

Building the future: Innovation in Project-Based Firms by entrepreneurial thinking



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Ir. M. (Michiel) van den Hoek 419724
Rotterdam School of Management, Erasmus University
MScBA / Drs. Business Administration

Rotterdam School of Management Erasmus University

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Author: ir. M. (Michiel) van den Hoek

Thesis supervisor: prof.dr.ir. J.C.M. (Jan) van den Ende

Co-reader: prof. dr. ir. G.H. (Gerrit) van Bruggen

Erasmus Universiteit

Rotterdam School of Management

MScBA / Drs. Business Administration

Burgemeester Oudlaan 50, J3-28

3062 PA Rotterdam

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Preface

This thesis completes the final stage of my Master Business Administration conducted at the Rotterdam School of Management of the Erasmus University. In the past two years have been challenging with a concatenation of intense moments. The unexpected loss of my father and best friend, the birth of my first son and my new best friend, the construction and moving in to our new home, the continuation of the family business and my fulltime job have been a constant struggle to balancing of my attention and energy. Fortunately attending lectures at the Erasmus University and completing assignments with my fellow students has always given me great energy.

Several persons have contributed academically, practically and with support to this master thesis. I would therefore firstly like to thank my head supervisor prof.dr.ir. J.C.M.(Jan) van de Ende and co-reader prof.dr.ir. G.H. (Gerrit) Bruggen for their time, valuable input and support. I would like to thank my employer Dura Vermeer and the other companies of the examined cases for their support and input. Furthermore I would like to thank my family and in particular my parents-in-law for being very helpful and supportive during this challenging period in my life. Finally and most of all I would like to thank my lovely wife Stefanie for the unconditional support, love and patience. Without her this thesis wouldn't be completed.

I want to dedicate this master thesis to my beloved lated father who thought me self-discipline, to persevere and to never give up.

Executing Summary

Companies like Facebook and Tesla Motors have shaped the anticipation that it'll be start-ups and not established corporations, who come up with the "next big thing" to create uncontested market space and disrupt entire industries (Weiblen & Chesbrough, 2015). A number of scholars have advanced the idea that entrepreneurial ventures are likely to be the source of highly valuable and innovative ideas (Dushnitsky & Lenox, 2005). An awareness of the actions and behaviours of entrepreneurs of start-ups is critical to understand how this can lead to innovation (Chandler, DeTienne, McKelvie, & Mumford, 2011). The research of Sarasvathy (2001,2008) advanced our understanding of the entrepreneurial process.

Project-based firms, such as engineering and construction companies, are service firms that solely execute projects for clients (Blindenbach-Driessen & van den Ende, 2006). Innovations developed within business projects are typically not executed in separate Research & Development departments, but performed within, or closely related to business projects (Blindenbach-Driessen & van den Ende, 2006). Management of innovation is complicated by the discontinuous nature of project-based production in which, often, there are broken learning and feedback loops (Gann & Salter, 2000).

What can project-based firms learn from successful innovation and new venture by start-up entrepreneurs? This research aims to explore how entrepreneurial thinking, like effectuation, can lead to innovation in project-based firms in the construction sector in the Netherlands.

To advance our understanding of the effects of the actions and behaviours of entrepreneurs on innovation we conducted a literature study of the groundbreaking research of Sarasvathy (2001,2003,2008) and the related literature. In this literature study we also examined the barriers that must be bridged to achieve more innovation in the construction industry by evaluating the specific conditions for innovation in project-based firms. Based on the literature, review propositions have been formed and the different variables of effectuation and the effect on R&D project success in PBF have been determined. We argue that effectuation process of exploring new opportunities leads to a high level of innovativeness i.e. radical innovation and the causation process of refining existing products, services, or technologies leads, to low level of innovativeness i.e. incremental innovations.

Because insight in the role of entrepreneurial thinking in project-based firms is limited, data was analysed using the multiple case study methodology. Multiple R&D projects from a population of start-ups and corporate firms of different project-based firms -with a distinct range of skills and specialisms, like general contractors, manufacturers, specialized subcontractors and advisors- were selected. In-depth analyses and cross-case analyses were conducted to test the propositions formed during the literature review. The in-depth analyses and cross-case analyses were based on the raw data from interviews with leading experts on innovation in project-based firms and entrepreneurs of start-ups in the construction sector and corporate publications and internet sources. The analyses lead to the following results.

A mean-driven approach is the preferable process when exploiting contingencies that arose unexpectedly over time (Sarasvathy, 2001) whereby firms create, value, assimilate and apply new knowledge (Brettel, Mauer, Engelen, & Kupper, 2012). Goals emerge by imaging courses of action, based on given means. Similarly, who comes on board determines what can be and needs to be done. Radical innovations require new competence and innovation paths and presuppose the acquisition of new knowledge, which hasn't been present in the company today. The acquisition of new knowledge by renewal learning, allows change to new competences and innovation paths that haven't been travelled. Based on the case research

we have found that a mean-driven innovation approach has a positive impact on the R&D project success of radical innovation projects in PBF.

Affordable loss predetermines how much loss is affordable and focuses on experimenting with as many strategies as possible with the given limited means (Saravathy, 2001). Radical innovation projects consist of high level of uncertainty. Those projects typically lack reliable forecast of returns and information on market acceptance and sales volumes (Brettel, Mauer, Engelen, & Kupper, 2012). Since reliable information on the upside potential of high innovative projects is both rare and fuzzy, the upside data is usually not reliable enough to be the key decision criteria, while the acceptable downside potential -the affordable loss- is easier to estimate (Dew, Sarasathy, Read, & Wiltbank, 2009). Based on the case research we have found that an affordable loss innovation approach has a positive impact on the R&D project success of radical innovation projects in PBF.

Partnerships reduce uncertainty, maintain flexibility and utilize experimentation and seek exert control over the unpredictable future, by making strategic alliances and pre-commitments (Chandler et al. 2011; Dew et al. 2009; Brettel et al. 2012). Each partner brings new opportunities that shape the coherent product, firm or market (Read, Song, & Smit, 2009). Pre-commitments are made by building partnerships and bringing stakeholders on board, even before clarifying what the innovation is going to be exactly. Pre-commitments allow firms to test the market without owning all the resources to do so (Chandler et al. 2011). Based on the case research we have found that an innovation approach directed by partnerships, has a positive impact on the R&D project success of radical innovation projects in PBF.

When using acknowledging the unexpected thinking, new business ideas are launched, before worrying about who the customers are. Strategic experimentations are utilized to minimize risk and maximize learning during the R&D process. Some experiments will fail, but as long as failure informs new approaches and understanding within the constraints of affordable loss, this is to be expected and even encouraged. By learning and unlearning, exploring and experimenting and searching and selecting new radical innovations could be found. Based on the case research we have found that an innovation approach that acknowledges the unexpected has a positive impact on the R&D project success of radical innovation projects in PBF.

Shortly summarized we conclude that there are different ways in which entrepreneurial thinking can lead to innovation in project-based firms. Mean-driven innovation approaches, approaches driven by partnerships, affordable loss thinking and approaches that acknowledge the unexpected all have a positive impact on the R&D project success of radical innovation project in project-based firms.

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2 Introduction

A new reality is upon the business world. We are living in a time where size no longer equals power and where technological innovation is more or less turning all sectors upside down. Well-known examples which have taken hard hits are the taxi business, due to the arrival of Uber and the travel industry due to the emergence of Airbnb (Horn & Keyzer, 2014). While the gradual destabilisation in other sectors may be less visible, that doesn't mean it is not there. Tech start-ups across various industries can leverage Internet-scale technologies like cloud computing, mobility and data analysis more quickly than large companies. This leaves established -and often regulated- industries exposed or vulnerable to this breed of disruption (Nahon, 2015). Facebook and Tesla Motors have shaped the anticipation that it'll be start-ups, not established corporations, who come up with the "next big thing" to create uncontested market space and disrupt entire industries (Weiblen & Chesbrough, 2015).

Large companies have long sought for ways to become more entrepreneurial. They've adopted -and often later abandoned- mechanisms like corporate venture capital, internal incubators, strategic alliance and joint ventures (Weiblen & Chesbrough, 2015). Despite the economic tendency to innovate, numerous researchers have highlighted the organizational limits of established firms to generate innovations internally (Dushnitsky & Lenox, 2005). A number of scholars have advanced the idea that entrepreneurial ventures are likely to be the source of highly valuable and innovative ideas (Dushnitsky & Lenox, 2005). In response, some companies invest in start-ups, as a way of embracing different types of tech-enabled business innovations (Nahon, 2015).

An awareness of the actions and behaviours of entrepreneurs of start-ups is critical to understand how this can lead to innovation. (Chandler, DeTienne, McKelvie, & Mumford, 2011). The research of Sarvasvathy (2001,2008) advanced our understanding of the entrepreneurial process by describing effectuation. A process consistent with emergent strategy which include a selection of alternatives, bases on loss affordability, flexibility and experimentation.

Project-based firms, such as engineering and construction companies, are service firms that solely execute projects for clients (Blindenbach-Driessen & van den Ende, 2006). Project-based firms rely on combining technical expertise from other organisations in order to deliver their own technical capabilities, usually in one-off process (Gann & Salter, 2000). Innovations developed within business projects, often contain the applications of traditional linear project management practices referred by Sarasvaty (2001) as causation. Those activities are typically not executed in separate Research & Development departments, but performed within, or closely related to business projects (Blindenbach-Driessen & van den Ende, 2006). Management of innovation is complicated by the discontinuous nature of project-based production in which, often, there are broken learning and feedback loops. (Gann & Salter, 2000).

Project-based firms, such as engineering and construction companies, could have the tendency to use causal processes by setting goals in their business projects of concrete, steel and asphalt. In the fast moving environment they must be more innovative to create uncontested market. What can project-based firms learn from successful innovation and new venture by start-up entrepreneurs? This research aims to explore how entrepreneurial thinking, like effectuation can lead to innovation in project-based firms.

Research question

The main research question that will be assessed in this thesis:

“How can entrepreneurial thinking lead to innovation in project-based firms in the construction sector in the Netherlands?”

With entrepreneurial thinking this paper refers to effectuation.

The following concrete research questions will be assessed in this thesis:

1. What is according to the literature the effect of effectuation on innovation at businesses in general?
2. What are according to the literature the specific conditions for innovation in project-based firms?
3. What is the effect of the application of the effectuation process on corporate and start-up project-based firms in the construction sector in the Netherlands?
4. What effect do we expect or find of entrepreneurial thinking in project-based firms in the construction sector?

After this brief introduction, the next chapter will provide an overview of all relevant existing literature. The methodology and data use will be further discussed in chapter four, after which the results will be presented in chapter five. In the sixth chapter, this thesis is concluded with an overview of all findings. In the seventh chapter we will end with a discussion of current limitations, and some suggestions for further research.

3 Literature review

3.1 Innovation: the degree of newness

In an uncertain world, where competition intensifies and the pace of change accelerates, firms need to renew themselves by exploring new competencies and exploiting existing competencies (Jansen, Van Den Bosch, & Volberda, 2006). In today's quickly changing business environment, innovation is therefore the key to competitive advantage (Asssink, 2006; Brettel, Mauer, Engelen, & Kupper, 2012). Chesbrough (2010) argues that companies need to develop the capability to innovate their technologies, as well as their ideas and business models. Innovation is about identifying, generating, developing and adapting new ideas and opportunities to create or improve new products, services, or work practices for current or prospective customer. (Andriopoulos & Lewis, 2010; Asssink, 2006; Blindenbach-Driessen & van den Ende, 2006; Damanpour, 1996; Van de Ven, 1986). However this definition does not emphasize that innovation varies in the degree of newness to an adoption unit. New products or services include new technologies to existing markets or existing technologies to new markets (Garcia & Calantone, 2002). The newness of innovation can be distinguished between incremental or radical innovation (Dewar & Dutton, 1986).

"Incremental innovations refine existing products, services, or technologies and reinforce the potential of established product/service design and technologies" (Subramaniam & Youndt, 2005). Hermann et al. (2006) adds to this that incremental innovation include minimal changes, which are matched by what is only a minimal improvement in benefits achieved for customers. Incremental innovations incorporate product or service improvements -features, benefits, price, manufacturing, process- into innovations using existing technologies targeted towards existing markets (Garcia & Calantone, 2002). Whereby the new product or service satisfies customers needs better in comparison to other products or services. Knowledge gained in the past has a crucial influence on current and future research and development activities for developing incremental innovation. Therefore successful companies profit from their superior knowledge and exploit the potential for improvement and development more effectively and quickly than their competitors do (Herrmann, Tomczak, & Befurt, 2006). Because incremental innovation is based on knowledge of the past, the spectrum of innovation options is considerably limited. This is why the process of incremental competence development is not suitable for fostering radical innovations (Herrmann, Tomczak, & Befurt, 2006).

Herrmann et al. (2006) argues that radical innovations requires new competence and innovation paths and presuppose the acquisition of new knowledge, which has not been present in the company to date. The acquisition of new knowledge by renewal learning, allows change to new competence and innovation paths that haven't been travelled. That is why the more radical the innovation, the more difficult it is to estimate it's market acceptance and potential (Asssink, 2006). Subramaniam & Youndt (2005) defined radical innovations as "major transformations of existing products, services, or technologies that often make the prevailing product/service design and technologies obsolete". "Schumpeter (1975) and Krichhoff (1991) state that radical or 'breakthrough' inventions lie at the core of entrepreneurial activity and wealth creation. Entrepreneurship focuses on how new product and services, new ways of embodying technologies, new institutions, new customers needs and wants, new production and supply variants and new ways of organization are introduced in a market economy (Dew, Read, Sarasvathy, & Wiltbank, 2008). Dew et al. (2008) claims that it were entrepreneurial start-ups that commercialized innovations that ended up eroding the incumbent firm's leadership in several markets.

Christensen (2013) claims that only a few corporate companies have come to understand what is necessary for succesful innovation, despite the succesful implementation of innovations. Many companies are not organised to adapt quickly to changing market

circumstances or to cause market changes in the first place (Asssink, 2006). Therefore one potentially successful way of understanding how innovation can be developed, is examining how entrepreneurs, in the absence of markets for future goods and services, those goods and services come into existence (Venkataraman, 1997).

Incremental Innovation	Radical Innovation
Building upon existing knowledge & resources	Requires new knowledge & resources
Competence-enhancing	Existing competence loses value
Relatively small changes in performance and utility	Step changes in performance

Table 1: Incremental vs. Radical Innovation

3.2 Effectuation: inverse of causation

To advance our understanding of the effects of the actions and behaviours of entrepreneurs on innovation we examine the groundbreaking research of Sarasvathy (2001,2003,2008) and the related literature. Sarasvathy described two distinct approaches to new venture creation: causation and effectuation. Causation is consistent with planned strategy. The effectuation approach has a strong bias for action so new data will be forthcoming, because for new opportunities there may be insufficient data available to analyze (Chesbrough, 2010). Using the effectuation approach, firms or entrepreneurs take actions that create new information that reveals latent possibilities in that environment.

Pre-existing knowledge and Causation

The main body of Research and Development (R&D) research is based on decision making models employed by neoclassical micro-economics (Perry, Chandler, & Markova, 2012). Those decision making models are based on the rational choice theory (Read & Sarasvathy, 2015). This predominant decision model is taught in many business schools as a goal-driven, deliberate model of decision making, referred to by Sarasvathy (2001) as a causation model. McGrath (1999) argues that the most of the R&D literature assume that to discover opportunities and exploit them, a set of planned strategy approaches to performing this task rely on predicting the future based on given information. Drucker (1988) argues that most opportunities are discovered through a purposeful search process of exploiting pre-existing knowledge and resources, which incorporates concepts as competitive analysis (Porter, 1985) and “real options” (McGrath, 1999). In this causal process an individual makes rational choices based on all possible information relevant to his decision and an estimated expected utility for each option. The planning and analysis of the causal process assume conditions in which the distribution of outcomes in a group is predictable through calculation or statistical inference. (Chandler, DeTienne, McKelvie, & Mumford, 2011). Thus, the causal logic frames the future as a continuation of the past whereby an accurate prediction is both necessary and useful. The previous section described incremental innovation as refining existing products, services, or technologies by improvements based on existing knowledge and resources. In the causational process the innovation is imagined from the beginning and all effort is directed at achieving the pre envisioned purpose with pre existing knowledge. We therefore hypothesize that the causation process of exploring new opportunities leads to low level of innovativeness i.e. incremental innovation.

Uncertainty and effectuation

Sarasvathy (2001) research on effectuation describes a theory to which the notion of uncertainty is central. Brettel et al. (2012) define uncertainty as the difference between the information possessed and the information required to perform particular tasks. Chandler et al. (2011) claims that conditions of uncertainty and unique circumstances make it impossible to draw statistical inferences as used at the causation process. Brettel et al. (2012) add to this that new, ambiguous and unknown information makes defining relevant competition, or the value of options, difficult or impossible. Read & Sarasvathy (2015) state that there is no rationality when the environment does not independently influence outcomes or even rules of the game (Weick 1979), the future is truly unpredictable (Knight, 1921), and the decision maker is unsure of his/her own preferences (March, 1982).

Effectuation is a straight inversion of the causal process based on rational choice theory (Read & Sarasvathy, 2015). Dewar & Dutton (1986) describe that since both entrepreneurs and decision-makers in innovation R&D projects face high levels of uncertainty effectuation logic may be particular suitable to form a conceptual basis for high levels of innovativeness like radical innovation. Read & Sarasvathy (2015) describe that when using the effectuation process, the end product is fundamentally unpredictable at the beginning of the process. The opportunity, and even the market itself, get created through the very process of effectuation. Because there may be insufficient data available to analyze one's way towards a new business model, effectuation has a strong bias for action over analysis: without action, no new data will be forthcoming. Chesbrough (2010) describes actors (such as firms or entrepreneurs that create new businesses- and associated business models) using the effectuation process, do not analyze their environment, so much as take actions that create new information, that reveals latent possibilities in that environment. Chandler et al. (2011) adds to the above that actors following an effectuation approach might begin with general aspirations to create new business, but as they make decisions and observe the result of those decisions. They utilize this new information to change the road. It allows a decision maker to change or shape and construct his or her goals over time, making use of contingencies as they arise (Sarasvathy, 2001). Rijdsdijk & van den Ende (2011) claim that an important condition for being effective in new product development, is dealing with uncertainty and adapting goals, where necessary. Enforcing the outcome eliminate all flexibility from the development process (Rijdsdijk & van den Ende, 2011). Entrepreneurs using an effectuation approach may try different approaches in the marketplace before setting on a business model because the future is unpredictable (Chandler, DeTienne, McKelvie, & Mumford, 2011). Thus, the effectuation process frames the future as shaped by creative agents whereby prediction is neither easy nor useful. The previous section described radical innovation as a major transformation of existing products, services or technologies that often make the prevailing product/service design and technologies obsolete, which requires new competence and innovation path as well as presuppose the acquisition of new knowledge. Using the effectuation process entrepreneurs take actions that create new information that reveals latent possibilities in the environment. We therefore hypothesize that the effectuation process of exploring new opportunities leads to high level of innovativeness i.e. radical innovation.

3.3 The four principles of effectuation

Based on the research of Sarasvathy (2001; 2003; 2008) the literature outlined four principles that differentiate causation and effectuation approaches, which can be applied to the context of new business and R&D projects in business in general.

Principle 1: Basis for taking action: Means-driven versus goals-driven

Sarasvathy (2001;2003;2008) describes two key different starting points in all publications on entrepreneurial process. She argues that the causation process builds on prediction and

processes that “take a particular effect as given and focus on selecting between means to create that effect”. Causation requires one to make sense of a linear process of aligning resources toward a pre-defined goal (Agogue, Lundqvist, & Middleton, 2015). The causation process is therefore goal-driven. The effectuation process starts with “a set of means as given and focus on selecting between possible effects that can be created with that set of means”. The existing means combined are creating something new. Read, Song, & Smit (2009) describe that means provide the decision-maker with a basis for direction, suggesting that opportunities emerge from the knowledge, contracts and resources at hand. Brettel et al. (2010) explain that relevant resources for innovation (i.e. existing means) may be existing competencies and project experiences (“Who I am”), skilled employees and experts in the appropriate field of R&D (“What I Know”), relationships with partners through R&D networks (“Whom I Know”), and financial means and tangible assets like R&D equipment (“What I have”). The effectuation process is therefore mean-driven.

Sarasvathy (2011) claims that effectuation is the preferable process when exploiting contingencies that arose unexpectedly over time. Brettel et al. (2010) assume that the effectuation logic carries notions of absorptive capacity, which relate to the firm’s ability to value, assimilate, create and apply knowledge. Brettel et al. (2010) hypothesize that mean-driven R&D have a positive impact on the R&D output and efficiency in projects with high innovativeness. Thus, we hypothesize that mean-driven innovation approaches have a positive impact on the R&D project success in innovation projects with a high level of innovativeness i.e. radical innovation.

Sarasvathy (2011) claims that when pre-existing knowledge, such as expertise in a particular new technology, forms the source of competitive advantage, causation might be the preferable process. Brettel et al. (2012) claim that the benefits of the causal process of goal-setting, are particularly evident when low levels of innovativeness limit the uncertainty in R&D projects and few or no changes are necessary in the planning process. Being goals-driven may not be suitable in the context of highly innovative projects, because comprehensive planning activities are negatively associated with firm performance in uncertain situations creating R&D projects. Brettel et al. (2012) have found evidence that goals-driven R&D practices have a positive impact on the R&D output and efficiency in projects with low innovativeness. Thus, we hypothesize that goal-driven innovation approaches have a positive impact on the R&D success in incremental innovation projects.

Principle 2: View of risk and resources: Affordable loss versus expected returns

The second principle consists of affordable loss (effectuation) versus expected returns (causation). Sarasvathy (2001) claims that affordable loss predetermines how much loss is affordable and focuses on experimenting with as many strategies as possible with the given limited means, while causation models focus on maximizing the potential returns for a decision by selecting optimal strategies. Brettel et al. (2012) contend that affordable loss considers the potential risk or downside of investment in a R&D project. R&D approach is guided by advance commitments to what one is willing to lose, while expected return R&D approach is guided by expected project returns (Brettel, Mauer, Engelen, & Kupper, 2012). Morrish (2009) adds to the above that effectuators using the affordable loss principle, first test the new product idea in the market, instead of setting returns-related goals. Instead of analyzing alternatives and selecting the one with the highest expected return, the entrepreneur selects alternatives based on loss affordability.

Radical innovation projects consists a high level of uncertainty. Those projects typically lack reliable forecasts of returns and information on market acceptance and sales volumes (Brettel, Mauer, Engelen, & Kupper, 2012). Since reliable information on the upside potential of high innovative projects is both rare and fuzzy, the upside data is usually not

reliable enough to be the key decision criterion, while the acceptable downside potential –the affordable loss – is easier to estimate (Dew, Sarasathy, Read, & Wiltbank, 2009). Brettel et al. (2012) have found evidence that R&D project practices that are guided by “affordable loss” thinking have a positive impact on the R&D efficiency in projects with high innovativeness. Thus, we hypothesize that “affordable loss” thinking has a positive impact on R&D project success, particularly in innovation projects with a high level of innovativeness i.e. radical innovation.

A low level of innovativeness implies less uncertainty and better access to reliable data, such as forecasts on market acceptances and sales volumes (Brettel, Mauer, Engelen, & Kupper, 2012). Brettel et al. (2012) have found evidence that R&D project practices that are driven by “expected return” logic have a positive impact on the R&D efficiency in projects with low innovativeness. Because incremental projects are low innovativeness and have a low level of uncertainty we hypothesize that an expected return innovation approach has a positive impact on R&D project success in innovation projects with a low level of innovativeness i.e. incremental innovation.

Principle 3: Attitude toward outsiders: Partnerships versus competitive market analysis

The third principle consists of an emphasis on pre-commitments and strategic alliances to control an unpredictable future (effectuation) versus business planning and competitive analyses to predict an uncertain future. Effectual logic strongly favours building partnerships and bringing stakeholders on board, even before clarifying what the product-markets and other goals for the venture are exactly going to be. (Dew, Read, Sarasvahty, & Wiltbank, 2009). Chandler et al. (2011) argue that the entrepreneur maintains flexibility, utilizes experimentation and seeks to exert control over the future, by making alliances with and getting pre-commitments from, potential suppliers, competitors and customers. Brettel et al. (2012) conclude that partnership reduces the uncertainty that is caused by highly innovative R&D projects. The result of the created innovation is shaped and defined by the very addition of the means of the partners in the process. Each partner brings new opportunities that shape the coherent product, firm or market (Read, Song, & Smit, 2009). Brettel et al. (2012) state that the effectuation practices seek to reduce uncertainty, through involving others, causation focuses on the reduction of uncertainty through competitive market analysis. Chandler et al. (2011) add that in the effectuation process pre-commitments are important, because they allow firms to test market without owning all the resources to do so. Brettel et al. (2012) add to this that partners may be able to provide the necessary information and resources to reduce uncertainty and ambiguity whereby positively influencing R&D output. Brettel et al. (2012) have found that R&D project practices that are guided by partnerships have a positive impact on the R&D output in project with high innovativeness. Thus, we hypothesize that innovation approaches that are directed by partnerships have a positive impact on the R&D projects success in innovation projects with a high level of innovativeness i.e. radical innovation.

Causal approaches for R&D projects prescribes first defining the market, then selecting segments within the market through detailed competitive analyses, and then using relevant specifications and needs of the target market (Dew, Read, Sarasvahty, & Wiltbank, 2009). In causal reasoning the emphasis is on trying to outdo the competition (Morrish, 2009). The causal approach is based on the existing markets, which will not lead to high levels of innovativeness. A less innovative project is less dependent on external stakeholders, because there is no need to reduce uncertainty. Projects that involve low levels of innovativeness are expected to profit from detailed markets and competitor analyses (Brettel, Mauer, Engelen, & Kupper, 2012; Brown & Eisenhardt, 1997; Ernst, 2002). Brettel et al. (2012) hypothesized that R&D project practices that are driven by “competitive market analysis” logic have a positive impact on the R&D output in project with low innovativeness. Thus, we hypothesize

that innovation approaches that are driven by competitive market analysis, have a positive impact on R&D project success in innovation projects with a low level of innovativeness i.e. incremental innovation.

Principle 4: Attitude toward unexpected events: acknowledge the unexpected vs. overcome the unexpected

The fourth principle consist of dealing with unexpected events during the R&D projects as a vital source of opportunity versus following a linear process that seeks to reach the project target as efficiently and with as few surprises as possible. (Brettel, Mauer, Engelen, & Kupper, 2012). Sarasvathy (2001) claims that effectuation focusess on controlling aspects of an unpredictable future. The logic of using effectuations is: To the extent that we can control the future, we do not need to predict it. In effectuation, contingencies are being explored, that new business ideas are launched before worrying about who the customer is. It is built on the acceptance that one will never know what could become of an idea unless it is out there. Dew et al. (2009) claim that with effectuation positive and negative contingencies have to be transformed into useful components of new opportunities. Sitoh et al. (2014) describes that strategic experimentation is utilized to minimize risk and maximize learnings during R&D processes. Some experiments will fail, but as long as failure informs new approaches and understanding within the constraints of affordable loss, this is to be expected - even encouraged-. Assink (2006) adds to the above that through learning and unlearning by exploring and experimenting, searching and selecting new radical innovations could be found. Contrary to causal linear procesess, incremental innovation processes-such as the causal stage-gate concepts-radical innovation is more like a spiral of circular development process of contiguous fast feed-forward and feed-back loops (Asssink, 2006). Brettel et al. (2012) have found that R&D project practices that are guided by “acknowledging the unexpected” thinking have a positive impact on the R&D output in projects with high innovativeness. Thus, we hypothesize that innovation approaches that acknowledge the unexpected have a positive impact on the R&D project success in innovation projects with a high level of innovativeness i.e. radical innovation.

Causation on the other hand focuses on the predictable aspect of an uncertain future. The logic of using causation is: To the extent that we can predict the future, we can control it (Saravathy, 2001). Morrish (2009) describes that causation focuses on exploitation of existing knowledge and using this to pursue pre-determined goals whereby there is an explicit effort to avoid unpleasant surprises (Dew, Read, Sarasvahty, & Wiltbank, 2009). Brettel et al. have found that R&D project practices that are driven by “overcoming the unexpected” logic have a positive impact on the R&D output and efficiency in projects with low innovativeness. Thus, we hypothesize that innovation approaches that overcome the unexpected have a positive impact on the R&D projects success in innovation projects with a low level of innovativeness i.e. incremental innovation.

Principles	Effectuation characteristics	Causation characteristics
Type of innovation projects	Innovation projects with a high level of innovativeness i.e. radical innovation.	Innovation projects with a low level of innovativeness i.e. incremental innovation.
View of the future	Creative. Effectual logic frames the future as shaped by wilful agents. Prediction is therefore neither easy nor useful	Predictive. Causal logic frames the future as a continuation of the past. Accurate prediction is both necessary and useful
Principle 1: Basis for taking action: Means vs. Goals	Innovation approach is driven by given means. Goals emerge by imagining courses of action based on given means. Similarly, who comes on board determines what can be and needs to be done.	Innovation approach is driven by given project targets. Goals, even when constrained by limited means, determine sub-goals. Goals determine actions, including which individuals to bring on board.
Principle 2: View of risk and resources: Affordable loss vs. Expected returns	Innovation approach is guided by advance commitments to what one is willing to lose. Pursuing adequately satisfactory opportunities without investing more resources than stakeholders can afford to lose. The focus is on limiting downside potential.	Innovation approach is guided by expected project returns. Pursuing the (risk-adjusted) maximum opportunity and raising required resources to do so. The focus is on the upside potential.
Principle 3: Attitude toward outsiders: Partnerships vs. Competitive market analysis	Uncertainty is reduced through partnerships and pre-commitments of self-selected stakeholders. Relationships, particularly equity partnerships drive the shape and trajectory of the innovation.	Uncertainty is identified and avoided through market and competitor analyses. Limiting dilution of ownership as far as possible.
Principle 4: Attitude toward unexpected events: Acknowledge the unexpected vs. Overcome the unexpected	Contingencies/surprises are seen as a source of opportunities. Imaginative rethinking of possibilities and continual transformations of targets.	Contingencies/surprises are avoided or quickly overcome to reach given project targets. Careful planning and unwavering focus on targets.

Table 2: Effectuation vs. Causation (Dew et al.,2009; Sarasvathy, 2001, Brettel et al. 2012)

3.4 The impact of effectuation on large corporations

The literature on innovation of large, established firms rest principally on the processes of causal logic thinking (Brettel, Mauer, Engelen, & Kupper, 2012). The concept of causal logic advises firms to set clear goals for product development and determine a strategy that can drive project selection. Decisions are often formed by upfront market research gained by pre-existing knowledge to elicit customers' preferences and predict future sales. Resources commitments depend on the actual deliverables at each gate in comparison to planned milestones (Berends, Jelinek, Reymen, & Stultiens, 2014). Thus, the causation process focuses on exploitation of existing knowledge and using this to pursue pre-determined goals whereby there is an explicit effort to avoid unpleasant surprises (Dew, Sarasathy, Read, & Wiltbank, 2009). Because causation is based on existing knowledge, we expect that the use of causal processes have a positive impact on the R&D project success in innovation projects with a low level of innovativeness i.e. incremental innovation in corporate firms.

The inverse of causation is effectuation, whereby entrepreneurs of corporations take actions that create new information that reveals latent possibilities in the environment (Chesbrough, 2010). The concept of effectuation logic advises firms to combine existing means to create something new. The existing means provide the decision-maker with a basis for direction, suggesting that opportunities emerge from the knowledge, contacts and resources at hand (Read, Song, & Smit, 2009). Resource commitments are based on the acceptable downside potential of exploring the opportunities, because there isn't reliable information on market acceptance and sales volumes. Pre-commitments are made by building partnerships and bringing stakeholders on board, even before clarifying what the innovation exactly is going to be. Effectuation approach focuses on controlling aspects of an unpredictable future whereby positive and negative contingencies have to be transformed into useful components of new opportunities. Thus, the effectuation process focuses on exploring new opportunities by using existing means to create value, assimilate and apply new knowledge. Because effectuation is based on new knowledge, we expect that the use of effectuation processes have a positive impact on the R&D project success in innovation projects with a high level of innovativeness i.e. radical innovation in corporate firms.

3.5 Project-based firms in the construction sector

The construction industry is one of the backbones of the economy in most countries (Eriksson, 2013). Within Europe, the turnover of the construction industry alone already exceeds one trillion Euros per year (Eurostat), underscoring the importance of project based firms (Blindenbach-Driessen & van den Ende, 2010). The construction industry is generally driven by single and unique projects, each creating and disbanding project teams (Barrett & Sexton, 2006). Construction work is characterized by inter-organizational collaboration of a number of different firms and a wide range of skills and specialisms, like architectural design practices, general contractors, specialized subcontractors, fabricators, manufacturers customers and suppliers (Harty, 2005). Barlow (2000) & Widen and Hansson (2007) describe that the construction industry lacks innovation. Eriksson (2013) add to the above that R&D expenditures are extremely low in construction companies. Which barriers must be bridged to achieve more innovation in the construction industry? This section reviews the literature on the specific conditions for innovation in project-based firms.

Characteristics Project-Based Firms

Project-based firms -such as engineering and construction companies- are service firms that solely execute projects for clients (Blindenbach-Driessen & van den Ende, 2006). Blindenbach-Driessen & van den Ende (2010) defined project-based firms (PBF) as firms that are organized around business projects and that produce complex integrated systems or knowledge-intensive services by order of their clients. They rely upon combining technical expertise from other organisations in order to deliver their own technical capabilities, usually in on-off processes (Gann & Salter, 2000). Hobday (2000) describes the difference between a project-based organisations and project-led organisation. A project-based organisation is an organization in which the functional organization has become completely obsolete, without formal functional coordination of activities. A project-led organisation still has some characteristics of a functional firm, since there is some coordination of functionally equivalent activities. However the needs of projects outweigh the functional influence on decision-making. In this research project-based organisations and project-led organisations are both defined as project-based firms.

In general, business processes are ongoing and repetitive, whereas business project processes have a tendency to be temporary and unique (Gann & Salter, 2000). Business projects differ in PBF with respect to duration, content, and project size (Blindenbach-Driessen & van den Ende, 2006). PBF are employed to meet the highly differentiated and customized nature of demand, where clients frequently negotiate and interact with project organizers over the product and services (Hobday, 2000). Because PBF deliver unique and complex services, the organizational structure asks for less hierarchy and a higher span of control, compared to manufacturing firms (Blindenbach-Driessen & van den Ende, 2006). The PBF is characterized by the co-existence of a continuing organization structure (Barrett & Sexton, 2006). The firms' operational activities describe this organization structure, that is, functionally or around projects (Blindenbach-Driessen & van den Ende, 2010). Gann & Salter (2002) state that in many project-based firms, project teams have limited contact with senior management, are based off-site and work in teams with many other firms. Value is created and profits generated by project groups that tend to operate at the boundaries of the firm. Multi-disciplinary teams are used to execute a business project and more disciplines will be involved if a project is more complex (Blindenbach-Driessen & van den Ende, 2006). Gann & Salter (2002) describe that the performance and competitiveness of PBF depends not solely on single firms, but on the efficient functioning of the entire network of architectural and design practices, general contractors, specialized subcontractors, fabricators, manufacturers and suppliers.

Conditions for innovation in Project-based firms

Separately of business projects, PBF perform development projects. This development projects are aimed at innovation, whereby new services are developed for a range of customers, with the objective to commercialize these services (Blindenbach-Driessen & van den Ende, 2006). In this section the specific conditions for innovation in PBF will be described.

Organisation configuration

PBF are often organized per area of expertise, combining sales, research and production in one department dedicated to this specific area, making functional departments entirely redundant (Blindenbach-Driessen & van den Ende, 2006). Gann and Salter (2002) add that innovation activities in PBF are typically not executed in separate R&D departments, but perform within -or closely related to- business projects. Gann and Salter (2002) suggest that project-based firms could better make a more strict distinction between their generic business processes, including research and development and business projects. At the same time they note that separating these activities will likely hamper knowledge transfer between R&D and business projects. Studies in the Swedish construction industry have shown that the decentralized and project-based nature of construction business hinders innovation diffusion (Dubois & Gadde, 2002).

Planning and control

Besides unique organizational characteristics, PBF also have unique capabilities, like project management (Leybourne & Sainter, 2012). Project planning is an essential part of project management. Blindenbach-Driessen & van den Ende (2006) and Keegan & Turner (2002) have found that innovation projects were managed in the same controlled way as the regular business projects, which stifled innovation. Nonproject-based firms generally have weaker capabilities and routines in efficient project management, thereby planning more flexible (Blindenbach-Driessen & van den Ende, 2010). The traditional ideas from the literature suggest that in order to be innovative, firms should de-emphasise planning and control and loosening control to a more organic management approach. Overlapping phases and iteration positively affect performance of projects with high uncertainty, such as radical innovation projects (Brown & Eisenhardt, 1997; De Meyer & Loch, 2002; Eisenhardt & Tabrizi, 1995). While doing new things is a risky and uncertain endeavour, PBF in general continue to try and control this in a conventional way, where the uncertainty is de-emphasised and project control and evaluation proceeds as through innovation can be precisely defined, planned and evaluated according to predetermined criteria (Keegan & Turner, 2002). Blindenbach-Driessen and van den Ende (2010) agree on this and add that innovation projects need more flexibility to cope with uncertainty and late changes. More flexible planning generally result in a better performance of innovation projects.

Provision of resources

Project managers of PBF are used to minimise the utilisation of resources on projects when managing projects (Keegan & Turner, 2002). Blindenbach-Driessen (2006) states that PBF development projects compete for the same monetary and human resources as used for business activities. Blindenbach-Driessen and van den Ende (2010) have found that the occupation rate -or so-called number of billable hours of employees on business projects- is the most important parameter to assess the performance of a firm. As a result, innovation projects are often considered a burden as they decrease the occupation rate. Therefore for PBF promoting and stimulating innovative activity is not a problem, but watching and waiting for results to emerges and supporting this process with additional resources, is a problem (Keegan & Turner, 2002). The research of Sidu et al. (2004) has shown a high degree of human and monetary resources boost innovation, inasmuch they condition information search, experimentation and risk-taking. Hence, resources for innovation

projects are in general expected to be lower in project-based firms than in nonproject-based firms.

Cross-functional teams

Several scholars emphasize the importance of effective collaboration in cross-functional teams as success factors for innovation (Cooper, 2001; Lovelace, Shaprio et al., 2001; Song & Montoya-Weiss, 2001). Brettel et al. (2012) claims that cross-functional integration is important, especially where high levels of uncertainty occur. Different functional perspectives provide different approaches to problem-solving, whereby the integration of other functions can provide missing resources. Blindenbach-Driessen and van den Ende (2006) have found that cross-functional teams have a lower effect on performance of innovation projects in PBF than in other firms. Due to firm-level collaboration, members of innovation project teams in PBF are likely to be familiar with the requirements and needs of other disciplines and interpretive barriers and fault lines are less likely to exist (Blindenbach-Driessen & van den Ende, 2010). PBF need specialization within their innovation projects, instead of collaboration between disciplines and functions.

Heavyweight Project Leaders

Many researches claim that heavyweight project leaders contribute to the performance of an innovation project (Brown & Eisenhardt, 1995; Ernst, 2002; Van der Panne, 2003). Wheelwright and Clark (1992) have defined heavyweight project leaders as “leaders that are capable to interpret the market, understand the multi-languages of different departments, deal with engineering issues, communicate effectively inside the team as well as outside, while guarding the concept and resolve conflicts”. Heavyweight project leaders in project-based firms have an increased effectiveness, compared to nonproject-based firms (Blindenbach-Driessen F. , 2006). Blindenbach-Driessen and van den Ende (2010) argue that heavyweight project leaders in PBF have a different function than heavyweight project leaders in non-project firms. In non-project firms heavyweight project leaders are coordinating, translating and integrating the demands from the different functional departments, whereas heavyweight leaders in PBF are more geared at knowledge transfer and the diffusion of the newly developed product or service within the firm (Blindenbach-Driessen & van den Ende, 2010). Hence, heavyweight project leaders have a more ambassadorial and technical scouting role.

Collaboration with customers and suppliers

Close collaboration is typical for PBF in construction projects whereby a broad range of actors with different competences and specialties are involved - e.g. architectural and design practices, general contractors, specialized subcontractors, fabricators, manufacturer's customers and suppliers- (Eriksson, 2013). Blindenbach-Driessen (2006) claim that external operational collaborative capabilities lead to a more frequent involvement of suppliers on development projects. PBF generally make use of existing supplier relationships when engaged in development projects (Gann & Salter, 2000). Iansiti and Clark (1994) state that suppliers should be involved as early as possible in development projects to improve quality and to prevent delays.

In incremental projects, customer involvement is essential for developing innovation projects (Brown & Eisenhardt, 1995; Ernst, 2002). Customer involvement in radical innovation projects is less important since customers cannot anticipate on the problems and opportunities involved (Christensen, 2003). Close collaboration with customers is typical for construction projects and often involves long-term interactions with customers for production and operation (Gann & Salter, 2000). Blindenbach-Driessen & van den Ende (2006) argue that because of the collaboration in business projects, PBF know their

customers well and therefore have less need to investigate customers needs (Blindenbach-Driessen F. , 2006).

3.6 Effectuation in PBF: Proposition based on the literature review

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Basis for taking action in project-based firms

Sarasvathy (2001;2003;2008) describes the different basis for taking action of causal- and effectuation processes. She argues that the goal-driven approach of the causation process builds on prediction and processes starts with “take a particular effect as given and focus on selecting between means to create that effect”. The effectuation process is mean-driven, whereby “ a set of means is given and focus on selecting between possible effects that can be created with that set of means”. PBF in general try to control innovation projects in the same conventional controlled way as regular business projects, where uncertainty is de-emphasised and project control and evaluation proceeds can be precisely defined, planned and evaluated (Blindenbach-Driessen & van den Ende 2006; Keegan & Turner 2002). Thus, we hypothesize that PBF prefer a goal-driven approach for innovation projects, instead of a mean-driven approach, as a basis for taking action for innovation projects.

Brettel et al. (2012) state that a goal-driven approach may not be suitable in the context of highly innovative projects, because comprehensive planning activities are negatively associated with firm performance in uncertain situations creating R&D projects. A mean-driven approach is the preferable process when exploiting contingencies that arose unexpectedly over time (Saravathy, 2001) whereby firms create, value, assimilate and apply new knowledge (Brettel, Mauer, Engelen, & Kupper, 2012). We therefore hypothesize that a mean-driven innovation approach has a positive impact on the R&D project success of radical innovation projects in PBF.

Proposition 1: Mean-driven innovation approaches have a positive impact on the R&D project success in innovation projects with a high level of innovativeness i.e. radical innovation in PBF.

View of risk and resources in project-based firms

Sarasvathy (2001) describes that affordable loss (effectuation) predetermines how much loss is affordable for a R&D project and focuses on experimenting with as many strategies as possible with the given limited means. Causation models focus on maximizing the potential returns for a decision, by selecting optimal strategies of an expected return on a R&D project. In PBF development projects compete for the same monetary and human resources as used for business projects. As a result innovation projects are often considered a burden as they decrease the occupation rate of human resources (Blindenbach-Driessen & van den Ende, 2006). Therefore watching and waiting for results to emerge and supporting this process with additional resources, is a problem (Keegan & Turner, 2002). Read & Sarasvathy (2015) argue that in a predominate resource-poor situation effectual strategies are more likely, simply because the resources required for implementing casual strategies may not be available. When resources to implement are not scarce, novices are less likely to change the “vision” of their goals. In such cases they are more likely to stay tethered to their goals, even in the face of negative feedback. We therefore hypothesize that PBF prefer an affordable loss approach for innovation projects, instead of an expected return approach as a view of risk and resources in project-based firms.

Radical innovation projects typically lack reliable information on the upside potential of returns and information on market acceptance and sales volumes, because they consist a high level of uncertainty (Brettel et al. 2012). Due to the upside data is usually not reliable

enough to be the key decision criteria, the acceptable downside – the affordable loss- is easier to estimate (Dew et al. 2009). Brettel et al. (2012) have found evidence that R&D project practices that are guided by “affordable loss” thinking have a positive impact on the R&D efficiency in projects with high innovativeness. Thus, we hypothesize that “affordable loss” thinking has a positive impact on the R&D project success of radical innovation project in PBF.

Proposition 2: “Affordable loss” thinking has a positive impact on the R&D project success in innovation projects with a high level of innovativeness i.e. radical innovation in PBF.

Attitude toward outsiders in project-based firms

Dew et al. (2009) & Chandler et al. (2011) describe that effectuation consist of an emphasis on pre-commitments and strategic alliances with potential suppliers, competitors and customers to control an unpredictable future. The causation approach consists of making a business planning and competitive analyses to predict an uncertain future (Chandler et al., 2011) and trying to outdo the competition (Morrish, 2009). Eriksson (2013) describes that close collaboration is typical for PBF in constructions projects, whereby a broad range of actors with different competences and specialties are involved. Also close collaboration with customers is typical for construction projects and often involves long-term interactions with customers for production and operation (Gann & Salter, 2000). Blindenbach-Driessen (2006) adds that external operational collaborative capabilities lead to a more frequent involvement of suppliers on development projects. Stakeholders can be either outside the organization, or within (Brettel, Mauer, Engelen, & Kupper, 2012). PBF make use of cross-functional teams, but Blindenbach-Driessen & van den Ende (2010) have found that PBF need specialization within their innovation projects, instead of collaboration between disciplines and function. We therefore hypothesize that PBF prefer partnership approach as an attitude toward outsiders in project-based firms.

Partnerships reduce uncertainty, maintain flexibility and utilize experimentation and seek to exert control over the unpredictable future, by making strategic alliances and pre-commitments (Chandler et al. 2011; Dew et al. 2009; Brettel et al. 2012). Each partner brings new opportunities that shape the coherent product, firm or market (Read, Song, & Smit, 2009). Pre-commitments allow firms to test the market without owning all the resources to do so (Chandler et al. 2011). Brettel et al. (2012) have found that R&D project practices that are guided by partnerships, have a positive impact on the R&D output in projects with high innovativeness. Thus, we hypothesize that innovation approaches directed by partnerships have a positive impact on the R&D project success of radical innovation projects in PBF.

Proposition 3: Innovation approaches directed by partnerships have a positive impact on the R&D project success in innovation projects with a high level of innovativeness i.e. radical innovation in PBF.

Attitude toward unexpected events in project-based firms

Effectuation consists of dealing with unexpected events during the R&D projects as a vital source of opportunity. Causation following a linear process that seeks to reach the project target as efficiently and with as few surprises as possible (Brettel, Mauer, Engelen, & Kupper, 2012). PBF manage innovation projects in the same controlled way as regular business projects, which stifled innovation (Blindenbach-Driessen & van den Ende, 2006). PBF in general try to control uncertainty in the same way as business projects. They expect that innovation can be precisely defined, planned and evaluated according to predetermined criteria (Keegan & Turner, 2002). Thus, we hypothesize that PBF prefer avoiding or quickly

overcome, unexpected events to reach given project targets, instead of seeing unexpected events as a source of opportunities.

When using “acknowledging the unexpected” thinking, new business ideas are launched, before worrying about who the customers are. Positive and negative contingencies are being explored and have to be transformed into useful components for new opportunities, whereby strategic experimentation is utilized to minimize risk and maximize learning (Dew et al. 2009). Through exploring and experimenting, searching and selecting, new radical innovations could be found (Asssink, 2006). Brettel et al. (2012) have found that R&D project practices that are guided by “acknowledging the unexpected thinking”, has a positive impact on the R&D output in projects with high innovativeness. Thus, we hypothesize that innovation approaches that acknowledge the unexpected have a positive impact on the R&D project success of radical innovation projects in PBF.

Proposition 4: Innovation approaches that acknowledge the unexpected have a positive impact on the R&D project success in innovation projects with a high level of innovativeness i.e. radical innovation in PBF.

Conceptual model

Based on literature review as described above we have determined the different variables of effectuation and the effect on R&D project success in PBF. We developed a basic understanding of effectuation, including how it differs from causation. In section 3.2 we argue that effectuation process of exploring new opportunities leads to high level of innovativeness i.e. radical innovation and the causation process of refining existing products, services, or technologies leads to low level of innovativeness i.e. incremental innovations. Section 3.3 describes the different principles of effectuation and causation and their effect on the success of radical and incremental innovation projects in business in general. The principles of effectuation lead the different independent variables of the R&D project success, of radical innovation projects. In contrast, the different principles causation leads to the independent variables of the R&D project success of incremental project. Section 3.6 deals with the impact of causation and effectuation on R&D project success of incremental and radical innovation projects in PBF. Firstly, we have examined which principles PBF would prefer, based on the condition for innovation in PBF described in section 3.5. Secondly, we have examined what effect we expect when the principles of effectuation are applied. Figure 1 summarizes the conceptual model. The main research question that will be assessed in this thesis is “*How can entrepreneurial thinking lead to innovation in project-based firms in the construction sector in the Netherlands?*” whereby we have defined entrepreneurial thinking as effectuation. Therefore we focus effectuation approach of the conceptual model.

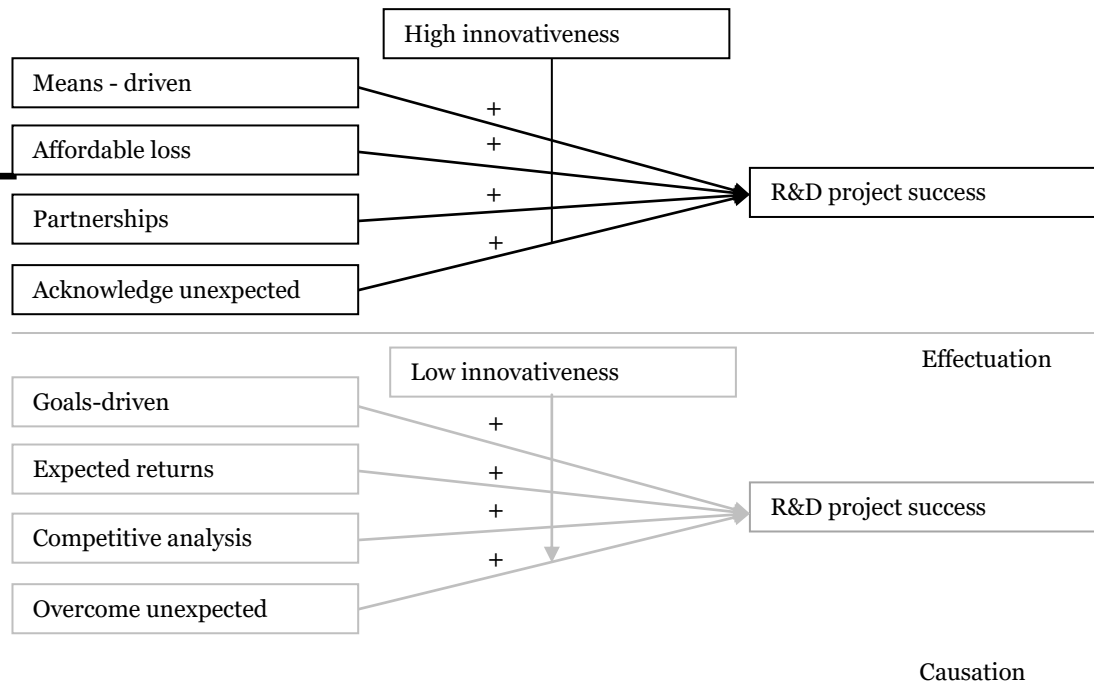


Figure 1: Conceptual model

4 Research methodology

Because insight in the role of entrepreneurial thinking in project-based firms is limited, data was analysed using the multiple case study methodology. Case study analysis, like most qualitative analyses, guides the investigator towards identifying abstract themes from the raw data (Griffin 2014). The essence of a case study, the central tendency among all types of case study, is that it tries to illuminate a decision or set of decisions: why were they taken, how they were implemented and with what result (Yin, 2009). Through case study analyse of raw data from interviews with leading experts on innovation in project-based firms and entrepreneurs of start-ups in the construction sector, literature research of innovations in the construction sector, corporate publications and through internet sources, the role of entrepreneurial thinking examined on innovation in project-based firms in the construction industry in the Netherlands.

4.1 Research participants

This research focuses on innovation in project-based firms in the construction sector. There is little known about innovation in project-based firms in the construction sector. This is why multiple R&D projects of PBF were selected in the construction sector. Because this paper examines how entrepreneurial thinking can lead to innovation, multiple R&D projects from a population of start-ups and corporate firms in the construction sector were selected. Having defined the study's population, we then created a diverse sample. The samples were not random, but reflected the selection of innovation in specific areas, to extend the theory to the project-based firms in the construction sector. We selected different R&D projects of different project-based firms, with a distinct range of skills and specialisms, like general contractors, manufacturers, specialized subcontractors and advisors. The selection of different project-based firms allowed the researcher to control organisational variation, while the focus on project-based firms in the construction sector constrained. The selection of different start-ups and corporate firms in the construction sector allowed the researchers to examine a variation on how entrepreneurial thinking can lead to innovation in the construction sector. All cases which have been selected occur in a technical environment. Studying such a diverse set cases offers a firmer grounding of theory than studying a more homogeneous one (Harris & Sutton, 1986). The study required that studied firms were willing to grant interviews. The following practical factors were also taken in account: Dutch and English stakeholders and sufficient access to the information of the cases.

4.2 Evaluation of measurement models

Independent variables

Based on the literature review, effectuation items have been contrasted with causation items. Based on the research of Brettel, Mauer, Engelen, & Kupper (2012) we used a six-point Likert scale to measure whether there was a preference for an effectual or causal approach in the examined innovation project case. Brettel et al. used a 6-point Likert scale because since effectuation is a comparatively novel theme for practitioners, it was important to force respondents to contemplate their preferences and forcing the respondents to choose one side of the continuum. Brettel et al. describes that these scales do not measure the kind of approach (effectual vs. causal) independently from each other, but the forced choice items rather cover the degree of differences between two extremes, ranging from effectual to causal dimensions in this case. The first dimension, mean-driven vs. goal-driven, contains six items ($\alpha=.90$). The second dimension, affordable loss vs. expected returns contains five items ($\alpha=.86$). The third dimension, partnerships vs. competitive market analysis contains two items ($\alpha=.82$). The fourth dimension, acknowledge the unexpected vs. overcome the unexpected contains seven items ($\alpha=.86$). The items are described in the interview script Appendix 1.

Dependent variables

The items of the success evaluation are based on the research of Blindenbach-Driessen & van den Ende, 2006.

Moderators

The items of the innovativeness dimensions are based on the research of Danneels & Kleinschmidt (2001). The technological innovativeness are based on three items and the market innovativeness are based on four items. These measures were specified as formative.

4.3 Data collection

We relied on two primary data sources: interviews with leading experts of corporate and executives of start-ups. The interviews were semi-structured, confidential conducted with founders or key executives -entrepreneurs- of project-based start-ups in the construction sector in the Netherlands. These individuals were chosen because of their extensive knowledge of the R&D projects, firm's history, individual goals, knowledge and skills, start-up process, R&D process and environmental conditions. A total of four interviews were conducted to examine research sub-question 3. The interviews were tape-recorded and transcribed and lasted between 45 minutes and two and a half hours. Data collection continued using a second primary data source were semi-structured, confidential interviews conducted with key leading experts which contribute, have interest in, or have knowledge of the R&D projects in project-based corporate firms. In total four interviews with stakeholders were conducted and transcribed to examine research sub-question 4. The interviews were also tape-recorded and lasted between 45 minutes and two and a half hours. The interview guide had four main sections. The first section was composed of open-ended questions that enabled the informants to provide a broader view of organisation and their R&D strategy. The second section focused on the degree of innovativeness and newness of the R&D project. Since we expected that the use of effectuation process has a positive impact on the R&D project success in radical innovation projects we mostly selected radical innovation projects to examine the use of effectuation. The third section was composed of open-ended questions on specific use of effectuation and causation during the innovation project. The last section focused on success of the innovation project. The interviews were collected between May and June 2016. As secondary data source, we also examined multiple corporate publications and internet sources about the innovation and the launching pad of the cases.

4.4 Data analysis

Unlike hypothesis-testing research, inductive researches lacks a generally accepted model for its central creative process. The danger is that investigators reach premature and even false conclusions, as a result of information processing biases. Therefore, the key to good cross comparison is counteracting these tendencies, by looking at the data in many divergent ways (Eisenhardt, 1989). This is why triangulation with data collected from multiple sources was applied. In the absence of a standard, the following approach was used: After collecting data from the interviews with start-up entrepreneurs, interviews with leading experts of corporates and examined multiple corporate publication and internet sources, we began with an in-depth analysis of each case through the lens of the research question: *"How can effectuation lead to innovation in project-based firms in the construction sector in the Netherlands"*. This tactic of in-depth analyses exploits the unique insights, possible from different types of data collection. When a pattern from one data source is corroborated by the evidence from another, the finding are stronger and better grounded.

As a second tactic we turned to cross-case analysis. We selected cases with different causal or effectuation approaches and to list the similarities and differences between each group. This tactic forces to look for the subtle similarities and differences between the innovation processes. We used the propositions based on the literature review to analyze each of the

types separately. For each case we analyzed the data for patterns effectuation, which could lead to innovation in project-based firms. Finally the data outcome from the start-up cases and the corporate cases was explicitly compared.

5 Results

This chapter describes the results of the conducted case studies of the examined R&D projects. Section 5.2 until 5.9 describes the results of the in-depth analyses of the separate cases. Section 5.10 describes the results of the cross-case analyse and evaluate, the propositions as described in section 3.6, based on the literature review.

5.1 Cases of R&D projects in PBF

To gain knowledge on how effectuation can lead to innovation in PBF, eight semi-structured interviews of start-ups and corporate firms were conducted. Table 3 gives an overview of the organisation, R&D project, the interviewees and experience in execution of projects. Appendix 3 gives an in-depth overview of the firm characteristics and the firm strategy.

Organization	Innovation project	Type of Organization	Number employees	organization provide product or	Experienced in the execution of projects
BLOC	The Dutch WindWheel	Start-up	8	Both (80% service and 20% products)	especially in new product and new service development projects, or R&D projects
Studio RAP	Building with robotcs	Start-up	5	producing and software)	especially in new product and new service development projects, or R&D projects
Physee	Power Window	Start-up	9	services (in the near future)	especially in new product and new service development projects, or R&D projects
XYZ-Builders	Using drones in the building process	Start-up	5	Both (mainly services a few products)	especially in new product and new service development projects, or R&D projects
Heijmans	Heijmans One	Corporate	6582	Both (70% products and 30% services)	predominant operatiol process is executing projects
Advin	De circulaire weg	Corporate	170	Services	predominant operatiol process is executing projects
SPIE	Spie Simple	Corporate	38.000	Both (mainly services a few products)	predominant operatiol process is executing projects
Dura Vermeer	Vlotterkering	Corporate	2500	Both	predominant operatiol process is executing projects

Table 3: Firm characteristics

5.2 The Dutch Wind Wheel – BLOC

BLOC is currently developing The Dutch Wind Wheel. The Dutch Wind Wheel is a unique landmark for the skyline of the city of Rotterdam. The state-of-the-art design consists of two of three-dimensional rings. The outer ring houses 40 rotating cabins on a rail system, the inner ring is a innovative windmill housing a top class panorama restaurant, sky lobby and hotel, apartments and commercial functions in the plinth. It is the dynamic showcase for Dutch Clean Technology and provides a continuous platform to demonstrate the latest technical and technological innovations. The pioneering wind turbine converts wind energy with a framework of steel tubes into electricity without moving mechanical parts (Mi-Ho, 2015).

Dimension 1: Preference for means vs. goals

The R&D project was mostly specified on the basis of given means/resources. The target of the R&D project “The Dutch Wind Wheel” was vaguely defined in the beginning. BLOC only defined that the DWW needed to be a highly innovative building with the latest technologies implemented. The project began with a simple analyse of Rotterdam and the economical position in of the City. They had found that Rotterdam didn’t had a iconic builder which could attract cruise ships which normally didn’t stop off in Rotterdam. They though Rotterdam needed some kind of London Eye. Then they came up with the idea that this icon should be the most sustainable and technological advanced building of the world. By framing and exaggerating this idea the international media picked it up and parties were interested in joining the development process. The project target has been deliberately kept open so the ownership of the idea could be broadened. BLOC provides a ecosystem of innovation the technological innovation have to come from the other partners.

Given means/resources have been the starting point for the project. The main resources where the competencies of skilled employees which had the know-how about how they had to bring the innovation to the market as well as a great network to organize the process and getting commitment of the proper partners. Further required means/resources have been determined on the basis of given project targets although those targets were loosely defined. Graaff explained that they have reached out to the companies who could add means/resources like specific knowledge to contribute to the given project target. But in general rather given means than concisely given project targets have been the starting point of the project.

Dimension 2: Preference for affordable loss vs. expected returns

Considerations about potential returns were decisive for the selection of the R&D options but not based on calculations of expected. Graaff claims that it is more a gut feeling that in the end the investments are worth it. The selection of the R&D-options was mostly based on a minimization of risks and costs. BLOC knows exactly how much money is spend on the projects on this moment. The most partners of the innovations project entered the project basis on affordable loss criteria. The invested In kind with mostly man-hours.

Dimension 3: Preference for partnerships vs. competitive market analysis

BLOC tried to reduce risks of the R&D project through external partnerships and agreements. Their focus was rather on the reduction of risks by approaching potential partners and customers than early identification of the risks through market analyses.

Dimension 4: Preference for acknowledge the unexpected vs. overcome the unexpected

The R&D process of the DWW was flexible enough to be adjusted to new findings. The project target was to create a highly distinctive innovative sustainable building in combination with a new development process. This is still the main target but the technology and techniques are constantly changing during the R&D process. So new R&D findings influence didn't the project target but was flexible enough to integrate surprising result and finding.

The project planning was carried out in small steps during the project implementation. The project planning was the guidance, but very global. BLOC only made a planning until the next phase of the project development process. At the beginning of the project they have defined the different phases during the development of the project. During executing the global planning the project team takes short sprints to global milestones. In the upcoming three months until the global milestone, there could be new insights that change the project planning or even the project target. For the achieved milestone they make a new sort planning until the next milestone. Graaff explained that they use the scrum technique but at major project level. Despite of potential delays in project execution the process was flexible and took advantage of opportunities as they arose. The R&D process is set up to find new opportunities. The process dynamics and output are leading for the project pace.

BLOC used potential setbacks or external threats as advantageous as possible but used upfront market analyses to avoid setbacks or external treats as well. By doing upfront market analyses of the city of Rotterdam and how to cope with municipalities the project strategy was set up. The setback that the municipality of Rotterdam didn't want to cooperate in a specific phase was a trigger to gather specific partners and research institutes onboard to make it a market initiative. Also the municipality of Rotterdam found the idea interesting. Due to those partners the initiative is now stronger.

Means	●	Goals
Affordable loss	●	Expected returns
Partnerships ..	●	Market analysis
Acknowledge		Overcome
unexpected	●	unexpected

R&D project success

Since the R&D project is not yet finalized, it is difficult to value the achieved project success. Table 4 shows the validation of the project success. Based on the validation of Graaff, the R&D project success is very high in comparison to other projects.

R&D project success	● ● ● ● ● ●
As a consequence of this project the reputation of our organization in the area related to this project is increased	● ● ● ● ● ● ●
The new or improved product / service provides us a competitive advantage	● ● ● ● ● ● ●
The new or improved product / service fulfils the needs of the clients	● ● ● ● ●
The new or improved product / service is of excellent (technical) quality	● ● ● ● ● ● ●
All project targets were met	● ● ● ● ● ● ●
Knowledge and experienced gained by the project members is of large value for subsequent development projects	● ● ● ● ● ● ●
The knowledge gained on this project is well secured in our organization	● ● ● ●
The project-team can be very satisfied with the final results.	● ● ● ● ● ● ●

Table 4: R&D project success The Dutch Wind Wheel

Degree of newness

BLOC didn't possess the required technological know-how at the beginning of the R&D process of the Dutch Wind Wheel. Because it takes a lot of time processing DWW, BLOC and their partners want to work with the latest technologies. Those technologies are not yet developed today. But BLOC use existing technological competencies and experience during the project. Those means came from relationships with partners through R&D Networks. Graaf claims that the degree of novelty of the Dutch Wind wheel is very high compared to previous projects. The development of DWW aimed at many new customers for the organization. The DWW is completely new for the organisation. For customers of the organisation and the world the used technology is new as well. Table 5 shows the validation of the project newness. Based on the validation of Graaff, the R&D project newness is very high in comparison to other projects.

Degree of newness			
Technological innovativeness	Innovativeness low	● ...	Innovativeness high
Market innovativeness	Innovativeness low	● ...	Innovativeness high
Newness of product or service	Newness low	● ...	Newness high

Table 5: Degree of newness DWW

5.3 Skilledin Office – Studio RAP

Studio RAP has developed the Skilledin Office. The Skilledin Office is an innovative indoor-office, built in the Innovation Dock (Rotterdam,NL) for the Port of Rotterdam. Its organic design balances program constraints and digital load-bearing optimization and fabrication possibilities. It's the first project in which they show the scalability of industrial robotic fabrication towards an architectural scale (Berendonk, 2016).

Dimension 1: Preference for means vs. goals

The R&D project was specified on the basis of given means/resources. The target of the R&D project was vaguely defined in the beginning. Starting the project RAP only had a vision on how the end result could look like. Given means/resources have been the starting point for the project. RAP could test there hypotheses, because they could loan a robot from a company specialized in second-hand robots. RAP was developing software that was affordable for companies with a low budget. The supplier of the second-hand robots was interested in the software, because the low costs would match with the market of low priced second-hand robots. Trough this cooperation RAP was able to use the robot free of charge and the supplier of the second-hand robots could sell those robots including the software, whereby the use of robots including good software was affordable for small and medium enterprises (SME). Rather given means, than concisely given project targets, has been the starting point for their project. The access to the robot was the starting point for the project of studio RAP. This is why the project specification was predominantly based on given resources.

Dimension 2: Preference for affordable loss vs. expected returns

Considerations about potential losses were decisive for the selection of the R&D option. New product development for a start-up is only costing money. RAP has only invested based on a vision that the execution of the project was valuable for the company. Decisions on capital expenditures were primarily based on potential risks of losses. In the end the company didn't earn any money with the project. It only lead to a lot of exposure and potentially worldwide orders. Project budgets were approved on the basis of considerations about acceptable losses. At the beginning of the project they decided what they could maximum lose with this project. The selection of the R&D-option was mostly based on a minimization of risks and costs, because they had to stay within their budget. That is the reason they couldn't go all the way.

Dimension 3: Preference for partnerships vs. competitive market analysis

RAP reduced risks of the R&D project through external partnerships and agreements. RAP didn't do any market or competitor analyses. For example through a partnership with a wood supplier they could get the building materials for a reduced price. Through a partnership with a supplier of second-hand robots they were able to test the software and to start the production. They always try to partner for specific resources. They just started a partnership for concrete printing. The focus of RAP was rather on the reduction of risks by approaching potential partners. They didn't approach any consumers yet, but in the near future they will approach customers as well.

Dimension 4: Preference for acknowledge the unexpected vs. overcome the unexpected

During the execution of the project, the project team had a preference for acknowledge the un expected. New R&D findings influenced the project target a little bit. The project was a continuously quest to new findings, which could influence the project target. The project planning was carried out in small steps during the project implementation. The employees of RAP did make a project planning, but they didn't make any sense. They had to make long working hours to deliver the project on time. Despite of potential delays in project, execution of the project was flexible and they took advantage of opportunities as they arose. At the

beginning of the project the project team didn't know where they would end up. Potential setbacks or external threats were used as advantageous as possible. An example of a setback used as advantage was that while programming the robot, the robot movements didn't work as planned. All the failed tests of the robot movements lead to possible solutions of making other specific parts.

Means ..● ..	Goals
Affordable loss ..● ..	Expected returns
Partnerships ..● ..	Market analysis
Acknowledge	Overcome
unexpected ..● ..	unexpected

R&D project success

Table 6 shows the validation of the project success. Although Studio RAP didn't make any money with the project, based on the validation of Berendonk, the R&D project success is very high in comparison to other projects.

R&D project success	● ● ● ● ●
As a consequence of this project the reputation of our organization in the area related to this project is increased	● ● ● ● ● ● ●
The new or improved product / service provides us a competitive advantage	● ● ● ● ● ● ●
The new or improved product / service fulfils the needs of the clients	● ● ● ● ●
The new or improved product / service is of excellent (technical) quality	● ● ● ● ● ● ●
All project targets were met	● ● ● ● ● ● ●
Knowledge and experienced gained by the project members is of large value for subsequent development projects	● ● ● ● ● ● ●
The knowledge gained on this project is well secured in our organization	● ● ● ●
The project-team can be very satisfied with the final results.	● ● ● ● ● ● ●

Table 6: R&D project success Skilledin Office

Degree of newness

Studio RAP did possess a little of the required technological know-how at the beginning of the R&D project. Berendronk explained that he didn't have the know-how how to program a robot, so he managed to learn it himself. He had to learn how to write the algorithms. Studio RAP didn't have any practical experience in the application of the required technological competencies and the technological know-how of using robotics for the production process of parts of a building. The degree of novelty of the R&D project was very high compared to previous products states Berendonk. Wood has been used to build things for centuries, but the application of wood in combination with robotics is completely new. Because Studio RAP is a start-up, they aimed at many new customers with this project. Berendronk explained that a lot of the marketing of the company is based on word of mouth advertising. RAP has modified a mill to the robot, which enables them to make some short-term money. The goal of the company is to make more and larger projects. This product is new for the organization, current customers of the organization, the target customers and the world says Berendonk. The used technology of milling in combination with robotics is already being used in other industries. Table 7 shows the validation of the project newness. Based on the validation of Berendonk, the R&D project newness is very high in comparison to other projects.

Degree of newness			
Technological innovativeness	Innovativeness low	●...	Innovativeness high
Market innovativeness	Innovativeness low	●...	Innovativeness high
Newness of product or service	Newness low	●...	Newness high

Table 7: Degree of newness Skilledin Office

5.4 Power Window – PHYSEE

PHSYEE is currently developing the Power Window. PowerWindows are patented and transparent double-paned windows that convert light into electricity. Conventional glass reflects about 30% of the incoming light, instead they collect that with the coating, transport it through the glass and convert it into electricity with solar cells inside the window frame (Grapperhaus, 2016).

Dimension 1: Preference for means vs. goals

The R&D project was specified on the basis of given means/resources. The target of the R&D project “Power Window” was vaguely defined in the beginning. PHYSEE knew that they wanted to develop a sustainable innovation, without any compromises. They didn’t even know who their customers should be. Developing the Power Window given means and resources has been the starting point for the project. During their research conducted at the department of Radiation, Science & Technology (RST) at the Delft University of Technology ,they found that there are materials that absorb and emit light, which they could convert to a coating. The process converged towards a project target on the basis of given means/resources.

Dimension 2: Preference for affordable loss vs. expected returns

At the beginning of the project considerations about potential losses were decisive for the selection of the R&D option. Grapperhaus argues that when starting a company you have nothing to lose. Grapperhaus explained that there is a lot of money involved with R&D of a new product. You never know if the investment will be recovered. Grappenhaus argues that project-based corporations should reserve a small percentage of the project budget for innovations. This enables the project teams to focus on innovations, instead of focussing only at the operational process and this provides start-ups an opportunity to apply their innovation.

Project budgets were approved on the basis of considerations about expected returns. Corporations and investors want to know how much is invested and what the expected returns are. In the end PHYSEE made a business plan including ROI, where they calculated the expected returns. The selection of the R&D-options was mostly based on analyses of future returns. During the R&D process they focused on the greatest possible power output. They calculated which power output resulted in a feasible and good business case. That is why decisions on capital expenditures were primarily based on potential returns.

Dimension 3: Preference for partnerships vs. competitive market analysis

PHYSEE tried to reduce risks of the R&D project through internal or external partnerships and agreements. PHSEE has a partnership with ASW, a supplier of window frames and with OVG, a real estate developer of offices. Grapperhaus argues that without the partnerships PHSEE couldn’t exist. Grapperhaus explained that they only enter into a partnership when partners add value. He claims that the most corporations who want to start a partnership in order to get media attention. PHSEE was very strict in selecting their partners. OVG was chosen because they are leading in the development of sustainable offices in the

Netherlands. OVG is now the launching costumer of the Power Window. A launching costumer helps the development of the product and creates trust in the new product. PHYSEE and OVG are going to test the Power Window during the development of the office of Rabobank Eindhoven. PHYSEE is responding to the market demand that in 2020 all buildings in the Netherlands have to be energy neutral. The focus of PHYSEE was on the reduction of risks, by approaching potential partners and customers. The partnerships with potential customers like OVG are aimed to supply the product and making money. The partnerships with other suppliers aim to test the market without owning all the resources.

Dimension 4: Preference for acknowledge the unexpected vs. overcome the unexpected

They always tried to integrate surprising results and findings during the R&D process — even though this was not necessarily in line with the original project target. Their R&D process was flexible enough to be adjusted to new findings. New R&D findings are constantly influencing the project target. Grapperhaus believes that is the strength of a young company. PHYSEE is using the scrum methodology as project planning. The project planning is carried out in small steps during the project implementation. Flexible planning provides the possibility to pivot the plan quickly. For the project development they use LEAN start-up methods as well. This enables us to test different R&D options, until they meet the perfect requirements. Despite of potential delays in project execution, the innovation process of PHYSEE was flexible and took advantage of opportunities as they arose. The partner OVG is able to think along in this process. When the power window is not ready for daily use at the completion of the construction project, they change the power window a day before completion for regular glass. Potential setbacks or external threats are being used as advantageous as possible. For example: The original materials which they used for creating the coating was not accepted by the industry. They are now working on a new coating. This coating is in terms of transparency and aesthetic a great leap forward.

Means ..●.....	Goals
Affordable loss●.....	Expected returns
Partnerships ..●.....	Market analysis
Acknowledge	Overcome
unexpected ..●.....	unexpected

R&D project success

Since the R&D project is not yet finalized it is difficult to value the achieved project success. Table 8 shows the validation of the project success. Based on the validation of Grapperhaus, the R&D project success is very high in comparison to other projects.

R&D project success	●●●●●●●
As a consequence of this project the reputation of our organization in the area related to this project is increased	●●●●●●●
The new or improved product / service provides us a competitive advantage	●●●●●●●
The new or improved product / service fulfils the needs of the clients	●●●●●●●
The new or improved product / service is of excellent (technical) quality	●●●●●●●
All project targets were met	-
Knowledge and experienced gained by the project members is of large value for subsequent development projects	-
The knowledge gained on this project is well secured in our organization	●●●●●●●
The project-team can be very satisfied with the final results.	-

Table 8: R&D project success Power Window*Degree of newness*

PHYSEE didn't have the required technological know-how at the beginning of the R&D project. For example they didn't have enough knowledge of the chemical principles of the coating. Therefore they involved someone with this knowledge. PHYSEE didn't have any practical experience in the application of the required technological competencies and the technological know-how. The degree of novelty of the Power Window was very high in comparison to previous products. World Wide there are a few competitors who are doing research to power generating windows. But no one is using this specific coating. PHYSEE aimed at many new customers to their organisation with the Power Window. With the Power Window PHYSEE catered new customer needs that haven't been served before. The product is new for the organization, current customers and target customers of the organisation and the world. The used technology is new as well.

Table 9 shows the validation of the project newness. Based on the validation of Grapperhaus, the R&D project newness is high in comparison to other projects.

Degree of newness			
Technological innovativeness	Innovativeness low	● ...	Innovativeness high
Market innovativeness	Innovativeness low	● ...	Innovativeness high
Newness of product or service	Newness low	● ...	Newness high

Table 9: Degree of newness Powerwindow

5.5 Using drones in the building process – ZXY Builders

ZXY Builders developed the ZXY Cloud platform for capturing aerial data, using autonomous drones. ZXY Cloud scans sites on a daily basis and sends the data to a secure cloud portal for immediate use. ZXY Cloud is used in construction, energy, utilities and governmental applications.

Dimension 1: Preference for means vs. goals

Their R&D project was specified on the basis of given means/resources. When ZXY-builders start to use drones in the building process, the target was vaguely defined in the beginning. Given means/resources has been the starting point for the project. The whole drone industry is mean driven. Entrepreneurs buy a drone and then try to figure out how they can use them. The process converged towards a project target on the basis of given means/resources. Verver explained that they had bought a drone before they had figured a business plan. But they had a gut feeling that they were going to arise growing markets. This is more a vision than a project target.

Dimension 2: Preference for affordable loss vs. expected returns

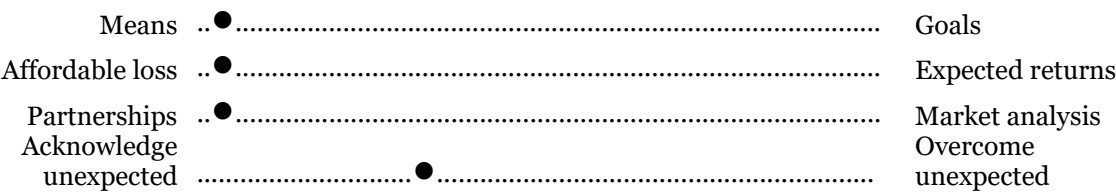
Verver explained that considerations about potential losses were decisive for the selection of the R&D option. ZXY-builders recently placed an order for an expensive drone. These decisions were approved on the basis of considerations about acceptable losses. They had a total budget for various expenses. This investment was included in the calculation of the expenses, which meant that other expenses couldn't be made. The selection of the R&D-option was mostly based on a minimization of risks and costs because potential returns are difficult to estimate at this point in time.

Dimension 3: Preference for partnerships vs. competitive market analysis

ZXY-builders tried to reduce risks of the R&D project through internal or external partnerships and agreements. Verver claims that they work with partners every day. They

recently started a partnership with an inspection company. With this partnership they can combine the knowledge of drones and software with the intrinsic knowledge of the market of inspections. In advanced they made arrangements about the commitment of the partners. This is primarily based on trust, but on contracts as well. ZXY-builders didn't made market analyses up front. Their focus was rather on the reduction of risks by approaching potential partners and customers. Verver argues that he wants to make more market analyses about small and big competitors and what their business models are. But in practice it is difficult to obtain this information and outsourcing of market analyses is expensive.

Dimension 4: Preference for acknowledge the unexpected vs. overcome the unexpected
Verver claims they always try to integrate surprising results and findings during the R&D process – even though this is not necessarily in line with the original project target. For example if they want to scan inside a building by using the photogrammetric technology. By flying with a drone and making a lot of photos the inside of the building could be mapped. This process lead to many technical problems. A project leader had an old scanner in the attic and he suggested to use the scanner simultaneously with the drone. This lead to a new process innovation. This method is now a common practice. The R&D process was flexible enough to be adjusted to new findings. Potential setbacks or external threats were used as advantageous as possible. New R&D findings influenced the project target. Verver explained that they have to plan their projects, because there is a limited time of flying with the drones on the projects. This planning is only based on practical applicability, not on bureaucracy. Despite of potential delays in the project execution they were flexible and took advantage of opportunities as they arose



R&D project success
Table 10 shows the validation of the project success, based on the validation of Verver the R&D project success is very high in comparison to other projects.

R&D project success	● ● ● ● ●
As a consequence of this project the reputation of our organization in the area related to this project is increased	● ● ● ● ● ● ●
The new or improved product / service provides us a competitive advantage	● ● ● ● ● ●
The new or improved product / service fulfils the needs of the clients	● ● ● ●
The new or improved product / service is of excellent (technical) quality	● ● ● ● ● ●
All project targets were met	● ● ● ● ● ●
Knowledge and experienced gained by the project members is of large value for subsequent development projects	● ● ● ● ● ● ●
The knowledge gained on this project is well secured in our organization	● ● ● ● ●
The project-team can be very satisfied with the final results.	● ● ● ● ● ●

Table 10: R&D project success using drones in the building process

Degree of newness

ZXY-builders did possess the technological know-how for most part, at the beginning of the R&D project. Verver learned this knowledge just by doing projects and from other people. Verver did have practical experience in the application of the required technological competencies and the technological know-how, in particular with the software development part. Verver and his partners had a background in software development. ZYX-builders could use existing technological competencies and experience during the project. The degree of novelty of the R&D output of using drones in the building process, is very high in comparison to previous products stated Verver. The market is new, as well as the technology and the governmental rules are new. The use of drones during the building process aimed at many new customers to the organisation. ZXY-Builders has conducted several pilots of using a drone in the building environment. They have mapped the site in several projects with air photos, movies and 3D models by using drones. It appeared that there was a great need for mapping the sites before the start of constructions. The product is new for the organization, the current customers and the target customers, as well for the world stated Verver. The used technology is new as well. Table 11 shows the validation of the project newness. Based on the validation of Verver, the R&D project newness is high in comparison to other projects.

Degree of newness			
Technological innovativeness	Innovativeness low	... ●	Innovativeness high
Market innovativeness	Innovativeness low ● ...	Innovativeness high
Newness of product or service	Newness low ● ...	Newness high

Table 11: Degree of newness using drones in the building process

5.6 Heijmans One – Heijmans

Heijmans has developed the Heijmans One. The Heijmans-ONE is a moveable single-occupancy house. Heijmans ONE intelligently combines the shortage of good temporary rental housing and the dreary sight of empty areas. Heijmans ONE is a complete home that is placed temporarily in empty urban areas. It has all the necessary facilities, such as a kitchen, bathroom, large living room with an open space, a separate bedroom and its own front door with an outside patio. Heijmans ONE is developed for single households between the ages of 25 and 35 which earn too much for social housing and too little for the free rental sector. Pre-fabrication means the Heijmans ONE can be realized and re-used fast and placed within a day. Because of the temporary use of the Heijmans ONE the product is circular. The homes are also extremely energy-efficient, thanks to the solid wooden skeleton, the all-electric use and generation of own energy (Hofmann, 2015).

Dimension 1: Preference for means vs. goals

The R&D project was specified on the basis of given means/resources. The target of the R&D project “Heijmans-One” was vaguely defined in the beginning. The target aimed at target groups and their needs not on the movability. The starting point of vaguely defined targets is often motivated by social transformations. Given means/resources have been the starting point for Heijmans One. Due to financial resources, the technical skills of the employee’s and the existing knowhow, Heijmans One was developed in the organisation, whereby the process converged toward a project target on the basis of those given means/resources. The project specification was predominantly based on given resources, but the longer the project took, the more specific the resources that been needed became clear. The stage-gat principles have been used to get the project target and the necessary means clear though time.

Dimension 2: Preference for affordable loss vs. expected returns

Both considerations about potential losses and potential returns were decisive for the selection of the R&D options. Project budgets were approved on the basis of considerations about whether they would fit within the innovation strategy and the belief and chances of success, as well as the calculations of expected returns. Koolen argues that preference for affordable loss or expected returns depending on the degree of newness of the innovation. When there is a high degree of newness, it is difficult to estimate the potential yield. Heijmans established a budget for the development of Heijmans One, by using both methods in different phases of the project. This is why decisions on capital expenditures were primarily based on potential risks of losses and potential returns, depending on the specific stage-gate.

Dimension 3: Preference for partnerships vs. competitive market analysis

Heijmans tried to reduce risks of the R&D project through partnerships. Heymans is often approached by partners because they have an integrated role in the building process and an innovative image. When an innovation idea is not ready for development, Heymans sends the idea to Spark. Spark is an open innovation, located at the TU Eindhoven. Spark is a partnership between TU Eindhoven, Avans, the province and Heijmans, for new idea creation and start-ups. Heijmans is often approached by Start-ups with new ideas. For the development of Heijmans One, Heijmans focus was rather on the reduction of risks by approaching potential partners. Heijmans entered several partnerships for the development of Heijmans One, including architects and suppliers like Eneco, Hamwell, Dus Architecten, Zown (start-up Aliander), BMW and University of Tilburg. At this moment Heijmans is testing the Heijmans One on a temporary innovation-campus in Amsterdam.

Dimension 4: Preference for acknowledge the unexpected vs. overcome the unexpected

Heijmans always tried to integrate surprising results and findings during the R&D process of Heijmans One— even though this was not necessarily in line with the original project target. Heijmans One was intended to sell to institutional investors. When it turned out that there were no investors interested, Heijmans switched their focus on selling their product to private homeowners. Those setbacks and external threats were used as advantageously as possible. New R&D findings influenced the project target. Heijmans incorporated an energy roof, which collects not only electrical energy, but also heat. The inclusion of this separate R&D project has moved the project target towards making housing of the future.

The R&D process was flexible enough to be adjusted to new findings. Koolen claims that they make a project planning and don't stick to it, because things don't always turn out to be as planned. Within Heijmans innovation, projects are managed by the same project leaders as the operational projects. Those project leaders have experience with managing innovation projects. As a result they are capable of managing the innovation project, without trying to control the process in a conventional way. The project planning was carried out in small steps during the project implementation, by using the stage-gate method. When an innovation project is ready to bring to the market, the project can be planned in a more conventional way.

Means ..● ..	Goals
Affordable loss ..● ..	Expected returns
Partnerships ..● ..	Market analysis
Acknowledge	Overcome
unexpected ..● ..	unexpected

R&D project success

Table 12 shows the validation of the project success, based on the validation of Koolen the R&D project success is very high in comparison to other projects.

R&D project success	● ● ● ● ●
As a consequence of this project the reputation of our organization in the area related to this project is increased	● ● ● ● ● ●
The new or improved product / service provides us a competitive advantage	● ● ● ● ●
The new or improved product / service fulfils the needs of the clients	● ● ● ● ● ●
The new or improved product / service is of excellent (technical) quality	● ● ● ● ●
All project targets were met	● ● ● ● ●
Knowledge and experienced gained by the project members is of large value for subsequent development projects	● ● ● ● ● ● ●
The knowledge gained on this project is well secured in our organization	● ● ● ● ● ● ●
The project-team can be very satisfied with the final results.	● ● ● ● ●

Table 12: R&D project success Heijmans One

Degree of newness

At the beginning of the R&D project “Heijmans One”, Heijmans possessed the required technological know-how. But they added new products like integrated PV panels to the project. Heijmans did have field experience in the application of the required technological competencies and technological know-how. Heijmans could use existing technological competencies and experience during the project. Koolen argues that during the development of innovation projects the technological know-how is not the issue, but to come up with a new business model innovations, which lead to new earning models. The degree of novelty of the R&D project was in terms of technology not very high, but in terms of market innovativeness very high compared to previous projects stated Koolen. Koolen claims that bringing together a number of new developments has been the greatest innovation. The main innovation was bringing together derelict land with temporary housing and residents with a low income, who did not qualify for social housing. The R&D output aimed at many new customers for the organisation. The customers were the landowners of derelict land and potential residents with a low income. The product was new for the organization, new for the current customers of the organization and the target customers, but not new for the world and there were no new technologies used. Table 13 shows the validation of the project newness. Based on the validation of Koolen, the R&D project newness is high in comparison to other projects.

Degree of newness			
Technological innovativeness	Innovativeness low	... ●	Innovativeness high
Market innovativeness	Innovativeness low ● ...	Innovativeness high
Newness of product or service	Newness low ●	Newness high

Table 13: Degree of newness Heijmans One

5.7 The Circular Road – Advin

Advin has developed The Circular Road. The circular road is a collaboration of founders from various organizations, who have connected their innovation projects into a total concept, which lead to a system revolution. The circular road delivers accessibility and availability. To build the road there are less materials needed in comparison to a traditional road with the same quality. The road consists of a top layer of Luminumpave. The ‘white’ roads could save up to 50 percent of the public illumination currently necessary. “This could mean enormous

energy saving and corresponding reduction of CO₂ emissions if this is administered. Luminumpave would also contribute to a reduction in temperature on hot days in intra-urban areas. The road is illuminated by led lights with solar panels. The road consists of an innovative green strip (van den Valk, 2016).

Dimension 1: Preference for means vs. goals

The R&D project was specified on the basis of given means/resources. The target of the R&D project was vaguely defined in the beginning of the project. The project target was mainly about the old business model of how to save cost but at the end it was about delivering added value. Given means/resources have been the starting points for the project. The project targets only came later. The process converged towards a project target on the basis of given means/resources. Van den Valk started by approaching partners. Because their company is known as reliable, people want to work with them. So rather given means, than concisely given project targets, has been the starting point for their project.

Dimension 2: Preference for affordable loss vs. expected returns

Considerations about potential losses were decisive for the selection of the R&D option. By internal lobbying they could get a budget to start the innovation. Van der Valk claims that by investing in innovation, project considerations about expected returns had to be taken into account. This could mean money, but exposure and social benefits as well. Project budgets were approved on the basis of considerations about acceptable losses and the expected results of the R&D project. They must achieve monthly results in order to get the budget. The R&D project provides step-by-step results. Decisions on capital expenditures were primarily based on potential risks of losses.

Dimension 3: Preference for partnerships vs. competitive market analysis

Advin tried to reduce risks of the R&D project through internal or external partnerships and agreements. Advin's focus was rather on the reduction of risks by approaching potential partners and customers. The R&D project was started because there was a vision of success, not through market analyses. Many innovations are being approached from the technical part, with the result that the market is not always interested.

Dimension 4: Preference for acknowledge the unexpected vs. overcome the unexpected

Advin always tried to integrate surprising results and findings during the R&D process — even though this was not necessarily in line with the original project target. The R&D process was flexible enough to be adjusted to new findings. They had found that with the use of a different surface, they could reduce the thickness of the asphalt with nine centimetres, which resulted in big cost savings. This led to an enormous energy boost in the team. The project planning was carried out in small steps during the project implementation. Van den Valk argues that the result is more important than the achieving of milestones in time. Despite of potential delays in project execution, they were flexible and took advantage of opportunities as they arose. Potential setbacks or external threats were used as advantageous as possible. As an example: One of the partners did not respect the agreements, what made them untrustworthy. By solving the problem and communicating, the team spirit was increased.

Means ..●	Goals
Affordable loss ..●	Expected returns
Partnerships ..●	Market analysis
Acknowledge	Overcome
unexpected ..●	unexpected

R&D project success

Table 14 shows the validation of the project success. Based on the validation of van den Valk the R&D project success is high in comparison to other projects.

R&D project success	● ● ● ●
As a consequence of this project the reputation of our organization in the area related to this project is increased	● ●
The new or improved product / service provides us a competitive advantage	● ● ● ● ● ●
The new or improved product / service fulfils the needs of the clients	● ● ● ●
The new or improved product / service is of excellent (technical) quality	● ● ● ● ● ●
All project targets were met	● ● ● ● ● ●
Knowledge and experienced gained by the project members is of large value for subsequent development projects	● ● ● ● ●
The knowledge gained on this project is well secured in our organization	● ●
The project-team can be very satisfied with the final results.	● ● ● ● ●

Table 14: R&D project success The Circular Road

Degree of newness

Van den Valk didn't possess the required technological know-how at the beginning of the R&D project. This had the advantage that he didn't saw any obstacles in order to carry out the project. Van der Valk did possess some practical experience in the application of the required technological competencies and the technological know-how. Advin could use existing technological competencies and experiences during the project. They already gave advice on building roads. By linking existing knowledge and networks van den Valk created a better proposition stated van den Valk. The degree of novelty of the R&D output was not very high compared to their previous products. It was the combination of all innovative products in the road that made it innovative. The R&D output aimed at many new customers to the organisation. The product was not new for the organization. The product is new for current customers and target customers, like governments and the end-user. Table 14 shows the validation of the project newness. Based on the validation of van der Valk, the R&D project newness is very high in comparison to their other projects.

Degree of newness			
Technological innovativeness	Innovativeness low	... ●	Innovativeness high
Market innovativeness	Innovativeness low ●	Innovativeness high
Newness of product or service	Newness low ●	Newness high

Tabel 15: Degree of newness The circulair road

5.8 SPIE Simple – SPIE

SPIE has developed SPIE simple. SPIE simple is a computerized maintenance management system. This system detects disturbances of installation in systems of customers in buildings and other related equipment and links those to the nearest service mechanic. Managing the mechanics happens automatically through the system (Saman, 2016).

Dimension 1: Preference for means vs. goals

The R&D project of "SPIE simple" was mostly specified on the basis of given project targets.

The target of the R&D project was clearly defined in the beginning. The target came from the problems that occurred in the organization. Those principles and the project target was clear in the beginning of the project. Required means/resources have been determined on the basis of given project targets. In this case those were the existing project experiences of the obstacles which occurred at the users of service technicians and the speed of solving technical disturbances, as well as the monitoring of the number of disturbances of a system. Also the existing skills of employees and experts in the appropriate field of internal business processes and ICT knowledge have contributed to the success of the R&D project. In the case of SPIE the process simply converged towards a project target on the basis of given means/resources, instead of required means/resources having to be determined on the basis of given project targets. SPIE wanted to create a process improvement, not knowing at the beginning of the project how much it would yield. Afterward it became clear that when the previous situation was maintained, the cost of five thousand mechanics were much higher than the investment cost of the hours of the ICT employees of SPIE.

Dimension 2: Preference for affordable loss vs. expected returns

Considerations about potential returns were decisive for the selection of the R&D options. Project budgets were approved based on calculations of expected returns of improving the deployment of the mechanics. The cost of the ICT investment didn't outweigh the potential returns on improving the deployment of the mechanics. So the selection of the R&D options and the decisions on capital expenditures were primarily based on analyses of future potential returns.

Dimension 3: Preference for partnerships vs. competitive market analysis

Because SPIE Simple was an internal R&D project, there were only internal partnerships between the specific business units. There were no risks identified through market and competitors analyses. There were no external potential partners and customers approached.

Dimension 4: Preference for acknowledge the unexpected vs. overcome the unexpected

SPIE Simple has characteristics of both acknowledge the unexpected and overcome the unexpected.

In the beginning of the project the R&D team had made a functional description of how the end result would look like. At the end of the project about 90% of this description was realized. The other 10% were new findings and improvements of initial functional descriptions. Saman argues that 90% of the functional description was executed as planned, because the functional description was based on the practical experience of the R&D team. New or surprising results and findings were only integrated when the original project target was not at risk. Saman claims that innovation projects within SPIE in general are based on a spot on the horizon, which can change over time, due to new findings or social changes in time. This was not the case at the development of SPIE simple. But the R&D process was flexible enough to be adjusted to new findings, although the new findings did not influence the project target, whereby the project planning was carried out in small steps during the project implementation of SPIE simple. The R&D process was flexible enough to be adjusted to new findings. New R&D findings did not influence the project target. The project planning was carried out in small steps during the project implementation. Despite of potential delays in the project execution, the R&D team process was flexible and took advantage of opportunities as they arose. Potential setbacks or external threats were used as advantageous as possible. At the presentation of the first draft version of the program, the CEO was not convinced about the R&D result. The presentation was just to inform the CEO about which steps had been taken. This setback motivated the team to improve the R&D project, to prove it could be a enormous innovation for the company.

Means ..●	Goals
Affordable loss ..●	Expected returns
Partnerships ..●	Market analysis
Acknowledge	Overcome
unexpected ..●	unexpected

R&D project success

Table 16 shows the validation of the project success. Based on the validation of Saman the R&D project success is high in comparison to previous projects.

R&D project success	● ● ● ● ●
As a consequence of this project the reputation of our organization in the area related to this project is increased	● ● ● ● ● ● ● ●
The new or improved product / service provides us a competitive advantage	● ● ● ● ●
The new or improved product / service fulfils the needs of the clients	● ● ● ● ● ● ●
The new or improved product / service is of excellent (technical) quality	● ● ● ● ● ● ●
All project targets were met	● ● ● ● ● ● ● ●
Knowledge and experienced gained by the project members is of large value for subsequent development projects	● ● ● ● ● ●
The knowledge gained on this project is well secured in our organization	● ●
The project-team can be very satisfied with the final results.	● ● ● ● ● ● ● ●

Table 16: R&D project success SPIE Simple

Degree of newness

SPIE did possess the required technological know-how at the beginning of the R&D project. SPIE knew the process and that this process could be meaner and leaner. SPIE also possessed the required technological know-how and ICT skills to program this functions, without hiring consultants or starting a R&D team. SPIE had practical experience in the application of the required technological competencies. Saman had an ICT and business administration background, which he could use for the development of the project. SPIE simply aimed at new customers like Rijkswaterstaat, the province and the municipalities. The R&D output catered new customer's needs that had not been served before. The response time was reduced, compared to the number of disturbances. There were no new sales and distribution channels needed for SPIE simple. The service was not new for current customers and targeted customers of the organisation, but the customers noticed that the response time of the service was shortened. They haven't studied the market. In Saman's opinion the product was not new for the world. He thinks that by the time they developed the product, it could already have existed in Japan. The used technology was not new. Table 17 shows the validation of the project newness. Based on the validation of Saman, the R&D project newness is low in comparison to other projects.

Degree of newness			
Technological innovativeness	Innovativeness low	... ●	Innovativeness high
Market innovativeness	Innovativeness low ●	Innovativeness high
Newness of product or service	Newness low ●	Newness high

Table 17: Degree of newness Spie Simple

5.9 Vlotterkering – Dura Vermeer

Dura Vermeer has developed the Vlotterkering. Vlotterkering is designed to be a temporary water barrier, integrated into a dike or embankment that protects the land and its inhabitants from extreme water surges. Vlotterkering is a flexible barrier that closes automatically. It consists of a cement basin and a float with a steel panel lid on top that serves as the water barrier. When the Vlotterkering is not in use, the float rests in the cement basin integrated in the embankment (Jansen & Vermond, 2016).

Dimension 1: Preference for means vs. goals

The R&D project was specified on the basis of given project targets. For most innovations it depends on the project of the target of the R&D project is vaguely or clearly defined in the beginning. When people have a new idea for a product or service it's more clearly, but it is always an iterative process. They improve existing ideas continuously with their partners. The given project-targets have been the starting point of the innovation project. The target of innovation projects is usually making something smarter or sustainable. There are always projects where they want to use the new innovation. When the project target is defined, they seek together with their partners for the required resources, but always with the customer in mind. So required means/resources have been determined on the basis of given project targets.

Dimension 2: Preference for affordable loss vs. expected returns

Considerations about potential losses were mostly decisive for the selection of the R&D option. Vermeer explained that the margins in the construction sector are very low and as a result there aren't big R&D budgets. The innovations are mostly incorporated in operational projects. For example: Dura Vermeer has developed a crusher for break-stones on site so they didn't need to feed and discharge break-stones. The investment was made on the operational project budget. Vermeer argues that when they had made a business case, the investment wasn't made. Money is spent step-by-step during the optional processes. Investments on R&D projects are mostly made when the customer wants to pay the process. When a new innovation is applied, it is often considered whether the technology has already proven itself in the market or not. Sometimes you just have to do it. They will continue to innovate by corporation with partners and suppliers. The innovation of products and services are mainly based in chain cooperation and an integrated process approach. They want to stimulate the fact that suppliers of innovate products, incorporate their product in the operational project of Dura Vermeer. The selection of the R&D-option was mostly based on a minimization of risks and costs. But analyses for future returns are taken into account as well.

Dimension 3: Preference for partnerships vs. competitive market analysis

They tried to reduce risks of the R&D project through internal or external partnerships and agreements. Vermeer argues that there are companies who only collaborate with a start-ups to improve their innovations skills. But it takes more to be an innovative company. Their focus was rather on the reduction of risks by approaching potential partners and customers. It could be useful to test the product or service during the innovation process

with the customer. Vermeer argues that most costumers are open to improvements. It's a combination of creating internal and external support. In the organization of Dura Vermeer a R&D project must be quickly profitable.

Dimension 4: Preference for acknowledge the unexpected vs. overcome the unexpected

They always tried to integrate surprising results and findings during the R&D process — even though this was not necessarily in line with the original project target. The R&D process was flexible enough to be adjusted to new findings. New R&D findings influenced the project target. The development of a R&D project is an iterative process. Most R&D projects they execute are linking existing technologies. During the R&D project the project planning was carried out in small steps during the project implementation. Vermeer argues that planning according to predetermined criteria will stifle innovation. Vermeer claims that R&D projects need project managers with other skills, like creativity and collaboration, more than the operational projects. Vermeer argues that because they always executed projects for specific clients, with a highly differentiated and customized nature of demand and low margins, it is unlikely that they come up with a radical/disruptive innovation. They only execute R&D projects when a customer is willing to pay for it.

Means	●	Goals
Affordable loss ..	●	Expected returns
Partnerships ..	●	Market analysis
Acknowledge		Overcome
unexpected ..	●	unexpected

R&D project success

Table 18 shows the validation of the project success. Based on the validation of Vermeer the R&D project success is high in comparison to previous projects.

R&D project success	● ● ● ●
As a consequence of this project the reputation of our organization in the area related to this project is increased	● ● ● ● ●
The new or improved product / service provides us a competitive advantage	● ● ● ● ●
The new or improved product / service fulfils the needs of the clients	● ● ●
The new or improved product / service is of excellent (technical) quality	● ● ● ●
All project targets were met	● ● ● ●
Knowledge and experienced gained by the project members is of large value for subsequent development projects	● ● ● ● ●
The knowledge gained on this project is well secured in our organization	● ●
The project-team can be very satisfied with the final results.	● ● ● ● ● ●

Table 18: R&D project success Vlotterkering

Degree of newness

Dura Vermeer did possess the required technological know-how at the beginning of the R&D project. Vermeer claims that this know-how didn't only come from Dura Vermeer, but from partners as well. Innovation is often born out of a problem. Vermeer explains that frustration gives innovation. Mostly there is a problem and to solve it they are looking for partners with knowledge and skills to solve the problem. Dura Vermeer used existing technological

competencies and experiences during the innovation project. Vermeer argues that innovation is linking together existing things. Connecting ideas with existing solutions. The degree of novelty of the R&D project output was very high compared to previous products states Vermeer. The R&D output aimed at many new customers to their organization. Vermeer claims that the innovation are always intended to be distinctive from competitors. The product is new for the organization, the current customers and target customers for the organisation and for the world. The technology is new as well. Table 19 shows the validation of the project newness. Based on the validation of Vermeer, the R&D project newness is high in comparison to other projects.

Degree of newness		
Technological innovativeness	Innovativeness low ... ●	Innovativeness high
Market innovativeness	Innovativeness low ●	Innovativeness high
Newness of product or service	Newness low ●	Newness high

Table 19: Degree of newness Vlotterkering

5.10 Cross-case comparison of R&D projects in PBF

Brettel et al. (2012) have found, by conducting a quantitative of 400 projects, that there are no significant influences for either effectuation or causation on project success, unless the moderating effect of innovativeness is added. This is why we looked at the direct effects of the four dimensions of effectuation and causation on the dependent variables project success with the moderating effect of innovativeness. When conducting the cross-case comparison, we analysed the four dimensions of effectuation and causation. Firstly we examined in which cases the dimensions of an effectuation approach or a causation approach have been used. Secondly we examined the items that indicate the use of an effectuation approach. Finally, we examined the direct effects of the dimensions on the R&D project success under the influence of the moderator innovativeness.

Basis for taking action of R&D projects in project-based firms

Of the eight examined cases, six cases are mean-driven (effectuation), whereby a set of means is given and focus on selecting between possible effects that can be created with that set of means. Two of the cases (SPIE Simple and Vlotterkering) use a Goal-driven approach (causation). Of all the mean-driven cases, the target of the R&D project was vaguely defined in the beginning. The project teams only had a vision of the possible end results. In most case, the project target has been deliberately kept open, so the ownership of the idea could be broadened. The existing means combined are creating something new, whereby opportunities emerge from the knowledge, contacts and resources at hand.

Read, Song, & Smit (2009) describe that means provide the decision-maker with a basis for direction, suggesting that opportunities emerge from knowledge, contracts and resources at hand. This was case for all the examined mean-driven innovations cases. For example existing competencies, skilled employees and project experience where used as basis for taking action at the development of the Dutch Wind Wheel, the Power Window and the Heijmans One. For the Dutch Wind Wheel this was the competencies of skilled employees which had the know-how about how they had to bring the innovation to the market with the use of an agile process. They had experience in bringing partners together with specific knowledge of innovative elements and marketing only the idea. By bringing to together the partners, new information was created and exposure was being generated. Then the concept was brought to the market. This resulted in interest of investors from all over the world. When a goal-driven approach was used this exposure wouldn't be created. For the Power

Window it was the discovery during their research at the Delft University of Technology of materials that absorb and emit light, which they could convert to a coating. This coating enabled them to create new information about the development of the Power Window. When a goal-driven approach had been used this discovery probably didn't have taken place. For the Heijmans One it was the technical skills and existing knowhow on how to build housing. This existing knowhow enabled the project team to test the Heijmans One in the market.

Existing and new relationships as basis for taking action were used at the development of The Dutch Wind Wheel and the Circular road. BLOC had a great network to organize the process and getting commitment of the proper partners. Graaff explained that they have reached out to the companies who could add means/resources like specific knowledge to contribute. Van den Valk started by approaching partners. Because their company is known as reliable, people want to work with them. The ability to get pre-commitment and partners have lead to creating new information that reveals latent possibilities in the environment. When a goal-driven approach had been used those possibilities wouldn't have been revealed.

Finally existing financial means and tangible assets as basis for taking action were used at the development of the R&D project building with robots and using drones in the building process. RAP could test there hypotheses, because they could loan a robot from a company specialized in second-hand robots. By testing there hypothesis of how a robot could be used new information has been created. Verver explained that they had bought a drone before they had figured a business plan. But they had a gut feeling that they were going to arise growing markets. This is more a vision than a project target. By conducting pilots of using the drone in the building process they have found the best way to use the drones during the building process. Without the drone the new information and latent possibilities wouldn't be revealed.

As shown in Table 20, the six cases which used a mean-driven approach scored high on R&D project success and the degree of newness. The two goal-driven approaches scored high on R&D project success as well, but one of the cases scored low on the degree of newness. The aforementioned examples indicate that the use of a mean-driven approach leads to the creation of new information, that reveals latent possibilities in the environment. The use of a goal-driven approach is based on the use of existing knowledge, instead of creating knowledge. As described in paragraph 3.1, radical innovation requires new knowledge & resources, whereby existing competence lose value and steps change in performance. We therefore conclude that both a mean-driven approach and a goal-driven innovation approach can lead to R&D success but a mean-driven approach lead to R&D success with a high degree of innovativeness i.e. radical innovations.

Basis on the case research we therefore support proposition 1: Mean-driven innovation approaches have a positive impact on the R&D project success in innovation projects with a high level of innovativeness i.e. radical innovation in PBF.

View of risk and resources of R&D projects in project-based firms

Of the eight examined cases four cases use an affordable loss approach (effectuation) (Vlotterkering, Circulair Road, Skilledin Office and Using drones in the building process), whereby there has been predetermined how much loss is affordable for a R&D project and focuses on experimenting with as many strategies as possible with the limited means. Three of the eight cases use both an affordable loss and expected return (causation) approach (Heijmans One, The Dutch Wind Wheel and Powerwindow). One of the cases used only an expected return approach (SPIE Simple).

Grapperhaus from PHYSEE argues that when starting a company you have nothing to lose. Grapperhaus explained that there is a lot of money involved with R&D of a new product. You never know if the investment will be recovered. Affordable loss predetermines how much loss is affordable and focuses on experimenting with as many strategies as possible with the given limited means (Saravathy, 2001). Berendonk agrees on this and explained that RAP studio has only invested based on a vision that the execution of the project was valuable for the company. At the beginning of the project studio RAP decided what they maximum could afford to lose with this project. The selection of the R&D-option was mostly based on a minimization of risks and costs, because they had to stay within their budget. That is also the reason they couldn't go all the way. Graaff from BLOCK claims for the development of radical innovations it is more a gut feeling that in the end the investments are worth it. This is why most partners of the Dutch Wind Wheel entered the project basis on affordable loss criteria and invested in kind with mostly man-hours.

Vermeer from Dura Vermeer explained that the margins in the construction sector are very low and as a result there aren't big R&D budgets. The innovations are mostly incorporated in operational projects. When a new innovation is applied, it is often considered whether the technology has already proven itself in the market or not. Grappenhaus argues that project-based corporations should reserve a small percentage of the project budget for innovations. This enables the project teams to focus on innovations, instead of focussing only at the operational process and this provides start-ups an opportunity to apply their innovation. Vermeer want to stimulate the fact that suppliers of innovate products incorporate their product in the operational project of Dura Vermeer.

PHYSEE used both methods of affordable loss and expected returns. Grapperhaus claims that corporations and investors want to know how much is invested and what the expected returns are. This is why PHSEE made a business plan including ROI, where they calculated the expected returns in the end. Vermeer argues that money is spent step-by-step during the operational processes. Investments on R&D projects are mostly made when the costumer wants to pay the process. Radical innovation projects typically lack reliable information on the upside potential of returns and information on market acceptance and sales volumes, because they consist a high level of uncertainty (Brettel et al. 2012). Koolen from Heijmans argues that preference for affordable loss or expected returns depending on the degree of newness of the innovation. When there is a high degree of newness, it is difficult to estimate the potential yield. For Heijmans project budgets were approved on the basis of considerations about whether they would fit within the innovation strategy and the belief and chances of success, as well as the calculations of expected returns. Van der Valk agrees on this and claims that by investing in innovation, project considerations about expected returns had to be taken into account. This could mean money, but exposure and social benefits as well. They must achieve monthly results in order to get the budget. The R&D project provides step-by-step results. Heijmans established a budget for the development of Heijmans One, by using both the affordable loss and expected return methods in different phases of the project. This is why decisions on capital expenditures were primarily based on potential risks of losses and potential returns, depending on the specific stage-gate.

As shown in Table 20, the seven cases used an affordable loss approach or an affordable loss approach in combination with an expected return approach and scored high on R&D project success and the degree of newness. The one case that only used an expected return approach scored high on R&D project success as well, but scored low on the degree of newness. The aforementioned examples indicate that reliable information on the upside potential of high innovative projects are both fare and fuzzy, the upside data is usually not reliable enough to be the key decision criteria, while the acceptable downside potential - the affordable loss- is easier to estimate. A low level of innovativeness implies less uncertainty and better access to

reliable data, such as forecast on market acceptances and sales volumes. We therefore conclude that the use of an affordable loss approach leads to the R&D project success with a high degree of innovativeness i.e. radical innovations.

Basis on the case research we therefore support proposition 2: Affordable loss” thinking has a positive impact on the R&D project success in innovation projects with a high level of innovativeness i.e. radical innovation in PBF.

Attitude toward outsiders during R&D projects in project-based firms

All eight examined cases had a partnership attitude towards outsiders. A causal approach for R&D projects prescribes first defining the market, then selecting segments within the market through detailed competitive analyses, and then using relevant specifications and needs of the target market. Effectual logic strongly favours building partnerships and bringing stakeholders on board, even before clarifying what the product-markets and goals of the innovation are going to be (Dew, Read, Sarasvahty & Wiltbank, 2009).

For example Studio RAP had set up a partnership with a wood supplier, so they could get the building materials for a reduced price. Through a partnership with a supplier of second-hand robots they were able to test the software and to start the production. Berendonk claims that they always try to partner for specific resources. ZXY builders recently started a partnership with an inspection company. With this partnership they can combine the knowledge of drones and software with the intrinsic knowledge of the market of inspections. Heymans is often approached by partners because they have an integrated role in the building process and an innovative image. Heijmans entered several partnerships for the development of Heijmans One, including architects and suppliers like Eneco, Hamwell, Dus Architecten, Zown (start-up Aliander), BMW and University of Tilburg. This partnerships enabled them to gather new information a insights. Vermeer argues that there are companies who only collaborate with a start-ups to improve their innovations skills. But it takes more to be an innovative company. It could be useful to test the product or service during the innovation process with the customer. Vermeer argues that most costumers are open to improvements. PHYSEE has a partnership with ASW, a supplier of window frames and with OVG, a real estate developer of offices. Grapperhaus argues that without the partnerships PHYSEE couldn't exist. Grapperhaus explained that they only enter into a partnership when partners add value. The partnerships with other suppliers aim to test the market without owning all the resources.

As shown in Table 20, all of the cases had a partnership attitude towards outsiders during the R&D project. All of the examined cases had a high degree of success and a high degree of newness, with the exception of SPIE simple. The corporate company that had the lowest score on the degree of newness, did only use internal partnerships.

Based on the case research we therefore support proposition 3: Innovation approaches directed by partnerships have a positive impact on the R&D project success in innovation projects with a high level of innovativeness i.e. radical innovation in PBF.

Attitude toward unexpected events of R&D projects in project-based firms

All six examined cases had an innovation approach that acknowledged the unexpected. Two cases had both an innovation approach that acknowledge the unexpected and overcome the unexpected. Effectuation consists of dealing with unexpected events during the R&D project as a vital source of opportunity versus following a linear process that seeks to reach the project target as efficiently and with as few surprises as possible. For effectuation approach

contingencies/surprises are seen as a source of opportunities, Imaginative rethinking of possibilities and continual transformations of targets are the main approach of this attitude.

Despite of potential delays in project execution, the process of all cases was flexible and took advantage of opportunities as they arose. In most case the R&D process was set up to find new opportunities. For example, BLOC only made a planning until the next phase of the project development process. During executing the global planning the project team took short sprints to global milestones. In the upcoming three months until the global milestone there was room for new insights that could change the project planning or even the project target. Graaff explained that they used the scrum technique but at major project level. PHYSEE did use the scrum methodology as project planning as well. Flexible planning provides the possibility to pivot the plan quickly. For the project development PHYSEE used LEAN start-up methods as well. This enables them to test different R&D options, until they met the perfect requirements. Koolen claims that they make a project planning and don't stick to it, because things don't always turn out to be as planned. The employees of RAP did make a project planning, but it didn't make any sense. They had to make long working hours to deliver the project on time. Van den Valk argues that the result is more important than the achieving of milestones in time.

Vermeer argues that planning according to predetermined criteria will stifle innovation. Vermeer claims that R&D projects need project managers with other skills, like creativity and collaboration, more than the operational projects. Koolen agrees on this but within Heijmans innovation, projects are managed by the same project leaders as the operational projects. Those project leaders have experience with managing innovation projects. As a result they are capable of managing the innovation project, without trying to control the process in a conventional way. For Heijmans the project planning was carried out in small steps, by using the stage-gate method. When an innovation project is ready to bring to the market, the project can be planned in a more conventional way.

Despite of potential delays in project, execution of the project in most cases was flexible and they took advantage of opportunities as they arose. For the Dutch Wind Wheel the setback that the municipality of Rotterdam didn't want to cooperate in a specific phase was a trigger to gather specific partners and research institutes onboard to make it a market initiative. For Studio RAP an example of a setback used as advantage was that while programming the robot, the robot movements didn't work as planned. All the failed tests of the robot movements lead to possible solutions of making other specific parts. PHYSEE used a setback as advantage as well. The original materials which they used for creating the coating were not accepted by the industry. They are now working on a new coating. This coating is in terms of transparency and aesthetic a great leap forward. Heijmans One was intended to sell to institutional investors. When it turned out that there were no investors interested, Heijmans switched their focus on selling their product to private homeowners.

As described in the cases above, strategic experimentations are utilized to minimize risk and maximize learning during the R&D process. Some experiments will fail, but as long as failure informs new approaches and understanding within the constraints of affordable loss, this is to be expected and even encouraged. By learning and unlearning by exploring and experimenting and searching and selecting new radical innovations can be found. Contrary to a causal linear process, incremental innovation process is more like a linear process (Assink, 2006). As shown in Table 20 all of the companies had an acknowledge the unexpected approach during the R&D project and a high degree of success and a high degree of innovativeness. The cases that both used an acknowledge the unexpected and avoid the unexpected approaches had a high degree of innovativeness and a low degree of innovativeness.

Based on the case research we therefore support proposition 4: “Innovation approaches that acknowledge the unexpected has a positive impact on the R&D project success of radical innovation in PBF.

Organization	R&D project success	Dimension 1: Preference for means vs. goals	Dimension 2: Preference for affordable loss vs. expected returns	Dimension 3: Preference for partnerships vs. competitive market analysis	Dimension 4: Preference for acknowledge the unexpected vs. overcome the unexpected	Technological innovativeness	Market innovativeness	The degree of newness	
Heijmans	●●●●●	Means	Affordable loss and expected returns	Partnerships	Acknowledge the unexpected	-	●●●●	●●●	7
Dura Vermeer	●●●●	Goals	Affordable loss	Partnerships	Acknowledge the unexpected	●	●●	●●●●	7
Advin	●●●●	Means	Affordable loss	Partnerships	Acknowledge the unexpected	●	●●●	●●●	7
SPIE	●●●●●	Goals	Expected returns	Intern partnerships	Both elements of acknowledge the unexpected and overcome the unexpected	-	●●●	●	4
BLOC	●●●●●●	Means	Affordable loss and expected returns	Partnerships	Both elements of acknowledge the unexpected and overcome the unexpected	●●	●●●●	●●●●	10
Physee	●●●●●●	Means	Affordable loss and expected returns	Partnerships	Acknowledge the unexpected	●●	●●●	●●●●	9
Studio RAP	●●●●●	Means	Affordable loss	Partnerships	Acknowledge the unexpected	●●	●●●●	●●●	9
XYZ-Builders	●●●●●	Means	Affordable loss	Partnerships	Acknowledge the unexpected	-	●●●●	●●●●	8

Table 20: Project success, effectuation and the degree of newness

6 Conclusion and discussion

New ventures have shaped the anticipation that it'll be start-ups, not established corporations, who come up with the next big thing to create uncontested market space and disrupt entire industries (Weiblen & Chesbrough, 2015). In the fast moving environment, corporate firms must be more innovative to create uncontested market. For project based firms, management of innovation is complicated due to the discontinuous nature of project-based production (Gann & Salter, 2000). What can project-based firms learn from successful innovation and new venture by start-up entrepreneurs? This study was set out to explore how entrepreneurial thinking can lead to innovation in project-based firms. In this chapter the answers to the main research question "How can entrepreneurial thinking lead to innovation in project-based firms in the construction sector in the Netherlands" will be formed. To answer this, we first examine the sub questions.

Sub question 1: What is according to the literature the effect of effectuation on innovation at businesses in general?

The literature on innovation of large, established firms rest principally on the processes of causal logic thinking (Brettel, Mauer, Engelen, & Kupper, 2012). The concept of causal logic advises firms to set clear goals for product development and determine a strategy that can drive project selection. The inverse of causation is effectuation, whereby entrepreneurs of corporations and start-ups take actions that create new information that reveals latent possibilities in the environment (Chesbrough, 2010). The concept of effectuation logic advises firms to combine existing means to create something new. The existing means provide the decision-maker with a basis for direction, suggesting that opportunities emerge from the knowledge, contacts and resources at hand (Read, Song, & Smit, 2009). Resource commitments are based on the acceptable downside potential of exploring the opportunities, because there isn't reliable information on market acceptance and sales volumes. Pre-commitments are made by building partnerships and bringing stakeholders on board, even before clarifying what the innovation exactly is going to be. Effectuation approach focuses on controlling aspects of an unpredictable future whereby positive and negative contingencies have to be transformed into useful components of new opportunities. Thus, the effectuation process focuses on exploring new opportunities by using existing means to create value, assimilate and apply new knowledge. According to the literature we concluded that the use of effectuation processes have a positive impact on the R&D project success in innovation projects with a high level of innovativeness i.e. radical innovation in corporate firms.

Sub question 2: What are according to the literature the specific conditions for innovation in project-based firms?

Innovation activities in PBF are typically not executed in separate R&D departments, but perform within -or closely related to- business projects (Gann & Salter, 2000). Studies in the Swedish construction industry have shown that the decentralized and project-based nature of construction business hinders innovation diffusion (Dubois & Gadde, 2002).

Blindenbach-Driessen & van den Ende (2006) and Keegan & Turner (2002) have found that innovation projects in PBF were managed in the same controlled way as the regular business projects, which stifled innovation. The traditional ideas from the literature suggest that in order to be innovative, firms should de-emphasise planning and control and loosening control to a more organic management approach. Overlapping phases and iteration positively affect performance of projects with high uncertainty, such as radical innovation projects (Brown & Eisenhardt, 1997; De Meyer & Loch, 2002; Eisenhardt & Tabrizi, 1995).

Blindenbach- Driessen (2006) states that PBF development projects compete for the same monetary and human resources, as used for business activities. Therefore for PBF promoting and stimulating innovative activity is not a problem, but watching and waiting for results to

emerges and supporting this process with additional resources, is a problem (Keegan & Turner, 2002). Resources for innovation projects are in general expected to be lower in project-based firms than in nonproject-based firms.

Brettel et al. (2012) claim that cross-functional integration is important, especially where high levels of uncertainty occur. Different functional perspectives provide different approaches to problem-solving, whereby the integration of other functions can provide missing resources. Blindenbach-Driessen and van den Ende (2006) have found that cross-functional teams have a lower effect on performance of innovation projects in PBF than in other firms. Due to firm-level collaboration, members of innovation project teams in PBF are likely to be familiar with the requirements and needs of other disciplines and interpretive barriers and fault lines are less likely to exist (Blindenbach-Driessen & van den Ende, 2010). PBF need specialization within their innovation projects, instead of collaboration between disciplines and functions.

Heavyweight project leaders in project-based firms have an increased effectiveness, compared to nonproject-based firms (Blindenbach-Driessen F. , 2006). Blindenbach-Driessen and van den Ende (2010) argue that heavyweight project leaders in PBF have a different function than heavyweight project leaders in non-project firms. In non-project firms heavyweight project leaders are coordinating, translating and integrating the demands from the different functional departments, whereas heavyweight leaders in PBF are more geared at knowledge transfer and the diffusion of the newly developed product or service within the firm (Blindenbach-Driessen & van den Ende, 2010). Hence, heavyweight project leaders have a more ambassadorial and technical scouting role.

Close collaboration is typical for PBF in construction projects whereby a broad range of actors with different competences and specialties are involved -e.g. architectural and design practices, general contractors, specialized subcontractors, fabricators, manufacturer's customers and suppliers- (Eriksson, 2013). Blindenbach-Driessen (2006) claims that external operational collaborative capabilities lead to a more frequent involvement of suppliers on development projects. PBF generally make use of existing supplier relationships when engaged in development projects (Gann & Salter, 2000). Close collaboration with customers is typical for construction projects and often involves long-term interactions with customers for production and operation (Gann & Salter, 2000).

Sub question 3: What is the effect of the application of the effectuation process on corporate and start-up project-based firms in the construction sector in the Netherlands?

To gain knowledge of how effectuation can lead to innovation in PBF eight cases of innovation projects in the construction sector were examined. During the case research pre-determined propositions based in the four principles of effectuation approaches, which can be applied to the context of new business and R&D projects were investigated.

Basis for taking action for innovation projects in project-based firms

Six of the eight examined cases had a mean-driven approach, whereby existing means combined were used to create something new. In those cases opportunities emerged from the knowledge, contacts and resources at hand. Existing competencies, skilled employees, project experience, existing and new relationships and tangible assets were used as basis for taking action. In the mean-driven cases the target of the R&D project was vaguely defined in the beginning. The project teams had only a vision of the possible end results. In most mean-driven cases the project target has been deliberately kept open, so the ownership of the idea could be broadened. The project team reached out to the companies who could add means/resources like specific knowledge, to contribute to the given project target.

The six cases which used a mean-driven approach scored high on R&D project success and the degree of newness. The two goal-driven approaches scored high on R&D project success as well but one of the cases scored low on the degree of newness. The cases indicated the use of a mean-driven approach lead to the creating of new information, that reveals latent possibilities in the environment. The use of a goal-driven approach is based on the use of existing knowledge instead of creating knowledge. Radical innovation requires new knowledge & resources whereby existing competence lose value and steps change in performance. We therefore conclude that both a mean-driven approach and a goal-driven innovation approach lead to R&D success but a mean-driven approach lead to R&D success with a high degree of innovativeness i.e. radical innovations. Based on the case research proposition 1 is supported: Mean-driven innovation approaches have a positive impact on the R&D project success of radical innovation projects.

View of risk and resources of R&D projects in project-based firms

Of the eight examined cases four cases use an affordable loss approach, whereby there has been predetermined how much loss is affordable for a R&D project and focuses on experimenting with as many strategies as possible with the limited means. Three of the eight cases use both an affordable loss and expected return (causation) approach. One of the cases used only an expected return approach.

Radical innovation projects typically lack reliable information on the upside potential of returns and information on market acceptance and sales volumes, because they consist a high level of uncertainty (Brettel et al. 2012). Koolen argues that preference for affordable loss or expected returns depend on the degree of newness of the innovation. When there is a high degree of newness, it is difficult to estimate the potential yield.

Vermeer explained that the margins in the construction sector are very low and as a result there aren't big R&D budgets. The innovations are mostly incorporated in operational projects and budget is spent step-by-step during the operational process. Investments on R&D projects are mostly made when the customer wants to pay the process. The R&D project provides step-by-step results. Heijmans established a budget for the development of Heijmans One, by using both the affordable loss and expected return methods in different phases of the project. This is why decisions on capital expenditures were primarily based on potential risks of losses and potential returns, depending on the specific stage-gate.

Seven cases used an affordable loss approach or an affordable loss approach in combination with an expected return approach and scored high on R&D project success and the degree of newness. The one case that only used an expected return approach scored high on R&D project success as well but scored low on the degree of newness. The cases indicated that reliable information on the upside potential of high innovative projects are both rare and fuzzy, the upside data is usually not reliable enough to be the key decision criterion, while the acceptable downside potential, the affordable loss, is easier to estimate. A low level of innovativeness implies less uncertainty and better access to reliable data, such as forecast on market acceptances and sales volumes. We therefore conclude that the use of an affordable loss approach lead to the R&D project success with a high degree of innovativeness i.e. radical innovations. Based on the case research proposition 2 is supported: "Affordable loss" thinking has positive impact on the R&D project success of radical innovation project in PBF.

Attitude toward outsiders during R&D projects in project-based firms

All eight examined cases had a partnership attitude towards outsiders. Effectual logic strongly favours building partnerships and bringing stakeholders on board, even before clarifying what the product-markets and goals of the innovation are going to be (Dew, Read, Sarasvahty & Wiltbank, 2009).

In all of the cases uncertainty is reduced through partnerships and pre-commitments of self-selected stakeholders. Relationships, particularly equity partnerships drive the shape and trajectory of the innovation. For example through partnerships equipment could be borrowed, knowledge was gained and combined, resources were shared and prototypes were tested in the building environment. A causal approach for R&D projects prescribes first defining the market, then selecting segments within the market through detailed competitive analyses, and then using relevant specifications and needs of the target market. Effectual logic strongly favours building partnerships and bringing stakeholders on board, even before clarifying what the product-markets and goals of the innovation are going to be (Dew, Read, Sarasvahty & Wiltbank, 2009). All of the cases had a partnership attitude towards outsiders during the R&D project. All of the examined cases had a high degree of success and a high degree on newness with the exception of SPIE simple. This corporate company who had the lowest score on the degree of newness did only use internal partnerships. Based on the case research proposition 3 is supported: “Innovation approaches directed by partnerships have a positive impact on the R&D project success of radical innovation projects in PBF”.

Attitude toward unexpected events of R&D projects in project-based firms

All six examined cases had an innovation approach that acknowledges the unexpected. Two cases had both an innovation approach that acknowledge the unexpected and overcome the unexpected. Effectuation consists of dealing with unexpected events during the R&D project as a vital source of opportunity. Contingencies/surprises are seen as a source of opportunities, imaginative rethinking of possibilities and continual transformations of targets are the main approach of this attitude. Despite of potential delays in project execution, the process of all cases was flexible and took advantage of opportunities as they arose. In most case the R&D process is set up to find new opportunities.

In most case during executing the innovation project the project teams took short sprints to global milestones. Vermeer argues that planning according to predetermined criteria will stifle innovation. Until the global milestone there could be new insights that change the project planning or even the project target. Some teams used the scrum technology during the executing of the innovation project. Flexible planning provides the possibility to pivot the plan quickly. Despite of potential delays in project, execution of the project was in most cases flexible and the team took advantage of opportunities as they arose.

R&D projects need project managers with other skills, like creativity and collaboration, more than the operational projects. Projects could be managed by the same project leaders as the operational projects as long as the project leaders have experience with managing innovation projects. As a result they are capable of managing the innovation project, without trying to control the process in a conventional way. When an innovation project is ready to bring to the market, the project can be planned in a more conventional way.

As described in the cases strategic experimentations is utilized to minimize risk and maximize learning during the R&D process. Some experiments will fail, but as long as failure informs new approaches and understanding within the constraints of affordable loss, this is to be expected and even encouraged. Learning and unlearning by exploring and experimenting, searching and selecting new radical innovations could be found. Contrary to causal linear process, incremental innovation process is more like a linear process (Assink, 2006). All of the companies had an acknowledge the unexpected approach during the R&D project and a high degree of success and a high degree of innovativeness. The cases that both used an acknowledge the unexpected and avoid the unexpected approaches had a high degree of innovativeness and a low degree of innovativeness. Based on the case research

proposition 4 is supported: “Innovation approaches that acknowledge the unexpected have a positive impact on the R&D project success of radical innovation in PBF”.

Sub question 4: What effect do we expect or find of entrepreneurial thinking in project-based firms in the construction sector?

With entrepreneurial thinking this paper refers to effectuation. In Chapter 3.6 we have determined the different variables of effectuation and the effect on R&D project success in PBF, whereby we argued that the effectuation process of exploring new opportunities leads to high levels of innovativeness i.e. radical innovation. Based on the case study we have found that the use of the variables mean-driven approach as basis for taking action, partnerships as an attitude towards outsiders and acknowledge the unexpected as an attitude towards unexpected events all lead to R&D project success in high level innovation projects i.e. radical innovations in PBF. We haven’t found enough evidence for the variable affordable loss in the examined cases.

Main question: How can entrepreneurial thinking lead to innovation in project-based firms in the construction sector in the Netherlands?

Mean-driven innovation approach

The concept of effectuation logic advises firms to combine existing means to create something new. The existing means provide the decision-maker with a basis for direction, suggesting that opportunities emerge from the knowledge, contacts and resources at hand (Read, Song, & Smit, 2009). A mean-driven approach is the preferable process when exploiting contingencies that arose unexpectedly over time (Saravathy, 2001), whereby firms create, value, assimilate and apply new knowledge (Brettel, Mauer, Engelen, & Kupper, 2012). Goals emerge by imaging courses of action based on given means. Similarly, who comes on board determines what can be and needs to be done. Radical innovations require new competence and innovation paths and presuppose the acquisition of new knowledge, which isn’t been present in the company today. The acquisition of new knowledge by renewal learning, allows change to new competences and innovation paths that haven’t been travelled. Based on the case research we have found that a mean-driven innovation approach has a positive impact on the R&D project success of radical innovation projects in PBF.

Affordable loss innovation approach

Affordable loss predetermines how much loss is affordable and focuses on experimenting with as many strategies as possible with the given limited means (Saravathy, 2001). The focus is on limiting downside potential. Pursuing adequately satisfactory opportunities without investing more resources than stakeholders can afford to lose. Radical innovation projects consist of a high level of uncertainty. Those projects typically lack reliable forecast of returns and information on market acceptance and sales volumes (Brettel, Mauer, Engelen, & Kupper, 2012). Since reliable information on the upside potential of high innovative projects are both rare and fuzzy, the upside data is usually not reliable enough to be the key decision criteria, while the acceptable downside potential, the affordable loss, is easier to estimate (Dew, Sarasathy, Read, & Wiltbank, 2009). Based on the case research we have found that a affordable loss innovation approach has a positive impact on the R&D project success of radical innovation projects in PBF.

Partnership innovation approach

Partnerships reduce uncertainty, maintain flexibility and utilize experimentation and seek to exert control over the unpredictable future, by making strategic alliances and pre-commitments (Chandler et al. 2011; Dew et al. 2009; Brettel et al. 2012). Each partner brings new opportunities that shape the coherent product, firm or market (Read, Song, & Smit, 2009). Pre-commitments are made by building partnerships and bringing stakeholders on

board, even before clarifying what the innovation is going to be exactly. Pre-commitments allow firms to test the market without owning all the resources to do so (Chandler et al. 2011). Based on the case research we have found that an innovation approach directed by partnerships has a positive impact on the R&D project success of radical innovation projects in PBF.

Acknowledge the unexpected

When using acknowledging the unexpected thinking, new business ideas are launched, before worrying about who the customers are. Positive and negative contingencies are being explored and have to be transformed into useful components for new opportunities, whereby strategic experimentation is utilized to minimize risk and maximize learning (Dew et al. 2009). Thus, the effectuation process focuses on exploring new opportunities by using existing means to create value, assimilate and apply new knowledge. Strategic experimentations are utilized to minimize risk and maximize learning during the R&D process. Some experiments will fail, but as long as failure informs new approaches and understanding within the constraints of affordable loss, this is to be expected and even encouraged. By learning and unlearning by exploring and experimenting, searching and selecting new radical innovations could be found. Based on the case research we have found that an innovation approach that acknowledge the unexpected has a positive impact on the R&D project success of radical innovation projects in PBF.

Shortly summarized we conclude that there are different ways in which entrepreneurial thinking can lead to innovation in project-based firms. Mean-driven innovation approaches, approaches driven by partnerships, affordable loss thinking and approaches that acknowledge the unexpected all have a positive impact on the R&D project success of radical innovation project in project-based firms.

7 Limitations and suggestions for further research

The investigated out comings of this study are constrained by some limitations, which could be improved in future research. This study aimed to get a first empirical foundation of its key constructs for the project-based firm context. The following limitations are applicable on this thesis:

- This research was conducted by multiple case studies, which influenced the level of objectivity of the researcher;
- Due to time limitations only eight cases have been examined;
- Since the project success is measured by validation of the interviewee, we also suggest that future studies could incorporate objective performance measures of the project success;
- When measuring project success, project results haven't been incorporated in this study;
- The innovation project of the Dutch Wind Wheel and the circular road were not completed yet, therefore project success is based on the results of the process so far;
- The research questions of this research are being re-used from Brettel et al. (2012) and Blindenbach-Driessen & van den Ende (2010), to have a validated interview script. Since the interviews are held in Dutch, the research questions and answers have been translated. This doesn't benefit the validity;
- The dimensions of effectuation were analyzed per item separately. The combination of manipulations and their effect is not considered here;
- The term innovation in this study is narrowed down to incremental and radical innovation. Different forms of innovation like product innovation, business case innovation and disruptive innovation are not being taken in to account.

The following future research is suggested:

- An additional in-depth analysis on each dimension;
- A quantitative research to the application of the four dimensions of effectuation on R&D projects in project based firms.
- Broadening the definition of entrepreneurial thinking, with concepts as lean start-up approach, scrum approach and bootstrapping.
- Research into how the attitude of heavyweight project leaders, the attitude of corporate firms to the provision of resources and the attitude of corporate firms to planning and control, influence the use of effectuation and the R&D project result.

8 Other observations during the research

8.1 Effectuation and organisational dualism

Sarasvathy (2001) states that to build a theory of effectuation in corporate businesses, the ideas on the tradeoffs between exploration and exploitation is particularly valuable. Various authors have claimed that organizations need to become ambidextrous and develop exploratory and exploitative innovation simultaneously in different organization units (Jansen, Van Den Bosch, & Volberda, 2006). Thushman (1997) stated that large corporations often lack a clear two-fold structure, combining consistency for incremental innovation and flexibility and experimenting capabilities for radical innovation. Chesbrough (2010) also noted the problems involved in organizations balancing exploration and exploitation. An organisation needs to continue to perform well in their current business - and business model-, while at the same time undertaking the experiments necessary to nurture a new business models or innovation. Sarasvathy (2001) speculates that decision units of exploration could contain processes of effectuation, whereas causation models would dominate exploitation. Brettel et al. (2012) argue that rethinking internal processes in favour of forming effectual cells that allow for more means-oriented innovation approach, leaves room for individual projects that are effectual and could drive corporate radical innovation capabilities. This could be of particular value in PBF since short-term project focus and decentralization of PBF inhibits learning from one point in time and space to another, making it easier to reap the benefits of exploitation than of exploration (Eriksson, 2013). Furthermore Sarasvathy (2001) claims that causal reasoning and effectual reasoning doesn't always pull in opposite directions. Sitoh, Pan & Yu (2014) support this claim and argue that the decision-making mechanisms of effectuation and causation can co-exist with one another, despite of contrasting approaches to new business development and innovation. Effectuation and causation can be configured in specific ways during different phases in the process of new product creation. Large organisations usually chose to strengthen the innovation base with high innovative R&D projects. Those projects are characterized by uncertainty, creating the necessity for organizations to develop structures that combine effectual processes with causal and adaptive processes in the R&D context (Brettel, Mauer, Engelen, & Kupper, 2012). Due to the project focus and decentralization, exploration in PBF isn't reaching its full potential (Eriksson, 2013). Thus, structures that combine effectual processes with causal processes could be particularly valuable in PBF.

8.2 Attitude of heavyweight project leaders toward effectuation in project-based firms

Read & Sarasvathy (2015) and Dew et al. (2009) have studied the relationship between expertise and an effectual approach, showing that whereas expert entrepreneurs are more likely to adopt an effectual approach, experts and novices cannot be differentiated by their use of causation reasoning. Van de Ven (1986) observed that, while the invention or conception of innovative ideas may be an individual activity, innovation -inventing and implementing new ideas- is a collective achievement. This is why managers need organizational processes and enough authority to implement effectuation by undertaking experiments and the ability to take actions based on results from test, which could lead to radical innovation (Chesbrough, 2010). This change presupposes that there is a willingness inside the company to cannibalize knowledge, experience and other assets (Herrmann, Tomczak, & Befurt, 2006). Blindenbach-Driessen and van den Ende (2010) have found that heavyweight project leaders of PBF have an increased effectiveness for implementing innovations in comparison to nonproject-based firms. This is because heavyweight project leaders of PBF are geared at knowledge transfer and the diffusion of the newly developed product or service within the firm. Due to this special role we speculate that heavyweight project leaders could have a crucial role in implementing effectual processes in project-based firms.

8.3 Attitude of corporate firms to the provision of resources

Blindenbach-Driessen and van den Ende (2010) have found that the occupation rate -or so-called number of billable hours of employees on business projects- is the most important parameter to assess the performance of a firm. As a result, innovation projects are often considered a burden as they decrease the occupation rate. Therefore for PBF promoting and stimulating innovative activity is not a problem, but watching and waiting for results to emerges and supporting this process with additional resources, is a problem (Keegan & Turner, 2002). Grappenhuis argues that project-based corporations should reserve a small percentage of the project budget for innovations. This enables the project teams to focus on innovations, instead of focussing only at the operational process and this provides start-ups an opportunity to apply their innovation. Most corporate firms want to stimulate the fact that suppliers of innovate products, incorporate their product in the operational project. When a new innovation is applied, it is often considered whether the technology has already proven itself in the market or not.

8.4 Attitude of corporate firms to planning and control

Blindenbach-Driessen & van den Ende (2006) and Keegan & Turner (2002) have found that innovation projects were managed in the same controlled way as the regular business projects, which stifled innovation. While doing new things is a risky and uncertain endeavour, PBF in general continue to try and control this in a conventional way, where the uncertainty is de-emphasised and project control and evaluation proceeds as through innovation can be precisely defined, planned and evaluated according to predetermined criteria (Keegan & Turner, 2002). A strict process management approach, that includes the concept Lean management has dominated the managerial practice in the construction industry. PBF should place greater emphasis on agile processes by using the scrum approach emergence from the software industry, as well as the stage-gate project management.

So effectuation and organisational dualism, attitude of heavyweight project leaders towards effectuation, attitude of corporate firms to the provision of resources and attitude of corporate firms to planning and control all have effect on the R&D projects success of radical innovation projects in project-based firms.

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10 Appendix 1: Semi-structured interview Script

Firm characteristics

Firm size

How many employees work for your organization?

Does your organization provide?

Products

Services

A combination of products and services

Project-based firm R&D

Is your organization experienced in the execution of projects?

-No, we rarely execute projects

-Yes, especially in new product and new service development projects, or R&D projects

-Yes, our predominant operational process is the execution of projects

Which of the following description matches best the relationship your organization have with customers? We deliver tailor made product and services

Which organizational forms match best with your organization?

Various departments (production, R&D etc.) have each their own responsibility in the production of our services or products (= functional organization)

A division or department has the responsibility for the production of a product or service (or a group of products or services targeted at one market) (=product/divisional organization)

Within our organizational structure there is an equal division in authority and control between two or more of the following subdivisions: functions, technical disciplines, location, product groups, projects, or other (= matrix organization)

Our products or services are primarily being delivered on project-basis. The entire organization is subsidiary to the projects we execute for our clients (=project organization)

To what extent do you agree with the following statement, regarding the development of new products or services within your organization ((1-7 point Likert scale)

R&D is primarily responsible for innovations within our organization. The organization of development projects is formalized within our organization

Firm strategy R&D

To what extent do you agree with the following statements

-New product and service development is very important to sustain our position in the market in which we operate

-New product and service development demands very high investment costs

-Innovation is very important within our organization

To what extent does your organization follow the following strategies

-We try to be the first in the development and application of new products and services

-It is not important to be ahead of the competition, we only change to new technologies when it is absolutely necessary

Innovativeness (radical innovation vs. incremental innovations)

Technological innovativeness

Did you possess the required technological know-how at the beginning of the R&D project?

Did you have any practical experiences in the application of the required technological competencies and the technological know-how?

Could your organization use existing technological competencies and experiences during the project?

Market innovativeness

Was the degree of novelty of the R&D output very high compared to previous products?

Did the R&D output aimed at many new customers to our organization?

Did the R&D output catered to new customer needs that we have not served before?

Did the new product required to use new sales and distribution channels?

Newness: How new was the new product or service (1-7 point Likertscale)?

For your organization

For the current customers of your organization

For the target customers

For the world

The used technology

Independent variable

Dimension 1: Preference for means vs. goals ($\alpha=.90$)

	Effectuation	Causation
1	Our R&D project was specified on the basis of given means/resources	Our R&D project was specified on the basis of given project targets
2	The target of our R&D project was vaguely defined in the beginning	The target of our R&D project was clearly defined in the beginning
3	Given means/resources have been the starting point for the project	Given project targets have been the starting point
4	The process converged towards a project target on the basis of given means/resources	Required means/resources have been determined on the basis of given project targets
5	Rather given means than concisely given project targets have been the starting point for our project	A concisely given project target has been the starting point for our project
6	The project specification was predominantly based on given resources	The project specification was predominantly based on given targets

Dimension 2: Preference for affordable loss vs. expected returns ($\alpha=.86$)

	Effectuation	Causation
1	Considerations about potential losses were decisive for the selection of the R&D option	Considerations about potential returns were decisive for the selection of the R&D option
2	Project budgets were approved on the basis of considerations about acceptable losses	Project budgets were approved based on calculations of expected returns (e.g., ROI)
3	The selection of the R&D-option was mostly based on a minimization of risks and costs	The selection of the R&D-option was mostly based on analyses of future returns
5	Decisions on capital expenditures were primarily based on potential risks of losses	Decisions on capital expenditures were primarily based on potential returns

Dimension 3: Preference for partnerships vs. competitive market analysis ($\alpha=.82$)

	Effectuation	Causation
1	We tried to reduce risks of the R&D project through internal or external partnerships and agreements	We tried to identify risks of the R&D project through thorough market and competitor analyses
2	Our focus was rather on the reduction of risks by approaching potential partners and customers	Our focus was rather on the early identification of risks through market analyses in order to be able to adopt our approach

Dimension 4: Preference for acknowledge the unexpected vs. overcome the unexpected ($\alpha=.86$)

	Effectuation	Causation
1	We always tried to integrate surprising results and findings during the R&D process — even though this was not necessarily in line with the original project target	We only integrated surprising results and findings when the original project target was at risk
2	Our R&D process was flexible enough to be adjusted to new findings	Our R&D process focused on reaching the project target without any delay
3	New R&D findings influenced the project target	New R&D findings did not influence the project target
4	The project planning was carried out in small steps during the project implementation	The project planning was basically carried out at the beginning of the project
5	Despite of potential delays in project execution we were flexible and took advantage of opportunities as they arose	We first of all took care of reaching our initially defined project targets without delays
7	Potential setbacks or external threats were used as advantageous as possible	By the use of upfront market analyses we tried to avoid setbacks or external threats

Dependent variable

Questionnaire questions related to success evaluation

To what extent do you agree with the following statements?

(1 = totally disagree, 7 = fully agree, 8 = not applicable)

As a consequence of this project the reputation of our organization in the area related to this project is increased

The new or improved product / service provides us a competitive advantage

The new or improved product / service fulfils the needs of the clients

The new or improved product / service is of excellent (technical) quality

All project targets were met

Knowledge and experienced gained by the project members is of large value for subsequent development projects

The knowledge gained on this project is well secured in our organization

The project-team can be very satisfied with the final results.

Achieved results of the development project?

De expenditures of the project were ...? Very much lower than expected 1 2 3 4 5 Very much higher than expected

The project duration was...? Very much shorter Very much longer

The gained profit is ...? Very much lower than expected Very much higher than expected

The achieved revenue is...? Very much lower than expected Very much higher than expected

What was developed came ... on the market? Far too early Far too late

Experience and competencies

The R&D project met its expectations in terms of the:

Learning and expertise that can be leveraged in other projects

Generation of new ideas as starting point of potential future projects

Enhancement of competencies and capabilities

Perceived value and future potentials

Perceived value and future potentials

Perceived value of the R&D output

Opportunities to market R&D output
Quality and performance of the R&D output

11 Appendix 2: Analysis interviews

11.1 Analysis interview- Lennart Graaff, BLOC

Analysis interview – Lennart Graaff, BLOC

Participants	Lennart Graaff ,BLOC
Organization	Michiel van den Hoek, Rotterdam School of Management Erasmus University
Date	BLOC
Location	26-04-2016
Interview type	Rotterdam
	Semi-structured
Innovation project	The Dutch Wind Wheel
	The Dutch Wind Wheel is a unique landmark for the skyline of the city of Rotterdam. The state-of-the-art design consists of two of three-dimensional rings with a light, open steel and glass construction. The outer ring houses 40 rotating cabins on a rail system, the inner ring is a innovative windmill housing a top class panorama restaurant, sky lobby and hotel, apartments and commercial functions in the plinth. It is the dynamic showcase for Dutch Clean Technology and provides a continuous platform to demonstrate the latest technical and technological innovations. The pioneering wind turbine converts wind energy with a framework of steel tubes into electricity without moving mechanical parts
Description innovation	
Firm characteristics	
Type of Organization	Start-up (founded October 2014)
Description of Organization	
Number employees	8 (6 partners and 2 employees)
Does your organization provide product or service or both	BLOC is a creative development agency. They develop pioneering concepts and turn ideas into business. Bloc provides both products and services. At this moment about 80% of the work is service related and about 20% is project related.
Project-based firm R&D	
Experienced in the execution of projects	BLOC is in particular specialized in new product- and new service-development projects, and R&D projects. They focus especially on the process of the execution of innovative real estate projects, til the realization phase. But they focus also on concept and product development and the development of

Tailormade products of services	<p>new services. They realize these products and service in corporation with al kind of different partners, depending on the kind of project. Their key strength is the development of area's and buildings and put processes in motion.</p> <p>Because BLOC is specialised in new product en service development in corporation with partners, all projects and services are tailor-made.</p>
Which organizational forms match best with your organization?	<p>The products or services of BLOC are primarily being delivered on project-basis. The entire organization is subsidiary to the projects we execute for their clients (=project organization)</p>
R&D is primarily responsible for innovations within our organization.	<p>All employees of the organisation are responsible for innovations within the organization. The primary business process of the company is innovation.</p>
The organization of development projects is formalized within our organization	-
Firm R&D strategy	
New product and service development is very important to sustain our position in the market in which we operate	<p>Graaff claims that new product- and service development is crucial to sustain their position in the market in which they operate.</p> <p>Graaff argues that new product- and service-development don't demand very high investment costs. Graaf claims that it depends on how the development of new products and services is organized. BLOC is using a trello board with a long list of al the projects en products they think are interesting. They also use a checklist as basis for new development. Components on the checklist include partners whothey want to work with and questions likeis there a social challenge. BLOC uses different phases and each phase has its own management decisions. BLOC has systematic organized their R&D process as lean as possible.</p>
New product and service development demands very high investment costs	
Innovation is very important within our organization	<p>Graaff argues that innovation is crucial within the organisation of BLOC.</p> <p>BLOC tried to be the first in the development and application of new product and services, this in collaboration with partners. BLOC wants to be the company that brings different technical and market innovations together, by initiating partnerships between stakeholders with necessary knowledge.</p>
We try to be the first in the development and application of new products and services	

It is not important to be ahead of the competition, we only change to new technologies when it is absolutely necessary nvt

Innovativeness

Technological innovativeness

Did you possess the required technological know-how at the beginning of the R&D project?	BLOC didn't possess the required technological know-how at the beginning of the R&D process of the Dutch Wind Wheel. Because it takes a lot of time processing DWW, BLOC and their partners want to work with the latest technologies. Those technologies are not yet developed today.
Did you have any practical experiences in the application of the required technological competencies and the technological know-how?	BLOC didn't have any practical experience in the application of the required technological competencies and the technological know-how.
Could your organization use existing technological competencies and experiences during the project?	But BLOC could use existing technological competencies and experience during the project. Those means came from relationships with partners through R&D Networks.

Market innovativeness

Was the degree of novelty of the R&D output very high compared to previous products?	Graaf claims that the degree of novelty of the Dutch Wind wheel is very high compared to previous projects. The development of DWW aimed at many new customers for the organization. Previously BLOCs main customers were governmental organisations like ministries, provinces and municipalities. As a result of the DWW they now work with real estate developers, contractors and financial investors.
Did the R&D output aimed at many new customers to our organization?	Those business hop on board because the new way of the development process of the DWW.
Did the R&D output catered to new customer needs that we have not served before?	Graaff thinks that the DWW requires the use of new sales and distribution channels. They want to develop a new way of real estate financing. Is it possible to directly involve the end user? Is it possible that the end user makes a financial reservation at the front of the project? How can we come up with new ways of financing projects in collaboration with Fintech companies?
Did the new product required to use new sales and distribution channels?	

Newness: How new was the new product or service

For your organization	The DWW is completely new for the organisation. For customers of the organisation and the world the used technology is new as well.
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For the current customers of your organization
 For the target customers
 For the world
 The used technology

Dimension 1: Preference for means vs. goals

The R&D project was mostly specified on the basis of given means/resources. The target of the R&D project “The Dutch Wind Wheel” was vaguely defined in the beginning. BLOC only defined that the DWW needed to be a highly innovative building with the latest technologies implemented. The project began with a simple analyse of Rotterdam and the economical position in the of the City. They had found that Rotterdam didn’t had a iconic builder which could attract cruise ships which normally didn’t stop off in Rotterdam. The that Rotterdam needed some kind of London Eye. Then they came up with the idea that this icon should be the most sustainable and technological advanced building of the world. By framing and exaggerating this idea the international media picked it up and parties were interested in joining the development process. The project target has been deliberately kept open so the ownership of the idea could be broadened. BLOC provides a ecosystem of innovation the technological innovation have to come from the other partners.

Given means/resources have been the starting point for the project. The main resources where the competencies of skilled employees which had the know-how about how they had to bring the innovation to the market as well as a great network to organize the process and getting commitment of the proper partners.

Further required means/resources have been determined on the basis of given project targets although those targets where loosely defined. Graaff explained that have reached out to the companies who could add means/resources like specific knowledge to contribute to the given project target.

But in general rather given means than concisely given project targets have been the starting point of the project

Means..... ●Goals

Dimension 2: Preference for affordable loss vs. expected returns

Considerations about potential returns were decisive for the selection of the R&D options but not based on calculations of expected. Graaff claims that it is more a gut feeling that in the end the investments are worth it. The selection of the R&D-options was mostly based on a minimization of risks and costs. BLOC knows exactly how much money is spend on the projects on this moment.

Affordable loss..... ●Expected returns

Dimension 3: Preference for partnerships vs. competitive market analysis

BLOC tried to reduce risks of the R&D project through external partnerships and agreements. There focus was rather on the reduction of risks by approaching potential partners and customers than early identification of the risks though market analyses.

Partnerships.. ●Market analysis

Dimension 4: Preference for acknowledge the unexpected vs. overcome the unexpected

The R&D process of the DWW was flexible enough to be adjusted to new findings. The project target was to create a highly distinctive innovative sustainable building in combination with a new development process. This is still the main target but the technology and techniques are constantly changing during the R&D process. So new R&D findings influence didn't the project target but was flexible enough to integrate surprising result and finding.

The project planning was carried out in small steps during the project implementation. The project planning was the guidance but very global. BLOC only made a planning until the next phase of the project development process. At the beginning of the project they have defined the different phases during the development of the project. During executing the global planning the project team takes short sprints to global milestones. In the upcoming three months until the global milestone there could be new insights that change the project planning or even the project target. For the achieved milestone they make a new sort planning until the next milestone. Graaff explained that they use the scrum technique but at major project level. Despite of potential delays in project execution the process was flexible and took advantage of opportunities as they arose. The R&D process is set up to find new opportunities. The process dynamics and output are leading for the project pace.

BLOC used potential setbacks or external threats as advantageous as possible but used upfront market analyses to avoid setbacks or external treats as well. By doing upfront market analyses of the city of Rotterdam and how to cope with municipalities the project strategy was set up. The setback that the municipality of Rotterdam didn't want to cooperate in a specific phase was a trigger to gather specific partners and research institutes onboard to make it a market initiative. Aldo the municipality of Rotterdam found the idea interesting. Due to those partners the initiative is now stronger.

Acknowledge unexpected..... ● Overcome unexpected

R&D project success	(1 = totally disagree, 7 = fully agree, 8 = not applicable)
As a consequence of this project the reputation of our organization in the area related to this project is increased	7
The new or improved product / service provides us a competitive advantage	7
The new or improved product / service fulfils the needs of the clients	5
The new or improved product / service is of excellent (technical) quality	7
All project targets were met	7
Knowledge and experienced gained by the project members is of large value for subsequent development projects	7
The knowledge gained on this project is well secured in our organization	4
The project-team can be very satisfied with the final results.	7
Achieved results of the development project?	

De expenditures of the project were ...? Very
much lower than expected 1 2 3 4 5 Very much
higher than expected 3

The project duration was...?
Very much shorter 1 2 3 4 5 Very much longer 3

The gained profit is ...?
Very much lower than expected 1 2 3 4 5 Very
much higher than expected -

The achieved revenue is...?
Very much lower than expected 1 2 3 4 5 Very
much higher than expected -

What was developed came ... on the market?
Far too early 1 2 3 4 5 Far too late -

Experience and competencies

Learning and expertise that can be leveraged in
other projects Yes

Generation of new ideas as starting point of
potential future projects Yes

Enhancement of competencies and capabilities Yes

11.2 Analysis interview- Wessel Berendonk, Studio RAP

Analysis interview – Wessel Berendonk, Studio RAP

Participants	Wessel Berendonk, Studio RAP
Organization	Michiel van den Hoek, Rotterdam School of Management Erasmus University
Date	Studio RAP (Robotics, Architecture and Production)
Location	28-04-2016
Interview type	Rotterdam
	Semi-structured
Innovation project	Skilledin Office
Description innovation	The Skilledin Office is an innovative indoor-office, built in the InnovationDock (Rotterdam,NL) for the Port of Rotterdam. It's organic design balances program constraints and digital load-bearing optimization and fabrication possibilities. It's the first project in which they show the scalability of industrial robotic fabrication towards an architectural scale.
Firm characteristics	
Type of Organization	Start-up
Number employees	5
Description of Organization	Studio RAP provides products and services. They design buildings and fabricate a part of the building. As a part of Studio RAP, RAP technologies sells licenses for software which translate the designs to the robotic machinery.
Does your organization provide product or service or both	
Project-based firm R&D	
Experienced in the execution of projects	RAP has experience in the execution of projects, especially in new product and new service development projects, or R&D projects. RAP is almost ready for operational projects.
Tailormade products of services	RAP designed parts of buildings, which are tailor made products. Berendonk explained that they want to make a shift from serial mass production to serial mass customerization. For a robot it doesn't matter if he has to do thousand the same operations or thousand different operations.
Which organizational forms match best with your organization?	Studio RAP products and services are primarily being delivered on project-basis. The entire organization is subsidiary to the projects they execute for their clients (=project organization)

R&D is primarily responsible for innovations within their organization.

Everyone in the organization is responsible for innovation. The majority of the R&D is improvements of the software and new production techniques.

The organization of development projects is formalized within their organization. -

Firm R&D strategy

New product and service development is very important to sustain their position in the market in which they operate.

For Studio RAP new product and service development is very important to sustain their position in the market in which they operate. Berendonk claims that new product and service development is their identity and image.

New product and service development doesn't demands very high investment costs.

Berendonk argues that new product and service development doesn't demands very high investment costs. For example the purchase of a robot is highly expensive. We have found a partner who could provide the robot for the production of the elements without having to purchase it.

Innovation is very important within their organization.

At Studio RAP everything is about innovation this is why innovation is very important within the organization.

They try to be the first in the development and application of new products and services.

Studio RAP tries to be the first in the development and application of new products and services. At this moment they try to be the first with a 3D printed object with the use of robotics.

It is not important to be ahead of the competition, they only change to new technologies when it is absolutely necessary. -

Innovativeness

Technological innovativeness

Did you possess the required technological know-how at the beginning of the R&D project?

Studio RAP did possess a little of the required technological know-how at the beginning of the R&D project. Berendronk explained that he didn't had the know-how how to program a robot so he managed to learn it himself. He had to learn how to write the algorithms, but for the optimization of the interface he needed to involve a software developer.

Did you have any practical experiences in the application of the required technological competencies and the technological know-how?

Studio RAP didn't had any practical experience in the application of the required technological competencies and the technological know-how of using robotics for the production process of parts of a building.

Could your organization use existing technological competencies and experiences during the project?

Studio RAP could use existing technological competencies and experiences during the project. They build the software they used to produce the element on top of an existing software package.

Market innovativeness

Was the degree of novelty of the R&D output very high compared to previous products?

The degree of novelty of the R&D project was very high compared to previous products. Wood has been used to build things for centuries, but the application of wood in combination with robotics is completely new.

Did the R&D output aimed at many new customers to our organization?

Because Studio RAP is a start-up, they aimed at many new customers with this project. Berendronk explained that a lot of the marketing of the company is based on word of mouth advertising. RAP has modified a mill to the robot, which enables them to make some sort-term money. The goal of the company is to make more and larger projects.

Did the R&D output catered to new customer needs that we have not served before?

The R&D project catered the needs of new customers that not have been served before. Studio RAP is applying current material in a new way, this is why suppliers of material find this very interesting. Through the application of new technologies, stone suppliers are able to make products based on new forms of brickwork.

Did the new product required to use new sales and distribution channels?

For the sales of the software the new product required to use new sales and distribution channels.

Newness: How new was the new product or service

For your organization

This product is new for the organization, current customers of the organization, the target customers and the world. The used technology of milling in combination with robotics is already been used in other industries.

For the current customers of your organization

For the target customers

For the world

The used technology

Dimension 1: Preference for means vs. goals

The R&D project was specified on the basis of given means/resources.

The target of the R&D project was vaguely defined in the beginning. Starting the project RAP only had a vision on how the end result could look like.

Given means/resources have been the starting point for the project. RAP could test there hypotheses, because they could loan a robot from a company specialized in second-hand robots. RAP was developing software that was affordable for companies with a low budget. The supplier of the second-hand robots was interested in the software, because the low costs would match with the market of low priced second-hand robots. Trough this cooperation RAP was able to use the robot free of charge and the supplier of the second-hand robots could sell those robots including the software. Whereby the use of robots including good software was affordable for small and medium enterprises (SME).

Rather given means, than concisely given project targets, have been the starting point for their project. The access to the robot was the starting point for the project of studio RAP. This is why the project specification was predominantly based on given resources.

Means..●.....Goals

Dimension 2: Preference for affordable loss vs. expected returns

Considerations about potential losses were decisive for the selection of the R&D option. New product development for a start-up is only costing money. RAP has only invested based on a vision that the execution of the project was valuable for the company. Decisions on capital expenditures were primarily based on potential risks of losses. In the end the company didn't earn any money with the project. It only lead to a lot of exposure and potentially worldwide orders.

Project budgets were approved on the basis of considerations about acceptable losses. At the beginning of the project they decided what they could maximum lose with this project.

The selection of the R&D-option was mostly based on a minimization of risks and costs, because they had to stay within their budget. That is the reason they couldn't go all the way.

Affordable loss..●.....Expected returns

Dimension 3: Preference for partnerships vs. competitive market analysis

RAP reduced risks of the R&D project through external partnerships and agreements. RAP didn't do any market or competitor analyses. For example through a partnership with a wood supplier they could get the building materials for a reduced price. Through a partnership with a supplier of second-hand robots they were able to test the software and to start the production. They always try to partner for specific resources. They just started a partnership for concrete printing.

The focus of RAP was rather on the reduction of risks by approaching potential partners. They didn't approach any consumers yet, but in the near future they will approach customers as well.

Partnerships..●.....Market analysis

Dimension 4: Preference for acknowledge the unexpected vs. overcome the unexpected

During the execution of the project, the project team had a preference for acknowledge the unexpected.

New R&D findings influenced the project target a little bit. The project was a continuously quest to new findings, which could influence the project target.

The project planning was carried out in small steps during the project implementation. The employees of RAP did make a project planning, but they didn't make any sense. They had to make long working hours to deliver the project on time.

Despite of potential delays in project, execution of the project was flexible and they took advantage of opportunities as they arose. At the beginning of the project the project team didn't know where they would end up.

Potential setbacks or external threats were used as advantageous as possible. An example of a setback used as advantage was that while programming the robot, the robot movements didn't work as planned. Al the failed tests of the robot movements lead to possible solutions of making other specific parts.

Acknowledge unexpected..●..... Overcome unexpected

R&D project success	(1 = totally disagree, 7 = fully agree, 8 = not applicable)
As a consequence of this project the reputation of our organization in the area related to this project is increased	7
The new or improved product / service provides us a competitive advantage	6
The new or improved product / service fulfils the needs of the clients	6
The new or improved product / service is of excellent (technical) quality	5
All project targets were met	2
Knowledge and experienced gained by the project members is of large value for subsequent development projects	7
The knowledge gained on this project is well secured in our organization	5
The project-team can be very satisfied with the final results.	7
Achieved results of the development project?	
De expenditures of the project were ...? Very much lower than expected 1 2 3 4 5 Very much higher than expected	3
The project duration was...? Very much shorter 1 2 3 4 5 Very much longer	3
The gained profit is ...? Very much lower than expected 1 2 3 4 5 Very much higher than expected	1
The achieved revenue is...? Very much lower than expected 1 2 3 4 5 Very much higher than expected	1
What was developed came ... on the market? Far too early 1 2 3 4 5 Far too late	2
Experience and competencies	
Learning and expertise that can be leveraged in other projects	Learning and expertise gained in the project could be leveraged in other projects.

Generation of new ideas as starting point of potential future projects

This project lead to new ideas as starting point of potential future projects. RAP is now exploring how they can use robotics to assemble building parts.

Enhancement of competencies and capabilities

Studio RAP enhanced the competencies and capabilities during the project.

11.3 Analysis interview- Robert Koolen, Heijmans

Analysis interview – Robert Koolen, Heijmans

Participants	Robert Koolen , Heijmans
Organization	Michiel van den Hoek, Rotterdam School of Management Erasmus University
Date	Heijmans
Location	02-05-2016
Interview type	Rosmalen
	Semi-structured
Innovation project	Heijmans One
Description innovation	
Firm characteristics	
Type of Organization	Corporate
Description of Organization	
Number employees	6582
Does your organization provide product or service or both	Heymans provides products and services. But their primary focus is on projects. 70% of all the revenue are project related and about 30% is maintenance service related.
Project-based firm R&D	
Experienced in the execution of projects	The predominant operational process of Heijmans is the execution of projects.
Delivery of tailor made product and services	Heijmans makes tailor-made products and services. Heijmans is traditionally a contractor. Lately they encounter a trend towards designing and building assignments. Heijmans wants to develop the company towards design, build, maintain, finance and operate projects.
Which organizational forms match best with your organization?	Firstly Heijmans is divided by country, namely the Netherlands, Belgium and Germany. Secondly Heymans has divisions and department with responsibility for the production of a product or service (or a group of products or services targeted at one market).
R&D is primarily responsible for innovations within our organization.	Heijmans doesn't have a specific R&D department for the development of innovations. But they have a department called Heijmans technologies, which is mainly responsible for scouting new technology and innovation. In the operational business units there are special innovation committees with employees who also work in business projects. This committees lead the new technologies or new business ideas through a funnel, using the stage gate principles.
The organization of development projects is formalized within our organization	The organization of development projects is formalized as described above. Heijmans technologies is responsible for the application of patents.

Firm R&D strategy

New product and service development is very important to sustain our position in the market in which we operate	Koolen argues that new product and service development is important to sustain the position in the market in which Heijmans operates, despite the daily effort is directed toward the operational processes. They are focusing themselves more on improving existing products and services, than on innovation.
New product and service development demands very high investment costs	New product and service development demands little investments costs. This depends on the probability of the investment which has to be made for the development of the innovation project. They estimate the expected returns. As a part of the stage-gate principle they estimate the potential business case.
Innovation is very important within our organization	Koolen indicates that innovation is important within Heijmans, but he adds that not every employee can be working on innovation projects daily.
We try to be the first in the development and application of new products and services	Depending on the subjects Heijmans tries to be the first in the development and application of new products and services. They do not always have to be the first who brings an innovation to the market but they try to focus on being the first in specific innovations.

Innovativeness

Technological innovativeness

Did you possess the required technological know-how at the beginning of the R&D project? Did you have any practical experiences in the application of the required technological competencies and the technological know-how?	At the beginning of the R&D project "Heijmans One" Heijmans possessed the required technological know-how. But they added new products like integrated PV panels to the project. Heijmans did have field experience in the application of the required technological competencies and technological know-how. Heijmans could use existing technological competencies and experience during the project.
Could your organization use existing technological competencies and experiences during the project?	Koolen argues that the development of innovation projects the technological know-how is not the issue, but to come up with a new business model innovations, which leads to new earning models.

Market innovativeness

Was the degree of novelty of the R&D output very high compared to previous products?	The degree of novelty of the R&D project was in terms of technology not very high, but in terms of market innovativeness very high compared to previous projects. Koolen claims that bringing together a number of new developments has been the greatest innovation. The main innovation was bringing together derelict land with temporary housing and residents with a low income, who did not qualify for social housing.
Did the R&D output aimed at many new customers to our organization?	The R&D output aimed at many new customers for the organisation. The customers were the landowners of derelict land and potential residents with a low income.
Did the R&D output catered to new customer needs that we have not served before?	The R&D output catered new customer's needs that hasn't been served before.

Did the new product required to use new sales and distribution channels?

The new product required to use new sales and distribution channels. Because the project could not be sold to investors -because of legislation- Heijmans was forced to sale the houses to private homeowners.

Newness: How new was the new product or service

For your organization

For the current customers of your organization

For the target customers

For the world

The used technology

The product was new for the organization, new for the current customers of the organization and the target customers, but not new for the world and there were no new technologies used.

Dimension 1: Preference for means vs. goals

The R&D project was specified on the basis of given means/resources.

The target of the R&D project “Heijmans One” was vaguely defined in the beginning. The target aimed at target groups and their needs not on the movability. The starting point of vaguely defined targets is often motivated by social transformations.

Given means/resources have been the starting point for Heijmans One. Due to financial resources, the technical skills of the employee’s and the existing knowhow, Heijmans One was developed in the organisation, whereby the process converged toward a project target on the basis of those given means/resources. The project specification was predominantly based on given resources, but the longer the project took, the more specific the resources that been needed became clear. The stage-gate principles have been used to get the project target and the necessary means clear though time.

Means..●.....Goals

Dimension 2: Preference for affordable loss vs. expected returns

Both considerations about potential losses and potential returns were decisive for the selection of the R&D options. Project budgets were approved on the basis of considerations about whether they would fit within the innovation strategy and the belief and chances of success, as well as the calculations of expected returns. Koolen argues that preference for affordable loss or expected returns depending on the degree of newness of the innovation. When there is a high degree of newness, it is difficult to estimate the potential yield. Heijmans established a budget for the development of Heijmans One, by using both methods in different phases of the project. This is why decisions on capital expenditures were primarily based on potential risks of losses and potential returns, depending on the specific stage-gate.

Affordable loss..●.....Expected returns

Dimension 3: Preference for partnerships vs. competitive market analysis

Heymans tried to reduce risks of the R&D project through partnerships. Heymans is often approached by partners because they have an integrated role in the building process and an innovative image. When an innovation idea is not ready for development, Heymans sends the idea to Spark. Spark is an open innovation, located at the TU Eindhoven. Spark is a partnership between TU Eindhoven, Avans, the province and Heijmans, for new idea creation and start-ups. Heijmans is often approached by Start-ups with new ideas. For the development of Heijmans One, Heijmans focus was rather on the reduction of risks by approaching potential partners. Heijmans entered several partnerships for the development of Heijmans One, including architects and suppliers like Eneco, Hamwell, Dus Architecten, Zown (start-up Aliander), BMW and University of Tilburg. At this moment Heijmans is testing the Heijmans One on a temporary innovation-campus in Amsterdam.

Partnerships.. ●Market analysis

Dimension 4: Preference for acknowledge the unexpected vs. overcome the unexpected

Heijmans always tried to integrate surprising results and findings during the R&D process of Heijmans One— even though this was not necessarily in line with the original project target. Heijmans One was intended to sell to institutional investors. When it turned out that there were no investors interested, Heijmans switched their focus on selling their product to private homeowners. Those setbacks and external threats were used as advantageously as possible. New R&D findings influenced the project target. Heijmans incorporated an energy roof, which collects not only electrical energy, but also heat. The inclusion of this separate R&D project has moved the project target towards making housing of the future.

The R&D process was flexible enough to be adjusted to new findings. Koolen claims that they make a project planning and don't stick to it, because things don't always turn out to be as planned. Within Heijmans innovation, projects are managed by the same project leaders as the operational projects. Those project leaders have experience with managing innovation projects. As a result they are capable of managing the innovation project, without trying to control the process in a conventional way.

The project planning was carried out in small steps during the project implementation, by using the stage-gate method. When an innovation project is ready to bring to the market, the project can be planned in a more conventional way.

Acknowledge unexpected.. ● Overcome unexpected

R&D project success	(1 = totally disagree, 7 = fully agree, 8 = not applicable)
As a consequence of this project the reputation of our organization in the area related to this project is increased	6
The new or improved product / service provides us a competitive advantage	5
The new or improved product / service fulfils the needs of the clients	6
The new or improved product / service is of excellent (technical) quality	5
All project targets were met	4
Knowledge and experienced gained by the project members is of large value for subsequent development projects	6
The knowledge gained on this project is well secured in our organization	6
The project-team can be very satisfied with the final results.	4
Achieved results of the development project?	

De expenditures of the project were ...?	
Very much lower than expected 1 2 3 4 5 Very much higher than expected	3
The project duration was...?	
Very much shorter 1 2 3 4 5 Very much longer	4
The gained profit is ...?	
Very much lower than expected 1 2 3 4 5 Very much higher than expected	1
The achieved revenue is...?	
Very much lower than expected 1 2 3 4 5 Very much higher than expected	1
What was developed came ... on the market?	
Far too early 1 2 3 4 5 Far too late	3

Experience and competencies

Learning and expertise that can be leveraged in other projects	Yes
Generation of new ideas as starting point of potential future projects	Yes. There is a lot of spinoff from the Heijmans One.
Enhancement of competencies and capabilities	Yes. In particular the way to use the stage-gate principles.

11.4 Analysis interview- Menno van den Valk, Advin

Analysis interview – Menno van den Valk, Advin

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Participants	Menno van den Valk , Advin Michiel van den Hoek, Rotterdam School of Management Erasmus University
Organization	Advin
Date	03-05-2016
Location	Rotterdam
Interview type	Semi-structured

Innovation project	Circulaire weg
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Description innovation

Firm characteristics

Type of Organization	Corporate Advin is a consultancy and engineering firm, with more than 25 years of experience in the Dutch building sector. They focus on the market segments of Mobility & Traffic, Infrastructure, Industry, Oil & Gas and Energy & Heat. They aim at high-quality technical solutions and services for their clients. Advin is a medium-sized consultancy and engineering firm, with around 170 employees and they are one of the top 20 firms in the Netherlands.
Description of Organization	
Number employees	170
Does your organization provide product or service or both	Advin provides services.

Project-based firm R&D

Experienced in the execution of projects	The predominant operational process of Advin is the execution of projects.
Tailormade products of services	A part of the services they provide are tailor-made. The services of Advin are primarily being delivered on project-basis. The entire organization is subsidiary to the projects they execute for their clients (=project organization).
Which organizational forms match best with your organization?	
R&D is primarily responsible for innovations within their organization.	Within Advin nobody is primarily responsible for innovations. They do have a specific innovation consultant, with the focus on laser scanning of roads and buildings. But for other innovations no one is primarily responsible.
The organization of development projects is formalized within our organization	The organization of the development of projects within Advin is not formalized.

Firm R&D strategy

New product and service development is very important to sustain their position in the market in which they operate.

New product and service development demands very high investment costs.

Innovation is very important within their organization

They try to be the first in the development and application of new products and services.

For Advin new product and service development is very important to sustain their position in the market in which they operate.

Van den Valk argues that new product and service development doesn't demands very high investment costs.

Innovation is crucial within the organisation of Advin, claims van den Valk. Innovations are needed to improve products, processes and collaboration.

Advin tries to be the first in the development and application of new products and services. To be a top-player in the marked, Advin has to focus on innovations.

It is not important to be ahead of the competition, they only change to new technologies when it is absolutely necessary. -

Innovativeness

Technological innovativeness

Did you possess the required technological know-how at the beginning of the R&D project?

Van den Valk didn't possess the required technological know-how at the beginning of the R&D project. This had the advantage that he didn't saw any obstacles in order to carry out the project.

Did you have any practical experiences in the application of the required technological competencies and the technological know-how?

Van der Valk did possess some practical experience in the application of the required technological competencies and the technological know-how.

Could your organization use existing technological competencies and experiences during the project?

Advin could use existing technological competencies and experiences during the project. They already gave advices on building roads. By linking existing knowledge and networks van den Valk created a better proposition.

Market innovativeness

Was the degree of novelty of the R&D output very high compared to previous products?

The degree of novelty of the R&D output was not very high compared to previous products. It was the combination of all innovative products in the road that made it innovative.

Did the R&D output aimed at many new customers to our organization?

The R&D output aimed at many new customers to the organisation.

Did the R&D output catered to new customer needs that we have not served before?

The R&D output catered to new customer's needs that had not yet served before. The circular road is not yet available.

Did the new product required to use new sales and distribution channels?

The new product can possible require the use of new sales and distribution channels.

Newness: How new was the new product or service

For your organization

The product is not new for the organization. The product is new for current customers and target customers, like governments and the end-user.

For the current customers of your organization

For the target customers

For the world

The used technology

Dimension 1: Preference for means vs. goals

The R&D project was specified on the basis of given means/resources.

The target of the R&D project was vaguely defined in the beginning of the project. The project target was mainly about the old business model of how to save cost but at the end it was about delivering added value.

Given means/resources have been the starting points for the project. The project targets only came later.

The process converged towards a project target on the basis of given means/resources. Van den Valk started by approaching partners. Because their company is known as reliable, people want to work with them.

So rather given means, than concisely given project targets, has been the starting point for their project.

Means..●.....Goals

Dimension 2: Preference for affordable loss vs. expected returns

Considerations about potential losses were decisive for the selection of the R&D option. By internal lobbying they could get a budget to start the innovation. Van der Valk claims that by investing in innovation, project considerations about expected returns had to be taken into account. This could mean money, but exposure and social benefits as well.

Project budgets were approved on the basis of considerations about acceptable losses and the expected results of the R&D project. They must achieve monthly results in order to get the budget. The R&D project provides step-by-step results.

Decisions on capital expenditures were primarily based on potential risks of losses.

Affordable loss..●.....Expected returns

Dimension 3: Preference for partnerships vs. competitive market analysis

Advin tried to reduce risks of the R&D project through internal or external partnerships and agreements.

Advin's focus was rather on the reduction of risks by approaching potential partners and customers. The R&D project was started because there was a vision of success, not through market analyses. Many innovations are being approached from the technical part, with the result that the market is not always interested.

Partnerships..●.....Market analysis

Dimension 4: Preference for acknowledge the unexpected vs. overcome the unexpected

Advin always tried to integrate surprising results and findings during the R&D process – even though this was not necessarily in line with the original project target.

The R&D process was flexible enough to be adjusted to new findings. They had found that with the use of a different surface, they could reduce the thickness of the asphalt with nine centimetres, which resulted in big cost savings. This led to an enormous energy boost in the team.

The project planning was carried out in small steps during the project implementation. Van den Valk argues that the result is more important than the achieving of milestones in time.

Despite of potential delays in project execution, they were flexible and took advantage of opportunities as they arose.

Potential setbacks or external threats were used as advantageous as possible. As an example: One of the partners did not respect the agreements, what made them untrustworthy. By solving the problem and communicating, the team spirit was increased.

Acknowledge unexpected..●..... Overcome unexpected

R&D project success	(1 = totally disagree, 7 = fully agree, 8 = not applicable)
As a consequence of this project the reputation of our organization in the area related to this project is increased	2
The new or improved product / service provides us a competitive advantage	5
The new or improved product / service fulfils the needs of the clients	5
The new or improved product / service is of excellent (technical) quality	5
All project targets were met	5
Knowledge and experienced gained by the project members is of large value for subsequent development projects	5
The knowledge gained on this project is well secured in our organization	2
The project-team can be very satisfied with the final results.	5
Achieved results of the development project?	
De expenditures of the project were ...? Very much lower than expected 1 2 3 4 5 Very much higher than expected	2
The project duration was...? Very much shorter 1 2 3 4 5 Very much longer	5
The gained profit is ...? Very much lower than expected 1 2 3 4 5 Very much higher than expected	-

The achieved revenue is...?
Very much lower than expected 1 2 3 4 5 Very
much higher than expected -

What was developed came ... on the market?
Far too early 1 2 3 4 5 Far too late 2

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Experience and competencies

Learning and expertise that can be leveraged in
other projects Yes

Generation of new ideas as starting point of
potential future projects No

Enhancement of competencies and capabilities Yes

11.5 Analysis interview – Jacco Saman, SPIE

Analysis interview – Jacco Saman, SPIE

Participants	Jacco Saman ,SPIE
Organization	Michiel van den Hoek, Rotterdam School of Management Erasmus University
Date	SPIE
Location	11-05-2016
Interview type	Rotterdam
	Semi-structured
Innovation project	SPIE Simple
Description innovation	SPIE simply said is a computerized maintenance management system. This system detects disturbances of installation in systems of costumers in buildings and other related equipment and links those to the nearest service mechanic. Managing the mechanics happens automatically through the system.
Firm characteristics	
Type of Organization	Corporate
Description of Organization	SPIE Nederland is a subsidiary of the SPIE group, the independent European leader in multi-technical services in the areas of energy and communications. SPIE Nederland provides advice and technical solutions in design, building and maintenance of network systems and energy, infrastructure, industrial and building installations. SPIE Nederland holds a position in the top 5 of technical service providers in the Netherlands. Within the SPIE Group there are 38.000 employees working from over 550 sites in 35 countries, the SPIE group achieved consolidated revenues of € 5.22 billion in 2014 and consolidated an EBITA of € 334 million. In its North-Western Europe segment, with 8.900 employees working from about 92 sites, the SPIE group generated revenues of € 1.21 billion in 2014. In the Netherlands there ar 3500 employees working for SPIE.
Number employees	38.000
Does your organization provide product or service or both	SPIE Netherlands has a number of products, but they are mainly a technical service provider in large operational projects. Products are delivered in cooperation with other parties.
Project-based firm R&D	
Experienced in the execution of projects	80% of the activities of SPIE are operational projects. The remaining 20% of the activities include renewing and innovation projects.

Tailor-made products of services

SPIE makes tailor made products and services on request. This depends on the procurement requirements.

Which organizational forms match best with your organization?

SPIE is organized as a division with departments, which is responsible for a group of products or services targeted at one market (=product/divisional organization).

R&D is primarily responsible for innovations within their organization.

SPIE hasn't got a specific R&D department responsible for innovations within their organization. The department Business Development initiate innovation projects in collaboration with suppliers and partners and engineers of operational projects. Engineers from operational projects are being asked to join cross-functional teams for the executing of R&D projects. This has to be approved by the business unit managers, because of the number of hours that the employees are working on R&D projects are not billable. Because the spend hours are not billable, the business unit of the operational projects are the ones who are investing in the R&D projects.

The organization of development projects is formalized within their organization.

Firm R&D strategy

New product and service development is very important to sustain their position in the market in which they operate.

For SPIE new product and service development is very important to sustain their position in the market which they operate, but only when the new product or service contributes to a public demand or customer demand.

New product and service development demands very high investment costs.

Saman argues that new product and service development does not require very high investment costs. This depends on how the R&D project is executed.

Innovation is very important within their organization.

Saman thinks that innovation is very important within the organisation. The importance of innovation fits within the core value's of SPIE, namely Local presence alongside its teams, customers and partners. Businesses and cultures grow by working as a network, fostering solidarity among teams. A catalyst of creativity and innovation, the breadth of these exchanges benefits customers, improves performance.

They try to be the first in the development and application of new products and services.

SPIE doesn't try to be the first in the development and application of new products and services. Their work is mainly based on today's costumers needs.

It is not important to be ahead of the competition, they only change to new technologies when it is absolutely necessary.

SPIE doesn't try to be ahead of competition implementing new technologies when it isn't absolutely necessary. They try to be ahead of competition by doing other things that the competition. One example is the collaboration in the Dutch Wind Wheel. There are no other competitors of the energy branch, who are also involved in this partnership.

Innovativeness	
Technological innovativeness	
Did you possess the required technological know-how at the beginning of the R&D project?	SPIE did possess the required technological know-how at the beginning of the R&D project. SPIE knew the process and that this process could be meaner and leaner. SPIE also possessed the required technological know-how and ICT skills to program this functions, without hiring consultants or starting a R&D team.
Did you have any practical experiences in the application of the required technological competencies and the technological know-how?	SPIE had practical experience in the application of the required technological competencies. Saman had an ICT and business administration background, which he could use for the development of the project.
Could your organization use existing technological competencies and experiences during the project?	This is why SPIE could use existing technological competencies and experience during the project.
Market innovativeness	
Was the degree of novelty of the R&D output very high compared to previous products?	The degree of novelty of “SPIE simple” was high compared to previous products.
Did the R&D output aimed at many new customers to our organization?	SPIE simply was aimed at new customers like Rijkswaterstaat, the province and the municipalities.
Did the R&D output catered to new customer needs that we have not served before?	The R&D output catered new customer’s needs that have not been served before. The response time was reduced compared, to the number of disturbances.
Did the new product required to use new sales and distribution channels?	There were no new sales and distribution channels needed for SPIE simpel
Newness: How new was the new product or service	
For your organization	The product was new for the organisation of SPIE. Service technicians were previously planned in by project leaders. Now the process-based management has been replaced by ICT.
For the current customers of your organization	The service was not new for current customers and targeted customers of the organisation, but the customers noticed that the response time of the service was shortened.
For the target customers	
For the world	They haven’t studied the market. In Saman’s opinion the product was not new for the world. He thinks that by the time they developed the product, it could already have existed in Japan.
The used technology	The used technology was not new.
Dimension 1: Preference for means vs. goals	

The R&D project of “SPIE simple” was mostly specified on the basis of given project targets. The target of the R&D project was clearly defined in the beginning. The target came from the problems that occurred in the organization. Those principles and the project target was clear in the beginning of the project. Required means/resources have been determined on the basis of given project targets. In this case those were the existing project experiences of the obstacles which occurred at the users of service technicians and the speed of solving technical disturbances, as well as the monitoring of the number of disturbances of a system. Also the existing skills of employees and experts in the appropriate field of internal business processes and ICT knowledge have contributed to the success of the R&D project. In the case of SPIE the process simply converged towards a project target on the basis of given means/resources, instead of required means/resources having to be determined on the basis of given project targets. SPIE wanted to create a process improvement, not knowing at the beginning of the project how much it would yield. Afterward it became clear that when the previous situation was maintained, the cost of five thousand mechanics were much higher than the investment cost of the hours of the ICT employees of SPIE.

Means.....●...Goals

Dimension 2: Preference for affordable loss vs. expected returns

Considerations about potential returns were decisive for the selection of the R&D options. Project budgets were approved based on calculations of expected returns of improving the deployment of the mechanics. The cost of the ICT investment didn't outweigh the potential returns on improving the deployment of the mechanics. So the selection of the R&D options and the decisions on capital expenditures were primarily based on analyses of future potential returns.

Affordable loss.....●...Expected returns

Dimension 3: Preference for partnerships vs. competitive market analysis

Because SPIE Simple was an internal R&D project, there were only internal partnerships between the specific business units. There were no risks identified through market and competitors analyses. There were no external potential partners and customers approached.

Partnerships..●.....Market analysis

Dimension 4: Preference for acknowledge the unexpected vs. overcome the unexpected

SPIE Simple has characteristics of both acknowledge the unexpected and overcome the unexpected.

In the beginning of the project the R&D team had made a functional description of how the end result would look like. At the end of the project about 90% of this description was realized. The other 10% were new findings and improvements of initial functional descriptions. Saman argues that 90% was of the functional description was executed as planned, because the functional description was based on the practical experience of the R&D team. New or surprising results and findings were only integrated when the original project target was not at risk. Saman claims that innovation projects within SPIE in general are based on a spot on the horizon, which can change over time, due to new findings or social changes in time. This was not the case at the development of SPIE simple. But the R&D process was flexible enough to be adjusted to new findings, although the new findings did not influence the project target. Whereby the project planning was carried out in small steps during the project implementation of SPIE simple.

The R&D process was flexible enough to be adjusted to new findings. New R&D findings did not influence the project target

The project planning was carried out in small steps during the project implementation.

Despite of potential delays in the project execution, the R&D team process was flexible and took advantage of opportunities as they arose.

Potential setbacks or external threats were used as advantageous as possible. At the presentation of the first draft version of the program, the CEO was not convinced about the R&D result. The presentation was just to inform the CEO about which steps had been taken. This setback motivated the team to improve the R&D project, to prove it could be a enormous innovation for the company.

Acknowledge unexpected..... ● Overcome unexpected

R&D project success	(1 = totally disagree, 7 = fully agree, 8 = not applicable)
As a consequence of this project the reputation of our organization in the area related to this project is increased	7
The new or improved product / service provides us a competitive advantage	4
The new or improved product / service fulfils the needs of the clients	6
The new or improved product / service is of excellent (technical) quality	6
All project targets were met	7
Knowledge and experienced gained by the project members is of large value for subsequent development projects	5
The knowledge gained on this project is well secured in our organization	2
The project-team can be very satisfied with the final results.	7
Achieved results of the development project?	

De expenditures of the project were ...?
 Very much lower than expected 1 2 3 4 5 Very
 much higher than expected 4

The project duration was...?
 Very much shorter 1 2 3 4 5 Very much longer 3

The gained profit is ...?
 Very much lower than expected 1 2 3 4 5 Very
 much higher than expected 4

The achieved revenue is...?
 Very much lower than expected 1 2 3 4 5 Very
 much higher than expected 4

What was developed came ... on the market?
 Far too early 1 2 3 4 5 Far too late -

Experience and competencies

Learning and expertise that can be leveraged in
 other projects

The learning points and expertise of SPIE simple
 can be leveraged in other projects. Saman stated
 that he got to know new employees within the
 organisation, who could contribute to other
 innovation projects.

Generation of new ideas as starting point of
 potential future projects

Spie Simple has been a major starting point of
 potential future projects. SPIE wants to use the
 same program, not only for the mechanics, but the
 equipment as well.

11.6 Analysis interview – Age Vermeer, Dura Vermeer

Analysis interview – Age Vermeer, Dura Vermeer

Participants	Age Vermeer, Dura Vermeer
Organization	Michiel van den Hoek, Rotterdam School of Management Erasmus University
Date	Dura Vermeer
Location	12-05-2016
Interview type	Rotterdam
	Semi-structured

Innovation project	Vlotterkering
Description innovation	Vlotterkering is designed to be a temporary water barrier integrated into a dike or embankment that protects the land and its inhabitants from extreme water surges. Vlotterkering is a flexible barrier that closes automatically. It consists of a cement basin and a float with a steel panel lid on top that serves as the water barrier. When the Vlotterkering is not in use, the float rests in the cement basin integrated in the embankment.

Firm characteristics

Type of Organization	Corporate
Description of Organization	Dura Vermeer is a national Construction company, with turnover of more than € 1 billion and about 2500 employees, they count among the top of the Dutch Construction market. Dura Vermeer is active in construction, infrastructure, engineering and services. They develop, realise and operate projects commissioned by third parties, at their own risk. Dura Vermeer tries to stand out and has an innovative method of working. Together with their partners, they offer industry-leading, integrated and sustainable solutions, for a wide range of building projects. This makes them a sound partner for their business relations, with a focus on continuity and sustainability.
Number employees	2500
Does your organization provide product or service or both	Dura Vermeer provides products and services. But their primary focus is on projects.

Project-based firm R&D

Experienced in the execution of projects	The predominant operational process of Dura Vermeer is the execution of projects.
Tailor-made products of services	Dura Vermeer makes tailor-made products and services.

Which organizational forms match best with your organization?	Dura Vermeer has divisions and departments, with the responsibility for the production of a product or service (or a group of products or services targeted at one market).
R&D is primarily responsible for innovations within their organization.	Dura Vermeer has no specific R&D Department. Within the board of Dura Vermeer a few people are strategically responsible. Dura Vermeer Infrastructure has several innovation managers, which focus on product or process innovations.
The organization of development projects is formalized within their organization.	The organization of development of projects is formalized within the organization of Dura Vermeer.

Firm R&D strategy

New product and service development is very important to sustain their position in the market in which they operate.	For Dura Vermeer new product and service development is very important to sustain their position in the market. Vermeer claims that with innovation you can make a difference. Vermeer argues that although innovation takes a lot of money and energy, new product and service development don't demand unnecessary high investment cost.
New product and service development demands very high investment costs.	
Innovation is very important within their organization.	For Dura Vermeer innovation is very important within their organization. Vermeer claims that Dura Vermeer doesn't try to be the first in the development and application of new products and services. In the overall strategy of Dura Vermeer is described that the company wants to be in the top 3 of most innovative companies in the construction sector of the Netherlands. But at this moment Dura Vermeer is not that far yet.
They try to be the first in the development and application of new products and services.	
It is important to be ahead of the competition, they change to new technologies even when it is not absolutely necessary.	For Dura Vermeer innovation is important. They try to change to new technologies, even when it is not absolutely necessary.

Innovativeness

Technological innovativeness

Did you possess the required technological know-how at the beginning of the R&D project?	Dura Vermeer did possess the required technological know-how at the beginning of the R&D project. Vermeer claims that this know-how doesn't only come from Dura Vermeer, but from partners as well. Innovation is often born out of a problem. Vermeer explains that frustration gives innovation. Mostly there is a problem and to solve it they are looking for partners with knowledge and skills to solve it.
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Did you have any practical experiences in the application of the required technological competencies and the technological know-how?

Could your organization use existing technological competencies and experiences during the project?

- Dura Vermeer used existing technological competencies and experiences during the innovation project. Vermeer argues that innovation is linking together existing things. Connecting ideas with existing solutions.

Market innovativeness

Was the degree of novelty of the R&D output very high compared to previous products?

Did the R&D output aimed at many new customers to our organization?

Did the R&D output catered to new customer needs that we have not served before?

Did the new product required to use new sales and distribution channels?

The degree of novelty of the R&D project output was very high compared to previous products.

The R&D output aimed at many new customers to their organization. Vermeer claims that the innovation is always intended to be distinctive from competitors.

The R&D project didn't cater to new customers needs, that have not served before.

The new product didn't require the use of new sales and distribution channels. Innovation is mostly developed for the operational projects. They try to incorporate the innovation into these projects.

Newness: How new was the new product or service

For your organization

For the current customers of your organization

For the target customers

For the world

The used technology

The product is new for the organization, the current customers and target customers for the organisation and for the world. The technology is new as well.

Dimension 1: Preference for means vs. goals

Their R&D project was specified on the basis of given project targets.

It depends on the project of the target of the R&D project is vaguely or clearly defined in the beginning. When people have a new idea for a product or service it's more clearly, but it is always an iterative process. They improve existing ideas continuously with their partners.

The given project-targets have been the starting point of the innovation project. The target of innovation projects is usually making something smarter or sustainable. There are always projects where they want to use the new innovation. When the project target is defined, they seek together with their partners for the required resources. But always with the customer in mind. So required means/resources have been determined on the basis of given project targets.

Means..... ●Goals

Dimension 2: Preference for affordable loss vs. expected returns

Considerations about potential losses were mostly decisive for the selection of the R&D option. Vermeer explained that the margins in the construction sector are very low and as a result there aren't big R&D budgets. The innovations are mostly incorporated in operational projects. For example: Dura Vermeer has developed a crusher for break-stones on site so they didn't need to feed and discharge break-stones. The investment was made on the operational project budget. Vermeer argues that when they had made a business case, the investment wasn't made. Money is spent step-by-step during the optional processes. Investments on R&D projects are mostly made when the customer wants to pay the process. When a new innovation is applied, it is often considered whether the technology has already proven itself in the market or not. Sometimes you just have to do it. They will continue to innovate by corporation with partners and suppliers. The innovation of products and services are mainly based in chain cooperation and an integrated process approach. They want to stimulate the fact that suppliers of innovate products, incorporate their product in the operational project of Dura Vermeer.

The selection of the R&D-option was mostly based on a minimization of risks and costs. But analyses for future returns are taken into account as well.

Affordable loss..●.....Expected returns

Dimension 3: Preference for partnerships vs. competitive market analysis

They tried to reduce risks of the R&D project through internal or external partnerships and agreements. Vermeer argues that there are companies who only collaborate with a start-ups to improve their innovations skills. But it takes more to be an innovative company.

Their focus was rather on the reduction of risks by approaching potential partners and customers. It could be useful to test the product or service during the innovation process with the customer. Vermeer argues that most customers are open to improvements. It's a combination of creating internal and external support. In the organization of Dura Vermeer a R&D project must be quickly profitable.

Partnerships..●.....Market analysis

Dimension 4: Preference for acknowledge the unexpected vs. overcome the unexpected

They always tried to integrate surprising results and findings during the R&D process — even though this was not necessarily in line with the original project target.

The R&D process was flexible enough to be adjusted to new findings.

New R&D findings influenced the project target. The development of a R&D project is an iterative process. Most R&D projects they execute are linking existing technologies.

During the R&D project the project planning was carried out in small steps during the project implementation. Vermeer argues that planning according to predetermined criteria will stifle innovation. Vermeer claims that R&D projects need project managers with other skills, like creativity and collaboration, more than the operational projects.

Vermeer argues that because they always executed projects for specific clients, with a highly differentiated and customized nature of demand and low margins, it is unlikely that they come up with a radical/disruptive innovation. They only execute R&D projects when a customer is willing to pay for it.

Acknowledge unexpected..●..... Overcome unexpected

R&D project success

(1 = totally disagree, 7 = fully agree, 8 = not applicable)

As a consequence of this project the reputation of our organization in the area related to this project is increased

5

The new or improved product / service provides us a competitive advantage 5

The new or improved product / service fulfils the needs of the clients 3

The new or improved product / service is of excellent (technical) quality 4

All project targets were met 4

Knowledge and experienced gained by the project members is of large value for subsequent development projects 5

The knowledge gained on this project is well secured in our organization 2

The project-team can be very satisfied with the final results. 6

Achieved results of the development project?

De expenditures of the project were ...?
Very much lower than expected 1 2 3 4 5 Very much higher than expected 3

The project duration was...?
Very much shorter 1 2 3 4 5 Very much longer 3

The gained profit is ...?
Very much lower than expected 1 2 3 4 5 Very much higher than expected 3

The achieved revenue is...?
Very much lower than expected 1 2 3 4 5 Very much higher than expected 2

What was developed came ... on the market?
Far too early 1 2 3 4 5 Far too late 2

Experience and competencies

Learning and expertise that can be leveraged in other projects Yes

Generation of new ideas as starting point of potential future projects No

Enhancement of competencies and capabilities Yes

11.7 Analysis interview – Ferdinand Grapperhaus, PHYSEE

Analysis interview – Ferdinand Grapperhaus, PHYSEE

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Participants	Ferdinand Grapperhaus , PHYSEE
Organization	Michiel van den Hoek, Rotterdam School of Management Erasmus University
Date	PHYSEE
Location	03-06-2016
Interview type	Delft
	Semi-structured

Innovation project	Power Window
Description innovation	PowerWindows are patented and transparent double-paned windows that convert light into electricity. Conventional glass reflects about 30% of the incoming light, instead they collect that with the coating, transport it through the glass and convert it into electricity with solar cells inside the window frame.

Firm characteristics

Type of Organization	Start-up PHYSEE was founded by Willem Kesteloo and Ferdinand Grapperhaus in September 2014. It is a spin-off from research conducted at the department of Radiation, Science & Technology (RST) at the Delft University of Technology on Luminescent Solar Concentrators, led by Erik van der Kolk. PHYSEE believes that sustainable innovations will only become and remain successful, if they are without compromise. Meaning that the innovation should be non-intrusive and cost-efficient. It is from that believe PHYSEE developed PowerWindow.
Description of Organization	
Number employees	9 PHYSEE doesn't provide any product and a service at this moment, but they are going to provide products and services in the near future. They have just closed a deal with Real Estate Developer OVG, to deliver the power window. The delivery is including the monitoring of the electricity.
Does your organization provide product or service or both	

Project-based firm R&D

Experienced in the execution of projects	PHYSEE has experience in the execution of projects, especially in new product and service development projects. PHYSEE delivers tailor made products. Their goal is to supply Power Windows to five signature building in the world. At this moment they have a patent for the coating that collects sunlight and
Tailormade products of services	

Which organizational forms match best with your organization?

R&D is primarily responsible for innovations within their organization.

sends it to the frames. The goal is to licence the coating in the near future to the four big glass suppliers of the world.

PHYSEE's products and services are primarily being delivered on project-basis. The entire organization is subsidiary to the projects they execute for our clients (=project organization)

In the organisation of PHYSEE every employee is responsible for innovation within the company. PHYSEE is founded by Ferdinand Grapperhaus and Willem Kesteloo. Grapperhaus is primarily responsible for product development and Kesteloo is primarily responsible for R&D.

The organization of development projects is formalized within their organization.

-

Firm R&D strategy

New product and service development is very important to sustain their position in the market in which they operate.

For PHYSEE new product and service development is their existence. It is crucial to sustain their position in the market in which they operate.

Grapperhaus agrees that new product and service development demands very high investment costs. But he explained that everyone who contributes to the innovation project, wants to be paid for it. At this moment they pay for all of this with a funding. Grapperhaus claims that you never know what the end result will be when you're investing in innovation.

New product and service development demands very high investment costs.

Innovation is very important within our organization

Innovation is very important within the organization of PHYSEE.

They try to be the first in the development and application of new products and services.

PHYSEE tries to be the first in the development and application of the new coating of the power windows.

It is not important to be ahead of the competition, they only change to new technologies when it is absolutely necessary.

-

Innovativeness

Technological innovativeness

Did you possess the required technological know-how at the beginning of the R&D project?

PHYSEE didn't have the required technological know-how at the beginning of the R&D project. For example they didn't have enough knowledge of the chemical principles of the coating. Therefore they involved someone with this knowledge.

Did you have any practical experiences in the application of the required technological competencies and the technological know-how?

PHYSEE didn't have any practical experience in the application of the required technological competencies and the technological know-how.

Could your organization use existing technological competencies and experiences during the project?

PHYSEE could use existing technological competencies and experience during the project. Graperhouse explained that when you're building a window which can transform solar light into electrical energy, there are a lot of components that already exist, like the insulated glass or window frames. They combine these components to a new product.

Market innovativeness

Was the degree of novelty of the R&D output very high compared to previous products?

The degree of novelty of the Power Window was very high in comparison to previous products. World Wide there are a few competitors who are doing research to power generating windows. But no one is using the specific coating.

Did the R&D output aimed at many new customers to our organization?

PHYSEE aimed at many new costumers to their organisation with the Power Window. With the Power Window PHYSEE catered new customer needs that have not been served before.

Did the R&D output catered to new customer needs that we have not served before?

The new product didn't require the use of new sales and distribution channels. PHYSEE wants to make use of the channels that already exist. They aim to sell the Power Window by existing suppliers of insulated glass or windows.

Did the new product required to use new sales and distribution channels?

Newness: How new was the new product or service

For your organization

The product is new for the organization, current customers and target customers of the organisation and the world. The used technology is new as well.

For the current customers of your organization

For the target customers

For the world

The used technology

Dimension 1: Preference for means vs. goals

The R&D project was specified on the basis of given means/resources.

The target of the R&D project "Power Window" was vaguely defined in the beginning. PHYSEE knew that they wanted to develop a sustainable innovation, without any compromises. They didn't even know who their costumers should be.

Developing the Power Window given means and resources has been the starting point for the project. During their research conducted at the department of Radiation, Science & Technology (RST) at the Delft University of Technology ,they found that there are materials that absorb and emit light, which they could convert to a coating.

The process converged towards a project target on the basis of given means/resources.

Means..●.....Goals

Dimension 2: Preference for affordable loss vs. expected returns

At the beginning of the project considerations about potential losses were decisive for the selection of the R&D option. Grapperhaus argues that when starting a company you have nothing to lose. Grapperhaus explained that there is a lot of money involved with R&D of a new product. You never know if the investment will be recovered. Grapperhaus argues that project-based corporations should reserve a small percentage of the project budget for innovations. This enables the project teams to focus on innovations, instead of focussing only at the operational process and this provides start-ups an opportunity to apply their innovation.

Project budgets were approved on the basis of considerations about expected returns. Corporations want to know how much is invested and what the expected returns are. In the end PHYSEE made a business plan including ROI, where they calculated the expected returns.

The selection of the R&D-option was mostly based on analyses of future returns. During the R&D process they focused on the greatest possible power output. They calculated which power output resulted in a feasible and good business case. That is why decisions on capital expenditures were primarily based on potential returns.

Affordable loss..... ●Expected returns

Dimension 3: Preference for partnerships vs. competitive market analysis

PHYSEE tried to reduce risks of the R&D project through internal or external partnerships and agreements. PHYSEE has a partnership with ASW, a supplier of window frames and with OVG, a real estate developer of offices. Grapperhaus argues that without the partnerships PHYSEE couldn't exist. Grapperhaus explained that they only enter into a partnership when partners add value. He claims that the most corporations who want to start a partnership in order to get media attention. PHYSEE was very strict in selecting their partners. OVG was chosen because they are leading in the development of sustainable offices in the Netherlands. OVG is now the launching customer of the Power Window. A launching customer helps the development of the product and creates trust in the new product. PHYSEE and OVG going to test the Power Window during the development of the office of Rabobank Eindhoven. PHYSEE is responding to the market demand that in 2020 all buildings in the Netherlands have to be energy neutral.

The focus of PHYSEE was on the reduction of risks, by approaching potential partners and customers. The partnerships with potential customers like OVG are aimed to supply the product and making money. The partnerships with other suppliers aim to test the market without owning all the resources.

Partnerships.. ●Market analysis

Dimension 4: Preference for acknowledge the unexpected vs. overcome the unexpected

They always tried to integrate surprising results and findings during the R&D process — even though this was not necessarily in line with the original project target.

Their R&D process was flexible enough to be adjusted to new findings

New R&D findings are constantly influencing the project target. Grapperhaus believes that is the strength of a young company. PHYSEE is using the scrum methodology as project planning.

The project planning is carried out in small steps during the project implementation. Flexible planning provides the possibility to pivot the plan quickly. For the project development they use LEAN start-up methods as well. This enables us to test different R&D options, until they meet the perfect requirements.

Despite of potential delays in project execution, the innovation process of PHYSEE was flexible and took advantage of opportunities as they arose. The partner OVG is able to think along in this process. When the power window is not ready for daily use at the completion of the construction project. They will then change the power window a day before completion for regular glass.

Potential setbacks or external threats are being used as advantageous as possible. For example: The original materials which they used for creating the coating was not accepted by the industry. They are now working on a new coating. This coating is in terms of transparency and aesthetic a great leap forward.

Acknowledge unexpected..●..... Overcome unexpected

R&D project success	(1 = totally disagree, 7 = fully agree, 8 = not applicable)
As a consequence of this project the reputation of our organization in the area related to this project is increased	7
The new or improved product / service provides us a competitive advantage	7
The new or improved product / service fulfils the needs of the clients	7
The new or improved product / service is of excellent (technical) quality	7
All project targets were met	?
Knowledge and experienced gained by the project members is of large value for subsequent development projects	8
The knowledge gained on this project is well secured in our organization	7
The project-team can be very satisfied with the final results.	?
Achieved results of the development project?	
De expenditures of the project were ...? Very much lower than expected 1 2 3 4 5 Very much higher than expected	5
The project duration was...? Very much shorter 1 2 3 4 5 Very much longer	5

The gained profit is ...?
 Very much lower than expected 1 2 3 4 5 Very
 much higher than expected ?

The achieved revenue is...?
 Very much lower than expected 1 2 3 4 5 Very
 much higher than expected ?

What was developed came ... on the market?
 Far too early 1 2 3 4 5 Far too late ?

Experience and competencies

Learning and expertise that can be leveraged in
 other projects Yes

Generation of new ideas as starting point of
 potential future projects Yes

Enhancement of competencies and capabilities Yes

11.8 Analysis interview – Steven Verver, ZXY-Builders

Analysis interview – Steven Verver, ZXY-Builders

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Participants	Steven Verver, ZXY-Builders Michiel van den Hoek, Rotterdam School of Management Erasmus University
Organization	ZXY-Builders
Date	20-06-2016
Location	Rotterdam
Interview type	Semi-structured

Innovation project	Using Drones in the building process
Description innovation	ZXY Builders develops the ZXY Cloud platform for capturing aerial data, using autonomous drones. ZXY Cloud scans sites on a daily basis and sends the data to a secure cloud portal for immediate use. ZXY Cloud is used in construction, energy, utilities and governmental applications.

Firm characteristics

Type of Organization	Start-up ZXY-Builders is a technology-based company that develops, integrates and operates small Unmanned Aerial Vehicles (UAV) for remote sensing applications. They provide operating services and assist clients to set up a complete end-to-end UAV operating and sensor data processing solution. In cooperation with their partners they're constantly developing new opportunities for remote sensing systems.
Description of Organization	
Number employees	5 ZXY-builders provides both products and services.
Does your organization provide product or service or both	They inspect buildings with the use of drones and provide software to process the inspections.

Project-based firm R&D

Experienced in the execution of projects	The use of drones in the building process is a developing market. This is why ZXY is currently focusing on new products and new service development projects and R&D projects.
Tailor-made products of services	ZXY-builders delivers only tailor -made services.
Which organizational forms match best with your organization?	The products and services of ZXY-builders are primarily being delivered on project-basis. The entire organization is subsidiary to the projects they execute for their clients (=project organization). Within ZXY-builders one employee is primarily responsible for innovations within the organization. This person stimulates the organisation at every project, to bring the development of new technology further. Staying at
R&D is primarily responsible for innovations within our organization.	

the same technical level is not acceptable. This process contradicts with how licenced drone companies have to work. They make a step-by-step plan and have to get the approval for each step of the process. Strangely enough you see less innovation in the types of companies that use a planned approach.

The organization of development projects is formalized within their organization. --

Firm R&D strategy

New product and service development is very important to sustain their position in the market in which they operate.

For ZXY-builders new product and service development is very important to sustain their position in the market in which they operate.

Verver argues that new product and service development doesn't always demand very high investment costs. Today there is the makers movement. Things can be recreated and assembled using unused, discarded or broken electronic, plastic, silicon or virtually any raw material and/or product from a computer-related device. This is also possible, specifically with drones. Verver claims that you can put a specific drone together for less than thousand euros. While instead you can buy a drone for fifty thousand euro, which can do less.

New product and service development demands very high investment costs.

Verver believes that the access to a lot of money can counterwork an innovation process.

Innovation is very important within their organization.

For ZXY-builders innovation is very important within the organization. Currently their searching for new business models to use drones in the construction sector.

They try to be the first in the development and application of new products and services.

ZXY-builders tries to be the first in the development and application of new products and services. ZXY-builders comes up with new things by trying and testing during projects.

It is not important to be ahead of the competition, they only change to new technologies when it is absolutely necessary. --

Innovativeness

Technological innovativeness

Did you possess the required technological know-how at the beginning of the R&D project?

ZXY-builders did possess the technological know-how for most part at the beginning of the R&D project. Verver learned this knowledge just by doing projects and from other people.

Did you have any practical experiences in the application of the required technological competencies and the technological know-how?

Verver did have practical experience in the application of the required technological competencies and the technological know-how, in particular with the software development part. Verver and his partners had a background in software development.

Could your organization use existing technological competencies and experiences during the project?

ZYX-builders could use existing technological competencies and experience during the project.

Market innovativeness

Was the degree of novelty of the R&D output very high compared to previous products?

The degree of novelty of the R&D output of using drones in the building process, is very high in comparison to previous products. The market is new as well as the technology and the governmental rules are new.

Did the R&D output aimed at many new customers to our organization?

The use of drones during the building process aimed at many new customers to the organisation. ZXY-Builders has conducted several pilots of using a drone in the building environment. They have mapped the site in several projects with air photos, movies and 3D models with drones. It appeared that there was a great need for mapping the site before the start of constructions.

Did the R&D output catered to new customer needs that we have not served before?

The use of drones during the building process catered to new customers needs that have not served before. The primary vision of ZXY-builders is that in the future every site has its one drone gathering new information about the construction process every day. At this moment this is technical not possible yet.

Did the new product required to use new sales and distribution channels?

When drones are going to be applied on large scale, the product requires using new sales and distribution channels. This shift is already happening in the sale of land surveying equipment where they already sell drones. ZXY-Builders want to focus on end-to-end solutions with drones.

Newness: How new was the new product or service

For your organization

The product is new for the organization, the current customers and the target customers, as well for the world. The used technology is new as well.

For the current customers of your organization

For the target customers

For the world

The used technology

Dimension 1: Preference for means vs. goals

Their R&D project was specified on the basis of given means/resources.

When ZXY-builders start to use drones in the building process, the target was vaguely defined in the beginning.

Given means/resources have been the starting point for the project. The whole drone industry is mean driven. Entrepreneurs buy a drone and then try to figure out how they can use them.

The process converged towards a project target on the basis of given means/resources. Verver explained that they had bought a drone before they had figured a business plan. But they had a gut feeling that they were going to arise growing markets. This is more a vision than a project target.

Means..●.....Goals

Dimension 2: Preference for affordable loss vs. expected returns

Verver explained that considerations about potential losses were decisive for the selection of the R&D option. ZXY-builders recently placed an order for an expensive drone. These decisions were approved on the basis of considerations about acceptable losses. They had a total budget for various expenses. This investment was included in the calculation of the expenses, which meant that other expenses couldn't be made.

The selection of the R&D-option was mostly based on a minimization of risks and costs because potential returns are difficult to estimate at this point in time.

Affordable loss..●.....Expected returns

Dimension 3: Preference for partnerships vs. competitive market analysis

ZXY-builders tried to reduce risks of the R&D project through internal or external partnerships and agreements. Verver claims that they work with partners every day. They recently started a partnership with an inspection company. With this partnership they can combine the knowledge of drones and software with the intrinsic knowledge of the market of inspections. In advanced they made arrangements about the commitment of the partners. This is primarily based on trust, but on contracts as well.

ZXY-builders didn't made market analyses up front. Their focus was rather on the reduction of risks by approaching potential partners and customers. Verver argues that he wants to make more market analyses about small and big competitors and what their business models are. But in practice it is difficult to obtain this information and outsourcing of market analyses is expensive.

Partnerships..●.....Market analysis

Dimension 4: Preference for acknowledge the unexpected vs. overcome the unexpected

Verver claims they always try to integrate surprising results and findings during the R&D process – even though this is not necessarily in line with the original project target. For example if they want to scan inside a building by using the photogrammetric technology. By flying with a drone and making a lot of photos the inside of the building could be mapped. This process lead to many technical problems. A project leader had an old scanner in the attic and hesuggested to use the scanner simultaneously with the drone. This lead to a new process innovation. This method is now a common practice. The R&D process was flexible enough to be adjusted to new findings. Potential setbacks or external threats were used as advantageous as possible.

New R&D findings influenced the project target. Verver explained that they have to plan their projects, because there is a limited time of flying with the drones on the projects. This planning is only based on practical applicability, not on bureaucracy. Despite of potential delays in the project execution they were flexible and took advantage of opportunities as they arose

The project planning was basically carried out at the beginning of the project.

Acknowledge unexpected..... ● Overcome unexpected

R&D project success	(1 = totally disagree, 7 = fully agree, 8 = not applicable)
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As a consequence of this project the reputation of our organization in the area related to this project is increased 7

The new or improved product / service provides us a competitive advantage 6

The new or improved product / service fulfils the needs of the clients 3

The new or improved product / service is of excellent (technical) quality 6

All project targets were met 6

Knowledge and experienced gained by the project members is of large value for subsequent development projects 7

The knowledge gained on this project is well secured in our organization 5

The project-team can be very satisfied with the final results. 6

Achieved results of the development project?

De expenditures of the project were ...?
Very much lower than expected 1 2 3 4 5 Very much higher than expected 5

The project duration was...?
Very much shorter 1 2 3 4 5 Very much longer 3

The gained profit is ...?
Very much lower than expected 1 2 3 4 5 Very much higher than expected 2

The achieved revenue is...?
Very much lower than expected 1 2 3 4 5 Very much higher than expected 2

What was developed came ... on the market?
Far too early 1 2 3 4 5 Far too late 2

Experience and competencies

Learning and expertise that can be leveraged in other projects Yes, Certainly

Generation of new ideas as starting point of potential future projects Yes

Enhancement of competencies and capabilities Yes

12 Appendix 3: Firm Characteristics and strategy

Organization	Innovation project	Experienced in the execution of projects	Tailor made products or services	Which organizational forms match best with your organization?	R&D is primarily responsible for innovations within our organization.	The organization of development projects is very important to sustain our position in the market in which we operate	New product and service development is very important to sustain our position in the market in which we operate	and service demands very high investment costs	Innovation is very important within our organization	We try to be the first in the application of new products and services	be ahead of the competition, we only change to new technologies when it is absolutely necessary
BLOC	The Dutch WindWheel	especially in new product and new service development projects, or R&D projects	Yes	The products or services are primarily being delivered on project-basis. The entire organization is subsidiary to the projects we execute for our clients (=project organization)	All employees of the organization are responsible for innovation. The primary business process of the company is innovation.	The organisation of development projects is not formalized within the organization	Yes	No	Yes, crucial	Yes, in collaboration with partners	No
Studio RAP	Building with robotics	especially in new product and new service development projects, or R&D projects	Yes	The products or services are primarily being delivered on project-basis. The entire organization is subsidiary to the projects we execute for our clients (=project organization)	The majority of the R&D is improvements of the software and new production techniques.	The organisation of development projects is not formalized within the organization	Yes	No	Yes, crucial	Yes	No
Physce	Power Window	especially in new product and new service development projects, or R&D projects	Yes	The products or services are primarily being delivered on project-basis. The entire organization is subsidiary to the projects we execute for our clients (=project organization)	The products or services are primarily being delivered on project-basis. This person stimulates the organisation at every project to bring the development of new innovations within the organization. This person stimulates the organisation at every project to bring the development of new innovations within the organization.	The organisation of development projects is not formalized within the organization	Yes, crucial	Yes	Yes, crucial	Yes	No
XYZ-Builders	Using drones in the building process	especially in new product and new service development projects, or R&D projects		The products or services are primarily being delivered on project-basis. The entire organization is subsidiary to the projects we execute for our clients (=project organization)	No specific R&D department. Innovation in operational business units. Employees work on innovation and business projects as well.	The organisation of development projects is not formalized within the organization	Yes, crucial	No	Yes	Yes	No
Heijmans	Heijmans One	predominant operational process is executing projects	Yes	divisions and department with the responsibility for the production of a product or service	The services are primarily being delivered on project-basis. The entire organization is subsidiary to the projects we execute for our clients (=project organization)	Organisation of development project is formalized in the operational business units	Yes, but the operational process is more important	No	Yes, but the operational process is more important	Yes/No depends on the subject	No
Advin	De circulaire weg	predominant operational process is executing projects	Yes	division with departments which are responsible for a group of products or services targeted at one market (= product/divisional organization)	department responsible for innovations within their organization. The department Business Development initiate innovation projects in collaboration with department. Innovation in operational business units. Within the board of Dura Vermeer a few people are strategically responsible. Dura Vermeer Infrastructure	The organisation of development projects is not formalized within the organization	Yes	No	Yes, crucial	Yes	No
SPTE	Spie Simple	predominant operational process is executing projects	Yes	division with departments which are responsible for a group of products or services targeted at one market (= product/divisional organization)	department responsible for innovations within their organization. The department Business Development initiate innovation projects in collaboration with department. Innovation in operational business units. Within the board of Dura Vermeer a few people are strategically responsible. Dura Vermeer Infrastructure	The organisation of development projects is not formalized within the organization	Yes, but only when the new product or service contribute to a public demand or customer demand	No	Yes	No	No
Dura Vermeer	Vlotterkering	predominant operational process is executing projects	Yes	(= product/divisional organization)		The organization of development projects is formalized within the organization of Dura Vermeer.	Yes	No	Yes	No, Yes in near future	No