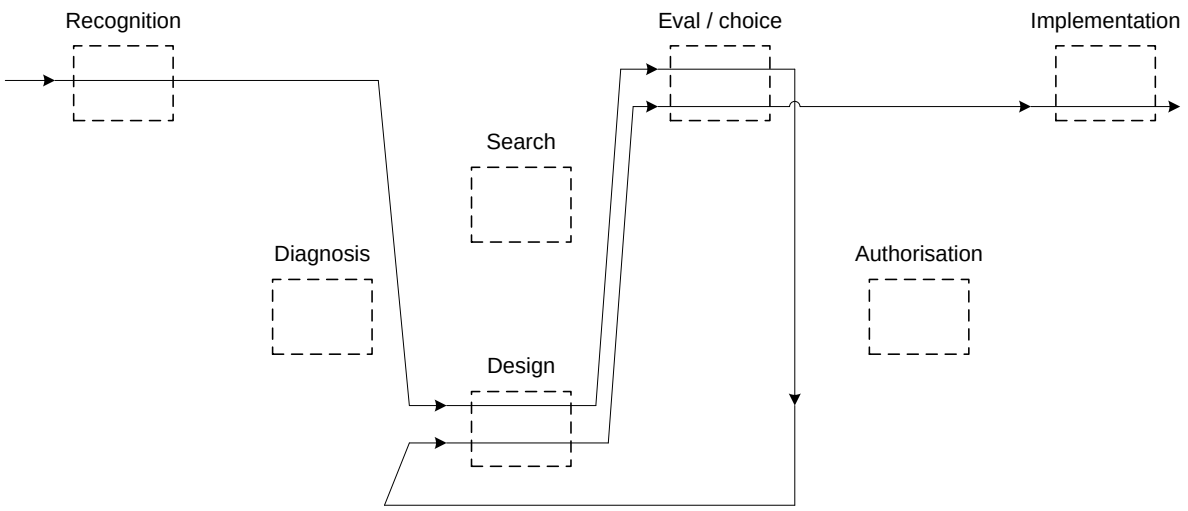


Routine in decision-making process	
Recognition	After the completion of the factory that would produce the elements of the iQwoning® it became clear that the production process was managed in an inefficient way. Because of the advantages that the iQwoning® offered the entity IQ Woning B.V. looked at other possibilities to manage the production process.
Diagnosis	
Search	For the new design of the production process of the iQwoning® other production processes of modular products are examined. The other production processes that were examined were processes in the construction industry and the automotive industry.
Design	A graduate studied again the original production process of the iQwoning®, but also examined the production processes of other companies. Based on these analyses a new production process was proposed.
Evaluation / choice	The studied production processes of the construction company and the automotive company gave IQ Woning B.V. insights how a production process could be arranged, but did not offer the design of a new production process. The first evaluation took place through bargaining. The second evaluation evaluated the design of the production process proposed by the graduate student. This production process was designed for the production of the iQwoning® and met all the requirements. Based on this evaluation the decision was made to rearrange the production process according to the design of the graduate. The evaluation took place by making use of bargaining.
Authorisation	
Implementation	The proposed production process is implemented so that the production process is more in line with the advantages of producing the iQwoning®. Improvements in the production process are still made. These improvements are presented by the management and the employees.

10. Improvement of reinforcement

Description of decision	In the first series of concrete elements it seemed that the reinforcement was not properly designed. At some points in the elements there were problems with the concrete (cracks, etc.), while at other points in the elements the reinforcement was oversized. Ultimately, the reinforcement was improved. The problems did no longer occur and the reinforcement steel was used more efficiently.
Phase in innovation process	☐ Idea generation and selection ☐ Pilot project ■ Development and testing ☐ Implementation and diffusion
Type of decision	☐ Organizations ☐ Operations ■ Product ☐ Marketing
Involved organizations	•
Decision making	■ Analysis ☐ Judgement ■ Bargaining
Form	☐ Extensive form ■ Normal form
Cooperation	☐ Cooperative game ■ Non-cooperative game
Information	■ Imperfect information ☐ Perfect information
Game	■ Strategic game ☐ Extensive game with perfect information ☐ Extensive game with imperfect information ☐ Coalitional game

Model of decision-making process



Routine in decision-making process	
Recognition	In the first series of concrete elements it seemed that the reinforcement was not properly designed. At some points in the elements there were problems with the concrete (cracks, etc.), while at other points in the elements the reinforcement was oversized.
Diagnosis	
Search	
Design	Initially, a constructor of Ballast Nedam Engineering tried to improve the reinforcement. However, due to the fact the constructor was not familiar with the software program that was used, changes could not be made. An external constructor was then approached to institute the changes. This constructor was capable of working with the software program and was able to identify the problems and to institute the changes in the design of the elements.
Evaluation / choice	In the first evaluation it was put forward that the constructor of Ballast Nedam Engineering was not able to identify the problems and to institute changes in the design. The evaluation took place through bargaining. In the second evaluation the proposed new designs of the elements, made by the external constructor, were evaluated. In this evaluation it was showed that the identified problems in the models matched the problems that were identified in practice. Based on this evaluation, the proposed designs were implemented. The evaluation took place by making use of analysis.
Authorisation	
Implementation	The proposed changes in the reinforcement were implemented. The previous problems did no longer occur and the reinforcement steel was used more efficiently.

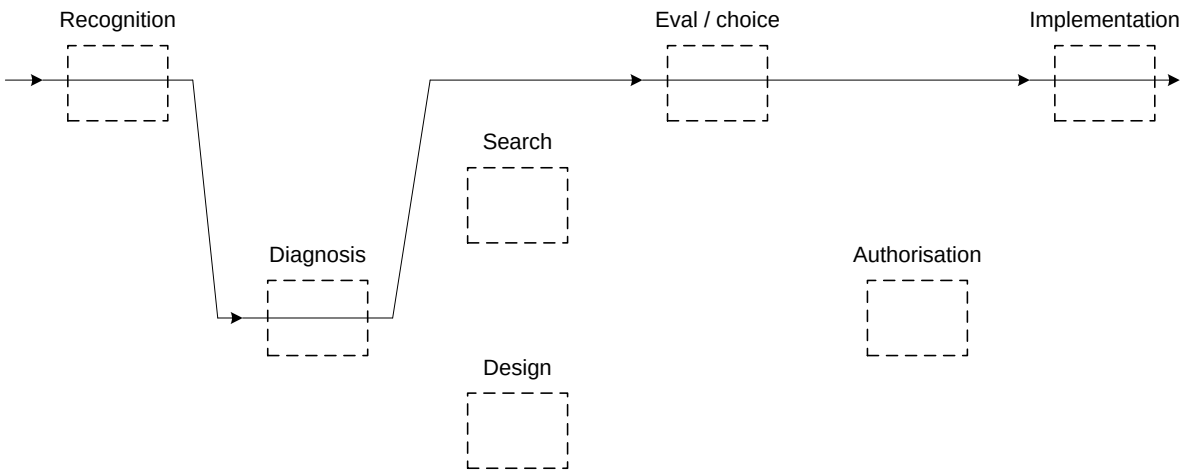
11. Start of iQteam

Description of decision	The organization IQ Woning B.V. proposed to set up a team that would be responsible for the commercialization of the iQwoning®. After consultation between IQ Woning B.V. and the directors of the regions a team was designed that consists of commercial managers of the regions and managers of IQ Woning B.V.
Phase in innovation process	☐ Idea generation and selection ☐ Pilot project ☐ Development and testing ■ Implementation and diffusion
Type of decision	■ Organizations ☐ Operations ☐ Product ☐ Marketing

Involved organizations	• IQ Woning B.V.
	• Ballast Nedam Bouw & Ontwikkeling
	• Regio's Ballast Nedam Bouw & Ontwikkeling
	  ○ NoordWest
	  ○ West
	  ○ Zuid
	  ○ Midden
	  ○ Noord
	  ○ Laudy Bouw & Ontwikkeling
	  ○ Heddes Bouw & Ontwikkeling

Decision making	☐ Analysis ☐ Judgement ■ Bargaining
Form	■ Extensive form ☐ Normal form
Cooperation	☐ Cooperative game ■ Non-cooperative game
Information	■ Imperfect information ☐ Perfect information
Game	☐ Strategic game ☐ Extensive game with perfect information ■ Extensive game with imperfect information ☐ Coalitional game

Model of decision-making process



Routine in decision-making process	
Recognition	The organization IQ Woning B.V. proposed to set up a team that would be responsible for the commercialization of the iQwoning®. IQ Woning B.V. approached the directors of the regions to assign a person that is responsible for the acquisition of the iQwoning® in the region.
Diagnosis	After consultation between IQ Woning B.V. and the directors of the regions it became clear that the team that would commercialize the iQwoning should consist of employees of both the IQ Woning B.V. and the regions.
Search	
Design	
Evaluation / choice	After consultation between IQ Woning B.V. and the directors of the region a proposal was made how the team would look like. From each region of Ballast Nedam a commercial manager would be appointed to the team and also from the IQ Woning B.V. some managers are involved in this team. The evaluation took place by making use of bargaining.
Authorisation	
Implementation	The iQ-team that is responsible for the commercialization of the iQwoning® consists of 11 people: 8 commercial managers of the regions, a sales manager of IQ Woning B.V., a plan developer and the director of IQ Woning B.V. Further, the commercial managers are supported by technical employees regarding the involved engineering and the development of the projects.

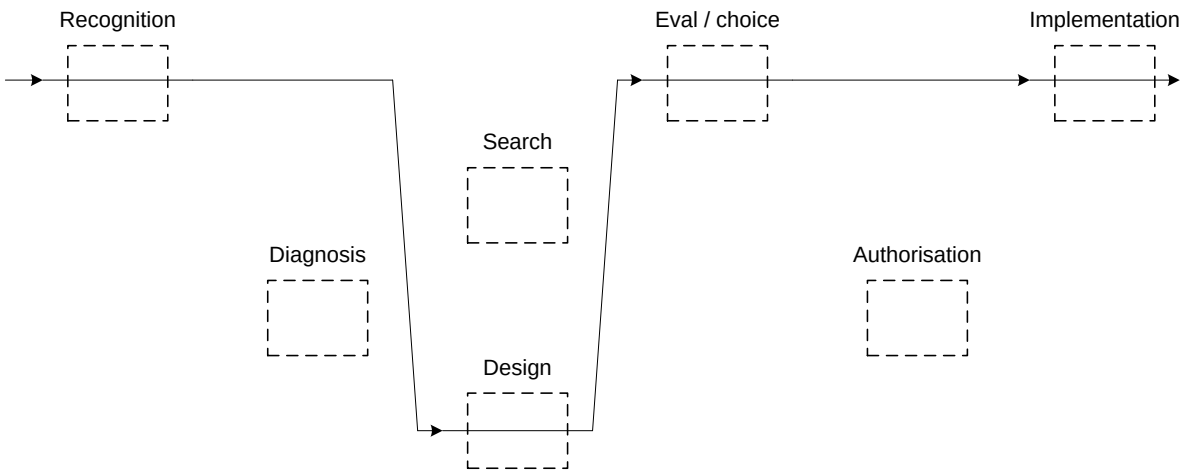
12. Adjustment in performing acquisition

Description of decision	The development of the iQwoning® resulted not only in an innovative product, but also in a new construction process, both in time and costs. Due to the new type of construction process the perspective have to change regarding the way of building and the calculation of the price, but also the perspective have to change from a short term perspective to a long term perspective. A group of 8 commercial managers use the concept of the iQwoning® for performing both cold and warm acquisition.
Phase in innovation process	☐ Idea generation and selection ☐ Pilot project ☐ Development and testing ■ Implementation and diffusion
Type of decision	☐ Organizations ☐ Operations ☐ Product ■ Marketing

Involved organizations	• IQ Woning B.V.
	• Ballast Nedam Bouw & Ontwikkeling
	• Regio's Ballast Nedam Bouw & Ontwikkeling
	  ○ NoordWest
	  ○ West
	  ○ Zuid
	  ○ Midden
	  ○ Noord
	  ○ Laudy Bouw & Ontwikkeling
	  ○ Heddes Bouw & Ontwikkeling

Decision making	☐ Analysis ☐ Judgement ■ Bargaining
Form	■ Extensive form ☐ Normal form
Cooperation	■ Cooperative game ☐ Non-cooperative game
Information	■ Imperfect information ☐ Perfect information
Game	☐ Strategic game ☐ Extensive game with perfect information ☐ Extensive game with imperfect information ■ Coalitional game

Model of decision-making process

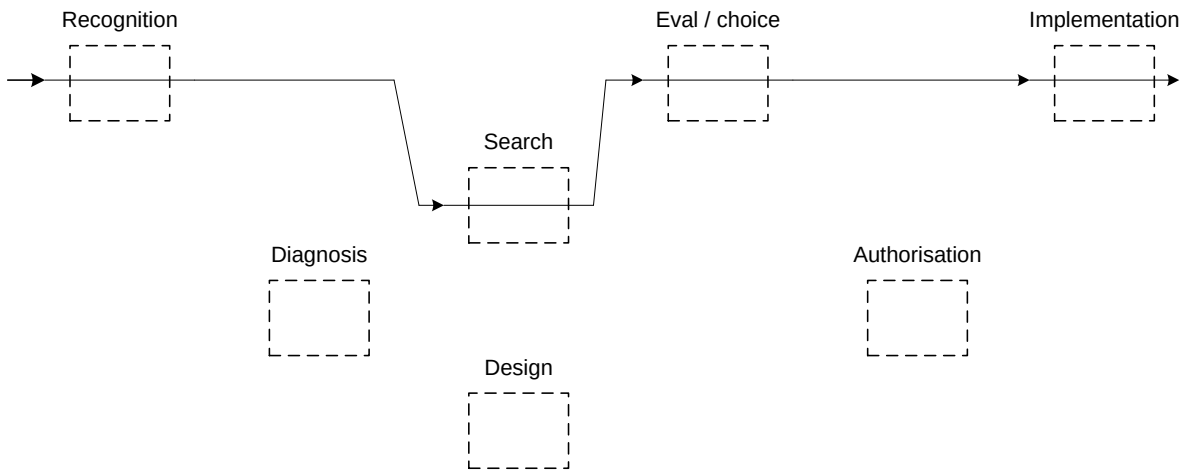


Routine in decision-making process	
Recognition	The development of the iQwoning® resulted not only in an innovative product, but also in a new construction process, both in time and costs. Due to the new type of construction process the perspective have to change regarding the way of building and the calculation of the price, but also the perspective have to change from a short term perspective to a long term perspective.
Diagnosis	
Search	
Design	From the IQ Woning B.V. and the regions of Ballast Nedam a proposal is made in which the commercial managers spend two days in the week to the commercialization of the iQwoning® and use the other three days for other projects.
Evaluation / choice	After consultation between IQ Woning B.V. and the regions the decision was made that 8 commercial managers will work two days in the week as commercial managers of the iQwoning and the other days in the week are used for other projects. Together with this proposal objectives are determined regarding the sales of the iQwoning®.
Authorisation	
Implementation	The 8 commercial managers use the concept of the iQwoning® both for cold and warm acquisition. Potential clients are approached by making use of the iQwoning®, while the existing clients are approached to turn short-term relations into long-term relations.

13. Adjustment of responsibilities of iQteam

Description of decision	In a number of projects that were executed some uncertainties and flaws were identified regarding the division of tasks of the iQ-team. As a result the division of tasks is adjusted. The IQ Woning B.V. became responsible for the production and transport of the elements, while the regions became responsible for the assembly of the elements and the commercialization of the iQwoning®.
Phase in innovation process	☐ Idea generation and selection ☐ Pilot project ☐ Development and testing ■ Implementation and diffusion
Type of decision	■ Organizations ☐ Operations ☐ Product ☐ Marketing
Involved organizations	• IQ Woning B.V. • Ballast Nedam Bouw & Ontwikkeling • Regio's Ballast Nedam Bouw & Ontwikkeling o NoordWest o West o Zuid o Midden o Noord o Laudy Bouw & Ontwikkeling o Heddes Bouw & Ontwikkeling
Decision making	☐ Analysis ☐ Judgement ■ Bargaining
Form	■ Extensive form ☐ Normal form
Cooperation	■ Cooperative game ☐ Non-cooperative game
Information	■ Imperfect information ☐ Perfect information
Game	☐ Strategic game ☐ Extensive game with perfect information ☐ Extensive game with imperfect information ■ Coalitional game

Model of decision-making process

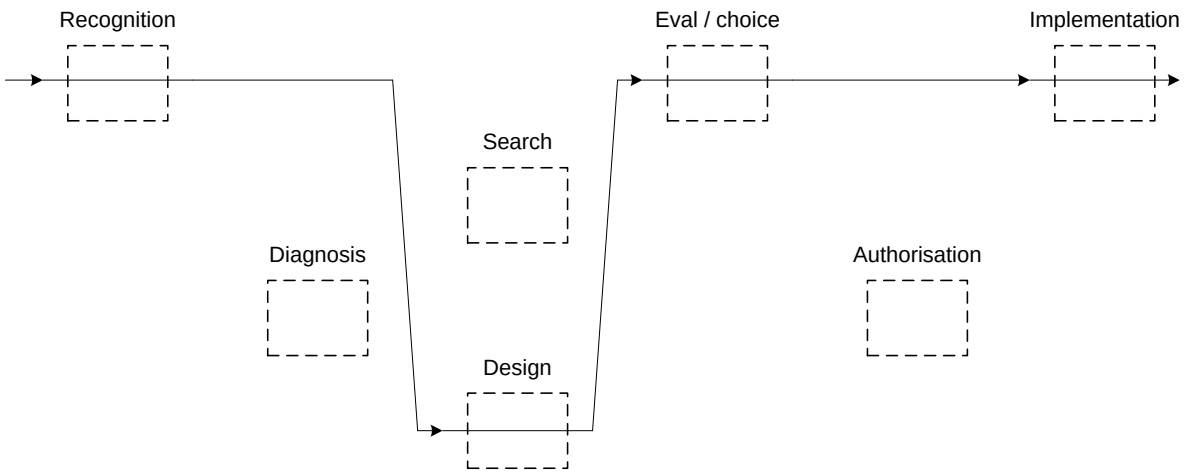


Routine in decision-making process	
Recognition	Based on a number of projects that were executed some uncertainties and flaws were identified regarding the division of tasks between the involved parties in the iQ-team. To avoid these uncertainties and flaws in future project the division of tasks had to be revised.
Diagnosis	
Search	The earlier projects showed that IQ Woning B.V. should be responsible for the production and the transport of the elements, while the regions should be responsible for the assembly of the elements on the construction site. Regarding the commercialization the regions should be the leading parties, because the regions stand closer to the (future) clients.
Design	
Evaluation / choice	The new division of tasks was based on the projects that were earlier executed. IQ Woning B.V. would be responsible for the production and the transport of the elements of the iQwoning®, while the regions of Ballast Nedam were responsible for the assembly of the elements and the completion of the iQwoning®. Further, the commercial managers in the regions became responsible for the commercialization of the iQwoning®. The evaluation took place through bargaining.
Authorisation	
Implementation	The new division of tasks will be used in future projects, but the division is considered to be dynamic, which means that in case of uncertainties or flaws the division can be adjusted.

14. Addition of new type of iQwoning®

Description of decision	To enter new market segments with the concept of the iQwoning® larger elements had to be realized. To produce larger elements the beech size had to be increased. After consultation with experts within the organization the decision was made to produce a mold with a beech size of 6.30 meters.
Phase in innovation process	☐ Idea generation and selection ☐ Pilot project ☐ Development and testing ☐ Implementation and diffusion
Type of decision	☐ Organizations ☐ Operations ■ Product ☐ Marketing
Involved organizations	• Ballast Nedam Bouw & Ontwikkeling • IQ Woning B.V.
Decision making	■ Analysis ☐ Judgement ■ Bargaining
Form	■ Extensive form ☐ Normal form
Cooperation	☐ Cooperative game ■ Non-cooperative game
Information	■ Imperfect information ☐ Perfect information
Game	☐ Strategic game ☐ Extensive game with perfect information ■ Extensive game with imperfect information ☐ Coalitional game

Model of decision-making process



Routine in decision-making process	
Recognition	To enter new market segments with the concept of the iQwoning® the beech size had to be increased, because with the original beech size the surface was too small to satisfy the needs and requirements of new market segments.
Diagnosis	
Search	
Design	After consultation with experts of Ballast Nedam and IQ Woning B.V. the proposal was made to create a mold with a beech size of 6.30 meters. With a beech size of 6.30 meters the surface is larger, which offers more opportunities regarding the interior design and ultimately offers more opportunities to satisfy the needs and requirements of potential customers in the new market segments.
Evaluation / choice	On basis of the consultation with the experts the choice is made to create a mold with a beech size of 6.30 meters. The evaluation took place through analysis and bargaining.
Authorisation	
Implementation	At this time the molds with a beech size of 6.30 meters, which offers the possibility to approach new market segments. These new market segments can now be approach, because now elements with a larger surface can be produced.

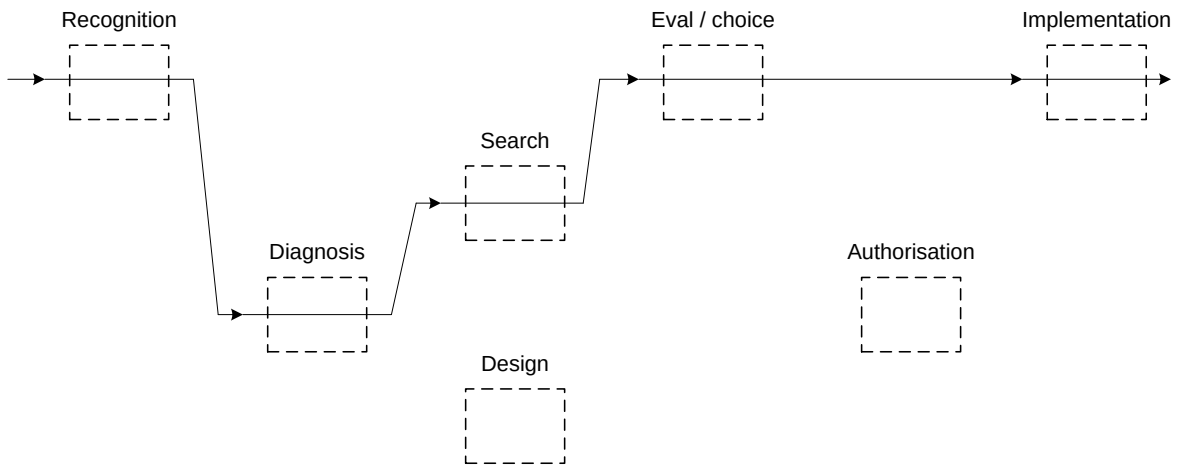
15. Development of iQconcept

Description of decision	Due to the beech size of 5.40 meters it was not possible to enter new market segments, because the needs and requirements of these segments could not be satisfied. By creating an element with a beech size of 6.30 it was possible to enter new market segments, in this case the market of life-proof houses.
Phase in innovation process	☐ Idea generation and selection ☐ Pilot project ☐ Development and testing ■ Implementation and diffusion
Type of decision	☐ Organizations ☐ Operations ☐ Product ■ Marketing

Involved organizations	• IQ Woning B.V.
	• Ballast Nedam Bouw & Ontwikkeling
	• Regio's Ballast Nedam Bouw & Ontwikkeling
	  ○ NoordWest
	  ○ West
	  ○ Zuid
	  ○ Midden
	  ○ Noord
	  ○ Laudy Bouw & Ontwikkeling
	  ○ Heddes Bouw & Ontwikkeling

Decision making	☐ Analysis ☐ Judgement ■ Bargaining
Form	■ Extensive form ☐ Normal form
Cooperation	■ Cooperative game ☐ Non-cooperative game
Information	■ Imperfect information ☐ Perfect information
Game	☐ Strategic game ☐ Extensive game with perfect information ☐ Extensive game with imperfect information ■ Coalitional game

Model of decision-making process



Routine in decision-making process	
Recognition	In an earlier stage of the process the market segments of the original iQwoning® were identified: buyers, renters, students and MOE-landers (migrant workers from Central and Eastern European countries). However, new market segments could not be approach with the dimensions of the original iQwoning®.
Diagnosis	The original beech size of 5.40 meters offered not the possibilities to approach new market segments. However, with the beech size of 6.30 meters elements with a larger surface could be produced and new market segments could be entered.
Search	Based on the opportunities that the elements with a beech size of 6.30 meters offered three new markets segments are identified: elderly people as end users, buyers of two in one-house and recreation parks as purchaser.
Design	
Evaluation / choice	Based on the search routine three market segments are selected that can be entered now the beech size is enlarged. The evaluation took place through bargaining.
Authorisation	
Implementation	At this moment, new molds are produced with a beech size of 6.30 meters. This way life-proof houses, two in one-houses and houses on a recreation park can be realized. However, there is also stated that now new segments will be identified or added to the current market segments. The choice is made to focus first on the production process of the iQwoning® and the current market segments.

11.7 Appendix G: Decisions in ModuPark

11.7.1 Overview of decisions

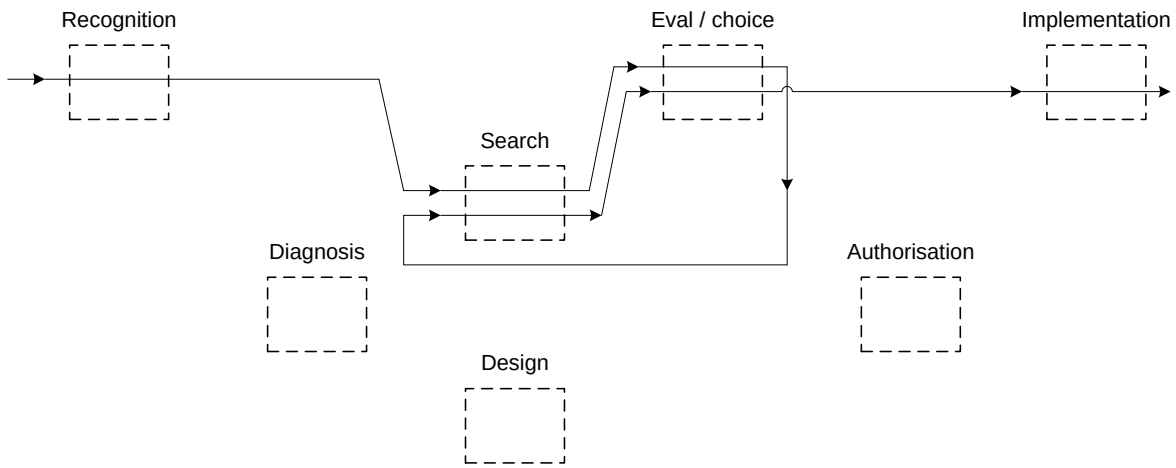
1. Cooperation between Ballast Nedam Infra Projecten, Grontmij Parkconsult and ParkMasters
2. Concept of the solution for temporary parking problems
3. Design of a modular car park
4. Determination of the types of customers
5. Founding of Ballast Nedam Parking v.o.f.
6. Design of business model
7. Founding of ModuPark v.o.f.
8. Expansion of the design with additional parking deck
9. Improvement of temporary fastening
10. Improvement of lateral load distribution
11. Defining the types of end users
12. Determination of new types of customers

11.7.2 Description of decisions

1. Cooperation between Ballast Nedam Infra Projecten, Grontmij Parkconsult and ParkMasters

Description of decision-making process	
Description of decision	Ballast Nedam Infra Projecten, Grontmij Parkconsult and ParkMasters decided to cooperate in the generation of ideas for the temporary parking problems. All the three organizations brought specific knowledge into the cooperation that was thought would be useful for the development of a solution for the temporary parking problems.
Phase in innovation process	■ Idea generation and selection □ Pilot project □ Development and testing □ Implementation and diffusion
Type of decision	■ Organizations ■ Operations □ Product □ Marketing
Involved organizations	• Ballast Nedam Infra Projecten • Grontmij Parkconsult • ParkMasters
Decision making	□ Analysis □ Judgement ■ Bargaining
Form	■ Extensive form □ Normal form
Cooperation	□ Cooperative game ■ Non-cooperative game
Information	■ Imperfect information □ Perfect information
Game	□ Strategic game □ Extensive game with perfect information ■ Extensive game with imperfect information □ Coalitional game

Model of decision-making process

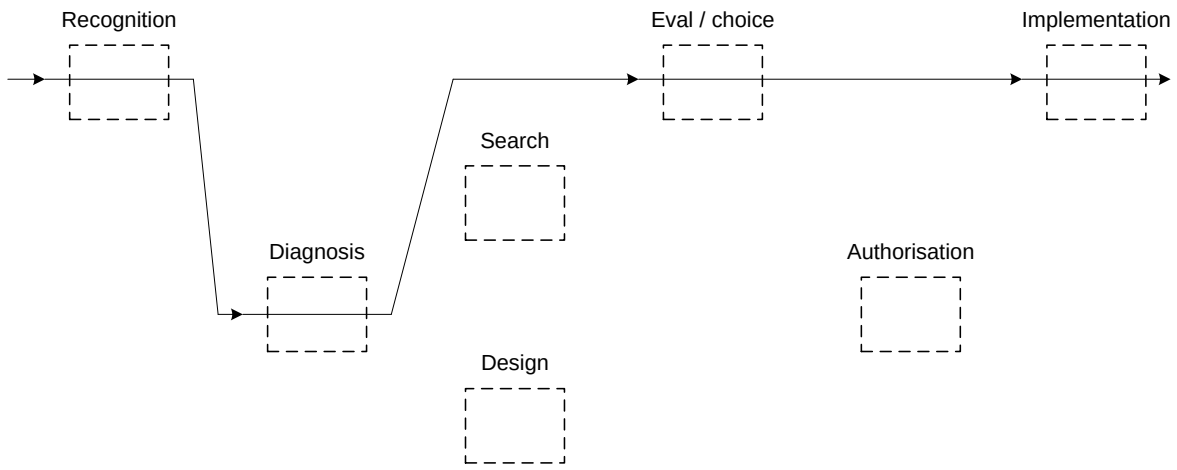


Routine in decision-making process	
Recognition	Ballast Nedam Infra Projecten detected a business opportunity in the field of temporary parking, but as a constructor it had only the knowledge to design solutions for parking problems. The knowledge regarding policies and legalisation about parking was not present within the organization and to be found outside the organization.
Diagnosis	
Search	At first Ballast Nedam Infra Projecten was approached by Grontmij Parkconsult with the question to cooperate in generating solutions for the temporary parking problems. Grontmij Parkconsult is an engineering agency and had knowledge regarding policy and legalisation about parking. After a first evaluation about the possible cooperation ParkMasters is approached to join the collaboration. The reason to approach ParkMasters was because of their knowledge in the commercialization of parking solutions.
Design	
Evaluation / choice	In the first evaluation Ballast Nedam Infra Projecten and Grontmij Parkconsult agreed to cooperate in generating a solution for temporary parking problems. However, both organisations agreed that knowledge about the commercialization of parking solutions was missing. The evaluation took place through bargaining. In the second evaluation the three organizations (Ballast Nedam Infra Projecten, Grontmij Parkconsult and ParkMasters) agreed to jointly develop solutions for temporary parking problems and to commercialize these solutions. The evaluation took place through bargaining.
Authorisation	
Implementation	Ballast Nedam Infra Projecten, Grontmij Parkconsult and ParkMasters developed together a solution for the temporary parking problems (ModuPark®) and commercialized this solution.

2. Concept of the solution for temporary parking problems

Description of decision-making process	
Description of decision	Ballast Nedam Infra Projecten and Grontmij Parkconsult had independent of each other identified a demand for a solution in the field of temporary parking. Together with ParkMasters the two organizations determined the preconditions of the solution for this demand and developed the concept of the solution for temporary parking problems.
Phase in innovation process	■ Idea generation and selection □ Pilot project □ Development and testing □ Implementation and diffusion
Type of decision	□ Organizations □ Operations ■ Product □ Marketing
Involved organizations	• Ballast Nedam Infra Projecten • Grontmij Parkconsult • ParkMasters
Decision making	□ Analysis □ Judgement ■ Bargaining
Form	■ Extensive form □ Normal form
Cooperation	■ Cooperative game □ Non-cooperative game
Information	■ Imperfect information □ Perfect information
Game	□ Strategic game □ Extensive game with perfect information □ Extensive game with imperfect information ■ Coalitional game

Model of decision-making process

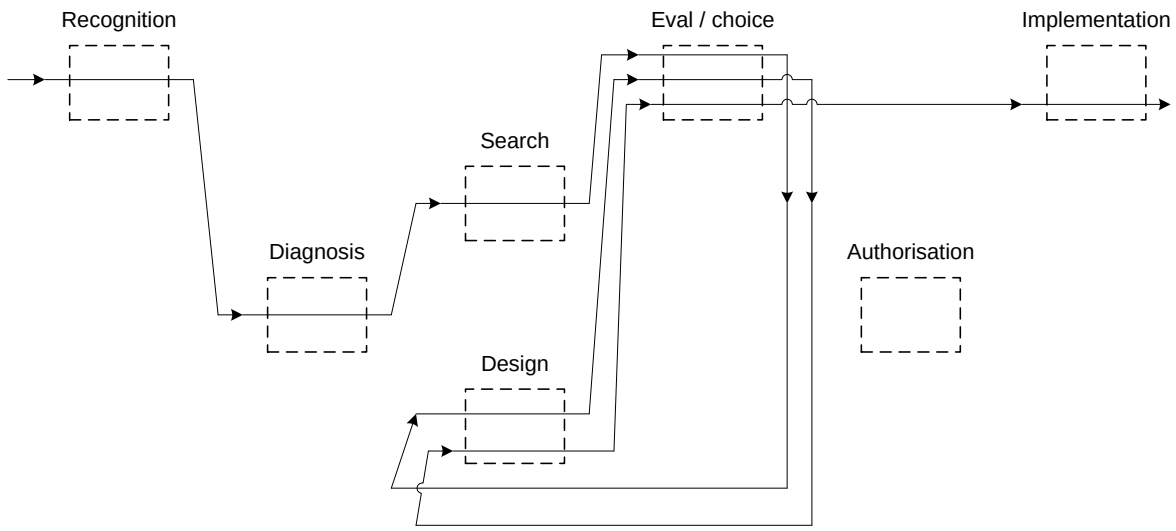


Routine in decision-making process	
Recognition	Ballast Nedam Infra Projecten and Grontmij Parkconsult had independent of each other identified a demand for a solution in the field of temporary parking since at that time there were no effective solutions for this problem.
Diagnosis	The three organizations divided the temporary parking problem into short-lasting parking problems and long-lasting parking problems. Parking problems of the first type can be found at events, while long-lasting parking problems are found in urban (re)developments.
Search	
Design	
Evaluation / choice	The solution to develop for the long-lasting parking problems had to have a temporary nature, to be able to build and disassemble in a short period of time and to be demountable so that materials can be reused. The evaluation took place through bargaining.
Authorisation	
Implementation	The three preconditions of the solutions (temporary nature, short time to build and disassemble and demountable) are used as input for the final design.

3. Design of a modular car park

Description of decision-making process	
Description of decision	The final design of the modular car park is a combination of a steel frame and concrete panels for the parking decks and the slopes in the car park. The reason to use a steel frame is because of the short time that is necessary to build and disassemble the car park and the reason to use concrete panels is because of the expertise of Ballast Nedam with this type of material.
Phase in innovation process	■ Idea generation and selection □ Pilot project □ Development and testing □ Implementation and diffusion
Type of decision	□ Organizations □ Operations ■ Product □ Marketing
Involved organizations	• Ballast Nedam Infra Projecten • Ballast Nedam Engineering • Haitsma
Decision making	■ Analysis ■ Judgement □ Bargaining
Form	■ Extensive form □ Normal form
Cooperation	□ Cooperative game ■ Non-cooperative game
Information	■ Imperfect information □ Perfect information
Game	□ Strategic game □ Extensive game with perfect information ■ Extensive game with imperfect information □ Coalitional game

Model of decision-making process



Routine in decision-making process	
Recognition	Earlier in the innovation process it was decided that the solution for the temporary parking problem had to satisfy the preconditions: temporary nature, short time to build and disassemble and demountable.
Diagnosis	A fourth precondition was formulated by the direction of Ballast Nedam Infra. This precondition was that the solution has to contain concrete, because the use of concrete would be profitable for Ballast Nedam.
Search	Three car parks are studied as input for the design of a temporary car park: a permanent car park in Rijswijk and two temporary car parks of respectively Ballfour Beatty and Another Level Car Parks. Although the latter two examples were temporary car parks, they were not applicable for the formulated problem, since these car parks were made of steel and further the offered parking area was too small. The car park in Rijswijk was more suitable for the formulated problem, expect for the fact that the car park was permanent.
Design	In a first attempt to design a temporary car park a draft design was made by combining elements of the three example car parks. In this design the frame consists of steel, while the parking decks are made of concrete. In the second round of the design routine different types of concrete floors in the design are designed that could be used in the final design.
Evaluation / choice	In the first evaluation the three examples were analyzed and the conclusion of the analyses was that none of the three designs was suitable as a whole for the design of a new type of temporary car park. Nevertheless, some elements of the three car parks are used in the final design. The evaluation took place through an analysis. In the second evaluation the draft design was evaluated and the idea to combine steel

Routine in decision-making process	
	and concrete in the design was approved. Further it was decided to design different types of concrete floors and to evaluate them in a third evaluation. The evaluation took place by means of analysis and judgement. In the third evaluation the different types of floors are compared and the type double T-beam was selected as type of floor to use in the temporary car parks. The evaluation took place through analysis and judgement.
Authorisation	
Implementation	The final design of the temporary car park is a combination of a steel frame and concrete panels with a double T-beam.

4. Determination of the types of customers

Description of decision-making process	
Description of decision	The temporary car park was developed to offer a solution for temporary parking problems. Temporary parking problems are often perceived in urban (re)development projects. Since municipalities and hospitals are often the principal in these projects both are identified as owners of the temporary parking problems and therefore they are potential customers.
Phase in innovation process	■ Idea generation and selection □ Pilot project □ Development and testing □ Implementation and diffusion
Type of decision	□ Organizations □ Operations □ Product ■ Marketing
Involved organizations	• Ballast Nedam Infra Projecten • Grontmij Parkconsult • ParkMasters
Decision making	□ Analysis □ Judgement ■ Bargaining
Form	■ Extensive form □ Normal form
Cooperation	■ Cooperative game □ Non-cooperative game
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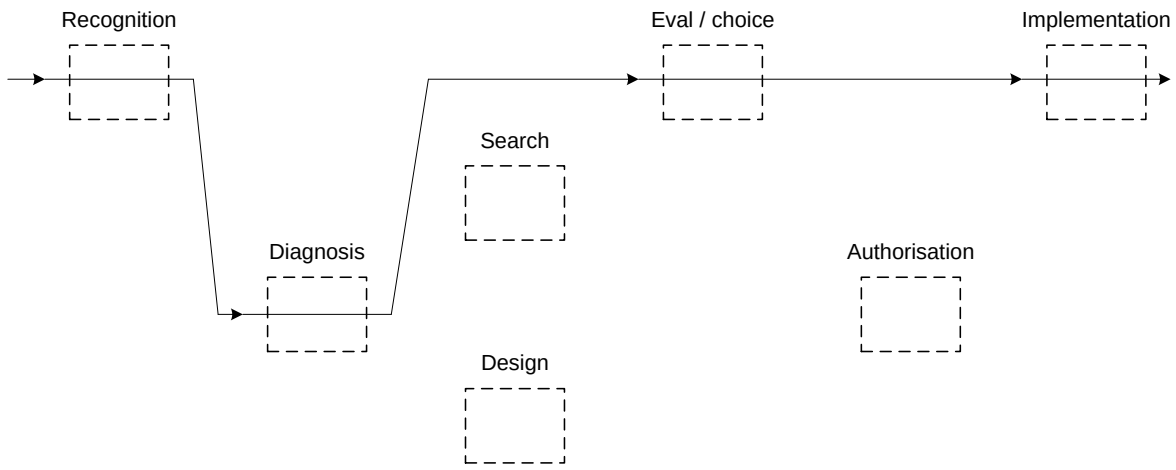
Model of decision-making process

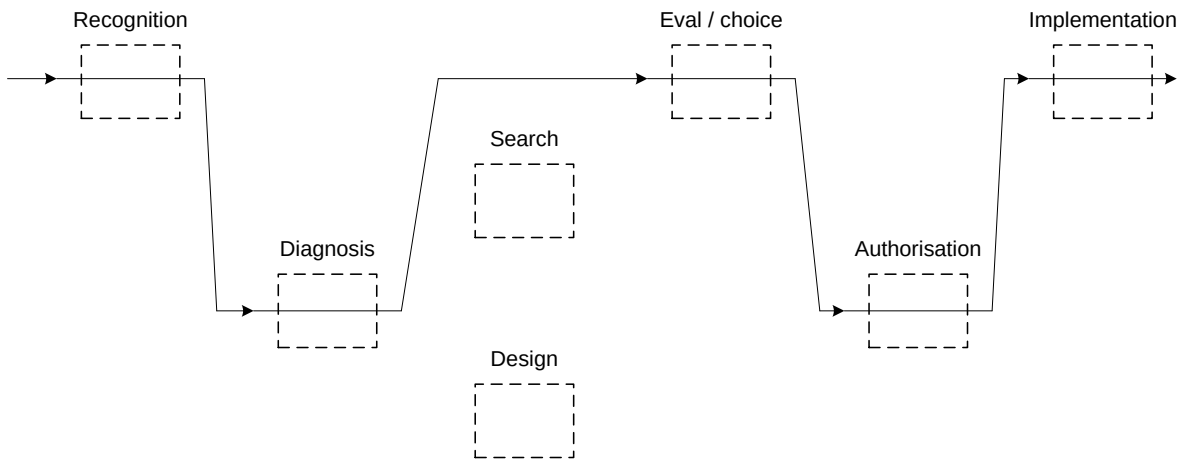


Routine in decision-making process	
Recognition	Ballast Nedam Infra Projecten and Grontmij Parkconsult had independent of each other identified a demand for a solution in the field of temporary parking. The temporary parking problems are divided into short-lasting parking problems and long-lasting parking problems.
Diagnosis	The final design that was developed by the three organizations seemed to be not applicable for the short-lasting parking problems because of technical and financial limitations. As a result the focus was shifted only to long-lasting parking problems.
Search	
Design	
Evaluation / choice	In the evaluation municipalities and hospitals are identified as potential customers of the temporary car park, since those two types of customers are the often principals of urban (re)development projects and therefore also the owners of long-lasting parking problems. The evaluation took place through bargaining.
Authorisation	
Implementation	The 10 temporary car parks that are realized up to now are rented or sold to municipalities or hospitals.

5. Founding of Ballast Nedam Parking v.o.f.

Description of decision-making process	
Description of decision	In 2006 the division Ballast Nedam Parking was founded, which was 50% part of Ballast Nedam Infra and 50% part of Ballast Nedam Bouw & Ontwikkeling. The reason to found Ballast Nedam Parking was ambiguous: on the one hand the risks and costs of building temporary car parks were shared between two subsidiaries, on the other hand the name of the new division was used as a marketing tool.
Phase in innovation process	☐ Idea generation and selection ■ Pilot project ☐ Development and testing ☐ Implementation and diffusion
Type of decision	■ Organizations ☐ Operations ☐ Product ■ Marketing
Involved organizations	• Ballast Nedam Infra Projecten • Direction of Ballast Nedam Infra • Direction of Ballast Nedam Bouw & Ontwikkeling
Decision making	☐ Analysis ■ Judgement ☐ Bargaining
Form	☐ Extensive form ■ Normal form
Cooperation	☐ Cooperative game ■ Non-cooperative game
Information	■ Imperfect information ☐ Perfect information
Game	■ Strategic game ☐ Extensive game with perfect information ☐ Extensive game with imperfect information ☐ Coalitional game

Model of decision-making process

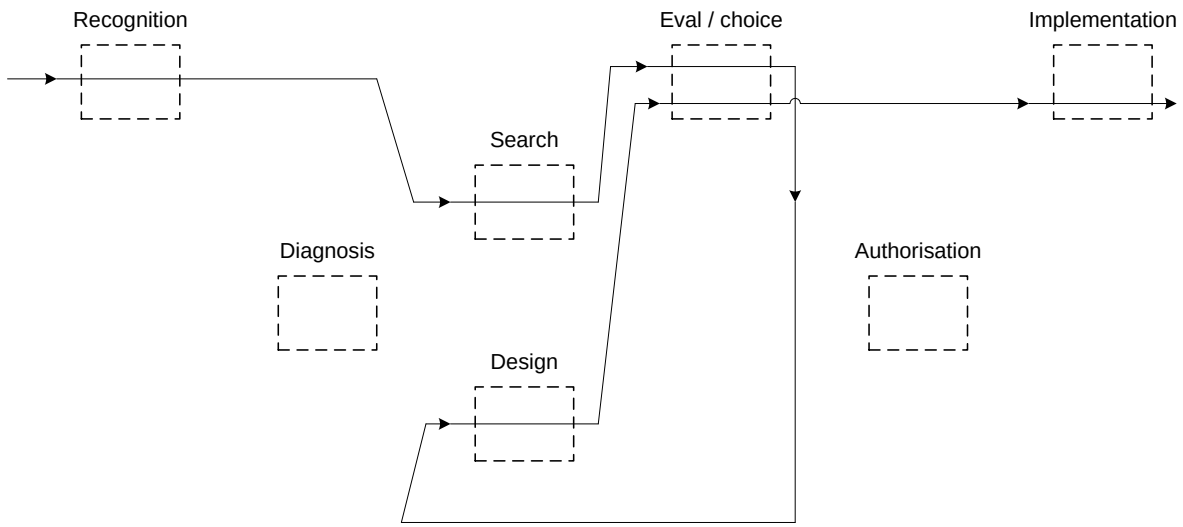


Routine in decision-making process	
Recognition	Ballast Nedam Infra Projecten, a division of Ballast Nedam Infra, identified the risks and costs that were involved in building and renting temporary car parks. The risks and costs would be too high for this division therefore a new organizational structure had to be created.
Diagnosis	The newly established division offered the opportunity to bundle the activities in the field of parking in one organization and to present itself as a specialized organization in the field of parking.
Search	
Design	
Evaluation / choice	The directions of the subsidiaries Infra and Bouw & Ontwikkeling decided to contribute proportional to the newly established division: Infra would be responsible for the underground car parks, while Ballast Nedam Bouw & Ontwikkeling would be responsible for the other car parks. The evaluation took place through judgement.
Authorisation	The decision to found the newly established division (Ballast Nedam Parking v.o.f.) was authorized by the Board of Management of Ballast Nedam N.V.
Implementation	In 2006 the general partnership Ballast Nedam Parking v.o.f. was founded. In recent years the division became a private company (Ballast Nedam Parking B.V.) and a division of the subsidiary Ballast Nedam Infra.

6. Design of business model

Description of decision-making process	
Description of decision	A new business model is developed for the temporary car parks. In contrast with the permanent car parks the temporary car parks would be rented. Otherwise the costs would be too high for the client, while by renting the car parks the costs can be shared among several clients.
Phase in innovation process	☐ Idea generation and selection ☐ Pilot project ☐ Development and testing ■ Implementation and diffusion
Type of decision	☐ Organizations ☐ Operations ☐ Product ■ Marketing
Involved organizations	• Ballast Nedam Parking • Municipality of Zaandam
Decision making	☐ Analysis ☐ Judgement ■ Bargaining
Form	☐ Extensive form ■ Normal form
Cooperation	☐ Cooperative game ■ Non-cooperative game
Information	■ Imperfect information ☐ Perfect information
Game	■ Strategic game ☐ Extensive game with perfect information ☐ Extensive game with imperfect information ☐ Coalitional game

Model of decision-making process

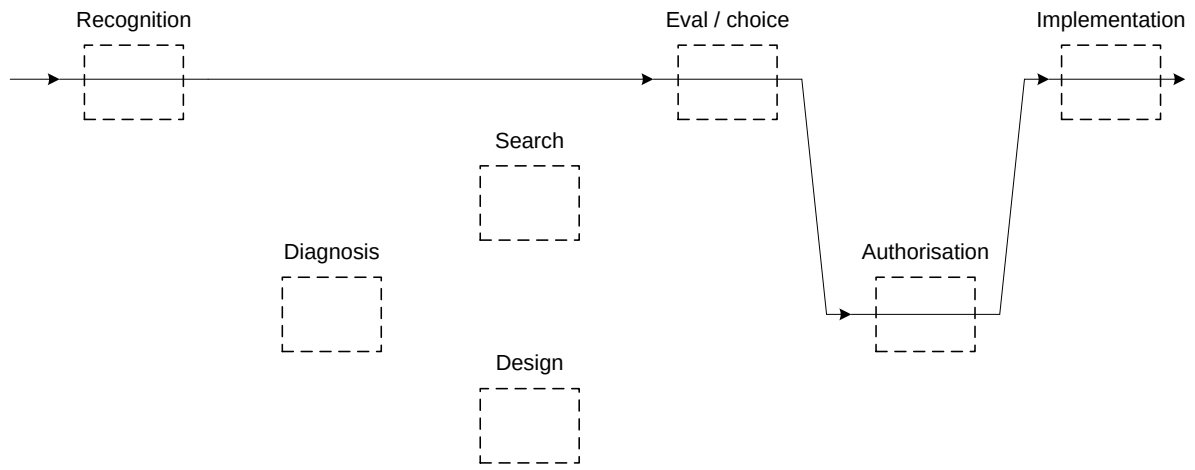


Routine in decision-making process	
Recognition	The new type of car park (temporary car park) required a new business model, because a temporary car park would be used for a certain period of time and in that case the price would be too high to sell it. Therefore the idea occurred to rent the temporary car park.
Diagnosis	
Search	At first the rent contracts of houses and stores are examined. Houses and Stores can both be considered as temporary facilities and renting these facilities is a common used business model.
Design	In collaboration with the municipality of Zaandam a rent contract is composed. Although this contract is partly based on the rent contracts of houses and stores, it is especially composed for the temporary car parks.
Evaluation / choice	In the first evaluation it was decided that the rent contracts of houses and stores did not fit the purpose. Although both are as well as the car park temporary facilities, a major distinction is that the houses and stores are real estate, while the car park is moveable. The evaluation took place through bargaining. In the second evaluation the concept of the rent contract especially made for the temporary car park in Zaandam is discussed and approved. The evaluation took place through bargaining.
Authorisation	The decision to use the selected business model (renting the temporary car park) is authorized by the direction of Ballast Nedam Infra.
Implementation	The rent contract is adjusted for the first temporary car park in Zaandam, also since the municipality of Zaandam cooperate in the composition of the rent contract. Rent contracts that are entered into with other clients are based on the rent contract with the municipality of Zaandam.

7. Founding of ModuPark v.o.f.

Description of decision-making process	
Description of decision	The general partnership ModuPark v.o.f. was founded in 2010, which is an alliance between Ballast Nedam Parking and Oostingh Staalbouw. The reasons to set up a general partnership are the sharing of risks between the two organizations and to increase the commitment of both organizations.
Phase in innovation process	☐ Idea generation and selection ☐ Pilot project ■ Development and testing ☐ Implementation and diffusion
Type of decision	■ Organizations ☐ Operations ☐ Product ☐ Marketing
Involved organizations	• Ballast Nedam Parking • Oostingh Staalbouw
Decision making	☐ Analysis ☐ Judgement ■ Bargaining
Form	■ Extensive form ☐ Normal form
Cooperation	☐ Cooperative game ■ Non-cooperative game
Information	■ Imperfect information ☐ Perfect information
Game	☐ Strategic game ☐ Extensive game with perfect information ■ Extensive game with imperfect information ☐ Coalitional game

Model of decision-making process

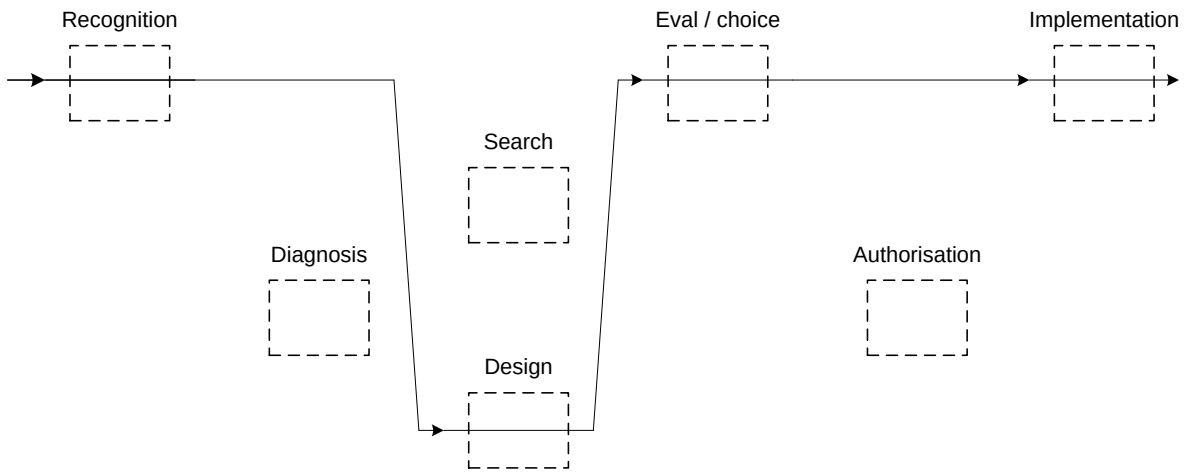


Routine in decision-making process	
Recognition	Ballast Nedam Parking made the conclusion that renting and storing the ModuPark® car parks would entail high financial risks. Oostingh Staalbouw was an already involved partner willing to share the financial risks. A partnership with Oostingh Staalbouw would not only spread the financial burden, but would also increase the commitment of both organizations and consequently boost the product development of the ModuPark®.
Diagnosis	
Search	
Design	
Evaluation / choice	Ballast Nedam Parking and Oostingh Staalbouw decided after consultation with each other to found a general partnership.
Authorisation	The decision to found a general partnership with Oostingh Staalbouw was authorized from the side of Ballast Nedam Parking by the direction of Ballast Nedam Infra.
Implementation	Ballast Nedam Parking and Oostingh Staalbouw founded the general partnership ModuPark v.o.f. in which Ballast Nedam Parking has a 66.66% stake and Oostingh Staalbouw a 33.33% stake.

8. Expansion of the design with additional parking deck

Description of decision-making process	
Description of decision	The first ModuPark®, the car park in Zaandam, consisted of 3 parking decks. However, clients of other ModuPark® car park demanded an additional parking deck to increase the total parking area. With some small adjustments it was possible to extent the design of the ModuPark® with an additional parking deck.
Phase in innovation process	☐ Idea generation and selection ☐ Pilot project ■ Development and testing ☐ Implementation and diffusion
Type of decision	☐ Organizations ☐ Operations ■ Product ☐ Marketing
Involved organizations	• Ballast Nedam Parking • Oostingh Staalbouw
Decision making	■ Analysis ☐ Judgement ■ Bargaining
Form	■ Extensive form ☐ Normal form
Cooperation	■ Cooperative game ☐ Non-cooperative game
Information	■ Imperfect information ☐ Perfect information
Game	☐ Strategic game ☐ Extensive game with perfect information ☐ Extensive game with imperfect information ■ Coalitional game

Model of decision-making process

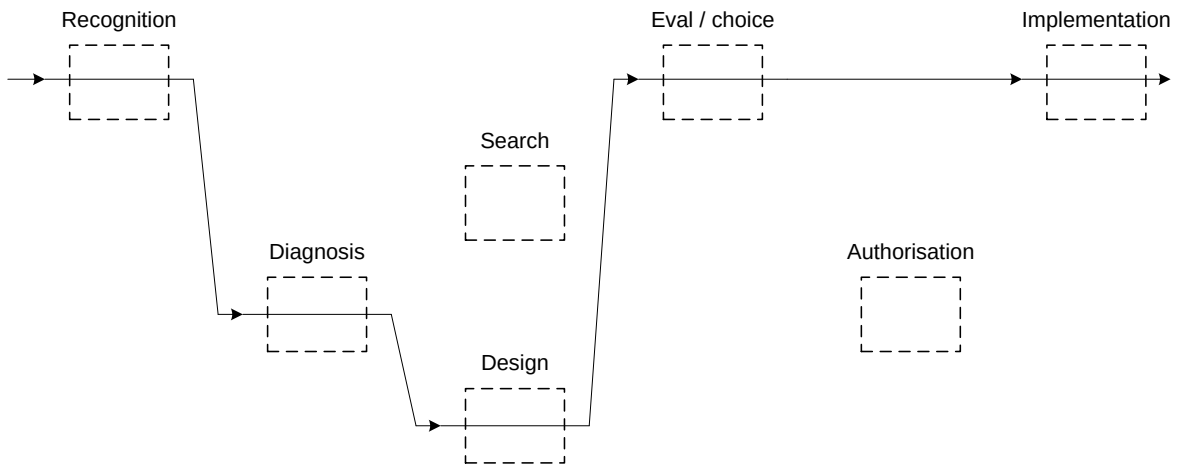


Routine in decision-making process	
Recognition	The first ModuPark®, the car park in Zaandam, consisted of 3 parking decks. However, clients of other ModuPark® car park demanded an additional parking deck to increase the total parking area. Also the municipality of Almelo that was interested in hiring the former car park in Zaandam demanded an additional parking deck.
Diagnosis	
Search	
Design	Only the ground floor of the ModuPark® differs of the other floors. Since the upper floors were identical to each other it was possible with some small adjustment to extent the design of the ModuPark® with an additional parking deck.
Evaluation / choice	In the evaluation it became clear that to extent the concept of ModuPark® with additional parking deck only minor adjustments in the design were required. For the adjusted design was no extra examination of the fire regulations necessary. The evaluation took place through analysis and bargaining.
Authorisation	
Implementation	The ModuPark car park in Almelo was realized with 4 parking decks and the concept of ModuPark® contains standard 4 parking decks.

9. Improvement of temporary fastening

Description of decision-making process	
Description of decision	During the disassembly of the car park of Sint Antonius Hospital in Nieuwegein it was revealed that the concrete elements of the ModuPark® were hard to disassemble. Ballast Nedam Engineering examined the fastening in the laboratory and made several adjustments in the design of the fastening to improve it. These improvements will be applied in future ModuPark® car parks and further the fastening between the steel elements and concrete elements will be examined in cooperation with Oostingh Staalbouw.
Phase in innovation process	☐ Idea generation and selection ☐ Pilot project ■ Development and testing ☐ Implementation and diffusion
Type of decision	☐ Organizations ☐ Operations ■ Product ☐ Marketing
Involved organizations	• Ballast Nedam Parking • Ballast Nedam Engineering
Decision making	■ Analysis ☐ Judgement ☐ Bargaining
Form	☐ Extensive form ■ Normal form
Cooperation	☐ Cooperative game ■ Non-cooperative game
Information	■ Imperfect information ☐ Perfect information
Game	■ Strategic game ☐ Extensive game with perfect information ☐ Extensive game with imperfect information ☐ Coalitional game

Model of decision-making process



Routine in decision-making process	
Recognition	During the disassembly of the car park of Sint Antonius Hospital in Nieuwegein it was revealed that the concrete elements of the ModuPark® were hard to disassemble.
Diagnosis	After further research it appeared that the concrete elements were hard to disassemble due to the tight fastening of the concrete elements.
Search	
Design	Because of the unique design of the ModuPark® car park there were no examples for the problem with the tight fastening and how to improve the fastening. In the laboratory of Ballast Nedam several types of fastenings are developed and tested.
Evaluation / choice	The various developed alternatives are compared with each other in an analysis and based upon this analysis an alternative is chosen.
Authorisation	
Implementation	The new type of fastening will be integrated into the design of future ModuPark® car parks. Further, the fastening between the concrete elements and the steel elements will be researched in cooperation with Oostingh Staalbouw.

10. Improvement of lateral load distribution

Description of decision-making process	
Description of decision	For the application of the building permit for the car park in Almelo the design of the ModuPark® car park was recalculated. Although the car park was previously used in Zaandam, the design of the car park did not meet the requirements for the building permit. To improve the lateral load distribution of the car park and consequently the stability of the car park steel trestles are used. The use of steel trestles is however a temporary solution.
Phase in innovation process	☐ Idea generation and selection ☐ Pilot project ☐ Development and testing ■ Implementation and diffusion
Type of decision	☐ Organizations ☐ Operations ■ Product ☐ Marketing
Involved organizations	• Ballast Nedam Parking • Oostingh Staalbouw
Decision making	■ Analysis ☐ Judgement ☐ Bargaining
Form	■ Extensive form ☐ Normal form
Cooperation	■ Cooperative game ☐ Non-cooperative game
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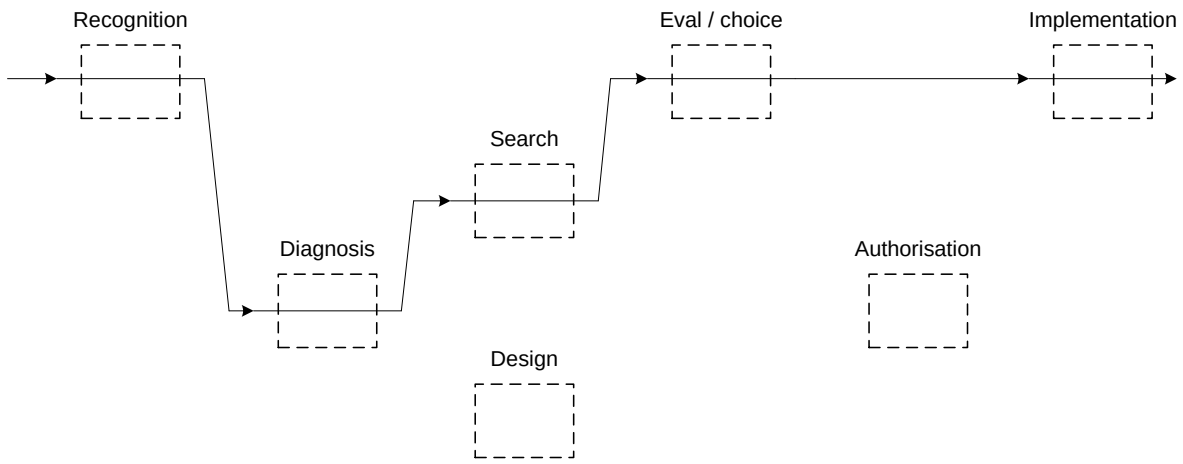
Model of decision-making process



Routine in decision-making process	
Recognition	For the application of the building permit for the car park in Almelo the design of the ModuPark® car park was recalculated. Although the car park was previously used in Zaandam, the design of the car park did not meet the requirements for the building permit.
Diagnosis	After further research it appeared that the design did not properly distribute the lateral load. As a consequence the design of the ModuPark® car park was not stable enough following the regulations.
Search	A suggested solution to improve the stability of the design was to use steel trestles. Trestles are used in the construction industry to strengthen the design and this way to improve the stability of the ModuPark® car park.
Design	
Evaluation / choice	In the evaluation the adjustments (use of steel trestles) in the design were evaluated and accepted. The use of trestles in the design of the ModuPark® is however a temporary solution and are in the first instance only used in the ModuPark® car park in Almelo. For future ModuPark® car parks other adjustments will be made in the design. The evaluation took place through analysis.
Authorisation	
Implementation	Based upon the improved design a building permit was granted. However, Ballast Nedam Parking and Oostingh Staalbouw decided to continue the research to improve the stability of the design with a final solution.

11. Defining the types of end users

Description of decision-making process	
Description of decision	Ballast Nedam Parking looked for opportunities to increase the market for the ModuPark® by paying more attention to the wishes and demands of the end user instead of the customer. Ballast Nedam Parking has distinguished four types of end users with different wishes and demands: residents, visitors, travellers and employees. Through understanding the wishes and demands Ballast Nedam Parking is able to improve the ModuPark car parks®.
Phase in innovation process	☐ Idea generation and selection ☐ Pilot project ☐ Development and testing ■ Implementation and diffusion
Type of decision	☐ Organizations ☐ Operations ☐ Product ■ Marketing
Involved organizations	• Ballast Nedam Parking
Decision making	☐ Analysis ■ Judgement ☐ Bargaining
Form	☐ Extensive form ■ Normal form
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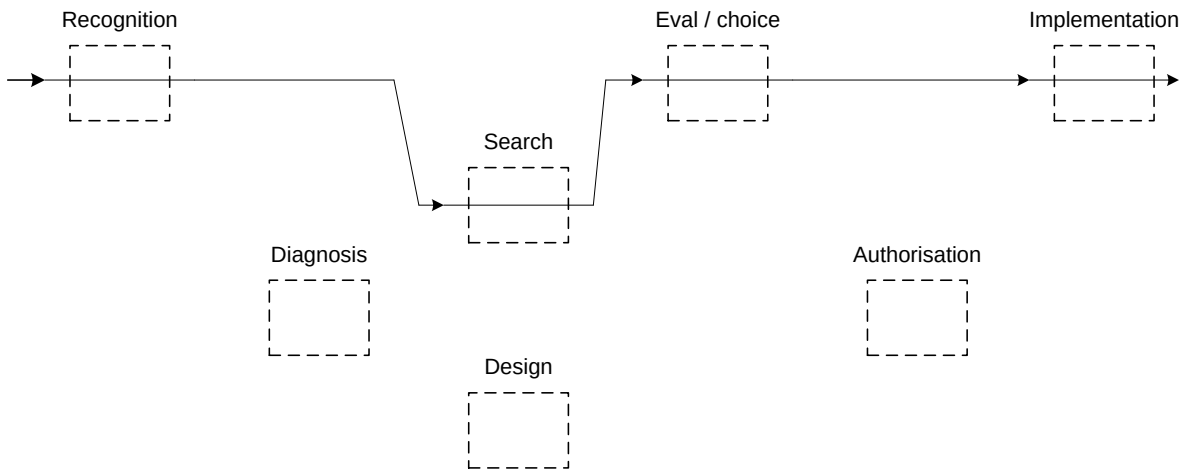

Routine in decision-making process	
Recognition	Ballast Nedam Parking looked for opportunities to increase the market for the ModuPark® by paying more attention to the wishes and demands of the end user instead of the customer. By focusing on the wishes and demands of the end user Ballast Nedam Parking is able to offer a better parking solution to the customer.
Diagnosis	
Search	Ballast Nedam Parking has distinguished four types of end users: residents, visitors, travellers and employees. These four types of end users have different demands and wishes and also use the car parks in different ways and at different moments.
Design	
Evaluation / choice	The decision to distinguish these four types of end users was based upon experience and judgement. These types of end users appear to cover the different demands and wishes with respect to car parks. The evaluation took place through judgement.
Authorisation	
Implementation	In cooperation with the municipality of Almelo the future end users of the car park are identified. It appeared that the car park could be smaller than in first instance was expected, which saves time and costs in the construction and renting.

12. Determination of new types of customers

Description of decision-making process	
Description of decision	Ballast Nedam Parking decided to focus on other market segments beside the municipalities and the hospitals to exploit the ModuPark® car parks. It appeared that project developers and customers are often faced with temporary parking problems and are therefore interesting market segments for the concept of ModuPark®.
Phase in innovation process	☐ Idea generation and selection ☐ Pilot project ☐ Development and testing ■ Implementation and diffusion
Type of decision	☐ Organizations ☐ Operations ☐ Product ■ Marketing
Involved organizations	• Ballast Nedam Parking
Decision making	☐ Analysis ■ Judgement ☐ Bargaining
Form	☐ Extensive form ■ Normal form
Cooperation	☐ Cooperative game ☐ Non-cooperative game
Information	☐ Imperfect information ☐ Perfect information
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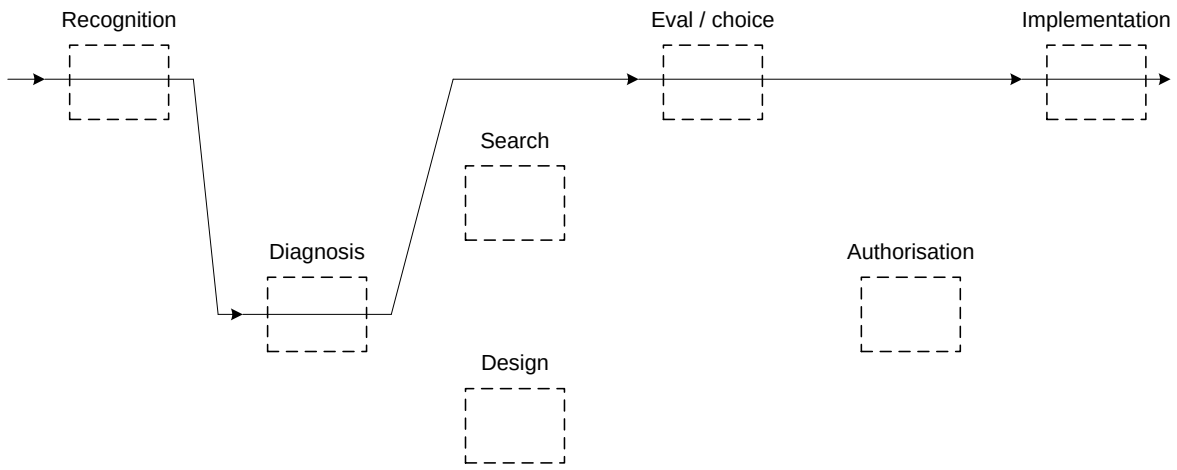
Model of decision-making process



Routine in decision-making process	
Recognition	Ballast Nedam Parking looked for new opportunities to exploit its modular car parks. New opportunities that Ballast Nedam Parking looked for were to adjust the product (ModuPark® car park), to enter new markets or to focus on other customers.
Diagnosis	After investigating closely the three types of opportunities it appeared that Ballast Nedam Parking should focus on other customers, namely project developers and investors.
Search	
Design	
Evaluation / choice	In the evaluation the decision was made to focus on other customers. This decision was based upon experience and judgement. The suggested customers (project developers and investors) appeared to be commercially considered the most attractive opportunity for Ballast Nedam Parking.
Authorisation	
Implementation	At this time Ballast Nedam Parking is in conference with a project developer that is interested to rent a ModuPark® car park for several years.