Patterns of Uncertainty and Equivocality during Predevelopment: Findings from Process-Based Firms

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Abstract

Previous literature suggests that innovation managers should prioritize uncertainty reduction in early phases of innovation projects. When uncertainty is high, the general prediction is negative consequences in the form of time-delays, waste of resources, unclear team vision and, ultimately, concept failure. There are strong reasons to believe, however, that simultaneous management of equivocality is equally important, but this concept has largely been neglected in previous research. By means of a case-study relying upon exploratory interviews addressing unique observations of 58 innovation projects, we notice that the perhaps most significant challenge for being successful or not is not the initial levels of uncertainty. Rather, it is managerial attempts to actively fight for reducing uncertainty but also addressing the equivocality dimension in the pre-development stages of the innovation process. We observe reduced patterns of uncertainty and equivocality in successful product innovation and process innovation projects in pre-development stages. This was not the case for unsuccessful projects. Similarly, we find significantly lower levels of equivocality for successful projects, which is a contribution to prior research suggesting that uncertainty is the major concern during predevelopment. Moreover, our results show that perceived patterns of uncertainty and equivocality differ between product innovation and process innovation projects in different sub-phases of pre-development. Key results are summarized as propositions which not only provide guidance for future research, but also provide direct managerial implications on how to address uncertainty and equivocality in different sub-phases of predevelopment.

1. Introduction

During the last two decades, increased attention has been directed towards improving knowledge about predevelopment activities in innovation projects (Khurana and Rosenthal, 1997; 1998; Schulze and Hoegl, 2008). Although predevelopment activities have been more frequently studied in the context of product innovation (e.g. Cooper, 1988; Cooper, Edgett and Kleinschmidt, 2002), the importance of such activities have as well been highlighted in the literature on process innovation (Lager, 2000; Lim, Garnsey and Gregory, 2006). The predevelopment stage, often referred to as the "fuzzy front end" of innovation, is crucial for two reasons. First, the foundation for success or failure is often established during predevelopment, before a new project enters the subsequent "formal" product- or process development phase (Cooper, 1988; Frishammar and Florén, 2008). Second, many firms lack proficiency in the way predevelopment activities are executed. Although possible to divide into separate stages, predevelopment activities are multifaceted, and include issues such as idea generation, market- and technology analysis, product- and portfolio strategy, the creation of a product- or process concept, feasibility analysis, and project planning (Khurana and Rosenthal, 1998).

One general implication from prior research is that management should be very concerned if participants perceive high levels of uncertainty in the early phases of development projects. Uncertainty is the difference between the information one has and the information one needs to complete a task (Galbraith, 1973). Uncertainty creates significant challenges and may imply the worst – that the odds of failing are highly significant. Without being necessarily interested in fighting this uncertainty proposition, we noticed that past research has been neglecting management of equivocality – situations where multiple meanings exist among project participants (Weick, 1995) and the actions needed to simultaneously manage these two concepts during front-end activities. We believe there are reasons to include the concept of equivocality in the study of the FFE. Our basic assumption is that firms, in order to succeed in predevelopment, need to be concerned not only with uncertainty reduction but also with equivocality reduction.

Inspired by an extensive empirical study of early innovation projects, we suggest some counterarguments for the fear of continuing innovation projects with initially high levels of perceived uncertainty among project participants. While the negative consequences of uncertainty are fairly well known and may not necessarily be questioned, we set out to study patterns of uncertainty during the various stages of predevelopment activities in product- and process innovation, which has not been explored in detail in previous studies. However, we also make a particular case of the management of equivocality. Besides showing that managing levels of uncertainty during predevelopment can be expected to be more important than the initial level at the first stage, we particularly propose that equivocality may be more important to care about and that the relationship between the two concepts is a challenge for management. While uncertainty can be reduced through information acquisition and analysis, equivocality reduction is achieved by other means. As such, in an extension of the literature there are reasons to include both of them in the same conceptual set-up. Otherwise, managerial mistakes are highly likely to occur. For example, in an equivocal situation, new information for reducing uncertainty may actually increase rather then decrease equivocality. Rather than by new and additional information, equivocality is reduced by means of people coming together to make sense of an ambiguous reality.

Obviously, in a fear of failing one could speculate that this bothersome association should imply that many managers may be reluctant to pursue projects if the two variables exhibit significant levels in the earliest stage of an innovation project – the initial pre-phase. High degrees of perceived uncertainty and equivocality can create a sense of high risk as it might cause an unclear team vision amongst development team members (e.g. confusion about what ought to be done next, or how this should be done). This would result in difficulties in creating stable and explicit concepts, time delays, waste of resources, and difficulties in performing feasibility analysis. As such, ultimately, high levels could lead to that new concepts might enter formal development only to fail in subsequent stages. Although we do not object to this assumption, we do a critical analysis that suggest otherwise, namely that managers may not necessarily hesitate when high levels are initially faced. Rather, they should develop strategies to subsequently reduce them for being successful.

To this background, when doing an extensive empirical study of participants and their unique observations of 58 innovation projects and comparing patterns of uncertainty and equivocality in successful and unsuccessful projects, we were able to outline some alternative suggestions on how to manage innovation projects that extend findings reported in previous studies. We used a combination of qualitative and quantitative data to communicate these potential insights and derive propositions about what these patterns imply.

Before turning to the research results and the section where our research propositions that are based upon our observations are presented, we first review the extant literature on uncertainty and equivocality and thus outline the background to our extensions. We also describe the methodology and research approach. The paper ends with theoretical and managerial implications, and a section on future research.

2. Theoretical Background to our Study Extensions: Key Assumptions in Research on Uncertainty and Equivocality

Organizations always suffer from imprecision in estimates of future consequences conditional on present actions (March, 1994). This is particularly so in the front-end of innovation projects, which are "... intrinsically non-routine, dynamic and uncertain" (Kim and Wilemon, 2002). Consequently, managers are unable to be certain about the outcomes which may follow any of their possible lines of action when engaged in predevelopment activities since all decisions are made in relation to a future situation that is difficult to be knowledgeable about.

To increase effectiveness of front-end activities in innovation projects, it appears elementary that firms must understand, make sense of and respond to what is happening in their environments. On the one hand, this necessitates acquiring and subsequently analyzing relevant information to improve current knowledge and thus decrease uncertainty. On the other hand, firms need also to possess proficiency in sense-making, which allows for equivocality reduction. Below, we elaborate the widely dispersed concept of uncertainty and the somewhat more elusive and less diffused concept of equivocality.

2.1 The influence of uncertainty on predevelopment activities

Historically, uncertainty has been central to general organization theory. The conceptualization of organizations as open systems (Burrell and Morgan, 1979; Frishammar,

2006; von Bertalanffy, 1956) emphasizes the interface between organizations and their environments, and put the question of how to cope with uncertainty in forefront.

A number of insights has been presented to illustrate the core of the concept uncertainty (e.g. Downey and Slocum, 1975; Galbraith, 1973; Milliken, 1987). The perhaps most cited study presents uncertainty as "the difference between the amount of information required to perform a particular task, and the amount of information already possessed" by the individual (Galbraith, 1973, p.5). A corresponding view of the concept specifies that uncertainty is "…a state that exists when an individual defines him-/herself as engaging in directed behavior based upon less than complete knowledge" (Downey and Slocum, 1975, p. 571). The general notation is that uncertainty concern environmental interpretations or perceptions in an individual related to an organizational attempt (Milliken, 1987).

Drivers of uncertainty can depend upon the state of the environment (Duncan, 1972), the situation per se where multiple actors are involved and are making simultaneous efforts (Corswant and Tunälv, 2002), or technology and market newness (Moenaert, De Meyer, Souder and Deschoolmeester, 1995). As such, there are numerous factors that determine uncertainty.

In the context of predevelopment activities, uncertainty typically relates to a firms target market or technological environment (Khurana and Rosenthal, 1997; 1998). If management or project participants face initial high levels of such uncertainties (i.e. fail to close important information gaps) when engaged with predevelopment, the general proposition is that they are likely to face severe consequences and project failures (see e.g. Herstatt and Verworn 2004; Moenaert *et al.* 1995; Murmann, 1994). The main consequence of uncertainty which is not sufficiently reduced is that it can force project participants to take larger risks, "... which increases the probability that they will fail" (Weick, 1995, p. 97).

Analogous to this idea, previous research has shown that successful projects are characterized by low uncertainty during predevelopment in innovation projects (Moenaert, De Meyer, Souder and Deschoolmeester, 1995). The influence of uncertainty can thus create significant difficulties for an innovation project. Previous research has demonstrated that technical uncertainty influences prototype development proficiency and moderate design change frequency and that market uncertainty influences both product launch proficiency and market forecast accuracy but also moderate prototype development proficiency and design change frequency (Souder, Sherman & Davies-Cooper, 1998). As such, prior literature suggests there are numerous reasons for expecting project failures if uncertainty is high in the initial development phase.

2.2 The influence of equivocality on predevelopment activities

Uncertainty implies a call for additional information in order to close an information or knowledge gap that, if not closed, will expose participants in an innovation project with high levels of risks concerning what to develop. Equivocality, on the other hand, viewed as the existence of multiple and conflicting interpretations about an organizational situation (Weick, 1979) should intuitively be a defining characteristic of any predevelopment activity, but has received surprisingly little attention in the predevelopment context of innovation. A plausible explanation for this lack of interest is that "... most unclear variables in a situation have been attributed to uncertainty" (Chang and Tien, 2006, p. 171).

The lack of interest in equivocality is particularly relevant in the sense that the mechanisms that innovation project participants can use to deal with equivocality differs

completely from those of uncertainty. One important difference between uncertainty and equivocality is that while uncertainty necessitates the acquisition of additional information, equivocality necessitates the exchange of subjective views among organizational members to define a problem and resolve disagreements (Daft, Lengel & Trevino, 1987). The key problem with equivocality is not that the real world is imperfectly understood and that additional information will resolve that; instead, the problem is that information may not resolve misunderstandings (Weick, 1995). Rather, firms that face an equivocal situation need to construct, coerce, or enact a reasonable interpretation that makes previous action sensible and suggests how to move forward (cf. Daft and Weick 1984).

Although often neglected, there are reasons believing that equivocality can actually be a defining and problematic characteristic of the early phases of innovation projects (Frishammar and Florén, 2008). Decisions often need to be made under conditions of high equivocality. In many cases little data is available in which decisions might be grounded, and organizational participants instead have to interpret the situation from vague cues and negotiate a solution (see also Mintzberg, Raisinghani and Theoret, 1976) from which planning and future action could be coordinated.

Signs of equivocality can be that actors instead of precise definitions or logical arguments use symbols or metaphors to express their points of view (McCaskey, 1982). Other signs of equivocality can be a lack of clarity (something "seems obscure or indistinct, and therefore hard to decipher"), high complexity ("a plethora of elements and relationships make it difficult to comprehend in any simple way"), or paradoxes ("an argument that apparently derives contradictory conclusions by valid deduction from acceptable premises") [see Weick, 1995, p. 92]. In situations where signs like these appear, development participants need to engage in a highly complex communication process to handle the input they are facing in an adequate way (cf. the principle of requisite variety). According to Weick (1979, p. 40) "... it takes equivocality to remove equivocality". From this follows that innovation development processes must have the same degree of order or chaos as there is in the input to these processes.

A general advice seems to be that management should avoid meeting an equivocal situation by searching for accuracy. Instead actors need to search for plausibility. As neatly put by Weick (1995, p. 56); accuracy is nice, but not important. This is especially relevant during the front end of innovation, as the "…ambiguity that are inherent in the [front end] process make mutual understanding, sensemaking and consensus formation key requirements of social interaction for success" (Kijkuit and van den Ende, 2007, p. 870). Hence, reasoning done by project participants during predevelopment need not necessarily (and perhaps cannot) be perfectly correct, but it should fit with the facts that the team is presently facing. For example, one core activity during predevelopment work involves going beyond the directly observable to form ideas or understandings that provide *enough* certainty. It may be less important to have an accurate environmental map than having a map that brings order to the world and that can prompt and guide future action (Sutcliffe, 1994).

3. Method and Research Approach

Our purpose with this research was to explore alternative implications of uncertainty and equivocality in the earliest phases of innovation projects. As indicated in the theoretical

review, the arguments found in earlier literature is not specific beyond the fact that project participants is likely to experience difficulties when entering projects with high levels of uncertainty and, to some extent, equivocality. We started this project with an open mind and "the story" presented in this paper was not something we initially thought was the case. Rather, as researchers subscribing to previous literature, we only hypothesized that something could be learnt from a study of patterns in the earliest predevelopment stages of innovation projects. Our goal was merely to increase the general understanding about the two concepts in innovation projects. As such, a case-study approach was selected as a research strategy, as it seemed feasible in order to provide a richer understanding (Sigglekow, 2007) and more complete assessment of the complex and iterative activities which constitute predevelopment in innovation projects (Clark and Fujimoto, 1991; Khurana and Rosenthal, 1998). The choice of a case-study also allowed us to study this complex phenomenon in context, rather than independent of context (cf. Pettigrew, 1973). We considered each unique narrative and report on an innovation project to be one case and thus studied a total number of 58 innovation projects.

The innovation projects were conducted in four firms that were selected by means of judgment sampling. Important were also our pre-understanding that they had a history of working with innovation projects that had various outcomes. Guided by the suggested importance in prior innovation research, we were particularly interested in studying early phases in both product- and process innovation projects. Therefore, we though one advantage was that our studied firms were related to the process-industry. First, both product- and process innovation projects are common in process industry, as mutual interdependence exist between these two ideal-type of innovative activities in such firms (Lager, 2002). Process innovation projects often result in changes to the end product, and product innovation projects almost always require changes in production processes (Hutcheson, Pearson and Ball, 1996; Linton and Walsh, 2007). Second, since firms in process industry develop and manufacture non-assembled products, the product- and process concepts under development contain fewer attributes compared with assembled products. It is therefore somewhat easier to get a holistic perspective about the "gestalt" of the concepts under development, which was an important criterion in this study as it facilitated enactment of shared understanding between researcher and respondents.

The firms studied operate in the metal and minerals industry. All four have their main R&D departments located in northern Europe, a centre of gravity of operations in northern Europe, but sell their products on a global world market. At these firms, we conducted a total number of 33 deep interviews and collected information about 58 innovation projects. Four of the interviews were exploratory and unstructured, and conducted with the aim of providing general information on innovation activities as well as identifying suitable innovation projects and respondents for the subsequent investigation. The remaining 29 interviews were semi-structured and addressed successful and unsuccessful innovation projects in the four companies. The respondents shared experiences in 58 innovation projects. 28 of these concerned process innovation projects, while the remaining 30 concerned product development projects. The typical interview lasted for about three hours, and provided general information about product- and process innovation activities, experiences and project outcomes with an emphasis on pre-development activities. All informants discussed one successful and one unsuccessful innovation project. Patterns of uncertainty and equivocality in the pre-development stages were given extensive attention during the interviews. Following Myers and Marquis (1967) and others, we asked

respondents to elaborate on both success- and failure cases that they had personal experience with, in order to see whether patterns of uncertainty and equivocality differed between these.

In order to isolate from respondent bias, the sample represents a cross-section of senior managers, middle managers, project leaders, and senior development engineers. The education level among respondents can be considered high: Only one person lacked academic training, while 20 held bachelors- or master's degrees in engineering, and the remaining 12 held PhD degrees in various engineering subjects. The average respondent had more than five years of working experience with their respective firm and had joined several innovation projects. This should ensure that we had experienced respondents that were able to provide useful and high-quality information to generate insights into our research interests. Although our units of observations are the experiences related to the innovation projects, the main interests in the analysis are the patterns of uncertainty and equivocality perceived in the innovation projects by the respondents.

To strengthen internal validity, the findings and framework was extensively discussed within the research team when trying to understand essence of the findings. Internal validity was also addressed by using multiple theoretical perspectives that we tested when trying to explain and find counter arguments to the main thesis of this paper, drawing on literature from both organization theory, psychology and the management of technology and innovation literatures. We only present theory that is relevant to our main idea in this paper. As the current study is new rather than a replication of previous research, pattern matching (a comparison between observed patterns and those established in previous studies) proved impossible, which might have affected internal validity negatively (Denzin and Lincoln, 1994; Eisenhardt, 1989). However, we were able doing some general comparisons through which we were able to extend some insights made in previous research. Construct validity was addressed mainly by trying to establish a clear chain of evidence to allow readers to see how initial research design match with key conclusions (Yin, 1994). Construct validity was also addressed by combining qualitative and quantitative data in the analysis, although the source of this data was respondents in both cases. We were also careful to explain what uncertainty and equivocality meant to the respondents in the beginning of each interview.

Although case-studies are not devoid of generalizations (Gibbert, Ruigrok and Wicki, 2008), external validity (generalizability) is problematic with a research design like the current one. Nevertheless, the main objective is to employ analytical generalization – from empirical observation to theory – rather than to a population. Hence, no claim is posed to generalize the findings beyond the sample investigated. Our only ambition is to provide readers with the insights won in this study. Whether or not our main conclusions hold is an issue for further studies. To increase reliability (transparency and future replication), a case study protocol was constructed together with a case study data base, containing case study notes, documents, and the narratives collected during the study, all with the aim of facilitating retrieval for future studies (Yin, 1994).

4. Study Findings

The case study of the 58 successful and unsuccessful innovation projects combined multiple data collection techniques. While open ended questions resulted in conventional narratives, respondents were also asked to extensively elaborate on their personal experience with

both successful and less successful product innovation and process innovation projects and subsequently to rate their perceived degree of uncertainty and equivocality for those projects. Although the two sources of information (the narratives and the quantitative ratings) point to similar findings, we organize our findings in such a way that we focus on the ratings of the participants with regard to perceived uncertainty and equivocality. This is argued to be a more effective means of communicating the main points of this study. The ratings resulted in descriptive data which is used below to illustrate patterns of uncertainty and equivocality across the three different sub phases of the fuzzy front end of the innovation process, referred to as pre-phase zero, phase zero, and phase one (cf. Khurana and Rosenthal, 1998). Activities in pre-phase 0 include preliminary opportunity identification, idea generation, market & technology analysis, and assessment of product & portfolio strategy. These activities are typically "ongoing". Phase zero implies the creation of a product or process concept, i.e. specifying attributes and properties of the product or process concept under creation, together with a "gestalt" for what the product or process concept should be. In phase 1, feasibility analysis and project planning are performed. Figure 1 below show these patterns for product innovation projects.

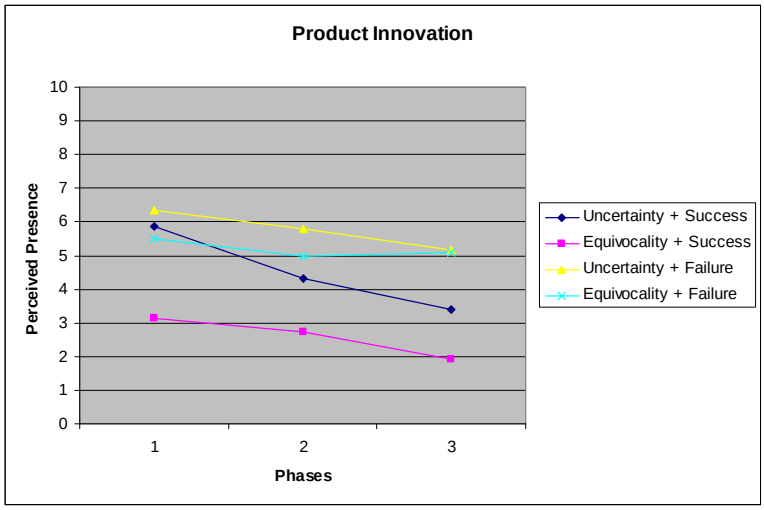

Figure 1: Patterns of uncertainty and equivocality for product innovation projects (successful projects and failure projects; n = 28)

Figure 1 allows for several interesting observations. One noteworthy observation is that successful projects are not characterized by lower degrees of uncertainty when compared with failure projects. In fact, a paired samples t-test between success and failure projects shows no significant differences for any of the three sub phases. This is something that is interesting to observe given its significant attention in previous research. In opposite, despite the modest attention given in prior research, equivocality differs significantly between success and failure projects, however. When comparing success and failure projects on the equivocality dimension, a significant difference exist for pre-phase zero (sig. <.05), for phase zero (sig. <.05) and for phase one (sig. <.01). Successful projects have significantly less equivocality.

A subsequent analysis "along" the curves (as opposite to "between" the curves) provides additional information. In general, Figure 1 shows a declining pattern of uncertainty and equivocality - both variables are reduced throughout the three sub-phases of the front-end for product innovation projects. However, when comparing successful to unsuccessful innovation projects reveal some notable insights that has not been outlined in previous

research. In specific, for successful product innovation projects, both uncertainty (sig. <.05) and equivocality (sig. <.05) differ significantly between starting points and end points, i.e. between pre phase zero and phase 1. For failure projects, no significant differences exist. This implies a presence of managerial attempts aiming to reduce uncertainty and equivocality in successful product innovation projects. Moreover, this clarify that it is more of management acts to reduce uncertainty and equivocality that matters for success than the actual initial levels. Further supporting this illustration is the fact that we also obtained numerous narrative accounts suggesting a presence of such activities in successful innovation projects.

As in the case of product innovation, Figure 2 also reveals similar findings with regard to the pattern of uncertainty and equivocality throughout the three sub phases of predevelopment for process innovation projects.

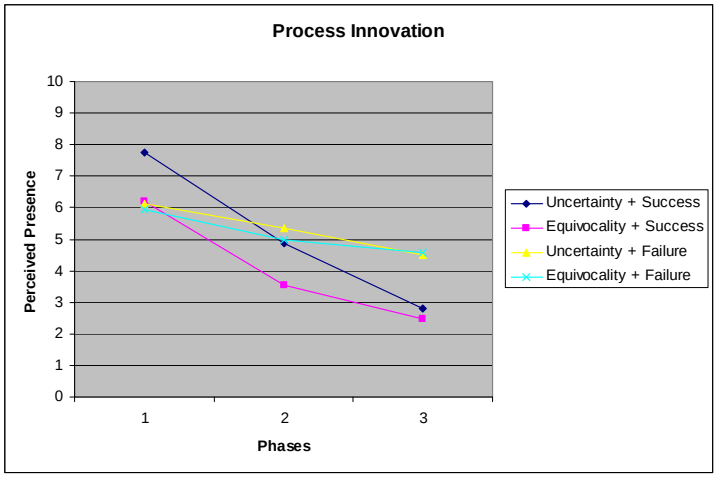

Figure 2: Patterns of uncertainty and equivocality for process innovation projects (successful projects and failure projects; n = 30)

A closer analysis of the figures illustrated in Figure 2 reveals that similar to product innovation projects, a paired samples t-test on the uncertainty dimension between success and failure projects reveal no significant differences for any of the three sub phases. As for equivocality, no significant differences exist between success and failure projects for pre-phase zero and phase zero. This indicates that it is difficult to predict success or failures based on levels of uncertainty or equivocality. A subsequent analysis along the curves reveals a pattern similar to that of product innovation projects. For successful process innovation projects, both uncertainty (sig. <.01) and equivocality (sig. <.01) differ significantly between starting points and end points, i.e. between the values for pre phase zero and phase 1. For failure projects, no significant differences exist. Similar to product innovation projects, this indicates that the success of process innovation projects is more likely to be attributed to managerial actions aiming to reduce uncertainty and equivocality throughout the pre-development stages. Similar to product innovation, our interview accounts also suggest a presence of such activities in the process innovation projects that were successful.

In order to research the possible paradoxical and challenging situation of simultaneously managing uncertainty or equivocality, we correlated the two concepts in successful innovation projects and compared them with the correlations in the unsuccessful projects. If our assumptions suggesting that the two should demand careful management, we should

observe that low or limited correlation in the successful projects as the attempts aiming for reducing uncertainty could increase equivocality. Consistent with our beliefs, we noticed that the Pearson correlation between uncertainty or equivocality was low across the stages in successful projects (p= >.05), which implies that managerial attempts is not activated simultaneously. Instead, they are sequential. Interestingly, we noticed significant correlations in the unsuccessful projects (p= <.05). This means that simultaneously fighting uncertainty or equivocality is not appropriate from a management perspective.

5. Discussion

While the explorative design and the limited prior research do not permit rigorously grounded formal hypotheses, it allows a set of conjectures to be formed that could serve as basis for further research.

P1: In both product- and process innovation, uncertainty and equivocality are more effectively reduced in successful projects than in failure projects.

Hence, although we noticed very limited differences of levels of uncertainty and equivocality in the beginning of pre-development (at the starting point of the pre-phase zero), successful projects are characterized by lower degrees of uncertainty and equivocality when entering the subsequent "formal" development process (which is the end-point of phase one). Based upon the interviews, the rationale could be as follows. Uncertainty requires development teams to seek additional information on product attributes, customer opinions, etcetera, activities which are time-consuming. If uncertainty is not sufficiently reduced, it eventually leads to concept failure (i.e. a no-go decision in the first gate, as it imposes on firms an unacceptable degree of risk). Similarly, equivocality also imposes time delays, as conflicting interpretations necessitates negotiation and enactment processes to reach shared understanding. If not sufficiently reduced, equivocality results in concept failure as it is impossible to continue development when equivocality is high.

Despite the suggestions presented in prior research, we did not find much difference with regard to levels of uncertainty. This was something we think is worth additional investigation. Our interpretation of the data also allows a more detailed proposition that could spark more work on a concept that has not much been studied in the literature on innovation projects in early phases. We propose:

P2: Initial levels of uncertainty do not seem to matter significantly for success. However, in both product- and process innovation, successful projects are characterized by lower initial levels of equivocality than failure projects.

Although we have both interview data and statistical support for this proposition, the proposition may be in some need of clarification, as unlike the clear significant difference for product innovations in the initial pre-phase (i.e. the starting point of the pre-phase), equivocality becomes significantly different only in the last phase (phase 1) of process innovation projects. A main reason for this fact is found in both the extant literature as well as when interpreting the qualitative data. Process innovation projects are "systemic" (more complex), and therefore, equivocality takes longer time to reduce. As process innovation

implies change in the overall process of converting inputs to outputs, it impacts on other sub-processes throughout an organization, for example administrative systems and human resource management practices (Gopalakrishnan et al., 1999). This explains the less significant difference for initial levels of equivocality in process innovation projects.

Arguably, however, it is the level of equivocality at the "finishing point" of predevelopment (i.e. phase 1) that counts. So, success in FFE seems to be determined by how much equivocality that remains after feasibility analysis and project planning (the key activities performed in phase 1) is completed. In essence, what makes successful projects different from failure projects is not the "starting point" but the "finishing point". Therefore, it is how "the race is finished" that counts, and not primarily "how the whole race is run". Thus, we posit:

P3: Equivocality causes more severe problems than uncertainty in terms of consequences.

Judging by the accounts, equivocality causes more severe problems than uncertainty (in terms of consequences), even though the degree of perceived equivocality may actually be lower than that for uncertainty. Our results from analyzing the qualitative data show that project participants are better suited to handle uncertainty than equivocality. Even moderate degrees of equivocality can paralyze a pre-development project, thus making it difficult for firms to proceed. Uncertainty can also be addressed with more "technical tools" and systematic work procedures, while equivocality reduction seems to require skills not sufficiently possessed by the respondents studied.

Our empirical findings much support our speculations implying that in an equivocal situation, new information for reducing uncertainty may actually increase rather then decrease equivocality. Therefore, we suggest the following proposition:

P4: In product and process innovation projects, managerial attempts to reduce equivocality and uncertainty should not be used simultaneously. Successful innovation projects are characterized by stepwise use of activities to reduce equivocality and uncertainty in the pre-development stages.

To a background of the above differences, it seems important for managers to make a conceptual and practical distinction between uncertainty and equivocality during predevelopment. If equivocality is mistaken for uncertainty, managers and project participants risk taking actions to reduce uncertainty (which actually is the default behavior in many organizations (Morgan, 1986). Such actions are likely to increase equivocality. Decision-making during predevelopment can be viewed as acts of selections of interpretations, which brings closure to the predevelopment process. Therefore, an important activity in predevelopment is that of meaning making. Team participants need to find ways to make sense of the world that is made up by an ambiguous field of experience (cf. Smirchich and Stubbart, 1985). This could be difficult if engaging in attempts for reducing uncertainty and bringing in additional information. In the process of meaning making, some organizational actors need to be those that provides selections of interpretation, or expressed differently; some actors need to become background generators and context composers (cf. ibid., p. 734) that can help others to pursue to common goals. As this is a complex and bothersome process, one understanding can be that unsuccessful innovation

projects is characterized by to highly correlated attempts in trying to reduce uncertainty parallel to equivocality.

6. Managerial implications

Although our results imply that equivocality is a more severe problem than uncertainty, none of the variables can be ignored. In essence, our research thus leads to the following managerial implications.

First, reliable information is the key to bring uncertainty down. As information reduce uncertainty, managers should continually engage in information acquisition and analysis regarding changes in technology, markets, internal organizational developments and priorities, external developments, and competitors (Bonaccorsi and Lipparini, 1994; Clark and Fujimoto, 1991; Kim and Wilemon, 2002; Koufteros, Vonderembse & Jayaram, 2005). It is therefore important that managers develop a work organization which allows processing of information and to act on that information. Organizational devices such as planning, special reports, and formal information systems can feed development participants with information and such devises has been demonstrated to be efficient in reducing uncertainty (Daft and Lengel, 1986). A complementary approach is to emphasize cross-functional integration, which impacts positively on uncertainty reduction in predevelopment. Moenaert and colleagues found that cross-functional information flows helped reduce task variability and increase task analyzability (Moenaert *et al*., 1995).

Second, we suggest managers should follow advises put forward in the literature and adopt different measures to reduce equivocality. Equivocal situations "... require hunches, discussion, and social support" (Daft, Lengel & Trevino, 1987, p. 357). This means that in situations characterized by equivocality, such as predevelopment, organizations should allow for rapid information cycles among people, typically face-to-face, and prescribe fewer rules for interpretation (Weick, 1979; Daft and Weick, 1984). Activities such as group meetings and direct contact between decision-makers that make it possible for participants to exchange opinions, perceptions and judgments face-to-face are helpful in reducing equivocality (Daft and Lengel, 1986). As such meetings facilitate the exchange of rich media, participants can converge on the meaning on equivocal cues, and are able to enact or define a solution. Another way for organizations to reduce equivocality is to make use of integrators, which can transcend boundaries within the organization (Galbraith, 1973). The main value of the integrator role is that it can help firms to overcome disagreement and thereby reduce equivocality about goals, the interpretation of issues, or a course of action (Daft and Lengel, 1986).

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