Measuring the effect of environmental uncertainty on process activities, project team characteristics, and new product success

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Abstract This empirical study examines the influence of environmental uncertainty on industrial product innovation. Addresses a perceived shortcoming in the new product development literature and explores direct and moderating effects of environmental uncertainty on the development process, project organization, and on new product success. Finds that several external market and technology factors do impact new product success directly. Further, finds that several market and technological uncertainties moderate the relationship between development process, project organization, and new product success. Consequently, innovating companies benefit by adopting their development approaches to different environmental conditions and to varying degrees of uncertainty. The results of 82 product development projects indicate, among others, that under conditions of high market and technology unpredictability process compression may increase time efficiency and product profitability.

Introduction

In this paper we explore the influence of environmental context factors on the new product development (NPD) process. We address what we believe to be a shortcoming within the NPD literature. Specifically, little attention has been placed on the influence of either the external market or the technological environment within which NPD occurs.

Logic suggests that these are influences. To illustrate, assume an extreme monopolistic environment – say one, perhaps, caused by tightly defined and protected patents within a market containing strong latent demand. The development of a total cure for HIV would be an example. Such an environment would hardly be the same as one involving numerous competitive efforts to develop close substitutes for products already on the market. Similarly, slight modifications of well-known existing technology might easily involve a different context for development than would some “miracle” breakthrough.

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While there has been some research reported that concerns the environmental and technological context (Brown and Eisenhardt, 1995), these variables have been largely ignored as influential factors of new product success. However, it is reasonable that the degree of external uncertainty moderates project performance, in particular technological discontinuity and market uncertainty. Here we refer to technical discontinuity as the stability and complexity of the technology, the R&D efforts within the industry, as well as to the unpredictability of rapid and significant change – such as the sudden emergence of new and breakthrough components or software. Today’s telephone companies, for example, are immensely challenged by revolutionary software that enables inter-phoning (real-time voice communication via the Internet) which bypasses long-distance telephone fees. Such rapidly changing technology could drive a major product into technological obsolescence before it sees the light of day (Udwarad and Kumar, 1991). Likewise, market uncertainty can be multidimensional. It can take the form of complexity, instability or unpredictability of markets, changes in market structure, and the degree of competition with respect to a development project.

The uncertainty and risk associated with new products makes it hardly surprising that innovating firms historically experienced high failure rates. Product development often requires navigating through unclear and shifting conditions. Both market and technology factors may moderate the relationship of process execution and project performance. As a consequence, the management of product development projects may require different strategies. As Christensen (1997a) argued, innovating companies need to follow an approach very different from what they would take toward an established technology when they are concerned with new products in emerging or highly unpredictable markets. We also intend to address this issue.

In particular, we concentrate on three important elements of successful new product development: the quality of the pre-development phase, the degree of process compression, and the management of the development process through a project team. All three elements may be affected by external project uncertainty and require flexible adaptation of planning and organizing activities.

We find that there are contradictory findings as to the impact of external market and technology factors and suspect there is no development performance profile that holds independent of environmental conditions. Thus, further investigation is needed to shed more light on the managerial implications of different environmental settings and the relative importance of the key determinants for new product success.

We attempt to provide two contributions in this article. First, we explore the direct and moderating effect of environmental uncertainty on success determinants and new product success (which we indicated above has not been sufficiently covered in previous studies). Second, we examine whether innovating companies may benefit by following development approaches adapted to different external project environments, such as environments that can be characterized as uncertain, unpredictable, or highly competitive. It is reasonable that different strategies are required in order to succeed under varying market and technological conditions. Both issues are investigated by using data from 82 new product development projects in the high-technology industry.
Literature background

The extent of market uncertainty and technical discontinuity reflect the amount of project task uncertainty faced by the innovating company. As such, environmental uncertainty originating in markets and technologies may impact on project performance. While this proposition might not be original, we were unable to locate previous research that explicitly probed for this direction. For example, Rumelt (1991) and Powell (1996) investigated industry membership and industry characteristics and found between 17 and 20 percent of success explained by industry context – which are factors beyond an organization’s control. However, moderating effects of environmental factors on success determinants were vaguely addressed, thus leaving a gap between external environment and overall project success.

In a replication study, Cooper and Kleinschmidt (1993) found that market competitiveness had no relationship with product success. Montoya-Weiss and Calantone (1994) noted that a factor like market competitiveness might not be as critical a determinant of success as other determinants. They argued that environmental factors may not have a strong impact on success and, thus, they assumed that environmental factors are often insignificant and not reported. However, they did caution that future research should be more explicit as to the influence of environmental factors on success, a caution that has largely gone unheeded.

Brown and Eisenhardt (1995), in contrast, argued that the direct effect of the market context on business success has been generally neglected, and that market context influences the development process variables to a varying degree which, in turn, impact on project success. In addition, Terwiesch (1996) reported that NPD performance and market environment are not independent but that this relation is impacted by the nature of competition in each industry. Similarly, LaBahn et al. (1996) recommended further inquiry into the dynamics of particular industries or competitive situations after finding that market growth moderated the relationship between cycle time and management’s focus on project deadlines.

In addition, environmental conditions for new product projects may be fundamentally different and, consequently, require varying development approaches. For instance, Calantone et al. (1994) reported that companies tend to adopt proactive strategic postures in terms of innovative and risk-taking behavior in uncertain environments and to adopt environmental hostility through suitable organizational structures. In a similar vein, Christensen (1997b) provided a detailed case study of the challenges that established manufacturers might face when trying to be innovative in unpredictably emerging markets. In particular, this author argued that in cases where initial market applications are uncertain, a discovery-driven learning process as compared to a formal development process may work better (Christensen, 1997a). We address this related issue next.

Considerable empirical research has been carried out to identify the determinants of new product performance at the project level. Particularly in the case where new products result from rational planning and execution, the proficiency of the development process and development team organization have been consistently identified as factors that may be used to fairly accurately predict whether a new product will be successful (Montoya-Weiss and Calantone, 1994). For example, how well product definition and market studies have been carried out and/or whether there was a strong project team driving a new product to market are quite consistently used to discriminate between successful and unsuccessful product development projects (Cooper,
Different organizational responses

However, successful development approaches may vary depending on the new product project, i.e., might be situationally dependent. Recent research has indicated that certain projects may require different organizational responses to improve the chance of success. For instance, Eisenhardt and Tabrizi (1995) noted that competitive advantage via new products in relatively stable or mature markets might be provided through a superior product proficiently based on a thorough understanding of user needs. In contrast, in dynamic and emerging markets, the search for competitive advantage via new products may be critically linked to the accumulation of resources and knowledge within the organization. In such situations a carefully selected multi-disciplinary development team led by a strong leader could be more important to success than any other factor (Eisenhardt and Tabrizi, 1995).

Consequently, researchers seem to be well advised to take into account such moderating variables when comparing different kinds of product cases. We intend to address this issue in this paper, however, with the focus on development approaches that should be emphasized under varying external project conditions that are beyond organizational control.

Conceptualization of the research problem

The conceptualization of our research is based on the potential effects of the external project environment on new product performance and on success determinants. We followed the “rational plan perspective,” as noted by Brown and Eisenhardt (1995) and as outlined in Figure 1, taking into account direct and moderating effects of the external project environment. The conceptual framework outlines the direct relationships of several success determinants on project success and the direct and moderating effect of the external environment on project success and success determinants.

There is a robust, documented stream of studies that looks into the determinants of new product success. Accordingly, we used some of the well-established determinants in our study to examine the moderating effects of external uncertainty. Specifically, we focused on three determinants: process compression, pre-development proficiency, and development team.

Increasingly, process acceleration through compression of the development process is reported to decrease cycle time (Clift and Vandenbosch, 1999; Eisenhardt and Tabrizi, 1995; Terwiesch and Loch, 1999). Cooper and

Three determinants

- Process compression
- Predevelopment activities
- Project team characteristics

Project success
- Time efficiency
- Profitability

- Market environment
- Technological environment

Figure 1. Conceptual framework
Kleinschmidt (1994) and Griffin (1997) report that one strong determinant of project timeliness is the use of a cross-functional, dedicated, and accountable team, led by a strong project leader. Another strong determinant is solid up-front homework, i.e. proficiency in pre-development planning as well as in product concept definition and evaluation. Both determinants are also reported to be strong correlates of financial performance (Cooper, 1993).

Specifically, we speculate that:

- external uncertainty directly affects project success;
- different environmental settings require a different accentuation of development approaches; and
- success determinants differently contribute to project performance in different environmental settings.

Research methodology

Data collection

A study was done of 50 Canadian high-technology companies. The companies primarily operated in electronics, aerospace, medical instruments, data-communications, industrial information and control systems, or measurement instruments. The companies were identified by using industry lists consisting of firms supposed to be active in research and development, new product development, and new business development. The sample group in the study was obtained by contacting representatives of the firms by telephone to ensure that they were indeed active in new product development or research, to identify the key respondents, and to solicit cooperation. A preliminary informant, the director of research and development, marketing, new product development, or new business development was then contacted to solicit cooperation, help identify appropriate projects, and help identify key informants, i.e. qualified and competent persons who were in charge of those development projects. The recommended key informants were then contacted by telephone and assessed in terms of role and responsibility as well as knowledge and involvement concerning the development projects, and were approached for cooperation. Each respondent, most often the project leader, decided the number and kinds of projects to be included, mostly in consultation with the preliminary informant. Data were gathered from structured face-to-face interviews with these key informants.

The units of analysis were individual product development projects in the business-to-business arena. Projects under investigation were, for example, switches, network products, acoustic wave signal processors, or measuring and tracking systems. All those projects were completed and launched within the previous three years. Overall, information was obtained on 82 product development projects within the companies. On average, the participating companies had 397 employees and annual sales of about C$137M.

Measures

Measures were identified from research into what determines a product a success. As such, variables were considered which helped to discriminate between successes and failures. Several authors consistently reported that factors decisive for success include: how a project is organized and managed, as well as the proficiency of technical and marketing activities (Cooper, 1979, 1985, 1993; Cooper and Kleinschmidt, 1986, 1995; Montoya-Weiss and Calantone, 1994). Variables measuring such factors were structured and administered to all respondents.
Two different measures of project success were used as our dependent variables: time efficiency and profitability, both of which were consistent with the literature (e.g., Cooper, 1993). The dependents were Likert scaled and indicated the extent to which a project met the manufacturer’s expectations in terms of time efficient product development as well as in terms of profitability.

**Questionnaire**

In the questionnaire, two sets of questions related to the development process: process completeness and pre-development proficiency. Completeness of the development process was measured as the number of development activities undertaken. Activities were included if they were done as part of the project and if identifiable time and money was spent on that activity (Cooper and Kleinschmidt, 1986). This included activities in the pre-development, development, testing, and commercialization phases. Dividing process completeness (the number of development activities) by project length (measured in months) resulted in an activity-per-month-ratio, which we used as a proxy for process compression. It indicated the number of process activities done per month (a higher ratio indicated greater process compression).

**Development activities**

The pre-development project phase was structured into several typical development activities:

- idea generation and screening (the first review of the venture and initial decision to commit resources);
- preliminary technical assessment (assessing the idea’s technical viability);
- product concept development (assessing needs, problems, market potential, and translating the market requirements into an operational concept); and
- business and financial analysis (assessing the projects financial viability leading to the “go to development” decision).

These activities served as measures of pre-development proficiency. Respondents rated on a Likert scale how well and thorough each of those activities was carried out, thus indicating the quality of project execution in the pre-development phase.

Another set of questions related to the organizational aspects of the development team. Several variables identified as related to the different success measures in previous studies were included (Cooper, 1993; Cooper and Kleinschmidt, 1994):

- the existence of a project leader (i.e., a person who takes an inordinate interest in seeing that the product was fully developed and marketed);
- the existence of a multi-disciplinary team (i.e., the functions of the company that were involved in the development project, such as marketing, R&D, production);
- the existence of a continuous project team (i.e., whether the team carried the project from beginning to end); and
- the existence of a dedicated team (i.e., the degree to which the project was a full-time effort of the team members).

Here, the respondents rated on a Likert scale to what extent each of those characteristics was existent throughout development.
Environmental uncertainty, as the moderating factor, was captured by eight variables which were adapted from previous research (Bucklin and Sengupta, 1992; Cooper, 1985, 1993; Khandwalla, 1976; Miller and Droge, 1986).

These measures were:

1. the unpredictability of market development;
2. the unpredictability of technological development;
3. the instability of market development;
4. the instability of technological development;
5. the degree of market competition;
6. the intensity of R&D efforts in the industry;
7. the complexity of the marketplace in terms of standard versus individual demands; and
8. the complexity of the technological development to which the new product project was exposed.

As such, the measures described the difficulty and inability to forecast accurately the changes in the market and technological project environment. Again, respondents were asked to rate their perceptions of each of the different environmental situations on Likert-type scales.

**Method of analysis**

A total of 17 predictor variables (independent variables) were originally used. We then departed from the typical methodology of analysis. Instead of using factors representing the underlying dimensions, as in previous research, we examined the effects of using the single variables themselves to detect whether each had a direct contribution to success. Then, we explored whether the contribution of these variables varied in relative importance according to the environmental setting.

Consequently, for the analysis we first checked for multicollinearity among the predictor set of variables. None of these had inter-correlations higher than 0.4, except for four environmental variables, which we then eliminated from the analysis. (Green and Tull, 1978; Hair et al., 1992). Then, we standardized the remaining 13 variables in order to measure each variable’s beta coefficient (beta weight) using ordinary least squares regression. This process enabled the comparison of the relative importance of each of the variables in the regression equations (Hair et al., 1992). In addition, it allowed the accounting of possible large deviations of certain projects and eliminated the potential effects of a response bias among projects. (Analysis was done using both standardized and non-standardized values to assure the identification of meaningful differences.) To explore the moderating effects of market or technology influences, i.e. to test whether successful strategies differ across environments, we performed subgroup analyses (50/50 median split) as suggested by Venkatraman (1989) and as employed in Terwiesch and Loch (1999).

**Results**

**Overall regression**

Table I presents the results of the ordinary least squares regression analysis, with time efficiency and project profitability as the dependent variables.
Only those variables with statistically significant beta coefficients (using two-tailed p-values) are discussed here. We used the indicated independent variables to test whether there was a direct impact of environmental variables on the success measures. For both concerns, time efficiency and project profitability, the explanatory power was at 0.45 ($r^2$) and above, thus lending support to the exploratory power of the success determinants.

For time efficiency, several of the predictor variables turned out to be significant contributors to fast and efficient product development. Not surprisingly, process compression, the proficiency of technical assessment and the proficiency of product concept development appeared to be useful approaches to increase time efficiency. For product profitability, a slightly different set of approaches contributed to this second measure. In particular, the proficiency of the business and financial analysis before development, a development team led by a strong project leader and process compression turned out to be successful approaches in terms of profitability. These findings were regarded as consistent with existing literature.

Environmental factors also appeared to have a direct impact on both dependent variables, also evident in Table I. When considering time efficiency, the degree of technological unpredictability and market competition directly and negatively affected this performance criterion, i.e. more competition and higher technical unpredictability decreased time efficiency. In contrast, we found that a higher degree of market unpredictability improved time efficiency. It may be that the presence of unpredictable markets increased the sensitivity to development time and exhorted the innovating companies to speed up NPD in order to benefit from expected time-to-market advantages. An extent of these effects was indicated in the second column in Table I. Here, we report the squared beta weights of the significant predictor variables. For the variables in question, the squared beta weights were 0.059, 0.034, and 0.027, which means that the degree of technological unpredictability represented about 14 percent of the relative importance of all the significance in the regression ($0.059/0.419 = 0.1398$).

<table>
<thead>
<tr>
<th>Independent variables</th>
<th>Time efficiency</th>
<th>Profitability</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Squared beta</td>
<td>Squared beta</td>
</tr>
<tr>
<td>Compression of process</td>
<td>0.169</td>
<td>0.039</td>
</tr>
<tr>
<td>Idea generation and screening</td>
<td>n.s.</td>
<td>n.s.</td>
</tr>
<tr>
<td>Preliminary technical assessment</td>
<td>0.076</td>
<td>n.s.</td>
</tr>
<tr>
<td>Product concept development</td>
<td>0.054</td>
<td>n.s.</td>
</tr>
<tr>
<td>Business and financial analysis</td>
<td>n.s.</td>
<td>0.177</td>
</tr>
<tr>
<td>Project leader</td>
<td>0.265**</td>
<td>0.070</td>
</tr>
<tr>
<td>Multidisciplinary team</td>
<td>n.s.</td>
<td>n.s.</td>
</tr>
<tr>
<td>Continuous project team</td>
<td>n.s.</td>
<td>n.s.</td>
</tr>
<tr>
<td>Dedicated team</td>
<td>n.s.</td>
<td>n.s.</td>
</tr>
<tr>
<td>Market unpredictability</td>
<td>0.034</td>
<td>n.s.</td>
</tr>
<tr>
<td>Market competition</td>
<td>0.027</td>
<td>n.s.</td>
</tr>
<tr>
<td>Technological unpredictability</td>
<td>0.059</td>
<td>0.092</td>
</tr>
<tr>
<td>Complexity of technology development</td>
<td>n.s.</td>
<td>n.s.</td>
</tr>
<tr>
<td>Sum</td>
<td>0.419</td>
<td>0.0379</td>
</tr>
<tr>
<td>Adj. $r^2$</td>
<td>0.54</td>
<td>0.45</td>
</tr>
<tr>
<td>$F$ value</td>
<td>6.84***</td>
<td>4.74***</td>
</tr>
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</table>

**Notes:** * < 0.10; ** < 0.05; *** < 0.01; n = 82.

**Table I. Regression results for overall sample: time efficiency and project profitability**
Likewise, market competition represented about 6 percent and market unpredictability about 8 percent of the relative importance. Such numbers gave us some idea of the proportional importance of each of the variables relative to each other. As Green and Tull (1978) point out, this measure is tricky and can lead to erroneous weights due to multi-collinearity. However, since we initially screened the variables to exclude the severe cases of non-orthogonality, the weights reported in Table I did give us some idea of relative importance. When excluding these variables from the regression analysis, the adjusted \( r^2 \) decreased by 7.3 percent, thus indicating a moderate absolute impact, which is generally consistent with the measures reported in Table I. Thus, we concluded that these variables together attribute somewhere around 7 to 28 percent toward time efficiency.

The findings indicate that technological unpredictability, market competitiveness, and market unpredictability did impact on the time efficiency of the projects and these environmental variables should, indeed, have been considered when discussing drivers of new product success. This is one of the major tenants that we set out to explore – the market and technological environment does matter.

With respect to the second dependent variable – profitability – the unpredictability of the technological development had a negative impact on profitability; i.e., the harder the technology development could be predicted, the lower was a project’s profitability, which also made intuitive sense. In relative terms, this variable’s squared beta weight represented about 24 percent of the total weighting (0.092/0.379). When this variable was excluded from the analysis, the adjusted \( r^2 \) decreased by 6.4 percent, thus indicating its direct impact. Here, we concluded that this variable accounted for somewhere between 6 and 24 percent of the importance toward project profitability. An estimate of the exact relative importance was not the thrust of this research. Instead, it was to assess whether or not the environment should be considered at all. Our conclusion was that it should be included, as evident in the above discussion.

**Moderating effects of environmental uncertainty on time efficiency**

We next investigated the moderating effects of different environmental variables in order to explore if the market and technological context affected process and team variables. For measuring any moderating effect we grouped the projects into high and low groups, below and above the median of the three significant uncertainty variables – market unpredictability, market competitiveness, and technological unpredictability – to assess the impact of the two groups on the dependent variables. Different levels of uncertainty (low or high on each moderating variable) could have required a different accentuation of success determinants. Support for this proposition would have required significant differences across the two groups. The results for the moderating effect of market unpredictability are presented in Table II.

The second column in Table II describes the group of development projects with a high degree of predictability of the marketplace. The proficiency of preliminary technical assessment, a dedicated development team that put a full-time effort into the project, and to a lesser extent process compression, were the key determinants associated with time efficiency. The quality of the technical assessment of the new product was highly significant and was the single most important contributing factor to fast-paced product development.
The overall fit of the model was 49 percent, of which 36 percent could be attributed to the proficiency of preliminary technical assessment alone. In contrast, having installed a development team carrying the project from beginning to end this had a negative impact on time efficiency and delayed expected project completion time. (We do not propose a full explanation within this paper, as further research is clearly needed. However, one explanation could be that fixed development teams became complacent, and perhaps overly cautious. Whatever the reason, the presence of a fixed team explained 31 percent of the relative importance).

The third column of Table II includes the projects that face hard-to-predict markets. Here, two variables drove time efficiency, in particular process compression and to a lesser extent the quality of the idea screening at the beginning of the development project. Higher process compression yielded higher time efficiency and was clearly the single most important variable for time efficient product development in highly unpredictable markets, accounting for about 71 percent of the variance of the relative importance.

Next, we examined the second variable that had a direct effect in the overall regression results. The second column in Table III describes the group of development projects with a low degree of competition in the marketplace. Process compression, the proficiency of product concept development, and a dedicated development team were strongly associated with time efficiency. The compression of the development process was highly significant and the single most important contributing factor to fast-paced product development. This variable accounted for about 53 percent of relative importance detected.

The third column of Table III includes the projects that faced intense market competition. In contrast to projects with low market competitiveness, two
different variables were related to time efficient project completion to about the same extent: the quality of the technical feasibility assessment in the pre-development phase and the management of the development project by a strong project leader. This difference in variables indicated the moderating effect of market competitiveness.

We further examined the third environmental variable directly affecting time efficiency. Technological unpredictability reflected task uncertainty faced by the innovating company. It is reasonable that such conditions may affect the key determinants and their impact on time. Table IV presents the regression results for time efficiency. For projects with low technological unpredictability, having a dedicated team committing full-time to the project, the proficiency of product concept development, and to a lesser degree preliminary technical assessment were found to have an acceleration effect. In contrast, having a continuous project team in place seemed to have a rather delaying effect, i.e., significantly decreased time efficiency.

The third column includes the subgroups of projects that faced high technological unpredictability. None of the aforementioned factors was found to be significant. In fact, only process compression had an accelerating effect on time efficiency. Accordingly, our conclusion is that the technological and market context should be considered when attempting to generalize about time efficient NPD.

**Moderating effect of environmental uncertainty on product profitability**

The last set of results concerns the moderating impact of technological unpredictability on product profitability (Table I). Again, a grouping was achieved by splitting the sample into projects below and above the median technological unpredictability score to assess the impact of these two groups on the dependent variable. The results are given in Table V.

We found that the technological context also played a role in indirectly affecting project profitability. If the technological context did not matter, then the same variables as well as their weights would apply to low and high predictability. We see that for projects that faced low technological unpredictability, the proficiency of business and financial analysis and a strong project leader positively impacted profitability. The activity of business and financial analysis was highly significant, indicating that under technological predictability a high proficiency in the analysis phase is of paramount importance for profitability.

It is also noteworthy that the compression of the development process decreased financial performance, but was not of high statistical significance.

<table>
<thead>
<tr>
<th>Independent variables</th>
<th>Time efficiency</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Low technological unpredictability</td>
</tr>
<tr>
<td>Compression of process</td>
<td>n.s.</td>
</tr>
<tr>
<td>Preliminary technical assessment</td>
<td>0.284*</td>
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<tr>
<td>Product concept development</td>
<td>0.460**</td>
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<tr>
<td>Continuous project team</td>
<td>−0.313***</td>
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<tr>
<td>Dedicated team</td>
<td>0.455***</td>
</tr>
<tr>
<td>Adj. $r^2$</td>
<td>0.49</td>
</tr>
<tr>
<td>$F$ value</td>
<td>4.50***</td>
</tr>
</tbody>
</table>

**Notes:** * < 0.10; ** < 0.05; *** < 0.01; $n = 41.0$

**Table IV.** Moderating effect of technological unpredictability on time efficiency
In contrast, for the sub-sample of projects facing high technological unpredictability, process compression was the primary contributor to project profitability. As such, the emphasis of process compression in a situation of high technical uncertainty seemed to have the opposite (positive) effect on profitability, compared with situations of low uncertainty where a strategy of process compression was negatively related to financial performance.

As evident in Table V, we found that the level of technological predictability was important for the financial success. If this were not so, then the relative sizes of the coefficients as well as the inclusion of the significant variables in low and high predictable situations would have been nearly identical. As can be seen in Table V this was not the case. Instead, basically the drivers changed as well as their coefficients. Accordingly, our conclusion was that the technological context should be considered when attempting to generalize about new product profitability.

**Financial success**

<table>
<thead>
<tr>
<th>Success determinants</th>
<th>Profitability</th>
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<tbody>
<tr>
<td></td>
<td>Low technological unpredictability</td>
</tr>
<tr>
<td>Compression of process</td>
<td>-0.276*</td>
</tr>
<tr>
<td>Business and financial analysis</td>
<td>0.441***</td>
</tr>
<tr>
<td>Project leader</td>
<td>0.316*</td>
</tr>
<tr>
<td>Adj. $r^2$</td>
<td>0.59</td>
</tr>
<tr>
<td>$F$ value</td>
<td>5.98***</td>
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</tbody>
</table>

**Notes:** * < 0.10; ** < 0.05; *** < 0.01; $n = 41.0$

Table V. Moderating effect of technological unpredictability on product profitability

Summary of findings and managerial implications

The aim of this paper was to explore the influence of market and technology factors on key determinants of NPD, and on project success. We were particularly interested in this topic, as there seems to be confusion about the role of environmental factors in the NPD literature. This issue was examined on data drawn from 82 projects in the electronics and electrical industry.

Overall, we set out to explore three issues. First, we were interested in any direct effect of environmental uncertainty on certain project performance measures. We found that some market and technology factors indeed influenced project success directly and, therefore, should not be neglected. In particular, market and technological unpredictability and market competitiveness all were related to project success.

Second, we claimed that environmental uncertainty in various forms would require different development approaches. When looking at more specific settings – compared to the whole sample – development approaches and their importance to project success did vary. Depending on the external environment of the development project – for instance, market competitiveness versus market predictability – different responses from the innovating companies were required in order to be more successful, indicating the moderating effect of environmental uncertainty. Since we did not feel that our research was definitive, we implore further research into this matter – an issue that we feel to be important for successful NPD.

Third, we further claimed that success determinants would differently contribute to project performance. Split-sample analysis showed that within-comparisons of projects indeed required different emphasis in order to
Basicly, none of the success determinants were identical for situations of a low- versus a high-degree of any environmental condition (exception: some were significant at the 0.1 level).

What makes for successful product development in a predictable market is a different story compared to success determinants in unpredictable environments. Consequently, managers should pay attention to the possible impact of different environmental conditions on key determinants, such as those examined in this paper, and how they play on eventual product success. It appeared that under conditions of hard-to-predict technologies and markets, and a lack of competition (characteristics that can be attributed to emerging markets), the compression of the development process is a most viable strategy. Installing fast-paced product development processes seem to help in exploiting such markets and may help in securing a pioneering advantage. Clearly, additional research into the impact of environmental variables appears warranted based upon the research reported in this paper.

References


Executive summary and implications for managers and executives

Effect of external market and technological environment on NPD
A firm trying to develop a total cure for HIV would obviously work in a different new product development context from a company trying to develop a close substitute for a product already on the market. Similarly, telephone companies’ research and development takes place in a different technological context from that of a company seeking to achieve a marginally better fuel consumption from the internal combustion engine. That is because telephone companies are challenged by revolutionary software that enables real-time voice communication over the Internet which bypasses long-distance telephone fees, and so could drive a major product into technological obsolescence before it sees the light of day. The internal combustion engine, in contrast, is likely to be with us for the foreseeable future. Bstieeler and Gross examine the influence of the external market and the technological environment within which new product development takes place.

Environmental uncertainty
Using information from 82 new product development projects in 50 Canadian high-technology companies, the authors explore the direct and moderating effect of environmental uncertainty on new product performance and success. Environmental uncertainty is captured by the unpredictability of market and technological development, the instability of market and technological development, the degree of market competition, the intensity of research and development efforts in the industry, the complexity of the market in terms of standard versus individual demands, and the complexity of the technological development to which the new product project is exposed.

Different development approaches
The authors also examine whether innovating companies may benefit by following development approaches adapted to different external project environments. The authors concentrate in particular on the way in which the quality of the pre-development phase (which covers idea generation and screening, preliminary technical assessment, product concept development, business and financial analysis), the degree of process compression (measured by the number of process activities done per month) and the management of the development process through a process team (the existence of a project leader, multidisciplinary team, continuous project team and/or dedicated team) affect the success of new product development. The authors measure success by the extent to which a project meets the manufacturer’s expectations in terms of profitability and time efficient product development.

Some conclusions
The research reveals that some market and technology factors – particularly market and technological unpredictability and market competitiveness – are related to project success. The harder the technology development can be predicted, the lower is a project’s profitability.

Depending on the external environment of the development project – for instance, market competitiveness versus market predictability – different responses from the innovating companies are required in order to be more
successful. What makes for successful product development in a predictable market differs from success determinants in unpredictable environments. For example, under conditions of hard-to-predict technologies and markets and a lack of competition – characteristics that can be attributed to emerging markets – the compression of the development process is a most viable strategy. Installing fast-pace product development processes seems to help in exploiting such markets and may help in securing a pioneering advantage.

(A précis of the article “Measuring the effect of environmental uncertainty on process activities, project team characteristics, and new product success”. Supplied by Marketing Consultants for Emerald.)