THE ROAD AHEAD

Business roadmapping and how to compensate for uncertainty: the case of the construction company

- Public version -

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UNIVERSITY OF TWENTE.

Ballast Nedam

Title: **The road ahead**

business roadmapping and how to compensate for uncertainty: the case of the construction company

A thesis submitted in partial fulfilment of the requirements for the degree of Master of Science in Civil Engineering and Management at the University of Twente

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Preface

By means of this research, I complete my two-year master program Civil Engineering and Management at the University of Twente. This report gives the results of the research I conducted at construction company Ballast Nedam during my ten-month master's thesis period. The research covers the topic of developing and partly applying a business roadmap process for Ballast Nedam that can cope with the uncertainty of the future external environment. To this end, the principle of scenario planning is integrated into the business roadmap development process.

When I started this master's thesis, I had never heard of the term business roadmap. As a consequence, I was neither familiar with the process to develop a business roadmap, nor with the layout of such a business roadmap. Nevertheless, during my journey I learned a lot about roadmapping and got fascinated by it. The latter can be partly explained by the support and freedom I received from Ballast Nedam, in particular in the person of Menno de Jonge. Therefore, I would like to thank him for his advice, support and trust, not only regarding my master's thesis, but also regarding other activities I was allowed to conduct during my period at the company. With this, I refer to the activities for drawing up the internal Position Paper of the firm, the shooting of a movie for an innovation management game, and the strategic analyses for the executive board of Ballast Nedam he guided me through. The effort necessary for the latter activity made the final steps for completing this master's thesis a challenge, but the experiences gained made it worth spending my time for these activities.

In this preface, I would also like to express a word of thanks to all people that contributed to this master's thesis. First of all, I would like to thank the members of my graduation committee. Besides Menno de Jonge, Joop Halman, Hans Voordijk and Michiel Wolbers provided me with sincere advices to improve my research. In addition, I would like to thank all members of Ballast Nedam that participated in the process or supported my research in another way, and Jules The for his help during the workshops. What is more, I would like to thank all my friends and fellow students for their effort and for giving me a pleasant time during my student days. Above all, I am grateful to my family for enabling me to focus completely on my study and for supporting me in all activities I undertook.

The completion of this master's thesis does not imply that I will stop working on the topic of business roadmaps. On the contrary. I am happy and honoured by the opportunity I was offered by Ballast Nedam and the University of Twente to keep working on improving and extending my research through a PDEng traineeship; I am really looking forward to it and I hope the pleasant relations will continue in the future.

Brummen, 9th of December 2013,

Remco Siebelink

NB In this public version of the report, sections are removed that contain confidential information. This information can be disclosed on demand by contacting the author.

Summary

Research problem
Ballast Nedam's current innovation process lacks demarcation: all kinds of ideas are worked out without a clear idea whether or not these ideas support the corporate strategy. Therefore, Ballast Nedam wants to develop a business roadmap that enables the company to focus its innovation effort. This business roadmap is the elaboration of a firm's innovation strategy into an easy to communicate graph. As such, prior to developing the business roadmap, a firm needs to embark on an innovation strategy formulation process. Although there is abundant attention to the uncertainty of the future and the need for strategies to cope with it, the business roadmap development process is presented as if the world does not change while the roadmap is being developed and implemented. Since the external environment is not stable, though, this research focuses on the development and application of a business roadmap process for Ballast Nedam that has concern for the external uncertainty while retaining the communicational and directive strengths of a business roadmap. This leads to the following research question:

How to develop and apply a business roadmap process for Ballast Nedam with concern for both external uncertainty and the strengths of a business roadmap?

Research methodology
For this thesis, both a desk research and a practical research are required. The desk research is used to gain scientific literature insights on the topics of innovation, the innovation strategy formulation process, external uncertainty and business roadmaps. The practical research includes a single case study with Ballast Nedam as the case under consideration. Here, first some points of attention for a successful application of a business roadmap development process within Ballast Nedam are gathered. Combined with the insights gained from scientific literature, a tailor-made business roadmap development process is established for Ballast Nedam. In this research, this process is partially applied with the use of a literature study, documentation study, individual interviews and two participatory workshops. The results of this case study and the discussion of the contribution and limitations of the research, lead to several conclusions and recommendations.

Scientific literature insights
A business roadmap is a time-based graph with three main layers about how the markets a firm wants to serve, the products it wants to deliver, and the technologies and other resources necessary for this, evolve over time. The business roadmap can also contain a fourth layer with the projects a firm is currently working on. The process to come to this business roadmap consists of a stage with multi-disciplinary workshops that is preceded by a preparation stage to ensure effective and efficient workshops, while a third stage is added to guarantee an effective implementation of the business roadmap. In the workshop stage, a firm performs multiple analyses to come to agreement about the areas where innovation is necessary and to determine what activities are required to get these innovations. However, these analyses cannot cope with the external uncertainty of the future, which is an inability of persons to predict accurately or to separate relevant and irrelevant information. An effective method to deal with this external uncertainty is scenario planning: a method that ensures that a firm considers a wide range of possible futures to build a strategy on, by developing multiple plausible stories about the future external environment. Integrating scenario planning into the business roadmap development process leads a company to explore multiple possible futures whereupon it can build a robust normative roadmap that can cope with these alternative futures. As such, a firm can prepare for the future whilst it will be successful under a wide range of circumstances.

Firm-specific insights
The case of construction firm Ballast Nedam is used to develop and apply the business roadmap process. Ballast Nedam is a large construction company that works in the areas of mobility, housing, nature and energy, with a focus on some niche markets and integrated projects. This strategy is however established ad-hoc without conducting analyses or involving an external facilitator. A business roadmap process can resolve these issues, but it should focus on a few overarching themes for the whole company to keep it simple for communication and getting commitment. The latter is really a point of attention in the firm. Therefore, the business roadmap should be coupled to other policies in the company, and managers and other employees with different backgrounds need to be included. A documentation study should reduce the bias of involving only Ballast Nedam employees.

Case study Ballast Nedam
The established business roadmap development process consists of a combination of the innovation strategy development process, the scenario planning process, the business roadmap development process and some Ballast Nedam points of attention. The heart of the process is formed by two participatory workshops to produce the innovation strategy of Ballast Nedam in a clear overview: a scenario workshop to get four scenarios on the future external environment of Ballast Nedam, and a business roadmap workshop to partly construct a robust business roadmap on the written scenarios. A preceding planning stage, involving amongst other conducting interviews and a documentation study to avoid time-consuming data collection during the workshops, ensures that a firm prudently prepares the workshops. A concluding implementation stage involves activities necessary for a successful use of the business roadmap in the organisation, e.g. by keeping the roadmap up-to-date.

Discussion
The partially applied business roadmap development process yielded useful results and is considered appropriate for reducing uncertainty. The research moreover revealed that the process takes a lot of effort and time, making it impossible to complete the roadmap and implement it across the organisation during this research. In addition, bias was evident in the results since only members of the Ballast Nedam organisation were involved in the workshop stage. It is therefore considered beneficial to incorporate external experts, suppliers and clients to both reduce this bias and limit the necessary time and effort for the process. What is more, the commitment across the organisation could be improved by making the executive board of Ballast Nedam the initiator of the research.

The research revealed that it is very important to have a dedicated and competent project manager that guides the process. Without such a project manager, it is considered hardly possible to get useful results. What is more, adding a third workshop to the workshop stage seems necessary: the business roadmap cannot be developed in just two workshops. The extra time gathered will be beneficial for the results as well, since it enables that more time can be spent to execute the required steps in an organisation that is not familiar with scenario planning and roadmapping.

These points of discussion are taken into account in the development of a generic business roadmap development protocol comprising the main steps to be conducted to get a business roadmap that can cope with external uncertainty. An evaluation on effectiveness and a comparison with other roadmap development processes, revealed that this generic protocol can be considered the only business roadmap development process that can cope with external uncertainty in a sound way.

Conclusions
The applied business roadmap development process proves that integrating scenario planning and business roadmapping is possible and is able to provide satisfying results. Using scenario planning first to explore four alternative futures around Ballast Nedam for 2020 reduces the external uncertainty substantially. Moreover, developing a robust normative business roadmap based on the common elements in these scenarios results in a business roadmap that keeps the directive strengths

of roadmapping while it will be successful under a wide array of circumstances. However, no decisive answer can be given on the business roadmap's communicational strengths as it is not completed and implemented yet, although including a small amount of focus areas is considered beneficial as it keeps the business roadmap simple in a firm that is active in many working areas.

In order for the business roadmap development process to remain viable within construction company Ballast Nedam, some points of attention need consideration, though. The three-stage business roadmap process with a planning stage, a workshop stage with two workshop, and an implementation stage, is appropriate but needs some revision in accordance with the proposed generic business roadmap development protocol to make it practically applicable. The current workshop stage is too limited for providing all required results and must be extended. What is more, improvements are required to limit the effort needed for executing the process and for obtaining commitment across the organisation. Above all, the research shows that without a major role for a competent project manager that performs the vital preparatory study, inspires participants, interprets results, and elaborates these results, no useful outcomes can be obtained within the firm.

Recommendations

From the applied business roadmap development process, six possible topics for future scientific research emerge. First, it is recommended to continue research on the applied business roadmap development process: extending the research in other cases will result in decisive conclusions that are widely applicable, whereas research could also focus on whether scenario planning is indeed beneficial for either the time necessary for keeping the business roadmap up-do-date, or for the long-term performances of a company. The other main theme for which recommendations are given, is about improving the established business roadmap process: scientific research is necessary to give insights into the way external parties can be involved in the business roadmap development process, the exact role ICT could have in the business roadmap process, and the way business roadmaps must be used in broadly oriented companies that are working on a wide array of activities that cannot all be represented on one roadmap.

The practical recommendations for Ballast Nedam are related to the future application of the developed business roadmap. First, the practical recommendations concern the current business roadmap development process. It is recommended to organise an extra workshop to complete the first business roadmap of the firm, to disseminate this roadmap across the firm to increase the chance that employees will use it, and it is recommended to keep the roadmap up-to-date for which the development of a digital business roadmap is considered necessary. Next, three recommendations are about improving the current business roadmap process. To this end, it is recommended to adjust the business roadmap development process to make it practically applicable within Ballast Nedam by amongst others incorporating external parties. In addition, it is recommended to improve the process by learning from experiences of firms that already have a rich history with scenario planning and roadmapping. To conclude, it is recommended to both make the focus areas on the roadmap the new future niche markets of Ballast Nedam and to develop detailed operational business roadmaps for activities the firm is currently working on. This way, both innovations for current activities of the firm and innovations for new markets are demarcated.

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Part A

Desk research

> *“The good cartographer is both a scientist and an artist. He must have a thorough knowledge of his subject and model, the Earth… He must have the ability to generalise intelligently and to make a right selection of the features to show. These are represented by means of lines or colours; and the effective use of lines or colours requires more than knowledge of the subject - it requires artistic judgement.”*
>
> *Erwin Josephus Raisz (1893 - 1968)*

Chapter 1

Introduction

This chapter provides a short introduction and justification of this thesis by elaborating the background, research motive, relevance of the research, and the company for which this thesis is executed. To conclude, the chapter gives the structure of this report and a list of definitions used.

1.1. Background

Innovation: many companies are giving attention to it. The fact is that innovation is considered to be one of the most important ingredients for a firm to survive and prosper (Brown & Eisenhardt, 1995; Tidd, Bessant, & Pavitt, 2005): it gives companies a source of competitive advantage over other companies in the sector (Abernathy & Clark, 1985; Brown & Eisenhardt, 1995; Seaden & Manseau, 2001; Tidd et al., 2005). This competitive advantage comes from the ability to lower production costs, outperform competitors with a higher quality product, and introduce new products to satisfy customer needs or create new market opportunities by using new technologies. Innovation is thus a remedy for the threat of being left behind by competitors and is a means to capture and retain market shares (Tidd et al., 2005).

The notion that innovation is a key element for companies, is however based on scientific literature that mainly focuses on the role of innovation in production firms, where fast-changing environments, mass-production and learning processes enable innovation (Hobday, 1998; Winch, 1998). The characteristics of the construction industry however make that the innovation process in this industry is different (Tatum, 1989) and cause the innovation rate of the industry to be low (Barlow, 2000; Gann, 2000; Seaden & Manseau, 2001; Winch, 1998). Construction industry characteristics like its one-off nature of projects (Barlow, 2000; Dubois & Gadde, 2002), dependence on client requirements (Barlow, 2000; Blayse & Manley, 2004; Hartmann, 2006), procurement regulations (Dubois & Gadde, 2002; Hartmann, 2006) and its high costs and low profit margins (Blayse & Manley, 2004; Miozzo & Dewick, 2002; Seaden & Manseau, 2001) used to result in project-specific solutions that hinder learning, standardisation and innovation (Barlow, 2000; Dubois & Gadde, 2002).

Recent developments in the construction industry however urged construction firms to put more effort in innovation (Pries & Dorée, 2005; Shaw, 2010). There is an increase in competition, partly due to globalisation of the construction market (Halman, Voordijk, & Reymen, 2008; Seaden & Manseau, 2001; Shaw, 2010), increased demand for customised products (Barlow, 2000; Halman et al., 2008; Pries & Dorée, 2005; Seaden & Manseau, 2001), more high complex and high risk projects (Barlow, 2000; Gann & Salter, 2000), new forms of procurement which both decrease the number of client requirements and increase design freedom (Blayse & Manley, 2004; Halman et al., 2008), more regulations regarding safety, environmental impact and working conditions (Pries & Dorée, 2005; Seaden & Manseau, 2001; Shaw, 2010) and a growing concern about scarcity of resources (Halman et al., 2008). Moreover, the recent economic situation results in declining public and private

investments, which forces firms to make the already existing awareness of efficiency (Gann & Salter, 2000) a top priority (Shaw, 2010).

These developments compelled construction company Ballast Nedam to direct its organisation towards innovation. In 2009, Ballast Nedam founded an innovation management department with the purpose to facilitate innovation within the company (Ballast Nedam N.V., 2010). It also started an innovation process that was inspired by the development funnel model of Wheelwright and Clark (1992). In line with the ideas of Van de Ven (1986), a context is created that actively stimulates employees to pay attention to new ideas (Ballast Nedam N.V., 2011). The innovation process within Ballast Nedam consists of four stages. In the first stage, the idea generation, employees of Ballast Nedam are encouraged to think about new ideas and to share these ideas with their colleagues on a digital platform called “Tok!”. During special sessions, the ideas are presented and embraced if there is support for it. In that case, an idea transfers to the feasibility and the development stage. If the business case is accepted, the idea will be implemented (Ballast Nedam N.V., 2012b).

Recently, the innovation process of Ballast Nedam is transformed in accordance with the open innovation paradigm discussed by Chesbrough (2003). This open innovation paradigm follows the development funnel of Wheelwright and Clark (1992), but emphasises that R&D activities do not necessarily have to be conducted within a firm to benefit from them: there are alternative paths for ideas to enter the firm, e.g. through idea generation by knowledge centres, suppliers or customers. Moreover, the open innovation paradigm stresses that markets can be expanded by using external development paths. In Figure 1, the Ballast Nedam innovation process is depicted schematically.

The front-end of this development funnel, where the ideas enter the innovation process, is an important area of corporate management (Brem & Voigt, 2009; Oliveira & Rozenfeld, 2010): the characteristics of the ideas that enter the funnel give direction to the new products a firm can develop and ultimately co-determine the future performance of a firm. Therefore, many scholars advocate the need to make conscious decisions about the innovation activity (Gann, 2000; Hartmann, 2006; Tatum, 1989) and the need to communicate these effectively (Bessant, Caffyn, Gilbert, Harding, & Webb, 1994; Brown & Eisenhardt, 1995; Mintzberg, 1994a), as these conscious decisions make innovations more likely to occur (Atkin, 1999; Blayse & Manley, 2004; Brown & Eisenhardt, 1995) and increase the performance of a firm (Cooper & Kleinschmidt, 2007).

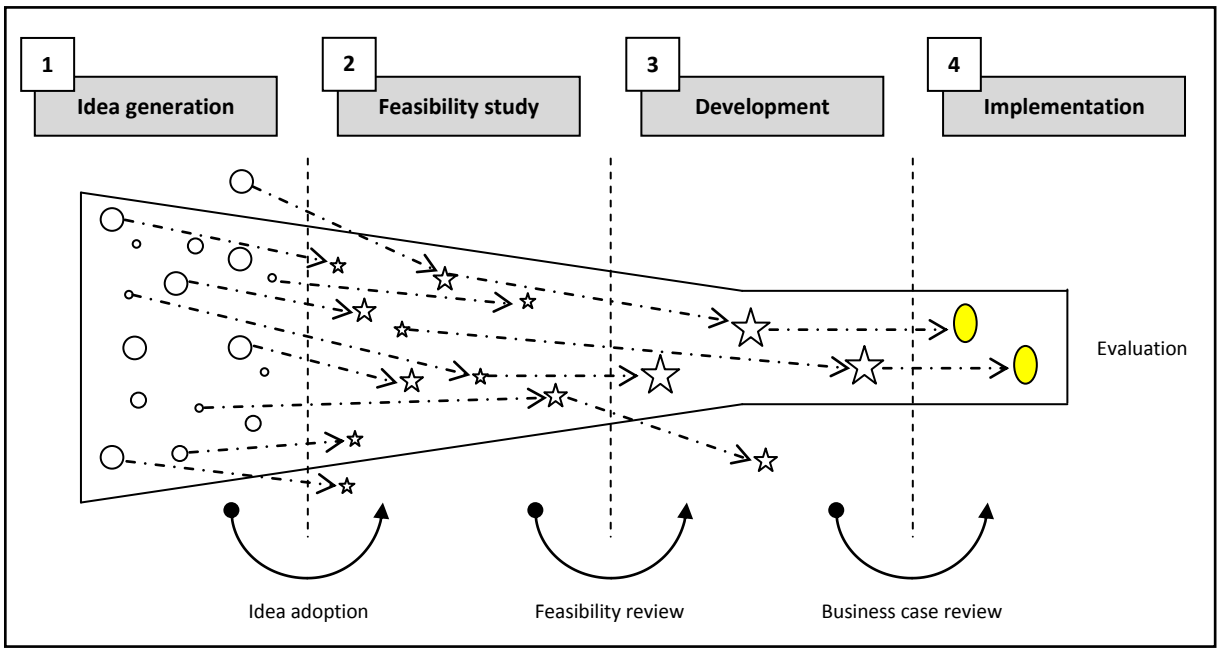

Figure 1: Ballast Nedam innovation process, following the open innovation paradigm of Chesbrough (2003).

1.2. Research motive

In the current innovation process of Ballast Nedam, every idea that is conceived beneficial is adopted and further elaborated. This means that all kinds of ideas are worked out, without a clear idea whether or not these ideas are the best to elaborate; there is no mechanism that canalises the ideas in such way that they support the corporate strategy of Ballast Nedam. Ballast Nedam is aware of this lack of demarcation. It wishes to get insight into the market needs it should fulfil in the future, and the products and technologies its scarce resources should be concentrated on to best serve these market needs. A key feature of this structure should be that it is capable of both making Ballast Nedam's employees enthusiastic for new idea generation and focussing effort on specific search areas for new ideas. Therefore, Ballast Nedam believes the structure should be both easy to communicate to employees and easy to understand by employees.

Ballast Nedam is convinced that a business roadmap is an effective way to focus its innovation effort. The roadmap, as a visual one-page overview of future markets, products and technologies (Phaal & Muller, 2009), middles between being too complex to understand or too generalised to be meaningful (Cummings & Angwin, 2011). What is more, as a program tool (Kappel, 2001), the roadmap is understandable to employees and can thus function as animator for people (Mintzberg, 1994b; Weick, 1983). This means that the business roadmap meets all requirements of Ballast Nedam for the structuring tool. Therefore, the company wants to start a business roadmap process.

1.3. Research relevance

This research is theoretically relevant since it contributes to scientific literature on the topics of:

- Applying and refining the business roadmap development process (Albright & Kappel, 2003; Garcia & Bray, 1997; Groenveld, 2007; Kostoff & Schaller, 2001; McCarthy, 2003; Phaal, Farrukh, Mitchell, & Probert, 2003; Phaal, Farrukh, & Probert, 2005; Phaal & Muller, 2009), by providing a detailed development process and subsequently executing this process in a case study;
- Applying the innovation strategy development process (Buijs, 2003; Dodgson, Gann, & Salter, 2008; Goffin & Mitchell, 2005; Johnson, Scholes, & Whittington, 2008; Tidd et al., 2005) preceding elaborating the roadmap, in particular in the context of the construction industry;
- Coping with external uncertainty in innovation strategy formulation and business roadmapping (Gerdsri & Kocaoglu, 2007; Petrick & Martinelli, 2012; Saritas & Aylen, 2010; Strauss & Radnor, 2004; Strauss, Radnor, & Peterson, 1998) by integrating the scenario planning approach; and
- Communicating strategy (Cummings & Angwin, 2011) with a business roadmap.

Practically, this research is relevant since it helps Ballast Nedam in:

- Focussing its innovation effort. As mentioned in section 1.2, the innovation effort of Ballast Nedam lacks demarcation. The company needs to structure its innovation effort in such way that its scarce resources are allocated to innovations that best support the corporate strategy. A business roadmap must ensure that this focus will be brought to the innovation effort.
- Developing a practically usable business roadmap development process. This business roadmap process gives the steps that should be worked through to come to a business roadmap, the methods that should be used to get the required information, the layout that should be used to draw up the business roadmap, and the steps necessary after the development of the business roadmap. This process allows Ballast Nedam to embark on a business roadmap process; and
- Applying this process to develop a partial business roadmap for Ballast Nedam, except the steps determined to complete the roadmap and implement it. By applying this process, Ballast Nedam gets insight in future developments and a first idea of how to anticipate on these by means of innovation. Next, applying this process improves Ballast Nedam's corporate strategy formulation process, since it creates insights into its internal and external environment, and provides Ballast Nedam with four scenarios on its external environment that are ready to be used across the organisation. In addition, Ballast Nedam gets acquainted with the business roadmap and scenario

planning process in order that subsequent initiatives can be executed by their managers, and the firm's employees both become more open for change and get accustomed to long-term thinking.

1.4. Company: Ballast Nedam N.V.

Ballast Nedam N.V. is a Dutch construction company, headquartered in Nieuwegein. With an annual turnover of around 1.3 billion Euros, Ballast Nedam is one of the largest construction companies of the Netherlands (Ballast Nedam N.V., 2013a; Cobouw, 2012). The businesses of Ballast Nedam are centred on a few working areas, i.e. mobility, housing, nature and energy, with a focus on integrated projects and the niche-markets industrial construction, offshore wind turbines, secondary raw materials and alternative fuels (Ballast Nedam N.V., 2013b).

The company structure of Ballast Nedam is shown in Figure 2. The company consists of six clusters: Building and Development, Building and Development Special Projects, Infrastructure, Infrastructure Special Projects, Specialised Companies and Supplies (Ballast Nedam N.V., 2012a). These departments are supported by several centralised services: Assurance, Communication and Investor Relations, Human Resources, ICT, Innovation Management, Legal, Compliance and Procurement.

The centralised Innovation Management department is founded in 2009 to facilitate the innovation process within Ballast Nedam (Ballast Nedam N.V., 2010). The tasks of the department are related to making employees enthusiastic for idea generation, getting an overview of all innovation processes, informing and advising employees, and representing the innovative character of Ballast Nedam. Ballast Nedam heavily focuses on innovation, since it believes it strengthens the organisation and it is crucial for providing sustainable solutions to clients (Ballast Nedam N.V., 2012a).

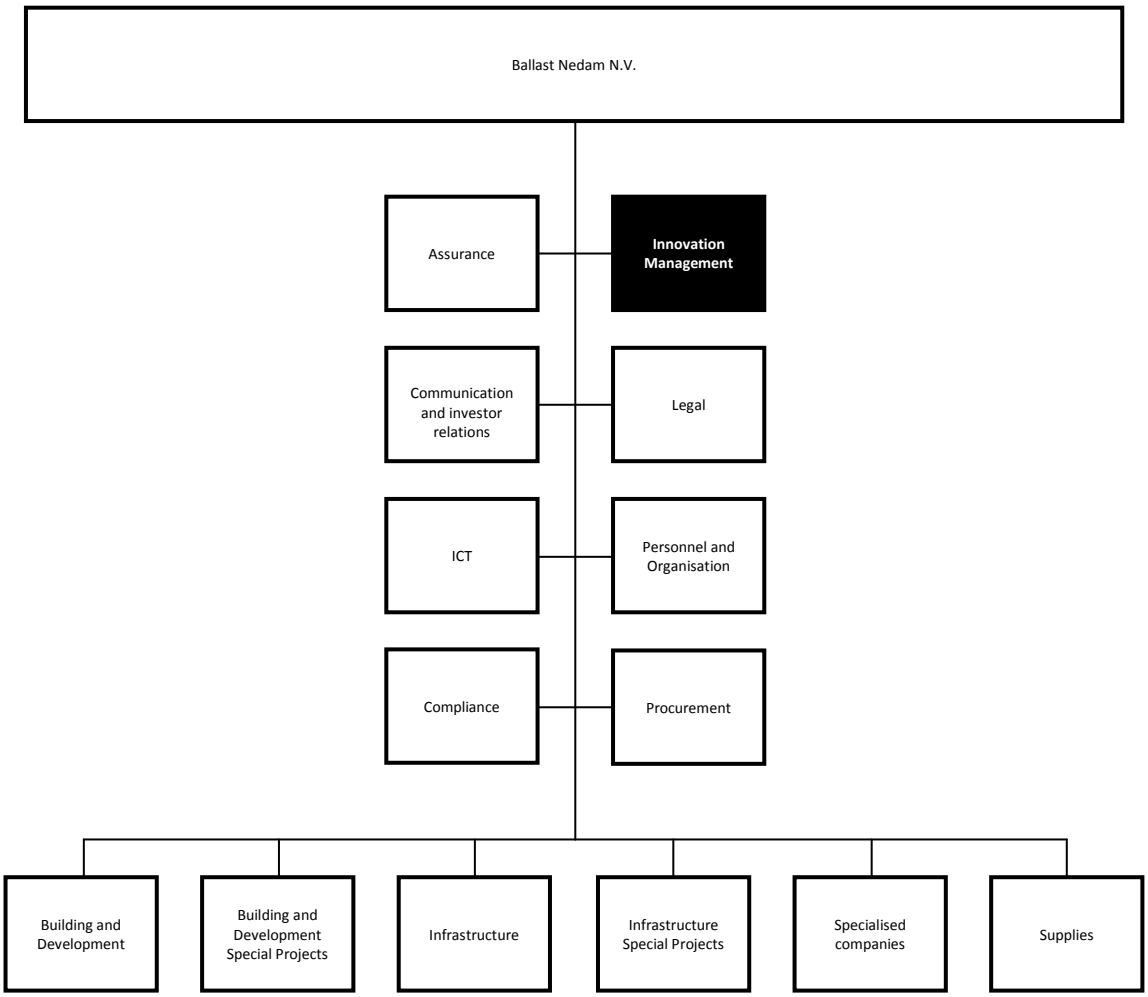

Figure 2: Organisational structure of Ballast Nedam.

1.5. Report structure

This report starts with an elaboration of the research design in Chapter 2. Next, Chapter 3 gives the theoretical framework that examines several topics further and concludes with insights on the business roadmap process gained from scientific literature. Chapter 4 deals with the firm-specific insights, while in Chapter 5 the business roadmap development process is established and applied within Ballast Nedam. Chapter 6 is used to discuss the research, contributions and limitations, whilst Chapter 7 and Chapter 8 respectively give the conclusions and recommendations.

1.6. List of definitions

Business roadmap	A one-page overview of a firm's innovation strategy. The business roadmap shows the evolution of markets, products and technologies of a firm over time. In this report, the business roadmap is also referred to as 'roadmap'.
Business roadmap architecture	The structure used in the business roadmap to show the information. The business roadmap architecture comprises the time-horizons shown on the horizontal axis and the taxonomy of layers incorporated on the vertical axis.
Business roadmap development process	The activity of developing the business roadmap, comprising all steps of the process from formulating an innovation strategy to the elaboration into a business roadmap. Alternatively, this process is abbreviated as 'business roadmap process' or just 'roadmapping'.
Case study	A research strategy in which a small number of cases are evaluated qualitatively in their real-life context (Dul & Hak, 2008). In this report, the case study under consideration is Ballast Nedam.
Construction industry	An industry sector engaged in the design, construction and maintenance of structures in the build and natural environment.
Corporate strategy	"The determination of the basic long-term goals and objectives of an enterprise, and the adoption of courses of action and the allocation of resources necessary for carrying out these goals" (Chandler, 1962, p. 13). This a so-called intended strategy.
Documentation study	A data collection method involving the consultation of a vast amount of several types of documents.
Effect uncertainty	A type of uncertainty that relates to a lack of knowledge about how a changing environment influences an organisation (Milliken, 1987).
External environment	The factors outside a company that could have implications for the functioning of a company and that are beyond the control of a company. These factors are referred to as external environmental factors.
External uncertainty	The perceived inability of a person to predict something accurately because he/she has insufficient information to predict. External uncertainty refers to uncertainty stemming from the organisation's external environment (Milliken, 1987).
Focus area	An area where a firm needs innovation. Focus areas are spearheads of an organisation for moneymaking.

Individual interview	A data collection method involving face-to-face conversations with a single person to elicit subjective information.
Innovation	"Innovation is the production, adoption, assimilation, and exploitation of value-added novelty in economic and social spheres" (Crossan & Apaydin, 2010, p. 1155).
Innovation driver	The motives that gets a firm to innovate.
Innovation process	The whole of decisions, activities and impacts that occur from recognition of a need or a problem, to the adoption of an innovation by users and its consequences (Rogers, 2003).
Innovation strategy	That part of the corporate strategy that determines where and when innovation is required to come to the organisational aims. The innovation strategy determines what actions are to be executed for this (Goffin & Mitchell, 2005). This is a so-called intended innovation strategy.
Internal environment	The factors inside a company that could have implications for the functioning of a company and that can be controlled by the company.
Literature study	A data collection method involving consulting scientific literature to gather knowledge as a foundation for the research.
Precondition	An area where a firm needs innovation. Preconditions have to be met in order to compete in the market, meet minimum client requirements and excel in other working areas.
Process innovation	A type of innovation related to the way a product is produced, either to improve the efficiency of the production process or to improve the quality of the product (Gopalakrishnan, Bierly, & Kessler, 1999; Schilling, 2010; Utterback & Abernathy, 1975).
Product innovation	A type of innovation related to new output of an organisation to increase the benefit of an end user. This new output may comprise either new goods or new services (Gopalakrishnan et al., 1999; Schilling, 2010; Utterback & Abernathy, 1975).
Response uncertainty	A type of uncertainty that relates to a lack of information about the options, and the consequences of them, an organisation has to respond to a changing environment (Milliken, 1987).
Robustness	A characteristic of a strategy meaning that the strategy is successful under a wide range of circumstances (Coates, 2000; Van der Heijden, 2005).
Scenario planning	An approach that attempts to capture a wide range of possible futures on which a firm can anticipate, by the formulation of narratives. A firm becomes aware of how actions might turn out in alternative futures, resulting in a more conscious decision-making process.
State uncertainty	A type of uncertainty related to a lack of information about how components of the environment might be changing in the future (Milliken, 1987).
Workshop	A data collection method involving a meeting with several managers that come together to share information and reach consensus using the interaction between participants.

Chapter 2

Research design

In this chapter, the design of the research is discussed with consideration of the research design theories of Verschuren and Doorewaard (2007). Successively, a description of the problem is given, a research objective is provided, research questions are deduced, a research strategy is defined, data collection methods are specified and an overview of the research process model is shown.

2.1. Problem description

Developing a business roadmap is no standalone activity. The roadmap is namely the elaboration of the innovation strategy, ideally into a one-page overview (Goffin & Mitchell, 2005; Phaal et al., 2005). This means that prior to developing the business roadmap, a company should embark on an innovation strategy formulation process. Here, however, seems to arise a contradiction. Roadmapping and its preceding process is often conducted as if there is a certain level of predictability about the future (Goffin & Mitchell, 2005): roadmapping is a normative forecasting and planning tool that addresses what a firm should do in an anticipated future by stipulating a series of products and technologies (Coates, 1999; Kappel, 2001; Strauss & Radnor, 2004). This feature is one of the strong points of the roadmap, since it gives direction to innovation efforts and enables clear communication of the strategy (Garcia & Bray, 1997; Kappel, 2001; Phaal & Muller, 2009).

The business roadmap process is in this respect comparable with a strategic planning process (Coates, 1999; Phaal et al., 2005): it supposes that the world does not change while a plan is being developed and implemented. This assumed stable environment is however a fallacy: there is a lot of uncertainty about future developments since discontinuities cannot be predicted (Mintzberg, 1994a). Therefore, scientific literature on strategy emphasises the need for flexibility in order that a strategy could be refined if a changing environment asks for it (Mintzberg, 1978, 1994a; Tidd et al., 2005).

Although the awareness of the need for coping with uncertainty within strategies is ubiquitous, there is little attention to it in the literature on business roadmaps. Several scholars acknowledge that the roadmap should incorporate flexibility so as to cope with uncertainty in the environment (Gerdsri & Kocaoglu, 2007; Saritas & Aylen, 2010; Strauss & Radnor, 2004), but a thorough understanding and sound methodology to cope with it are still lacking in this relatively new topic. In particular, the way to deal with uncertainty without violating the strengths of the roadmap is paid little attention to.

As the business roadmap will be developed for construction company Ballast Nedam, this leads to the following problem statement:

Ballast Nedam wishes to focus its innovation effort by developing a business roadmap. This business roadmap should be able to cope with external uncertainty in the environment, and at the same time should keep its communicational and directive strengths.

2.2. Research objective

Based on the problem statement formulated in section 2.1, the objective of this research is:

Supporting Ballast Nedam in focussing its innovation effort

by

Developing and partially applying a process to facilitate both the formulation of the firm's innovation strategy and the elaboration of this innovation strategy into a business roadmap, with concern for both external uncertainty and the roadmap's strengths.

2.3. Research questions

The research objective is translated into a research question:

How to develop and apply a business roadmap process for Ballast Nedam with concern for both external uncertainty and the strengths of a business roadmap?

This research question is translated into four central questions and underlying sub questions:

1. *What insights on the business roadmap development process can be gained from literature?*
    - 1.1. *What requirements can be deduced from theory on innovation?*
    - 1.2. *What innovation strategy formulation process should be gone through for defining a business roadmap?*
    - 1.3. *How to deal with external uncertainty in business roadmaps?*
    - 1.4. *What architectural requirements exist for business roadmaps?*

2. *What firm-specific insights need to be included in the business roadmap development process?*
    - 2.a. *Why is the case of Ballast Nedam appropriate for the problem under consideration?*
    - 2.b. *What are the characteristics of case firm Ballast Nedam?*
    - 2.c. *What points of attention need to be taken into account for the business roadmap development process to be implemented successfully within Ballast Nedam?*

3. *What is the result of applying the business roadmap development process to Ballast Nedam?*
    - 3.a. *What is the Ballast Nedam business roadmap development process when combining theoretical and firm-specific insights?*
    - 3.b. *What content must be presented on the business roadmap?*
    - 3.c. *What is the external and internal environment of Ballast Nedam that must be considered for the business roadmap?*
    - 3.d. *What are the focus areas for innovation for Ballast Nedam to survive and prosper?*

4. *What are the findings of applying the business roadmap development process to Ballast Nedam?*
    - 4.a. *What are the findings of the applied research process?*
    - 4.b. *How to leverage the contributions of the research?*
    - 4.c. *How to overcome the limitations of the research?*
    - 4.d. *What generic business roadmap development protocol can be deduced from these findings?*

2.4. Research strategy

According to Verschuren and Doorewaard (2007), a research strategy is the whole of decisions about the way in which the research will be conducted. In particular, the research strategy deals with the way relevant information is gathered and the way this information is processed to valid answers on the research questions. The choice for a research strategy is based upon three considerations, i.e. a

breadth or in-depth research, a quantitative or qualitative research, and an empirical or desk research. As a result, basically five strategies can be distinguished: a survey, an experiment, a case study, grounded theory, or a desk research.

A study on relevant literature by means of a desk research is part of every type of research (Verschuren & Doorewaard, 2007). A desk research is used to get acquainted with the relevant theory, in this research the theory on innovation, innovation strategy, external uncertainty and business roadmaps. The desk research is the theoretical basis for the main part of the research.

The research motive, research objective and research questions strictly demarcate the choice about the research strategy. The end result of this research should namely encompass a partial business roadmap for Ballast Nedam. This means that this research is an in-depth research focused on Ballast Nedam, which should yield qualitative results based on information from within the firm. As a consequence, the choice for the research strategy is a single case study (Verschuren & Doorewaard, 2007): the business roadmap process is applied to Ballast Nedam. Based on the application of the process and the resulting business roadmap, some conclusions can then be drawn about the possibilities and limitations of roadmapping and increasing the flexibility of roadmapping.

The single case study

"The case study is a study in which one case or a small number of cases in their real life context are selected, and scores obtained from these cases are analysed in a qualitative manner" (Dul & Hak, 2008, p. 4). A type of case studies is the single case study, "a case study in which data from one instance is enough to achieve the research objective" (Dul & Hak, 2008, p. 4). Within a single case, several sub cases could be investigated if desirable (Eisenhardt, 1989; Verschuren & Doorewaard, 2007). In this research, the case under consideration is construction firm Ballast Nedam as Ballast Nedam is the initiator of this research. This means that there is a matter of an intrinsic case study (Stake, 1995), in which it could be possible to consider Ballast Nedam segments as separate sub-cases in the business roadmap on the corporate level. Yin (2003) calls this a single case study with embedded units of analysis.

The single case study allows for a thorough investigation and analysis of the case in order to get a profound understanding of it (Eisenhardt, 1989; Stake, 1995; Verschuren & Doorewaard, 2007). A limitation of this strategy is however that it does not allow for generalisation of the results because of the possible occurrence of coincidence (Dul & Hak, 2008; Hodkinson & Hodkinson, 2001; Stake, 1995; Verschuren & Doorewaard, 2007), whereas this is possible for multiple case studies through replication in different cases (Dul & Hak, 2008). However, as advocated by Stake (1995) and Verschuren and Doorewaard (2007), this lack of generalisability is of minor importance in single case studies because of their practical line of approach. What is more, the single case study can nevertheless be used as supporting argument for other researches (Dul & Hak, 2008; Hodkinson & Hodkinson, 2001).

2.5. Data collection

Collecting data is an important aspect of the research. The fact is that it is the translation of the research questions to research material. Verschuren and Doorewaard (2007) distinguish five types of data collection, namely persons, documents, literature, reality and media.

Several authors, like Eisenhardt (1989), Verschuren and Doorewaard (2007) and Saunders, Lewis, and Thornhill (2009), argue that it is beneficial to use multiple methods for data collection. This triangulation namely ensures that all research questions can be answered, since different research questions need different data types and each data collection method has its strengths and weaknesses with regard to obtaining useful results. Moreover, triangulation strengthens the results

of a case study since it compensates for variation and coincidence (Eisenhardt, 1989; Verschuren & Doorewaard, 2007). In this research, therefore multiple data collection methods are used: persons, documents and literature. Below, per report section a description is provided on what data was necessary and how this data is collected.

Introduction
In the introduction part of this research, data is necessary for investigating the background and justification of the research. This data needs to be valid; it is a source of knowledge that forms the basis for the whole research. Verschuren and Doorewaard (2007) argue that such knowledge can be gathered by conducting a scientific literature research. Based on this scientific literature, a theoretical framework can be constructed that enables and shortens the execution of a research. In the introduction part of this research, also firm-specific information is used. This data is gathered by means of a documentation study as reasoned by Verschuren and Doorewaard (2007). The documentation study namely allows for collecting a vast amount of qualitative and objective information on numerous topics, if there is no need to capture the opinions of people. Since no people have to be consulted for the documentation study, it can be executed whenever it is considered opportune.

Research design
In the research design part, data is necessary for determining what problem is worth investigating. As with the data for the background and justification of the research, the problem needs to be based on scientific knowledge (Verschuren & Doorewaard, 2007). Therefore, a study on scientific literature is part of the data collection process.

Theoretical framework
The theoretical framework consists of scientific knowledge relevant for this research. It provides insights that enable the investigation of the problem under consideration. The scientific knowledge is collected by means of a scientific literature study (Verschuren & Doorewaard, 2007).

Case study
Before conducting the case study, insight was provided on the background of the case under consideration by means of executing a documentation study. Moreover, this introduction contains a research on the suitability of the case for the intended purpose. For this suitability assessment, a scientific literature study is conducted.

The business roadmap development process followed during the case study, is based on both the insights gained during the literature study and written down in the theoretical framework, and insights gained from Ballast Nedam managers. To get the opinion of Ballast Nedam managers on the value and filling-in of the business roadmap process, individual interviews are used. By this, the required information can be provided very quickly, in addition to which it is both possible to steer the answers of the interviewees exactly to the information needed for the research and to capture the opinions of the interviewees (Verschuren & Doorewaard, 2007). The interview design is enclosed in Appendix A.1. The resulting business roadmap development process is a combination of literature insights and company insights, so as to get a business roadmap that is both theoretically underpinned and applicable within the company under consideration.

Then, for the case study, data is required on both the internal and external environment of Ballast Nedam. Here, a distinction is made between objective information and subjective information. For the analysis of the external environment, objective data is necessary for constructing a reliable sketch of the future environment of the firm. This data comes from conducting a documentation study since this allows for collecting objective information on many subjects (Verschuren & Doorewaard, 2007). Examples of documents that are consulted are general trend and sector trend

analyses of governmental institutes and consulting agencies. Documents are also used as means to create insight about the internal environment of Ballast Nedam, especially with regards to its corporate strategy and organisation. For this information, internal and annual reports of Ballast Nedam are used.

The subjective information necessary in the case study is about what Ballast Nedam considers important for its future. Here, employees are used as a source of data since this makes it possible to quickly capture the opinions of the interviewees, in addition to which it is possible to steer the answers of the interviewees exactly to the information needed for the research (Verschuren & Doorewaard, 2007). There are several ways to open up the information from people. In this research, face-to-face contact is used since this allows for interaction with the interviewee and since it is a means to show the importance of the research. Verschuren and Doorewaard (2007) classify the face-to-face interviews to individual interviews and group interviews. The benefit of the group interview over the individual interview is that the interaction between interviewees can be used to obtain new insights amongst the interviewees. This is especially important in case of difficult issues about reaching consensus on future developments (Longhurst, 2010; Verschuren & Doorewaard, 2007).

However, the time and resources available for this research do not allow to solely rely on group interviews. Therefore, individual interviews are used prior to group interviews so as to capture important themes that must be discussed plenary. In line with the reasoning of Eisenhardt (1989), Saunders et al. (2009) and Longhurst (2010), a semi-structured interview is used so as to be able to "probe emergent themes or take advantage of special opportunities which may be present in a given situation" (Eisenhardt, 1989, p. 539), though having a list of themes that must be covered during the interview for assuring consistency. Appendix A.2 contains the interviews used and a list of interviewees.

For the group interviews, a workshop setting is used since this is considered an effective way for both eliciting information from participants and reaching consensus (Nuseibeh & Easterbrook, 2000). In corporate strategy formulation, such workshops are commonly used to reach consensus on the future direction of a firm (Hodgkinson, Whittington, Johnson, & Schwarz, 2006). These strategy workshops can be characterised as processes in which a firm's top managers come together to arrive at a shared understanding of the future direction by discussing the firm's environment, strategic options and actions plans (Bowman, 1995; Hodgkinson et al., 2006; Johnson et al., 2008). Similar workshops are also applied for developing a business roadmap (see e.g. Phaal, Farrukh, Mitchell, et al. (2003)). Appendix A.3 provides the design of the workshops that are held.

Each interview and workshop is transcribed quickly after it is held. This transcription is based on recordings of the interviews or workshops, if the interviewees give permission for recording the talk, since this enables the researcher to fully focus on the interaction instead of focusing on capturing the interviewee's opinions in words. If no permission is given, the transcription is nevertheless based on notes.

Evaluation

During the evaluation phase of the research, information is required on the value Ballast Nedam attaches to the developed business roadmap process and the resulting partial business roadmap. This information is elicited by conducting semi-structured individual interviews, for which the interview set-up is shown in Appendix A.4. The outcome of these interviews revealed contributions and limitations of the research. In addition, other contributions and limitations observed during the research are included as well. Solutions for the limitations are provided through a study on scientific literature. To conclude, the generic business roadmap development protocol that is deduced from the findings is compared to other processes, for with also scientific literature is necessary.

2.6. Research process model

The phases this research consists of are schematically represented in Figure 3. In words, the research comprehends the following:

The research started with a desk research that is used to gain insights into the background and justification of the research by means of a literature and documentation study. These insights allowed for the formulation of the research design: it enabled the description of the problem and the elaboration of the remaining part of the research design. Based on the questions that were deduced, the theoretical framework for the research is constructed. This results in a theoretical foundation on innovation, innovation strategy, external uncertainty and business roadmaps. The insights gained out of this theoretical framework form the answer on central question 1.

After an introduction to the Ballast Nedam case based on both a documentation study and literature study, the Ballast Nedam firm-specific insights are elicited by conducting several interviews, resulting in the answer on central question 2. Next, the third central question is answered by first developing the business roadmap process by combining the theoretical insights and the Ballast Nedam specific context. This way, a business roadmap process is obtained that is theoretically grounded and adapted to function within Ballast Nedam. Next, this business roadmap development process is

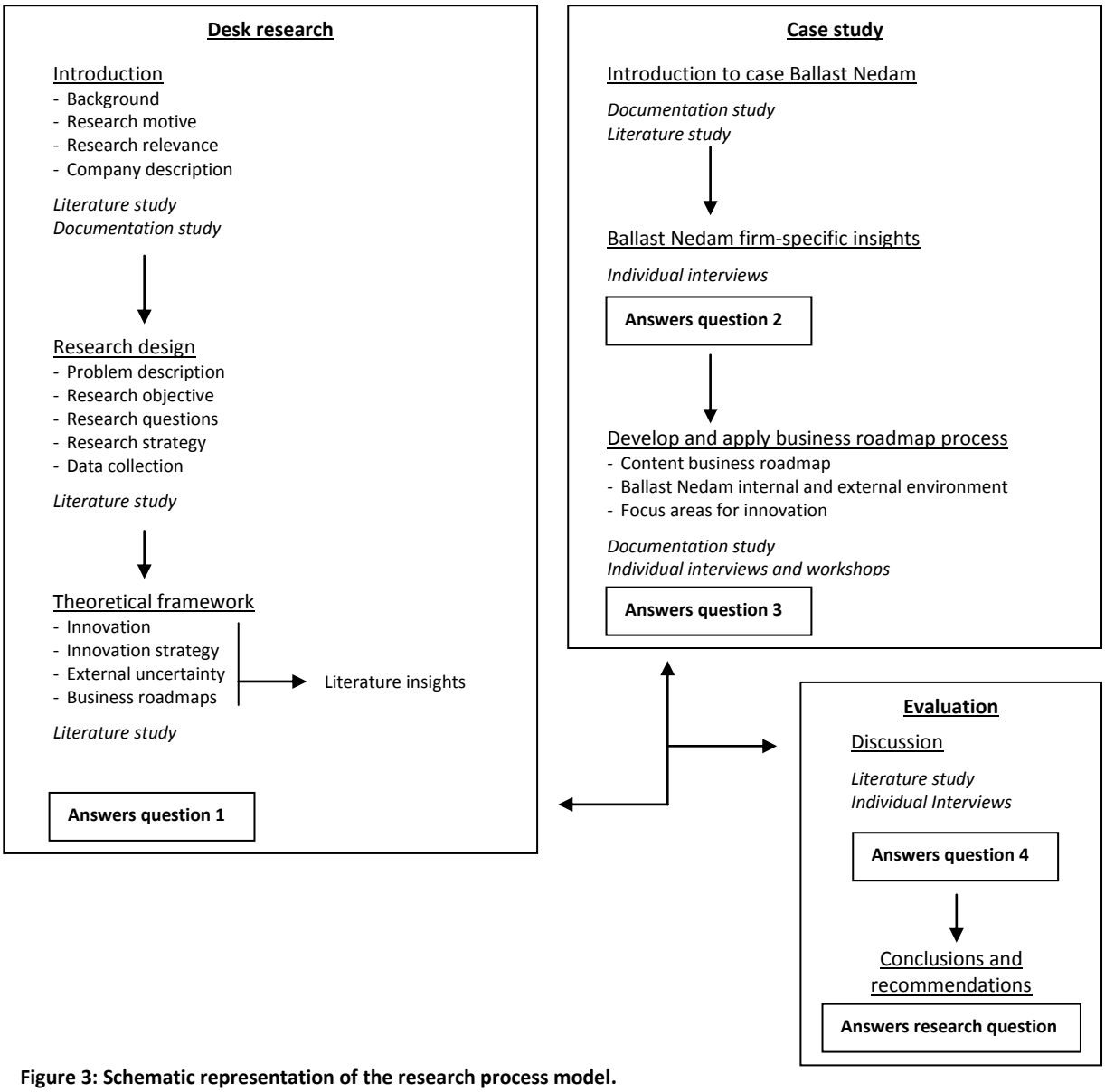

Figure 3: Schematic representation of the research process model.

applied within the context of Ballast Nedam through a single case study. First, a documentation study is used to understand the corporate strategy of Ballast Nedam. Next, the participatory process is prepared and the layout of the business roadmap is determined. Subsequently, also by means of a documentation study, insight is created about the internal and external environment of Ballast Nedam. Through conducting individual interviews, this insight is further enhanced, after which it was possible to facilitate two workshops with multiple managers for partly elaborating the business roadmap.

Based on the case study results the applicability of the developed business roadmap process is analysed during individual interviews. During these interviews both perceived contributions and limitations are discussed, and afterwards ways to leverage the contributions and overcome the limitations are given through a coupling with scientific literature. Out of these findings, a generic business roadmap development protocol is developed. The result of this evaluation is the answer on central question 4. To conclude, both scientific and practical conclusions are formulated to answer the research question, and afterwards several recommendations are given based on this research.

Chapter 3

Theoretical framework

In this chapter, the theoretical framework for the research is defined. Section 3.1 covers the topic of innovation, section 3.2 elaborates the topic of innovation strategy, section 3.3 describes the theory on uncertainty, and section 3.4 gives insights in the theory on business roadmaps. In section 3.5, to conclude, the answer on central question 1 is drawn up by concluding on the literature insights.

3.1. On innovation

Nowadays, the term innovation is often used since many firms are giving attention to it. This results in a myriad of definitions that might provoke confusion (Van der Kooij, 1988). Therefore, this section gives due consideration to the meaning of innovation and some related topics.

Definition of innovation

In their literature review on innovation, Garcia and Calantone (2002) conclude that there are many different definitions used for innovation. They found that a good definition of innovation requires two aspects. First, the definition must give attention to the development of an invention combined with the market adoption and diffusion: commercialisation is needed for an invention to become an innovation. Second, they stress that the definition should include the iterative nature of an innovation process. In this, Garcia and Calantone (2002) neglect however that innovation does not necessarily mean that a new product is put on a market: firms can also use innovations internally.

For this research, therefore the definition of Crossan and Apaydin (2010) is used. This definition namely covers the whole process of innovation with the need for an innovation to be implemented, but without focussing on the need for a product to be put on the market. Moreover, it leaves open the opportunities of external development of a solution, as well as perceived newness of it for a firm.

Definition 1: Innovation.

> *Innovation is the production, adoption, assimilation, and exploitation of value-added novelty in economic and social spheres (Crossan & Apaydin, 2010, p. 1155).*

Typology of innovations

Authors like Kline and Rosenberg (1986), Miles (1993), Schumpeter (2004) and Varis and Littunen (2010), identified multiple types of innovations ranging from product to process, service, business model and organisational innovations. Often, however, a distinction is made between either product innovations or process innovations (Garcia & Calantone, 2002; Schilling, 2010), referring to the areas and activities of a firm that are affected by it. A product innovation is a new output (i.e. goods or services) of an organisation that is introduced to increase the benefit of an end user (Gopalakrishnan et al., 1999; Schilling, 2010; Utterback & Abernathy, 1975). A process innovation is related to the way

a product is produced: it concerns new tools, knowledge, or resources that improve the efficiency of the production process or improve the quality of the product (Gopalakrishnan et al., 1999; Schilling, 2010; Utterback & Abernathy, 1975).

Innovation does not necessarily mean that complete new products or processes are to be implemented: there are many kinds of innovation that can lead to significant benefits (Kanter, 2006). Henderson and Clark (1990) developed a framework that can give further insight in the types of innovation. The framework is developed for product innovations, but can also serve for process innovations. It emphasises that two types of knowledge are required for successful innovations. First, it requires knowledge about a component of a product, in which a component is considered to be "a physically distinct part of a product that embodies a core design concept" (Henderson & Clark, 1990, p. 11). Second, it requires knowledge about the functions a product must fulfil, the mapping of functions to components and the way in which the components are integrated and linked together in coherent whole, i.e. knowledge about the product architecture (Baldwin & Clark, 1997; Henderson & Clark, 1990; Ulrich, 1995). This distinction results in four types of innovation, as shown in Figure 4:

- *Incremental innovation:* the already existing product or process is refined or extended marginally by changing one or a few of its components. The changes to the components are based on existing knowledge and do not alter the core concept underlying the component or the architecture (Bessant et al., 1994; Ettlie, Bridges, & O'Keefe, 1984; Garcia & Calantone, 2002; Henderson & Clark, 1990; Schilling, 2010);

- *Architectural innovation:* the core concept underlying the components, and thus the knowledge required for it, remains the same. The idea of architectural innovation is that the overall design of the product or process, i.e. the functions, modules necessary or interaction between components, is changed (Baldwin & Clark, 1997; Henderson & Clark, 1990; Schilling, 2010);

- *Modular innovation:* the core concept underlying a component is fundamentally changed. This is possible since if a component adheres to the architecture, the precise design of the component is not important. This means that components can be changed without the functioning of the whole product or process being affected (Baldwin & Clark, 1997; Halman et al., 2008; Henderson & Clark, 1990; Schilling, 2010; Ulrich, 1995); and

- *Radical innovation:* the product or process differs completely from prior solutions: the core idea behind components is changed fundamentally and a new design is established, resulting in a complete different architecture (Ettlie et al., 1984; Henderson & Clark, 1990; Schilling, 2010).

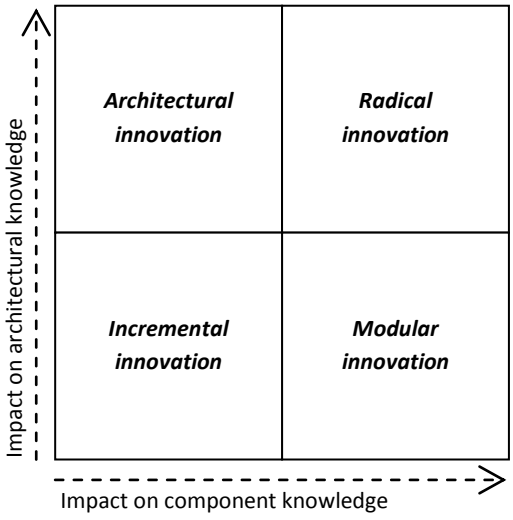

Figure 4: Innovation framework (Henderson & Clark, 1990).

The innovation process

Multiple authors have studied the different stages that together comprise the innovation process, and found different models to describe this process (Brem & Voigt, 2009; Cooper, 1990; Kline & Rosenberg, 1986; Rogers, 2003; Rothwell, 1994; Trott, 2005; Veryzer, 1998; Wheelwright & Clark, 1992). According to Rogers (2003), the innovation process consists of all decisions, activities and impacts that occur from recognition of a need or a problem, to the adoption of an innovation by users and the consequences of this. Combining the different innovation models, the innovation process can be regarded as a four-stage process, starting with the idea generation and selection, through a study on the feasibility, to the development stage and finally to the implementation stage. This innovation process, sometimes depicted as a funnel when the whole innovation activity of a firm is analysed, is depicted in Figure 5. Cooper (1990) argues that, before an innovation can proceed to a next stage, a firm decides whether to continue the development process.

Idea generation stage

The first stage of the innovation process starts with the identification of an opportunity (Koen et al., 2001). This opportunity can either originate from an identified market need or from existing knowledge within a firm (Kline & Rosenberg, 1986; Koen et al., 2001). Koen et al. (2001) describe that the next step is to generate ideas for the identified opportunity. These new ideas go through an iterative process: after several rounds of discussion and modification, final ideas will be formed (Koen et al., 2001; Veryzer, 1998). The decision about which ideas to further elaborate, is often based on a selection process with several appraisals, like an evaluation whether the idea fits within the innovation strategy and rough financial estimations (Cooper, 1990; Koen et al., 2001).

Feasibility stage

The next stage in the innovation process is an assessment of the feasibility of the idea (Cooper, 1990; Koen et al., 2001; Veryzer, 1998). In this stage, a research is executed concerning the potential of the idea. If the idea comprises new output for the firm, the analysis moreover includes a competitive analysis and evaluation of market acceptance. What is more, the feasibility stage contains a thorough analysis on technical feasibility. The analyses give the chance of successful technology development, the investments required and the time needed for this development. Often, this stage includes a financial analysis for future expenses, and future returns or savings (Cooper, 1990; Koen et al., 2001).

Development stage

After a successful completion of the feasibility stage, the idea proceeds to the development stage (Cooper, 1990; Kline & Rosenberg, 1986; Veryzer, 1998). In this stage, the idea is transformed to a form that is expected to meet the needs of the target audience (Rogers, 2003). Moreover, this stage often involves elaborate testing and drawing up of both a detailed marketing and operations plan. After the development, the product is tested and validated concerning quality, production process, viability and acceptance (Cooper, 1990; Veryzer, 1998).

Implementation stage

The last stage of the innovation process is about the implementation and diffusion of the innovation, and subsequently its adoption by users (Cooper, 1990; Rogers, 2003). In this stage, the marketing and operation plans are put into force. Kline and Rosenberg (1986) show that after implementation, there are feedback loops that link user perception to product or process improvement. Such iterations can also be found between the other stages of the process: the process is not linear.

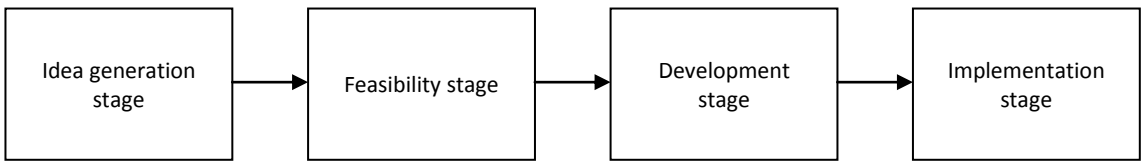

Figure 5: The innovation process. Instead of a purely linear process, some feedback loops may occur.

Drivers for innovation

Trott (2005) describes two schools of thought on what firms drives to innovate, i.e. what motives or sources for innovation exist for a firm. The first school of thought comprises the market-based or external view. In this view, market conditions provide the context for the innovation activity: a firm adapts itself to exploit changing market conditions (Sexton & Lu, 2012). The basic idea behind this market-based view is that a firm becomes aware of unfulfilled customer needs in the marketplace. These customer needs are communicated to the R&D department and new products are manufactured that meet the unfulfilled customer requirements. This mechanism with the market as driver for innovation, is called 'market-pull' (Brem & Voigt, 2009; Chidamber & Kon, 1994; Di Stefano, Gambardella, & Verona, 2012; Dosi, 1982; Trott, 2005). Sexton and Lu (2012) add that the market-based view comprises both the general business environment and the interaction environment of a firm. The general business environment covers social, legal, economic, political, environmental, and technological forces, while the interaction environment comprises the industry structure, clients, suppliers, competitors, financiers, and regulators. So, other market-based drivers for innovation could be e.g. changing legislation, competitors that introduce new products, a scarcity of resources and increasing international competition forcing a firm to lower its production costs (Brem & Voigt, 2009; Geels & Schot, 2007; Halman et al., 2008; Tatum, 1989; Tidd et al., 2005).

The resource-based or internal view emphasises that the firm's own resources are the key for the innovation activity and that these can shape the marketplace. This is contrary to the market-based view in which is advocated that the market shapes the activities of a firm (Sexton & Lu, 2012; Trott, 2005). In the resource-based view, the knowledge and competencies of a firm are deployed to gain a competitive advantage, e.g. through lowering production costs or improving the quality of products (Abernathy & Clark, 1985; Brown & Eisenhardt, 1995; Di Stefano et al., 2012; Seaden & Manseau, 2001; Tidd et al., 2005). A firm can also create new market opportunities: through 'technology push', a firm's scientific discovery is translated into a product and promoted on the marketplace to shape demand for it (Chidamber & Kon, 1994; Dosi, 1982; Trott, 2005). Dosi (1982) argues that this 'technology push' mechanism is relevant for explaining the introduction of breakthrough products.

The contemporary view on the driving forces for innovation, is that the resource-based view and the market-based view are complementary to each other (Chidamber & Kon, 1994; Di Stefano et al., 2012; Dosi, 1982; Sexton & Lu, 2012; Trott, 2005): through interaction between the marketplace for adoption and the organisation's resources for creating products, successful innovations are obtained.

3.2. On innovation strategy

An ad-hoc innovation activity within a firm might produce successful innovations. However, it is questionable whether these innovations support the areas in which the firm is active or fulfil relevant market demands. Moreover, longer-term perspectives, necessary for a firm to survive and prosper, might be lacking. Therefore, a firm needs an innovation strategy to steer its innovation activity.

Definition of innovation strategy

Strategy has long been associated with the military. Etymologically, the word stems from the Greek term 'stratego', which has the meaning of 'to plan the destruction of one's enemies through the effective use of resources' (Bracker, 1980). Not until the era after World War II, the concept of strategy was introduced into business management with the emerging interest for long range planning (Bracker, 1980; Grant, 2003; Johnson et al., 2008). Early corporate strategy theory emphasises the need to apply systemised analysis techniques to seek a good fit between the internal and external environment of a firm and by that cope with the complexity of the future (Bracker, 1980). This rational strategic planning process, defined by Grant (2003, p. 491) as "systematic, formalised approaches to strategy formulation", was considered valuable in relatively stable environments.

Scholars have found that a corporate strategy covers two areas. First, the corporate strategy is about deciding which direction the firm shall go, and subsequently deciding about the route to get where the firm wants to be (Brown & Eisenhardt, 1998). These two areas demonstrate clearly the rational idea behind strategic planning: the strategy is a conscious plan that is made in advance and executed after it is developed. Mintzberg (1978) contests this view on strategy. In his article, he shows that there are two variants of strategy formation. The first one is the intended strategy, which is the strategy as described above. A strategy can also emerge due to learning about decisions made and actions taken, without conscious or deliberate thought. A sudden environmental change may ask for decisions without conscious thought, and gradually a strategy may form. Mintzberg (1978) labels these kinds of strategies emergent strategies. He therefore defines strategy as "a pattern in a stream of decisions", which means that "when a sequence of decisions in some area exhibits a consistency over time, a strategy will be considered to have formed" (Mintzberg, 1978, p. 935).

The goal of this research is to formulate a strategy upfront: an intended strategy. Therefore, in this research the well-known definition of Chandler (1962) is used for corporate strategy.

Definition 2: Corporate strategy.

> *Corporate strategy is the determination of the basic long-term goals and objectives of an enterprise, and the adoption of courses of action and the allocation of resources necessary for carrying out these goals (Chandler, 1962, p. 13).*

As part of the overall corporate strategy, a firm needs to formulate an innovation strategy (Brem & Voigt, 2009; Cooper & Kleinschmidt, 2007; Dwyer & Mellor, 1991; Fisscher, van Looy, de Weerd-Nederhof, & Debackere, 2004; Goffin & Mitchell, 2005; Tidd et al., 2005) as this innovation strategy increases the performance of the firm (Cooper & Kleinschmidt, 2007) and ensures that new products and processes are aligned with the overall goals of the firm (Dodgson et al., 2008; Tidd et al., 2005). This innovation strategy, alternatively named new product strategy if it solely deals with new output of a firm (e.g. Cooper and Kleinschmidt (2007); Dwyer and Mellor (1991)), determines the role of innovation in the business, specifies the areas in which products, processes and capabilities are to be developed and is leading in the decision what projects to do and how a firm will execute the projects (Cooper & Kleinschmidt, 2007; Dodgson et al., 2008; Dwyer & Mellor, 1991; Fisscher et al., 2004).

The term innovation strategy is in this research defined as formulated by Goffin and Mitchell (2005).

Definition 3: Innovation strategy.

> *An innovation strategy is part of the overall strategy. The innovation strategy determines where and when innovation is required to meet the aims of the organisation and lays out in broad terms what is to be done about it (Goffin & Mitchell, 2005, p. 98).*

The innovation strategy development process

According to Johnson et al. (2008), there is no single right way for developing strategies. Dependent on the context and resources available, firms can use different processes for strategy development so as to build organisations that are capable of coping with the environment. They stress that firms need to seek a strategic fit between their internal environment and external environment, for which some formal analysis processes are very valuable. Both Kaplan, Norton, and Barrows (2008) and Goffin and Mitchell (2005) agree with this view, as does Buijs (2003) in his article on new product development. The strategic analysis of the environment gives insight in the competencies and assets of the firm and the important factors of the external environment in which it operates. This analysis

may reveal a mismatch between the anticipated external environment, the goals formulated in the corporate strategy of the firm, the current activities of the firm, and its internal environment. Here, the need for innovation may arise: the innovation strategy must make clear what type of innovations, i.e. radical, modular, incremental or architectural product or process innovations, are necessary to leverage the identified opportunities and to reduce threats for the future. It must also make clear what types of resources are required to implement these innovations successfully. Nagel (1992), in his step-by-step plan for technology strategy formulation, adds that a choice is required on acquisition and exploitation of knowledge, as well as on action plans. As such, the innovation strategy makes clear where the organisation faces problems, direct employees to search solutions where they are most needed and acts as a means to program the innovations (Goffin & Mitchell, 2005).

Johnson et al. (2008), as well as Hodgkinson et al. (2006) and Bowman (1995), indicate that workshops are a usual way for carrying out the strategy development process. These workshops are one- or two-day meetings with senior managers and lower managers allowing for a wide range of perceptions to be incorporated. Johnson et al. (2008) stress that the preparation for these workshops is essential: participants must gather important data beforehand since the workshop duration does not allow for elaborate data collection. Therefore, the purpose of the workshops must be clearly communicated amongst the participants. During the workshops, the internal environment, external environment, and confrontation of the environments with options for the future are discussed. By this discussion, the participants learn about the future of customers and markets, science and technology, regulations, competition, suppliers etc., creating awareness about the possibilities and limitations in regard of the innovation activity (Dodgson et al., 2008). In Table 1 (see page 23), an overview of the analyses to be conducted is given, as well as the intended results of these analyses.

Analysis of internal environment

The analysis of the internal environment of a firm comprises the evaluation of both the current activities and the capabilities of a firm. The capabilities of a firm first contain its resources and competencies to meet the minimum requirements of users. Moreover, these capabilities can be a source of competitive advantage if they are different from the capabilities of other firms, difficult to obtain, valuable to buyers and non-substitutable (Johnson et al., 2008). Johnson et al. (2008) distinguish four types of resources, i.e. physical resources like machines and buildings, financial resources like capital, human resources like skills of employees, and intellectual resources like patents. Johnson et al. (2008) continue that the way these resources are employed and deployed, matters as much as the availability of the resources. For this, the term competence is used, which is the ability to use the resources effectively and efficiently for the organisation's activities. Examples of competencies are management skills, routines, adaptability or the relation with customers and suppliers (Johnson et al., 2008). The analysis of the internal environment reveals whether the organisation has the minimum capabilities needed to survive and meet the requirements of customers, for now and a changing future. What is more, the analysis indicates whether a firm has unique resources or core competencies that drive competitive advantage (Johnson et al., 2008).

There is no single way for analysing the internal environment of a firm. In the view of Johnson et al. (2008) and Kaplan et al. (2008), the Value Chain method discussed by Porter (2008) is an appropriate way to examine this internal environment of the firm, as it allows for a systematic analysis of relevant company areas by giving general descriptions of activities. Moreover, the approach is widely used and managers are familiar with it (Tidd et al., 2005), which makes it an appropriate tool for this research. The Value Chain method proposes to evaluate the firm's internal processes firstly in the fields of activities concerned with the inputs for the products and services, processing these inputs to the end product, delivering the products to customers, selling the products and providing service like installation and training. Secondly, the Value Chain method comprises an evaluation of supporting activities: the process of acquiring resources, technology development, human resource management, and the firm's infrastructure like planning, finance and information management.

Analysis of external environment

The analysis of the external environment of a firm includes an evaluation of the broad macro-environment of the firm to identify the key drivers on the macro-level, and an evaluation of the industry and micro-environment of the firm (Johnson et al., 2008; Kaplan et al., 2008). The broad macro-environment is the high-level environment that influences all organisations to some extent. The analysis of the macro-environment must give a wide overview of factors that are likely to affect the success of the firm. The PESTEL-framework is an effective means for identifying these key drivers, as the framework allows for a structured examination of the environment by providing a broad and comprehensive list of possible influences on the organisation. The analysis reveals what the drivers are currently and what their change might be in the future. The PESTEL-analysis contains factors in the field of politics (role of governments), economics (macro-economic factors), social influences (culture and demographics), technology (emerging technologies), environment (green issues) and legislation (Johnson et al., 2008; Kaplan et al., 2008). In section 3.1, these broad macro-environmental drivers are called the general business environment that drives innovation.

The industry level analysis reveals how attractive an industry is and whether an organisation in the industry is likely to be successful. It helps a firm to differentiate from other firms and focus on particular areas. This analysis contains an assessment of the industry on five forces (see Porter (2008)), as well as a benchmark of a company's performance against competitor's performances (Johnson et al., 2008; Kaplan et al., 2008). The Five-Forces analysis includes an examination of the ease for firms to enter the industry, the existence of substitute products that may provide the same benefit to customers, the power of buyers, the power of suppliers, and the existing rivalry in the industry. The method allows for a structured analysis and, as it is widely known in businesses (Tidd et al., 2005), it fits the purpose of and resources available for this research. To conclude, the industry analysis gives insight in industry trends, and the performance of the firm in the current industry and the expected performance in the future industry. The analysis of the external environment also includes the micro-environment with an assessment of the activities and performance of competitors and an examination of the requirements of customers or potential customers (Johnson et al., 2008; Trott, 2005). In section 3.1, these factors together are called the interaction environment of the firm.

Confrontation of internal and external environment

The factors identified by the analysis of the external environment, could have implications for the organisation (Johnson et al., 2008). Therefore, a key element of the analyses is to draw opportunities and threats for the organisation stemming from the external environment. These opportunities and threats are coupled to the factors identified in the internal environment, i.e. current activities, strengths and weaknesses of the organisation, to determine whether the organisation is capable of performing in the external environment. By this, threats can be minimised, advantage can be taken from opportunities, and other focus areas are identified, for which an action plan for innovation can be formulated (Goffin & Mitchell, 2005; Johnson et al., 2008; Kaplan et al., 2008).

Table 1: Overview of the innovation strategy development process.

Step	Activity	Result
Analysis of internal environment	Evaluate firm's activities, resources and competencies	Reveals whether firm has resources and competencies needed to survive and meet minimum user requirements
		Reveals whether firm has unique resources and competencies that are a source of competitive advantage
		Overview of firm's activities, strengths and weaknesses
Analysis of external environment	Evaluate firm's macro-, industry and micro-environment	Reveals key-drivers that are likely to affect the success of a firm: external environmental factors
		Helps a firm to differentiate from other firms and focus on specific areas
		Overview of firm's opportunities and threats
Confrontation of environments	Coupling factors from internal and external environment	Reveals whether firms is capable of performing in the industry
		Gives areas where innovation is required

Dealing with uncertainty in strategy

Extensive literature advocates that there is a need for firms to adapt to changing environments and to cope with uncertainty to remain viable (Brown & Eisenhardt, 1998; Duncan, 1972; Grant, 2003; Miles, Snow, Meyer, & Coleman, 1978; Mintzberg, 1978, 1994a; Tidd et al., 2005): a firm needs to avoid long-term commitment to a single technology or process, since this weakens its position when environments change as it cannot defend against threats or take advantage of new opportunities (Courtney, Kirkland, & Viguerie, 1997; Miles et al., 1978). Scholars argue that the analytical strategy development process described in this section is not capable of coping with changing environments, since this process contemplates the future as more or less like the present and it thus cannot cope with discontinuous change (Grant, 2003; Mintzberg, 1994a). However, assuming a totally unpredictable world and hence abandoning the strategy formulation process in favour of deciding based on gut feeling, is also dangerous since this will result in being left behind by competitors (Brown & Eisenhardt, 1998; Courtney et al., 1997).

Therefore, scholars stress that a strategy should be flexible to cope with changing environments (Brown & Eisenhardt, 1998; Courtney et al., 1997; Grant, 2003; Miles et al., 1978; Mintzberg, 1994a; Tidd et al., 2005). Due to the unpredictability of the changes in the environment, Brown and Eisenhardt (1998) emphasise that it is important to gain insight in what is likely to occur in the future, and anticipate for those changes. Scholars namely also commend more formal strategies and strategy execution for their value, e.g. through creating structure and the ability to develop capabilities (Brown & Eisenhardt, 1998; Lindgren & Bandhold, 2003; Mintzberg, 1994b; Weick, 1983). It is thus important that strategies are both flexible and robust (Brown & Eisenhardt, 1998; Lindgren & Bandhold, 2003), in which robustness means that the strategy is successful under a wide range of circumstances (Coates, 2000; Van der Heijden, 2005).

3.3. On uncertainty

Uncertainty about the future is thus a critical aspect in formulating a strategy. In this section, the term uncertainty is unravelled with particular interest for the way to cope with it. A summary of a part of the discussed topics is included in Table 2 (page 25).

Definition of uncertainty

Both Downey and Slocum (1975) and Milliken (1987) argue that, since the term uncertainty is used daily in several ways, there is a need to define it. For this definition, they build upon the conclusion of Duncan (1972, p. 325) that uncertainty is no constant feature of the environment, but that it is "dependent on the perceptions of organisation members". Therefore, the perceived uncertainty may vary between individuals (Downey & Slocum, 1975; Duncan, 1972; Milliken, 1987). This aspect of uncertainty is combined with the main characteristic of uncertainty, namely that there is a lack of information available for making accurate predictions about the future (Downey & Slocum, 1975; Duncan, 1972; Miller, 1992; Milliken, 1987; Rogers, 2003). Milliken (1987) emphasises that uncertainty does not stem from a changing environment, or even a fast changing environment, but that it is the unpredictability of the changes that causes uncertainty. Duncan (1972) and Milliken (1987) add that, to emphasise that the perceived uncertainty emanates from sources outside the organisation, the label external environmental uncertainty should be used.

For this research, the definition given by Milliken (1987) is used, as it captures all these aspects of uncertainty.

Definition 4: External uncertainty.

> *Uncertainty is defined as an individual's perceived inability to predict something accurately. An individual experiences uncertainty because he/she perceives himself/herself to be lacking sufficient information to predict accurately or because he/she feels unable to discriminate between relevant and irrelevant data. The label 'environmental', when attached to the term uncertainty, suggests that the source of uncertainty is the organisation's external environment (Milliken, 1987, p. 136).*

External uncertainty can be divided into several types of uncertainty (Downey & Slocum, 1975; Duncan, 1972; Milliken, 1987). Milliken (1987) classifies these types of uncertainty as state uncertainty, effect uncertainty and response uncertainty. State uncertainty relates to a lack of information about how components of the environment might be changing in the future. Effect uncertainty relates to a lack of knowledge about how the changing environment influences the organisation: there is no information about the causal effects. To conclude, the response uncertainty is concerned with a lack of information about what options an organisation has to respond to the changing environment, whereas the consequences of these options are also unpredictable.

Sources of uncertainty

Scholars have found several sources for external uncertainty (Bessant, 2008; Duncan, 1972; Freeman & Soete, 2012; Jalonen, 2012; Miller, 1992). Generally, these sources can be divided into three groups (Bessant, 2008; Duncan, 1972; Freeman & Soete, 2012). The first group of sources comprises market uncertainty. Market uncertainty means that there is an uncertainty about future market conditions with regards to customer's needs, characteristics and behaviours, the actions of competitors or new entrants, substitute products, suppliers of components or labour, and new products and technologies available (Duncan, 1972; Jalonen, 2012; Miller, 1992).

The second group of uncertainty sources is concerned with technological uncertainty (Bessant, 2008; Duncan, 1972; Freeman & Soete, 2012; Jalonen, 2012; Miller, 1992). This group of uncertainty sources deals with the uncertainty regarding the feasibility, usefulness, functionality or quality of new technologies, meeting industry standards with this technology, and the skills and knowledge necessary to develop the technology (Duncan, 1972; Jalonen, 2012; Miller, 1992). This is related to another source of uncertainty identified by Jalonen (2012), namely the uncertainty about desirable or undesirable results of the innovation projects.

Table 2: Detailed overview of term external uncertainty.

Type of uncertainty	Source of uncertainty		Explanation of uncertainty sources
State uncertainty	Lack of information about how the external environment might be changing in the future		
		Market uncertainty	Uncertainty about customer needs
			Uncertainty about actions of competitors
			Uncertainty about availability of labour, products and knowledge
		Macro-economic and social-political uncertainty	Uncertainty about economic climate
			Uncertainty about changing governmental regulations
Effect uncertainty	Lack of knowledge about how the changing external environment affects the organisation		
Response uncertainty	Lack of information about the options the organisation has to respond to the changing external environment, and their consequences		
		Technological uncertainty	Uncertainty about knowledge required for technologies
			Uncertainty about technology required in future to meet industry and client requirements
			Uncertainty about consequences of technology development

Thirdly, some sources of uncertainty are centred on macro-economic and social-political uncertainty (Bessant, 2008; Duncan, 1972; Freeman & Soete, 2012; Jalonen, 2012; Miller, 1992). The unpredictability of economic activity, changing governmental regulations and policies, or the interaction with stakeholders with diverse interest, can result in uncertainty (Duncan, 1972; Jalonen, 2012; Miller, 1992).

To conclude, scholars recognised that more complex and more dynamic environments, respectively environments in which there are numerous sources of uncertainty and environments with constantly changing components, are perceived more uncertain (Downey & Slocum, 1975; Duncan, 1972).

Scenario planning: coping with uncertainty

Many scholars, like Brown and Eisenhardt (1998), Lindgren and Bandhold (2003), Van der Heijden (2005), and Coates (2000), stress the need for strategies to be flexible and robust in order to get a strategy that is valid, can cope with uncertainty and is successful under a wide range of circumstances. According to Lindgren and Bandhold (2003), scenario planning is an effective means to get this flexibility and robustness in strategies. The scenario planning approach originates from the United States military around World War II and found its way to the corporate setting in the 1960s. A well-known and admired user of the approach is oil company Royal Dutch Shell, who adopted it in the late 1960s and profited greatly from it in the decades afterwards. This resulted in more attention to the approach (Coates, 2000; Ringland, 1998; Schwartz, 1996; Van der Heijden, 2005).

Scenario planning is an approach that attempts to capture a wide range of possible futures on which a firm can anticipate. Scenario planning directs the attention of managers to changes they would never consider; it challenges the prevailing mind-set and stimulates to think in a different way. Through this, it reveals assumptions one makes about the future, structures uncertainty, and can create a different view and awareness about the possibility of changing environments (Coates, 2000; Schoemaker, 1995; Schwartz, 1996; Wack, 1985). These alternative views of the future are no predictions, but plausible futures that help to identify threats and opportunities for business (Coates, 2000; Grant, 2003; Schoemaker, 1995; Schwartz, 1996; Van der Heijden, 2005). In Figure 6 (see page 26), the essence of the approach is shown.

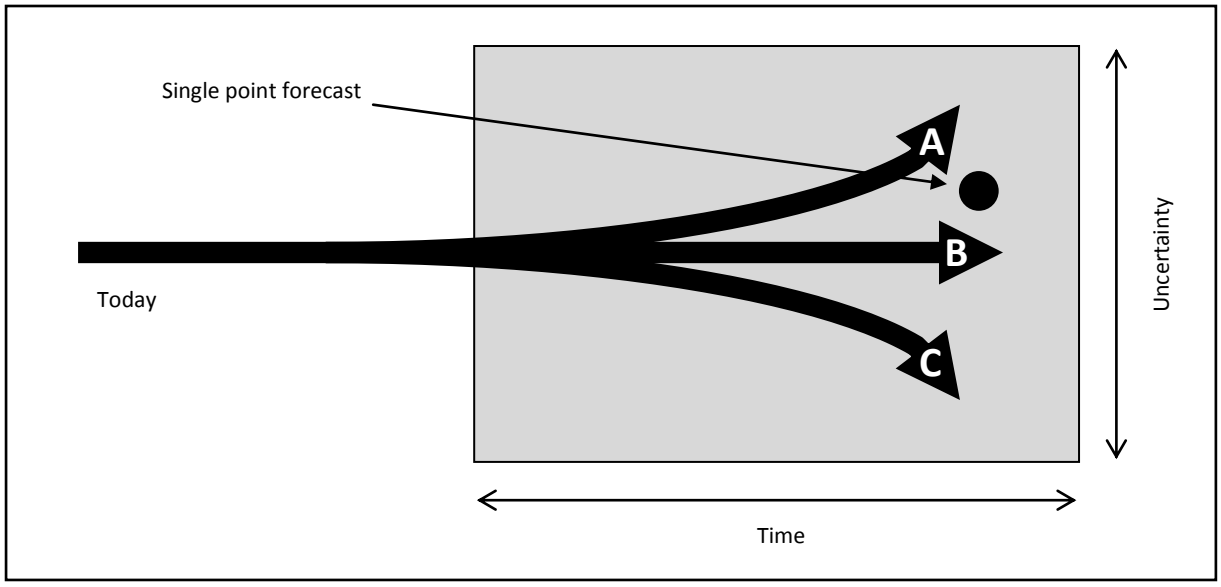

Figure 6: Essence of scenario planning. A decision is more robust if it can handle scenario A, B and C, than if it is based on the single point forecast. Figure based on Ringland (1998).

Definition 5: Scenario planning.

> *Scenarios are a tool for helping us to take a long view in a world of great uncertainty. Scenarios are stories about the way the future might turn out tomorrow, stories that can help us recognize and adapt to changing aspects of our present environment. They form a method for articulating the different pathways that might exist for you tomorrow, and finding your appropriate movements down each of those possible paths. Scenario planning is about making choices today with an understanding of how they might turn out (Schwartz, 1996, pp. 3-4).*

Roughly, two types of scenarios can be identified (Coates, 2000; Godet, 2000; Ringland, 1998; Schoemaker, 1995). First, there are scenarios developed upfront, either to explore possible futures for which a strategy can be formulated to deal with the consequences of this future, or to describe how to arrive at a desirable future. Second, there are evaluation scenarios that are used to find the consequences of a particular strategy or plan in several possible futures.

The scenario planning process

Several scholars described the scenario planning process, see e.g. Coates (2000), Schoemaker (1995) and Schwartz (1996), and Ringland (1998) for an overview of multiple approaches. These scenario planning processes are merely comparable to each other, except that they put some emphasis on different aspects. In principle, the scenario planning process can be regarded as listed below in five steps. These steps are based on Coates (2000), Schoemaker (1995) Schwartz (1996) and Slocum (2003).

1. *Define the scope for the scenario planning process*. In this step, the issues for which the process will be used are elaborated. This covers the timeframe and markets, and considers what knowledge is of value by considering the past rate of change in the industry and anticipating a same rate of change for the future.
2. *Identify the driving forces*. In this step, the macro-economic and industry forces that are important for shaping the future are identified. This analysis contains a view on basic political, economic, social, technological, environmental and legal factors, as well as industry factors like customers, regulators, suppliers and competitors that can affect the success of the business. The factors are divided into two groups: factors for which unanimously is determined that they will affect the organisation and how they will affect the organisation, and factors for which there is no consensus about whether they will affect the organisation or what their effect on the organisation will be. For the latter group of factors, a few possible outcomes must be defined, as well as relationships between uncertainties since not every combination may occur.
3. *Select the scenario themes*. This step begins with determining which two uncertainties are the most important and most uncertain. These two factors are then crossed, which results in four scenario themes that illustrate different, but the most significant kinds of potential future developments.
4. *Develop the scenarios*. For each scenario, a name should be found that covers its storyline. Then, for each scenario, the list of driving forces must be worked through. Each factor must be given attention in the scenario, after which these pieces must be weaved together in a narrative that describes how the world will come from the current situation to the end state.
5. *Evaluate the scenarios*. In this step, the developed scenarios are judged on their consistency and plausibility. If necessary, several steps of the process must be executed again.

Ringland (1998), Van der Heijden (2005) and Schoemaker (1995) describe that this scenario planning process involves conducting interviews and a desk research, and subsequently conducting a scenario workshop that lasts one or two days. The workshop includes a multidisciplinary team of six to twenty

people from internal parties like decision makers, people with expertise and creative thinkers, and external parties like customers and suppliers, to gain legitimacy and a broad range of knowledge to identify key issues (Coates, 2000; Schoemaker, 1995; Slocum, 2003; Van der Heijden, 2005). The value of such scenario workshops is considered twofold (Coates, 2000; Ringland, 1998; Van der Heijden, 2005): the outcome of the process comprising a robust and flexible strategy based on multiple possible futures, and a broad and shared understanding amongst the participants of the workshop about the future. Based on the common elements found in the scenarios, a strategy can be formulated that can cope with changing environments (Ringland, 1998).

3.4. On business roadmaps

Clear communication of the innovation strategy is essential. It enables employees to work on ideas where they are most needed. An effective way to communicate and elaborate an innovation strategy is the business roadmap. In this section, this concept is further discussed.

Origin of business roadmap

For innovation, it is important to consider both short-term and long-term new product options. However, many firms tend to focus on short-term options since these seem to be the most profitable. This focus on the short-term may result in investments that are unsustainable due to a lack of consideration for the dynamics of technology evolution. Moreover, short-term thinking may lessen flexibility due to the early allocation of scarce resources to development projects. Therefore, considering long-term expectations is considered more meaningful to successful business than just relying on short-term returns (Petrick & Echols, 2004). Nevertheless, Groenveld (2007, p. 49) argues that many management practices “fail to recognize far enough in advance which products and technologies should be available and when”. He continues that to get this awareness, a long-term view is required based on close cooperation amongst several disciplines. To achieve this long-term view and thus to be able to make conscious investment decisions, the United States automotive industry invented the roadmapping approach. The method, labelled technology roadmapping, gained publicity through its successful implementation by communication technology firm Motorola around the 1980s (Probert & Radnor, 2003). This led other firms, like Royal Philips (Groenveld, 2007), to introduce the methodology in their own business.

Phaal, Farrukh, Mitchell, et al. (2003) contest using the term technology roadmap, since this term does not properly reflect the methodology due to its focus on technology. They suggest that a more appropriate name for the methodology is, amongst others, business roadmap. In this research, therefore the term business roadmap is used.

Definition of business roadmap

A business roadmap is a visual representation of how the markets, products and technologies of a firm evolve over time. This time-based graph consists of separate layers for markets, products and technologies and provides the way in which elements in these layers are linked to each other (Groenveld, 2007; Kappel, 2001; McCarthy, 2003; Petrick & Echols, 2004; Phaal, Farrukh, Mitchell, et al., 2003; Phaal, Farrukh, & Probert, 2004; Rinne, 2004). A business roadmap as such provides a way to develop, organise and communicate information about targets that must be satisfied by certain time frames, and technologies and products that need to be developed to meet these targets (Garcia & Bray, 1997; Groenveld, 2007; Phaal et al., 2004).

The business roadmap contains the view of a group of stakeholder on the near-, mid- and long-term for R&D, new product and process development (Garcia & Bray, 1997; Petrick & Echols, 2004). The business roadmap helps to develop an innovation strategy through the process preceding the elaboration of the roadmap, and helps to implement this strategy with which the firm wants to achieve corporate objectives; the roadmap ensures that the right capabilities are in place at the right

time (Albright & Kappel, 2003; Kostoff & Schaller, 2001; McMillan, 2003; Phaal, Farrukh, Mitchell, et al., 2003; Phaal et al., 2004; Probert & Radnor, 2003). With a business roadmap, a firm can then focus on high-priority topics for idea generation, making investments more effective and efficient. Besides this directive feature of the business roadmap, the roadmap can also serve as a decision aid tool by assessing new ideas based on their alignment with the innovation strategy (Albright & Kappel, 2003; Garcia & Bray, 1997; Kappel, 2001; Kostoff & Schaller, 2001; Petrick & Echols, 2004).

For this research, the comprehensive definition formulated by Phaal, Farrukh, Mitchell, et al. (2003) is used, since this gives a sound overview of the whole methodology.

Definition 6: Business roadmap.

> *Business roadmapping is a powerful technique for supporting technology management and planning in the firm. . . . The generic roadmap is a time-based chart, comprising a number of layers that typically include both commercial and technological perspectives. The roadmap enables the evolution of markets, products and technologies to be explored, together with the linkages between the various perspectives (Phaal, Farrukh, Mitchell, et al., 2003, p. 52).*

Application of business roadmap

Roadmapping in general has a variety of applications since it is a very flexible approach in both aims and graphical forms (Phaal et al., 2004; Probert & Radnor, 2003). Rinne (2004) enumerates that roadmaps can be used as both retrospective means to discover past technologies, products and linkages that were successful, and as prospective means to plan for the future. Basically, four types of overarching roadmap types can be identified (Kappel, 2001): science and technology roadmaps that help to understand the future by specifying trends (Kappel, 2001; Kostoff & Schaller, 2001); industry roadmaps that describe the future paths of progress in an industry by defining the industrial context and competitive landscape in combination with technology progression (Garcia & Bray, 1997; Kappel, 2001; Phaal, Farrukh, Mitchell, et al., 2003; Probert & Radnor, 2003), product-technology roadmaps for combining product evolution with trends and the firm's strategic objectives (Kappel, 2001; Probert & Radnor, 2003), and the product roadmap to communicate product evolution to stakeholders (Kappel, 2001). As this research focuses on the development of a business roadmap for strategic purposes, a product-technology roadmap is appropriate. Groenveld (2007) and Phaal and Muller (2009) add that after such product-technology roadmap for strategic purposes is developed, it is possible to develop a family of product-technology roadmaps within a firm for detailed operational business.

Benefits and limitations of business roadmap

A main benefit of the business roadmap is that it is able to show integrally the relations between markets, products and technologies. Distinguishingly, it gives an insight in the time component: over time, both on the short- and long-term, insight is provided in the connection between the aspects and their evolution (Albright & Kappel, 2003; McMillan, 2003; Phaal, Farrukh, Mitchell, et al., 2003; Phaal et al., 2004; Probert & Radnor, 2003; Rinne, 2004).

For the development of the business roadmap, input of multiple perspectives within a firm is necessary. By discussing the content of the roadmap and establishing a common language, the internal communication of a firm improves to a great extent; for the departments, clarity is provided on the necessary technologies and products to be developed and more commitment is achieved. The process of coming to this common view is widely contemplated to be very valuable (Phaal, Farrukh, Mitchell, et al., 2003; Phaal et al., 2004; Rinne, 2004). What is more, the simplicity of the roadmap makes that is a convenient means to communicate complicated matters to stakeholders such as

customers, suppliers and partners (Albright & Kappel, 2003; Garcia & Bray, 1997; Kostoff & Schaller, 2001; McCarthy, 2003; McMillan, 2003; Phaal, Farrukh, Mitchell, et al., 2003; Phaal et al., 2004; Probert & Radnor, 2003).

Roadmapping moreover improves business processes. Employees learn about the firm's core competencies, identify gaps and discover threats for the business (Groenveld, 2007; McMillan, 2003; Probert & Radnor, 2003). In addition to this, scanning the environment of the firm keeps the firm up with technology and industry changes which enables it to faster leverage opportunities (McCarthy, 2003; McMillan, 2003). Through this, the products better fit market demands and the performances are improved, resulting in an increased competitive advantage for the firm (Kostoff & Schaller, 2001; McMillan, 2003; Phaal et al., 2004).

To conclude, the business roadmap helps the firm to be more effective and efficient. The roadmap demarcates the areas in which departments should search for new ideas and thus focus resources on high-priority topics. Moreover, the roadmap helps the firm to stick to the strategy. As such, the business roadmap improves the time-to-market and time-to-money, resulting in a better competitive edge (Albright & Kappel, 2003; Garcia & Bray, 1997; Groenveld, 2007; Kostoff & Schaller, 2001; McMillan, 2003). Efficiency is also gained through reuse of products or technologies. Through communication amongst multiple departments, a business roadmap can identify common needs and opportunities for reuse (Albright & Kappel, 2003; Garcia & Bray, 1997; McMillan, 2003). Rinne (2004) adds that the business roadmap enables virtual innovation: it encourages envisioning what might be the next in line, without the need to create costly tangible products. Moreover, he argues that the roadmap can show never realised or past and failing products that can offer useful knowledge.

Despite these benefits attributed to the business roadmap, several difficulties and limitations can be noticed. First, Groenveld (2007) and McMillan (2003) emphasise that the development of the business roadmap needs the commitment of both top management for vision and a strategic view, and multiple departments for elaborating and discussing the plan. Without such commitment, the process is likely to fail.

Another limitation stressed by many authors is the time and effort necessary for business roadmapping, especially to keep it alive (Groenveld, 2007; McMillan, 2003; Phaal, Farrukh, Mitchell, et al., 2003; Probert & Radnor, 2003). The main reason for the need to iterate the process is that the business roadmap is only valid at the time of publication (Kappel, 2001; McMillan, 2003; Phaal, Farrukh, Mitchell, et al., 2003). The business roadmap namely has a linear tendency and thus assumes a certain level of predictability and certainty about the future, which makes it weak for coping with changing circumstances (Coates, 1999; Goffin & Mitchell, 2005; Kappel, 2001; Strauss & Radnor, 2004). So, regularly updating the business roadmap is necessary to reflect the changing circumstances the firm faces over time (Phaal, Farrukh, Mitchell, et al., 2003). Rinne (2004) moreover argues that maintaining and manipulating a business roadmap itself is very labour-intensive, whereas Phaal et al. (2004) put that a roadmap should also be accompanied by a comprehensive text document to explain the simple graphical representation. According to Groenveld (2007) and Garcia and Bray (1997), a solution for this problem is that a firm can pursue multiple paths for technology and product development simultaneously. They, however, do not give attention to the fact that firms are limited in their actions by a scarcity of resources available.

Business roadmap development process

Phaal et al. (2005) discourse two distinct processes within the business roadmap process. They state that roadmaps provide a framework within which information can be stored, positioned and linked, and shared or disseminated. The other process is the strategic planning process, with roadmapping "providing a mechanism, catalyst and common language to carry the strategic planning process forward" (Phaal et al., 2005, p. 104). Prior to beginning to design the roadmap, a firm needs strategic

thinking to draw its context for the future by considering what its environment will be and what resulting strengths, weaknesses, opportunities and threats are (Phaal, Farrukh, & Probert, 2001).

Phaal et al. (2001) developed an approach aiming at strategy implementation that integrates both the strategic planning process and business roadmap development: the T-Plan approach, which is widely applied since it is developed. This approach comprises four half-day workshops to be conducted that cover the market layer of the roadmap, product layer of the roadmap, technology layer of the roadmap and the development of the linkages between these layers. A short introduction to this approach can also be found in Phaal, Farrukh, Mills, and Probert (2003), Phaal, Farrukh, Mitchell, et al. (2003) and Phaal et al. (2004). Here, they also advocate that the approach should be adapted to the specific situation of a firm, considering for instance the resources available.

The T-Plan approach comprises three stages, i.e. a planning stage, a workshops stage and a rollout stage. In the planning stage, the scope for the business roadmap process, its focus, the resources available, the layout for the roadmap, activities to be executed, participants of the process, workshop schedule, information supplied to the participants and their necessary preparation are determined. Part of the preparation are activities such as market research, interviews, surveys and analysis to sketch the environment of the firm (Phaal, Farrukh, Mills, et al., 2003; Phaal, Farrukh, Mitchell, et al., 2003). The workshops are the heart of the T-Plan approach, whereas the rollout phase is considered to improve the likelihood of success for the business roadmap.

The main part of the roadmap process is the workshop stage (Phaal, Farrukh, Mills, et al., 2003). Depending on the approach followed and adaptations made to a specific context, a number of workshops are conducted to come to agreement about the environment of the firm and actions to be taken. The analyses performed in the T-Plan approach to define the internal and external environment of the firm are described in section 3.2. Other authors, like Groenveld (2007) and Albright and Kappel (2003), also use these analyses for developing their roadmap. Based on the analyses, focus areas can be identified (Albright & Kappel, 2003).

Within the focus areas, a firm can identify opportunities that should be worked out. Central to this elaboration of the innovation strategy, is the determination of what end users drive in adopting a product or process, i.e. what do the end users value. These drivers are than translated into concrete product characteristics that satisfy those end user drivers, and the targets for these characteristics. Next, a product or process is broken down to determine what elements are necessary to realise the product characteristics, after which it is possible to determine the technologies required for these elements and the targets set. In every step, relations between the markets, products and technologies are defined (Garcia & Bray, 1997; Groenveld, 2007; Phaal, Farrukh, Mitchell, et al., 2003; Phaal et al., 2001). An example of this process is given by Albright (2002) for a cell phone: a customer driver to buy a cell phone is the style. This need for style drives small size and low weight, for which SMART targets are set. Then, the cell phone is broken down to elements that have the most impact on the size like the display, the keypad and the antenna, to determine where development efforts should be focused on. To conclude, for each element the technologies that are used to achieve the targets are put on a time-line.

Based on existing capabilities, available or planned projects, and future goals, a program is made to fill in product and technology gaps. This program includes the timing of the projects with consideration of the priorities and linkages between several markets, products and technologies (Petrick & Martinelli, 2012; Phaal, Farrukh, Mills, et al., 2003; Phaal, Farrukh, Mitchell, et al., 2003).

Keeping the business roadmap up-to-date

A particular area of focus for scholars is the question how the business roadmap must be kept up-to-date effectively and efficiently. Phaal, Farrukh, Mills, et al. (2003) conclude that future research is

necessary to determine how the business roadmap process can be sustained on an on-going basis. This question is important, as uncertainties inherent in foresight change: over time, as aspects are explored and better understood or perceived differently, this uncertainty may be reduced and other areas of uncertainty may emerge. Moreover, a firm's vision on the future or its strengths and weaknesses might change. This requires the business roadmap to be reviewed and updated periodically (Garcia & Bray, 1997; Goffin & Mitchell, 2005; Phaal et al., 2004; Strauss & Radnor, 2004). According to Petrick and Martinelli (2012), keeping the business roadmap up-to-date involves rethinking and re-evaluating the analyses underlying the roadmap. Attention must be paid to whether the trends or scenarios are changed, whether timing or assumptions have changed et cetera. If necessary, the business roadmap can be adjusted or refined (Garcia & Bray, 1997; Petrick & Martinelli, 2012). Phaal et al. (2004) add that such business roadmap reviews need to be executed at least once a year. If a firm's strategic planning process is mature, updating the business roadmap itself will be just a small effort. The use of software might help to decrease the resources necessary for this (Phaal et al., 2005).

Architecture of business roadmap

There is no standard architecture for business roadmaps. Business roadmapping is a flexible approach that can take various forms and it should be adapted to the specific context in which it is used (Groenveld, 2007; Kappel, 2001; Lee & Park, 2005; Phaal, Farrukh, Mitchell, et al., 2003; Phaal et al., 2004; Phaal & Muller, 2009). The multiple formats identified by Phaal et al. (2004), like roadmaps based on multiple layers, tables and graphs, illustrate this. According to Phaal and Muller (2009), the multi-layered business roadmap is preferable since it is the most flexible format and is able to answer where a business is now, where it wants to be, and how to get where it wants to be. This makes that this business roadmap architecture is suitable for strategic purposes (Phaal et al., 2004). Figure 7 (see page 33) gives an example of such a multi-layered business roadmap.

The business roadmap contains two distinct components: an underlying structure about information to be shown, i.e. the business roadmap architecture, and an overlying graphical layer about the format, style and colours chosen for communication (Phaal & Muller, 2009). The business roadmap architecture itself is comprised of two dimensions, of which the content depends upon the focus, scope and aims of the roadmapping process, and the resources available for it (Groenveld, 2007; Lee & Park, 2005; Phaal, Farrukh, Mills, et al., 2003; Phaal & Muller, 2009). The first dimension is the timeframe of the business roadmap, which is shown on the horizontal axis (Groenveld, 2007; Petrick & Echols, 2004; Phaal & Muller, 2009). The second dimension is the taxonomy of layers and sub-layers on the vertical axis.

The timeframes included on the business roadmap depend on the rate of change to which the business is subject. Normally, a ten-year range is appropriate, but the time covered could range from two years up to one-hundred years (Groenveld, 2007; Phaal & Muller, 2009). Phaal and Muller (2009) recommend incorporating five different time horizons in the business roadmap to arrive at the desired future state of the firm. The first horizon comprises the past and current situation of the firm to assess how the firm arrived where it is now. This horizon also affects the short-term, one-years, horizon that is next to incorporate. It namely limits the ways open to the firm. The short-term horizon contains concrete plans for the upcoming years (Groenveld, 2007; Phaal & Muller, 2009). The medium-term is a three-year timeframe with broader options open to the firm. The long-term timeframe then shows the options and expectation for the ten-year horizon concerning new technologies and market demands. It provides the linkage to the vision of the firm, which shows where the firm wants to be in the future (Phaal & Muller, 2009).

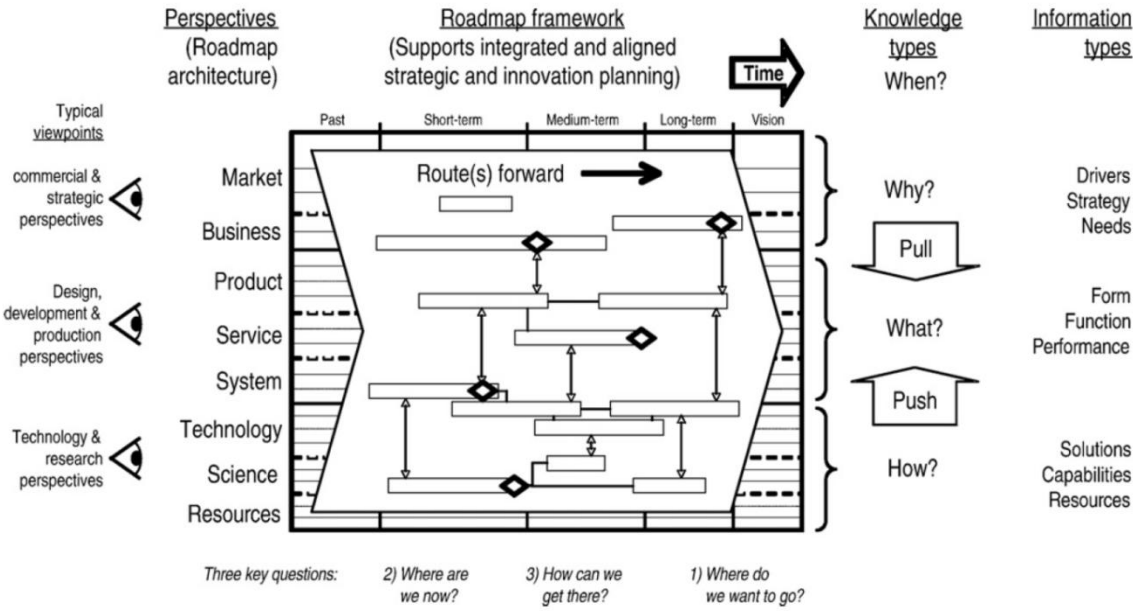

Figure 7: Example of multi-layered business roadmap (Phaal, Farrukh, Mills, et al., 2003).

The vertical axis of the roadmap is usually divided into three main sections (Albright & Kappel, 2003; Groenveld, 2007; Phaal, Farrukh, Mitchell, et al., 2003; Phaal & Muller, 2009; Rinne, 2004), by Phaal, Farrukh, Mills, et al. (2003) referred to as the 'know-why', 'know-what' and 'know-how' dimensions of knowledge. The top-layer of the roadmap relates to the trends and drivers (like social, environmental and political) and industry landscape from which the firm can determine what its goals and purposes are (see section 3.1 and 3.2). The middle layer then relates to the products or processes a firm needs to develop to respond to the market developments. It shows the evolution of products and its functions, features and performances over time to satisfy customer preferences. The bottom layer relates to the technologies and resources that are required to deliver the product features. The layers then should make possible that clear linkages can be drawn between the market demands (market pull) and technology areas that drive progress (technology push).

According to Phaal and Muller (2009), there are many ways to structure the layers and sub-layers of the business roadmap, as there is no unique or best way to do it. Nevertheless, they give several practical recommendations that should guarantee that the roadmap is effective. First, they advise that the roadmap contains a maximum of five to eight sub-layers per layer, in order to avoid complexity. Next, they recommend that the layers reflect the organisational structure and are clearly differentiated from each other. To conclude, the structure should both enable to show the evolution of the content within the layer and to communicate uncertainties within the layers. Albright (2002) adds that it is handy to make distinctions between the sources of products and technologies in terms of in-house development or sourced from a supplier, and to make distinctions between staffed, planned and un-planned developments.

The roadmap as a project decision-making tool

The business roadmap demarcates what types of ideas will be further elaborated: as discussed earlier, it provides a way to make sure that there is a fit between the innovation strategy of a firm and its innovation activity by guiding a firm's employees to specific search areas and assessing new ideas on their alignment with the roadmap. Groenveld (2007) takes the business roadmap even further. He adds another layer to the roadmap, below the 'know-how' layer, in which the projects the firm works on are depicted. This layer opens up the way to a more portfolio-approach within the roadmap, as already touched on by Oliveira and Rozenfeld (2010).

According to Cooper, Edgett, and Kleinschmidt (2001) portfolio management is about the allocation of resources in the firm: it is about the decision what projects to fund and what projects to prioritise, considering the resources available, risks, expected value and time available until introduction, i.e. balancing the long-term and short-term. This quest for the most effective way to invest the innovation resources involves making trade-offs between projects that are in different stages of the innovation process while competing for the same resources (Cooper, Edgett, & Kleinschmidt, 2002). The decision-making process about which project to execute may be accompanied by the execution of some tools like a Net Present Value calculation or a resource capacity analysis (Cooper et al., 2002).

Integrating the outcome of these analyses in the business roadmap, facilitates the decision making process about what projects are possible to execute, since insight is created about the resources available for innovation projects. Moreover, this project-layer works as a communication tool about the projects the firm is already working on, making the innovation process more effective and efficient.

Business roadmapping and scenario planning

In the literature on roadmapping, incorporating scenario planning in order to cope with external uncertainty has received little attention. Nevertheless, several authors have applied the scenario planning approach to business roadmaps (see Petrick and Martinelli (2012), Saritas and Aylen (2010), Strauss and Radnor (2004), Strauss et al. (1998)), yet none of the authors provided a detailed overview of activities to be worked through. Two different approaches can be identified. The first approach comprises building roadmaps for different scenarios and identifying where some points of attention are. This normative scenario approach is applied by Strauss and Radnor (2004) and Strauss et al. (1998). The second approach, which is preferred by Coates (2000) and Slocum (2003), comprises an explorative scenario approach to consider what futures are possible by assessing the external environment, and subsequently building a robust normative roadmap that can cope with these alternative futures by using backcasting (see Dreborg (1996) and Robinson (1990)): reasoning back from the desired end products to identify the changes necessary to arrive at them. This approach is partially applied by Petrick and Martinelli (2012) and Saritas and Aylen (2010).

3.5. Conclusion of theoretical framework

This section gives the answer on the first central question of the research, which is:

What insights on the business roadmap development process can be gained from literature?

This central question is divided into four themes, which are innovation, innovation strategy, external uncertainty and business roadmaps. For these four themes, important insights for the business roadmap process are discussed briefly. Afterwards, several requirements are deduced a business roadmap development process must meet.

Innovation

According to Crossan and Apaydin (2010, p. 1155), innovation can be seen as “the production, adoption, assimilation, and exploitation of value-added novelty in economic and social spheres”. A distinction can be made regarding types of innovation, since innovation does not necessarily mean that a new product is put on a market. A common distinction is made between either product or process innovations: a product innovation is a new output of an organisation that is introduced to increase the benefit of an end user, while a process innovation is related to the way a product is made. Besides, an innovation can be typified as incremental, architectural, modular or radical referring to the extent to which new knowledge concerning the architecture and the components are needed for an innovation.

A firm can decide to innovate based on external and internal motives. The external motives relate to a firm adapting itself to exploit changes in its external environment, being for instance unfulfilled customer needs or changing legislation. The internal motives relate to a firm's resources and competencies that are employed to shape the marketplace and create competitive advantage. If a company identified an opportunity for innovation, usually a combination of the internal or external environment, and generated ideas for this opportunity, it has entered the innovation process. This innovation process consists of four stages: in succession, the idea generation stage, feasibility stage, development stage and implementation stage are gone through.

Innovation strategy

To survive and prosper on the longer term, a company formulates a corporate strategy in which it determines which direction it shall go and describes the route to get where it wants to be. As part of this corporate strategy, a firm needs to formulate an innovation strategy that determines where and when innovation is required to meet the aims of the company. This innovation strategy moreover defines in broad terms what a firm must do about innovation: it states the role of innovation in the firm and the areas in which innovation is necessary. Such an innovation strategy, in which deliberately is chosen for several innovations, is called an intended innovation strategy.

The process to come to this intended innovation strategy comprises the search for a strategic fit between a company's internal and external environment. This is done during a well prepared strategy workshop in which top managers discuss and come to agreement about the options open for the firm. Based on a careful analysis of the internal environment, the resources and competencies of a firm are identified, as well as its current activities. The analysis of the external environment reveals macro-environmental, industry and micro-environmental factors that have an impact on the company, i.e. factors in both the general business and interaction environment of the firm. A confrontation of the internal and external environment reveals whether the organisation is capable of performing in the external environment. An action plan for innovation describes how threats in the environment can be minimised and how opportunities can be leveraged. However, there is a lot of uncertainty about future external environmental developments and this innovation strategy formulation process cannot cope with unforeseen threats and opportunities. Therefore, an innovation strategy should be both flexible and robust, in which robustness means that the strategy is successful under a wide range of circumstances.

External uncertainty

"Uncertainty is the individual´s perceived inability to predict accurately because of a lack of information or an inability to discriminate between relevant and irrelevant information" (Milliken, 1987, p. 136). When this uncertainty stems from the external environment, the uncertainty is called ´external uncertainty´. This external uncertainty can be divided into three types of uncertainty, i.e. the uncertainty about the future state of the environment, the uncertainty about the effect this state has on an organisation and the uncertainty about the options open to an organisation to respond to the changing environment. With regards to the state uncertainty, a distinction can be made to uncertainty about future market conditions and macro-economic or social-political conditions. Regarding the response uncertainty, mainly the uncertainty about technological capabilities and performances is meant.

Scenario planning ensures that a strategy can cope with this external uncertainty: it is an effective means to get flexibility and robustness in strategies. Scenario planning is namely an approach to capture a wide range of possible futures on which a firm can anticipate by the development of plausible narratives about the future, creating awareness about the possibility of changing environments. The scenario planning process involves a multidisciplinary, participatory process of conducting interviews, documentation studies and workshops. These activities must yield multiple scenarios upon which a robust strategy can be formulated.

Business roadmaps

A business roadmap is a visual representation of how the markets, products and technologies of a firm evolve over time. It is a time-based graph that consists of multiple layers for markets, products and technologies which provides linkages between the external and internal drivers for innovation. The business roadmap as such shows what markets to serve and the products and technologies necessary for this by several timeframes: it is the graphical representation and elaboration of a broad-termed innovation strategy, allowing a firm to focus on high priority topics. The business roadmap directs a firm to search for innovation in predetermined areas and can be used to evaluate ideas on their alignment with the strategy. A fourth layer can be added to the business roadmap to show the innovation projects a firm is currently working on: this layer functions as decision-making and communication aid, making the innovation process of a firm more effective and efficient.

The process to come to a business roadmap needs the input from multiple perspectives during participatory workshops. The process should be adapted to the specific situation of a firm, but generally a three stage process is recommended. The first stage ensures that the workshops are properly prepared, involving amongst others the development of the business roadmap layout and workshop program. The workshop stage is the heart of the business roadmap process: it involves several workshop rounds to come to agreement about the environment of the firm and the actions to be taken. In this stage, the scenario planning approach can be incorporated to explore possible futures and build a robust normative business roadmap that can cope with these alternative futures. The implementation stage describes the steps necessary for an effective rollout and sustained use of the business roadmap, e.g. on the need to re-evaluate the analyses underlying the business roadmap to keep the roadmap up-to-date.

Requirements for a business roadmap development process based on scientific literature

Based on the insights gained from scientific literature, six major requirements can be formulated which a business roadmap development process must give attention to. These requirements are:

- The business roadmap development process must be able to give direction to future innovations by demarcating multiple high priority topics in which innovation is required so as to make the innovation activity of a firm more effective and efficient;
- The business roadmap must be appropriate for communication and must thus be easy to understand. For this, simplicity is very important. The business roadmap must show details about the innovations regarding whether it is an internal or external development, about what type of innovation is concerned and about what the status of the innovation is. Moreover, is must make clear what projects the firm is currently working on;
- The business roadmap must cope with the uncertainty in the external environment by being both robust and flexible;
- The process must improve the company's knowledge on its internal and external environment;
- The business roadmap development process must give attention to getting support in the organisation for the roadmap and its implementation. In particular, commitment must be obtained from the top management to get strategic views and support, and commitment must be obtained from the departments to be able to develop the roadmap;
- The business roadmap development process must be practically applicable and should therefore keep the necessary time and effort limited.

Part B

Case study

> *“If one does not know to which port one is sailing, no wind is favourable.”*
>
> *Lucius Annaeus Seneca (4 B.C. - A.D. 65)*

Chapter 4

Firm-specific insights

In this chapter, the practical insights for the business roadmap development process are gathered. To get these firm-specific insights, first the case study is introduced in section 4.1 with a justification of the selected case. Next, this chapter deals with the case firm Ballast Nedam by elaborating its firm characteristics (section 4.2.) and points of attention for a successful application of the business roadmap process (Section 4.3). To conclude, the second central question is answered in section 4.4.

4.1. Introduction to the case study

The business roadmap process is explored by means of a single case study. This means that the business roadmap process is developed and applied in one case that is analysed in its real context. After the execution of the single case study, conclusions could then be drawn on the possibilities and limitations of the developed business roadmap process.

Case study selection

For this research, the case study under consideration is construction firm Ballast Nedam. Ballast Nedam is namely in search of more demarcation within its innovation activity and considers the development and application of a business roadmap process as an appropriate way to focus its innovation effort. This way, Ballast Nedam both gets acquainted with the process of business roadmapping and receives a first partial business roadmap. As Ballast Nedam is the initiator of this research, there is no selection of a case; in the language of Stake (1995), there is a matter of a pre-selected, i.e. intrinsic, case study. The business roadmap is developed for strategic purposes at the corporate level, so there is neither a selection of sub-cases, although it would have been possible to consider Ballast Nedam's working areas as separate sub-cases within the roadmap, referred to as a single case study with embedded units of analysis by Yin (2003).

Appropriateness of case Ballast Nedam

Although the case of Ballast Nedam is predetermined, it is necessary to evaluate whether the case is appropriate in the view of the problem of this research described in section 2.1 and theoretical insights gained. For this case assessment, Miles and Huberman (1994) developed a framework incorporating amongst others the relevance of the case to the research, likelihood of providing rich information on the matter of research, and feasibility of conducting the research. For the relevance of the case Ballast Nedam to the research, it is necessary to determine whether the industry in which Ballast Nedam operates, the construction industry, is subject to a reasonable level of uncertainty. For this assessment, the uncertainty framework discussed in section 3.3 is used.

Uncertainty in the construction industry

The construction industry, in particular the part working on large-scale integrated projects, can be labelled as a Complex Products and Systems (CoPS) industry (Gann & Salter, 2000; Hobday, 1998;

Seaden & Manseau, 2001; Tidd et al., 2005; Winch, 1998). Based on Hobday (1998), CoPS are high cost, engineering-intensive products with a large number of customised components that require broad knowledge and are purchased by a small number of users. This results in a high level of external uncertainty that increases with the levels of cost and complexity (Hobday, 1998).

The construction industry, especially the part concerning integrated projects, is characterised by unique projects in which the client involvement is very high and meeting end user requirements is increasingly important (Gann & Salter, 2000; Halman et al., 2008; Hobday, 1998; Winch, 1998). Next, the products are predominantly made for a small number of highly professional clients, namely governmental organisations, with a clear understanding of their product and the requirements this product should meet (Caerteling, Di Benedetto, Dorée, Halman, & Song, 2011; Hobday, 1998). Moreover, as discussed by Caerteling, Halman, and Dorée (2008), construction firms generally lack the capability to anticipate on future customer needs, due to past practices of traditional design-bid-build contracts. The change to more integrated contracts since 2000 (Boes & Dorée, 2008), resulted in different types of knowledge necessary, e.g. financing knowledge: changing contract forms are a source of uncertainty. Hence, there is a matter of customer uncertainty in the construction industry.

Other elements of market uncertainty, i.e. uncertainty regarding competitors and suppliers, also apply to the construction industry. The construction industry is namely subject to increasing globalisation (Halman et al., 2008; Seaden & Manseau, 2001; Shaw, 2010) in a market that is already dominated by heavy competition and resulting low profit margins (Blayse & Manley, 2004; Miozzo & Dewick, 2002; Seaden & Manseau, 2001). Moreover, construction firms are not capable or willing to execute construction projects alone: today's projects require complex and diverse knowledge delivered by many suppliers (Gann & Salter, 2000; Hobday, 1998; Tatum, 1989), which results in a lack of information regarding the availability and quality of the required products, knowledge and resources. What is more, the large share of suppliers in innovation in the construction industry (Pries & Dorée, 2005), might result in a lack of information regarding newly developed or upcoming technologies and products that should be incorporated in a firm's products to survive and prosper.

For decades, the construction industry did not face technological uncertainty since the rate of change of technologies was very slow, especially compared to other industries (Winch, 1989). In the current construction industry, especially when analysing it as CoPS, technological uncertainty is evident (Gann & Salter, 2000; Hobday, 1998) since a broad range of knowledge and technologies is required, with increasing application of ICT technologies. Moreover, it is not possible to fully predict what kinds of technologies are required or available to execute future projects, partly due to project-specific requirements and technology championing by governments (Caerteling et al., 2011). To conclude, construction projects and their innovations can have a long lead-time with high costs (Caerteling et al., 2011; Hobday, 1998; Tidd et al., 2005), which means that the payback time might be relatively long, and that it is difficult to switch rapidly between products and technologies or to test technologies by building prototypes. As such, it is uncertain whether technologies will be successful, what knowledge is necessary to complete future projects, and whether new industry standards can be met rapidly: counterbalancing failing innovations can be difficult.

The construction industry is heavily influenced by governmental actions, as is for instance reasoned by Caerteling et al. (2011) for road construction. Since the government is the principal client in the sector, there is a matter of macro-economic uncertainty: in case of economic decline, and resulting governmental cuts, the construction industry is heavily affected as shown by the current economic recession (Shaw, 2010). Besides, the government also affects the construction industry by promulgating regulations and policies to an increasing extent, especially in the fields of safety, environmental impact, working conditions and procurement (Caerteling et al., 2011; Pries & Dorée, 2005; Seaden & Manseau, 2001; Shaw, 2010). These regulations have strong influence on demand and play a role in shaping future technological change (Gann & Salter, 2000).

Table 3: Appearance of state uncertainty, effect uncertainty and response uncertainty in the construction industry.

Type of uncertainty	Source of uncertainty		Explanation of uncertainty sources	Appearance in construction industry
State uncertainty	Lack of information about how the external environment might be changing in the future			
		Market uncertainty	Uncertainty about customer needs	Unique projects: customer involvement, end-user requirements, contract forms
			Uncertainty about actions of competitors	Increasing globalisation and competition
			Uncertainty about availability of labour, products and knowledge	Diverse knowledge from many suppliers and unknown supplier innovations
		Macro-economic and social-political uncertainty	Uncertainty about economic climate	Dependence on external financiers, e.g. governmental financial position
			Uncertainty about changing governmental regulations	Increasing governmental policies and regulations
Effect uncertainty	Lack of knowledge about how the changing external environment affects the organisation			The extent to which the factors mentioned in 'state uncertainty' affect an organisation
Response uncertainty	Lack of information about the options the organisation has to respond to the changing external environment, and their consequences			
		Technological uncertainty	Uncertainty about knowledge required for technologies	Broad range of knowledge and technologies required
			Uncertainty about technology required in future to meet industry and client requirements	Difficult to predict what technology is required and available in future due to project-specific requirements
			Uncertainty about consequences of technology development	Long lead-time of projects: difficult to switch rapidly and test technologies

In Table 3, the appearance of external uncertainty in the construction industry is summarised and linked to the generic types of external uncertainty found in section 3.3.

Justification of case Ballast Nedam

Based on an evaluation of the criteria mentioned by Miles and Huberman (1994), it is concluded that the case of construction firm Ballast Nedam is appropriate for the problem under consideration. First, external uncertainty is evident in the construction sector (see Table 3). Ballast Nedam also faces this uncertainty, as stated by its Chief Executive Officer Theo Bruijninckx: "A conclusion regarding the pace of change in the industry for the coming years? I don't know exactly. The financial crisis, for instance… it might take several years before it will end. But I don't really know. The industry will change certainly, most probably gradually" (Mr T.A.C.M. Bruijninckx, personal communication, July 15th, 2013). The case Ballast Nedam in the Dutch construction industry is therefore considered to be suitable to give insight in the matter of coping with uncertainty within roadmapping. Moreover, as Ballast Nedam thus has an intrinsic motivation for participating in this study, the access to relevant information, employees and resources necessary for carrying out this case study is guaranteed.

4.2. General description of Ballast Nedam

In this section, insight is given into the background of the case firm Ballast Nedam. By this, one becomes familiar with the firm and its activities, which increases the understanding when applying the business roadmap development process to the firm and studying the results.

Ballast Nedam history

Ballast Nedam is a Dutch construction firm established in 1969 after the merger of two separate corporations. The first corporation, 'N.V. Amsterdamse Ballast Maatschappij', was founded in 1877 at the time of the construction of the North See Canal in the Netherlands. Afterwards, the company worked on many national and international projects in the fields of civil engineering and dredging, like the construction of the IJsselmeer Dam in the Netherlands (Ballast Nedam N.V., n.d.). The second pillar of Ballast Nedam is the 'N.V. Nederlandse Aannemingsmaatschappij', originally founded in 1917

Table 4: Overview of Ballast Nedam's organisation and markets (Ballast Nedam N.V., 2013b).

Ballast Nedam segment	Market
Building and Development	Development, construction, renovation and maintenance of residential and commercial buildings
	Providing filling stations for (liquid) natural gas
	Management and maintenance of assets
	Process management on e.g. innovation and area development
Infrastructure	Development, construction and maintenance of infrastructure, car parks and industrial buildings
	Construction of offshore wind parks
	International construction projects
Specialised Companies	Foundations and groundwork
	Pre-stressed constructions for roads, hydraulic structures and buildings
	Engineering
	Services on environmental, safety and material issues
	Consultancy on installation technology
	Asphalt, equipment and greenery
Supplies	Extraction, production, transport and sale of primary and secondary resources
	Production of prefab concrete elements
	Modular products (housing, stadiums)

as a successor of a local contractor that was established in 1899. This predecessor of 'De Nedam' earned reputation with the construction of the Peace Palace in The Hague. In later days, the company worked on many projects both in the Netherlands and abroad (Ballast Nedam N.V., n.d.). After the merger of both companies, Ballast Nedam kept working on many prestigious (inter)national projects. Examples of these projects are the construction of the Oosterscheldekering in 1986, which is a part of the Dutch Delta Works to prevent flooding of the south-western part of the Netherlands, King Fahd Causeway in Saudi Arabia and football stadium Amsterdam Arena in 1996. Since 2002, Ballast Nedam N.V. mainly focuses on the Dutch national market (Ballast Nedam N.V., n.d.).

Contemporary Ballast Nedam

Ballast Nedam is currently one of the largest construction companies of the Netherlands with an annual turnover of around 1.3 billion Euros. Headquartered in Nieuwegein, scattered around the Netherlands with some regional offices, and in possession of multiple subsidiary companies, Ballast Nedam employs around 3.700 people. Since 1994, Ballast Nedam is quoted on the Amsterdam stock exchange (Ballast Nedam N.V., 2013a, 2013b, n.d.; Cobouw, 2012).

The businesses of Ballast Nedam are centred on a four working areas that, according to Ballast Nedam, together form the living environment, i.e. mobility, housing, nature and energy, with a focus on integrated projects and the niche-markets industrial construction, offshore wind turbines, secondary raw materials and alternative fuels. These markets are served through a company structure of four segments, i.e. Building and Development with the clusters Building and Development and Building and Development Special Projects, Infrastructure with the clusters Infrastructure and Infrastructure Special Projects, Specialised Companies and Supplies (Ballast Nedam N.V., 2013b). In Table 4, an overview is provided on the markets Ballast Nedam serves.

4.3. Ballast Nedam points of attention for a business roadmap

The theoretical insights gathered in Chapter 3 allow for the establishment and application of a business roadmap development process that is able to cope with external uncertainty. Nevertheless, in order for this business roadmap development process to function properly within the Ballast Nedam context, Ballast Nedam specific characteristics need to be paid attention to: the combination of both elements results in the establishment of a business roadmap development process that is theoretically grounded as well as practically applicable so as to provide fruitful results.

The points of attention for the successful application of the business roadmap development process within Ballast Nedam, are highlighted during several individual interviews. Afterwards, the listed points of attention are intermingled with the theoretical insights to get the business roadmap

development process. The interviewees, seven in total, are all managers and executives within the Ballast Nedam organisation and are either capable of providing a vision concerning the current strategy development process of Ballast Nedam, or possess valuable knowledge about roadmapping and the implications of its application within Ballast Nedam. Moreover, these managers and executives are included so as to gain support for the initiative. The interviewees are asked for their opinion about the value of the research for Ballast Nedam and the way they think the process should be designed to function properly within Ballast Nedam. Below, the points mentioned during the interviews are summarised briefly, as well as the way to deal with these point of attention. In Appendix A.1, both the interview scheme used and a list of the interviewees are included.

Remarks on the value of the business roadmap process for Ballast Nedam

A business roadmap process is considered to have benefits for Ballast Nedam. First, the interviewees indicate that the current strategy formulation process within Ballast Nedam is executed ad-hoc, primarily based on intuition, and lacking analytical ground. It is therefore uncertain whether these strategy sessions provide satisfying results. A business roadmap process is able to add structure to the strategy formulation process, and it stimulates discussion about choices to be made by incorporating scenarios to cope with external uncertainty in the future. This latter point is considered to be beneficial as well, since the Ballast Nedam strategy is often missing a link with the outside world: the strategy is internally prepared, without a clue about market requirements. The business roadmap process ought to take away this solely insight viewing. Related to this topic, is the tendency of Ballast Nedam managers to focus on short-term products and profit, neglecting longer-term opportunities, since the manager are judged on their year result.

In order to ensure that the results of the business roadmap process are useful, some interviewees suggest that it could be wise to make use of an experienced external facilitator for the workshops. As suggested by Mezias, Grinyer, and Guth (2001), workshop participants can feel compelled to suppress ideas about politically sensitive issues due the presence of the top management. A hierarchical structure can impede the genuine discussion about touchy subjects. A skilled facilitator can help to stimulate the necessary open climate.

The scenarios that are a result of this process are also considered to be useful for other departments within the company, e.g. in assisting the risk management activities, since Ballast Nedam currently does not use scenarios for these activities but yet intends to do so. The interviewees are thus advocates of using scenarios, since these allow to think about things that can turn out completely different than expected: it helps employees in assessing new, and unexpected, information.

One interviewee remarks that Ballast Nedam can be contemplated as a many-headed monster. Different units of Ballast Nedam require different strategies, so it could be difficult to develop a business roadmap for the whole company. Therefore, the interviewee's advice is to search for a few overarching themes and elaborate them well.

Quote 1: Interviewee about the value of the business roadmap process for Ballast Nedam.

"A business roadmap process with workshops is very valuable for Ballast Nedam. The current strategy formulation process is namely executed ad-hoc: there is no preparation nor an external facilitator involved, which results in strategy sessions that do not yield the desired outcomes."

Remarks on the participants of the business roadmap process

The interviewees state that asking Ballast Nedam top managers and executives to participate and give trends and developments in the external environment, is likely to yield few, if any, useful results. These managers and directors are namely mainly focused on the current environment of the firm and are therefore unable to take an objective view on the future, proving the value of the business roadmap process. Nevertheless, the participation of top managers and directors is required for the

future vision on Ballast Nedam they are supposed to have, and to gain the necessary support for the initiative. In order to ensure that the business roadmap both includes objective and subjective information though, the interviewees suggest to incorporate Ballast Nedam employees with an overview of markets and trends, employees with technical expertise and employees with a strategic view, and to consciously select the appropriate participants for the workshops. The selection of the workshop participants should therefore primarily be based on market knowledge for constructing the scenarios and a strategic view for developing the business roadmap. In addition, a documentation study should ensure that an objective and complete picture of the important future aspects is taken into account.

Quote 2: Interviewee about the participants for the business roadmap process.

"Ballast Nedam managers find it difficult to mention trends and possible future developments. Their focus on current activities limits them to distance themselves and take a more objective point of view. It is therefore wise to differentiate between participants for developing the scenarios and participants for developing the business roadmap."

Remarks on the implementation of the business roadmap

Recently, there is a tendency within Ballast Nedam to introduce documents, policies and working methods top-down. Examples are a policy on compliance and risk management activities as indicated in Quote 3. The business roadmap is likely to be considered as the next thing imposed on the organisation by the top management. As a result, the chance that the business roadmap will be put aside is high due to a lack of willingness or a restraint of resources in the organisation. It is therefore considered important to involve members across the organisation in the business roadmap process in order that commitment is achieved for it, and to integrate the business roadmap in existing policies to make it an inextricable part of the business. The roadmap can for instance be coupled to innovation management in general, but also to the already top-down imposed Position Paper.

The interviewees might overestimate the importance of commitment for the business roadmap. For the development of the business roadmap, commitment is necessary across the organisation: the market view, technology expertise and strategic view are required. But after the development, the function of the business roadmap is twofold. On the one hand, the business roadmap presents the areas in which Ballast Nedam employees should search for innovation. For this, some commitment within the organisation is desirable. On the other hand, the business roadmap must ensure that only those ideas that fit within the innovation strategy of Ballast Nedam, proceed into the innovation process. For this, the commitment of the decision makers on this topic is required to ensure the functioning of the business roadmap: it is not necessary to put maximum effort in gaining full commitment across the organisation. The participants of the business roadmap process should therefore originate from multiple segments with different backgrounds, including top managers, while in the communication with the workshop participants and other Ballast Nedam managers emphasis should be put on the fact that the business roadmap will be an integrated part of other centralised top-down documents, policies and working methods. By this, the importance of the business roadmap is stressed, which must give rise to an increased attention for the business roadmap and an increased willingness to use the roadmap.

Quote 3: Interviewee about implementing the business roadmap.

"The last years, many policies and documents have been introduced top-down within Ballast Nedam. However, managers within the organisation are facing budgetary constraints and do not have the time to give the necessary attention to these policies and documents. The business roadmap is likely to experience these problems. The implementation of the business roadmap must therefore be given due consideration, and integrating the business roadmap into other top-down policies or documents could be a solution: by this, its importance is increased and attention is ensured."

4.4. Conclusion of firm-specific insights

This section presents the answer on the second central question of the research, which is:

What firm-specific insights need to be included in the business roadmap development process?

In order to answer this central question, consecutively the case under consideration, its main characteristics, and points of special attention for the application of a business roadmap development process within the case firm are discussed briefly. To conclude, several requirements are deduced for a business roadmap development process.

The case firm: Ballast Nedam

The case study under consideration in this research is construction firm Ballast Nedam. Ballast Nedam is namely striving for more focus in its innovation activity, for which it considers the development and application of a business roadmap process appropriate. Since this business roadmap is aimed for strategic purposes at the corporate level, there is no selection of sub-cases involved in this research. In the light of the problem of this research, the case of construction firm Ballast Nedam is appropriate: external uncertainty is evident in the construction sector and Ballast Nedam also faces this uncertainty, for instance with regards to uncertainty about the promulgation of governmental policies and uncertainty about what supplier-based innovations will be introduced.

Ballast Nedam characteristics

Ballast Nedam is a Dutch construction firm that is established in 1969 after the merger of two separate corporations. Today, the firm is one of the largest construction companies of the Netherlands with an annual turnover of around 1.3 billion Euros. Ballast Nedam employs around 3.700 people in multiple offices and subsidiary companies working on all kinds of construction activities in the working areas mobility, housing, nature and energy. What is more, the firm has a special focus on integrated projects and industrial construction, offshore wind turbines, secondary raw materials and alternative fuels. These markets are served through a company structure with the segments Building and Development, Infrastructure, Specialised Companies and Supplies.

Ballast Nedam points of attention for the business roadmap development process

A business roadmap process is considered to have benefits for Ballast Nedam. The fact is that the current strategy formulation process within Ballast Nedam is executed ad-hoc, and lacks analytical ground, preparation and an external facilitator: it is uncertain whether these sessions provide useful results. As such, the Ballast Nedam strategy is often missing a link with the outside world and managers tend to focus on the short term. A business roadmap process can resolve these issues. However, in order to get useful results, an external facilitator is necessary to stimulate discussion, whereas a focus on a few overarching themes for the whole company should reduce complexity.

The tendency within Ballast Nedam to focus on the short term, resides for a large part with the top managers. Therefore, it is considered expedient to involve Ballast Nedam managers and executives in the business roadmap development process to acquire support for the initiative, and to involve different employees from across the company to get market knowledge in the scenario workshop, and both technical expertise and strategic view in the business roadmap workshop. A documentation study should ensure that an objective picture of the important future aspects is taken into account.

The business roadmap for Ballast Nedam might experience problems concerning its implementation. Many policies and working methods that are introduced top-down within the company in recent years, are put aside easily by Ballast Nedam employees due to a lack of either willingness or resources. In order to increase the commitment for the business roadmap, involving managers from

across the organisation is considered essential. Moreover, integrating the roadmap with other centralised policies might increase both its importance and the willingness to use it.

Requirements for a business roadmap development process based on firm-specific insights

Based on the insights gained from Ballast Nedam, five major requirements can be formulated which a business roadmap development process must give attention to. These requirements are:

- The business roadmap development process must demarcate a few areas on which innovations should be focused;
- The business roadmap process must be simple to execute with understandable activities as the firm is not accustomed to long-term thinking;
- The process must improve the company's knowledge on its internal and external environment;
- The business roadmap development process must give attention to getting support in the organisation for the roadmap and its implementation, by integration of the process into existing policies and involving a broad range of employees with either strategic view or market knowledge;
- The business roadmap development process must be practically applicable and should therefore keep the necessary time and effort limited.

Chapter 5

Case study Ballast Nedam

In this chapter, first the Ballast Nedam business roadmap development process is established in section 5.1. Next, the results of the partial execution of this process are given in sections 5.2, 5.3 and 5.4. To conclude, the answer on the third central question of this research is drawn up in section 5.5.

5.1. Ballast Nedam business roadmap development process

Based on the requirements stemming from either scientific literature or Ballast Nedam points of attention, seven requirements are formulated the business roadmap process must meet. These are:

- The business roadmap development process must be able to give direction to future innovations by demarcating multiple strategically important areas in which innovation is required;
- The business roadmap process must be simple to execute with understandable activities;
- The business roadmap must be appropriate for communication and thus easy to understand;
- The business roadmap must cope with the uncertainty in the external environment;
- The process must improve the company's knowledge on its internal and external environment;
- The business roadmap development process must give attention to getting support in the organisation for the roadmap and its implementation;
- The business roadmap development process must be practically applicable and should therefore keep the necessary time and effort limited.

Main principles of the established business roadmap development process

The business roadmap development process established consists of a combination of the innovation strategy development process, the scenario planning process and the business roadmap development process, while Ballast Nedam points of attention are given the necessary consideration as well. The intended end result, the business roadmap, gives insights into the markets that a firm would like to serve by certain timeframes, and the products and technologies that are necessary for serving these markets. Since there is uncertainty about how the future external environment of a firm might turn out, a business roadmap process is developed that can cope with several possible futures. Scenario planning, a tool that ensures that a wide range of possible futures is explored before the route to the future goals of a firm is mapped out, is used to cope with this external uncertainty. As such, a business roadmap development process is established that aims at keeping the intrinsic communicational and directive strengths of a business roadmap and taking away its limitations of rigidity and resulting need for frequent elaborate update processes.

The heart of the business roadmap development process is formed by two workshops: a scenario workshop and a business roadmap workshop. Workshops are namely commonly used for strategy development, scenario planning and roadmapping. In addition, workshops are beneficial for reducing uncertainty through discussion amongst participants. The workshops aim at reducing all aspects of uncertainty, i.e. state uncertainty, effect uncertainty and response uncertainty.

The business roadmap process comprises three distinct stages. Consecutively, a planning stage, workshop stage and implementation stage are elaborated. The steps within these stages depend upon the specific situation of a firm, e.g. concerning the resources available for the business roadmap process. Where necessary, insights gathered within Ballast Nedam are included to make the business roadmap better fit the reality of businesses and thus increase the chance of obtaining fruitful results. Figure 10 on page 51 shows a coarse overview of the business roadmap development process with an explanation as to where the various elements of this process are discussed in this chapter. Figure 12 on page 121 presents in detail the rationale behind the business roadmap process.

Planning stage

The planning stage of the business roadmap process ensures that a firm prudently prepares the workshop stage, in order that the workshop stage is structured and the resulting business roadmap is meaningful. During the planning stage, first the content of the business roadmap process needs to be determined based on a careful evaluation of a firm's corporate strategy. This evaluation gives the scope for which innovation is desired and reveals what the role is of innovation within the firm, so that it is possible to determine what kinds of innovations should be part of the business roadmap and what resources should be made available for it. Moreover, it involves an assessment of the worth of the prevailing corporate strategy: the evaluation makes clear whether it is opportune to take parts of the corporate strategy as ground for the business roadmap, or whether it is necessary to first embark on a corporate strategy formulation process before embarking on a business roadmap initiative.

What is more, the planning stage involves the determination of the layout for a multi-layered business roadmap by making choices regarding both the timeframes and taxonomy of the four layers to be included on the roadmap. This task includes a design for the bars shown in each of the layers as well. The layout of the business is based on scientific literature, but needs to be adapted to both the firm-specific context and the results of the evaluation of the corporate strategy. The timeframe considered on the horizontal axis of the business roadmap depends on the rate of change in the industry. This timeframe is divided in a past and current, a one-year, a three-year and a ten-year horizon that represent the increasing openness of plans on the longer term. To conclude, a vision is included to show where the firm wants to be. The layers on the vertical axis ideally reflect a structure that is logical regarding the corporate strategy. These layers comprise up to eight sub-layers each. The four main layers are the know-why layer giving the targets of the firm gained from the external environmental analysis, the know-what layer giving the products and processes over time to reach the targets, the know-how layer showing the knowledge or resources needed to deliver the products and processes, and the project layer giving current and planned projects to get this know-how.

In the planning stage, the analyses are to be determined that will be executed during the workshops, while the selection of the participants for these workshops need to be determined as well. For the latter, attention should be paid to the number and background of the participants: each workshop requires different choices for these matters, since support for the business roadmap should be achieved across the organisation, and since this will improve the knowledge that is present. In order for the workshops to be effective and efficient, it is advised to appoint an external facilitator and to prepare for the workshops carefully. The first ensures an open discussion amongst the workshop participants, whilst the latter is necessary as the workshops are not intended for time-consuming data collection or elaborate explanations of methodologies. Therefore, participants need to be supplied with information on the purpose of the workshops, the basic principles of the methodologies that will be used, and the necessary preparation for them, as they need an open mind-set for the workshops. This preparation includes market research and conducting interviews to sketch the environments of the firm with both objective and subjective information, and to let the workshop participants become familiar with the market, macro-economic and social political, and technological uncertainty. The detailed process followed for the preparation of the workshops in this research is given in Figure 8 (page 49).

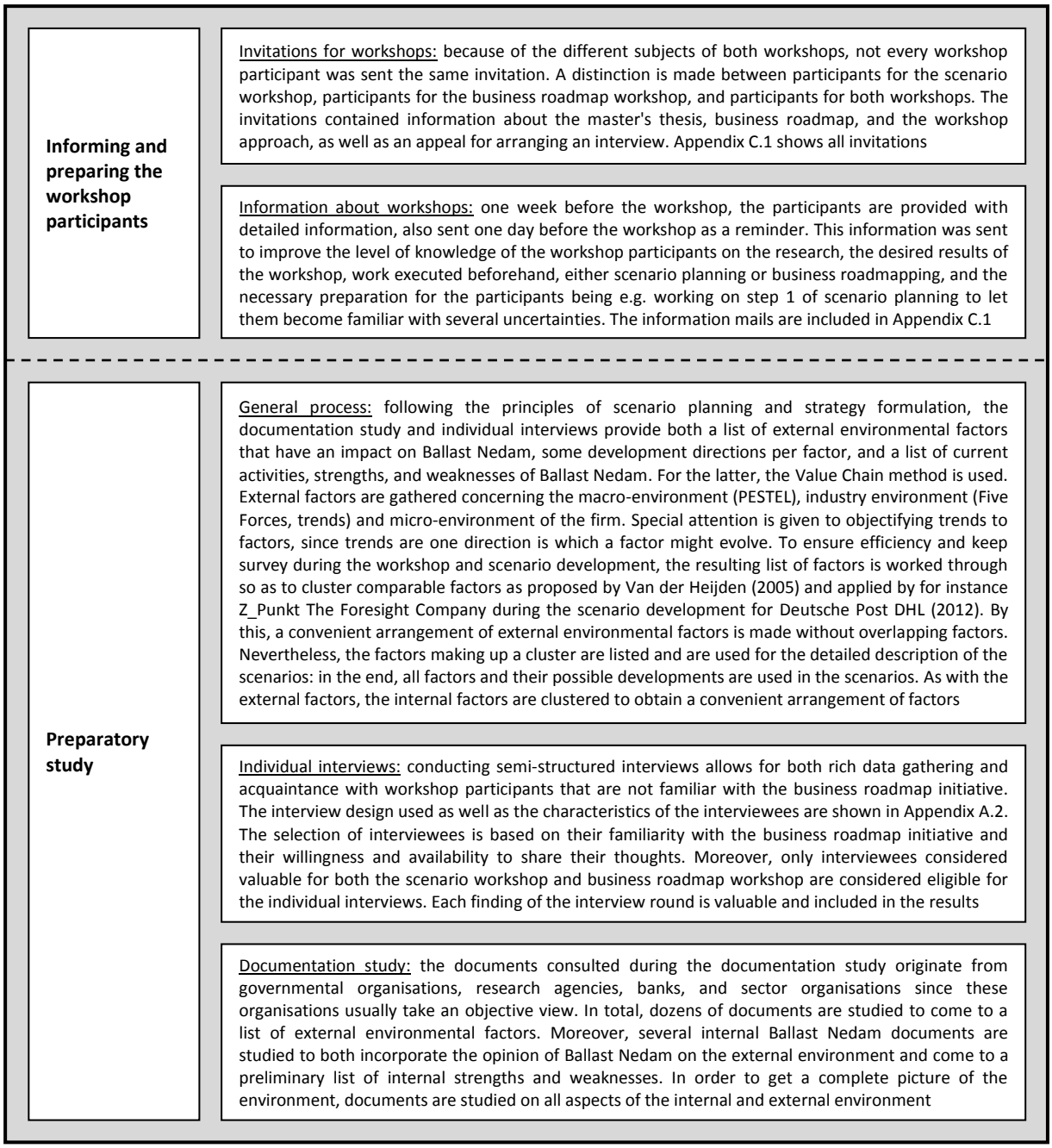

Figure 8: Detailed preparation process. The preparation consisted of conducting interviews with several workshop participants and conducting a documentation study in order to include both objective information about the future and subjective information about Ballast Nedam. Moreover, the workshop participants are informed about the workshop and are asked to prepare themselves for these. All activities ensured an effective and efficient workshop round.

Workshop stage

The workshop stage contains two half-day workshops so as to minimise the effort necessary of workshop participants. These two workshops are intended to produce the innovation strategy of Ballast Nedam in a clear overview. After the workshops have been conducted, the firm knows what innovations are required to support its corporate strategy and what route it shall take to get these innovations. The first workshop, the scenario workshop, follows the principle of scenario planning: by the gradual development of four scenarios, a wide range of possible future external environments of Ballast Nedam is explored. Afterwards, a robust normative roadmap is constructed during the business roadmap workshop by following the innovation strategy formulation process and business roadmap development process in analysing the scenarios to get scenario-overarching opportunities

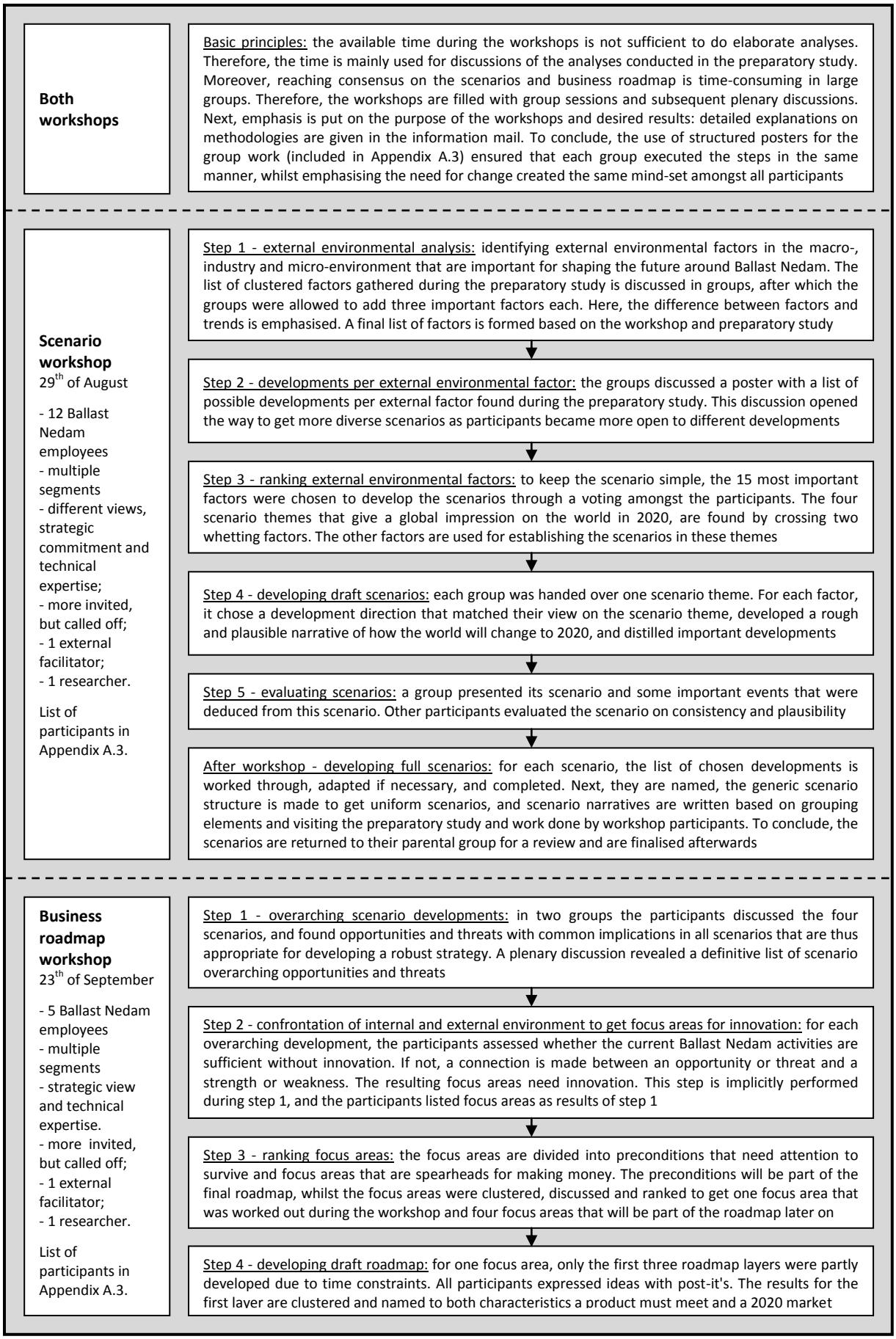

Figure 9: Detailed design for the conducted scenario workshop and business roadmap workshop, both with a duration of 4.5 hours. The original workshop protocols are shown in Appendix A.3 with explanations of the deviations made.

and threats, confronting these with the internal strengths and weaknesses of Ballast Nedam to get areas where innovation is required, and elaborating these areas on the business roadmap. After the workshop, a business roadmap guide needs to be written that both contains information on the purpose of the business roadmap and gives account on the elements shown on the business roadmap.

This way of combining scenarios and roadmapping ought to leverage the strengths of scenarios and business roadmaps: the business roadmap can cope with a wide range of futures, whilst the communicational and directive strengths of the roadmap are retained trough providing one business roadmap in which all scenarios are included. The detailed workshop designs are given in Figure 9.

Implementation stage
After the development of the business roadmap, the approach for the implementation is important to make a success out of it. The first step involves the dissemination of the business roadmap across the company, accompanied by an explanation of the purpose of the roadmap to create commitment amongst employees to use the roadmap. The importance of the roadmap and the willingness to use it, might be increased by coupling up the business roadmap and other working methods and policies, and by learning from experiences with other imposed methods and policies. What is more, the roadmap needs to be kept up-to-date to reflect contemporary thinking: although the scenarios make the business roadmap more capable of coping with external uncertainty about the future, this does not mean that the roadmap does not need any revision. The development of software can be useful for this process, since it reduces the resources necessary for creating the roadmap and can be helpful for representing approved projects on the roadmap to improve decision-making and idea-generation.

In order to improve future business roadmap development processes, an evaluation of the conducted process needs to be performed. This evaluation must highlight what changes should be made to the process for next business roadmap initiatives, for instance with regards to the content, participants, business roadmap layout, and workshop designs. What is more, this evaluation might be beneficial for the development of a hierarchy of detailed operational roadmaps that support the high-aggregation roadmap on the strategic level, if the organisational structure of a firm and its resources allow for the development of these operational roadmaps.

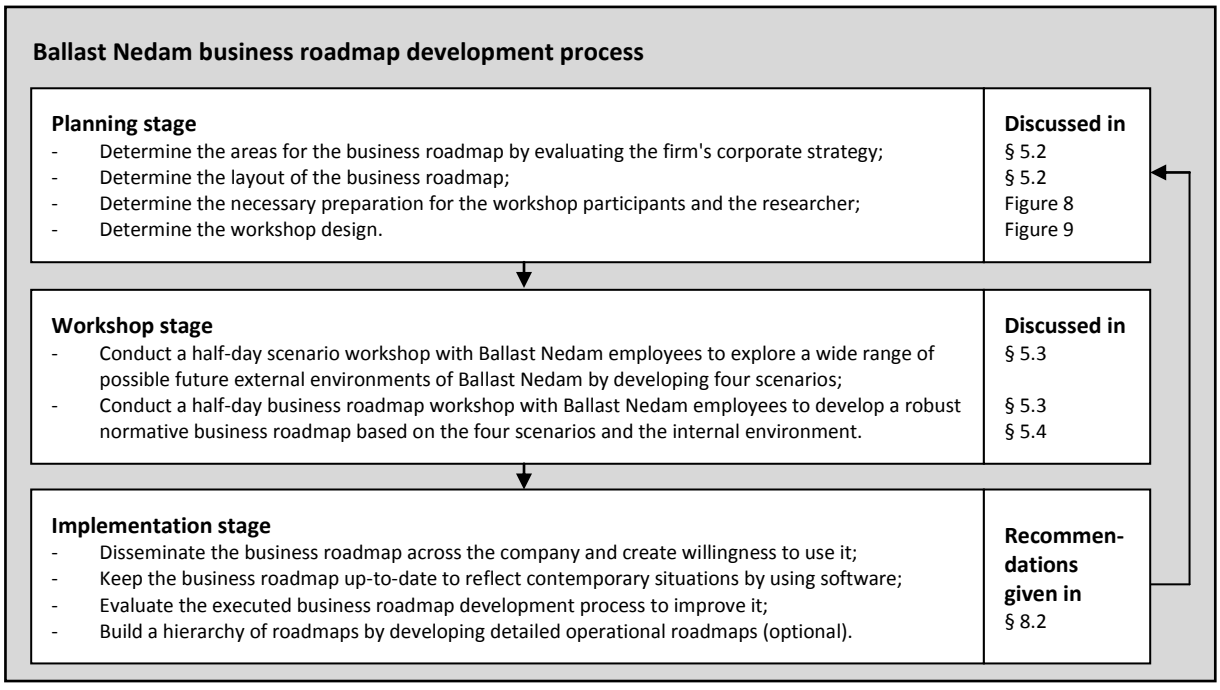

Figure 10: Overview of the business roadmap development process for Ballast Nedam. This process is based upon both theoretical and firm-specific insights. For each element of the process, the figure shows where it is discussed.

In Figure 10 on page 51, a schematic overview is depicted of the business roadmap development process for Ballast Nedam, including an arrow that indicates that the process is continuous. For each element, the section where it is discussed is included as well. The elements of the planning stage and workshop stage are executed during this case study. Executing the elements of the implementation stage is beyond the scope of the research; these elements are given consideration in Chapter 8.

5.2. Content of the business roadmap

This section contains confidential information that is not disclosed in the public version of the report.

5.3. Internal and external environment of Ballast Nedam

This section contains confidential information that is not disclosed in the public version of the report.

5.4. Focus areas for innovation

This section contains confidential information that is not disclosed in the public version of the report.

5.5. Conclusion of case study Ballast Nedam

This section presents the answer on the third central question of the research, which is:

What is the result of applying the business roadmap development process to Ballast Nedam?

This central question is answered by means of four sub questions for which the answers are briefly discussed in this section. Consecutively, the business roadmap development process as established for Ballast Nedam, the content that must be shown on the business roadmap, the external and internal environment of Ballast Nedam that have to be taken into account, and the focus areas and preconditions where innovation is required, are discussed.

Ballast Nedam business roadmap development process

The business roadmap development process must meet seven requirements that are based on scientific literature and Ballast Nedam motives. These requirements include the following:

- The business roadmap development process must be able to give direction to future innovations by demarcating multiple strategically important areas in which innovation is required;
- The business roadmap process must be simple to execute with understandable activities;
- The business roadmap must be appropriate for communication and thus easy to understand;
- The business roadmap must cope with the uncertainty in the external environment;
- The process must improve the company's knowledge on its internal and external environment;
- The business roadmap development process must give attention to getting support in the organisation for the roadmap and its implementation;
- The business roadmap development process must be practically applicable and should therefore keep the necessary time and effort limited.

The designed business roadmap development process for Ballast Nedam consists of a combination of the innovation strategy development process, the scenario planning process and the business roadmap development process. Moreover, Ballast Nedam points of attention are taken into account: some points of special interest are similar to theoretical insights, while other points are easily added and intermingled with these insights. The final process comprises three distinct stages, which are consecutively the planning stage, workshop stage and implementation stage. The workshop stage is the heart of the processes, containing both a scenario workshop and a business roadmap workshop.

The planning stage ensures that a firm prudently prepares the workshop stage. The activities in this stage aim to get an effective and efficient workshop round. These activities involve an evaluation of the corporate strategy of the firm to get the areas the business roadmap should focus on, the design

of the business roadmap layout and the determination of the design and participants for the workshops. To conclude, the workshops are prepared through conducting interviews and market research to avoid time-consuming data collection during the workshops, whilst the workshop participants are informed about the purpose of the workshops and the methodologies to be used, as well as the preparation required for them to become open-minded and receivable for uncertainty.

The workshop stage involves conducting two half-day workshops so as to produce the innovation strategy of Ballast Nedam in a clear overview. After the workshops have been conducted, the firm knows what innovations are required to support its corporate strategy and what route it shall take to get these innovations. During the scenario workshop, the principles of scenario planning are applied to get four scenarios on the future external environment of Ballast Nedam. Next, the business roadmap workshop was conducted to partly construct a robust normative business roadmap based on the written scenarios by applying and elaborating the remaining steps for formulating a strategy.

The implementation stage of the business roadmap process is about the activities necessary to make a success of the business roadmap. The steps involved in this stage are the dissemination of the roadmap across the organisation and a coupling on existing policies to get commitment for it, keeping the business roadmap up-to-date to reflect both today's thinking and the innovations the firm is currently working on, evaluating the followed process to improve next business roadmap initiatives, and possibly the translation of the strategic roadmap to detailed operational roadmaps.

Content of the business roadmap
This section contains confidential information that is not disclosed in the public version of the report.

Internal and external environment
This section contains confidential information that is not disclosed in the public version of the report.

Focus areas for innovation
This section contains confidential information that is not disclosed in the public version of the report.

Part C

Evaluation

> *“I can’t change the direction of the wind, but I can adjust my sails to always reach my destination.”*
>
> *James Byron Dean (1931 - 1955)*

Chapter 6

Discussion

In this chapter, the findings of this research are discussed on contributions and limitations of the followed process and obtained results. For this evaluation, the information elicited during several interviews with employees of Ballast Nedam that were involved in the business roadmap development process are used as a source of inspiration. The interview scheme used for this interview, as well as the list of the interviewees, is included in Appendix A.4. In addition, the results of the evaluation of the performed workshop activities at the end of both workshops, are used. This discussion starts with an recapitulation and evaluation of the followed research process. Afterwards, the contributions and limitations of the research are discussed. Based on the findings, this chapter gives a generic business roadmap development protocol that is considered to be generally applicable in other cases. This protocol is evaluated and compared to other roadmap development methodologies as well.

6.1. Evaluation of the research process

This section contains an evaluation of the chosen research processes. First, the research process is briefly summarised. Next, the chosen research strategy, and data collection and data analysis methods are discussed.

Recapitulation research process

The objective of this research was supporting Ballast Nedam in focussing its innovation effort, by developing and applying a process to facilitate the formulation of the firm's innovation strategy and the elaboration of this innovation strategy into a business roadmap. Both the uncertainty of the future external environment and the intrinsic strengths of the business roadmap should have been given attention in this process. This objective is being strived after through conducting a single case study, i.e. the case of construction firm Ballast Nedam, which means that the developed business roadmap process was analysed qualitatively in the real Ballast Nedam context. To get the required data, the principle of triangulation was applied: scientific literature is used as a theoretical foundation for the established business roadmap development process, a documentation study is used for sketching the internal and external environment of Ballast Nedam in an objective way as well as for getting firm-specific insights, whereas members of the Ballast Nedam organisation were incorporated both to get subjective information about the internal and external environment by means of interviews and to participate in two workshops to develop the business roadmap.

Evaluation research strategy

The research strategy for this research is a single case study with an intrinsic case: Ballast Nedam was the initiator of this research to get a business roadmap development process for the firm. As a consequence, no other research strategy was applicable. Nevertheless, the assessment of the appropriateness of the Ballast Nedam case for the research problem in Chapter 4, based on a

framework developed by Miles and Huberman (1994), revealed that the construction industry and Ballast Nedam are subject to uncertainty, and Ballast Nedam was supposed to have a cooperative attitude towards the research. The developed future external environmental scenarios for Ballast Nedam confirm that uncertainty is evident in the construction sector, whilst the at large open and collaborative attitude of members of the Ballast Nedam organisation was amply sufficient for the execution of the research: regarding this, the Ballast Nedam case was indeed appropriate for investigating the problem under consideration. In addition, the results obtained, i.e. the combination of scenario planning and roadmapping resulting in multiple focus areas and preconditions, also prove that the case is appropriate for this problem.

The single case study provided profound knowledge for Ballast Nedam, for instance with regards to the process to follow for developing a business roadmap, the possible future external environment of the firm, and marking several areas where innovation is required. The downside of a single case study is however that it is inappropriate for generalising results due to the possible occurrence of coincidence, whereas the multiple case study is appropriate for generalising results. Therefore, the suggestion put forward by Yin (2003), which holds that a single case study with embedded units of analysis can be used for generalising results, was investigated: the organisational structure of Ballast Nedam and its four segments could have been used for this. However, during the research it turned out that such embedded units were not visible in this case research: the business roadmap is developed for Ballast Nedam on the corporate level and the members of the organisation involved in the process originate from both the holding and the segments and are thus mixed up during the process. There has been no extra attention for one of the segments with only members of that particular segment, which means that this research cannot be used to generalise results. Detailed operational roadmaps for each segment can function as separate cases though, so as to test the developed process.

Evaluation data collection

In this research, multiple data collection methods are applied: studying scientific literature, performing a documentation study, and conducting both semi-structured interviews and workshops. These data collection methods were necessary to obtain all the required data, since several research questions required different data sources: without multiple data collection methods, both designing the business roadmap development process and applying this process would not have been possible. What is more, the multiple data collection methods are sometimes complementary to each other or confirm already gathered data. This is for instance shown in Appendix C.2 for the sources of the found external environmental factors, and for the sources of the factors found for the internal environment: some factors were found during the documentation study, some were elicited during the interviews, and some showed up in both methods.

Despite this value of triangulation, an important downside is the enormous amount of effort necessary to elicit the data: studying dozens of documents and conducting and transcribing multiple interviews take many hours of work. Appendix C.2 shows that it could be possible to limit the amount of documents to be studies, since, despite the fact that they are complementary, the results of the interview round are at large very comparable to the results of the documentation study. The semi-structured interviews were necessary for rich data collection: it allowed for a deep understanding of the topic. Other forms of data collection are not interchangeable with this method: in an unstructured interview no list of themes to be discussed is available, making them useless for this purpose, whereas the structured interview allows no deviation from the interview scheme. This deviation of topics or sequence of themes turned out to be very important for the profound understanding of the topics. Other data collection methods, like observations or questionnaires, do not allow to get this deep understanding as well. To conclude, the workshops are considered the most effective and efficient form of group interviews to come to agreement on important topics: other interview methods cannot be used for joint decision-making.

Evaluation of data analysis methods

The data gathered during the preparation stage by means of interviews and a documentation study, is analysed with several easy applicable methods, i.e. PESTEL, industry trends, Five Forces (Porter, 1998) and micro analysis for the external environmental factors, and the Value Chain method (Porter, 2008) for the internal environment. Although not all elements of these methods could have been applied, they helped to structure the analysis and made sure a broad and complete picture was taken into account. After the data was collected, the principle of clustering was applied to get a convenient list of external factors and sub factors. Although these clustered factors were subject to different interpretations, they helped for the development of the scenarios: after the scenario workshop, the final scenarios were quickly developed with these clustered factors that were stated on structured posters. The data gathered for the various scenarios, was adjusted when necessary to get distinct scenarios that cover a broad array of developments. Although the scenario did not fully reflect the thoughts of the workshop participants through these adjustments, this method is considered appropriate to led the scenarios fulfil their intended purpose.

6.2. Contributions of the research

This section comprises an evaluation of both the scientific and practical contributions of the research. These contributions are briefly discussed around three themes.

Applying and refining roadmapping

In this research, a business roadmap development process is developed and applied for construction company Ballast Nedam, and as such it contributes to a broad range of scientific literature on the development and application of roadmap development processes, like Albright and Kappel (2003), Groenveld (2007), and Phaal, Farrukh, Mitchell, et al. (2003). The developed three-stage process, starting with a planning stage, followed by a workshop stage, and completed with an implementation stage, is considered appropriate and clear for constructing a business roadmap. The process namely emphasises the need to think before one acts: an elaborate planning stage ensures that the participatory part of the process can be completed smoothly, whilst the implementation stage gives due consideration to the follow-up regarding the use of the business roadmap. Regarding the substantive elements, i.e. the business roadmap itself, the process is strong due to its linkage with the ruling corporate strategy of a company: the evaluation of the company's corporate strategy and the resulting conclusions concerning the areas incorporated in the business roadmap process, ensures that the focus areas and preconditions on the roadmap are really meaningful for the company. What is more, such an evaluation might even result in more support for the roadmap from across the organisation since employees of the organisation might be sceptical about the current corporate strategy and might doubt about some choices that are made in this.

A great benefit of the developed business roadmap process concerns its flexibility. The process roughly indicates what activities are necessary to come to the business roadmap, but does not strictly stipulate the way to do these activities. Instead, the process functions as a means to hold on to, whilst the precise execution of the steps depends on the situation of the company under consideration. An example of variation can be found in this research during the workshop stage. Contrary to the regular scenario planning process, the workshop participants did neither seek consensus about the external environmental factors that needed analysis, nor about the development directions for these factors. Instead, the ensuing ranking activity gave an indication about whether or not there was consensus about the importance of a certain external environmental factor, whereas during the development of the draft scenarios the development directions chosen by the groups for their scenario indicated whether there was consensus about these development directions. Nevertheless, essential for skipping the consensus-seeking activity is the availability of a clear and comprehensive list of external environmental factors and development directions stemming from the preparation study. Another example of variation can be found in the business

roadmap workshop: the internal environmental analysis and the confrontation of the internal and external environment are performed implicitly instead of that they are performed formally and separately. Presumably, the workshop participants did not have all internal strengths and weaknesses in mind during the implicit confrontation. However, the question is whether this resulted in worse findings: the confrontation of the internal and external environment of Ballast Nedam executed after the workshop and included in Chapter 5, revealed that the participants supposedly did make such a consideration in their mind, since every focus area and precondition can be coupled to several external and internal factors. This means that not following the exact process to a certain extent does not mean that no meaningful results can be obtained.

Related to the flexibility of the process, is the possibility during the workshops to give the groups of participants some freedom to follow their own route to get the desired end result of a step. As shown during the business roadmap workshop, this might result in more substantive results: the findings of the groups might strengthen and complement each other, since each group has its own point of view to evaluate matters. During the business roadmap workshop, this is shown by one group that primarily came up with the preconditions for Ballast Nedam to survive, whilst the other group mainly came up with focus areas by using a complete different analysis technique. A prerequisite for this freedom for the groups is that the desired end result of a step is completely clear to all workshop participants to ensure that uniform results are obtained.

This research revealed that the role of the project manager for the business roadmap process is very important for obtaining results. First, this researcher is responsible for the preparatory study that is part of the planning stage and provides amongst others a list of external environmental factors and development directions for each of these factors. Although the workshop participants might feel primed by such a list, it turned out during the workshops that the available time is insufficient for performing all analyses and activities in detail, let alone reaching consensus on these matters. Therefore, it is strictly recommended to led the preparatory study be guiding during the workshop stage. Nevertheless, the workshop participants still need to perform the steps during the workshop to make them familiar with scenario planning and roadmapping, and to bring them into the desired mind-set. The second issue in which the role of the project manager is vital, is the translation of the draft scenarios, resulting from the scenario workshop, to final scenarios: the project manager needs to be able to both interpret the draft scenarios and elaborate them into uniform, consistent and understandable scenarios. Here, the influence of the project manager is apparent, but essential: without one person with both knowledge on the matter of scenario planning and the background information about the possible developments in the construction industry, it is questionable whether the scenarios will be usable.

During the preparatory study, several analysis methods are used for sketching the internal and external environment of Ballast Nedam. For the internal analysis, the Value Chain method (Porter, 2008) is applied. Although not many members of the Ballast Nedam organisation are familiar with this method, it turned out that the implicit use of the methodology is appropriate for its function, which is broadening the view of the project manager and interviewees. Using the elements of the Value Chain method caused the interviewees and the project manager to think about other strengths and weaknesses than those obviously related to construction activities, although construction activity related strengths and weaknesses still make up a large share of the results. For the external environmental analysis, the used analysis methods also caused the members of the Ballast Nedam organisation and the project manager to widen their view and to search for factors on several levels. Although the widely known PESTEL-factors constitute the main part of the results, other factors can be related to the industry trend analysis and analysis on Five Forces (Porter, 1998). Hence, the used methods set people thinking, and are therefore considered to be appropriate for this process.

In this business roadmap development process for Ballast Nedam, a distinction is made between focus areas and preconditions as areas where innovation is required. Although this distinction between spearheads for the organisation and areas that need attention for the firm to survive cannot be linked to scientific literature, its use is considered beneficial: preconditions need always attention since they are vital for a firm, so leaving them aside in the voting for focus areas to show on the roadmap ensures that they will get attention: there is no chance that the preconditions are being overlooked with the possibly major consequences of it.

Scenario planning as a means to cope with uncertainty

The objective for this research was to find a way to deal with uncertainty in business roadmapping, without violating the communicational and directive strengths of the method. To reach this objective, the principle of scenario planning is integrated into business roadmapping in order for the roadmap to be robust, i.e. being able to function in multiple alternative futures. The workshop participants indicate that the integration of scenario planning works for reducing uncertainty, and as such this research contributes to literature on dealing with uncertainty in roadmapping like Strauss and Radnor (2004). With regard to state and effect uncertainty, the members of the Ballast Nedam organisation report that sharing their thoughts in small groups, developing the scenarios, and evaluating the scenarios to find common elements for a robust strategy, helped them both to take a broader view and to find relationships between factors in the external environment they would otherwise never have found, which is in line with existing literature on scenario planning (see e.g. Coates (2000) and Schwartz (1996)). With regard to the response uncertainty, the question whether the business roadmap workshop decreased this uncertainty cannot be answered yet due to the scant attendance; following workshops must indicate whether the response uncertainty will decrease.

What is more, the way scenario planning and business roadmapping are integrated, is considered suitable: first evaluating the scenarios for common elements and building a robust roadmap afterwards is more effective and efficient in organisations where time is scarcely available. The other way of combining scenario planning and business roadmapping, i.e. developing a roadmap for each scenario and comparing four roadmaps for similarities, would require unrealistically more time: the applied process revealed that developing one roadmap alone needs multiple workshops, let alone that multiple roadmaps require many more workshops.

The business roadmap for Ballast Nedam is not completed yet, so a definitive conclusion on the established business roadmap development process cannot be given. However, the remaining steps to develop the roadmap follow the regular roadmapping process, which supposedly should not give many problems. The question remains though what the business roadmap will look like in a company that is called a 'many-headed monster' in Chapter 4. According to Kappel (2001), a business roadmap will be beneficial exactly in circumstances of Complex Products and Systems and a complex or distributed company structure. It is however questionable whether this is the case for Ballast Nedam's business roadmap on the strategic level: within a big and varied company like Ballast Nedam, a roadmap must cover a wide array of themes which could make the business roadmap complex and less suitable for communication across the company. The choice for a few focus areas and preconditions should prevent such a complex roadmap, while the use of symbols is supposed to decrease complexity as well. The current state of the roadmap is however not able to give a decisive answer on this matter, but nevertheless it can be concluded that it will be hardly possible to develop a convenient and non-digital roadmap that shows a lot of details: the space available on the roadmap does not allow a moderate to high detail level.

A business roadmap development process for Ballast Nedam

This research yielded a business roadmap development process for Ballast Nedam. This business roadmap process is considered beneficial in several ways. First, the corporate strategy formulation process within Ballast Nedam is conducted ad-hoc. The business roadmap development process is

able to give structure to this process, whereas it gives an analytical underpinning to a strategy as well. This link with the external world, which lacks generally in the technology-oriented construction industry (Pries & Dorée, 2005), is established through the business roadmap process. In particular the preparation activities conducted preceding the workshop stage are essential for this matter. Moreover, the preparation asked for by the workshop participants is beneficial for this, as it places participants own interpretation on the developments in the external environment, which results in the necessary diverse and creative thinking for scenario planning and strategy formulation.

The members of the Ballast Nedam organisation that were involved in the process, appreciate that a business roadmap initiative incorporating scenario planning is initiated in the company, propose to continue this effort since the purpose of it is clear, and generally want to be included in subsequent initiatives. The open discussion with newly met colleagues during the workshop, ensured by the presence of an external facilitator, is considered very valuable and stimulating. Including more external facilitators that can inspire the workshop participants, for instance an external facilitator for each group during the workshops, is considered even more valuable. In addition, the scenarios that are developed during the process are considered very inspiring and are therefore appropriate for other purposes in the organisation, for instance for risk management activities. Including more examples of possible developments would make the scenarios more inspiring and useful though.

The business roadmap for Ballast Nedam is just partially finished: a further elaboration is necessary as a follow-up of this research. As a consequence, the layout of the business roadmap for Ballast Nedam is not tested. Therefore, it is possible that there are adjustments necessary either after the completion of the business roadmap or after feedback from the organisation. This should be borne in mind during the completion of the business roadmap: the layout is just preliminary and some iterations could be required.

6.3. Limitations of the research

This section contains the discussion of the limitations of the conducted research and the business roadmap process. These limitations are centred on five themes that are given consideration briefly.

An internal business roadmap development process entails bias

The result of the business roadmap development process is dependent on the people that are involved in it: by definition, there will always be a certain amount of subjectivity in the obtained results, and multiple business roadmap processes with different participants are likely to yield at least slightly different results. Nevertheless, in order to get reliable and representative results for which there is commitment across an organisation, the possible occurrence of bias needs to be marginalised as much as possible. In the performed business roadmap development process, multiple members of the Ballast Nedam organisation with different backgrounds are involved to keep the bias as low as possible. In addition, a documentation study covering dozens of reports from supposedly objective institutes like governmental agencies and consulting agencies, is conducted to lower bias. Nevertheless, bias is evident in the obtained results: during the workshops, only members of the Ballast Nedam organisation are involved so as to keep the process a Ballast Nedam matter for acquiring support, stimulate open discussion and accustom Ballast Nedam to the process. This means that there is a high chance of tunnel vision, since the participants interpret and judge the work performed in the objective documentation study and by that provide this information with a Ballast Nedam layer. What is more, just a select gathering from the organisation was present, in particular during the business roadmap workshop, which increases the chance of getting bias in the results.

The bias in the research can for instance be observed in the part of the external environment that the involved members of the Ballast Nedam organisation focus on. During the preparatory study, there is not much difference between the external environmental factors that are mentioned in

objective documents, and the factors mentioned in Ballast Nedam documents or interviews. However, the ranking to get the important external environmental factors that were incorporated in the scenarios, shows that there is a matter of bias. What is more, the developments mentioned by the workshop participants for their draft scenario also depend on their own background, and contain bias as well since they are for a large part related to current Ballast Nedam activities. In the final scenarios, mentioned developments with a linkage with current Ballast Nedam activities are replaced by the project manager by more general developments. The project manager thus has a high influence on the results, also because of the preparatory study, which causes a bias as well.

The construction industry has had for many years a tendency to execute innovation projects alone. However, Pries and Dorée (2005) prove that there is increasing attention for collaborative innovation projects. Within Ballast Nedam, such a shift has also come about with the introduction of the open innovation process as described in section 1.1. Considering Ballast Nedam's relatively marginal innovation budget (15 million Euros, which is a lot compared to other construction companies) compared to other industries and taking stock of the uncertainty in the construction industry (see Chapter 4), a need for more collaboration is evident and hence expanding the open innovation concept to the business roadmap process could be worth investigating. This idea, partially elaborated upon by e.g. Caetano and Amaral (2011), has a twofold working. First, with regard to the earlier mentioned bias when involving only some members of the Ballast Nedam organisation, involving external experts and other stakeholders in the business roadmap development process will bring in state-of-the-art knowledge and a different, more objective and wide view which supposedly results in a decreased bias (Phaal et al., 2004). Next, involving clients and suppliers gives more insight in their activities and development paths for the next years which might results in a better alignment between the supply chain partners and a higher value end product (Albright & Kappel, 2003; Brown & Eisenhardt, 1995; Petrick & Echols, 2004; Ragatz, Handfield, & Petersen, 2002). Nevertheless, a point of attention is how to deal with possibly confidential information, which these parties might not be willing to share.

Business roadmapping takes time

As already mentioned in section 3.4, a limitation of roadmapping is the time and effort necessary for it (Groenveld, 2007; McMillan, 2003; Phaal, Farrukh, Mitchell, et al., 2003; Probert & Radnor, 2003; Rinne, 2004). The business roadmap process developed for Ballast Nedam is not able to take away this limitation. On the contrary, integrating scenario planning into business roadmapping even increases the time and effort necessary for it, since, as already indicated by Slocum (2003), scenario planning itself is a very time-consuming activity and takes many extra weeks of work. This amount of time and effort necessary for the roadmap development caused that the business roadmap development process is not applied completely yet. Although executing a business roadmap process is expected to take less time if the process is already developed and executed before, this time and effort necessary remains a point of attention. Related to this is the time span included on the business roadmap: this research revealed that the business roadmap should be developed one year before the start of the roadmap in order to get useful results. The partly developed business roadmap for Ballast Nedam starts in 2013, but will not even be completed in the year 2013.

The implementation stage of Ballast Nedam’s business roadmap development process includes that the developed business roadmap needs iterations in order to let it reflect contemporary thinking. In scientific literature, this update process is considered very labour-intensive as stated by e.g. Rinne (2004). However, the value of integrating scenario planning into business roadmapping is supposed to manifest in this update process. Through basing the roadmap on multiple future scenarios, the update process is expected to take less time and effort: due to its robustness, it is less likely that the complete business roadmap must be revised. Nevertheless, some re-analyses and workshops will be required periodically.

A substantial part of the time spent for this research, is used for the analyses conducted in the preparatory study. In particular the documentation study, in which dozens of documents are analysed, is very time-consuming. For subsequent business roadmap processes, it is therefore worth considering to limit the amount of documents to be studied. However, the documentation study is included in this research in order to get objective data on the external environment of Ballast Nedam and by that avoiding bias in the results. Nevertheless, it turned out that the data elicited during interviews with Ballast Nedam employees or obtained by studying Ballast Nedam documents, does not deviate much from the data gathered in the objective documentation study. In order to keep the valuable triangulation, keep using objective data, and to decrease the necessary effort, the possibility of combining up to ten documents on macro environmental issues and including external views could be given consideration.

The implementation stage of the business roadmap development process points moreover out that integrating ICT and roadmapping might be beneficial. Many scholars, like Lee and Park (2005), Petrick and Echols (2004), Phaal, Farrukh, Mills, et al. (2003) and Phaal et al. (2004), argue that software is worth considering for supporting the development and dissemination of the roadmap since it decreases the time and effort necessary for these issues. However, Phaal, Farrukh, Mills, et al. (2003) indicate that the question how this strength of software can be leveraged for the business roadmap development, is yet unanswered. Within Ballast Nedam, though, an interesting possibility might be the linkage of a digital business roadmap with the already existing digital Tok! platform that is used to discuss new ideas. By this, Ballast Nedam employees can for instance check whether their idea fits within the roadmap or whether there is another idea that overlaps with their own idea. Integrating the roadmap and Tok! in this way might make the roadmap more accessible and might increase the willingness to work with it.

Commitment across the organisation is a point of attention

Groenveld (2007) and McMillan (2003) emphasise that a lack of commitment of both top management for vision and a strategic view, and multiple departments for elaborating and discussing the roadmap, is a threat for the successful development and implementation of a business roadmap. What is more, getting commitment within Ballast Nedam to use the business roadmap is a point of consideration as discussed in section 4.3. Therefore, in the developed and partially applied business roadmap processes for Ballast Nedam, extra focus is put on getting support for the business roadmap by involving multiple members of the organisation with different backgrounds into the process. In addition, in the implementation stage of the business roadmap development process the integration with existing policies within Ballast Nedam needs to be ensured to increase the commitment across the organisation.

Despite the effort at getting commitment across the organisation, the support for the process and participation in it is still a bit disappointing, although some high-placed employees like the Chief Executive Officer and the Director of Communication & Investor Relations were involved. Multiple other members of the Ballast Nedam organisation are tried to get involved in the process as well, by tempting them to participate through emphasising both that their expertise is needed and that they are amongst the few employees that are selected to participate. Nevertheless, in the end less than half of the employees that was sent an invitation, joined the business roadmap process. In addition, the members of the Ballast Nedam organisation that did participate, generally scored bad in fulfilling their duty regarding for instance evaluating the final scenarios. This might affect the support for the developed business roadmap, since it is unknown what stance some managers have regarding the roadmap.

The argument put forward by Petrick and Echols (2004), holding that many organisations tend to focus on the short term as this seems to be the most profitable, could account for the organisation's conduct. Several interviewees indicate that this argument is true for Ballast Nedam: many members

of the organisation are not willing to sacrifice scarce time for time-consuming and preparation expecting issues that do not help them to meet their own yearly business objectives, especially in a company that is greatly affected by the current economic crisis. Another point that could explain the behaviour of possible participants, is mentioned during one of the interviews that are conducted to get the points of attention for a Ballast Nedam business roadmap: the company's managers think that they know what the future will look like, while they are convinced that the innovative and entrepreneurial culture in the company will ensure that Ballast Nedam will survive and prosper in this future.

The employees of Ballast Nedam that participated in the process, propose that the business roadmap should be part of the corporate strategy formulation process, and as such should be initiated by the executive board of the company. This is considered a good suggestion, as starting a business roadmap process at the instigation of the board, should ensure that there is more commitment across the organisation to participate in it: the strong signal given with this can hardly be neglected by the organisation. In addition, extra effort could be given at getting people involved into the workshops, for instance by conducting interviews with each invited employee, since the workshop participants state that they are enthusiastic about the initiative and would like to attend next business roadmap processes: this way, the process is selling itself and support for subsequent processes is acquired automatically. To conclude, decreasing the amount of preparation to be done by the workshop participants can be considered, but this could compromise the results of the business roadmap process as employees might be more inclined to put no effort in it, making the results less substantive and by that less useful.

Roadmapping and scenario planning require the ability to think abstractly

Employees of Ballast Nedam are not familiar with the principles of scenario planning and roadmapping, and they are even not accustomed to long-term planning at all. Because of this, these employees hardly possess the competence to distance themselves from contemporary developments in the external environment and to ignore current activities of Ballast Nedam, preventing most of them to take an abstract and strategic view in these. This is why the scenarios run up to 2020 instead of up to 2023. The systematic steps that are to be executed during both workshops, are as a consequence considered very difficult by the workshop participants, although the information emails were considered clarifying and beneficial. This showed up for instance during the scenario workshop: the workshop participants were in majority unable to differentiate between external environmental factors, sub factors, and development directions for these factors, and intermingled these elements instead. In addition, during the plenary discussion of the draft scenarios, a few workshop participants were cynical about the possibility of occurrence of some presented developments. During the business roadmap workshop, filling the business roadmap was considered difficult: markets, products and knowledge on the strategic level need a coarse level of detail, making the tags on the roadmap very abstract. As a consequence, the line between the know-what and the know-how layer is somewhat blurred: the tags are primarily focused on resources and knowledge.

These experiences show the importance of a well prepared workshop stage and a well-informed project manager or facilitator that is able of distilling useful results. Next, screening workshop participants on eligibility, for instance by interviewing all possible participants before inviting them to attend the workshops, is a solution that is suggested by interviewees. What is more, changing the workshop stage from two workshops to three workshops, is recommended by them: a scenario workshop, a separate innovation strategy workshop, and a concluding business roadmap workshop, give more time to execute the required steps and allow to present more examples and success stories that are supposed to make the necessary steps less abstract: as mentioned before, the time during the workshops was insufficient to do the required steps comprehensively. However, adding an extra workshop would ask for even more time from members of the Ballast Nedam organisation. Therefore, relying on both habituation of the Ballast Nedam employees to scenario planning and

roadmapping, and relying on a larger attendance during the business roadmap workshop to get more views that could make the development of the roadmap easier, is also considered necessary. If the Ballast Nedam employees will have become more familiar with scenario planning and roadmapping, two workshops instead of three workshops might be possible, whilst adjusting the scenario time span to ten years could be a possibility as well then.

Risk of rigid use of roadmap

Having a developed business roadmap might entail that a firm will strictly follow this business roadmap, since the function of a business roadmap is both to steer a company's employees to certain areas for idea generation and to evaluate generated ideas on their fit with the business roadmap. Nevertheless, in a firm with the characteristics of Ballast Nedam, the question is whether such an approach will hold: Ballast Nedam is active in many different working areas that cannot be represented on the business roadmap. Instead, the business roadmap shows some new strategic areas to focus on in a few years. However, this does not mean that Ballast Nedam has to abandon its current activities, or abandon innovating for these activities; innovation in these activities is considered necessary to survive. There is nevertheless a gap in scientific literature as to how a company should cope with this problem: this issue is not addressed and as a consequence no solution is provided yet. A possible solution could be that the company uses the business roadmap for major innovations that impact on a considerable part of the organisation, whereas the segments of the firm could state in a detailed operational roadmap what their plans, for instance related to product or process innovations, are for their part of the present company activities.

Another form of rigidity that might be observed in a firm that possesses a roadmap, is related to the scheduling of innovations and projects. A business roadmap namely stipulates when a certain product, process et cetera needs to be developed, and as such it would be easy to strictly follow this schedule without considering the external environment anymore, especially regarding competitor's actions or new technologies. Of course, the periodical update process is intended to keep track of the competition or technological developments. However, a technology may advance quicker than expected, bringing its implementation closer to reality and alerting competitors to use it in their products, whereas it is also possible that another external development takes place earlier than expected. In such a case, it would be beneficial if a company could accelerate some developments in its roadmap. In order to enable this acceleration, a possibility could be to follow the principle of technology readiness that is widely applied at e.g. NASA's since the mid-1970s and embraced by many other organisations afterwards (Mankins, 2009b). The principle of technology readiness involves that a company documents the maturity of new technologies that could be implemented (Mankins, 1995, 2009b). These levels of maturity may range from the first level where a company observed a potential technology and reported about its possible usefulness, to a maturity level in which a technology is ready to be implemented on a large scale (Mankins, 2009a, 2009b). Showing a technology's maturity level on the business roadmap indicates the steps that must be taken to implement a product successfully. What is more, a second benefit is that it prevents that an immature technology is implemented, which could have been resulted in bad performances, wasted time and unsatisfied customers (Clausing & Holmes, 2010).

6.4. Generic business roadmap development protocol

Based on the established business roadmap development process and the partial application of this process at Ballast Nedam, for which this chapter discusses the findings, a generic business roadmap development protocol is drawn up that ought to be widely applicable in other case studies. This rough protocol is given in this section. Afterwards, this protocol is evaluated on the requirements given in section 5.1 and compared to already existing business roadmap development processes.

Proposed generic business roadmap development protocol

Figure 11 on page 68 gives the generic business roadmap development protocol. This protocol is at large based on the business roadmap process that is applied in this research, which was founded on both scientific literature and points of consideration for Ballast Nedam, and gives the main steps to be executed; the detailed steps are dependent on the organisation where it will be applied. For this generic business roadmap protocol, the business roadmap development process is nevertheless adjusted in accordance with the points of discussion mentioned in this chapter. The satisfactory steps are maintained, and the protocol emphasises that both internal and external participants must be included in process, that the preparatory study is important, that informing the workshop participants is necessary, that a separate innovation strategy workshop must be included, that integration in the organisation's policies is necessary, that software is beneficial to keep the roadmap up-to-date, and that detailed operational business roadmaps must be created for current activities.

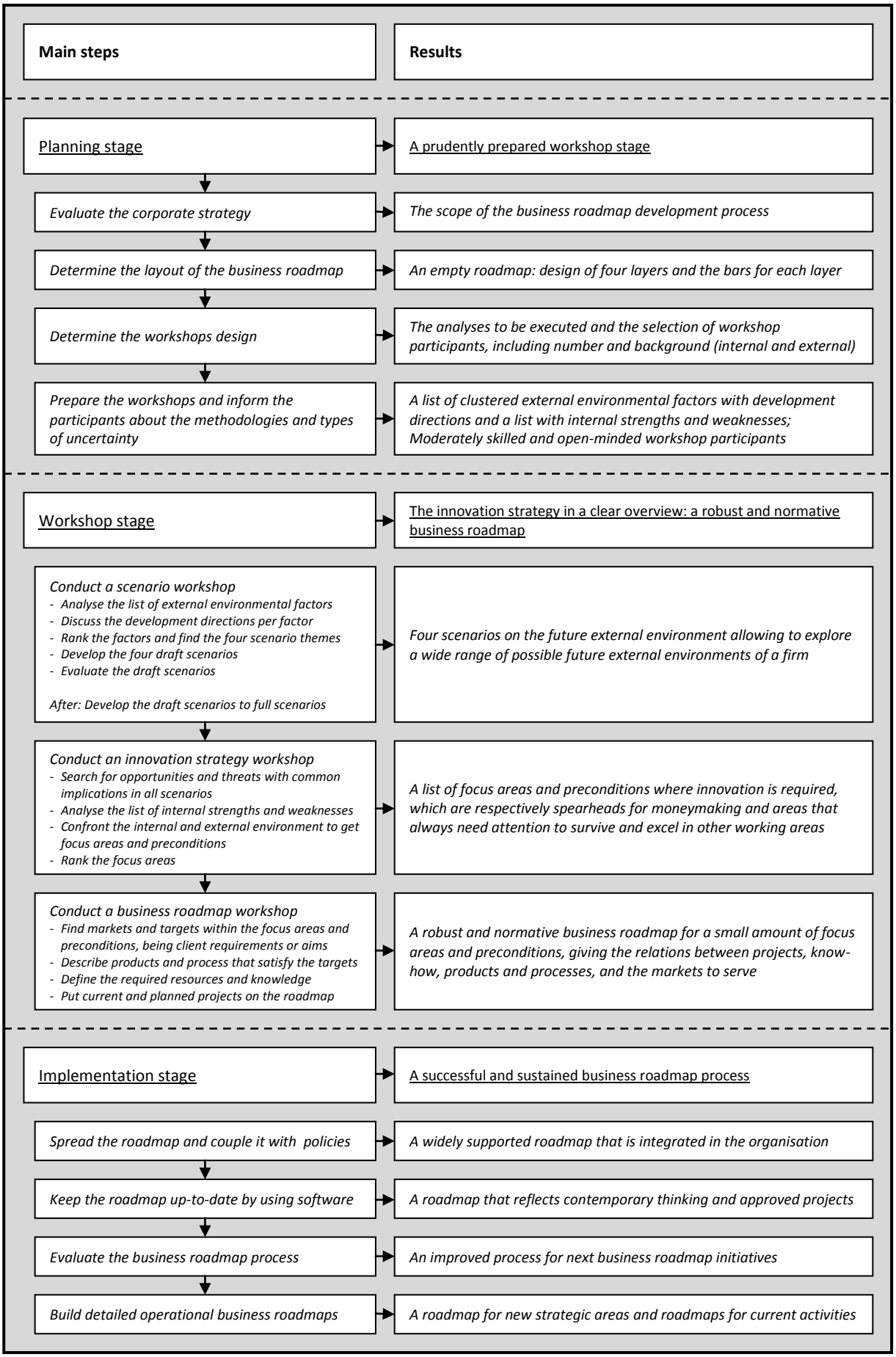

Figure 11: Proposed generic business roadmap development protocol, based on the findings of this research.

Effectiveness of protocol and comparison with other business roadmap development processes
In section 5.1, based on scientific literature and Ballast Nedam insights, seven requirements are formulated a business roadmap development process must satisfy. These seven requirements, also presented below, are used to evaluate the effectiveness and efficiency of the proposed generic business roadmap development protocol as depicted in Figure 11 on page 68. In addition, three other business roadmap development processes are put to these requirements in order to be able to give a conclusion on the contribution of the generic business roadmap development protocol.

One of the three other business roadmap development processes included in this evaluation is the 'T-Plan' approach (see e.g. Phaal et al. (2001)), which is widely discussed in scientific literature as the standard for an ordinary technology roadmap on the operational level. The second process is the 'Multi-scenario roadmapping' method, discussed by Strauss and Radnor (2004), which is a method that combines scenario planning and technology roadmapping for the operational level. The final method discussed is the 'Strategic roadmapping' approach discussed by Petrick and Martinelli (2012), which uses scenario planning as well, but on the strategic level. In addition, these three processes are amongst the few processes for which a detailed overview is available. In this evaluation, these processes are all considered to be applied at the same strategic level as is done in this research.

The generic business roadmap development protocol and the three other processes, are put to these seven requirements:
- The business roadmap development process must be able to give direction to future innovations by demarcating multiple strategically important areas in which innovation is required;
- The business roadmap process must be simple to execute with understandable activities;
- The business roadmap must be appropriate for communication and thus easy to understand;
- The business roadmap must cope with the uncertainty in the external environment;
- The process must improve the company's knowledge on its internal and external environment;
- The business roadmap development process must give attention to getting support in the organisation for the roadmap and its implementation;
- The business roadmap development process must be practically applicable and should therefore keep the necessary time and effort limited.

The generic business roadmap development protocol and the other three processes get a qualitative score for each of the requirements, ranging from negative (-), to neutral (0) and positive (+). These scores are based on an imaginary application of the process at Ballast Nedam. The scores can be found in Table 5 and are described below for each requirement. For the generic business roadmap development protocol, the scores are related to the findings of this research. Therefore, between brackets the scores for the applied business roadmap development process are included as well.

Demarcation
The business roadmap development process included that only several focus areas and preconditions are shown on the business roadmap, giving strict focus to the innovation activity of a firm. What is

Table 5: Evaluation of the business roadmap development protocol and three other methods on the seven requirements for a business roadmap development process. Between brackets, the scores for the business roadmap development process as applied in this research are included.

Process	Demarcation	Simplicity of process	Easy to communicate	Coping with uncertainty	Improve knowledge	Support in organisation	Time and effort needed
Developed protocol	+ (+)	0 (-)	0 (0)	+ (+)	+ (+)	+ (0)	0 (-)
T-Plan	0	+	0	-	+	0	+
Multi-scenario roadmapping	-	-	-	+	+	0	-
Strategic roadmapping	+	0	0	0	+	0	0

more, in the generic business roadmap development protocol emphasis is put on developing a business roadmap for a few new strategic areas and developing detailed operational roadmaps for current activities of the firm. By this, innovation for both new areas and existing working areas is demarcated. The 'Strategic roadmapping' approach also incorporates making explicit choices about the elements to be put on the roadmap by prioritising problems and putting only a few viable solutions on the roadmap. In the other methods, the demarcation is less clear: the 'T-Plan' approach does give consideration to prioritising important developments, but what elements should be shown on the roadmap is not very clear. The 'Multi-scenario roadmapping' approach does not mention demarcation at all.

Simplicity of process
The applied business roadmap process consists of three separate stages with convenient and easy to follow steps. Nevertheless, the workshop participants considered the steps to be executed during the workshops difficult and abstract. Therefore, the proposed generic business roadmap development protocol emphasises the need to prepare the workshop participants through information mails, and includes three workshops by adding a separate innovation strategy workshop. Long-term thinking is however considered to always ask for abstract thinking; the opinion about the simplicity of the process depends at large on the involved people. Nevertheless, clarity, attendance of people with different backgrounds, and abundant time to execute the steps, are important to decrease the abstractness. These elements are emphasised in the proposed generic business roadmap development protocol.

The other approaches are considered to experience similar problems regarding abstractness inherent in long-term thinking. The 'T-Plan' approach, consisting of three clear stages, nevertheless does not include scenario planning and as such could be considered less difficult. The 'Strategic roadmapping' approach does include developing scenarios, but it uses ten fairly understandable steps to come to results. The 'Multi-scenario roadmapping' approach is however less understandable. This method includes scenario planning, but is not clear about the steps to be executed and their sequence, and it comprises many different notions that are difficult to grasp.

Easy to communicate
The applied business roadmap development process and the generic business roadmap development protocol make use of a select gathering of focus areas and preconditions. This is supposed to keep the business roadmap simple and conveniently arranges to make it suitable for communication across an organisation. However, it turned out that developing a simple, non-digital, roadmap, is hardly possible. Therefore, the generic business roadmap protocol emphasises the need to use software in the implementation stage. The question remains though to what extent complexity can be avoided with this: the array of the activities in which an organisation is active, could affect the communicational strength of a business roadmap. Other business roadmap development process are supposed to be unable to take away this complexity. What is more, the communicational strength of the 'Multi-scenario roadmapping' approach is considered worse: the (simplified) example shown for this method contains many different lines and symbols, which need a lot of explanation before it can be used. Because of this, this roadmap is not appropriate for communication across an organisation.

Coping with external uncertainty
The applied business roadmap development process proved that scenario planning can be integrated in business roadmapping and is able to reduce the external uncertainty, since at least the state and effect uncertainty are lowered. Therefore, the generic business roadmap development protocol also incorporates scenario planning. The 'T-Plan' approach does not give consideration to external uncertainty and can therefore not cope with it. The 'Multi-scenario roadmapping' approach uses four scenario roadmaps and one robust overarching scenario, and is therefore considered to be able to cope with external uncertainty. The 'Strategic roadmapping' approach does use scenarios, but not

necessarily to cope with external uncertainty. Rather, the scenarios are used to scan a broad range of possible options in order to find new potential disruptive technologies.

Improve knowledge
The knowledge in an organisation about the external and internal environment, is during the applied business roadmap process increased by using a multidisciplinary team that conducts activities in small groups. The workshop participants prepared for the workshop by thinking about the environments upfront as well, which increases the views incorporated in the workshop. In the generic business roadmap development protocol, the prepared multi-disciplinary teams are retained, and external parties are involved as to decrease bias. All other business roadmap development processes also mention the importance of involving participants with a wide variety of backgrounds.

Support in organisation
The support for a business roadmap initiative is dependent on the context of the organisation where it is initiated. However, support can be actively searched for. During the applied business roadmap development process, involving a wide variety of participants and integrating the process into other organisational policies is found to be beneficial, as is evaluating the corporate strategy to find the scope for the business roadmap. Therefore, all these aspects are maintained and extra emphasised in the proposed generic business roadmap development protocol. The other business roadmap development processes all mention the importance of a multi-disciplinary team. In addition, the 'T-Plan' approach gives some points of consideration for a successful rollout of the roadmap in an organisation, whereas the 'Strategic roadmapping' approach emphasises both that a strong leader is necessary for initiation of the process and that effort is needed to keep the business roadmap green.

Time and effort needed
The applied business roadmap development process shows that integrating scenario planning into business roadmapping takes time and effort. Especially the time and effort necessary for conducting a comprehensive documentation study is responsible for this. This preparatory study is conducted to decrease the necessary time for the workshops, which turned out to be a right judgement. Nevertheless, the time and effort for the preparatory study should be decreased to make to process better applicable. Therefore, the generic business roadmap development protocol gives attention to the preparatory study, but also emphasises the need to include external parties that should compensate for a smaller documentation study. In addition, the integration of scenario planning, and the use of software, are considered beneficial to decrease the amount of time necessary to keep the roadmap up-to-date. However, one extra workshop is added, increasing the time that is needed from workshop participants. In the 'Multi-scenario roadmapping' approach, multiple roadmaps are constructed, which is supposed to take a lot more time and effort. In the 'T-Plan' approach, no scenarios are to be developed, which should decrease the time and effort that is necessary, although the process contains four workshops. To conclude, in the 'Strategic roadmapping' approach scenarios need to be developed, supposedly in multiple workshops. This is considered to take at least as much time and effort as is necessary for the generic business roadmap development protocol.

Contribution of the proposed generic business roadmap development protocol
The comparison in Table 17 on page 87 shows that the generic business roadmap development protocol can be considered to be an effective means to get focus in the innovation activity, while coping with external uncertainty and getting broad support in the organisation. As such, it is considered to be the only applicable process to cope with external uncertainty in a sound way. The 'T-Plan' approach can be used in contexts with low uncertainty or when little time and resources are available, whereas 'Strategic roadmapping' can be used to search for disruptive technologies. 'Multi-scenario roadmapping' is considered inappropriate based on the available information. Above all, it can be concluded that all methods can improve the knowledge in the organisation, while it is considered difficult to get a (non-digital) roadmap with good communicational strengths.

6.5. Conclusion of findings

This section discusses the answer on the fourth central question of this research, which is:

What are the findings of applying the business roadmap development process to Ballast Nedam?

In order to answer this question, the followed research process, the contributions of the developed business roadmap process, and the limitations of this business roadmap process, are discussed. Afterwards, the generic business roadmap development protocol is given attention.

Evaluation of the research process

In this research, the case study of Ballast Nedam is used and considered appropriate due to the external uncertainty Ballast Nedam faces and the cooperative attitude in the firm during the execution of the research. The research provided Ballast Nedam with profound knowledge. However, the findings gathered in this research cannot be generalised: only one case was investigated and there was no possibility to make a distinction to multiple embedded sub cases in this case. Since the organisational structure of Ballast Nedam is appropriate for embedded case studies, continued research could nevertheless provide generalisable results.

This research makes use of the principle of triangulation in order to be able to both develop and apply a business roadmap process. The use of multiple data collection method yielded complementary information as well. However, triangulation requires a large amount of effort, and the at large comparable results of the documentation study and semi-structured interviews therefore makes limiting the time-consuming documentation study worth considering. For the necessary joint decision-making, the included workshops are considered appropriate.

In addition, the multiple data analysis methodologies used during the research, i.e. the methods to analyse the external environment and internal environment, and the methods to analyse the data gathered during the scenario workshop and process this data to final scenarios, are considered applicable and useful to get the desired results.

Contributions of the business roadmap development process

The developed three-stage business roadmap process is considered appropriate, inspiring and valuable. First, it emphasises that one should think before one acts as it involves a detailed preparatory study, has concern for implementation issues, and gives attention to acquiring support. Next, executing scenario planning and developing one robust roadmap afterwards is considered effective and efficient, whereas the process is also able to reduce at least state and effect uncertainty. By distinguishing between focus areas and preconditions, the process moreover yields useful results as the preconditions that always need attention cannot be neglected. To conclude, the process gives rough steps a company must undertake, leaving space for multiple pragmatic interpretations and variety amongst workshop groups that could strengthen the results.

This research revealed that a business roadmap process should be facilitated by a dedicated and competent project manager that is able to prepare the workshops, inspire the workshop participants, explain the methodology clearly, interpret the gathered outcomes, and elaborate these in useful results for the organisation, since many employees are not familiar with the process and since there is little time available for it during the workshops.

The business roadmap for Ballast Nedam is not completed yet: a third workshop is necessary to complete the roadmap. Not until the completion of the roadmap, a decisive answer can be given on the value of the roadmap and its communicational strength, but the use of a limited amount of focus areas and preconditions is supposed to be beneficial for this.

Limitations of the business roadmap development process

The outcome of a business roadmap development process is dependent on the people that are involved in it. The characteristics of the participants involve that the results possess a bias. During the executed process, this bias is tried to minimise by involving employees of Ballast Nedam with different backgrounds and by conducting a documentation study with documents published by objective institutions. However, in the workshops only a select gathering of Ballast Nedam employees is present, increasing the chance of tunnel vision. Involving external experts in the process is supposed to lower this bias, while involving suppliers and clients could moreover result in a better alignment in the supply chain. Involving these external parties is also considered beneficial for reducing the amount of time and effort necessary for the developed business roadmap process: the time-consuming objective documentation study can be limited, since the external views will decrease the bias.

The time and effort necessary to develop and apply the business roadmap process, is a common limitation of the principle. This is the reason why the developed process is not applied completely: the roadmap is not completed yet, while no conclusions can be given on implementation issues at all. The integrated scenario planning approach is however supposed to decrease the amount of time and effort necessary for updating a roadmap, while the use of special roadmapping software is also beneficial in this matter. Coupling this developed software to the digital platform Tok! is an opportunity to increase the willingness to use the business roadmap within Ballast Nedam.

Another common limitation of roadmapping is getting commitment for it. Therefore, extra focus is put on getting support for its development in the organisation. Despite this, the support is still disappointing: many of the invited employees did not attend the workshops, either because they do not want to sacrifice their scarce time for it or because they think the roadmap is not necessary in the innovative and entrepreneurial culture of Ballast Nedam. This limited attendance had also consequences for the quality of the results. Since the organisation is not familiar with scenario planning and roadmapping, the steps executed during the workshops are considered difficult and abstract. The involvement of more employees with different background is beneficial for decreasing this abstractness. For getting the organisation to participate, the board of Ballast Nedam has to be the initiator of the process, whereas for decreasing the abstractness of the necessary steps extending the workshop stage with one extra workshop is also considered opportune since this results in more time to execute the difficult steps. To conclude, the success of a sustained process is dependent on habituation of the organisation to business roadmapping.

Having a strategic business roadmap at Ballast Nedam does not mean that no innovations are permitted for other activities. The activities Ballast Nedam is involved in, are very diverse and cannot be represented on the business roadmap. Therefore, the resulting focus areas and preconditions can be used as major, strategic areas to focus on for 2020. With regards to the current activities, detailed operational roadmaps could indicate how individual segments proceed with these activities. In addition, flexibility is also worth considering for the scheduling of the activities on the business roadmap, as unforeseen developments may ask for accelerating the roadmap. In such case, it is important to know what the status is of a certain technology within the firm and what steps are necessary before a technology can be introduced. Therefore, it is considered beneficial to show the maturity of a technology within Ballast Nedam, i.e. its technology readiness, on the business roadmap.

Generic business roadmap development protocol

Based on the applied business roadmap development process and the points of discussion, a generic business roadmap development protocol is established comprising main steps to be conducted to get a business roadmap that can cope with external uncertainty. In this protocol, the satisfactory steps from the applied business roadmap development process are retained, while the protocol

emphasises that both internal and external participants must be included in process, that the preparatory study is important, that informing the workshop participants is necessary, that a separate innovation strategy workshop must be included, that integration in the organisation's policies is necessary, that software is beneficial to keep the roadmap up-to-date, and that detailed operational business roadmaps must be created for current activities.

A comparison with other roadmap development processes based on seven requirements for a business roadmap development process, revealed that the generic business roadmap development protocol can be considered to be an effective means to get focus in the innovation activity, while coping with external uncertainty and getting broad support in the organisation. As such, the generic business roadmap development protocol is considered to be the only applicable business roadmap development process to cope with external uncertainty in a sound way.

Chapter 7

Conclusions

In this chapter, the final conclusions of this research are given by discussing the answers on the four central questions and drawing up the answer on the research question.

Research problem
Ballast Nedam's current innovation process lacks demarcation: all kinds of ideas are worked out without a clear idea whether or not these ideas support the corporate strategy. Therefore, Ballast Nedam wants to develop a business roadmap that enables the company to focus its innovation effort. This business roadmap is the elaboration of a firm's innovation strategy into an easy to communicate graph. As such, prior to developing the business roadmap, a firm needs to embark on an innovation strategy formulation process. Although there is abundant attention to the uncertainty of the future and the need for strategies to cope with it, the business roadmap development process is presented as if the world does not change while the roadmap is being developed and implemented. Since the external environment is not stable, though, this research focuses on the development and application of a business roadmap process for Ballast Nedam that has concern for the external uncertainty while retaining the communicational and directive strengths of a business roadmap. The research question therefore is:

How to develop and apply a business roadmap process for Ballast Nedam with concern for both external uncertainty and the strengths of a business roadmap?

Conclusion theoretical framework
A business roadmap is a time-based graph with three main layers about how the markets, products and technologies of a firm evolve over time, while it can also contain a fourth layer with the projects a firm is currently working on. The process to come to this business roadmap consists of a stage with multi-disciplinary workshops that is preceded by a preparation stage to ensure effective and efficient workshops, while a third stage is added to guarantee an effective implementation of the business roadmap. In the workshop stage, a firm performs multiple analyses to come to agreement about the areas where innovation is necessary and to determine what activities are required to get these innovations. However, these analyses cannot cope with the external uncertainty of the future, which is an inability of persons to predict accurately or to separate relevant and irrelevant information. An effective method to deal with this external uncertainty is scenario planning: a method that ensures that a firm considers a wide range of possible futures to build a strategy on, by developing multiple plausible stories about the future external environment. Integrating scenario planning into the business roadmap development process leads a company to explore multiple possible futures whereupon it can build a robust normative roadmap that can cope with these alternative futures. As such, a firm can prepare for the future whilst it will be successful under a wide range of circumstances.

Conclusion firm-specific insights
The case of construction firm Ballast Nedam is used to develop and apply the business roadmap process. Ballast Nedam is a large construction company that works in the areas of mobility, housing, nature and energy, with a focus on some niche markets and integrated projects. This strategy is however established ad-hoc without conducting analyses and involving an external facilitator. A business roadmap process can resolve these issues, but it should focus on a few overarching themes for the whole company to keep it simple for communication and getting commitment. The latter is really a point of attention in the firm. Therefore, the business roadmap should be coupled to other policies in the company, and managers and other employees with different backgrounds need to be included. A documentation study should reduce the bias of involving only Ballast Nedam employees.

Conclusion case study Ballast Nedam
The established business roadmap development process consists of a combination of the innovation strategy development process, the scenario planning process, the business roadmap development process and some Ballast Nedam points of attention. The heart of the process is formed by two participatory workshops to produce the innovation strategy of Ballast Nedam in a clear overview: a scenario workshop to get four scenarios on the future external environment of Ballast Nedam, and a business roadmap workshop to partly construct a robust business roadmap on the written scenarios. A preceding planning stage, involving amongst other conducting interviews and a documentation study to avoid time-consuming data collection during the workshops, ensures that a firm prudently prepares the workshops. A concluding implementation stage involves activities necessary for a successful use of the business roadmap in the organisation, e.g. by keeping the roadmap up-to-date.

Conclusion evaluation
The partially applied business roadmap development process yielded useful results and is considered appropriate for reducing uncertainty. The research moreover revealed that the process takes a lot of effort and time, making it impossible to complete the roadmap and implement it across the organisation during this research. Although the applied triangulation is necessary to reduce bias, especially the documentation study takes much time whereas bias remained evident in the results. Therefore, limiting the documentation study and instead incorporating external experts, suppliers and clients is more appropriate. What is more, the limited commitment across the organisation, which affected the results, could be improved by making the executive board of Ballast Nedam the initiator of the research. In addition, rigid use of the roadmap could be avoided by allowing innovations for current activities based on a detailed operational roadmaps for each company segment, while including maturity levels enables that activities can be speeded up.

The research revealed that it is very important to have a dedicated and competent project manager that guides the process. Without such a project manager, it is hardly possible to get useful results. What is more, adding a third workshop to the workshop stage seems necessary: the business roadmap cannot be developed in just two workshops. The extra time gathered will be beneficial for the results as well, since it enables that more time can be spent to execute the required steps in an organisation that is not familiar with scenario planning and roadmapping.

These points of discussion are taken into account in the development of a generic business roadmap development protocol comprising the main steps to be conducted to get a business roadmap that can cope with external uncertainty. The evaluation on effectiveness and a comparison with other roadmap development processes, revealed that the generic business roadmap development protocol can be considered to be an effective means to get focus in the innovation activity, while coping with external uncertainty and getting broad support in the organisation. As such, the generic business roadmap development protocol is considered to be the only applicable business roadmap development process to cope with external uncertainty in a sound way.

Final conclusion

The applied business roadmap development process proves that integrating scenario planning and business roadmapping is possible and is able to provide satisfying results. Using scenario planning first to explore four alternative futures around Ballast Nedam for 2020 reduces the external uncertainty substantially. Moreover, developing a robust normative business roadmap based on the common elements in these scenarios results in a business roadmap that keeps the directive strengths of roadmapping while it will be successful under a wide array of circumstances. However, no decisive answer can be given on the business roadmap's communicational strengths as it is not completed and implemented yet, although including just five focus areas and three preconditions is considered beneficial as it keeps the business roadmap simple in a firm that is active in many working areas.

In order for the business roadmap development process to remain viable within construction company Ballast Nedam, some points of attention need consideration, though. The three-stage business roadmap process with a planning stage, a workshop stage with two workshop, and an implementation stage, is appropriate but needs some revision in accordance with the proposed generic business roadmap development protocol to make it practically applicable. The current workshop stage is too limited for providing all required results and must be extended. What is more, improvements are required to limit the effort needed for executing the process and for obtaining commitment across the organisation. Above all, the research shows that without a major role for a competent project manager that performs the vital preparatory study, inspires participants, interprets results, and elaborates these results, no useful outcomes can be obtained within the firm.

Chapter 8

Recommendations

In this chapter, some recommendations are formulated that are based on this research. These recommendations are divided to recommendations for future scientific research and practical recommendations for Ballast Nedam.

8.1. Future research

Several possible topics for future scientific research in the field of business roadmapping emerge from the applied business roadmap development process and the limitations observed.

Business roadmapping and open innovation

Keeping business roadmapping an internal firm activity, entails a high chance of getting bias since all data is provided with the company's layer, as is highlighted in this research. Therefore, it is recommended to include external experts into the business roadmap development process to get a broad view, and to incorporate suppliers and customers to get supply chain alignment as well. Nevertheless, the question remains what parties and how much parties should exactly be involved as to keep the process convenient. In addition, scientific research must reveal how these parties should be included to leverage the strength of the external views and at the same time keep the process a matter of the company. A question in these could be whether the external parties must be present during the workshop stage, or whether it is appropriate to include them into the planning stage of the business roadmap development process.

An interesting topic for research might be the topic of including competitors in this analysis as well, although this means that the developed roadmap is no business roadmap for Ballast Nedam but an industry roadmap for the entire Dutch construction industry. As such, the focus of the roadmap is to bring the industry forward by defining desired and widely supported development paths on which individual companies can base their own business roadmap. Future research could focus on how to organise such a process, and could apply the developed process for the construction industry afterwards.

Business roadmapping and the integration of ICT

This research revealed that developing a business roadmap takes a lot of time and effort. Scientific literature recognises this drawback of roadmapping and states that software is able to reduce this amount of time and effort necessary. What is more, software is considered to be beneficial as well for communicating a business roadmap across the organisation. This research contributes to this statement by proving that it is hardly possible to design a detailed non-digital business roadmap. However, no sound methodology for integrating ICT into business roadmapping is presented yet. Therefore, an interesting topic for future research would be to explore what the precise role of ICT

could be in developing a business roadmap, and to develop a sound and usable process to let ICT play this part in business roadmapping.

Implementing a business roadmap at a multi-industry firm
Construction company Ballast Nedam is active in many different working areas, ranging from modular buildings to offshore wind turbines and infrastructural projects. This makes that not all activities can be represented on a business roadmap that is focused on the strategic level of the firm: just a small amount of high-potential areas are shown. However, this does neither mean that the other activities of the firm need to be abandoned, nor that for these activities of the company no innovation is permitted. On the contrary, for the company to survive and prosper, innovation in these areas is supposed to be a key element. Although there are many companies that are active in multiple industries, current scientific literature does not discuss solutions for implementing a strategic business roadmap in such a broadly oriented company. Therefore, future research must give insight into the way to deal with this issue, for instance by investigating the possibility of having a strategic business roadmap with a few focus areas and some detailed operational roadmaps on which one segment can present its view on innovations in its current activities. A point of special attention in this solution is the way to communicate these multiple roadmaps in an understandable way though. What is more, the research could focus on what the most appropriate way is for implementing a business roadmap in a company at all.

Extending the research to generalise findings
The business roadmap development process is partly gone through in this research. Although some conclusions have been drawn on the executed process so far, the process must be completed so as to be able to give decisive conclusions. However, even if the process is completely applied, the findings of the research are not appropriate for generalising them, as these findings are based on a single case study. Therefore, additional research is necessary to be able to draw up findings that are considered to be widely applicable. The required scientific research can either be conducted at Ballast Nedam or at other companies in different sectors by using the established generic business roadmap development protocol. If the research is executed at Ballast Nedam, the principle of a single case study with embedded units of analysis should be applied by focussing on one of the company's segments. A research with a case firm that is active in another industry, might reveal interesting results about differences between the construction industry and the other industry.

Keeping the business roadmap up-to-date
Part of the business roadmap development process is to keep the business roadmap up-to-date. This research revealed that developing a business roadmap is time-consuming, but the expectation is uttered that, by the application of scenario planning, the business roadmap would be more robust and therefore less time-demanding during the update process. Nevertheless, it would be necessary to align the roadmap with contemporary thinking, so updating will be necessary. Therefore, future scientific literature could focus on the question if integrating scenario planning into business roadmapping is indeed beneficial for reducing the time required to update the business roadmap, and on what process should be gone through: is it for instance recommended to keep updating an existing business roadmap by going through each of the development steps and evaluating their content on correctness, or is it necessary to start the entire process anew once in a few years?

Long-term effects of the business roadmap
Since the business roadmap development process is partly gone through and as a result the business roadmap is not implemented yet, the effects of the business roadmap on the performance of a firm are uncertain. Especially the effects on the long-term are an interesting topic for future scientific research. The research should reveal what exactly are the consequences of integrating scenario planning into business roadmapping and what the effects are of limiting the strategic innovation areas to five focus areas and three preconditions.

8.2. Practical recommendations

This section contains practical recommendations for Ballast Nedam on the future application of the developed business roadmap. These recommendations are based on the conclusions of this research and the limitations observed.

Complete the business roadmap

The business roadmap for Ballast Nedam currently contains the five focus areas and three preconditions in the know-why layer. For one of these focus areas, the market to be served is determined. This means that developing the business roadmap needs more attention. It is therefore recommended to arrange at least one extra workshop to complete the business roadmap. In order for the business roadmap to be accepted across the company, it is recommended to invite a broad audience for this session, incorporating the members of the organisation that are already involved in the process and other managers and executives of Ballast Nedam. Since not all of them are familiar with the business roadmap process executed so far, during the workshop attention should be given to the process gone through: why does Ballast Nedam need a business roadmap, what approach is used, what scenarios are developed, and what focus areas and preconditions are agreed upon? The broad audience must ensure that the steps to develop the business roadmap are made less abstract. These steps need some further elaboration before the workshop to ensure an effective and efficient workshop, and should involve activities related to finding markets and targets within the focus areas and preconditions, describing products, processes, and their characteristics that satisfy these targets, defining the knowledge and other resources necessary to make these products and processes, and putting current and planned projects on the roadmap. What is more, attention must be given to possible external developments or necessary partners, and the linkage with existing or recent activities. On the longer term, related elements should be grouped together in order not to focus too much on specific topics yet, but still gaining capabilities that ask for long-term commitment and are necessary to survive. After the workshop, the results must be elaborated into a roadmap document.

Disseminate and implement the business roadmap across the company

Part of the implementation stage of the business roadmap development process, is the dissemination of the business roadmap across the company. In the executed business roadmap process, just a minor part of the organisation of Ballast Nedam is involved. Therefore, the method for disseminating the roadmap across the company should make clear for all employees what the purpose is of the roadmap, where it could be found, and it must ensure that the business roadmap will be used. In order to create awareness across the organisation for the existence and purpose of the business roadmap, it is recommended to periodically attract and tempt the employees to consult the roadmap by using catchy means like messages on the Insite, promotion films and posters; comprehensive reports should be avoided.

In order to ensure that the business roadmap will be used, several other measures are necessary. It is recommended to couple the business roadmap development process to the strategy formulation process, and as such to the annual Position Paper of the firm, in order to get commitment and create willingness to use the roadmap. In addition, extra attention should be paid to get the commitment of the managers that decide about allocating money for innovation, since these managers are supposed to use the business roadmap as a guiding principle for accepting innovations. To conclude, it is recommended that the Innovation Management department actively stimulates the organisation to put attention to innovating in the areas mentioned on the business roadmap, for instance by arranging special participatory sessions for this.

Keep the business roadmap up-to-date

The implementation stage of the business roadmap development process contains activities to keep the business roadmap up-to-date. This update process comprises both that the approved innovation

projects within Ballast Nedam are represented on the business roadmap, and that the business roadmap is adjusted to reflect contemporary thinking. For both activities, the development of a digital business roadmap is recommended as it could make the update-process less labour-intensive and as it is beneficial for communicating a roadmap as well. This digital business roadmap can be coupled to the online innovation platform Tok!, which makes that employees can easily see where ideas are already generated, where no ideas are generated, and if there are ideas that are complementary to their own ideas. It is however recommended to make one person or a team responsible for updating this digital roadmap and to check whether an idea fits within the roadmap, so as to avoid chaos on the roadmap.

After de business roadmap is completely developed for the first time, it is recommended to evaluate the business roadmap yearly at the beginning of the year as input for the Position Paper. Pending the year, it is however recommended to do a quick scan on the external environment quarterly to be able to speed up some elements on the business roadmap if that is considered necessary in the view of some essential external environmental developments. Applying the principle of technology readiness is beneficial for this. For the yearly update process, the necessary steps are not elaborated in this research. Nevertheless, it is recommended to investigate the possibilities to found the following business roadmap on the already existing business roadmap, as this will decrease the amount of time and effort necessary for its development. Furthermore, it is recommended to set a policy about the interval with which a new business roadmap must be developed from scratch to avoid tunnel vision.

Evaluate and adjust the business roadmap development process

This research indicates that the three-stage business roadmap development process that integrates both scenario planning and business roadmapping to cope with uncertainty, is appropriate for this purpose. Nevertheless, it is recommended to adjust the process in line with the established business roadmap development protocol to keep it practically applicable within Ballast Nedam. First, it is advisable to incorporate external parties in the process. These external parties, being experts, suppliers and customers, avoid that the results of the process are affected by tunnel vision, allow for minimising the time-consuming documentation study, and ensure a better alignment between supply chain partners.

Second, it is recommended to extend the workshop stage from two workshops to three workshops in order to increase the time to execute the steps and by that decrease the abstractness and improve the quality of the results. Hence, the new workshop stage starts with a scenario workshop in which the same activities are performed as during the applied scenario workshop. Next, a new innovation strategy workshop must be added incorporating employees with strategic view, in which the steps are included to come to focus areas and preconditions. To conclude, the business roadmap workshop deals with elaborating the business roadmap. In order to decrease the abstractness even more, it is recommended to screen all possible workshop participants during an interview and let employees that already participated in the process function as guide for employees that did not participate in the applied business roadmap process.

Third, it is recommended to increase the support across the organisation for the development of the business roadmap. For this, partly changing the composition of the group with workshop participants is advisable to increase the part of the company that will become accustomed to the process. What is more, it is recommended to make the executive board the initiator of the research, as the strong signal given by this can hardly be neglected by the organisation.

To conclude, this research shows that it is recommendable to appoint one employee that manages the entire process. This employee should be familiar with the principles of scenario planning and business roadmapping and must be able to explain these principles to other employees, perform the

guiding preparatory study, interpret results, and elaborate these results to useful outcomes. What is more, it is recommended to let this employee guide the implementation and update process as well.

Make the focus areas the future niche markets and build a hierarchy of roadmaps
This research revealed that the current corporate strategy of Ballast Nedam is not fully supported: employees of Ballast Nedam find it difficult to understand the status of the niche markets in which the company operates, since these niche markets are established in an ad-hoc manner during strategy sessions and since both the number and content of these niche markets are yearly subject to change. Hence, the argument to work in these niche markets is a point of consideration. What is more, the question is whether all niche markets the firm currently serves will continue to be niche markets in the near future due to developments in the external environment, as the niche markets are small and specialist markets in which Ballast Nedam can deliver added value. It is therefore recommended to use the business roadmap, more precise the focus areas on the business roadmap, as a starting point for developing new niche markets. The business roadmap is namely developed on the strategic level and is able to give a sound and robust analytical grounding to the niche markets, whereas the participatory process creates support for them across the organisation. What is more, upgrading the focus areas to new niche markets could increase the willingness to work on them across the organisation. However, it is advisable to give attention to the formulation of criteria which the focus areas must meet in order to become new niche markets.

This way of using the business roadmap takes away the uncertainty about the status of the business roadmap's content and the ensuing risk of rigid use of this roadmap. For the current activities Ballast Nedam is working on, it is recommended to develop detailed operational roadmaps on the segment level. On these roadmaps, the segments can state what their plans are for the activities of the firm they are responsible for. This way, both innovations for the current activities of the firm and innovations for new markets are demarcated. However, it is recommended to give special attention to the way these roadmaps will be integrated and communicated in an understandable way.

Learn lessons from other companies
Business roadmapping and scenario planning are no standard principles within Ballast Nedam. On the contrary, the methodologies are applied for the first time during this research and as such there is not much practical experience of how to implement them within the firm: the entire process is currently based on scientific literature, with some practical points of attention. Therefore, it is recommended to exchange experiences with companies that have a rich history with applying roadmapping and scenario planning, in order to get practical tips about how the methodologies can be used in real life in a sustained way. For scenario planning, it is recommended to visit Royal Dutch Shell as this tool has been used for decades now by this company, whereas for roadmapping Royal Philips and ABN Amro will be attractive partners.

References

Abernathy, W.J., & Clark, K.B. (1985). Innovation: mapping the winds of creative destruction. *Research policy, 14*(1), 3-22. doi: 10.1016/0048-7333(85)90021-6

Albright, R.E. (2002). How to use roadmapping for global platform products. *PDMA visions, 26*(4), 19-22. http://www.technologyforge.net/enma/6020/6020Lectures/TechnologyRoadmapping/ENMA291TRReferences/RoadmappingAlbright.pdf

Albright, R.E., & Kappel, T.A. (2003). Roadmapping in the corporation. *Research technology management, 46*(2), 31-40. http://www.ingentaconnect.com/content/iri/rtm/2003/00000046/00000002/art00006

Atkin, B (1999). Innovation in the construction sector. Brussels, Belgium: European council for construction research, development and innovation.

Baldwin, C.Y., & Clark, K.B. (1997). Managing in an age of modularity. *Harvard business review, 75*(5), 84-93. doi: 10.1225/97502

Ballast Nedam N.V. (2010). Jaarverslag 2009. Nieuwegein, the Netherlands: Ballast Nedam N.V.

Ballast Nedam N.V. (2011). Jaarverslag 2010. Nieuwegein, the Netherlands: Ballast Nedam N.V.

Ballast Nedam N.V. (2012a). Jaarverslag 2011: realiseren van blijvende kwaliteit. Nieuwegein, the Netherlands: Ballast Nedam N.V.

Ballast Nedam N.V. (2012b). Strategie en beleid (internal company report).

Ballast Nedam N.V. (2013a). Jaarcijfers 2012. Retrieved March 14th, 2013, from http://www.ballast-nedam.nl/

Ballast Nedam N.V. (2013b). Jaarverslag 2012: realiseren van blijvende kwaliteit. Nieuwegein, the Netherlands: Ballast Nedam N.V.

Ballast Nedam N.V. (n.d.). Ontstaan Ballast Nedam. Retrieved May 29th, 2013, from http://www.ballast-nedam.nl/

Barlow, J. (2000). Innovation and learning in complex offshore construction projects. *Research policy, 29*(7-8), 973-989. doi: 10.1016/S0048-7333(00)00115-3

Bessant, J. (2008). Dealing with discontinuous innovation: the European experience. *International journal of technology management, 42*(1-2), 36-50. doi: 10.1504/IJTM.2008.018059

Bessant, J., Caffyn, S., Gilbert, J., Harding, R., & Webb, S. (1994). Rediscovering continuous improvement. *Technovation, 14*(1), 17-29. doi: 10.1016/0166-4972(94)90067-1

Blayse, A.M., & Manley, K. (2004). Key influences on construction innovation. *Construction innovation: information, process, management, 4*(3), 143-154. doi: 10.1108/14714170410815060

Boes, J., & Dorée, A.G. (2008). *Public procurement of local authorities in the Netherlands: a case of breaking tradition for a more strategic approach?* Paper presented at the 24th Annual ARCOM Conference, Cardif, UK.

Bowman, C. (1995). Strategy workshops and top-team commitment to strategic change. *Journal of managerial psychology, 10*(8), 4-12. doi: 10.1108/02683949510100732

Bracker, J. (1980). The historical development of the strategic management concept. *The academy of management review, 5*(2), 219-224. doi: 10.5465/AMR.1980.4288731

Brem, A., & Voigt, K.-I. (2009). Integration of market pull and technology push in the corporate front end and innovation management - insights from the German software industry. *Technovation, 29*(5), 351-367. doi: 10.1016/j.technovation.2008.06.003

Brown, S.L., & Eisenhardt, K.M. (1995). Product development: past research, present findings, and future directions. *The academy of management review, 20*(2), 343-378. doi: 10.2307/258850

Brown, S.L., & Eisenhardt, K.M. (1998). *Competing on the edge: strategy as structured chaos*. Boston, MA: Harvard business school press.

Buijs, J. (2003). Modelling product innovation processes: from linear logic to circular chaos. *Creativity and innovation management, 12*(2), 76-93. doi: 10.1111/1467-8691.00271

Caerteling, J.S., Di Benedetto, C.A., Dorée, A.G., Halman, J.I.M., & Song, M. (2011). Technology development projects in road infrastructure: the relevance of government championing behavior. *Technovation, 31*(5-6), 270-283. doi: 10.1016/j.technovation.2011.02.001

Caerteling, J.S., Halman, J.I.M., & Dorée, A.G. (2008). Strategy implementation in project-based firms: an empirical analysis of three road construction firms., In Caerteling, J.S., *doctoral dissertation at the University of Twente, the Netherlands*. http://doc.utwente.nl/59766/1/thesis_Caerteling.pdf

Caetano, M., & Amaral, D.C. (2011). Roadmapping for technology push and partnership: a contribution for open innovation environments. *Technovation, 31*(7), 320-335. doi: 10.1016/j.technovation.2011.01.005

Chandler, A.D., Jr. (1962). *Strategy and structure: chapters in the history of the industrial enterprise*. Cambridge, MA: MIT press.

Chesbrough, H.W. (2003). *Open innovation: the new imperative for creating and profiting from technology*. Boston, MA: Harvard business school press.

Chidamber, S.R., & Kon, H.B. (1994). A research retrospective of innovation inception and success: the technology-push, demand-pull question. *International journal of technology management, 9*(1), 94-112. doi: 10.1504/IJTM.1994.025565

Clausing, D., & Holmes, M. (2010). Technology readiness. *Research technology management, 53*(4), 52-59.

Coates, J.F. (1999). Boom in forecasting. *Technological forecasting & social change, 61*(1-2), 37-40. doi: 10.1016/S0040-1625(99)00013-X

Coates, J.F. (2000). Scenario planning. *Technological forecasting & social change, 65*(1), 115-123. doi: 10.1016/S0040-1625(99)00084-0

Cobouw. (2012). Cobouw 50. Retrieved March 14th, 2013, from http://www.cobouw.nl/cobouw50

Cooper, R.G. (1990). Stage-gate systems: a new tool for managing new products. *Business horizons, 33*(3), 44-54. doi: 10.1108/02651339410057491

Cooper, R.G., Edgett, S.J., & Kleinschmidt, E.J. (2001). *Portfolio management for new products*. Cambridge, MA: Perseus publishing.

Cooper, R.G., Edgett, S.J., & Kleinschmidt, E.J. (2002). Portfolio management: fundamental to new product success. In P. Belliveau, A. Griffin & S. Somermeyer (Eds.), *The pdma cookbook for new product development* (pp. 331-364). New York, NY: John Wiley & Sons, Inc.

Cooper, R.G., & Kleinschmidt, E.J. (2007). Winning businesses in product development: the critical success factors. *Research technology management, 50*(3), 52-66. http://www.stage-gate.com/newsletter/downloads/WP_26_WinningBusiness.pdf

Courtney, H., Kirkland, J., & Viguerie, P. (1997). Strategy under uncertainty. *Harvard business review, 75*(6), 67-79. doi: 10.1225/97603

Crossan, M.M., & Apaydin, M. (2010). A multi-dimensional framework of organizational innovation: a systematic review of the literature. *Journal of management studies, 47*(6), 1154-1191. doi: 10.1111/j.1467-6486.2009.00880.x

Cummings, S., & Angwin, D. (2011). Stratography: the art of conceptualizing and communicating strategy. *Business horizons, 54*(5), 435-446. doi: 10.1016/j.bushor.2011.04.005

Deutsche Post DHL (2012). Delivering tomorrow: logistics 2050, a scenario study. Bonn, Germany: Deutsche Post AG.

Di Stefano, G., Gambardella, A., & Verona, G. (2012). Technology push and demand pull perspectives in innovation studies: current findings and future research directions. *Research policy, 41*(8), 1283-1295. doi: 10.1016/j.respol.2012.03.021

Dodgson, M., Gann, D.M., & Salter, A.J. (2008). *The management of technological innovation: strategy and practice*. New York, NY: Oxford university press.

Dosi, G. (1982). Technological paradigms and technological trajectories: a suggested interpretation of the determinants and directions of technical change. *Research policy, 11*(3), 147-162. doi: 10.1016/0048-7333(82)90016-6

Downey, H.K., & Slocum, J.W., Jr. (1975). Uncertainty: measures, research, and sources of variation. *The academy of management journal, 18*(3), 562-578. doi: 10.2307/255685

Dreborg, K.H. (1996). Essence of backcasting. *Futures, 28*(9), 813-828. doi: 10.1016/S0016-3287(96)00044-4

Dubois, A., & Gadde, L.-E. (2002). The construction industry as a loosely coupled system: implications for productivity and innovation. *Construction management and economics, 20*(7), 621-631. doi: 10.1080/01446190210163543

Dul, J., & Hak, T. (2008). *Case study methodology in business research*. Oxford, United Kingdom: Butterworth-Heinemann Elsevier.

Duncan, R.B. (1972). Characteristics of organizational environments and perceived environmental uncertainty. *Administrative science quarterly, 17*(3), 313-327. doi: 10.2307/2392145

Dwyer, L., & Mellor, R. (1991). Organizational environment, new product process activities, and project outcomes. *Journal of product innovation management, 8*(1), 39-48. doi: 10.1111/1540-5885.810777

Eisenhardt, K.M. (1989). Building theories from case study research. *The academy of management review, 14*(4), 532-550. doi: 10.5465/AMR.1989.4308385

Ettlie, J.E., Bridges, W.P., & O'Keefe, R.D. (1984). Organization strategy and structural differences for radical versus incremental innovation. *Management science, 30*(6), 682-695. doi: 10.1287/mnsc.30.6.682

Fisscher, O., van Looy, B., de Weerd-Nederhof, P., & Debackere, K. (2004). Organisatie van innovatie: een radicale, gelaagde procesbenadering. In P. de Weerd-Nederhof, B. van Looy & K. Visscher (Eds.), *Innovatie(f) organiseren*. Deventer, the Netherlands: Kluwer.

Freeman, C., & Soete, L. (2012). *The economics of industrial innovation* (3rd revised ed.). Abingdon, United Kingdom: Routledge.

Gann, D.M. (2000). *Building innovation: complex constructs in a changing world*. London, United Kingdom: Thomas Telford.

Gann, D.M., & Salter, A.J. (2000). Innovation in project-based, service-enhanced firms: the construction of complex products and systems. *Research policy, 29*(7-8), 955-972. doi: 10.1016/S0048-7333(00)00114-1

Garcia, M.L., & Bray, O.H. (1997). Fundamentals of technology roadmapping. Albuquerque, NM: Sandia national laboratories.

Garcia, R., & Calantone, R. (2002). A critical look at technological innovation typology and innovativeness terminology: a literature review. *Journal of product innovation management, 19*(2), 110-132. doi: 10.1111/1540-5885.1920110

Geels, F.W., & Schot, J. (2007). Typology of sociotechnical transition pathways. *Research policy, 36*(3), 399-417. doi: 10.1016/j.respol.2007.01.003

Gerdsri, N., & Kocaoglu, D.F. (2007). Applying the analytic hierarchy process (AHP) to build a strategic framework for technology roadmapping. *Mathematical and computer modelling, 46*(7-8), 1071-1080. doi: 10.1016/j.mcm.2007.03.015

Godet, M. (2000). The art of scenarios and strategic planning: tools and pitfalls. *Technological forecasting & social change, 65*(1), 3-22. doi: 10.1016/S0040-1625(99)00120-1

Goffin, K., & Mitchell, R. (2005). *Innovation management: strategy and implementation using the pentathlon framework*. Basingstoke (Houndmills), United Kingdom: Palgrave Macmillan.

Gopalakrishnan, S., Bierly, P., & Kessler, E.H. (1999). A reexamination of product and process innovations using a knowledge-based view. *Journal of high technology management research, 10*(1), 147-166. doi: 10.1016/S1047-8310(99)80007-8

Grant, R.M. (2003). Strategic planning in a turbulent environment: evidence from the oil majors. *Strategic management journal, 24*(6), 491-517. doi: 10.1002/smj.314

Groenveld, P. (2007). Roadmapping integrates business and technology. *Research technology management, 50*(6), 49-58. http://www.ingentaconnect.com/content/iri/rtm/2007/00000050/00000006/art00007

Halman, J.I.M., Voordijk, J.T., & Reymen, I.M.M.J. (2008). Modular approaches in Dutch house building: an exploratory survey. *Housing studies, 23*(5), 781-799. doi: 10.1080/02673030802293208

Hartmann, A. (2006). The context of innovation management in construction firms. *Construction management and economics, 24*(6), 567-578. doi: 10.1080/01446190600790629

Henderson, R.M., & Clark, K.B. (1990). Architectural innovation: the reconfiguration of existing product technologies and the failure of established firms. *Administrative science quarterly, 35*(1), 9-30. doi: 10.2307/2393549

Hobday, M. (1998). Product complexity, innovation and industrial organisation. *Research policy, 26*(6), 689-710. doi: 10.1016/S0048-7333(97)00044-9

Hodgkinson, G.P., Whittington, R., Johnson, G., & Schwarz, M. (2006). The role of strategy workshops in strategy development processes: formality, communication, co-ordination and inclusion. *Long range planning, 39*(5), 479-496. doi: 10.1016/j.lrp.2006.07.003

Hodkinson, P., & Hodkinson, H. (2001). *The strengths and limitations of case study research*. Paper presented at the Learning and skills development agency conference, Cambridge, United Kingdom.

Jalonen, H. (2012). The uncertainty of innovation: a systematic review of the literature. *Journal of management research, 4*(1). doi: 10.5296/jmr.v4i1.1039

Johnson, G., Scholes, K., & Whittington, R. (2008). *Exploring corporate strategy* (8th ed.). Harlow, United Kingdom: Pearson education.

Kanter, R.M. (2006). Innovation: the classic traps. *Harvard business review, 84*(11), 72-83. http://hbr.org/2006/11/innovation-the-classic-traps/ar/1

Kaplan, R.S., Norton, D.P., & Barrows, E.A., Jr. (2008). Developing the strategy: vision, value gaps, and analysis. *Balanced scorecard report, 10*(1), 1-5. http://www.exed.hbs.edu/assets/Documents/developing-strategy.pdf

Kappel, T.A. (2001). Perspectives on roadmaps: how organizations talk about the future. *Journal of product innovation management, 18*(1), 39-50. doi: 10.1111/1540-5885.1810039

Kline, S.J., & Rosenberg, N. (1986). An overview of innovation. In R. Landau & N. Rosenberg (Eds.), *The positive sum strategy: harnessing technology for economic growth* (pp. 275-305). Washington, D.C.: National academy press.

Koen, P., Ajamian, G., Burkart, R., Clamen, A., Davidson, J., D'Amore, R., . . . Wagner, K. (2001). Providing clarity and a common language to the fuzzy front end. *Research technology management, 44*(2), 46-55.

Kostoff, R.N., & Schaller, R.R. (2001). Science and technology roadmaps. *IEEE transactions on engineering management, 48*(2), 132-143. doi: 10.1109/17.922473

Lee, S., & Park, Y. (2005). Customization of technology roadmaps according to roadmapping purposes: overall process and detailed modules. *Technological forecasting & social change, 72*(5), 567-583. doi: 10.1016/j.techfore.2004.11.006

Lindgren, M., & Bandhold, H. (2003). *Scenario planning: the link between future and strategy*. Basingstoke (Houndmills), United Kingdom: Palgrave Macmillan.

Longhurst, R. (2010). Semi-structured interviews and focus groups. In N. Clifford, S. French & G. Valentine (Eds.), *Key methods in geography* (pp. 103-115). London, United Kingdom: Sage publications.

Mankins, J.C. (1995). Technology readiness levels. Huntsville, AL: Advanced concepts office, office of space access and technology, NASA.

Mankins, J.C. (2009a). Technology readiness and risk assessments: a new approach. *Acta Astronautica, 65*(9-10), 1208-1215. doi: 10.1016/j.actaastro.2009.03.059

Mankins, J.C. (2009b). Technology readiness assessments: a retrospective. *Acta Astronautica, 65*(9-10), 1216-1223. doi: 10.1016/j.actaastro.2009.03.058

McCarthy, R.C. (2003). Linking technological change to business needs. *Research technology management, 46*(2), 47-52. http://www.ingentaconnect.com/content/iri/rtm/2003/00000046/00000002/art00006

McMillan, A. (2003). Roadmapping - agent of change. *Research technology management, 46*(2), 40-47. http://www.ingentaconnect.com/content/iri/rtm/2003/00000046/00000002/art00006

Mezias, J.M., Grinyer, P., & Guth, W.D. (2001). Changing collective cognition: a process model for strategic change. *Long range planning, 34*(1), 71-95. doi: 10.1016/S0024-6301(00)00096-0

Miles, I. (1993). Services in the new industrial economy. *Futures, 25*(6), 653-672. doi: 10.1016/0016-3287(93)90106-4

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

Miles, R.E., Snow, C.C., Meyer, A.D., & Coleman, H.J., Jr. (1978). Organizational strategy, structure, and process. *The academy of management review, 3*(3), 546-562. doi: 10.5465/AMR.1978.4305755

Miller, K.D. (1992). A framework for integrated risk management in international business. *Journal of international business studies, 23*(2), 311-331. doi: 10.1057/palgrave.jibs.8490270

Milliken, F.J. (1987). Three types of perceived uncertainty about the environment: state, effect and response uncertainty. *The academy of management review, 12*(1), 133-143. doi: 10.5465/AMR.1987.4306502

Mintzberg, H. (1978). Patterns in strategy formation. *Management science, 24*(9), 934-948. doi: 10.1287/mnsc.24.9.934

Mintzberg, H. (1994a). The fall and rise of strategic planning. *Harvard business review, 72*(1), 107-114. doi: 10.1225/94107

Mintzberg, H. (1994b). Rethinking strategic planning part II: new roles for planners. *Long range planning, 27*(3), 22-30. doi: 10.1016/0024-6301(94)90186-4

Miozzo, M., & Dewick, P. (2002). Building competitive advantage: innovation and corporate governance in European construction. *Research policy, 31*(6), 989-1008. doi: 10.1016/S0048-7333(01)00173-1

Nagel, A.P. (1992). *Verhogen van het strategisch produktinnovatievermogen* (Doctoral dissertation, Eindhoven University of Technology, the Netherlands). Retrieved from http://alexandria.tue.nl/repository/books/369615.pdf

Nuseibeh, B., & Easterbrook, S. (2000). *Requirements engineering: a roadmap.* Paper presented at the Conference on the future of software engineering (ICSE'00), New York, NY.

Oliveira, M.G., & Rozenfeld, H. (2010). Integrating technology roadmapping and portfolio management at the front-end of new product development. *Technological forecasting & social change, 77*(8), 1339-1354. doi: 10.1016/j.techfore.2010.07015

Petrick, I.J., & Echols, A.E. (2004). Technology roadmapping in review: a tool for making sustainable new product development decisions. *Technological forecasting & social change, 71*(1-2), 81-100. doi: 10.1016/S0040-1625(03)00064-7

Petrick, I.J., & Martinelli, R. (2012). Driving disruptive innovation - problem finding and strategy setting in an uncertain world. *Research technology management, 55*(6), 49-57. doi: 10.5437/08956308X5506902

Phaal, R., Farrukh, C.J.P., Mills, J.F., & Probert, D.R. (2003). *Customizing the technology roadmapping approach*. Paper presented at the Portland international conference on management of engineering and technology (PICMET'03), Portland, OR.

Phaal, R., Farrukh, C.J.P., Mitchell, R., & Probert, D.R. (2003). Starting-up roadmapping fast. *Research technology management, 46*(2), 52-58. http://www.ingentaconnect.com/content/iri/rtm/2003/00000046/00000002/art00006

Phaal, R., Farrukh, C.J.P., & Probert, D.R. (2001). *T-plan: the fast-start to technology roadmapping - planning your route to success*. Cambridge, United Kingdom: Institute for manufacturing, University of Cambridge.

Phaal, R., Farrukh, C.J.P., & Probert, D.R. (2004). Technology roadmapping - a planning framework for evolution and revolution. *Technological forecasting & social change, 71*(1), 5-26. doi: 10.1016/S0040-1625(03)00072-6

Phaal, R., Farrukh, C.J.P., & Probert, D.R. (2005). *Developing a technology roadmapping system*. Paper presented at the Portland international conference on management of engineering and technology (PICMET'05), Portland, OR.

Phaal, R., & Muller, G. (2009). An architectural framework for roadmapping: towards visual strategy. *Technological forecasting & social change, 76*(1), 39-49. doi: 10.1016/j.techfore.2008.03.018

Porter, M.E. (1998). *Competitive strategy: techniques for analyzing industries and competitors* (reprint 1980 ed.). New York, NY: The free press.

Porter, M.E. (2008). *Competitive advantage: creating and sustaining superior performance* (reprint 1985, 1st ed.). New York, NY: The free press.

Pries, F., & Dorée, A.G. (2005). A century of innovation in the Dutch construction industry. *Construction management and economics, 23*(6), 561-564. doi: 10.1080/01446190500040349

Probert, D.R., & Radnor, M. (2003). Frontier experiences from industry-academia consortia. *Research technology management, 46*(2), 27-30. http://www.ingentaconnect.com/content/iri/rtm/2003/00000046/00000002/art00006

Ragatz, G.L., Handfield, R.B., & Petersen, K.J. (2002). Benefits associated with supplier integration into new product development under conditions of technology uncertainty. *Journal of business research, 55*(5), 389-400. doi: 10.1016/S0148-2963(00)00158-2

Ringland, G. (1998). *Scenario planning: managing for the future*. Chichester, United Kingdom: John Wiley & Sons Ltd.

Rinne, M. (2004). Technology roadmaps: infrastructure for innovation. *Technological forecasting & social change, 71*(1-2), 67-80. doi: 10.1016/j.techfore.2003.10.002

Robinson, J.B. (1990). Futures under glass: a recipe for people who hate to predict. *Futures, 22*(8), 820-842. doi: 10.1016/0016-3287(90)90018-D

Rogers, E.M. (2003). *Diffusion of innovation*. New York, NY: Free press.

Rothwell, R. (1994). Towards the fifth-generation innovation process. *International marketing review, 11*(1), 7-31. doi: 10.1108/02651339410057491

Saritas, O., & Aylen, J. (2010). Using scenarios for roadmapping: the case of clean production. *Technological forecasting & social change, 77*(7), 1061-1075. doi: 10.1016/j.techfore.2010.03.003

Saunders, M., Lewis, P., & Thornhill, A. (2009). *Research methods for business students* (5th ed.). Harlow, United Kingdom: Pearson education.

Schilling, M.A. (2010). *Strategic management of technological innovation* (International ed.). New York, NY: McGraw-Hill.

Schoemaker, P.J.H. (1995). Scenario planning: a tool for strategic thinking. *Sloan management review, 36*(2), 25-40.

Schumpeter, J.A. (2004). *The theory of economic development: an inquiry into profits, capital, credit, interest, and the business cycle* (10th ed.). New Brunswick, NJ: Transaction publishers.

Schwartz, P. (1996). *The art of the long view: planning for the future in an uncertain world*. New York, NY: Doubleday.

Seaden, G., & Manseau, A. (2001). Public policy and construction innovation. *Building research & information, 29*(3), 182-196. doi: 10.1080/09613210010027701

Sexton, M.G., & Lu, S.-L. (2012). Construction innovation: theory and practice. In A. Akintoye, J. Goulding & G. Zawdie (Eds.), *Construction innovation and process improvement*. Chicester, United Kingdom: Wiley-Blackwell.

Shaw, N. (2010). *Improving innovation management in construction* (Doctoral dissertation, Loughborough University, United Kingdom). Retrieved from https://dspace.lboro.ac.uk/dspace-jspui/handle/2134/8465

Slocum, N. (2003). Participatory methods toolkit: a practitioner's manual. Bruges, Belgium: United nations university.

Stake, R.E. (1995). *The art of case study research*. Thousand Oaks, CA: Sage publications.

Strauss, J.D., & Radnor, M. (2004). Roadmapping for dynamic and uncertain environments. *Research technology management, 47*(2), 51-57. http://www.technologyforge.net/STMWarsaw/TechnologyRoadmapping/ENMA291TRReferences/RoadmapScenario.pdf

Strauss, J.D., Radnor, M., & Peterson, J.W. (1998). *Plotting and navigating a non-linear roadmap: knowledge-based roadmapping for emerging and dynamic environments*. Paper presented at the Conference on knowledge creation management in Asia, Singapore.

Tatum, C.B. (1989). Organizing to increase innovation in construction firms. *Journal of construction engineering and management, 115*(4), 602-617. doi: 10.1061/(ASCE)0733-9364(1989)115:4(602)

Tidd, J., Bessant, J., & Pavitt, K. (2005). *Managing innovation: integrating technological, market and organization change* (3rd ed.). Chichester, United Kingdom: John Wiley & Sons Ltd.

Trott, P. (2005). *Innovation management and new product development* (3rd ed.). Harlow, United Kingdom: Pearson education.

Ulrich, K. (1995). The role of product architecture in the manufacturing firm. *Research policy, 24*(3), 419-440. doi: 10.1016/0048-7333(94)00775-3

Utterback, J.M., & Abernathy, W.J. (1975). A dynamic model of process and product innovation. *Omega, 3*(6), 639-656. doi: 10.1016/0305-0483(75)90068-7

Van de Ven, A.H. (1986). Central problems in the management of innovation. *Management science, 32*(5), 590-607. doi: 10.1287/mnsc.32.5.590

Van der Heijden, K. (2005). *Scenarios: the art of strategic conversations* (2nd ed.). Chichester, United Kingdom: John Wiley & Sons Ltd.

Van der Kooij, B.J.G. (1988). Innovatie gedefinieerd; een analyse en een voorstel - een nader onderzoek naar de definities van het begrip innovatie over de periode 1939-1988 alsmede een voorstel voor een meer algemene definitie. *TUE research report*. http://alexandria.tue.nl/repository/books/305860.pdf

Varis, M., & Littunen, H. (2010). Types of innovation, sources of information and performance in entrepreneurial SMEs. *European journal of innovation management, 13*(2), 128-154. doi: 10.1108/14601061011040221

Verschuren, P., & Doorewaard, H. (2007). *Het ontwerpen van een onderzoek* (4th ed.). The Hague, the Netherlands: Uitgeverij Lemma.

Veryzer, R.W., Jr. (1998). Discontinuous innovation and the new product development process. *Journal of product innovation management, 15*(4), 304-321. doi: 10.1016/S0737-6782(97)00105-7

Wack, P. (1985). Scenarios: uncharted waters ahead. *Harvard business review, 63*(5), 72-89. doi: 10.1225/85516

Weick, K.E. (1983). Misconceptions about managerial productivity. *Business horizons, 26*(4), 47-52. doi: 10.1016/0007-6813(83)90010-1

Wheelwright, S.C., & Clark, K.B. (1992). *Revolutionizing product development: quantum leaps in speed, efficiency, and quality*. New York, NY: Free Press.

Winch, G. (1989). The construction firm and the construction project: a transaction cost approach. *Construction management and economics, 7*(4), 331-345. doi: 10.1080/01446198900000032

Winch, G. (1998). Zephyrs of creative destruction: understanding the management of innovation in construction. *Building research & information, 26*(5), 268-279. doi: 10.1080/096132198369751

Yin, R.K. (2003). *Case study research: design and methods*. Thousand Oaks, CA: Sage publications.

Appendices

Appendix A

Case study data collection

A.1. Interview review business roadmap process

This appendix contains a list of Ballast Nedam employees interviewed to give their opinion on the value of a business roadmap process for Ballast Nedam and the points of attention for a successful application of the process within Ballast Nedam. Next, this appendix shows the interview design for these interviews. The results of the interviews are described in section 4.3.

List of interviewees

The choice what employees of Ballast Nedam to interview for their opinion about the business roadmap process, is based on their knowledge about roadmapping or strategies, and their position within the organisation of Ballast Nedam: several top managers are included to gain support for the process. The list of interviewees is shown in Table 6.

Table 6: List of interviewees for review business roadmap process.

Name	Position	Interview date
B. Bloemers	Risk manager, Ballast Nedam Infrastructure Special Projects	5th of June
A.A. Kaper	Medior advisor sustainable building and process manager, ABL2	20th of June
T.A.C.M. Bruijninckx	Chief Executive Officer, Ballast Nedam	15th of July
J.J. Blüm	Market researcher, Ballast Nedam Building and Development Special Projects	15th of July
D. van Hoogstraten	Director, Ballast Nedam Development Company	16th of July
I. van der Meijden	Director Communication and Investor Relations, Ballast Nedam	19th of August
S. van der Linden	Director, Ballast Nedam Infrastructure Special Projects	20th of August

Interview design

Below, an indication is given on the interview design. The precise interview depended on how the interview unfolded, since a semi-structured interview is used. Here, an example is given of such a semi-structured interview; in the other appendices, just the themes to be covered are discussed. The two questions cover the areas that must be given attention to. The interviews lasted about 0.5 hour.

Master's thesis:

I conduct my master's thesis as part of the master Civil Engineering and Management at the University of Twente. Besides the relevance of the research for finalising this study, the thesis needs to be useful for the external organisation for which the research is conducted. To maximise the value of the research for Ballast Nedam, I would like to discuss the important parts of my research briefly.

Research motive: In the current innovation process of Ballast Nedam, every idea that is conceived beneficial is adopted and elaborated. This means that all kinds of ideas are worked out, without a clear idea whether or not these ideas are the best to elaborate; there is no mechanism that canalises the ideas in such way that they support the corporate strategy of Ballast Nedam. Ballast

Nedam is aware of this lack of demarcation, and it therefore wishes to focus its innovation effort by developing a business roadmap. The business roadmap, that provides a one-page overview of the markets a firm would like to serve in the future, and the products and technologies necessary for this, is an excellent means to communicate this focus to employees.

Problem description: In order to develop a business roadmap, a company has to formulate an innovation strategy. However, roadmapping and its preceding process is often conducted as if there is a certain level of predictability about the future: with a certain view about the future in their mind, a company maps out a route for the products and technologies it would like to develop. The future, however, is not predictable; there is a lot of uncertainty about future developments. Current business roadmap processes tend to neglect this uncertainty, while the literature on strategy, on the contrary, puts a lot of emphasis on managing this uncertainty. Therefore, the problem for this research is how to develop a business roadmap for Ballast Nedam that is capable of coping with uncertainty in the external environment, and at the same time keeps its communicational and directive strengths.

Research approach: In order to get a business roadmap that can cope with the uncertainty of the future, I am about to use a process that integrates both the scenario planning process and business roadmap process. By this, a business roadmap is developed that can cope with multiple alternative pictures of the future. Within this business roadmap process, first a workshop will be conducted with Ballast Nedam employees to design four future scenarios for the external environment of Ballast Nedam. This environment contains macro-, industry and micro-factors. Next, elements that are found in every scenario will be deduced, since these can be used for developing a robust business roadmap. Before the scenario workshops, several interviews will be held to elicit important information and introduce participants in the business roadmap process. Moreover, multiple documents will be consulted so as to gather information on for instance trends in society.

A second workshop will be conducted subsequently to formulate an innovation strategy after confronting external opportunities and threats, and strength and weaknesses of Ballast Nedam. This innovation strategy will be elaborated into a business roadmap. The result of the workshop is a business roadmap that can cope with the uncertainty of the future.

Opinion about the relevance and value of this research for Ballast Nedam:

…….

…….

This research approach is based on scientific literature and is thus not customised to the situation of the construction industry and Ballast Nedam. What is your opinion about this process and the adaptations necessary to apply it to Ballast Nedam?

…….

…….

A.2. Individual interviews case study

This appendix covers the interviews that are held as part of the preparation for the workshop stage. Together with the documentation study, the results of the interviews are used in sections 5.3 and 5.4, and in detail described in Appendix C.2. This appendix contains the list of persons that were interviewed, as well as the areas discussed during the interview sessions.

List of interviewees

The interviewees selected for the individual interviews, originate from the Ballast Nedam managers who were invited to participate in both the scenario workshop and business roadmap workshop. Through this, relevant opinions on both the internal and external environment of Ballast Nedam are gathered. What is more, due to time constraints, only the managers without knowledge about the business roadmap initiative and both willing and available for an interview, are included in the list. Table 7 shows the list of the interviewees for the case study interview.

Table 7: List of interviewees case study.

Name	Position	Interview date
T.A.C.M. Bruijninckx	Chief Executive Officer, Ballast Nedam	15th of July
J.J. Blüm	Market researcher, Ballast Nedam Building and Development Special Projects	15th of July
D. van Hoogstraten	Director, Ballast Nedam Development Company	16th of July
I. van der Meijden	Director Communication and Investor Relations, Ballast Nedam	19th of August
S. van der Linden	Director, Ballast Nedam Infrastructure Special Projects	20th of August

Interview design

For the interviews, semi-structured interviews are used. Such semi-structure interviews namely give the opportunity to react on emerging themes, while the list of areas that should be covered during the interviews guarantees the consistency that all important subjects are discussed. The interview scheme that is roughly used, is provided below in Table 8. In general, the interviews lasted 1 to 1.5 hour.

Table 8: Interview design for case study interview.

Area	Content of discussion
Introduction	Introduction of interviewee, introduction of facilitator, introduction to master's thesis and interview structure.
Evaluation of external environment	Discussion about the pace of change of the construction industry, by pointing to past changes in the external environment and the reaction of Ballast Nedam and the construction industry in general. By this, a conclusion is drawn on the pace of change for which the business roadmap must anticipate.
	Discussion about the macro-environmental factors that could have an impact on the functioning of Ballast Nedam. Each of the PESTEL-areas is gone through, guaranteeing a structured approach that covers a wide array of factors. Per factor indicated, possible developments are discussed.
	Discussion about the trends in the construction industry, divided into general trends and trends for the individual segments of Ballast Nedam.
	Discussion about industry structure of the construction industry. During this discussion, the aspects of the Five Forces model are given attention to.
	Discussion about the most important competitors of Ballast Nedam and a prediction of their future route.
	Discussion of the micro-environment of Ballast Nedam. This discussion includes the development of client wishes and developments in availability of knowledge and products delivered by suppliers and subcontractors.
Evaluation of internal environment	Discussion about the internal environment of Ballast Nedam. During this discussion, attention is given to the aspects of the Value Chain model. Moreover, both the strong points providing competitive advantage and the weak points that hinder the functioning of Ballast Nedam in the industry, are discussed. In the discussion, a distinction is made between resources and competences available or lacking.
Closing the interview	The interview is ended with recapitulating important points, giving the opportunity to ask questions, and indicating the next steps of the research.

A.3. Workshops case study

This appendix contains the design for the two workshops that are held to come to the business roadmap. Successively, the design for the scenario workshop and the design for the business roadmap workshop are described, incorporating the list of attendants per workshop. The results of the workshops are discussed in section 5.3 for the scenario workshop and section 5.4 for the business roadmap workshop.

Scenario workshop

The scenario workshop is meant to produce four scenarios on the future external environment of Ballast Nedam. The workshop is held under expert guidance. The participants of the workshop originate from multiple segments and working areas of Ballast Nedam to ensure different views to be included, as well as that they originate from different ranks so as to involve strategic commitment and technical expertise (Table 9). In line with the reasoning of Coates (2000), Schoemaker (1995), Slocum (2003) and Van der Heijden (2005), no more than twenty attendants are selected.

Table 9: List of participants scenario workshop.

Name	Position
J. The (facilitator)	Senior consultant, The Bridge Business Innovators
R. Siebelink (researcher)	Master's thesis, Ballast Nedam Innovation Management
T.A.C.M. Bruijninckx	Chief Executive Officer, Ballast Nedam
R.J. Kathmann	Director ICT, Ballast Nedam
J.B.F.M. IJsenbrandt	Senior advisor corporate social responsibility, ABL2
P.G.M. Ballast	Manager, Dibec
N.A.T. Langenhuizen	Project manager, Ballast Nedam Building and Development
T.J.F. Paap	Project Manager, Ballast Nedam Infrastructure
J.T.F.M. Tünnissen	Head Structures, Ballast Nedam Engineering
J.D. van Groesen	Head Market Research and Pre-qualifications, Ballast Nedam Building and Development Special Projects
A.A. Kaper	Medior advisor sustainable building and process manager, ABL2
M.F. de Jonge	Director, Ballast Nedam Innovation Management
M.C. Wolbers	Innovation advisor, Ballast Nedam Innovation Management
R. van der Wal	Master's thesis, Ballast Nedam Infrastructure Special Projects

Workshop date: 29th of August, 2013.

Scenario workshop protocol

Before the scenario workshop, a workshop protocol was designed. This workshop protocol is included in this appendix. However, some changes were made to this protocol during the workshop. Therefore, the changes made to the protocol are explained. The actually followed steps are described in Figure 9 on page 50. In the workshop protocol, some posters are mentioned in several steps. These posters are included after the description of the protocol.

Changes made to the originally designed scenario workshop protocol shown in Table 10 on page 99:

- The workshop participants found it difficult to start the scenario planning process. In order to let the workshop participants become accustomed to scenario planning, the first step, the environmental analysis, is extended. This step has taken slightly more than one hour. Seeking consensus amongst the workshop participants was considered to ask even more time, so all groups shortly explained their thoughts about important external factors, and afterwards every group was allowed to mark three external factors on the central poster as very important. These factors could either originate from the preparatory study, or added factors from the discussion in the group. By this, the workshop participants had a voice in the final list of external factors.
- In order to not get further behind schedule, the second step, developments per external environmental factor, is also changed. Here, searching for consensus is also abandoned since the workshop facilitators noticed that all groups had very different thoughts about possible development directions for the external factors: searching for consensus would have been hard, or even impossible, although for some external factors the groups had the same development

direction in mind. Instead, al groups discussed the developments and afterwards their thoughts were shared with the other groups. By this, the groups became more open to alternative development directions. The step took about 50 minutes.

- Step 3, ranking the external environmental factors, is combined with the break in order to get back on schedule. The ranking method with post-it's was changed into a ranking method of giving numbers to each external factor, in order to make the ranking step less complex. All workshop participants, some in groups, were allowed to give the marks 1 to 15 to the 15 most important and uncertain factors. The other factors got the number 16. After summing the marks for each factor, the fifteen factors with the least sum are chosen for developing the scenarios. The external factors used for the scenario themes, are not the two factors with the least sum. These two factors namely do not possess a significant amount of uncertainty between the development directions. Instead, two whetting and stimulating factors are chosen.
- Developing the scenarios was considered difficult by the workshop participants. Therefore, this step took 75 minutes. The groups were allowed to use the developments direction they considered appropriate: there were no development directions that were indicated as certain development during a plenary session, as explained above, but there were some developments that every group included in its scenario. All developments found in the preparatory study and added in step 2 by the group are used during this step.
- Since the development of the scenarios and the other steps took more time than expected, the evaluation round is changed. Every group explained its scenario, and the other workshop participants had the opportunity put forward some remarks.
- Due to the time available for the workshop and the time spent on the other steps, the brainstorm session was cancelled. This step is advanced to the business roadmap workshop.

Table 10: Originally designed scenario workshop protocol. This protocol is changed during the scenario workshop.

Time	Activity	Who	Needs	Input	Output
08:45 - 09:00	**Welcome** Acquaintance workshop participants with coffee	All	Catering for 15 persons. Pencils and paper for every participant		
09:00 - 09:05	**Introduction:** Catch attention of participants: several quotes from CEOs about changes they are convinced of that they will never happen, but that though happened and changed the world drastically. End with quote Theo Bruijninckx. Words of welcome, introduction of myself, purpose of the workshop, program.	Remco	Beamer, laptop, pointer	PowerPoint-presentation	
09:05 - 09:10	**Introduction Jules:** Jules The (external facilitator). Movies of dancing guy and a broken escalator.	Jules	Beamer, laptop, pointer.	PowerPoint-presentation with two short movies	
09:10 - 09:20	**Introduction workshop participants:** Each participant introduces until a match is dead.	Jules, all	Beamer, Laptop, pointer, matches		
09:20 - 09:40	**Introduction workshop:** 5 minutes: short explanation about master's thesis: what, why and how. What is	Remco	Beamer, laptop, pointer	PowerPoint-presentation, Quotes Tok!	At 09:40, every workshop participant must know what the purpose is of the

	done before? What is a business roadmap and are there companies who developed one already? 10 minutes: what are scenarios, how to develop them, what companies use scenarios (Shell) and what steps to execute to get scenarios? Why are they beneficial and what steps to perform during the workshop? 5 minutes: content of business roadmap Ballast Nedam: time period 2020. Stimulate participants to think differently by giving quotes and posing the phrase that they must think about 2005 and compare their expectations about the future then, with the present world.			Content business roadmap process	workshop and what steps are to be executed during the workshop.
09:40 - 10:20	**External environmental analysis** 10 minutes: explanation about external factors. Discussing elements of external environment, i.e. macro-environment, industry environment and micro-environment. Explaining difference between trends and factors. Discussing method and preparatory study. Giving examples. 20 minutes: systematic analysis of external environment in groups. The list of factors is on the poster, and groups discuss these factors and add new factors through discussion. Macro (PESTEL), industry (trends, structure, competition) and micro (suppliers, clients). Groups use post-it's, Remco and Jules answer questions. 10 minutes: participants assemble around the central poster and add their factors. Through discussion, a new list of clustered factors and sub factors is developed. Possibly, some factors are removed from the list.	Remco All, Remco, Jules Remco, Jules	Beamer, laptop, pointer 5 pre-structured posters A0 with factors from the preparatory study, marks, post-it's, group division, four standing tables.	PowerPoint-presentation, list of external factors from preparatory study Workshop participants use their own list of factors they made as preparation for the workshop.	Workshop participants know what the difference is between a trend and an external factor, and they know where to find external factors. Clustered list of external factors and sub factors that can have an impact on Ballast Nedam.

10:20 - 10:50	**Developments per external environmental factor** 20 minutes: the groups discuss the developments per external factor. If there is consensus about a development, this development is noted, if there is no consensus, a maximum of four developments is noted for a factor. The groups use the posters and think about the mutual dependencies between factors. Remco and Jules answer questions. 10 minutes: the poster of each group will be discussed. The list of factors will be gone through, and per factor a conclusion is given on whether there is consensus about the development direction, or whether there is no consensus. If there is no consensus, no more than four developments are given on the central poster.	All, Remco, Jules	Beamer, laptop, pointer, marks, 5 A0 posters, post-it's	PowerPoint-presentation, list of developments per factor	Final list with developments per external factor an relations between external factors.
10:50 - 11:15	**Ranking external environmental factors** 25 minutes: each workshop participant gets 15 post-it's and marks the 15 most important and uncertain factors with a post-it. Discussion is allowed. The 15 factors with the most votes, are used for the scenarios, and the two most important factors that possess uncertainty are used for the scenario themes.	Remco and Jules, all	A0 poster with factors, beamer, laptop.	Final list with external factors	List with 15 most important and uncertain external factors for Ballast Nedam. Four scenario themes by crossing the two most important and uncertain factors.
10:40 - 10:55	**Break**	All, catering	Catering for all participants		
11:30 - 12:20	**Developing scenarios:** 5 minutes: Remco explains the steps for developing the scenarios. Each group elaborates its scenario theme by working through the list of external factors. The groups decides which development direction is suitable for the scenario theme, but external factors for which no uncertainty exists about its development direction, will be put in	Remco	Beamer, laptop/pc, pointer.		

	every scenario. The group develops a draft scenario with a rough narrative of how the world changes from 2013 to 2020. 45 minutes: the groups develop their scenario. Remco and Jules give advice. The groups decide their working method and the name for their scenario. The groups use the posters to write down what development direction they choose for each factor, what events cause their picture of the world, and what important developments there are in the scenario for Ballast Nedam.	Remco and Jules, all	Pencils, marks, 5 A0 posters, tape, beamer, laptop, pointer.		One scenario of each group with rough narrative and name.
12:20 - 12:40	**Evaluating scenarios:** 20 minutes: each group presents in 2 minutes its scenario by discussing the narrative and important developments. Afterwards, there are 3 minutes for the other participants to comment on the scenario about the consistency and plausibility. Try to find consensus about the scenarios and the possible changes for each scenario.	Remco, Jules, all	Marks, 4 posters (same as previous step, there is space for comments on these posters)	Rough scenario for each group	Four draft scenarios that are evaluated on consistency and plausibility. Some changes to be made to the scenarios after the workshop.
12:40 - 13:00	**Brainstorm:** Jules leads a short brainstorm session in order to come to scenario overarching developments. In each scenario developments, opportunities and threats are highlighted. The results are noted on a central poster. Afterwards, the results of the four scenarios are compared and the overarching developments are noted.	Jules, all	Poster A0, pencils, paper, marks	Four draft scenarios with important developments.	List with important developments per scenario and overarching developments.
13:00 - 13:30	**Lunch and evaluation:** Concluding remarks, lunch, discussion and evaluation of workshop and workshop results.	All, Jules	Lunch for all participants		

Omgevingsanalyse

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Uitleg omgevingsanalyse

In deze stap worden de omgevingsfactoren geïdentificeerd die belangrijk zijn voor het vormgeven van de toekomst rondom Ballast Nedam. Deze omgevingsfactoren kunnen worden gevonden in de macro-omgeving op politiek, economisch, sociaal, technologisch, milieu of juridisch vlak. Voorbeelden van zulke omgevingsfactoren zijn de demografie en mate van technologische ontwikkeling.

Naast de macro-factoren zijn de omgevingsfactoren ook te vinden op industrieniveau of op microniveau, zoals de beschikbaarheid van kennis en producten van leveranciers, en de ontwikkeling van concurrentie in de bouwwereld. Trends die op dit moment waarneembaar zijn, zoals een toename van het aantal huishoudens en een behoefte om in steden te wonen, zijn een richting waarin een bepaalde omgevingsfactor zich kan ontwikkelingen. Een trend kan echter ook veranderen, waardoor het van belang is om bij scenario's rekening te houden met andere richtingen waarin een omgevingsfactor zich kan ontwikkelen. Voor de omgevingsfactor 'economisch klimaat', kan dit bijvoorbeeld economische groei, economische krimp, of stabiliteit zijn.

In de voorbereiding op de scenarioworkshop, heb ik zelf al een lijst met omgevingsfactoren gemaakt op basis van een documentenstudie en enkele interviews.

Deze lijst staat op deze poster weergegeven. Zoals u kunt zien, zijn de omgevingsfactoren geclusterd rondom grote thema's om het aantal factoren te beperken. Daarnaast zijn er bij enkele omgevingsfactoren subfactoren gegeven die de moeite waard zijn om in scenario's te benoemen, maar niet als losstaande omgevingsfactor gebruikt kunnen worden.

Tijdens de scenarioworkshop wordt deze lijst in groepjes besproken en aangevuld. Als een omgevingsfactor niet ter zake doet, kunt u deze doorstrepen. Tot slot wordt het groepswerk besproken om tot een definitieve lijst van omgevingsfactoren te komen.

Macro-factoren:	factoren uit de externe omgeving van een bedrijf die ieder bedrijf in een zekere mate beïnvloeden. Politiek gaat om de rol van overheden, economisch over macro-economische factoren, sociaal over cultuur en demografie, technologie over opkomende technologieën, milieu over 'groene' zaken en wettelijk over nieuwe wet- en regelgeving.
Industriefactoren:	factoren die betrekking hebben op de structuur van de constructie-industrie, zoals de macht van leveranciers en opdrachtgevers, concurrentie in de markt en gemak waarmee er nieuwe toetreders kunnen komen. Daarnaast bevat deze categorie industrietrends.
Micro-factoren:	factoren die betrekking hebben op de relatie tussen Ballast Nedam in de omgang met zijn partners, te weten klant en leveranciers. Het gaat hierbij bijvoorbeeld om veranderende klanteisen of de beschikbaarheid van kennis en producten bij onderaannemers.

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Omgevingsanalyse

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Omgevingsfactor	Subfactor	
Beleid nationale overheid	Coalitie	
	Publieke versus private initiatieven	
Structuur van de wereld	Europese integratie	
	Mondiale relaties	
Technische arbeidskrachten		
Economisch klimaat		
Globalisering	Belang van opkomende landen	
	Internationalisering van markten	
Demografie	Bevolking	
	Huishoudens	
	Ouderen	
Gezondheidszorg		
Voorkeur van de bevolking	Leefgebied	
	Europese Unie	
	Privacy en ICT	
	Milieu en natuur	
	Bezit	
Leefgewoontes		
Individualisering		
Mondigheid van bevolking		
Toepassing van ICT		
Mate van technologische ontwikkeling	Toename van mobiel internet	
	Automation of knowledge	
	Internet of things	
	Cloud computing	
	Betere robots	
	Zelfstandige auto's	
	Betere energie-opslag	
	3D printen	
	Verbeterde materialen	
	Verbeterde gas- en oliewinning	
	Hernieuwbare energie	
	Energie en gebouwen	
	R&D-uitgaven	
Klimaat		
Beschikbaarheid van natuurlijke grondstoffen		
Kwaliteit van omgeving	Luchtkwaliteit	
	Waterkwaliteit	
	Natuur en biodiversiteit	
Milieubeleid en - wetgeving	Duurzaamheids-beleid	
	Afvalbeleid	
	Beleid stimuleren duurzame groei	
Klanteisen	Type contracten	
	Evaluatie op prijs of op kwaliteit	
Beschikbaarheid van kennis en producten van leveranciers		
Focus op efficiëntie		
Concurrentie		

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Ontwikkelingen per omgevingsfactor

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Uitleg ontwikkelingen per omgevingsfactor

In groepjes wordt de lijst met omgevingsfactoren doorlopen. Per factor wordt aangeduid of er onzekerheid is over de richting waarop deze factor zich gaat ontwikkelen, of over de mate waarin de factor van invloed is op Ballast Nedam.

Indien er geen consensus is over of een omgevingsfactor een 'zekere ontwikkeling' doormaakt, worden maximaal vier mogelijke ontwikkelingsrichtingen gedefinieerd. Daarnaast wordt per factor vermeld of er een relatie is tussen de richting waarop deze factor zich gaat ontwikkelen en de richting waarop een andere factor zich gaat ontwikkelen.

Er is al enig voorwerk verricht middels de documentenstudie en interviews. Tijdens de scenarioworkshop wordt deze lijst bediscussieerd en aangevuld, waarna als uitkomst van deze stap een definitieve lijst ontstaat van mogelijke ontwikkelingen per omgevingsfactor. De reeds genoemde ontwikkelingsrichtingen mogen veranderd en aangevuld worden.

Omgevingsfactor	Subfactor	Ontwikkeling 1	Ontwikkeling 2	Ontwikkeling 3	Ontwikkeling 4	Relatie met
Beleid nationale overheid		Blijft gelijk of verandert				
	Coalitie	Huidige coalitie	Meer links	Meer rechts	Politieke chaos	
	Publieke versus private initiatieven	Overheidsbezuinigingen	Meer private investeringen	Meer publieke en private investeringen	Geen investeringen	
Structuur van de wereld		Blijft gelijk of verandert				
	Europese integratie	Meer integratie en groei van EU	Meer autonomie terug naar lidstaten			
	Mondiale relaties	Vriendschappelijke relaties wereldwijd	Vijandige relaties wereldwijd	Interne focus Nederland	Externe focus Nederland	
Technische arbeidskrachten		Tekort aan geschoolde mensen door demografie	Meer geschoolde mensen door beleid, economisch klimaat of buitenlandse krachten			
Economisch klimaat		Krimp op korte termijn; krimp op lange termijn	Krimp op korte termijn; stabiliteit op lange termijn	Krimp op korte termijn; groei op lange termijn		
Globalisering		Blijft gelijk of verandert				
	Belang van opkomende landen	Verplaatsing van productiefaciliteiten naar andere landen.	Geen verplaatsing van productie-faciliteiten naar andere landen			
	Internationalisering van markten	Vanwege de toename van ICT, meer internationale bedrijven en arbeidskrachten	Minder internationale bedrijven en arbeidskrachten door beleid etc.			

Ontwikkelingen per omgevingsfactor

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Omgevingsfactor	Subfactor	Ontwikkeling 1	Ontwikkeling 2	Ontwikkeling 3	Ontwikkeling 4	Relatie met
Demografie		Zal veranderen				
	Bevolking	Aantal blijft gelijk	Aantal groeit licht			
	Huishoudens	Zal groeien, maar onzeker hoeveel exact. Minder mensen per huis-houden.				
	Ouderen	Meer ouderen en minder jongeren, resulterend in andere vraag.				
Gezondheidszorg		Meer zorg op maat in huis	Minder vraag door bezuinigingen	Meer vraag door meer ouderen		
Voorkeur van de bevolking		Blijft gelijk of verandert				
	Leefgebied (onder andere invloed op mobiliteit)	Grote steden	Landelijk gebied	Hoge kwaliteit leefomgeving	Lage kwaliteit leefomgeving	
	Europese Unie	Positieve houding	Negatieve houding			
	Privacy en ICT	Meer gebruik van ICT en samen-gaande houding ten opzichte van opslag en gebruik van gegevens: wel problemen	Geen problemen			
	Milieu en natuur	Belangrijk gevonden door bevolking en professionele organisaties	Niet belangrijk gevonden door bevol-king en professionele organisaties			
	Bezit	Meer belang gegeven aan bezit van goederen	Minder belang gegeven aan bezit van goederen			
Leefgewoontes		Druk leven met constante stroom aan informatie en minder scheiding van werk en privé	Vraag om aandacht voor vrije tijd, rust en kwaliteit van leven			
Individualisering		Keuze, customisering en flexibiliteit in veel producten	Vraag naar minder individualisering door bijvoorbeeld een information overload.			
Mondigheid van bevolking		Meer uiting van meningen en onte-vredenheid door middel van protest, rechtszaken etc.	Minder uiting van meningen en onte-vredenheid			
Toepassing van ICT		Meer toepassing van ICT in veel gebieden, ook in constructieproces en gebouwen. Bijvoorbeeld industri-alisatie.				

Ontwikkelingen per omgevingsfactor

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Omgevingsfactor	Subfactor	Ontwikkeling 1	Ontwikkeling 2	Ontwikkeling 3	Ontwikkeling 4	Relatie met
Mate van technologische ontwikkeling		Geen ontwikkeling	Geringe ontwikkeling	Grote ontwikkeling		
	Toename van mobiel internet	Ja: technologie die ervoor zorgt dat mensen 24/7 verbonden zijn met internet en toegepast waar mogelijk.	Nee			
	Automation of knowledge	Ja: computers die complexe taken kunnen verrichten die momenteel door mensen worden verricht.	Nee			
	Internet of things	Ja: sensoren etc. in fysieke objecten stoppen zodat zij kunnen communiceren over hun status.	Nee			
	Cloud computing	Ja: alle software in de cloud zodat het overal gebruikt kan worden.	Nee			
	Betere robots	Ja: beschikbaarheid van compacte en aanpasbare robots waarmee interactie mogelijk is.	Nee			
	Zelfstandige auto's	Ja: introductie van zelfstandig rijdende auto's.	Nee			
	Betere energie-opslag	Ja: grote vooruitgang in opslag van energie.	Nee			
	3D printen	Ja: 3D printen wordt of grote schaal toegepast.	Nee			
	Verbeterde materialen	Ja: introductie van materialen met hightech functies	Nee			
	Verbeterde gas- en oliewinning	Ja: Vooruitgang in winningstechnologie zorgt ervoor dat moeilijk winbare gas en olie kan worden gebruikt, zoals schaliegas.	Nee			
	Hernieuwbare energie	Ja: grootschalige en goedkope toepassing van wind-, zonne-, of andere duurzame energie, mogelijk gemaakt door veranderingen in energienet (omgang met fluctuaties).	Nee			
	Energie en gebouwen	Ja: technologieën die het mogelijk maken dat een huis energie terug-levert.	Nee			
	R&D-uitgaven	Blijft onder 2% bnp	Meer dan 2% bnp			

Ontwikkelingen per omgevingsfactor

GROEP: 20 MINUTEN PLENAIR: 10 MINUTEN

SCENARIO WORKSHOP
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Omgevingsfactor	Subfactor	Ontwikkeling 1	Ontwikkeling 2	Ontwikkeling 3	Ontwikkeling 4	Relatie met
Klimaat		Geen veranderingen	Kleine veranderingen	Grote veranderingen in bijvoorbeeld waterhoeveelheid, temperatuur en wind		
Beschikbaarheid van natuurlijke grondstoffen		Beschikbaarheid verzekerd	Schaarste	Niet beschikbaar		
Kwaliteit van omgeving		Stabiele kwaliteit	Verminderde kwaliteit	Verbeterde kwaliteit		
	Luchtkwaliteit	Stabiel	Beter	Slechter		
	Waterkwaliteit	Stabiel	Beter	Slechter		
	Natuur en biodiversiteit	Stabiel	Beter	Slechter		
Milieubeleid en - wetgeving		Losgelaten	Lagere doelstellingen	Gelijke doelstellingen	Hogere doelstellingen.	
	Duurzaamheids-beleid	EU2020-doelstellingen losgelaten	EU2020-doelstellingen verlaagd	EU2020-doelstellingen aangehouden	EU2020-doelstellingen verscherpt. Nederlandse vertaling in bijvoorbeeld energie-efficiëntie van gebouwen	
	Afvalbeleid	Geen aandacht en regelgeving voor afvalpreventie en recycling	Minder aandacht	Gelijke aandacht	Meer aandacht	
	Beleid stimuleren duurzame groei	Meer aandacht voor stimuleren van ontwikkeling en toepassing van duurzame en hernieuwbare energie-bronnen met beleid en investeringen	Geen aandacht	Minder aandacht		
Klanteisen		Blijven gelijk of veranderen.				
	Type contracten	Terug naar traditionele contracten	Mix van traditionele en integrale contracten	Meer integrale contracten	Andere contracten met nog integralere oplossingen (meer werkgebieden)	
	Evaluatie op prijs of op kwaliteit	Evaluatie op basis van initiële kosten	Evaluatie met inbegrip van levens-cycluskosten en kwaliteit van proces en product			
Beschikbaarheid van kennis en producten van leveranciers		Niet beschikbaar	Goede kwaliteit voor enkele bedrijven	Goede kwaliteit voor iedereen beschikbaar		
Focus op efficiëntie		Meer focus op investeringen in procesoptimalisatie, bijvoorbeeld industrialisatie of ketenintegratie	Minder focus op procesoptimalisatie			
Concurrentie		Minder concurrentie door minder aannemers en meer samenwerking	Stabiele mate van concurrentie	Meer concurrentie door buitenlandse inmenging	Totale concurrentie met andere ketenpartners of toetreders uit andere markten	

Rangschikken omgevingsfactoren

PLENAIR: 25 MINUTEN

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Rangschikken van omgevingsfactoren

Uiteindelijk zullen er vier scenario's ontworpen worden. Ieder scenario krijgt van tevoren een hoofdthema: een belangrijk en plausibel beeld van hoe de wereld er in het algemeen uit zal zien in 2020. Om deze vier hoofdthema's te krijgen, worden de gevonden omgevingsfactoren (poster omgevingsfactoren) gerangschikt: iedere workshopdeelnemer mag 15 omgevingsfactoren aanduiden waarvan hij vindt dat deze het meest belangrijk zijn. De twee omgevingsfactoren die de meeste stemmen krijgen en daarnaast een bepaalde mate van onzekerheid bezitten, vormen gekruist de vier hoofdthema's. De 13 overige omgevingsfactoren zullen worden gebruikt om de scenario's verder vorm te geven.

Omgevingsfactor	Stemruimte	Rang
Beleid nationale overheid		
Structuur van de wereld		
Technische arbeidskrachten		
Economisch klimaat		
Globalisering		
Demografie		
Gezondheidszorg		
Voorkeur van de bevolking		
Leefgewoontes		
Individualisering		
Mondigheid van bevolking		
Toepassing van ICT		
Mate van technologische ontwikkeling		
Klimaat		
Beschikbaarheid van natuurlijke grondstoffen		
Kwaliteit van omgeving		
Milieubeleid en - wetgeving		
Klanteisen		
Beschikbaarheid van kennis en producten van leveranciers		
Focus op efficiëntie		
Concurrentie		

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Scenario's opstellen

GROEP: 45 MINUTEN. PLENAIR: 20 MINUTEN

SCENARIO WORKSHOP
29 AUGUSTUS 2013

Hoe de wereld verandert richting 2020?

Vier groepen werken elk een scenariothema uit door de lijst met de belangrijke omgevingsfactoren door te lopen en een geschikte ontwikkeling voor het scenario uit te kiezen en te noteren. Omgevingsfactoren waarover consensus is qua ontwikkeling, komen in ieder scenario voor. Een groep ontwerpt een ruw scenario, waarbij het een plausibel verhaal opstelt van hoe de wereld verandert richting 2020. Hiervoor gebruikt de groep realistische gebeurtenissen; het scenario moet geloofwaardig overkomen. Tot slot geeft de groep een pakkende naam aan zijn scenario en geeft de belangrijkste ontwikkelingen, kansen en bedreigingen van zijn scenario weer.

Scenariothema:

Naam scenario:

Omgevingsfactor	Subfactor	Gekozen ontwikkeling
Beleid nationale overheid	Coalitie	
	Publieke versus private initiatieven	
Structuur van de wereld	Europese integratie	
	Mondiale relaties	
Technische arbeidskrachten		
Economisch klimaat		
Globalisering	Belang van opkomende landen	
	Internationalisering van markten	
Demografie	Bevolking	
	Huishoudens	
	Ouderen	
Gezondheidszorg		
Voorkeur van de bevolking	Leefgebied	
	Europese Unie	
	Privacy en ICT	
	Milieu en natuur	
	Bezit	
Leefgewoontes		
Individualisering		
Mondigheid van bevolking		
Toepassing van ICT		
Mate van technologische ontwikkeling	Toename van mobiel internet	
	Automation of knowledge	
	Internet of things	
	Cloud computing	
	Betere robots	
	Zelfstandige auto's	
	Betere energie-opslag	
	3D printen	
	Verbeterde materialen	
	Verbeterde gas- en oliewinning	
	Hernieuwbare energie	
	Energie en gebouwen	
	R&D-uitgaven	
Klimaat		
Beschikbaarheid van natuurlijke grondstoffen		
Kwaliteit van omgeving	Luchtkwaliteit	
	Waterkwaliteit	
	Natuur en biodiversiteit	
Milieubeleid en - wetgeving	Duurzaamheids-beleid	
	Afvalbeleid	
	Beleid stimuleren duurzame groei	
Klanteisen	Type contracten	
	Evaluatie op prijs of op kwaliteit	
Beschikbaarheid van kennis en producten van leveranciers		
Focus op efficiëntie		
Concurrentie		

Scenario

Belangrijke ontwikkelingen

Opmerkingen plenaire sessie

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Business roadmap workshop

The business roadmap workshop is used to formulate the innovation strategy for Ballast Nedam and elaborating this innovation strategy into a business roadmap. The workshop is held under expert guidance. The participants of the workshop originate from multiple segments and working areas of Ballast Nedam to ensure different views to be incorporated, as well as that they originate from different ranks so as to involve strategic commitment and technical expertise. The group size is kept limited, since this allows for a good quality of results and makes consensus possible. The workshop participants are given in Table 11.

Table 11: Participants business roadmap workshop.

Name	Position
J. The (facilitator)	Senior consultant, The Bridge Business Innovators
R. Siebelink (researcher)	Master's thesis, Ballast Nedam Innovation Management
I. van der Meijden	Director Communication and Investor Relations, Ballast Nedam
A.M. Adriaanse	Manager Building Process Integration, Ballast Nedam Engineering
M.F. de Jonge	Director, Ballast Nedam Innovation Management
M.C. Wolbers	Innovation advisor, Ballast Nedam Innovation Management
N.J. Bouman	Apprentice, ABL2

Workshop date: 23th of September, 2013.

Business roadmap workshop protocol

Before the business roadmap workshop, a workshop protocol was designed. This workshop protocol is included in this appendix. However, some changes were made to this protocol during the workshop. Therefore, the changes made to the protocol are explained. The actually followed steps are described in Figure 9 on page 50. In the workshop protocol, some posters are mentioned in several steps. These posters are included at the end of this appendix.

Changes made to the originally designed business roadmap workshop protocol depicted in Table 12 on page 112:

- The two first steps of developing the business roadmap, the brainstorm session to find scenario overarching developments, opportunities and threats, and the confrontation of the internal and external environment of Ballast Nedam to find focus areas for innovation, are more or less merged during the business roadmap workshop. Although the working method for the brainstorm session prescribed that the groups should first note important opportunities and threats per scenario before searching overarching opportunities and threats, one group started to search for overarching elements. Moreover, both groups already had the internal strengths and weaknesses of Ballast Nedam in mind during this brainstorm session, and thus listed focus areas instead of overarching elements. The result is that each group presented its conclusions, and the results of one group more or less contained the definitive list of focus areas. Step 2 is therefore not performed separately: the workshop participants already read the current activities, strengths and weaknesses of Ballast Nedam before the start of the workshop, so this step is abandoned as well. The merged step 1 and step 2 took one hour in excess of the first step, so no major changes had to be made to the workshop protocol afterwards.
- The resulting focus areas caused the workshop protocol to be changed: after discussion with the workshop participants, it was found appropriate to distinguish between preconditions and focus areas. Preconditions are elements that need innovation, but that are no spearhead for new business. These preconditions are ignored during the workshop, but need elaboration for the business roadmap after the workshop. The resulting focus areas are clustered in such way, that no ranking was necessary to determine which focus areas should be put on the business roadmap. There was consensus about which focus areas to put on the roadmap. Nevertheless, the ranking method was used to get the focus area that needed elaboration during the workshop. This focus area was the focus area the participants considered the most convenient to

elaborate during the workshop. The experiences with the other steps induced to choose for the focus area that was the easiest one to develop the roadmap for.

- Developing the business roadmap for one focus area was considered very difficult by the workshop participants, because of the abstraction level and the absence of many (invited) employees with different background. The presence of these employees could have made the results less abstract and might have made the brainstorm more easy to follow. Therefore, the several steps took more time than expected. Moreover, the result was less detailed than expected: it was neither possible to indicate several characteristics of products and processes, nor to cluster elements of the second and third layer. That is why the establishment of linkages between the three layers is abandoned during the workshop: all effort was put into filling in the three layers.

Table 12: Originally designed business roadmap workshop protocol. This protocol is changed during the workshop.

Time	Activity	Who	Needs	Input	Output
08:45 - 09:00	**Welcome** Acquaintance workshop participants with coffee	All	Catering for 15 persons. Pencils and paper for every participant		
09:00 - 09:05	**Introduction:** Catch attention of participants: all participants have sent their vision on Ballast Nedam in 2020, these are anonymously handed out, the participants read them and are asked to fill in the front page of the paper. Words of welcome, introduction of myself, purpose of the workshop, program.	Remco	Beamer, laptop, pointer, visions of participants on Ballast Nedam 2020	PowerPoint-presentation, Design front-page of paper	
09:05 - 09:10	**Introduction Jules:** Jules The (external facilitator)	Jules	Beamer, laptop, pointer.	PowerPoint-presentation with two short movies	
09:10 - 09:20	**Introduction workshop participants:** Each participant introduces until a match is dead.	Jules, all	Beamer, Laptop, pointer, matches		
09:20 - 09:40	**Introduction workshop:** 10 minutes: short explanation about master's thesis: what, why and how. What is done before and what is the relation between the scenario workshop and the business roadmap workshop? What are scenarios, how to develop them and what are the final scenarios for the external environment of Ballast Nedam? 5 minutes: explanation business roadmap and business roadmap for Ballast Nedam. 5 minutes: content of	Remco	Beamer, laptop, pointer	PowerPoint-presentations, four scenarios on the future external environment of Ballast Nedam Business roadmap design for Ballast Nedam Content business	At 09:40, every workshop participant must know what the purpose is of the workshop and what steps are to be executed during the workshop.

	business roadmap Ballast Nedam: time period, all segments, what can change and what cannot change.			roadmap process	
09:40 - 10:40	**Brainstorm session scenario overarching developments:** Short explanation: all workshop participants have read the scenarios and have done some preparation: for every scenario, they indicated the important developments, opportunities and threats for Ballast Nedam. In order to get a robust roadmap, the scenarios will be evaluated: what opportunities and threats are common to all scenarios? Special attention is given to developments with the same implication for Ballast Nedam, for instance: scenario x contains economic recession and more households, scenario y contains more students, then a common opportunity might be a demand for low cost housing.	Remco	Beamer, laptop, pointer	PowerPoint-presentation	
	40 minutes: two groups discuss the scenarios. They make notes per scenario and give overarching developments on a separate document.	Groups, Remco and Jules answer questions and stimulate discussion	Pre-structured A4s for each group, pencils, markers, group division, printed scenarios for each participant	Per participant a list of developments, opportunities and threats per scenario.	
	20 minutes: all participants assemble around the central poster and stick/note their developments down. The developments will be clustered and a final list of scenario overarching developments will be developed		A0-poster, post-it's, tape, markers.	Each group takes a list with scenario developments and scenario overarching developments	At 10:40, the poster contains a list of scenario overarching opportunities and threats
10:40 - 10:55	**Break**	All, catering	Catering for all participants		
10:55 - 11:45	**Internal analysis and confrontation of internal and external environment:** 10 minutes: the two groups discuss shortly the list of current activities, strengths and weaknesses of Ballast	Groups, Jules and Remco answer questions and stimulate discussion	A0-poster, each group gets a list of activities, strengths and weaknesses, post-it's, pencils,	List of activities, strengths and weaknesses of Ballast Nedam, list of scenario overarching developments.	

	Nedam and get the opportunity to add three elements on the central poster. 40 minutes: the group assembles around the central poster. Facilitated by Remco and Jules, the list of overarching developments is worked through. For each development, the workshop participants indicate whether a current activity of Ballast Nedam without innovation is able to handle an opportunity or threat. If not, a coupling is sought between the internal and external environment by means of a SWOT-analysis. The resulting couples of internal strengths or weaknesses and external opportunities or threats, are called focus areas: areas where innovation is necessary.	All	tape, flip-overs.		At 11:45, there is a list of focus areas
11:45 - 12:00	**Break and ranking focus areas:** Over a cup of coffee, each workshop participant gives a number to all focus areas. Discussion amongst participants is allowed. The number one for the most important focus area, number 2 for the next important area, etc. All areas get a number, the lower the number, the more important the focus area. All numbers can be assigned once per participant. After ranking, the five most important focus areas are put on the roadmap.	All, catering	Catering for all participants, Excel file for ranking, A0 poster, markers, tape	List of focus areas	Five most important focus areas
12:00 - 13:00	**Business roadmap development:** The most important focus area will be developed during the workshop. 5 minutes: short explanation on the business roadmap design and an example how to fill in the roadmap. The groups assemble around the central poster.	All, Remco and Jules guide the process	A0 poster with Business roadmap, post-it's, pencils, tape.	List of most important focus areas.	

	15 minutes: all participants get post-it's. Brainstorm session about the why-layer: what is important in the focus area? What do clients value? What market do we want to serve? What goals do we have? After 10 minutes, there are 5 minutes to cluster the post-it's to overarching themes. On the longer term, these themes are more global. 15 minutes: brainstorm session about the what-layer. All participants get post-it's and can stick on the poster for every working area of Ballast Nedam. What products and processes does Ballast Nedam need to fulfil the goals of the why-layer? What products and targets of products over time? What is the connection with current products? The participants reason back from 2020 point on the horizon to 2013. More global on the longer term. The participants indicate whether an external party is necessary for a certain development and whether the development is already planned or not. After 10 minutes, the situation is frozen and the post-it's are clustered. 15 minutes: for the how-layer, the same procedure is followed as for the what-layer. Here, attention must be given to both sides of a focus area: the internal and external side. 10 minutes: the workshop participants first get the chance to comment on the roadmap. The they try to connect the elements in different layers with each other by starting left in the how-layer				At 13:00, the business roadmap is developed for one focus area (The project-layer is left aside today).
13:00 - 13:30	**<u>Lunch and evaluation:</u>** Concluding remarks, lunch, discussion and evaluation of workshop and workshop results.	All, Jules	Lunch for all participants		

Brainstormsessie

PLENAIR: 20 MINUTEN

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Brainstormsessie scenario-overschrijdende ontwikkelingen

In groepsverband hebben de workshopdeelnemers per scenario de belangrijkste ontwikkelingen, kansen en bedreigingen voor Ballast Nedam genoteerd. Daarnaast hebben de workshopdeelnemers scenario-overschrijdende ontwikkelingen, kansen en bedreigingen genoteerd: ontwikkelingen die min of meer in alle scenario's voorkomen, of verschillende ontwikkelingen die eenzelfde implicatie voor Ballast Nedam kunnen hebben. Tijdens de plenaire discussie plakken de groepjes met post-it's hun ontwikkelingen per scenario en overkoepelende ontwikkelingen op. Vervolgens worden deze door middel van discussie geclusterd: er ontstaat een definitieve lijst van scenario-overkoepelende ontwikkelingen.

bekende energie en bezit: hoogspanning	bekende energie en gebruik: terug naar de kern	onbekende energie en bezit: energieke opleving	onbekende energie en gebruik: L.I.E.S	Overkoepelende ontwikkelingen

Confrontatie interne en externe omgeving Ballast Nedam

PLENAIR: 40 MINUTEN

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In groepsverband hebben de workshopdeelnemers de activiteiten, sterke en zwakke punten van Ballast Nedam besproken en op deze poster aangevuld. Vervolgens wordt de bij stap 1 gevormde lijst met scenario-overschrijdende ontwikkelingen plenair doorlopen (tweede kolom): per ontwikkeling geven de workshopdeelnemers aan of een huidige activiteit van Ballast Nedam zonder innovatie voldoende is om met een bepaalde ontwikkeling overweg te kunnen. Zo niet, dan wordt er een koppeling gezocht tussen een sterk of zwak punt van Ballast Nedam en een externe ontwikkeling.

Een voorbeeld hiervan is een sterkte van Ballast Nedam die een externe bedreiging kan verminderen. Het resultaat van deze sterkte-zwakteanalyse geeft een lijst van focusgebieden waar innovatie benodigd is. Deze lijst komt in de derde kolom te staan.

Activiteiten, sterke en zwakke punten	Overkoepelende ontwikkelingen	Focusgebieden
HUIDIGE ACTIVITEITEN		
Ontwerp, bouw, renovatie en onderhoud van woningen en commerciële gebouwen incl. industriebouw		
Leveren van autogasvulstations		
Beheer en onderhoud van gebouwen en werken		
Procesmanagement op gebied van innovatie, gebiedsontwikkeling, duurzaamheid		
Ontwerp, bouw en onderhoud van infrastructuur en parkeergarages		
Bouw van offshore windparken		
Internationale bouwprojecten		
Funderingstechniek en grondverzet		
Voorgespannen constructies voor wegen, waterwerken en gebouwen		
Engineering		
Advies op gebied van milieu, veiligheid en materialen		
Advies op gebied van installatietechniek		
Asfalt, materieel en groenvoorziening		
Winning, verwerking, en verkoop van grondstoffen en terugwinning van alternatieve grondstoffen		
Productie van prefab betononderdelen		
Modulaire producten		
STERKE		
Kennis en ervaring in ontwerpen		
Kennis en ervaring in engineering		
Veel kennis en ervaring met project- en procesmanagement		
Kennis en faciliteiten voor industriële en modulaire bouw		
Kennis en faciliteiten voor terugwinnen van grondstoffen		
Kennis, ervaring, mensen en financiële middelen voor integrale projecten: goed vertalen klantvraag en goede prijs		
Kennis en ervaring in alternatieve brandstoffen		
Kennis, ervaring, mensen en faciliteiten voor offshore-bouw		
Herkennen, adopteren en toepassen van nieuwe technologieën		
Groot budget voor innovatie (15 miljoen euro)		
Goede reputatie		
Aantrekkelijk bedrijf om te werken: dynamisch, projecten		
Kennis, ervaring en mensen voor utiliteitsbouw: beste utiliteitsbouwer van Nederland		
Kennis en toepassing van ICT en BIM in projecten		
Goed in logistiek complexe projecten op een postzegel		
Goede connecties met andere bedrijven, klanten en stakeholders: willen graag met Ballast Nedam samenwerken		
Grootte van bedrijf: dicht op elkaar en makkelijk switchen		
Goede internationale contacten in West-Afrika, Caraïben en Noordwest-Europa		
Kennis en ervaring in industriebouw		
Kennis van energie-infrastructuur		
Grote hoeveelheid grondposities		
Kennis over technologische en architectonische hoogwaardige betonoplossingen		
ZWAKTE		
De organisatie van Ballast Nedam is niet goed geïntegreerd		
Sterk variërende managementkwaliteiten: techneuten op verkeerde plek		
De organisatie van Ballast Nedam is ongeschikt voor capaciteitgedreven markten door grootte en hoge kosten		
Ballast Nedam is actief in een industrie met een slecht imago		
Ballast Nedam loopt achter bij concurrenten en ingenieursbureaus op het gebied van arbeidsvoorwaarden en aantrekkelijkheid voor jongeren		
Te weinig kennis van duurzaamheid: lopen achter bij concurrenten en vervullen slecht sociale plicht		
Te weinig kennis over wat de klant werkelijk wil		
Slechte en opportunistische behandeling onderaannemers		
ICT ondersteunt te weinig het integraal werken		
Slechte financiële positie		
Grote afhankelijkheid van Nederlandse markt		
Grote afhankelijkheid van overheidsuitgaven		
Weinig bekendheid merk 'Ballast Nedam'		
Ballast Nedam is te klein om zelfstandig grote integrale projecten uit te voeren		
Weinig kennis over installatietechniek		

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Rangschikken focusgebieden

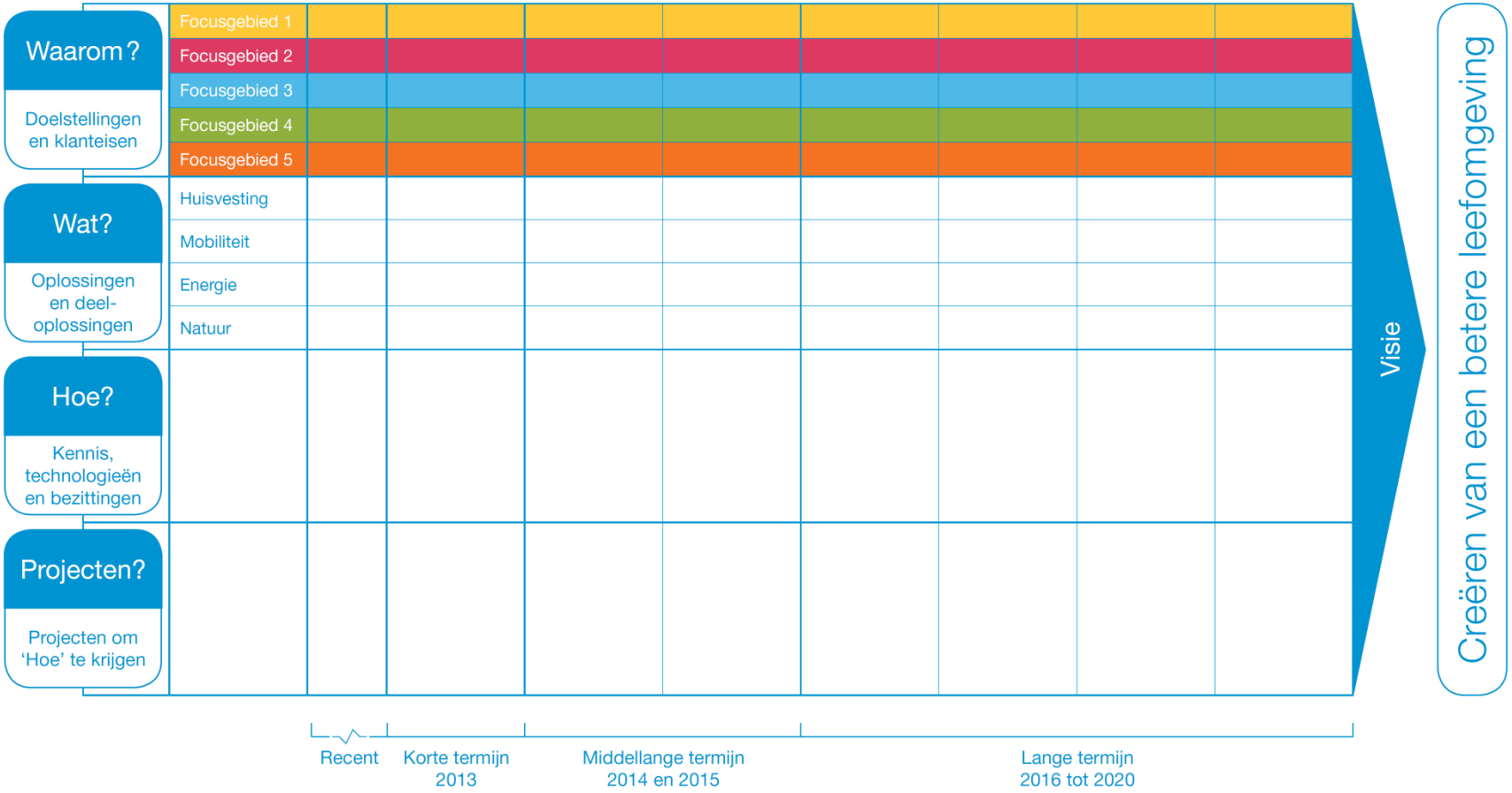
PLENAIR: 15 MINUTEN

Om de business roadmap overzichtelijk te houden, worden hierop slechts de vijf belangrijkste focusgebieden uitgewerkt. Deze vijf focusgebieden worden verkregen door een stemming onder de workshopdeelnemers: iedere workshopdeelnemer geeft zijn of haar rangschikking door het belangrijkste focusgebied het cijfer 1 te geven, het op één na belangrijkste focusgebied het cijfer 2, etc. Alle focusgebieden krijgen dus een cijfer, waarbij elk cijfer slechts één keer mag voorkomen. Hoe lager het cijfer, des te belangrijker het focusgebied. De vijf focusgebieden die na deze stemronde het meeste belang toegewezen hebben gekregen, worden op de business roadmap genoteerd.

Focusgebied	Stemruimte									Rangschikking
	TB	IvdM	EK	JJB	HB	AA	SIJ	MdJ	MW	

Business Roadmap Ballast Nedam 2013-2020

Ballast Nedam



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A.4. Individual interviews evaluation

This appendix contains the interviews that are held as part of the evaluation of the business roadmap process and the results of applying this process. The results of the interviews are described in Chapter 6. This appendix contains the list of persons that were interviewed, as well as the areas discussed during the interview sessions.

List of interviewees

The interviewees selected for the individual interviews originate from the Ballast Nedam organisation members that were already included in the preparation of the workshops, scenario workshop or business roadmap workshop. Through this, opinions can be gathered both regarding the process followed and the results of the business roadmap process, since the interviewees already possess a high level of knowledge in this matter. What is more, due to time constraints, only the managers that are both willing and available for an interview are included in the list. Table 13 depicts the list of interviewees for the evaluation interview.

Table 13: List of interviewees evaluation.

Name	Position	Interview date
A.M. Adriaanse	Manager Building Process Integration, Ballast Nedam Engineering	31th of October
J.J. Blüm	Market researcher, Ballast Nedam Building and Development Special Projects	16th of October
J.D. van Groesen	Head Market Research and Pre-qualifications, Ballast Nedam Building and Development Special Projects	28th of October
J.B.F.M. IJsenbrandt	Senior advisor corporate social responsibility, ABL2	28th of October
I. van der Meijden	Director Communication and Investor Relations, Ballast Nedam	12th of November

Interview design

For the interviews, semi-structured interviews are used. Such semi-structured interviews give the opportunity to react on emerging themes, while the list of areas that should be covered during the interviews guarantees both consistency and that all important subjects are discussed. The interview scheme used roughly, is provided below in Table 14. In general, the interviews lasted 0.5 hour.

Table 14: Interview design for evaluation interview.

Area	Content of discussion
Introduction	Introduction interview structure and objectives.
Evaluation of business roadmap process	Discussion about the whole process. Interviewees give their opinion, limitations and suggestions for improvement regarding the invitations, preparatory study, interviews, information email preceding the workshops, preparation to be done by the workshop participants, workshops, information after the workshops and a general judgment on the process. Extra attention is given to the clearness of the steps to be followed and the accountability of why these steps are followed, as well as the quality of the process.
Evaluation of results of business roadmap process	Discussion about the results of the business roadmap process. Interviewees give their opinion regarding the usefulness of the results, clarity of the results, and whether the results conform to their expectations about the initiative. Special attention is paid to the four future scenarios, the initial business roadmap design, the end result of the business roadmap process, whether the principles of scenario planning and business roadmapping are clear, whether the process is appropriate for the intended objectives, and a general judgment on the value of the results.
Closing the interview	The interview is ended with recapitulating important points, giving the opportunity to ask questions, and indicating the next steps of the research.

Appendix B

Rationale behind the business roadmap process

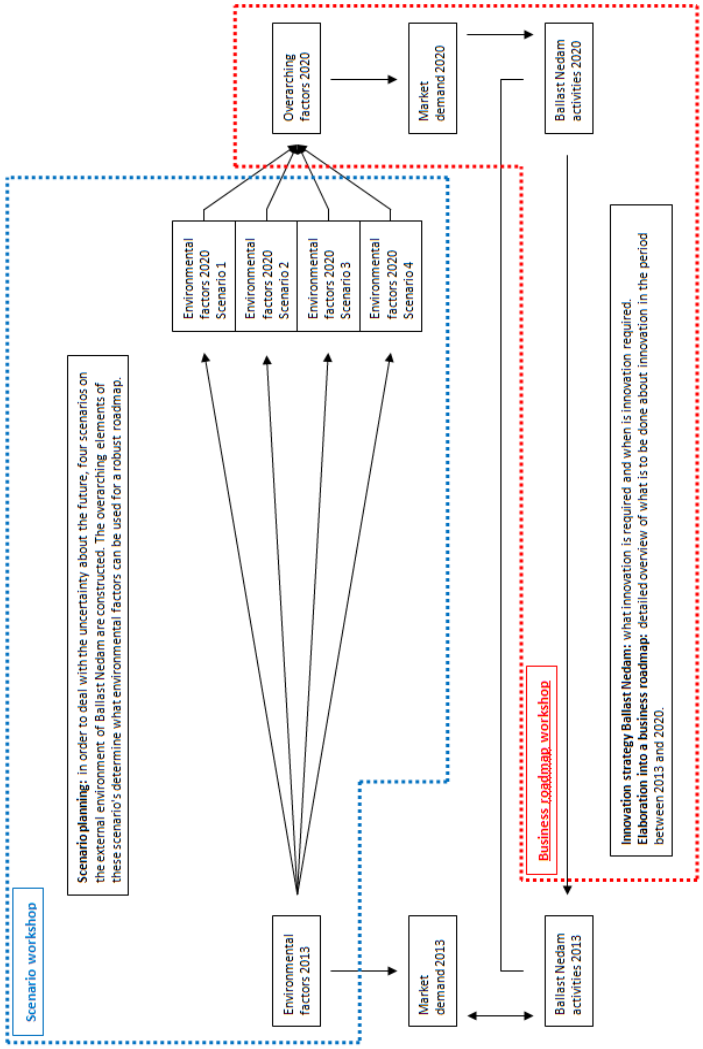

Figure 12: Overview of the rationale behind the business roadmap development process. The current activities of Ballast Nedam are aligned with the market. However, these activities cannot be used for the market in 2020, since the market demand will be different then. External environmental factors create the market demand. Therefore, if one knows these factors for 2020, one might know the market demand in 2020. However, one cannot predict the external environmental factors in 2020. To cope with the uncertainty about these factors, scenarios are used for sketching alternative pictures of the future. Developments that are common in all scenarios, can be used for building a robust business roadmap. One can determine the market demand in 2020 and pose products and processes to serve this demand. Then, the innovation strategy stipulates what innovation is required and when; the business roadmap makes this visible.

Note: in the figure external environmental factor is meant when referring to environmental factor.

Appendix C

Planning stage documents and data

C.1. Informing and preparing the workshop participants

In this section, the communication with workshop participants is described by giving the invitations and information emails as described in Figure 8 on page 49. These invitations and emails are included in their original Dutch state.

Invitations for workshops

Three different invitations are sent: invitations to participate in the scenario workshop, invitations to participate in the business roadmap workshop, and invitations to participate in both workshops. These invitations do not differ much. Therefore, in the invitations the variable part is included between dotted lines in the same order as described above.

Beste heer,mevrouw …,

Bij dezen wil ik u van harte uitnodigen om samen met enkele collega's richting te geven aan de toekomstige innovaties van Ballast Nedam.

In het kader van mijn studie Civil Engineering & Management aan de Universiteit Twente, ben ik momenteel bezig met een afstudeeropdracht bij de afdeling Innovatiemanagement van Ballast Nedam. Het doel van deze afstudeeropdracht is het ontwikkelen van een business roadmap voor Ballast Nedam. Deze business roadmap is een gedetailleerde uitwerking van een innovatiestrategie. Hierin worden de markten gedefinieerd die Ballast Nedam in de toekomst wil bedienen, alsmede de producten en technologieën die hiervoor benodigd zijn. De business roadmap geeft deze markten, producten en technologieën overzichtelijk weer, waardoor het een geschikt middels is om de innovatiestrategie van een bedrijf te communiceren.

Essentieel bij het ontwikkelen van een business roadmap, is dat er vanuit meerdere disciplines van een bedrijf kennis wordt ingewonnen. Na overleg met Menno de Jonge, directeur innovatie en tevens mijn begeleider, zijn wij van mening dat uw kennis en medewerking hierbij van toegevoegde waarde zal zijn.

Op basis van een uitvoerige literatuurstudie heb ik een proces ontwikkeld voor het ontwerpen van de business roadmap. Het hart van dit proces wordt gevormd door een tweetal workshops die zullen worden gefaciliteerd door dhr. Jules The van The Bridge Business Innovators. Tijdens de eerste workshop staat het opstellen van een aantal toekomstscenario's voor de externe omgeving van Ballast Nedam centraal. Op basis van deze scenario's zal tijdens de tweede workshop een innovatiestrategie worden geformuleerd en worden uitgewerkt in een business roadmap.

Bij dezen wil ik u uitnodigen om bij de scenarioworkshop aanwezig te zijn. Deze scenarioworkshop staat gepland op donderdag 29 augustus van 09:00 uur tot 13:30 uur. Graag hoor ik van u of u wilt participeren en op deze datum beschikbaar bent. Voor de deelname aan de workshop is enige voorbereiding vereist. U zult ruim voor de datum van de workshop geïnformeerd worden over de vereiste voorbereiding, het programma van de workshop en de locatie.

Bij dezen wil ik u uitnodigen om bij de business roadmapworkshop aanwezig te zijn. Deze business roadmapworkshop staat gepland op maandag 23 september van 09:00 tot 13:30 uur. Graag hoor ik van u of u wilt participeren en op deze datum beschikbaar bent. Voor de deelname aan de workshop is enige voorbereiding vereist. U zult ruim voor de datum van de workshop geïnformeerd worden over de vereiste voorbereiding, het programma van de workshop en de locatie.

Bij dezen wil ik u uitnodigen om bij beide workshops aanwezig te zijn. De scenarioworkshop staat gepland op donderdag 29 augustus van 09:00 uur tot 13:30 uur, de business roadmapworkshop op maandag 23 september van 09:00 tot 13:30 uur. Graag hoor ik van u of u wilt participeren en op beide data beschikbaar bent. Voor de deelname aan de workshops is enige voorbereiding vereist. U zult ruim voor de data van de workshops geïnformeerd worden over de vereiste voorbereiding, het programma van de workshop en de locatie.

Om de workshops effectief en efficiënt te laten verlopen, wil ik daarnaast interviews afnemen met enkele workshopdeelnemers. Tijdens deze interviews wil ik alvast inzicht verkrijgen in wat medewerkers van Ballast Nedam als belangrijke ontwikkelingen in de omgeving beschouwen en of zij sterke en zwakke punten van Ballast Nedam kunnen aanwijzen. Deze interviews zullen anderhalf tot twee uur in beslag nemen en plaatsvinden vóór vrijdag 19 juli. Graag hoor ik van u of u beschikbaar bent voor het afnemen van een interview.

Onderstaand heb ik ter informatie een korte samenvatting weergegeven van mijn afstudeeronderzoek. Indien u nog vragen of opmerkingen heeft, dan nodig ik u uit contact met mij op te nemen.

Ik hoor graag spoedig van u.

Information about the workshops

In accordance with the approach for informing the workshop participants as described in Figure 8 on page 49, the workshop participants are informed about the research, purpose of the workshop, the work performed beforehand, the approach for the workshop and the necessary preparation for them. This information is sent approximately one week before the workshops, and one day before the workshop as a reminder. The information emails refer to an appendix included in the email. Due to space considerations, these appendices are not included.

Information about the scenario workshop

Here, the information email and the remainder are included for the scenario workshop.

Beste workshopdeelnemer,

Enkele weken geleden heb ik u uitgenodigd om samen met collega's richting te geven aan de toekomstige innovaties van Ballast Nedam. Volgende week donderdag, 29 augustus, wordt hier invulling aan gegeven middels een scenarioworkshop. De bijlage van deze mail bevat nadere informatie over de scenarioworkshop en de voorbereiding die hiervoor benodigd is. Ik wil u bij dezen vragen de informatie goed door te lezen, zodat we hier tijdens de workshops zo weinig mogelijk tijd aan hoeven te besteden.

Ik hoop dat middels deze mail duidelijk is wat de bedoeling is van de scenarioworkshop van 29 augustus aanstaande. Indien er nog onduidelijkheden zijn, dan kunt u uiteraard contact met mij opnemen.

Ik hoop u allen te begroeten tijdens de scenarioworkshop.

Beste workshopdeelnemer,

Morgen van 09:00 uur tot 13:30 uur staat de scenarioworkshop op het programma. Ik ben blij dat u hierbij aanwezig zult zijn. In het bijgevoegde document stuur ik u ter herinnering nogmaals de informatie omtrent de scenarioworkshop. Ik wil u erop wijzen dat het vanwege de beschikbare tijd noodzakelijk is dat u deze informatie tot u neemt. Daarnaast wil ik benadrukken dat enige voorbereiding vereist is door na te denken over mogelijke omgevingsfactoren en deze op papier te zetten. Informatie over de voorbereiding kunt u vinden in het bijgevoegde document.

Ik zie u morgen graag in E2.08 te Nieuwegein.

Information about the business roadmap workshop
Here, the information email and the remainder are included for the business roadmap workshop.

Beste workshopdeelnemer,

Enkele weken geleden heb ik u uitgenodigd om samen met collega's richting te geven aan de toekomstige innovaties van Ballast Nedam. Aankomende maandag, 23 september, wordt hier invulling aan gegeven middels een business roadmapworkshop. Deze workshop volgt op een scenarioworkshop die ik op 29 augustus jl. heb gehouden met enkele collega's. De bijlage van dit bericht bevat nadere informatie over de business roadmapworkshop en de voorbereiding die hiervoor benodigd is, alsmede de vier scenario's die het resultaat zijn van de scenarioworkshop. Ik wil u bij dezen vragen de informatie goed door te lezen, zodat we hier tijdens de workshop zo weinig mogelijk tijd aan hoeven te besteden. Daarnaast wil ik hierbij nogmaals benadrukken dat ik, zoals in de informatie beschreven, aankomende vrijdag om 12 uur uw visie op Ballast Nedam in 2020 zou willen ontvangen. Alvast hartelijk dank voor uw medewerking.

Ik hoop dat middels dit bericht duidelijk is wat de bedoeling is van de business roadmapworkshop van 23 september aanstaande. Indien er nog onduidelijkheden zijn, dan kunt u uiteraard contact met mij opnemen.

Ik hoop u allen te begroeten tijdens de business roadmapworkshop.

Beste workshopdeelnemer,

Aankomende maandag van 09:00 uur tot 13:30 uur staat de business roadmapworkshop op het programma. Ik ben blij dat u hierbij aanwezig zult zijn. In de bijgevoegde documenten stuur ik u ter herinnering nogmaals de informatie omtrent de business roadmapworkshop en de vier scenario’s die het resultaat zijn van de recentelijk gehouden scenarioworkshop. Ik wil u erop wijzen dat het vanwege de beschikbare tijd noodzakelijk is dat u de informatie tot u neemt. Daarnaast wil ik benadrukken dat enige voorbereiding vereist is door het bestuderen van de bijgevoegde scenario’s en het noteren van hun implicaties voor Ballast Nedam. Tot slot ontvang ik vandaag graag voor 12.00

uur in vijf tot tien regels uw visie op Ballast Nedam in 2020. Meer informatie over de voorbereiding kunt u vinden in het bijgevoegde document.

Ik zie u maandag graag in E2.08 te Nieuwegein.

C.2. Data gathered during the preparatory study

This section contains confidential information that is not disclosed in the public version of the report.

Appendix D

Workshop results

D.1. External environmental factors for scenario development
This section contains confidential information that is not disclosed in the public version of the report.

D.2. Scenario development
This section contains confidential information that is not disclosed in the public version of the report.

D.3. Final scenarios
This section contains confidential information that is not disclosed in the public version of the report.

D.4. Dutch versions final scenarios
This section contains confidential information that is not disclosed in the public version of the report.

D.5. Finding focus areas and preconditions
This section contains confidential information that is not disclosed in the public version of the report.

D.6. Impressions workshops
This section contains confidential information that is not disclosed in the public version of the report.

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