

A revised process model with an integrated management control system in the front-end of radical innovation

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ABSTRACT

This study considers how a management control system could be designed and used in the front-end of radical innovation to build an appropriate business case. The front-end of innovation provides relatively great and cheap iteration opportunities for organizations that have the need to build a total innovation process that is efficient and effective. Objective in the front-end is to find an affordable, appropriate, viable and worthwhile innovation (within the boundary of acceptable risk) based on useful information and strategic decisions. The triggers of proposing the revised model are the difficulty that managers perceive in managing the tension between empowerment and control in the front-end and shortcomings found in widely applied project management and Stage-Gate ®. The iterative process model, based on the required business case information aspects, with an integrated management control system aims to show and explain how to best shape, divide and control the front-end process to possibly lower the fuzziness and resolving identified shortcomings. Recognized in the model are the two different levels in a front-end process: the strategic and project actor. A management control system in this sense lets the two levels of control come and work together to control and direct front-end activities and decisions in the project towards the best interest of the organization and fulfill long-term strategic objectives. Simons' LOC model gives substance to the management control system with a belief, boundary, diagnostic and interactive aspect. Basic principles of the model are customer-driven, strategic foresights as starting point, emphasis on iteration/learning and an appropriate business case including a risk analysis. The model has not been tested and has no predictive value for innovation processes, but should be seen as a suggestion for or assistance in practice to be in control of appropriate control in the front-end of radical innovation.

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Keywords

front-end of radical innovation, project management, Stage-Gate ®, management control, efficiency, effectiveness

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1. INTRODUCTION

Innovations are everywhere around us in all types and sizes. Innovating can be seen as an intention to improve the competitive position of an organization by taking advantage of new ideas and opportunities. This intention must be reflected in the mission, vision and strategy of an organization. A mission is a statement about the purpose and primary function of the organization. This statement is often accompanied by a vision, which is a statement about the policy and ambition for the future grounded with norms and values of the organization. Based on this, the strategy is the “determination of the basic long-term objectives of an organization, and the adoption of courses of action and the allocation of resources necessary for carrying out these objectives” (Chandler, 1962). Mintzberg (1987) considers strategy as a pattern of decisions about the organization’s future implying that strategic decisions are concerned with the long-term direction of an organization. The mission, vision and strategy can be seen as a reference point for the front-end and further parts of the innovation process, by which innovation is treated as a mean to a certain end. Not only strategy but also the external environment (e.g. customers or regulation) has an influence on or provides input to the innovation process.

The incidental, complex and changing nature of such a demarcated process in which a radical innovation is conceptualized and developed causes that most organizations assumingly use a project structure to execute this focused cross-functional task, segregated from current organizational activities. An innovation process itself may be divided into three important areas: the front-end, the development process and the commercialization (Koen et al., 2001). The choice for a radical innovation process is made on the basis that it is characterized by relatively high risk when doing something that is revolutionary or “new to the world”. Risk in radical innovation projects constitutes of three aspects: uncertainty, impact and controllability (Keizer and Halman, 2007). The objective is to finding an affordable, appropriate, viable and worthwhile innovation with the boundary of acceptable risk based on useful information and strategic decisions. A business case including a risk analysis capture the logic and reasons for doing an investment in the development phase of an innovation process. Obviously a good risk analysis is necessary, because managers or a project should take acceptable risks that don’t put the continuity of the organization at stake.

In the article “Control in an Age of Empowerment” of Simons (1995), he argues that his levers of control model with four interrelated control systems, as package, balance or reconcile the theoretical tension between empowerment and control. This tension has to be managed in situations that resemble the front-end of radical innovation, in which conditions to be creative but also appropriate control is necessary to secure the efficient and effective use of resources and foster the achievement of the organizational long-term objectives (Poskela and Martinsuo, 2009). Too much control can be too time-consuming and constraining and too little control can be very risky with regard to the achievement of objectives.

The achievement of organizational objectives is the ultimate responsibility of senior management. Senior management is the highest level of organizational management that has the day-to-day responsibilities of managing an organization and the authority to commit and allocate resources. So in an innovation process project management and senior management provide two levels of control. Project management is a consequence of using a project structure for managing the project and the activities in the front-end. Stage-Gate®, widely applied, is a process that provides an

activity and decision structure in which senior management has the authority to commit resources at gates (Cooper, 2008). However project management and the Stage-Gate approach in the front-end have some shortcomings that could be possibly resolved by an appropriate management control system. The shortcomings in project management and Stage-Gate may lead to a total innovation process that is less efficient and effective. A failure in or a failed process may have positive (e.g. learning) and negative (e.g. loss of time, resources or reputation) consequences for an organization. Shortcomings in the front-end based on project management and Stage-Gate are:

- Inadequately frame or define the front-end process and clarify its purpose. Stage-Gate is relatively vague about the front-end.
- No explicit strategic starting or reference point. Most models (Koen et al. and Cooper) start with an idea and/or opportunity.
- Unclear customer problem or product specifications.
- No room for or focus on iteration and learning. In Stage-Gate it is identified with significant delays, added costs, and poorly managed projects.
- Lack of senior management involvement and control: only “awake” when large resources are committed at gates or problems arise in the development part.
- Inadequately direct or control implicit decisions of project members.

In my understanding there is a control gap between project management, the operational level of control, and the Stage-Gate approach that offers the strategic level of control at gates. How can senior management have more control in the process than only at the gates? In this perspective an adequate management control system provides tools to aid project management to direct and control front-end activities in the project towards the long-term strategic objectives of the organization. This management control could be formal as formulated by Simons (1994, 1995) and informal which is also an important part of management control in an innovation process, but that will not be included in this paper. What is being studied in this paper is *in which way a management control system could be designed and used in the front-end of a radical innovation process to control and direct project activities and decisions to build an appropriate business case as result from an efficient and effective front-end process.* The answer to this question is a revised iterative front-end process model with an integrated management control system (appendix 9.2). The model contains a structured process, in which management control forms the link between the project actor and the strategic actor and has the function to direct and control the activities and decisions in the project. The business case with risk analysis is the output of the front-end. Simons’ levers of control model gives substance to the management control system with a belief, boundary, diagnostic and interactive aspect. The front-end process is divided in parts based on the own formulation of a clear and comprehensive business case for innovation (appendix 9.1). This model aims to show and explain how to best shape, divide and control the front-end process, but it has no predictive value for innovation processes in organizations. Basic principles of this model are customer-driven, strategic foresights as starting point (not an idea or opportunity), emphasis on iteration/learning and an appropriate business case including a risk analysis. Organizations could apply it in a flexible way (I am not dictating) in a front-end project of a radical innovation process. A step further could be testing the model on efficiency and effectiveness and evaluate how it works in practice. In short, the paper is a new addition to existing literature in the innovation management field and hopefully provides assistance in practice.

The practical relevance lays in the fact that the front-end provides one of the greatest opportunities for improvement of the overall innovation process, but simultaneously the front-end can also be seen as the most troublesome, fuzzy, unpredictable and chaotic phase. (e.g. Koen et al., 2001; Herstatt and Verwon, 2001; Reid and de Brentani, 2004). Literature recognizes that managers have and perceive great difficulty in managing the front-end (Khurana and Rosenthal, 1998) and that the front-end is often seen as fuzzy. The importance of management control in the front-end is large due to the relatively large and cheap improvement opportunities, the shortcomings in project management and Stage-Gate and the ability of senior management to influence strategic decisions in a temporary organization, which have profound implications in the long-term (Artto et al., 2011). In the next chapter the front-end is considered.

2. FRONT-END OF RADICAL INNOVATION

2.1. Innovation and Management

The definition of innovation is a very diverse one. Many studies use slightly different definitions of innovation in the scientific literature. From a synthesis of definitions in this literature, innovation is mostly defined as or has the meaning of a successful commercialization or bringing into common use of an invention (Conway and Steward, 2009). This is innovation as output (e.g. product, service or process), but besides that that also innovation as process plays a large role in this paper by looking at a specific phase of and its role in the process: the front-end of radical innovation. A classical definition of radical innovation captures the following aspects: it explores non-existing technology, focused on unheard performance features that creates a transformation of existing markets or industries or create revolutionary new ones. Because of the high degree of novelty and uncertainty the innovation process is characterized by relatively high risk.

Innovation can take place in the area of marketing, organization, products and so on. But why is it so important to innovate for organizations? Schumpeter introduced in 1950 the term “creative destruction” for the continuous process in which organizations or entrepreneurs look for the creation and use of something new that at the same time destroys the old “rules of the game” (e.g. for technology, resources, competences) and establish new ones driven by promising profits. Other possible reasons for innovation is to find better ways to fulfill customer needs, doing things more efficiently or effectively, respond to trends or threats in a dynamic and changing environment or comply to strategy and objectives. Eventually, it can be argued that organizations innovate for profit and survival reasons.

The generally accepted definition of management is “the function that coordinates the efforts of people to accomplish goals and objectives using available resources efficiently and effectively.” There are studies found that emphasize the trade-off between control/structure (e.g. Cooper, 2008) and creativity (e.g. Amabile, 1998) when managing the innovation process. Besides this there are studies that focus on the need and act to manage the balance between control and empowerment (Poskela and Marinsuo, 2009; Simons, 1995), what is in the interest of this paper. The “balancing proposition” plays a crucial role in the front-end of radical innovation in which conditions to be creative but also appropriate control is necessary to secure the efficient and effective use of resources and foster the achievement of the organizational long-term objectives (Poskela and Martinsuo,

2009). It raises also the question what the effect of control is on empowerment and creativity. As experienced in practice a radical innovation process is almost never a sequential, linear and rational process. Therefore innovation management can be seen as “the creation of conditions within an organization under which a successful resolution of multiple challenges under high levels of uncertainty in the innovation process are made more likely” (Tidd and Bessant, 2009). In the next section the first phase of the innovation process will be considered: the front-end.

2.2. Front-end of (Radical) Innovation

An innovation process may be divided into three phases: the front-end, the development process, and the commercialization. In literature some different names are utilized for the description of the front-end of innovation, e.g. “pre-development” (Cooper and Kleinschmidt, 1994) or fuzzy front-end (Khurana and Rosenthal, 1997). The front-end of innovation is the start of the innovation process that must lead to an appropriate business case and risk analysis. Organizational strategy and functional strategies (e.g. innovation or marketing) could be applied as starting or reference point for the front-end. The innovation process is so treated as a mean to a certain end. The intention is to manage the desired decrease in risk that is relatively high for a radical innovation, because uncertainty and impact are less easily controlled. Thus relevant information must be gathered, processed and analyzed to reduce uncertainties (Moenaert et al., 1995) throughout the process. Risk in radical innovation project constitutes of three aspects: uncertainty, impact and controllability (Keizer and Halman, 2007). Uncertainty is defined as “the difference between the amount of information required performing a particular task, and the amount of information already possessed by the organization” (Galbraith, 1973). Impact may relate to financial or organizational consequences (positive and negative) of strategic decisions. Controllability is about the available ability and resources to control or direct outcomes. So actually it refers to a management control system that tries to control and direct the front-end process. An example in this sense is adding structure by dividing the process in parts to make it better controllable for project management. Uncertainty may be controlled by the search for and interpretation of useful information. The impact may be controlled by building or testing a minimum viable product that only uses what is necessary and effective or allocating resources in parts, instead of all at once, to a project. If uncertainty is high, impact of failure is high and controllability is low a project should be considered as “risky” (Keizer and Halman, 2007).

The front-end is ended when decided to invest or not to invest in the further development of an idea (Khurana and Rosenthal, 1998). The idea is in this sense a complete solution to a validated customer problem with underlying business model. It is important to note that the investment decision is not the only decision that is made or has to be made in the front-end, because before developing the business case there will be many implicit and explicit decisions made in the project or at gates.

Every innovation is based on an idea (and opportunity). Koen et al. (2001) clearly defines the terms opportunity¹ and idea². They

¹ “a business or technology gap, that a company or individual realizes, that exists between the current situation and an envisioned future in order to capture competitive advantage, respond to a threat, solve a problem, or ameliorate a difficulty.”

² “the most embryonic form of a new innovation. It often consists of a high-level view of the solution envisioned for the problem identified by the opportunity.”

use the term new concept development (NCD) for the relationship model that describes the front-end as a circular, non-sequential and iterative process between the five front-end activities that are influenced by influencing factors and the organizational engine. The five controllable activities are:

- opportunity seeking;
- opportunity selection;
- idea generation and enrichment;
- idea selection;
- concept development.

An organization could look for opportunities internally and/or externally in its search field and have to assess and decide which opportunity fits strategically and is worth pursuing. An opportunity includes minimally one customer problem that could be solved. Idea generation and enrichment is an evolutionary, creative and iterative process of internally (e.g. R&D) and/or externally (e.g. end-users or research institutes) finding, developing and refining a solution envisioned for the customer problem identified by the opportunity. Idea generation is often not the problem, because ideas are relatively easily found. Somewhat more difficult is the selection of the best idea to pursue, which fits strategically and is feasible and worth pursuing. Also assessing if an idea or invention is actually new in the form of “prior art research” is an activity that shouldn’t be forgotten. Developing a concept has to do with defining the specific solution (including product specification) to a customer problem with an understanding of what technology is needed (Koen et al., 2001). The proposed model in this paper uses this model in the synthesis phase. The NCD model does not consider project initiation and ending, the conceptualization of a business model or formulation of a business case and risk analysis.

As said in the introduction the front-end provides one of the greatest opportunities for improvement of the overall innovation process, but simultaneously the front-end can also be seen as the most troublesome, fuzzy, unpredictable and chaotic phase of the process. (e.g. Koen et al., 2001; Herstatt and Verwon, 2001; Reid and de Brentani, 2004). Is this a perception or reality insight? Literature recognizes that managers have and perceive great difficulty in managing the front-end (Khurana and Rosenthal, 1998). Of course relatively more difficulties and fuzziness are assumed to be found in the front-end of radical innovation, because something non-existing, revolutionary or “new to the world” is conceptualized with possible high degrees of risk. This present risk can be linked to the uncertainty and impact of “the scale and variety of unpredictable, non-linear drivers and inputs from the environment that may or may not combine to shape the future desirability, acceptability and feasibility of a given innovation” (Mootee, 2011). More grip and a lower degree of risk is found in the front-end of incremental innovation, because the intention here is to improve (e.g. quality or cost) something that already exists by which knowledge, resources and competences are almost captured, difficulties can be easily anticipated and uncertainties are lower. This is why managers could increasingly focus on the “easy” incremental innovation, rather than more complex radical innovation. Also the aversion for high risks inherent to radical innovation and the fear of being held responsible for failure could managers push towards the less risky incremental option. Important factors here are the risk perception and risk sensitivity of managers. Obviously a good risk assessment is necessary, because managers should take acceptable risks that don’t put the continuity of the organization at stake.

The process of radical innovation is a long-term and high investment (strategic decision) that will not bring a return or

success in the short-term immediately. By communicating and getting approval from owners senior managers try to indemnify themselves for lower performance (e.g. rentability) in the short-term and promise owners good long-term results.

Adequately managing the front-end of innovation is crucial for organizations that have the intention to innovate efficiently and effectively. For several reasons it is beneficial when front-end is better shaped and managed. Some important are mentioned here. First, the business case can be strengthened by iterations and improvements in a relatively easily and cheaply manner compared to later phases of the innovation process (Smith and Reinertsen, 1998). Secondly, the value and success probability of a concept could be increased (Koen et al., 2001) and so lowering the failure and dropout further in the innovation process. And thirdly, an appropriate business case can increase the speed and decrease the cost of development (Bacon et al., 1994). In short, the front-end of innovation provides relatively great and cheap opportunities for organizations that have the need to build a total innovation process that is efficient and effective. In the next section the output of the front-end is considered: the business case.

2.3. Business Case

A business case is the basis for the further innovation process. It is together with a risk analysis the output of the front-end: an information package that captures the logic and reasons for doing an investment in the development of an affordable, appropriate, viable and worthwhile innovation within the boundary of acceptable risk. It is also a plan of action, documentation of the front-end, a communication tool towards stakeholders³, a control tool and clarification of expectations of and assumptions for the innovation and so on. When management provide people in a project with the purpose of the innovation and what kind of information elements in the business case have to be covered, they could assumingly search, create and decide in a easier and more structured way. The front-end process could be divided in phases and decisions based on these information elements. It is important to note that the focus of a business case for radical innovation should be on the future (more uncertain) in which a product will be developed and commercialized. Crucial strategic decisions related to the conceptualization of the innovation in a business case (e.g. strategic arena, customer problem or solution direction) are made at the front-end. The intention is to construct an explicit template that formulates information aspects that must be covered in a business case in the front-end of innovation. An outline of the business case information aspects is given in appendix 9.1 and applicable to the front-end of incremental and radical innovation. The business case is classified in the following sections including information requirements and strategic decisions:

- Strategic foresights.
- Project initiation.
- Synthesis of a customer problem and a solution direction in a product concept with product specifications.
- Business model and feasibility study.
- Risk analysis: uncertainty, impact and controllability.
- Planning for development and documentation of the front-end.

The intention is to come to a clear and comprehensive formulation of business case elements for a radical innovation to add some focus to the front-end for information gathering and analyzing

³ stakeholders: senior management, functional groups, project members, the receiving development project (team) and external groups.

activities on which strategic decision can be based. Important question is: what do we want to know and have in the end? The appropriateness of a business case is in my opinion dependent on the inclusiveness and elaboration of the elements stated. The right information, criteria and decision making makes the business case possibly even better. Consideration of validity, reliability and comprehensiveness of information and logic at a sufficient (not perfect) level is recommended to keep intentional and unintentional bias/biases of project members and formal decision makers as small as possible. But the possibility to do this assumingly depends on the complexity, time-horizon or available resources and competencies. In the next chapter operational project management and the strategic Stage-Gate process are considered.

3. PROJECT MANAGEMENT AND A STAGE-GATE ® PROCESS

3.1. Project Management

The front-end as part of a radical innovation process could have a temporary structure with limited resources segregated from current organizational activities with people from different organizational disciplines to achieve a specific objective: selection and conceptualization of an affordable, appropriate, viable and worthwhile innovation in a business case with an appropriate risk analysis.

A front-end project with a leading project manager and performing project members contain the following elements:

- Input: strategic foresights, resources, design of management control system and a project plan.
- Process: front-end phases and decisions and working of management control system.
- Output: business case with risk analysis.
- Project evaluation and ending

Because of the incidental, complex and changing nature of the demarcated process of conceptualizing and developing a radical innovation most organizations assumingly use a project structure to execute this focused cross-functional task. A necessary condition for success in innovation projects is the cross-functional integration of R&D and marketing insights and personnel (Moenaert et al., 1995).

At the first place a decision to start a radical innovation project have to be approved, funded and supported by senior management. Senior management provides the strategic level of control, because it will be ultimately responsible for organizational performance and strategic alignment. More about the strategic level of control represented in a Stage-Gate process is said in the next section (3.2). A general picture of the project phases are initiation and planning, execution of activities, controlling and closing which are managed by ten knowledge areas categorized in core, facilitation and integration functions (PMI, 2001). Project management is a consequence of using a project structure and contains the planning, organization and control of the front-end activities and the project to accomplish stated project objectives. "Project management has a primary focus on meeting cost, time, and quality objectives and on controlling specific activities or issues of individual projects" (Schultz, et al., 2009). Besides cost, time, quality and scope project results will to a large extent be focused on organization and information in the front-end. Project management provides the operational level of control and drives the project through the

process. The project manager makes things work and is the link between the project team and senior management.

Some shortcomings of project management are found when it comes to situations that resemble the front-end of radical innovation. Some are mentioned here. Firstly, there is relatively high focus on boundary and operational control in an innovation project (Kapsali, 2011). Prescriptions are made of what project members cannot do and project activities are being managed using planning tools and norms (e.g. costs or time). Of course boundaries and operational control must be present, but should not predominate empowerment and creativity. If these boundaries have to be changed, the consequences must be clear. Secondly, a project manager can be complemented by a belief and interactive control system (Simons, 1995), considered as very important in the case of renewal and radical innovation. Belief and interactive control systems are scarcely found in innovation project practice (Arto et al., 2011). Thirdly, the project manager is mostly the only (formal) link between senior managers and project members, so it can be said that the possibility for senior management to control, direct and interact with individual project members directly is lacking. Senior management cannot be involved all the time in an innovation project because it has to allocate its scarce time and attention over multiple tasks. But it has to be involved regularly and personally to control the front-end project. In the next section an innovation process model is considered: Stage-Gate.

3.2. Stage-Gate ® Process

Senior management is mostly the funder of an innovation project and wants control so that resources are used efficiently and effectively and that a project is aligned with the organizational objectives and strategies. The Stage-Gate approach is recognized and widely applied in organizations (Grönlund et al., 2010). After research on how successful organizations structure their NPD processes (Cooper, 1988), Cooper introduced a Stage-Gate process as conceptual and operational model for moving a product from idea to launch and beyond (Cooper, 1990). The front-end in this model consists of the discovery, scoping and building a business case phase and "is perhaps the most critical part of Stage-Gate" (Cooper, 2008). Cooper recognized that the development of an innovation is a process and that it can be managed. The Stage-Gate process consists of, as the name says, a series of stages followed by gates. Stages contain the execution of development, information gathering and analysis activities. "Each stage is designed to gather information to reduce key project uncertainties and risks; the information requirements thus define the purpose of each of the stages in the process" (Cooper, 2008). Deliverables, in which interim project activities and achievements are formulated, are inputs to the gate review. The deliverables are evaluated on both must-meet (yes/no) and should-meet (scale) criteria. At gates one project at time is evaluated in depth. The output of a gate is a go/no go decision and when approved a plan of action for the next stage. Senior managers, who act as gatekeepers have the power to commit resources to the project in a gate, but the project manager drives the project through the process. In thriving organizations, the strategic objectives are identified in the executed projects. Projects individually and the portfolio of projects collectively are thus the practical translation of strategy.

The objective of a Stage-Gate process is to improve effectiveness and efficiency by adding structure and discipline into the innovation process (Cooper, 1990). But there are also some shortcomings of a Stage-Gate process. Some are mentioned here.

Firstly, the Stage-Gate approach vaguely indicates what needs to be done in some stages (e.g. less elaboration on front-end activities) and what the role of management control could be. The model doesn't also start with a strategic reference point, but with a discovery phase (Cooper, 2008). Secondly, looping back and redirect or redo activities in Stage-Gate, needed to take advantage of the front-end and learning opportunities, are associated with significant delays, added costs, and poorly managed projects (Koen et al., 2001). Thirdly, a Stage-Gate process tends to have problems with governance (e.g. gates with no teeth or gatekeepers behave badly) and results in too much bureaucracy (Cooper, 2008). Fourthly, before developing the business case there will be many implicit decisions made in a project and the question is how those decisions are controlled and directed. How can senior management have more control in the process than only at the gates? In my understanding there is a control gap between project management, the operational level of control, and the Stage-Gate process that offers the strategic level of control. Stage-Gate is considered as a macro process and project management as micro process (Cooper, 2008). So project management cannot be substituted by Stage-Gate. Rather Stage-Gate and project management are used together in an innovation project, in which project management is needed within the stages of the Stage-Gate process. In the next chapter management control is considered.

4. MANAGEMENT CONTROL

4.1. Introduction to Management Control

As literature stands now, some contradictory findings are found with regard to the question if management control is suitable for managing the innovation process or not. These contradictory findings could be partly explained by the differences in the definition of or perspectives on management control. Anthony (1965) sees management control as ensuring that resources are used effectively and efficiently in the accomplishment of objectives. A classical view of management control suggests that management control is the basis for efficient and effective managerial decision-making, primarily based on internal, formal and quantifiable (accounting) information, with the intention to ensure that people or groups comply to organizational objectives (Chenhall, 2003) or control outcomes and behaviors (Ouchi, 1979). Over time management control became broader with regard to its approaches and functions with formal control processes (Simons, 1995), informal control processes (e.g. social, clan or personal control) and including more sorts of information: e.g. external and non-quantifiable. Simons (1994, 1995) defines management control as "the formal, information-based routines and procedures managers use to maintain or alter patterns in organizational activities."

Ensuring that activities and implicit/explicit decisions serve the best interest of the organization and fulfill long-term strategic objectives is the role of management control in the front-end. The ability of senior management to influence strategic decisions is of course the greatest at the front-end (Artto et al., 2011). However, senior management support and involvement typically increases when it is too late, for example when problems arise in the development phase (Smith and Reinertsen, 1998). With an eye on the strategy as reference point for an innovation processes it is important to assess if a strategy is feasible (Smith and Reinertsen, 1998) and that the strategy is both effectively implemented at the operational level and innovatively renewed (Artto et al., 2011). So a condition to let management control be favorable for the organizational well-being is that the organizational strategy to

achieve long-term objectives is appropriate and feasible. It also make sense to say that senior managers not always have the total freedom to formulate the strategy for an organization, because it is determined by or aligned with owners or other stakeholders in the environment. The strategy of the organization is further translated in functional strategies (e.g. innovation, financial or marketing).

The importance of management control in the front-end is large due to three reasons. The first reason is that the front-end of innovation provides relatively great and cheap opportunities for iteration to build a total innovation process that is efficient and effective as mentioned earlier. The second reason is the ability of senior management to control and direct strategic decisions made in a temporary organization, which have profound implications in the long-term, is of course the greatest in the front-end (Artto et al., 2011). The third reason is the opportunity to resolve the shortcoming in project management and Stage-Gate. In the next section formal control mechanisms as proposed by Simons are considered.

4.2. Simons' levers of control (LOC) model

The tension between empowerment and control has to be managed in situations that resemble the front-end of radical innovation, in which conditions to be creative but also appropriate control is necessary to secure the efficient and effective use of resources and foster the achievement of the organizational long-term objectives (Poskela and Martinsuo, 2009). Empowerment refers to the individual ability to exercise choice and creativity refers to the finding or creation of something new and useful.

A management control system is in my belief a system that gathers and uses information to direct and control the executing activities and decisions in a process towards the strategic long-term objectives. It must link strategic planning and operational control (Otley, et al., 1995). Simons states that his management control package contains four aspects: a belief system, a boundary system, diagnostic control system and an interactive control system (Simons, 1994; Simons 1995). Simons' LOC model gives substance to the management control system and will be explained in section 5.2.

The focus of management control systems is not only a stand-alone control system but on multiple control systems working together in an appropriate combination to benefit an organization (Widener, 2007). These interrelated control systems are fed by strategy. They have the objective to direct and control the practical translation of the strategy. Strategy is often derived from the organizational mission and vision and state how objectives are achieved. Generally known, strategic decisions run over a long-term period and are therefore a reference point for smaller short-term decisions. The paradox is that these strategic decisions are taken in a temporary organization, a front-end project, and intended to serve long-term organizational objectives (Turner and Keegan, 2001). This results in a complex relation between short-term decisions and long-term outcomes and accountability.

The levers of control model is derived from the Chinese Ying-Yang thought by creating opposing forces, positive and negative for effective strategy implementation in e.g. an innovation process. That's why Simons called the interrelated systems the *levers of control*. Belief and interactive control systems have a positive, inspirational or enabling effect. Boundary and diagnostic control systems create constraints and compliance. Note that Simons is only concerned with formal management control. Internal accounting controls are excluded. Informal control processes (e.g. culture, clan or personal control) are not explicitly included in its model (Simons, 1994; Simons 1995), but they are

also an important part of management control in an innovation process, seen in studies like Chiesa et al. (2009) or Poskela and Martinsuo, (2009). In the next subsection literature based on Simons' levers of control model and other important studies are considered.

4.2.1. *Some literature based on Simons' LOC and management control in the front-end of radical innovation*

Simons' control model is widely recognized and used in literature over the years. Telling you that his book *The Levers of Control* (Simons, 1995) has 2100 citations (Google Scholar, 2014) must be impressive. Although it is widely used it is good to mention the strength and weakness of the model. The strength of the model is its broad perspective and different types of control in a management control system (Ferreira and Otley, 2009). The main infirmity is the sometimes vague and ambiguous concepts in the model (Ferreira and Otley, 2009). Tessier and Otley (2012) are the first that attempt to come with a conceptual development of the *whole* LOC model. The revised framework, based on LOC principles, makes a distinction between managerial intentions, presentation of controls and employee perceptions/attitudes. These managerial intentions contains two types of controls (social and technical), which are organized in four control systems (strategic performance, operational performance, strategic boundaries and operational boundaries) that can be used diagnostically or interactively, have an enabling or constraining role and can lead to reward and punishment. The revised model shows the LOC model in a different view, but it adds only the presentation of controls and perceptions/attitudes of employees towards controls.

There are studies that considers the levers of control (e.g. Artto, et al., 2011; Bisbe and Otley, 2004; Collier, 2005; Henri, 2006; Marginson, 2002; Tuomela, 2005). In this paper the working of the whole LOC package is of importance. Widener (2007) found evidence from 122 CFOs that suggests that the four control system are inter-dependent and complementary and together have a greater impact on performance. This confirms the proposition of Simons (1995) that management must take into account all the four systems in a management control system to increase its effectiveness and thereby increase organizational performance. Van Elten and Widener (2013) found a positive relation, based on data from 233 business unit managers, between the LOC package and both empowerment and creativity. They conclude that "there is not a conflict between control and creativity per se. Rather, paradoxically, we conclude that creativity can flourish in the presence of control". There are studies that focus on management control in the front-end of an innovation process. Chiesa et al. (2009) found evidence from four innovation projects that flexible and social control are important in the front-end of radical innovation, while diagnostic control especially appear in later phases of the innovation process. They also found that the reliance on interactive systems was great in early stages. Poskela and Martinsuo (2009) found also evidence, based on data from 133 projects that suggests that managers could largely influence a front-end project through defining front-end task and allocating resources to it, but at the same time offer sufficient freedom to pursue intrinsic motivations, implying the balance between control and empowerment. In the next chapter the conceptual model is considered.

5. CONCEPTUAL MODEL

5.1. A revised iterative front-end process

5.1.1. *Introduction*

A redefined process (appendix 9.2) is proposed with the intention to give a better understanding of the structure and control in the front-end of innovation. The model can be seen as process control, because it suggests what to do or to decide in specific phases and gates, without influencing the content of the innovation. Besides that it also indicates how a management control system exercise influence on activities and decisions in the project. A management control system in this sense let the two levels of control come and work together to control and direct the front-end. The process model and required business case information aspects are applicable to the front-end of incremental and radical innovation. The difference lays in the fact that, arguing with the risk definition of Keizer and Halman (2007), radical innovation has assumingly more uncertainty and greater impact (e.g. financial or organizational) and are both less easily controlled.

The revised iterative front-end process model uses the front-end process (new concept development) model of Koen et al. (2001) for a synthesis, a Stage-Gate process of Cooper (2008) as basis and some lean-start up principles of Ries (2011), like customer problem and minimum viable product. The structure of phases in the front-end is based on business case information aspects (appendix 9.1). Each phase in the model is designed to gather, process and analyze information to reduce risks and strengthen the finding of an affordable, appropriate, viable and worthwhile innovation. The information requirements determine the purpose of each phase in the process. A front-end project is considered as input (strategic foresights, resources, management control system and project plan), process (controlled activities and decisions) and output (business case with risk analysis). The layout of the phases is as follows from beginning to end: strategic foresights, project initiation, synthesis, business model and feasibility, business case and risk analysis and at last project ending with a resource decision about development. Between the phases, in which activities and decisions take place in the project actor, are gates. A gate is a reflection, decision and planning point in which both the strategic and project actor participate. The following is considered at a gate based on a deliverable:

- What did we do and decide in the phase?
- What did we learn (formalizing) about the strategic foresights, the process, the strategic decisions etc.?
- Do we decide to proceed, iterate or stop based on information and criteria?
- What to do next?

Integrated in the model are the two different levels in a front-end project: the strategic and project actor. The strategic actor, represented by senior management or people that have access to or are empowered to decide by senior management, is concerned with the effective and efficient use of resources and achievement of long-term objectives. The project actor represents the project manager and project members that are responsible for the empowered execution and decisions in the operational phases. The activities within phases are undertaken by a project team with appropriate people from different functional areas inside and possibly outside the organization's boundaries. A necessary condition for success in innovation projects is the cross-functional integration of R&D and marketing insights and personnel (Moenaert et al., 1995).

Basic principles of this model are customer-driven, strategic foresights as starting (not an idea or opportunity as in other models), emphasis on iteration/learning and an appropriate business case including a risk analysis. It is an attempt to be more substantive than Cooper's Stage-Gate model of the front-end and to add a management control system to possibly solve some shortcomings. The model is general in nature, fitting the intention to let organizations use it in an adaptive way in a front-end project. Of course, in each case it is good to consider whether the model is applicable. It is important to indicate what the model is not. It is not a rigid, linear or bureaucratic system, but a flexible model that aims to show and explain how to best shape, divide and control the front-end process to possibly lower the fuzziness and solving difficulty in managing the front-end (Khurana and Rosenthal, 1998). The model has not been tested and has also no predictive value for innovation processes in organizations. In the next subsections the phases of the model are considered.

5.1.2. *Strategic foresights*

In my opinion an innovation process must have a starting or reference point by which innovation is treated as a mean to a certain end: achievement of long-term objectives. So the first phase is called strategic foresights and executed by the strategic actor to provide input for initiating, executing and controlling a front-end project. This phase forces senior management to look at the future and reconsider the vision, mission and strategy, by looking at present organizational working and well-being, environmental screening to track technological, market and regulation changes and possibly getting feedback of owners with regard to its interests and/or insights. This results in a possible renewed formulation of a mission, vision and strategy of the organization, which will be translated into functional strategies like an innovation strategy, marketing strategy or financial strategy. Strategic foresights lay the basis for the creation of a belief and boundary system. The functional strategies set boundaries for an innovation process what strategically not to do and so operationally demarcate what to do. At the gates and the interactive control system in the process focus on learning with regard to the feasibility and appropriateness of the strategy is important to improve it and come with a good innovation. The next phase is project initiation.

5.1.3. *Project initiation*

At the project initiation phase an innovation process is started by the senior actor to communicate intentions through the organization and form a project organization with appropriate people from different functional areas from inside and possibly outside the organizational boundaries. The project actor thus consists of a project manager and project members. After an introduction day and team development, the strategic actor and project actor determine together the strategic arena (scope) for innovation derived from the strategic foresights. Both actors institutionalize the management control system that should direct and control the activities and decisions in the front-end. The design of a belief and boundary system is derived from the strategic foresights. Besides that an interactive and diagnostic control system are set. After that both actors have to agree on and formalize the structure of the front-end process and business case aspects. All this is defined in a project plan including objectives, organization, resource commitment, empowerment, structure, criteria, place, contracts and timing. In the next gate only a plan of action is made for the next phase synthesis.

5.1.4. *Synthesis*

The synthesis phase consists of three steps that builds on another and is executed by the project actor to lay a foundation for innovation. The first step in the synthesis phase is the selection of a customer segment that the organization wants to serve. This could be derived from the marketing strategy. When a specific customer has been selected the search for a validated customer problem is the next activity. Validation is intended to check if the customer problem is really perceived by observing customers in their environments. Important here is that the project members get to know what people really do and need, triggering the use of user-centric empathic techniques (Leonard and Rayport, 1997) or a lead user method (Von Hippel et al., 1999) to uncover unarticulated customer needs (including functional, social and emotional aspects) that may be needed to develop solution directions and a clear product concept. Based on a preliminary assessment of the attractiveness (business viability) and the priority of solving a particular customer problem, a customer problem is selected for which a solution will be found or created. This step could also be called a customer analysis that delivers an opportunity for innovation.

The second step builds on the strategic decisions with regard to selection of a customer segment and a validated customer problem. The next activity is thus the search for solution directions, in other words idea generation and enrichment (Koen et al., 2001). It is highly important to have a clear understanding of existing and possible future (competitive) solutions to the customer problem. "Prior art research" seen as "passive" searching for technical reports, scientific publications or patents in databases is practical to find existing technologies and determine technology gaps.

The question is if and how customers solve this customer problem today and if there are possible new trends on solving this customer problem inside and outside the organizational and industry boundaries. Idea generation and enrichment is an evolutionary, creative and iterative process of internally (e.g. R&D) and/or externally (e.g. end-users or research institutes) finding, developing and refining a solution envisioned for a validated customer problem. Based on a preliminary assessment of possible solutions with regard to the effectiveness to solve a customer problem, the technical feasibility and its costs or resources needed to create and deliver value, a selection of a solution direction is made.

In the last step the synthesis of a validated customer problem (opportunity) and a solution direction (idea) is made, in which a clear product concept with specifications will be formulated. The product concept must satisfy the lean and mean principle: using what is necessary and effective. This means that a minimum viable product (Ries, 2011), the right attributes and combination of attributes to solve a customer problem, has to be conceptualized. A minimum viable product assumingly reduces risk by only using what is necessary and effective and not more. Consideration of legal, environmental, health and safety factors shouldn't also be forgotten by the project team. The last activity in this step is gathering possible feedback and qualitatively validating the product concept with "innovators" on a small scale. In between the steps there are sub-gates in which the project actor is empowered to evaluate, learn, decide and plan. Of course will there be many interactions between the project actor and the senior actor facilitated by the interactive control system. All control systems are most needed in this phase, because of high empowerment and the importance of laying the foundation for innovation. In the next gate both the strategic actor and project

actor evaluate what is done, decided and learned in the total phase. Based on this a decision to proceed, iterate or stop is made. In the case of iteration or proceeding a plan for the next step is build.

5.1.5. *Business model and feasibility*

The objective of this phase for the project actor is to build a business around a product concept and to check the total feasibility (e.g. market, technical, financial or legal) of the product concept and underlying business model. A feasibility study looks mostly if something is realizable with regard to regulation (are we allowed to do it?) and available resources and competences (are we able to do it?). It also considers the two criteria cost required and value obtained (is it viable to do?). The following need to be considered in this phase:

- A final feasibility study on the product concept and underlying business model.
- Take the make or buy decision. Will the product be developed internally or externally with internal or external technology and science?
- Assessment of existing and possible future competing solutions (with underlying business models).
- Stating a unique value proposition of the solution to the end-user.
- The conceptualization of a value chain and the role of the organization in it: how value is created and delivered and to whom?
- The way of value capturing (e.g. IP, first-to-the-market or exclusive contracting) and the consequences for development (applying for IP rights, to be fast to be the first to the market or finding partners).
- Development of a revenue model and clarifying the costs (note also: opportunity and displacement costs) and the cost structure based on reasonable assumptions.

The core question is why the solution is worth pursuing, financially and non-financially, for the organization? This could be based on financial projections with regard to the investment in and return of the innovation and other non-financial factors as improving reputation or societal responsibility. The opportunity to afford the investment and the source of funding needs also be checked and determined. In the next gate both the strategic actor and project actor evaluate what is done, decided and learned in the total phase. Based on this a decision to proceed, iterate or stop is made. In the case of iteration or proceeding a plan for the next step is build.

5.1.6. *Business case and risk analysis*

In this phase all the activities in the previous phases are further elaborated in a detailed business case working towards a final decision. An overview of the business case information aspects is given in appendix 9.1. This includes also documentation of process phases, iterations, learning and underpinnings of strategic decisions in the front-end project. A risk analysis contains the identification and evaluation of risk factors (e.g. financial, market or technical) for the innovation process based on uncertainty, impact and controllability. The final feasibility study in the previous phase could be helpful to the risk analysis by identifying possible difficulties or uncertainties. Important is to consider what the effect of failure would be on the organization? Obviously a good risk assessment is necessary, because managers should take acceptable risks that don't put the continuity of the organization at stake. Besides that, it gives an understanding of the risks in order to prioritize and control them. The business case and the risk analysis capture the logic and reasons for doing an investment in

the development phase of an innovation process. In the next phase the front-end project is ended.

5.1.7. *Project ending*

In the gate after the previous phase the strategic actor and project actor evaluate what is done, decided and learned in that phase. In this phase the same is done for the whole front-end. Both actors are also active in the project ending phase, the phase that is often forgotten. Based on the evaluation in the gate a resource decision for development is taken with decision criteria by the strategic actor to go, stop or iterate based on the information in the business case and the risk analysis. In the case of proceeding a project plan for development is build. Important is the interaction between the front-end team and the development team to explain the product concept and underlying business model to let developers participate in the innovation process and communicate intentions in order to let the development be efficiently and effectively. This means that the strategic actor must be proactive in forming a development team and let them participate in this phase in order to facilitate a good and smooth transfer. After an end-day the people in the front-end project will break off and the development team possibly takes over. In the next section integrated management control system is considered, which is based on the design and use of Simons LOC model that had to be adapted to a project structure.

5.2. **Integrated management control system**

In this section the design and use of management control aspects are considered for a front-end process. It also describes on which and how the four aspects direct and control the front-end process. A management control system is designed and introduced in the project initiation phase by input from the strategic and project actor. The phases that are directed and controlled by the management control systems are the last four phases (thus not the strategic foresights phase that is executed by the strategic actor only). Objective is the forming of a link between the project and strategic actor.

5.2.1. *Belief system*

People in a project want to understand the organizational purpose and how they can contribute to that. When mission, vision and strategy are communicated clear towards the project actor through the front-end process, it has a clear notice of the expectations and their potential contribution to achieve objectives. The belief aspect is an explicit set of organizational statements that the strategic actor communicates formally and reinforces systematically to provide important values, purpose and direction to the project actor activities and decisions.

The design of the belief system is influenced by the reconsideration and explicit formulation of the mission, vision and strategy of the organization in the strategic foresights phase by the strategic actor. The system is institutionalized in the project initiation phase by formally communicating it. An appropriate communication plan is desired to let a belief system be effective. The formulated norms and values are rooted in documents, regularly communicated and reinforced systematically through the process, so that it will be possibly grounded in the mind of the project actor, which will have an influence on the implicit decisions that project members make in the phases. It is important that the definition of the purpose is clear and consistent so that when communicated it can be understood and adopted by people in project. In short, the potential is that individuals are enabled to contribute and are motivated and inspired to work on the development of an appropriate business case for innovation in the

front-end. Rokeach (1968) proposed that persons' beliefs, attitude and behavior are influenced by values. These values provide a reference point in a situation that is new or uncertain with little guidance. Managers must ensure that the danger of no consensus on objectives and many different perceptions and interpretations of values will be resolved. Beliefs stated in a shared strategic vision in the front-end can increase consensus on objectives and decrease different perceptions of an expected outcome (Zhang and Doll, 2001).

5.2.2. *Boundary system*

Telling people what to do discourages initiative and creativity. Telling people what not to do allows innovation, but within clearly defined limits. A boundary system is a formal system which is created to establish explicit limits and rules in negative terms. It is exemplified through strategic planning with regard to functional strategies and determination and application of a process model and business case template. So it puts boundaries on e.g. the use of technology or people outside the organization, the customer that the organization wants to serve, how much money or time is available, the structure and activities in the process or the information aspects that have to be covered in a business case. These aspects in a boundary system are formalized and institutionalized in a project plan in the project initiation phase by both the strategic actor and project actor. It provides people with guidance in the consideration process to do or not do things that will also have an influence on the implicit decisions that project members make in the phases. So it can be said that a boundary is the acceptable domain for activity and innovation and have to be respected in the project. When a boundary reasonably has to be changed then a clear and complete understanding of the consequences must be there. The decision to change a boundary is taken by the strategic actor. In short, a boundary system with regard to the front-end tells what won't be done strategically and so transform limitedless opportunity and activity into a focused strategic arena and front-end process to let people do the right thing and allow individual empowerment and creativity within defined limits of freedom. Project members can view boundary systems as constraining or liberating (Simons, 1995).

5.2.3. *Diagnostic control system*

Periodically managers have to measure outputs and compare them to pre-set performance objectives. Feedback gives management the possibility to adjust, correct or fine-tune inputs and processes so that future outputs will comply with performance objectives. It is exemplified by a monitor and feedback system created in the project initiation phase by both the strategic actor and the project actor. The content of a performance management system could be designed as the balanced scorecard (Kaplan and Norton, 2005). This is a performance measurement tool (with objectives, measures and targets) regarding four perspectives: financial, customer, internal processes and innovation/learning. In the revised process model a monitor and feedback system is reflected in project management (section 3.1), interactive aspect and the gates between the phases. In these gates the project actor and strategic actor can monitor and evaluate what the project actor did, decided and learned in the previous phase. This information has to be sufficiently checked on reliability, validity and comprehensiveness. Based on the information feedback is provided and a decision to stop, iterate or proceed is taken by the strategic actor. Besides that a project manager can reward all project members financially and non-financially for delivered work. The diagnostic control system has also the task to check if

formulated boundaries and beliefs are respected by the project actor.

When operational control with regard to cost or time predominate empowerment and creativity it could imply that an innovation project cannot or not fully take advantage of the relatively cheap and large iteration opportunities in the front-end. Room for experimentation or failure with a learning purpose has to be supported.

5.2.4. *Interactive control system*

An interactive control system is used by and provides benefits for both the project actor and senior actor. It has the purpose that senior managers are regularly and personally involved in the front-end process by building and supporting open dialogue and debate with the project actor to:

- Identify and evaluate the impact of threats and opportunities in the environment regarding the project.
- Encourage information sharing about important aspects.
- Learn about strategic foresights, the process and strategic decisions.
- Control and direct empowered activities directly.

If used properly this aspect partially solves the lack of senior management support and involvement that is often perceived in front-end practice, in which it is only "awake" when large resources are committed or problems arise in the development part. Besides that a project manager is mostly the only (formal) link between the strategic actor and project members, so it can be said that the possibility for senior management to control, direct and interact with individual project members directly is institutionalized by this system, not only at gates. Interactive controls, created in the project initiation phase, are illustrated by e.g. formal meetings, informal visits/telephone calls or participative planning. Of course new information and communication technologies can be used as social media (e.g. Whatsapp groups or Google+) to facilitate the interaction.

The system is used through the process and enhances the three other control aspects by interacting about them. Note that this system also demands willingness to participate from project members to be effective. In short regarding a management control system, creating is one, using is two and continuing to use is the most important through the process, especially if it takes longer or if it went well till that time. A crucial decision for managers is selecting and using the control systems properly (Simons, 1994). In the next chapter the discussion, with conclusion, limitations and future research is considered.

6. DISCUSSION

6.1. Conclusion

The answer to the research question is a revised iterative front-end process model, based on required business case information aspects, with an integrated management control system. The model contains a divided process, in which management control forms the link between the project actor and the strategic actor and has the function to direct and control the activities and decisions in the project phases. Simons' levers of control model gives substance to the management control system with a belief, boundary, diagnostic and interactive aspect. The front-end process is divided in parts based on the own formulation of a clear and comprehensive business case for innovation. It aims to show and explain how to best shape, divide and control the front-end process to possibly lower the fuzziness and solving the difficulty in managing the front-end (Khurana and Rosenthal, 1998). The importance of management control in the front-end is large due to

three reasons. The first reason is that the front-end of innovation provides relatively great and cheap opportunities for iteration to build a total innovation process that is efficient and effective. The second reason is the ability of senior management to control and direct strategic decisions made in a temporary organization, which have profound implications in the long-term, is of course the greatest in the front-end (Artto et al., 2011). The third reason is the opportunity to resolve the shortcomings in widely applied project management and Stage-Gate. In the next part is shortly explained how the proposed model with management control possibly resolves the identified shortcomings:

Inadequately frame or define the front-end process.

The formulated process model and business case criteria in this paper try to shape, divide and frame the front-end process and clarify the purpose of different phases and gates in the model. Both the model and required business case information aspects are reflected in a project plan as boundary aspect in the management control system. The model can be seen as process control, because it suggests what to do or to decide in specific phases and gates, without influencing the content of the innovation.

No explicit strategic starting or reference point.

The strategic foresight phase in the process model forces senior management to reconsider and explicitly formulate the mission, vision and strategy of the organization and so functions as starting or reference point for the front-end project. These formulated statements are reflected as beliefs and boundaries in the management control system by formally communicating and systematically reinforcing them to provide important values, boundaries, purpose and direction to the project actor activities and decisions.

Unclear customer problem or product specifications.

The process model has a customer-driven approach by first targeting a customer (derived from marketing strategy), searching for and validating a customer problem and finding or creating solution directions to formulate a minimum viable product concept with clear specifications. This means that end-users have to be involved early. Credo is to go always (back) to the articulated and unarticulated need of the end-user and not simply relying on the possibilities or quality of a solution.

Inadequately direct or control implicit decisions.

Before developing the business case there will be many implicit decisions made by the project members. The belief and boundary aspect provide guidance by formulated values and norms that are rooted in documents, regularly communicated and reinforced systematically and must be respected through the process. In this way it will be possibly grounded in the mind of the project actor, which will have an influence on its implicit decisions. When beliefs and boundaries are communicated clear towards the project actor through the front-end process, it has a clear notice of the expectations and its potential contribution to achieve objectives. The interactive aspect by which the strategic actor is regularly and personally involved in the front-end process provides possibilities to directly (not via the project manager) control through open dialogue and debate. The three aspects try to control and direct implicit decisions without dictating what to do and so leave room for empowerment.

No room for or focus on iteration and learning in SGS.

At gates and in the interactive aspect of the management control system is room for evaluation and learning about the process, decisions, strategy and other things. It is of course better to track an error or incorrect assumption in the front-end than in later parts

in the innovation process. Room for experimentation or failure with a learning purpose has to be supported.

Lack of senior management involvement and control.

The process model has assigned tasks to the strategic actor in two phases and all gates. The interactive aspect has the purpose that senior managers are regularly and personally involved in the front-end process by building and supporting open dialogue and debate with the project actor to evaluate, learn, decide and control.

As last point in the conclusion the model is shortly positioned regarding the generations of R&D management. The generations are derived from the article "Towards the sixth generation of R&D management" of Nobelius (2004). The main objective of the model is the most in line with the third generation of R&D management (Roussel et al., 1991) because of linking R&D to strategy. The proposed model is an addition, because it includes more principles of other generations⁴ and emphasis is more on showing and explaining how to shape and control one front-end process with a project and strategic actor. This makes it more operational and applicable for one project or process and not an R&D department with various projects and processes. Besides that it formulates how the implementation of or link towards strategy can be controlled in situations that demand empowerment.

6.2. Limitations and future research

By providing a conceptual model, a simplification of reality, it may be that not all relevant aspects are included, so the model could be adapted and elaborated. Besides that the performance of the front-end phase is dependent on more aspects than only management control (e.g. managing capability, absorptive capacity or financial resources). It is important to note that the proposed model considers not explicitly informal control and considers only one innovation project. The model has no predictive value for innovation processes, but it is a suggestion to show and explain how to best shape, divide and control the front-end part and so hopefully provides assistance in practice. Organizations could apply it in a flexible way in a front-end project of an innovation process. A step further could be testing the model on efficiency and effectiveness and evaluate how it works in practice. Of course, in each case it is good to consider whether the model is applicable. An important question would be what the perceptions/attitudes of the project actor and strategic actor are towards the way of working described in the model and what the impact of these perceptions/attitudes are on the working of the model. Also the appropriate level of using and the presentation of the controls in the model could be studied. Stated from Simons' LOC model the four control systems must be all present. An important question would be how and why the use of or emphasize on the four management control aspects differ between the front-end of incremental and radical innovation. Studies on the use of management control in the front-end of radical innovation are scarcely found (Chiesa et al., 2009; Poskela and Martinsuo, 2009) and most management control studies tend to look at management control systems as "snapshot" and ignoring the dynamics. "A more explicit consideration of the process of change and of its dynamics would clearly enrich the study of management control systems" (Ferreira and Otle, 2009). All this calls for further research.

⁴ e.g. market-pull and project management (2nd generation), learning, total business concept and cross-functional integration (4th generation) or collaboration in a network (5th generation).

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8. REFERENCES

Amabile, T. M. (1996). Creativity and innovation in organizations, Harvard Business School Boston.

Anthony, R. N. (1965). "Planning and control systems: a framework for analysis."

Artto, K., et al. (2011). "The integrative role of the project management office in the front end of innovation." *International Journal of Project Management* 29(4): 408-421.

Bacon, G., et al. (1994). "Managing product definition in high-technology industries: a pilot study." *California Management Review* 36: 32-32.

Bisbe, J. and D. Otley (2004). "The effects of the interactive use of management control systems on product innovation." *Accounting, Organizations and Society* 29(8): 709-737.

Bonner, J. M., et al. (2002). "Upper management control of new product development projects and project performance." *Journal of Product Innovation Management* 19(3): 233-245.

Chandler, A. D. (1976). "Strategy and structure: Chapters in the history of the American industrial enterprise, 1962." Irwin, Boston, MA.

Chenhall, R. H. (2003). "Management control systems design within its organizational context: findings from contingency-based research and directions for the future." *Accounting, Organizations and Society* 28(2): 127-168.

Chesbrough, H. W. (2003). *Open innovation: The new imperative for creating and profiting from technology*, Harvard Business Press.

Chiesa, V., et al. (2009). "Exploring management control in radical innovation projects." *European Journal of Innovation Management* 12(4): 416-443.

Collier, P. M. (2005). "Entrepreneurial control and the construction of a relevant accounting." *Management Accounting Research* 16(3): 321-339.

Conway, S. and F. Steward (2009). "Managing and shaping innovation."

Cooper, R. G. (1988). "Predevelopment activities determine new product success." *Industrial Marketing Management* 17(3): 237-247.

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

Cooper, R. G. (2008). "Perspective: The Stage-Gate® Idea-to-Launch Process—Update, What's New, and NexGen Systems*." *Journal of Product Innovation Management* 25(3): 213-232.

Cooper, R. G. and E. J. Kleinschmidt (1993). "Stage gate systems for new product success." *Marketing Management* 1(4): 20-29.

Davila, T. (2000). "An empirical study on the drivers of management control systems' design in new product development." *Accounting, Organizations and Society* 25(4): 383-409.

Ferreira, A. and D. Otley (2009). "The design and use of performance management systems: An extended framework for analysis." *Management Accounting Research* 20(4): 263-282.

Galbraith, J. R. (1973). *Designing complex organizations*, Addison-Wesley Longman Publishing Co., Inc.

Grönlund, J., et al. (2010). "Open innovation and the stage-gate process: a revised model for new product development." *California Management Review* 52(3): 106-131.

Guide, A. (2001). *PROJECT MANAGEMENT BODY OF KNOWLEDGE (PMBOK® GUIDE)*. Project Management Institute.

Henri, J.-F. (2006). "Management control systems and strategy: a resource-based perspective." *Accounting, Organizations and Society* 31(6): 529-558.

Herstatt, C. and B. Verworn (2001). The "fuzzy front end" of innovation, Working Papers/Technologie-und-Innovationsmanagement, Technische Universität Hamburg-Harburg.

Kaplan, R. S. and D. P. Norton (2005). "The balanced scorecard: Measures that drive performance." *Harvard business review* 83(7-8): 172-+.

Kaplan, R. S. and D. P. Norton (2008). *The execution premium: linking strategy to operations for competitive advantage*, Harvard Business Press.

Kapsali, M. (2011). "Systems thinking in innovation project management: A match that works." *International Journal of Project Management* 29(4): 396-407.

Keizer, J. A. and J. I. Halman (2007). "Diagnosing risk in radical innovation projects." *Research-Technology Management* 50(5): 30-36.

Keizer, J. A. and J. I. Halman (2009). "Risks in major innovation projects, a multiple case study within a world's leading company in the fast moving consumer goods." *International Journal of Technology Management* 48(4): 499-517.

Khurana, A. and S. R. Rosenthal (1997). "Integrating the fuzzy front end of new product development." *Sloan management review* 38: 103-120.

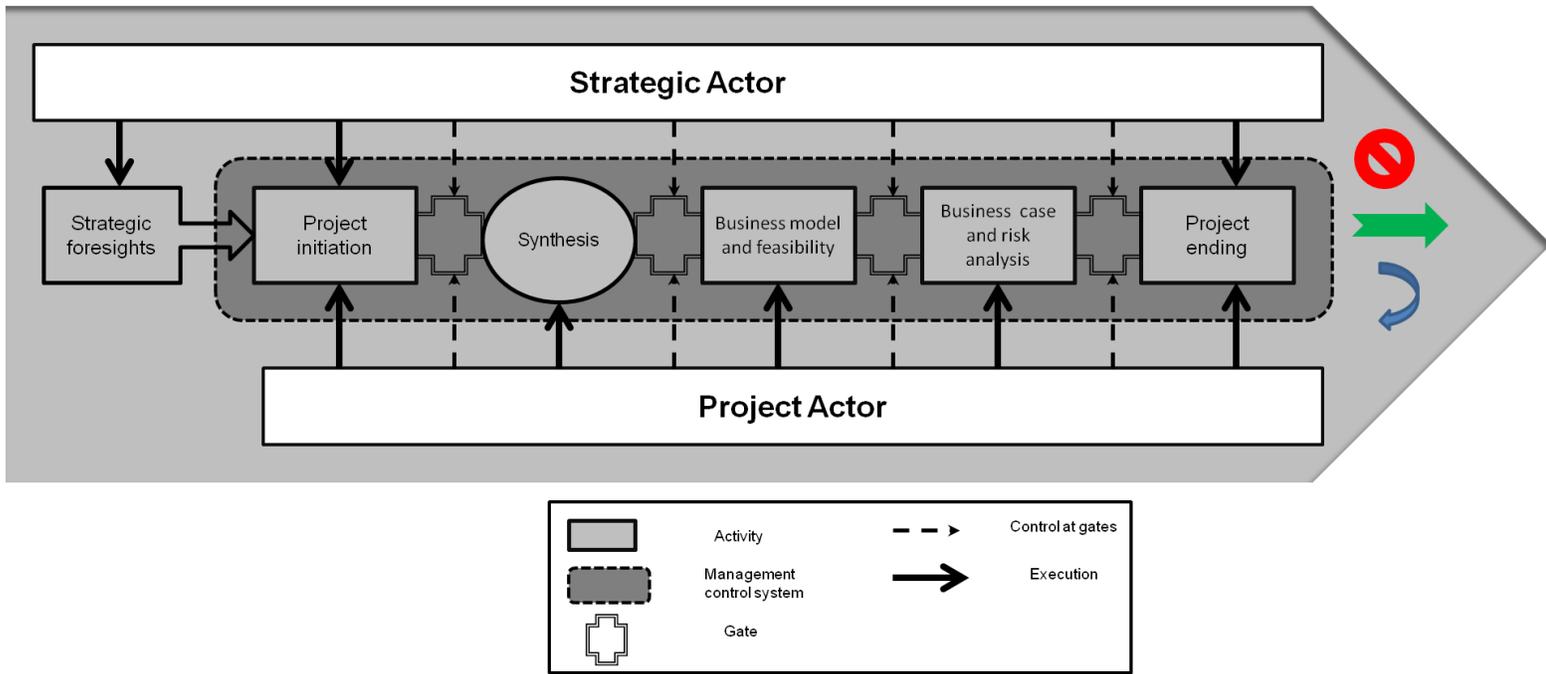
- Khurana, A. and S. R. Rosenthal (1998). "Towards holistic "front ends" in new product development." *Journal of Product Innovation Management* 15(1): 57-74.
- Kim, J. and D. Wilemon (2002). "Focusing the fuzzy front-end in new product development." *R&D Management* 32(4): 269-279.
- Kim, J. and D. Wilemon (2002). "Strategic issues in managing innovation's fuzzy front-end." *European Journal of Innovation Management* 5(1): 27-39.
- Koen, P. A., et al. (2001). *Fuzzy front end: effective methods, tools, and techniques*, Wiley, New York, NY.
- Malmi, T. and D. A. Brown (2008). "Management control systems as a package—Opportunities, challenges and research directions." *Management Accounting Research* 19(4): 287-300.
- Marginson, D. E. (2002). "Management control systems and their effects on strategy formation at middle-management levels: evidence from a UK organization." *Strategic management journal* 23(11): 1019-1031.
- Mintzberg, H. (1987). *Crafting strategy*, Harvard Business School Press.
- Moenaert, R. K., et al. (1995). "R&D/marketing communication during the fuzzy front-end." *Engineering Management, IEEE Transactions on* 42(3): 243-258.
- Mootee, I. (2011). "Strategic Innovation and the Fuzzy Front End." Retrieved 25-06-2014, from <http://www.iveybusinessjournal.com/topics/innovation/strategic-innovation-and-the-fuzzy-front-end#.U6rQITaKCM8>.
- Nobelius, D. (2004). "Towards the sixth generation of R&D management." *International Journal of Project Management* 22(5): 369-375.
- Otley, D. (1999). "Performance management: a framework for management control systems research." *Management Accounting Research* 10(4): 363-382.
- Otley, D., et al. (1995). "Research in management control: an overview of its development." *British Journal of management* 6(s1): S31-S44.
- Ouchi, W. G. (1979). "A Conceptual Framework for the Design of Organizational Control Mechanisms." *Management Science*: 833-848.
- Poskela, J. and M. Martinsuo (2009). "Management control and strategic renewal in the front end of innovation." *Journal of Product Innovation Management* 26(6): 671-684.
- Reid, S. E. and U. De Brentani (2004). "The fuzzy front end of new product development for discontinuous innovations: a theoretical model." *Journal of Product Innovation Management* 21(3): 170-184.
- Ries, E. (2011). *The lean startup: How today's entrepreneurs use continuous innovation to create radically successful businesses*, Random House LLC.
- Rokeach, M. (1968). "Beliefs, attitudes and values: A theory of organization and change."
- Roussel, P. A., et al. (1991). *Third generation R&D: managing the link to corporate strategy*, Harvard Business Press.
- Google Scholar (2014). http://scholar.google.nl/scholar?hl=en&q=levers+of+control&btnG=&as_sdt=1%2C5&as_sdtp=. Retrieved 25-06-2014.
- Schultz, C., et al. (2013). "How Formal Control Influences Decision-Making Clarity and Innovation Performance." *Journal of Product Innovation Management* 30(3): 430-447.
- Simons, R. (1994). "How new top managers use control systems as levers of strategic renewal." *Strategic management journal* 15(3): 169-189.
- Simons, R. (1995). "Control in an age of empowerment." *Harvard business review* 73(2): 80-88.
- Simons, R. (2013). *Levers of control: How managers use innovative control systems to drive strategic renewal*, Harvard Business Press.
- Smith, P. and D. Reinertsen (1998). *Developing Products in Half the Time, (Advanced Praise for Developing Products in Half the Time: New Rules, New Tools)*, New York: John Wiley & Sons, Inc.
- Tessier, S. and D. Otley (2012). "A conceptual development of Simons' Levers of Control framework." *Management Accounting Research* 23(3): 171-185.
- Tidd, J. and J. Bessant (2009). "Managing innovation: integrating technological, market and organizational change."
- Tuomela, T.-S. (2005). "The interplay of different levers of control: A case study of introducing a new performance measurement system." *Management Accounting Research* 16(3): 293-320.
- Turner, J. R. and A. Keegan (2001). "Mechanisms of governance in the project-based organization: Roles of the broker and steward." *European Management Journal* 19(3): 254-267.
- Van Elten, H. J. and S. K. Widener (2013). "Creativity and Control: A Paradox-Evidence from the Levers of Control Framework." Available at SSRN 2311779.
- Von Hippel, E., et al. (1999). "Creating breakthroughs at 3M." *Harvard business review* 77: 47-57.
- Widener, S. K. (2007). "An empirical analysis of the levers of control framework." *Accounting, Organizations and Society* 32(7): 757-788.
- Zhang, Q. and W. J. Doll (2001). "The fuzzy front end and success of new product development: a causal model." *European Journal of Innovation Management* 4(2): 95-112.

9. APPENDICES

9.1. Formulation of business case information aspects

Business case information aspects
Strategic Foresights <ul style="list-style-type: none">- Screening of the organization: where does it stand now?- Environmental screening: present and future technological, market and regulation threats or opportunities.- Formulation of a mission, vision and strategy of the organization as reference point for the total innovation process.- Possibly gathering of feedback of owners with regard to management's strategic planning and long-term objectives.- Translation of the strategy into functional strategies: innovation, marketing and financial.- Testing and learning in the front-end to improve: are the strategies feasible and appropriate?
Project initiation <ul style="list-style-type: none">- Determination of the strategic arena (scope) for innovation derived from financial, innovation and marketing strategy.- Agreement on and formalization of the structure of a front-end process and a management control system.- Establishment of a project plan including objectives, organization, resource commitment, structure, criteria, contracts, place and timing.
Synthesis <p><i>Customer segment and problem (who and why?)</i></p> <ul style="list-style-type: none">- Identification of a customer segment that the organization wants to serve derived from the marketing strategy.- Identification and validation of customer problems (functional, social and emotional aspects) in the targeted customer segment.- Preliminary assessment of the attractiveness and priority of solving a customer problem.- Selection of a customer problem for which a solution will be created. <p><i>Solution directions (how?)</i></p> <ul style="list-style-type: none">- What are existing or possible future (competitive) solutions to the customer problem?- Finding of existing or creation of novel internal or external ideas to solve the customer problem.- Preliminary assessment of ideas with regard to its effectiveness to solve a customer problem, its technical feasibility and its costs or resources needed to create and deliver value.- Selection of a solution direction based on the previous assessment. <p><i>Synthesis: a clear product concept with product specifications (what?)</i></p> <ul style="list-style-type: none">- Lean and mean (using what is necessary and effective): conceptualizing a minimum viable product with the right attributes and combination of attributes to solve a customer problem based on an empathic insight.- Consideration of legal, environmental, health and safety factors.- Gathering possible feedback and qualitatively validate the product concept with "innovators" on a small scale.
Business model and feasibility <ul style="list-style-type: none">- Consideration of existing and possible future competing solutions (with underlying business models).- Stating a unique value proposition. How is value created and delivered and to whom?- The way of value capturing (e.g. IP, first-to-the-market or exclusive contracting) and its consequence for development.- Conceptualization of a value chain and the role of the organization in it. Assessment of the willingness to adopt the solution based on involvement of partners (e.g. suppliers and distributors).- Development of a revenue model and clarifying costs (note also: opportunity and displacement costs) and the cost structure based on reasonable assumptions.- Why is the solution worth pursuing, financially and non-financially, for the organization?- Financial projections with regard to the investment in and return of the innovation. Can the organization afford the investment? How is the investment funded?- Consideration of possible product or technology portfolio opportunities and threads.- Make or buy decision. Will the product be developed internally or externally with internal or external technology and science?- A final feasibility study of the product concept with underlying business model.
Risk analysis <ul style="list-style-type: none">- Identification and evaluation of risk factors (e.g. financial, market or technical) in the innovation process based on uncertainty, impact and controllability.
Planning and documentation <ul style="list-style-type: none">- A project plan for development including objectives, organization, resource commitment, process, contracts, place and timing.- Documentation of process phases, iterations, learning and underpinnings of strategic decisions in the front-end.

9.2. An iterative front-end process model with an integrated management control system



The synthesis phase in the model:

