

# **MANAGEMENT CONTROL AND STRATEGIC RENEWAL IN THE FRONT-END PHASE OF THE INNOVATION PROCESS**

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## **ABSTRACT**

Should management control the front end phase of the innovation process in companies, and if so, how? This paper examines the use of management control in the front end of innovation, how the different mechanisms of control are associated with generating strategic renewal, and what is the moderating effect of technology and market uncertainty.

The front end phase has been characterized as highly uncertain, innovative and creative, thereby requiring high freedom and independence for people executing front-end activities. However, certain control appears to be needed to secure the effective use of resources and the achievement of the company's long-term objectives. The current findings of management control and its influence on performance in new product development context in general are conflicting. While many authors argue that behavioral control kill creativity and decrease innovativeness, some others emphasize advantages of improved communication, coordination and learning created by process formalization. Some authors stress the importance of setting specific and challenging strategic goals for development work but some articles indicates this inhibits creativity and learning. One challenge of interpreting the conflicting results of existing management control research in new product development context is the fact that most studies treat the front-end phase simultaneously with product development projects, thereby averaging the totally different characteristics of these two innovation phases. Studies that would have investigated management control in the front-end phase are still scarce. This theoretical gap is in the focus of this paper.

This paper develops a framework on management control in the front-end of innovation and tests hypotheses on the relationship between different mechanisms of control and achieving strategic renewal. Also, the role of technology and market uncertainty as potential moderators of this relationship is investigated. Seven management control constructs are investigated: input control, front-end process formalization, outcome-based rewarding, influence of strategic vision, informal communication, involvement in goal setting, and influence of intrinsic task motivation. Strategic renewal is used as a front-end performance indicator. Data from the front-end phase of 133 new product development projects from different large and medium-sized companies were collected and analyzed. A factor model was used to test the validity of the management control framework, and a moderated regression analysis was used for hypothesis testing.

The results show that input control is positively associated with achieving strategic renewal through product concepts in the front-end phase. The results also confirm the importance of intrinsic task motivation of the front-end group. Under high technology uncertainty, the use of output-based rewarding or front-end process formalization has an increasingly negative influence on strategic renewal.

## **INTRODUCTION**

The foundation for successful new product development is created in the front-end of innovation, which refers to the activities that take place before the formal product development project (Koen et al., 2001). The overall structure and the main characteristics of the future product are all decided in the front-end phase, which then strongly affects subsequent new product development activities. Early front-end activities are generally regarded as the most troublesome phase of the innovation process, and at the same time one of the greatest opportunities to improve the overall innovation capability of a company (Reid and de Brentani, 2004; Herstatt et al., 2004; Nobelius and Trygg, 2002; Kim and Wilemon, 2002). The front-end phase should result in a well-defined product concept, clear development requirements and a business plan aligned with the corporate strategy (Kim and Wilemon, 2002).

A critical activity in the front-end phase is to ensure that decisions and choices serve the best interests of the company and fulfill its long-term strategic objectives. The front-end phase has a very strategic nature since important decisions related to e.g. target markets, customer needs satisfaction, value propositions, expected product price and product costs, the main functionalities of products, and the predominately used technologies are all made at this stage (Bonner et al., 2002; Smith and Reinertsen, 1998; Wheelwright and Clark, 1992). These decisions embodied in a product concept define and guide the subsequent development activities later in the innovation process. However, such decisions may fail if product concepts become “moving targets” (Wheelwright and Clark, 1992), if product initiatives are cancelled half-way through (Englund and Graham, 1999; Khurana and Rosenthal, 1997), if senior managers do not communicate their strategic level expectations, or if the strategies are too abstract to give any direction to front-end activities (Smith and Reinertsen, 1998).

Management’s ability to influence strategic choices in product development is naturally greatest at the beginning of the innovation process. However, the typical real involvement pattern shows that management gets heavily involved in the initiative after the design phase has already been completed when development problems have become visible and just when large financial commitment is actually needed (Smith and Reinertsen, 1998; McGrath, 1996; Wheelwright and Clark, 1992). Unfortunately, the ability to influence the outcome then without considerable and costly redesign effort is low. Management should invest their time proactively to confirm that critical choices made in the front-end phase are strategically feasible from the company’s point of view (Smith and Reinertsen, 1998; McGrath, 1996; Wheelwright and Clark, 1992).

The challenges in front-end execution and management involvement relate to how R&D (research and development) directors or technology directors should actually control the front-end phase of the innovation process, to fulfill strategic objectives and serve the long-term development needs of the organization. The creative nature of the front-end phase makes it difficult to use a hard command type of control, but still certain

controllability is needed to secure the effective use of resources and the achievement of the company's long-term objectives. Contingency theorists and many others have acknowledged that the degree of task uncertainty influences the optimal way of organizing management processes (see e.g. Donaldson, 2001; Tidd et al., 2001; Burns and Stalker, 1966). Innovations including different degrees of task uncertainty, e.g. incremental or radical product innovations, probably need different control approaches. We may ask how task uncertainty in front-end initiatives influences the use of different control mechanisms.

Several studies have discussed the need to balance control and creativity in management literature in general (see e.g. Marginson, 2002; Simons, 1995) and in the innovation and new product development (NPD) context in particular (see e.g. Bonner et al., 2002; Tatikonda and Rosenthal, 2000; Brown and Eisenhardt, 1997). Many of these studies have investigated NPD projects as a whole, without considering the characteristics of the front-end phase and the development project phase separately, which has generated conflicting research results and difficulties with their interpretation. As several studies have shown, the nature of the front-end is different from that of the NPD project in terms of task characteristics and people involved (Kirsch, 2004; Koen et al., 2001; Zien and Buckler, 1997). The front-end phase shows characteristics of high uncertainty and ambiguity, while the development project phase shows characteristics more of formality and certainty. The importance of studying different phases of the innovation process separately has been discussed by Davila (2000), Olson et al. (1995), and Kirsch (2004).

Because of the different nature of the front-end and NPD project, they should be managed differently as well. Research on management control of information system development projects give indications that types of management control and control mechanisms change when the initiative proceed from the idea stage towards commercialization (Kirsch, 2004; Choudhury and Sabherwal, 2003). Simple output based controls are preferred over behavior control at the beginning of projects (Choudhury and Sabherwal, 2003). In another study, informal control modes dominated over formal methods in the requirements definition phase of information system projects whereas formal methods were taken into use in the implementation phase (Kirsch, 2004). Prior research raises a question whether any type of control has a positive effect on performance in the highly uncertain and even chaotic front-end phase, and whether there is a certain limit (measured in terms of uncertainty) where different types of control becomes ineffective.

This paper pursues increased understanding on how management can effectively control the front-end phase of the innovation process in a product innovation context. We investigate factors that can explain front-end performance in terms of strategic renewal. Two research questions have been set for this paper:

- How are management control mechanisms associated with front-end performance?
- How does task uncertainty influence the relationship between management control mechanisms and the front-end performance?

## **FRONT-END PERFORMANCE**

Evaluation of front-end performance is a challenging task compared e.g. to estimation of success in product development projects. For example, project management success is impossible to estimate in terms of traditional measures because specifications, performance and schedule targets and exact budgets have not been fixed yet. As the front end of innovation is largely about information search, exploration and iteration of initial ideas and product concept drafts, its performance should be estimated with criteria specific to the front end, not for a project. However, there are a few certain facts that can be used as success criteria. Instead of artificial facts and measures assuming complex causalities in the innovation process, the explorative nature of the front end requires putting emphasis on more immediate, subjective, perception based criteria (Smith-Doerr et al., 2004; Shenhar et al., 2001). Evaluation success through perception sets more requirements for a person who evaluates the overall front-end performance. Due to their central role in social networks, top managers have a more knowledgeable, balanced view and multiple perspectives on the front-end performance than managers that only focus on single development initiatives at the time (Smith-Doerr et al., 2004).

With its explorative nature, the front-end phase contributes to achieving a superior, validated product concept (Kleinschmidt et al., 2005, Kim and Wilemon, 2002; Khurana and Rosenthal, 1997; Cooper, 1994) and strategic renewal (Kleinschmidt et al. 2005; Herstatt et al., 2004). The front-end phase contributes to organizational learning which enables the organization to prepare and confront challenges in the future. Strategic renewal deals with the ability of the front-end phase to create an opportunity window for new market entries or new product development activities (Cooper and Kleinschmidt, 1987; Kleinschmidt et al., 2005). That is, the front-end provides stepping stones that provides fast start for future development activities. In addition, the know-how and new information created in terms of target markets and used technologies can be used as a reference point evaluation the level of strategic renewal (Herstatt et al., 2004, Kleinschmidt et al., 2005). The influence of different front-end activities on strategic renewal have been investigated in prior literature (e.g. Kleinschmidt et al. 2005) but the role of management control on strategic renewal is still unexplored area in front-end of innovation context. In this study, we aim at filling this gap and focus on strategic renewal as the main construct measuring performance in the front-end phase.

## **MANAGEMENT CONTROL IN FRONT-END OF INNOVATION**

Management control has been stated to be an important aspect of organizational design (Eisenhardt, 1985), fundamental management activity (Jaworski, 1988), critical activity for organizational success (Merchant, 1982), and also a central feature of all human organizations (Otley and Berry, 1980). Merchant (1982) argues that control should especially be directed to strategically important areas in organizations such as new product development. The present understanding of management control considers it as a function of divergent requirements between creativity and innovativeness, and intended goal achievement (Simons, 1995). Management control in this article is defined as a management activity that is used to maintain or alter patterns in organizational activities to achieve successful front-end results (modified from Simons, 1995).

Simons emphasizes that the competitive pressure created by senior management is a catalyst for innovation and adaptation. Traditional command type, top-down oriented

control is no longer sufficient. In addition to the top-down information flows and commands that inform lower level employees about the organization's intended strategies, there needs to be channels transferring information from the bottom of the hierarchy to the top. Through these channels the top management receives information about progress in achieving intended strategies and also information about threats and opportunities that may contain seeds of new emergent strategies. (Simons, 1995)

The theoretical framework of management control in this article is based on Hales (1993) who separates four dimensions of control: 1) focus of control, 2) level of formality of control 3) level of interactiveness of control, and 4) locus of authority of exercising control. The first dimension, focus of control, categorizes management control by placing control practices in a chronological order based on the actual sequence when the control is implemented. This is a traditional distinction between input, process, output and value control. Input control occurs before the controlled activity focusing on resources, instructions and the knowledge of those carrying out the forthcoming work. Process control, in turn, is exercised during the activity focusing on work processes and technical work methods of the controlled employees. Output control takes place after the activity and focuses on end results. Finally, value control is a meta control by continuously influencing the planning, implementation and evaluation of work activities. (Hales, 1993)

Typically, management control mechanisms can be applied either informally or formally. Jaworski (1988 p. 26), who studied control in marketing units, defines formal controls as *"written, management-initiated mechanisms that influence the probability that employees or groups will behave in ways that support the stated [marketing] objectives"*. Management control can also be applied either in interactive/personal or bureaucratic/impersonal ways (Hales, 1993; Bonner et al., 2002; Simons, 1995). Interactive control means that managers have personal contact with the decision making activities of their subordinates (Simons, 1994). Hales emphasizes that personal control manifests that control is exercised by one individual over others, whereas impersonal control is based on rules and regulations (Hales, 1993). The locus of responsibility for implementing the control may also be possessed by different parties within the organization. The control may rest in the hands of individuals (self-control), a group of colleagues (mutual, peer or clan control) or a body which is separated from the work process itself (external control) (Hales, 1993). The latter case refers to traditional top-down implemented control.

Based on this theoretical model, seven different control mechanisms were selected into more detailed investigation to study their relationship with strategic renewal. Seven hypotheses test the direct relationship between the used control mechanism and strategic renewal (Figure 1). Four hypotheses (H2b, H2c, H3b, H3c) test market and technology uncertainty as moderators of relationships between front-end process formalization or outcome based rewarding and strategic renewal. Evidence suggesting the hypotheses are presented briefly in Table 1.

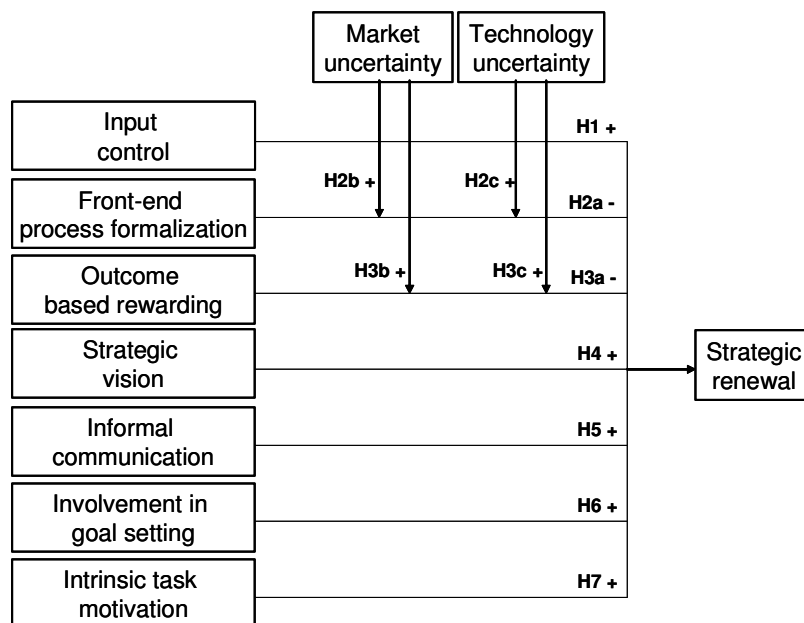


Figure 1: Research model.

**Table 1: Summary of previous research on the relationship between management control mechanisms and front-end performance.**

<b>Control mechanism</b>	<b>Prior research findings</b>	<b>Literature</b>	<b>Hypothesis</b>
Input control	Defining the front-end task and strategy and allocating resources for the front end provide sufficient direction and freedom for the work and thereby positively drive strategic renewal.	Davila, 2000; Imai et al., 1985; Bonner et al., 2002; Zhang & Doll, 2001; Sundbo, 1996; Latham & Yukl, 1975; Kim & Wilemon, 2002.	H1. Input control is positively associated with strategic renewal
Front-end process formalization	Process and behavioral control cause routines and practices that limit freedom and thereby reduce strategic renewal. The more market and technology uncertainty, the less need for process formalization.	Bonner et al., 2002; Tatikonda & Rosenthal, 2000; Hertenstein & Platt, 2000; Amabile, 1998; McGrath, 1996; Abernethy & Brownell, 1997	H2a. Front-end process formalization is negatively associated with strategic renewal. H2b. The more market uncertainty / H2c. The more technology uncertainty, the more negative the association between front-end process formalization and strategic renewal.
Outcome-based rewarding	As deliverables are not known in the front end, rewarding based on outputs hampers creativity and reduces risk taking and thereby reduces strategic renewal. The more market and technology uncertainty, the less need for outcome-based rewarding.	Simons, 1995; Ramaswami, 1996; Bartol & Srisastava, 2002; Jenkins et al., 1998; Amabile, 1998; Snell, 1992; Smith & Reinertsen, 1998, Bonner et al., 2002	H3a. Outcome-based rewarding is negatively associated with strategic renewal. H3b. The more market uncertainty / H3c. The more technology uncertainty, the more negative the association between outcome-based rewarding and strategic renewal.
Strategic vision	A clear vision of the future of the business helps focus on the right issues and promotes shared beliefs and thereby positively drives strategic renewal.	Schilling and Hill, 1996; McGrath, 1996; Englund and Graham, 1999; Kotter, 1990; Baker, 1993, Marginson, 2002	H4. Strategic vision is positively associated with strategic renewal.
Informal communication	Exchanging information, meetings and other forms of informal dialogue supplement formal forms of control, promote freedom, enable corrective actions if needed and thereby positively drive strategic renewal.	Merchant, 1985; Anthony, 1988; Bisbe & Otley, 2004; Cleland & King, 1975; Smith & Reinertsen, 1998; Harborne & Johnne, 2003	H5. Informal communication between management and the front-end group is positively associated with strategic renewal.
Involvement in goal setting	Interactive task and goal setting, with front-end team's participation, increases commitment, ownership and understanding and thereby positively drives strategic renewal.	Bonner et al., 2002; Ramaswami, 1996; Schilling & Hill, 1998; Sagie, 1996; Fang et al., 2005	H6. Involvement in goal setting is positively associated with strategic renewal.
Intrinsic task motivation	Empowerment and self-control generate intrinsic task motivation that drives flexibility, initiative and commitment and thereby strategic renewal.	Manz, 1986; Thomas & Velthouse, 1990, Luthans & Davis, 1979; Mills, 1983; Govindarajan, 1988; Otley, 1994, Kirsch, 1996, 2004	H7. Intrinsic task motivation of front-end group members is positively associated with strategic renewal.

## **RESEARCH METHOD**

### **Sample and data collection**

This study employs a cross-sectional survey design to collect information on management control and product concept superiority in the front end of innovation in industrial firms. The sample was derived from a national database which includes information of all the industrial companies in Finland. All companies with more than 50 employees and with product development activities were included in the sample. Also different business units of the fifty largest companies fulfilling the above criteria were included in the research. In total, 888 companies and business units fulfilling these criteria were found. A questionnaire survey was sent to this population. The questionnaire was addressed to R&D Director, Research director, Technology director, CEO or R&D responsible person in each company. The purpose was to find key informants on the front end of innovation, i.e. a director or person who participates in controlling the front end of new product development projects from management's point of view.

The mailing process included three separate contacts to the company representative. First contact was a mail consisting of a cover letter emphasizing the importance of the survey, response instructions, the eight-page questionnaire, and a pre-paid return envelope. Three weeks after first mailing, second contact was taken by an e-mail to non-respondents as suggested by Dillman (2000). The final third contact was taken by a phone to randomly selected 50 non-respondents.

Of the 888 firms, 137 respondents returned the filled questionnaire, which leads to a response rate of 15.8 %. The response rate can be considered as acceptable in the light of the long questionnaire and the director level target group where time resources are always scarce. The final useable sample for statistical testing was 133. As the survey relies on the responses of a single informant, we paid special attention to identifying knowledgeable informants (John and Reve, 1982). The majority of respondents (91.8 %) represented exactly the right target group of experienced R&D director or similar. The respondents had an average of 5.7 years of experience in their current position (range: 0-30), and an average of 12.8 years of experience in the organization (range: 0-40). We also tested for non-response bias by comparing early and late respondents (Armstrong and Overton, 1977), through testing a difference in turnover, number of employees and R&D intensity (% of turnover to R&D) between early (63 companies) and late (70 companies) respondents. No statistically significant differences were found between early and late respondent groups.

The survey questionnaire requested some background information of the company, and covered different control mechanisms (independent variables), front-end performance measures (dependent variables) and also some contextual information regarding the front-end project. Before sending the questionnaire, it was tested both with academics and practitioners as suggested by Fowler (2002). Herman's one-factor test was used to analyze common method variance (Podsakoff and Organ, 1986), with good indication that common method variance is not a serious problem in this study. To avoid success bias, the respondents were requested to select the last completed front-end initiative and base their answers on that.



### **Measurement constructs**

This study applies existing, validated measurement constructs as much as possible. As empirical quantitative studies focusing on management control in the front-end phase are scarce, some new measurement constructs needed to be created. Two principles were applied. First, the new measurement construct was based on modification of existing and validated measurement constructs from the other contexts, if the close proxy was found. Second, when the new measurement construct was created from the scratch, it was based on extensive literature analysis and tested with both academics and practitioners. The measurement of the dependent variable, independent variables 'intrinsic task motivation', 'strategic vision', and moderating variable 'uncertainty' was based on the Likert scale from one to five (1 = strongly disagree, 5 = strongly agree). Other independent variables were measured in the scale one to five asking respondents to judge the intensity to which extent different control mechanisms were used in a particular case (1 = not at all, 5 = used in a great extent).

Strategic renewal (dependent variable) measurement construct consists of four measures. Two items measure the extent to which a new product concept helps to create new markets or open up new product development opportunities for the company, and two items measure the level to which the development of the product concept increased know-how in terms of both technology and markets. Measures for this strategic renewal construct were collected and modified based on variables used by Shenhar et al. (2001), Cooper and Kleinschmidt (2000), and especially by Herstatt et al. (2004) and Kleinschmidt et al. (2005). Cronbach's inter-item coefficient alpha for the strategic renewal is .76.

Input control was operationalized with four measures. Input control concerns, firstly, management considerations about the persons who are selected for running the front-end case, and participating in the case as group members. Two new items were created to investigate the extent to which management put emphasis on this selection process (McGrath 1996, Nonaka 1988, Smith and Reinertsen 1998). Secondly, the definition of the forthcoming task to the front-end group is an important part of input control. Two new items were created to investigate the extent to which management defined the task and strategic goals for the front-end work, based on the discussion of importance of task assignments or even written contract books (Bonner et al., 2002; Davilla, 2000; Wheelwright and Clark, 1992), and setting strategic direction and goals (Bonner et al., 2002; Cooper, 1998). Cronbach's inter-item coefficient alpha for the input control construct is .79.

Process formalization measurement construct consists of four items. The first item concerned the use of a reporting system informing the management about the progress of the front-end case (based on e.g. Simons, 1995; Cleland and King, 1975). The second item measured the extent to which the front-end case was executed in accordance with the defined process model (Bonner et al., 2002; Hertenstein and Platt, 2000; Tatikonda and Rosenthal, 2000). The third item focused on the existence of specific evaluation gates during the front-end (Davila, 2000; Tatikonda and Rosenthal, 2000). Finally, the fourth item measured direct supervision over the procedures used by the front-end group (modified from Ramaswami, 1996). Cronbach's inter-item coefficient alpha for this construct is .79.

Outcome-based rewarding was operationalized with three measurement items focusing on rewarding structures used in the front-end case. Two items are derived from Bonner et al. (2002), who applied separate measures for rewarding through promotion, recognition and financial means in new product development context. One item concerns financial rewarding and the other item other types of rewarding. The third item was created focusing on rewarding based on individual accomplishment. Cronbach's inter-item coefficient alpha for the output control construct is .76.

Strategic vision was operationalized with a single measurement item dealing with the influence of strategic vision to the decision making of the front-end group (based on McGrath, 1996). Strategic vision is connected to broader context of belief or value systems providing an overall direction for the organization (Simons, 1995). The variable was measured with a five point Likert scale (1 = strongly disagree, 5 = strongly agree).

Informal communication consists of three items (based on Davila, 2000; Merchant, 1985; Anthony, 1988). The first item measured the extent to which there was informal communication, the second the extent to which there was informal information exchange and finally the third the extent to which there was informal meetings between the front-end group and the management. Cronbach's inter-item coefficient alpha for this measurement construct is .91.

Involvement in goal setting measurement construct was operationalized with three items. Two items were derived and modified from Bonner et al. (2002), measuring the extent to which the responsibility of defining strategic objectives was transferred to the group within the limits of overall strategy and the level of participation in defining the strategic objectives. The third item measured the extent to which the front-end group had a role in defining formal control mechanisms for the case (based on Ramaswami 1996). The Cronbach's inter-item coefficient alpha is .73.

Intrinsic task motivation measurement construct includes three items and concentrates on the degree to which the employee assumes responsibility for his job activities and is intrinsically motivated. Two items were modified based on Ramaswami (1996) and one based on Kirsch (1996). The items were measured with a five point Likert scale (1 = strongly disagree, 5 = strongly agree). The Cronbach's inter-item coefficient alpha is .74.

Uncertainty is used both as a control variable and as a moderating variable. Typically, two different forms of uncertainty are acknowledged in the product development context: technology and market uncertainty (Tidd et al., 2001, Danneels and Kleinschmidt, 2001). The newer the technology or the more unfamiliar the target market is, the more uncertainty the development task includes. Both forms of uncertainty are included in this study. Our measures for technology and market uncertainty take into account industry and firm perspectives (Garcia and Calantone, 2002) and use or non-use of existing competences (Danneels, 2002), and were modified based on the variables used by Danneels and Kleinschmidt (2001). Two different factors with clear factor solution and high loadings were found as expected. Cronbach's alpha for market uncertainty is 0.76 and for technology uncertainty 0.84.

Several control variables were included in the regression model to take into account of the potential effects of the firm, industry, and the case itself to the final results. Control variables for firm-level effects included the size (logarithmic transformation of turnover) and R&D intensity (logarithmic transformation of percent of turnover invested in R&D). Industry-level effects were considered by using industry sector as a dummy variable. In

addition, the objectives set for a front-end initiative were controlled (short term vs. long term).

### Analysis methods

Exploratory factor analysis was applied to test the validity and unidimensionality of the created measurement constructs (Hair et al., 1998). Exploratory factor analysis was favored over confirmatory factor analysis since the verified management control measurement constructs applied in the front-end context are scarce. The exploratory factor analysis supported the anticipated variable structure of independent variables well. Bartlett's statistic was significant and MSA was 0.69 for the created factor solution. The factor solution explained 71 % of total variance. Cronbach's inter-item coefficient alphas were calculated for each variable to evaluate the reliability of the measurement constructs.

Multiple regression analysis was used to test the created hypothesis (Hair et al., 1998). The appropriateness of empirical data (such as a normality of residuals) was tested to investigate that multiple linear regression analysis can be applied (Hair et al., 1998; Cohen and Cohen, 2003). Predictor value centering was used to overcome problems of multicollinearity while investigating the moderating effects of task uncertainty (Cohen and Cohen, 2003). The highest VIF value was 2.81.

### RESULTS

Descriptive statistics and correlations of the used measurement constructs are presented in Table 2. Strategic renewal has a significant positive correlation with input control and intrinsic task motivation, and a, strongly significant positive correlation with market uncertainty and technology uncertainty. There are also many positive and significant correlations between the different variables of management control.

Table 2: Descriptive statistics and correlations.

	Items	Mean	Std.Dev.	1	2	3	4	5	6	7	8	9	
1.	Input control	4	3.26	0.80									
2.	Process formalization	4	2.65	0.74	.41**								
3.	Outcome-based rewarding	3	2.01	0.89	.21*	.26**							
4.	Influence of strategic vision	1	4.06	0.72	.19*	.10	.00						
5.	Intrinsic task motivation	3	3.82	0.70	.13	.11	.25**	.20*					
6.	Informal communication	3	3.43	0.89	.31**	.26**	.12	.15	.11				
7.	Involvement in goal setting	3	3.10	0.72	.13	.19*	.16	.27**	.18*	.25**			
8.	Market uncertainty	4	2.37	1.01	.00	-.03	.17	.09	.05	.18*	.16		
9.	Technology uncertainty	4	2.90	1.08	.15	.04	.18*	.03	.05	.10	.02	.36**	
10.	Strategic renewal	4	3.85	0.76	.21*	.03	.10	.09	.20*	.07	.13	.41**	.38**

\* p < .05; \*\* p < .01

The hypotheses were tested by regressing the front-end performance variable (strategic renewal) on all the management control variables, control variables and interaction terms. Table 3 reports results on the basic model as well as the moderated effects of front-end process formalization. The overall explanatory power of the basic model, model 1, is good ( $R^2 = .25$ ) and statistically significant. The results for model 1 show that input control is positively associated with strategic renewal ( $\beta = .218$ ,  $t = 2.38$ ,  $p = .019$ ) and lend strong support to hypothesis H1. Hypothesis H2a, H3a, H4, H5 and H6 are not supported: front-end process formalization, outcome-based rewarding, strategic vision,

informal communication and involvement in goal setting are not associated with strategic renewal at a statistically significant level. Hypothesis H7 is supported: intrinsic task motivation of front-end group members is positively and significantly associated with strategic renewal (beta = .208,  $t = 2.51$ ,  $p = .014$ ).

Table 3: Regression analysis for strategic renewal and the moderated effects of front-end process formalization.

Variables entered	Model 1	Model 2	Model 3
<b>Independent variables</b>			
Input control	.22***	.22***	.23***
Front-end process formalization	-.04	-.03	-.04
Outcome based rewarding	-.07	-.07	-.05
Strategic vision	.01	.02	.01
Informal communication	-.08	-.07	-.08
Involvement in goal setting	-.01	-.01	-.01
Intrinsic task motivation	.21***	.21***	.20***
Market uncertainty	.39***	.39***	.36***
Technology uncertainty	.18**	.18**	.18**
<b>Moderated variables</b>			
Front-end process formalization x Market uncertainty		-.03	
Front-end process formalization x Technology uncertainty			-.14**
R <sup>2</sup>	0.34	0.34	0.35
Adjusted R <sup>2</sup>	0.25	0.24	0.26
F	3.925***	3.666***	3.927***
Sig. of F change		0.67	0.09*

\*  $p \geq 0.10$ ; \*\*  $p \geq 0.05$ ; \*\*\*  $p \geq 0.01$

Standard coefficient betas are shown

Control variables are not shown

Dependent variable: strategic renewal

Hypothesized paths one-tailed tests, control variables two-tailed tests

Model 2 tested the influence of market uncertainty on the relationship between front-end process formalization and strategic renewal and has a good explanatory power ( $R^2 = .24$ ). Hypotheses H2b is rejected: higher degrees of market uncertainty do not increase the negative effect of front-end process formalization as predicted and as shown in Table 3.

Model 3 tested the impact of technology uncertainty on the relationship between front-end process formalization and strategic renewal and also has good explanatory power ( $R^2 = .26$ ). Hypothesis H2c is supported: the more technology uncertainty, the more

negative the association between front-end process formalization and strategic renewal (beta = -.143, t = -1.72, p = .044). F value change has only marginal statistical significance (.09) and thus the result needs to be interpreted with caution.

Model 4 tested the impact of market uncertainty on the relationship between outcome-based rewarding and strategic renewal and has good explanatory power ( $R^2 = .25$ ). Table 4 shows that hypothesis H3b is rejected: higher degrees of market uncertainty do not increase the negative effect of outcome-based rewarding as predicted.

Model 5 tested the impact of technology uncertainty on the relationship between outcome-based rewarding and strategic renewal and has good explanatory power ( $R^2 = .27$ ). Hypothesis H3c is supported: the more technology uncertainty, the more negative the association between outcome based rewarding and strategic renewal (beta = -.162, t = -1.95, p = .027). F value change is also statistically significant ( $p \leq .05$ ).

Table 4: Regression analysis for strategic renewal and the moderated effects of outcome-based rewarding.

Variables entered	Model 1	Model 4	Model 5
<b>Independent variables</b>			
Input control	.22***	.22**	.23***
Front-end process formalization	-.04	-.04	-.01
Outcome based rewarding	-.07	-.07	-.05
Strategic vision	.01	.01	.04
Informal communication	-.08	-.07	-.07
Involvement in goal setting	-.01	-.01	-.04
Intrinsic task motivation	.21***	.21***	.19**
<b>Moderated variables</b>			
Outcome based rewarding x Market uncertainty		-.06	
Outcome based rewarding x Technology uncertainty			-.16**
$R^2$	0.34	0.34	0.36
Adjusted $R^2$	0.25	0.25	0.27
F	3.925***	3.697***	4.006***
Sig. of F change		0.47	0.05**

\* p ? 0.10; \*\* p ? 0.05; \*\*\* p ? 0.01

Standard coefficient betas are shown

Dependent variable: strategic renewal

Hypothesized paths one-tailed tests, control variables two-tailed tests

## DISCUSSION

### Management control and strategic renewal in innovation front end

The analysis showed that input control and intrinsic task motivation were necessary for strategic renewal in the front end of innovation (H1 and H7). The findings support

prior research that favors clear focusing of development work and sharing of strategic goals in the front end of innovation (McDonough, 2000; Davila, 2000; Zhang & Doll, 2001), selecting the right leaders and front end teams (Stevens and Burley, 2003; Smith & Reinertsen, 1998; Kim & Wilemon, 2002), and the team being empowered and motivated and putting their own effort into solving uncertainties in innovation front end.

Without a specific and challenging strategic goals set by the management, there is a danger that front-end group ends up with making choices and decisions that contains less risks and where chances of success are more obvious. The level of risk taking is lower and likelihood of strategic renewal is lower. Strategic goals set by the management give permission for developers to take risks in pursuing strategic objectives. Risks and potential failures in development work are better tolerated. This is true especially if the defined strategic goals mean hard challenges for the development group. This kind of reasoning is in line with goal setting theory which argues that specific and challenging goals lead to higher performance (Locke and Latham, 1990; Campbell and Furrer, 1995). The findings indicate that principles of goal setting theory are also applicable in non-routine environment aiming at developing products pursuing strategic renewal.

The other important element in input control is to allocate appropriate resources for the front-end initiative. By studying 267 new business development projects and by applying Myers Briggs Type Indicator (MBTI) to analyze personality traits of group leaders, Stevonn and Burley (2003) found that similarly coached individuals differed in terms of preference for “intuition” (N) and “thinking” (T). By further comparing groups of the highest NT scores and lowest NT scores they found huge differences in terms of new business development project success and profits. This was due to capability for creative work that was required on reshaping ideas to find uniqueness and branching a project in an appropriate direction. Amabile (1998) strongly argues that ignoring individual preferences and capabilities in resource allocation is one of the most infallible ways of killing creativity. A group leader selection that is identified to be a critical success factor in new product development projects (McGrath, 1996; Nonaka, 1988; Smith and Reinertsen, 1998; Brown and Eisenhardt, 1995) seems to be even more important in the front-end phase.

Increased motivation in turn gives employees extra stimulus to work hard and persistence to attain organizational goals (Manz, 1986; Thomas and Velthouse, 1990). Management has many choices to influence employees and work tasks they are doing. They can for example set compelling vision (Kotter, 1990), use non-monetary rewarding (Amabile, 1998) or set challenging strategic goals (Campbell and Furrer, 1995) to raise the level of intrinsic task motivation. These all are elements that may promote employees feeling that they are doing meaningful jobs. However, the other important element to contribute intrinsic task motivation is to give empowerment and decision making responsibilities to those people who are actually executing jobs (McGrath, 1996; Wheelwright and Clark, 1992; Tatikonda and Rosenthal, 2000). Empowerment has been noticed positively influence creativity in problem solving, learning and speed of decision making (Imai et al., 1985; Smith and Reinertsen, 1998). This does not necessarily mean that the management loses the control. Combination of self control and external management guidance (e.g. input control) may actually increase the total level of control (Barker 1993).

Contrary to expectations, the survey findings did not reveal linear negative impacts of front-end process formalization and outcome-based rewarding on strategic renewal (H2a and H3a). Indeed prior research has debated the need for process and output controls in the front end of innovation, with conflicting conclusions and suggestions (Nobelius and Trygg, 2002; Koen et al., 2001; Cooper, 1998; Khurana & Rosenthal, 1998, Montoya-Weiss & O'Driscoll, 2000). Part of prior research has not necessarily distinguished between different types of innovations, or between front-end of innovation and product development projects. Although our survey contributed to prior research by centering on the front end of innovations particularly in product innovation contexts, the non-significant impacts of front-end process formalization and outcome-based rewarding on strategic renewal open avenues for further research. For example, other than linear relationships should be explored, to better understand the use of process and output controls in the front end of innovation. Also, the interrelationships between different control mechanisms in the form of company-specific control strategies and their possible impact on performance outcomes should be investigated, to increase understanding on the complex nature of management control in the front end of innovation.

Also deviating from our hypotheses, strategic vision, informal communication and involvement in goal setting did not appear as significant variables in explaining strategic renewal in the front end of innovation (H4-H6). It is possible that strategic vision, informal communication and involvement in goal setting fill critical gaps that formal control modes such as input control leave for front-end activities, or that their relationship with strategic renewal is mediated by some other variables. For instance, there was a positive correlation between informal communication and input control, lending support to the prior need to investigate broader control strategies besides separate mechanisms. The results are also in line with Bonner et al. (2002) who found that employees' involvement in operative level matters is positively associated with project performance but regarding strategic level issues employees are not well positioned in the organization to help management.

### **Role of task uncertainty in management control**

The results revealed that the relationship between front-end performance and output-based rewarding and front-end process formalization was moderated by technology uncertainty but not by market uncertainty. Market uncertainty was positively associated with strategic renewal, but its moderating effect was non-significant (H2b and H3b). From the perspective of management control the results indicate that the firms included in the survey have been able to develop process and output controls that at least fit well their market uncertainty conditions.

The more technology uncertainty, the more negative association there was between front-end process formalization and strategic renewal (H2c, this was only marginally supported and thus needs to be interpreted with caution) and outcome-based rewarding and strategic renewal and (H3c). Front-end initiatives under high technology uncertainty aiming at strategic renewal are long-term technology development initiatives that need a lot of free-wheeling in order to find a right direction and solid decision criteria (Moneart et al., 1995). They need more trial and error attitude where technological solutions develop with small steps, rather than a formalized and planned processes. It is likely that in the very front end of innovation, uncertainty is purposefully sought to identify new

opportunities, and collaboration across units is exploratory and difficult to frame in process models. If formal processes are in use, they may be poorly fit for the uncertain context and, therefore, perform poorly. The results support existing understanding that outcome based rewarding may have harmful effects on product quality in new product development context (Sarin and Mahajan, 2001). Explanation for counterproductive effect on performance can be sought from risk taking attitude (Snell, 1992). If rewarding is tied on achievement of defined goals or objectives, this may lead front-end group members making choices and decisions that do not contain risks

### **Managerial implications**

Managerial implications can be summarized as follows: First, practitioners are advised to put special emphasis on human resource allocation considerations in front-end initiatives aiming at strategic renewal. These kinds of front-end initiatives are the most challenging and require special skills from front-end group leaders and group members. Management should take care that the front-end group is cross-functional including necessary expertise and competence for the given task. The leader of the front-end group has a critical role in terms of front-end performance. Capability through natural tendencies and acquired skills for creative thinking, reshaping and branching of ideas in order to get right direction for front-end efforts is of importance.

Second, practitioners are advised to put emphasis on task definition and definition of strategic goals for the front-end initiatives. It is management's job to frame the task for front-end groups in order to give focus for development efforts. Moreover, practitioners are advised to set challenging strategic goals for front-end initiatives. Through task definition and strategic goal setting, management gives a common direction and challenging targets for development activities while decisions of more operative level matters can be left for the front-end group. This is not an easy task from management's point of view but still the time devoted to this activity is well compensated by improved front-end

Third, internal task motivation of front-end group members is important in front-end initiatives aiming at strategic renewal due to challenging execution and transformation of embryonic ideas into product concepts. Obstacles and even organizational resistance against new product ideas require highly motivated front-end group members to create successful end results. Practitioners are advised to build mechanisms and to remove obstacles to get front-end group members motivated.

Fourth, in the case of high technology uncertainty (e.g. front-end initiatives applying totally new technology), practitioners are advised to loosen up formalized processes and allow more freedom on how the activities are carried out. In addition, tying rewarding only to the achieved outcome in the case of high technology uncertainty may lead "playing for sure" and selecting more reliable, less risky alternatives, thus decreasing potential for strategic renewal.

### **CONCLUSIONS**

This study has contributed to research on the front-end of innovation by developing and testing a framework for investigating management control in the front-end of innovation. The framework included seven constructs for management control, covering both formal and informal mechanisms with regards to inputs, process and outputs in the



front end of innovation, strategic renewal as the dependent variable, and two constructs for task uncertainty. Secondly, we have shown empirical evidence from a survey with 133 firms, emphasizing the importance of input control and intrinsic task motivation in achieving strategic renewal and suggesting more complex associations between other forms of management control and strategic renewal. Thirdly, we reported technology uncertainty as an important variable moderating the relationship between process and output-based control and strategic renewal. Finally, the study has drawn attention to the complex nature of management control in the front end of innovation, given it an empirically grounded structure, and revealed evident connections between what managers do and how the front-end group performs. More research is suggested on holistic control strategies that could better cover the interdependencies between management control mechanisms in different contexts.

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