

Critical success factors in early new product development: a review and a conceptual model

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Abstract The literature on the front end in the New Product Development (NPD) literature is fragmented with respect to the identification and analysis of the factors that are critical to successful product development. The article has a two-fold purpose. First, it describes, analyses, and synthesizes those factors through a literature review of the research on the front end in NPD. Second, it conceptualizes a framework that features two types of success factors: foundational success factors (common to all the firm's projects) and project-specific success factors (appropriate for the firm's individual projects). The article makes recommendations for the management of this important phase of product development, discusses limitations of relevant previous research, and offers suggestions for future research. The article makes a theoretical contribution with its analysis and synthesis of the reasons for success in front-end activities and a practical contribution with its conceptual framework that can be used as an analytical tool by firms and their product managers.

Keywords Product development · NPD · Innovation · Front end · Literature review · Conceptual framework

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Introduction

New product development (NPD) projects tend to fail, either in the last stage of the development process or in the later commercial stage. The underlying causes of failure can often be traced to the beginning stage, in what is often called the front end of NPD. Broadly speaking, this stage is defined as the period between the initial consideration of a new product idea and the decision to begin or to abort development of the product (Kim and Wilemon 2002a).

Prior research on managing NPD has shown that the front end of NPD often has a dynamic and interactive nature (Akbar and Tzokas 2013). This stage is characterized by complex information processing (Khurana and Rosenthal 1997; De Brentani and Reid 2012), ad hoc decision-making (Montoya-Weiss and O'Driscoll 2000), and conflicting organizational pressures caused by, for example, high degrees of complexity and uncertainty (Chang et al. 2007). These challenging characteristics frequently result in missteps, time delays, and product failure (Goldenberg et al. 2001).

Prior research also shows that ability to manage the front end of NPD, in which robust product definitions are developed, has a significant effect on product success (Cooper and Kleinschmidt 1987; Murphy and Kumar 1996; Khurana and Rosenthal 1997, 1998). Vague or faulty product definitions may result in high costs and/or failure in subsequent stages of the development process (Bacon et al. 1994).

Most research on the front end of NPD concludes that this stage – from a managerial point of view – is different from later product development stages. Therefore, the front end of NPD must be managed following a different logic (Markham 2013). However, the extant front-end literature, which relies considerably on anecdotal evidence, lacks a comprehensive conceptual framework that identifies, describes, and synthesizes the key success factors in front-end management.

This article, which reviews the literature on the front end of NPD, focuses on these success factors. The article then uses these factors to create a conceptual framework that firms can use to manage the front end of NPD. Although the literature on the later stages of NPD is well developed (e.g., Brown and Eisenhardt 1995; Cooper et al. 2002), we still lack a conceptual understanding of how firms that seek to enhance their front-end competence should proceed (e.g., Florén and Frishammar 2012; Chang et al. 2007; Kim and Wilemon 2002a, 2002b). Our conceptual framework is intended to provide that assistance.

The article is structured as follows. We begin by describing how we conducted our literature review. Based on the results of this review, we present a discussion of success factors for the front end of NPD, including commentary on robust product definition, open innovation, and on go/no-go decision-making in NPD. We distinguish between foundational success factors and project-specific success factors. We then present our conceptual framework that is based on these factors. Thereafter we discuss our findings with reference to previous research and describe our practical and theoretical contributions. We conclude with suggestions for future research.

Method and research procedure

Choosing sources for literature review is a process of inclusion and exclusion. We followed several steps to minimize this risk of including the “right” literature and excluding the “wrong” literature.

We searched for articles on the front end in NPD that were published in the last fifteen years in well-known, peer-reviewed technology and innovation management journals. We found that the articles use various terms to refer to the front end of NPD. We identified the following synonyms for “front end”: *early*, *discovery*, *idea*, *concept*, and *predevelopment*. We also identified three words that refer to the time in which front-end activities are conducted: *stage*, *process*, and *phase*. Last, we identified three terms that describe the work in front-end activities: *product development*, *innovation*, and *NPD*. We used these search words and terms, in various combinations, in selected databases to produce a list of articles for our review.

We searched the following databases: Business Source Elite, Emerald Insight, ABI/Inform, JSTOR, IEEE Xplore, and Blackwell Synergy. These are databases commonly used to review the published work of innovation and entrepreneurship researchers (George et al. 2016).

For various reasons, we excluded many of the retrieved articles from our review. For example, we found articles that only briefly addressed the importance of the front end of NPD and did not describe the success factors related to front-end activities. We also excluded articles that focused on sources of ideas for innovation (e.g. McAdam and McClelland, 2002; Salter and Gann, 2003). The reason for this decision was that most authors conceptualize the front end as beginning when firms already have an idea. We excluded other articles because they dealt only minimally, or not at all, with how to organize and manage the front end of NPD.

Success factors for the front end in the new product development literature

Many studies on the front end of NPD do not define success. However, for purposes of our conceptual framework, a definition of success is required. We agree with Kim and Wilemon (2002b) that the success of front-end activities depends on whether they lead to a *robust product definition* that, in turn, leads to product development. A robust or corroborated product definition is one that is clear, stable, and unambiguous, and has passed business and feasibility analysis (Florén and Frishammar 2012). Product concepts, which are at the core of robust product definitions, are “representations of the goals for the development process” (Seidel 2007, p. 523).

According to Montoya-Weiss and O'Driscoll (2000), a product concept requires a definition of the underlying technologies plus statements on customer benefits and evaluations of market opportunities. A product concept also includes analyses of market segments and positioning, competitors, and alignments with existing business and technology plans (Khurana and Rosenthal 1997; Montoya-Weiss and Calantone 1994; Song and Parry 1996; Cooper and Kleinschmidt 1987).

Popper (1959, 1972) concludes that scientific laws are falsifiable rather than verifiable. We apply this reasoning when we state that robust product definitions derived from front-end activities cannot be verified as completely valid; rather, we argue they

only can be evaluated as unflawed. Therefore, relevant actors at a firm (e.g., the development team, the review committee, and other decision-makers) must accept the robust product definition and agree that it has the potential to lead to product development.

We use the robust product definition as a proxy for front-end success. We acknowledge that such a managerial definition of front-end success potentially neglects alternative definitions that other decision-makers, with other NPD interests and perspectives, support. Such definitions typically do not align with the robust product definition that the firm supports. Examples are skunkworks projects that are generally found outside traditional NPD processes.

We claim that the front end of NPD begins when relevant key actors in the firm recognize the potential of an idea to lead to product development. The front end of NPD concludes with the go/no-go decision for a proposed product. The decision to begin or to abort product development is made with reference to the robust product definition. This means that the robust product definition exerts a powerful influence on product development.

Two major reasons explain a no-go decision. First, an idea is “killed” if decision-makers conclude the proposed product has no or low commercial potential. Second, an idea is abandoned if it does not fit with the firm’s current business model even though the idea may, in some respects, have commercial value. The latter reason leads to reflections on the open innovation paradigm.

In promoting the open innovation paradigm, Chesbrough (2003, 2006) comments that ideas that do not align with a focal firm’s current business may still be successfully commercialized outside that firm. The implication is that a robust product definition can still lead to product development even if the focal firm chooses not to develop the idea into a product. Hence, we argue that a robust product definition is also a valid measure of the success of front-end activities when it leads to insights relevant to the open innovation paradigm.

Figure 1 presents our conceptual framework. Tables 1 and 2 develop the success factors in the framework. In agreement with Khurana and Rosenthal (1997), we distinguish between foundational success factors and project-specific success factors. Foundational success factors apply to all of the firm’s front-end projects whereas project-specific success factors apply to the firm’s individual front-end projects. Hence, top management should oversee the foundational success factors, and front-end project managers and teams should oversee the project-specific success factors.

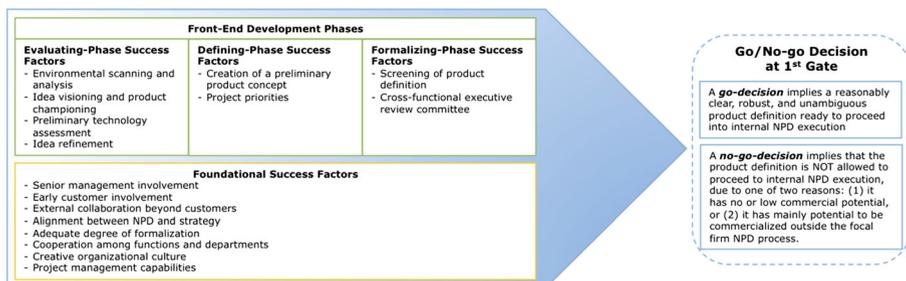


Fig. 1 A conceptual framework of success factors in the front end of new product development

Table 1 Measurement and evaluation of the conceptual framework: foundational success factors

Factor	Key questions	Ideal condition/situation
Senior management involvement	Has commitment from senior management been secured?	Senior management provides internal legitimacy and momentum for the new idea and concept
Early customer involvement	Are customer inputs integrated?	Customers are closely involved in the development process
External collaboration beyond customers	Is cooperation with the broader value chain partners achieved and sustained?	Effective interaction with value chain partners that reduces technological and market uncertainty
Alignment between NPD and strategy	Do the new product development activities align with the firm's general business strategy?	High level of alignment between NPD and business strategy
Adequate degree of formalization	Are the activities sufficiently formalized to ensure orderly and predictable management, without over-formalization?	Adequate level of formalization that reduces uncertainty and equivocality
Cooperation among functions and departments	Is cross-functional cooperation identified and utilized?	Sufficient cross-functional integration benefits are achieved
Creative organizational culture	Does the firm culture encourage the use of employees' innovation talents to produce and refine ideas?	Highly innovative-friendly culture promotes creativity
Project management capabilities	Do the project managers have relevant expertise and experience with project management?	Significant experience and expertise of project management

Table 2 Measurement and evaluation of the conceptual framework: project-specific success factors

	Factor	Key questions	Ideal condition/situation
Evaluating-Phase Success Factors	Environmental scanning and analysis	Has the scanning process provided the necessary environmental knowledge for evaluation?	An effective scanning process exists for integrating broad external information into the project
	Idea visioning and product championing	Is the idea sufficiently visionary to promote ideas to different stakeholders?	Commitment of enthusiasts who enable linkage between project goals and the firm
	Preliminary technology assessment	Is the product's viability attainable based on the technological assessment?	Well defined technical requirements for reducing uncertainty
	Idea refinement	Can the individuals in the project communicate a clear solution?	Systematic approach to idea refinement in place
Defining-Phase Success Factors	Creation of a preliminary product concept	Is it possible to present a robust preliminary product definition for a clear understanding?	Clear visual presentation of early product concept for feedback and development
	Project priorities	Are priorities set for the key product features?	Significantly developed project requirements or priority list that ranks key product features
Formalizing-Phase Success Factors	Screening of the preliminary product Concept	Can the product concept be screened and evaluated?	Effective way to screen obvious no-go projects and go projects
	Cross-functional executive review committee	Is a cross-functional executive review committee involved in the evaluation?	Interests of different department and functional level are captured in the review committee

Next we describe how these two groups of factors lead to corroborated or robust product definitions. We begin with the foundational success factors followed by the project-specific success factors.

Foundational success factors

Senior management involvement Senior management can support managers and teams who work with front-end activities in various situations and in various ways (De Cleyn et al. 2015). First, such support is essential when resistance to change is encountered (McAdam and Leonard 2004). Second, the momentum behind new product ideas is stronger if senior management is directly involved during the front end of NPD (Murphy and Kumar 1997; Lauto et al. 2013). Third, senior management's support in front-end activities promotes greater innovation (Koen et al. 2001). Fourth, senior management can provide resources, clarify project objectives (Kim and Wilemon 2002a, 2002b), and create vision statements (Koen et al. 2014). Fifth, senior management can coordinate individual activities that span functional boundaries (Khurana and Rosenthal 1998).

Early customer involvement The value of customer involvement in the front end of NPD is somewhat controversial. For example, some commentators argue that customers rarely provide rich or diverse information to firms (Granovetter 1982; Krackhardt 1992). Alam (2006), who warns against asking customers to suggest solutions for product problems, thinks that firms learn more from asking customers about the benefits they seek.

However, other researchers support the positive effects of customer involvement in product development. For example, Bacon et al. (1994) claims that NPD teams that do not include customer input in their development projects seldom produce successful products. Other researchers agree that firms should explore customer expectations and requirements before product development begins (Kim and Wilemon 2002b; Smith et al. 1999; Verworn 2006; Verworn et al. 2008). Such information is useful because it clarifies project objectives early in the development stages (Cooper 1988; Cooper and Kleinschmidt 1987; Zien and Buckler 1997; Robbins and O'Gorman 2015; Verworn et al. 2008; Murphy and Kumar 1997). In addition, customers may offer product ideas at the front end of NPD that developers have not yet considered (Cooper et al. 2002; Kim and Wilemon 2002a).

External cooperation beyond customers External actors (e.g., suppliers) can offer assistance in the front end of NPD (Harvey et al. 2015). Murmann (1994) found that partnering with competent suppliers in the front end may reduce technological uncertainty. Effective supplier cooperation has also been found to decrease time-to-market, reduce development costs, and improve product quality (Kim and Wilemon 2002a, 2002b). Khurana and Rosenthal (1997) show that some firms take a broad perspective on the value chain in the front end of NPD. Such firms, for example, address their suppliers' requirements in the front end in order to acquire useful input for concept development.

Alignment between NPD and strategy From a more strategic perspective, researchers have identified the firm's alignment of NPD with its general business strategy as a critical front-end success factor (Koen et al. 2001; Schröder and Jetter 2003; Trimi and Berbegal-Mirabent 2012; Khurana and Rosenthal 1997). Some researchers recommend that firms use their core competences in front-end projects to ensure that their business strategy stays in focus (Bacon et al. 1994; Smith et al. 1999).

Costa et al. (2013) found that inadequate strategic planning has a negative influence on the front end of NPD. Khurana and Rosenthal (1998) found that successful firms link business strategy, product strategy, and product-specific decisions. Good alignment between NPD and strategy also highlights the need for firms to engage in product portfolio planning. An example is the need to think strategically when planning an optimal mix of product attributes that meet customers' wishes and expectations (Kim and Wilemon 2002b).

Adequate degree of formalization Several researchers propose that orderly and predictable management that reduces uncertainty in the front end benefits NPD (Khurana and Rosenthal 1998; Smith et al. 1999; De Brentani 2001; Boeddrich 2004). Other researchers conclude success is more likely if front-end activities are broken into modules or sub-phases, just as they are in the later stages of NPD (Cooper et al. 2002; Flint 2002; Verworn et al. 2008; Williams et al. 2007; Van Der Duin et al. 2014). Khurana and Rosenthal (1998) claim that management should explicitly communicate around NPD, clearly assign decision-making responsibilities, and specifically identify performance measurements. Markham (2013) corroborates these recommendations.

However, the relationship between formalization and success is not necessarily linear. Rather, the literature suggests the relationship has an inverted u-shape: Too little as well as too much formalization seems to damage the chance of success of front-end activities (Khurana and Rosenthal 1998). In particular, too much formalization may lead to rigidity that dampens creativity (Gassmann et al. 2006) that – in turn – may risk negative effects, particularly in cases of radical innovation (Florén and Frishammar 2012). Furthermore, recent research indicates that a low degree of formalization in the front end, in a climate that promotes psychological safety, is a possible avenue to front-end success (Nienaber et al. 2015).

Cooperation among functions and departments Cross-functional cooperation has been identified as essential to front-end success (Bocken et al. 2014; Kim and Wilemon 2002a, 2002b; Smith and Reinertsen 1992; Verganti 1997). One explanation may be that cross-functional cooperation benefits task analysis and reduces uncertainty in the front end (Moenaert et al. 1995). A second explanation may be that idea selection often takes place in meetings with representatives from different functional areas of the firm (Verworn 2006). In such meetings, cross-functional cooperation facilitates screening of ideas. A third explanation may be that cross-functional cooperation is necessary for “keeping an idea alive and active” (Conway and McGuinness 1986, p. 287) and for creating new knowledge (Heller 2000).

Various researchers have examined types of cross-functional cooperation. Kohn (2006) identifies the R&D and marketing relationship as the most likely cooperative interdependency in the front end of NPD. These two areas take responsibility for

product definition and product concept, which is then shared among the firm's other functions and departments. The areas of manufacturing and process design should also cooperate in the front end of NPD to assure the feasibility of manufacturing proposed products (Bacon et al. 1994; Verganti 1997).

Creative organization culture Creativity is clearly essential in the front end of NPD (Koen et al. 2001), as good ideas emerge in innovation-friendly cultures that foster the communication and development needed in the front end (Koen et al. 2014; Schröder and Jetter 2003; Smith et al. 1999). A creative culture encourages a firm's employees to use their innovative talent to produce and refine a steady stream of ideas (Kim and Wilemon 2002b; Murphy and Kumar 1997). A creative culture also reinforces a firm's market orientation by promoting consistency, efficiency, and productivity in the front end (Langerak et al. 2004).

Project Management capabilities The project manager has ultimate responsibility for managing a project through its various stages – one of which is the front-end stage, including its sub-phases. A good project manager requests support, lobbies for resources, and manages technical problems and design issues. Khurana and Rosenthal (1997) found that project managers at successful firms are involved in all these tasks. As far as the front-end tasks, project managers also define goals, prioritize work, and provide leadership (Kim and Wilemon 2002b). Project managers influence the product definitions, promote teamwork, facilitate strategic alignment, create a sense of joint team mission, and define project objectives (Koufteros et al. 2002; Rauniar et al. 2008).

Although researchers have not yet extensively investigated the characteristics of successful project management in the front end, the extant research shows that front-end activities may vary greatly as far as sequences, degree of overlap, and relative time duration (Nobelius and Trygg 2002; Reinertsen 1999). This means that front-end project managers must have many and varied capabilities.

Project-specific success factors

Evaluating-phase success factors

Environmental Scanning and Analysis Firms should ensure that relevant external information is made available to projects in the front end of NPD. Bacon et al. (1994) state that firms should pay close attention to competitors' current and planned products. They found that successful teams generally make such analyses whereas unsuccessful teams do not. They also found it is essential that firms pay attention to the applicable regulations and standards related to their NPD.

However, information about competitors, regulations, and standards is often firm-specific or industry-specific. Therefore, Börjesson et al. (2006) warn practitioners against taking too narrow a focus that may lead to ideas for products already available. Hence, it is recommended that firms adopt a scanning process, which includes more experimentation than the strategy literature suggests when they engage in NPD (e.g., Bocken et al. 2014).

Idea visioning and product championing Committed enthusiasts in leadership positions are valuable for overcoming firms' inertia that tends to support the status quo (Grant 1995; Griffiths-Hemans and Grover 2006; O'Regan and Ghobadian 2006; Markham 2013). Such enthusiasts are typically referred to as product champions (Conway and McGuinness 1986; Kim and Wilemon 2002b) or as idea visionaries (Griffiths-Hemans and Grover 2006).

The idea originator, the individual who is affected by a specific problem, or the individual with new product responsibilities are possible product champions (Conway and McGuinness 1986). Their involvement in front-end activities is essential.

Idea visionaries and product champions are, by definition, highly committed to product ideas. This commitment, which is reflected in their perseverance despite feelings of frustration and uncertainty (Kim and Wilemon 2002a), contributes to front-end results that add strategic value to the firm. Thus, they exert persistent, forward pressure on their firms (Conway and McGuinness 1986). Moreover, in providing the linkage between the project and the firm, they assist in interpreting the strategic meaning of product ideas (Heller 2000).

Preliminary technology assessment A product's required technology must be determined before product development begins (Cooper and Kleinschmidt 1987). This determination, which is mainly aimed at reducing technological uncertainty, is essential before significant resources are invested (Murnann 1994; Verworn et al. 2008). Cooper (1988) states that evaluation of technology requirements should address the product's viability. This means addressing the product's required technical solutions, its manufacturing feasibility, and its cost. In most successful projects, pre-development technology uncertainty is relatively low when technical requirements are explicitly defined and are shown to be technically feasible (Verworn 2006).

Idea refinement The front end of NPD is frequently said to begin when a firm first spots an opportunity (Khurana and Rosenthal 1997; Kim and Wilemon 2002b). Individuals create ideas (Boeddrich 2004; Kijkuit and van den Ende 2007). A product idea is a mental image of a solution to a problem (Griffiths-Hemans and Grover 2006). The qualities of the initial idea typically "make or break the project" (Cooper et al. 2002, p. 22).

As ideas are generally nebulous in their early stages, they need refinement so that risks and problems associated with them can be identified (Boeddrich 2004; Zien and Buckler 1997). As many, if not most, ideas eventually prove unviable, idea refinement is especially important in the front end. Poor idea refinement often results in costly problems in later stages (Cooper 1988). Therefore, careful refinement of ideas allows firms to move rapidly from new ideas to assessable concepts (Smith et al. 1999).

Defining-phase success factors

Creation of a preliminary product concept In the lead-up to the finalization of a robust product definition, a team prepares product specifications (Kalyanaram and Krishnan 1997) using different sources (Backman et al. 2007). Eventually a preliminary product concept is developed that allows the firm to decide whether further

development is warranted. If the decision is to move forward, the preliminary product concept enables the prioritization of activities in the development phase (Khurana and Rosenthal 1997; Kohn 2006). A preliminary product concept can be visualized as a picture, a drawing, a three-dimensional model, or a mock-up (Dickinson and Wilby 1997). Often, however, the concept is only described in text that explains its primary features and its customer benefits (Parish and Moore 1996).

Researchers have found that careful concept development is associated with project success (Cooper and Kleinschmidt 1987; Kim and Wilemon 2002b; Song and Parry 1996; Verworn et al. 2008). In addition, concept development influences the final go/no-go decision on product development (Cooper 1988).

Bacon et al. (1994) found that to create a robust product definition, information, including feedback, from all the firm's main functions is required. Insufficient information from these functions may explain why firms report severe difficulties in clarifying product concepts (e.g., Khurana and Rosenthal 1997).

In sum, a well-defined preliminary product concept allows for a better understanding of many important matters, including development time, costs, technical expertise, market potential, risk, and organizational fit (Kim and Wilemon 2002a).

Project priorities According to Khurana and Rosenthal (1997), project prioritization requires making trade-offs among scope (product functionality), scheduling (timing), and resources (cost). After observing a great deal of confusion about project priorities, they concluded that fuzzy project priorities were the single most important cause of time delays and product over-engineering. Murphy and Kumar (1997) support this finding in their conclusion that the clarification of project requirements is a key objective in the front end. Bacon et al. (1994) provide additional support in their finding that a priority list (i.e., a ranking of key product features) is crucial for developing robust product definitions.

Formalizing-phase success factors

Screening of the preliminary product concept Deficiencies in screening preliminary product concepts often cause problems in the development phase (Cooper 1988). Hence, it is not surprising that effective screening has been found to be an essential activity in the front end (Elmquist and Segrestin 2007; Kim and Wilemon 2002a, 2002b; Kohn 2005; Rosenthal and Rosenthal and Capper 2006).

The purpose of such screening is to evaluate product concepts. In principle, firms can make two screening mistakes: rejection of "good" product concepts or acceptance of "bad" product concepts (Reinertsen 1999). According to Lin and Chen (2004), abandoning inferior product concepts at an early stage often results in large cost savings since costs increase progressively in the NPD process. However, Cooper (1988) found that screening was most ineffective when it was used only to screen out obvious no-go projects. Firms should therefore assure that their screening activities are not conducted in a way that risks screening out good ideas and product concepts.

Murphy and Kumar (1997) found that screening takes place in two related domains: business analysis and feasibility analysis. In business analysis, the firm evaluates the

viability of a new product concept as a business proposition. In feasibility analysis, the firm decides if it has the resources to support the development of a product concept.

However, if the screening of preliminary product concepts is too restrictive, potentially valuable ideas may be eliminated. Conway and McGuinness (1986) found that an overreliance on formal processes in the front end might slow the momentum that the concept acquired in the informal debate. An additional complexity is that research has identified a tendency for tacit rules to act as filters when screening ideas (McAdam and Leonard 2004). The conclusion is that firms need to consider both the formal and the informal aspects of concept screening.

Cross-functional executive review committee Prior research shows that cross-functionality is a success factor at the executive level as well as at the department and functional levels. An executive review committee for the front end adds various competencies and perspectives. Khurana and Rosenthal (1997) found that product success in the front end is associated with the existence of a cross-functional, executive review committee. They state that the committee members' roles and decision responsibilities must be well-defined. The review criteria must also be explicit. In addition, they emphasize the importance of the on-going interaction between the committee and the development team.

Discussion and concluding remarks

There are many explanations for the failure of new products. Some explanations relate to problems in the front-end activities of NPD. Complex information may be inadequately processed (Khurana and Rosenthal 1997), decisions may be taken on an ad hoc basis (Montoya-Weiss and O'Driscoll 2000), and/or conflicting organizational pressures may create unmanageable complexity and uncertainty (Chang et al. 2007). In explaining these problem areas, this article helps managers and their teams identify the factors that contribute to the success of front-end activities in NPD.

This article uses a review of the literature on the front end in NPD as the inspiration for the creation of a front-end conceptual framework. The framework is built on two groups of success factors for front-end activities identified in the literature: foundational success factors and project-specific success factors. The framework also highlights the interplay between these success factors that is relevant for firms working with new product ideas and concepts, regardless of firm size.

By visualizing these success factor groups in a conceptual framework, we provide firms and their managers with an analytical tool useful for working with front-end activities in NPD. In tabular and textual presentations, we list the success factors, ask key questions related to these factors, and describe the ideal condition/situation action responses. Product managers and their teams can use our conceptual framework to identify the front-end success factors and thereby better deal with this early stage of NPD. Use of the framework can reduce development time and mitigate the problems associated with rework in front-end activities that are characterized by great complexity and uncertainty.

At present, the theory on the front end in NPD is rather weak when judged by the evaluation criteria for theory development (Bacharach 1989; Edmondson and McManus 2007; Suddaby 2010). About 95% of the articles we reviewed do not address the issue of performance measurement (i.e., the dependent variables) although there are exceptions (e.g., Khurana and Rosenthal 1997; Montoya-Weiss and O'Driscoll 2000). We were not surprised, however, by our finding that the NPD literature, with the exceptions noted above, is not particularly theoretical. We were not surprised, however, by our finding that the NPD literature, with the exceptions noted above, is not particularly theoretical. As Daft (1985) explains, research topics behave like product life cycles. When a research field is new, many researchers add new knowledge. Because the front-end literature is relatively new, it is still open to new theoretical observations.

Given the gaps in the literature on front-end success in NPD, it seems worthwhile to address this topic more specifically. This effort requires an understanding of the front end itself. Where, when, and how does the front end begin? What does it look like? Where and how does it end? Khurana and Rosenthal (1997, 1998), for example, who do not explicitly examine the creative act of idea generation, conceive of the beginning of the front end as the point when firms “first recognize, in a semi-formal way, an opportunity” (Khurana and Rosenthal 1997, p. 106). This statement implies that when a firm has recognized an opportunity, that idea, which originates very possibly with a single individual, must be shared collectively among others in the firm. The statement also implies that sources of ideas (e.g., from customers, suppliers, etc.) fall *outside* the front end. Although relevant, our framework does not capture this view, but instead focuses on the management *inside* the company.

We found greater agreement among researchers that the front end concludes when firms decide to approve or to abort a NPD project idea (Herstatt et al. 2004; Khurana and Rosenthal 1998; Verworn 2006). Because the front end concludes with a go/no-go decision, the “output” of the front end should be a *product definition* rather than a *product concept*. The reason is that a go/no-go decision cannot be made without consideration of available resources, market estimates, and business plans (e.g., Herstatt et al. 2004; Verworn 2006).

To this background, our position is that the front end begins when the organization recognizes that an idea presents an opportunity, and that the front end concludes with approval or disapproval of the proposed project. Moreover, because the front end concludes with a go/no-go decision (i.e., when a robust product definition exists), we argue that a reasonable evaluation of front-end success depends on two conditions: the quality and status of the product definition when it “leaves” the front end; and the usefulness of the product definition relative to enlightened decision-making about product development (Florén and Frishammar 2012).

Our study adds to previous research on the critical success factors for front-end innovation (e.g., Russell and Tippett 2008) in that it presents a general synthesis of these factors that previous research has identified. This synthesis can be useful to researchers as they expand on this area of research, especially from a theoretical perspective, and to practitioners who can use our conceptual framework as an analytical tool when working with front-end activities in NPD.

Future research suggestions

We offer several suggestions for future research. We assume some success factors will moderate the relationship between front-end activities and front-end success. Extant research, however, does not clearly address the relationship between foundational success factors and project-specific success factors. For example, a creative organizational culture might moderate the relationship between early customer involvement/active environmental scanning and success in front-end activities. In firms that have a creative culture, idea refinement might advance creatively without early customer involvement/active environmental scanning, especially in the development of radically new products. Conversely, when firms lack a creative culture, early customer involvement/active environmental scanning might substitute for a creative culture. Therefore, we recommend that researchers conduct quantitative studies on the moderating role of foundational success factors in positive relationships between front-end development and front-end performance.

Another opportunity for future research stems from one shortcoming of extant research and of our conceptual framework. Our understanding of the iterative aspects in the front end is insufficient. While prior research emphasizes the importance of probing and learning in the front end (e.g., Verganti 1997; Florén and Frishammar 2012), it is not clear how the success factors in our conceptual framework relate to such activities or how iterations play out as a consequence of such activities. Therefore, we recommend that researchers examine the relationship between the success factors of probing and learning in the front end of NPD.

We admit that our review does not reveal how the context of the front-end activities influences the success factors. Although, the results are developed based on empirical and conceptual studies, further investigation on how well the proposed successful factors holds in different context would be beneficial, for example in the context of new entrepreneurial ventures (George et al. 2016). From this follows that our study has certain limitations that should be considered when interpreting the results.

Thus, we encourage researchers from entrepreneurship and innovation management to take our study as a starting point for providing novel insights related to the front end of NPD.

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