Determinants of New Industrial Product Performance: A Strategic Reexamination of the Empirical Literature

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Abstract—In this paper we reexamine and generalize research findings on the determinants of industrial innovation performance using a three-dimensional framework. Those dimensions are: generality over innovations, decision focus, and managerial controllability. The major determinants identified are: a) strategic and organizational factors including general management’s support, business-project fit, and R&D–marketing interaction; b) R&D and production factors including product superiority, experience and synergy effects, user benefit of the product, and patent protection; and c) market and environmental factors including degree of competition and market growth. An empirical study of 112 new industrial products confirms that dynamic interaction exists between these determinants and the launch time of the product.

I. INTRODUCTION

EMPIRICAL RESEARCH on new product performance has focused on the factors leading to success and the reasons for failure. In this paper we review that literature and summarize the major determinants of industrial innovation performance using a three-dimensional framework (Section II). The three dimensions are 1) generality over innovations, 2) decision focus, and 3) managerial controllability. We found that major strategic and organizational determinants are a) general management’s support and involvement, b) business-project fit, and c) R&D–manufacturing–marketing interaction. Major R&D and production determinants are a) product superiority, b) experience and synergy effects, c) user benefit of the product, and d) patent protection. Market/environmental factors are a) degree of competition, and b) market size and growth rate. We suggest that strategic or organizational determinants are controllable but virtually static, whereas R&D and marketing determinants are dynamically controllable, and market/environmental determinants are uncontrollable and dynamic.

In Section III, using a French data base of new industrial products, we perform an empirical study to examine the dynamics of these determinants and develop managerial implications. In Section IV we summarize the findings of this research and suggest directions for future research on the innovation strategy in a competitive, dynamic market environment.

II. DETERMINANTS OF INNOVATION SUCCESS

A. Research on Industrial Innovation Performance

Empirical research on the determinants of industrial innovation performance has generally focused on a) key factors leading to success, b) reasons for failure, or c) comparison between success and failure. Table I lists the major empirical research on each of these issues and the Appendix summarizes the associated data bases, analytic methods, and findings. New product success studies (Glove, Levy, and Schwartz [10], Roberts and Burke [16], Rubinstein et al. [18], Cooper [7], Yoon and Lilien [21], and Voss [20]) identify key success factors and suggest strategies to enhance success. New product failure studies (Lazo [13], Constandse [5], and Hopkins [11]) investigate common reasons for failures and prescribe strategies to avoid failures. Studies comparing product successes with failures (Rothwell et al. [17], Utterback et al. [19], Cooper [6], [8], Calantone and Cooper [4], Maidique and

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Zirger [14], Yoon and Lilien [21], and Baker et al. [2]) isolate the factors that differentiate success from failure and develop strategies to increase the likelihood of success.

Analytic procedures vary from study to study depending on the structure and measures of the variables in the respective data bases and on research objectives. In-depth study of selected case histories is one method used while statistical analysis of cross-sectional data is another. Statistical approaches include correlation analysis, factor analysis, ANOVA, and regression analysis, which are typically used to identify variables or dimensions that determine success or failure (see Appendix). Discriminant analysis is used to identify factors differentiating successes and failures and to measure the relative importance of each discriminating factor. And cluster analysis is used to segment sample products into homogeneous groups for further study.

In spite of differences between studies in terms of data base, variable descriptions, models, and analytic procedures, the findings of these studies are often similar and consistent.

B. A Three-Dimensional Interpretation

To summarize the research findings on the determinants of innovation performance, we use a three-dimensional framework. The dimensions are a) generality of determinants over innovations, b) decision focus, and c) managerial controllability of each determinant.

1. Dimension 1: Generality Over Innovations: The determinants of innovation performance may differ according to whether the innovation is a product or a process, whether the product or process is intended for consumer or industrial use, and whether the innovation is completely new or a new item in an established product or process class [2], [21]. For industrial product innovations, we use the following classification in examining the generality of determinants of innovation success or failure: PD&PC: determinants common to product and process innovations; PD: determinants common to product innovations; and LOB: determinants for a specific line of business.

2. Dimension 2: Decision Focus: Management of the innovation process includes responsibility for: a) business strategy and organizational interactions, b) R&D planning and control, c) marketing support, d) monitoring of the development of market environments, and e) deciding on the launch time [1], [21]. We categorize these variables as follows.

BSO: Business strategic and organizational issues include deciding whether the innovation program is consistent with corporate strategy; whether organizational structure facing innovation is flexible; facilitating the interaction between R&D, manufacturing, and marketing.

R&D: R&D issues include specifying R&D objectives; coordinating departments involved in research; and determining the R&D investment schedule.

MKT: Marketing issues include competitive marketing efforts to support a rapid diffusion of the innovation.

ENV: Market/environmental issues include predicting the market size and the development of the product life cycle.

3. Dimension 3: Managerial Controllability: Management control of the determinants of innovation performance varies. Some determinants are controlled within the firm, while others can be only partly controlled, or are not under the control of management at all. Managerial controllability is relatively static and discrete for some determinants, but dynamic and continuous for others, as follows.

CS (controllable–static): Entry strategy (for example, to be a leader or a follower), top management’s support and coordination, and other business strategic factors are controllable by management, but the control of these factors is discrete and static (that is, subject to a one-time decision).

CD (controllable–dynamic): Product quality, production expertise, and marketing efficiency are controlled by management through internal decisions and investments, and the control of these factors is generally dynamic (that is, determined by a continuous policy or a series of decisions).

US (uncontrollable–static): Factors that are not subject to management control and static are the patent system, the government’s subsidy policy, and other legal and social influences.

UD (uncontrollable–dynamic): Dynamically changing determinants that are not controllable through internal decisions and resources are economic trends and cycles, market size and growth, and competitive rivalry.

Table II summarizes research findings on the determinants of industrial innovation performance, using this three-dimensional framework. To show the generality of determinants over project types, we compared the innovation studies in Table I by data base type (Appendix), that is, a) product and process data (PD&PC), b) product data (PD), and c) specific line-of-business data (LOB). Product and process data were used in Glove et al. [10], Rubinstein et al. [18], Rothwell et al. [17], and Utterback et al. [19]. Product data were used in Cooper [6], [7], Lazo [13], Constandse [5], Hopkins [11], and Yoon and Lilien [21]. Specific line-of-business data were used in Roberts and Burke [16], Maidique and Zirger [14], Voss [20], and Baker et al. [2]. Decision focus and controllability are given a priori for each determinant.

The following business strategic and organizational (BSO) factors arise repeatedly as major determinants of industrial innovation performance:

- general management’s support and involvement,
- business–project fit, and
- R&D–manufacturing–marketing interaction.

BSO determinants are controllable by management through internal decisions, but only at the corporate level and in the long run. So they are relatively static over the innovation phases.

Table II also lists the following R&D and production factors as major determinants of innovation performance:

- relative superiority or uniqueness of the innovation,
Experience and synergy in R&D and production are relatively static and discrete.

MKT determinants can be controlled by the individual firm’s management decisions. These determinants are dynamic parts of the market environment.

Dynamic determinants of new product success are strategically very important if a firm would like to manage the product innovation as a continuous process of the firm’s business activity. The dynamic behavior of those determinants are closely associated with the launch time decision of a new product. In new product failure studies [5, 11, 13] the launch time decision (LTD) has been cited as one of the major influences on innovation performance (Appendix). Launching a new product at an inappropriate time has been one of the three most commonly cited reasons for a downfall, along with poor market research or planning and the product’s technical problems or its uniqueness [3], [9], [12]. However, the dynamics of the determinants of market success have been studied only occasionally. Our classification of the determinants of new product success into static or dynamic in this section was also a priori and subjective. We investigate the existence of dynamics of those determinants next.

III. AN EMPIRICAL STUDY OF THE DYNAMICS OF THE
DETERMINANTS OF SUCCESS AND FAILURE

A. The Data Base and Variables

The data base used here represents 112 new industrial products from 52 French firms. Although those products were developed by European companies, most were marketed in several major industrial countries, including the United States. It was created in 1980 by the Center for Research in Management Science at Ecole Superieure des Sciences Economiques et Commerciales (ESSEC) in conjunction with The French Ministry of Industry and the Novaction Company. 1

The products studied represent a convenience sample from a list of 500 industrial firms registered in France, drawn randomly from a national directory in proportion to the importance of top priority sectors for French national policy. Firms were contacted in a two-step procedure. They were selected after a telephone interview, checking whether they had introduced a new product in the last five years. Next, selected firms were contacted sequentially and asked to participate in the study, after receiving a statement of the project objectives. The acceptance rate was 83 percent or 52 firms. Data were collected by personal interview on the R&D process, market introduction strategy, market penetration, managerial judgments about the new product performance, and information on the objectives for the new product.

We have reproduced the distribution of the sample across industrial sectors in Table III. The electronics and scientific instrumentation area is well represented, reflecting both national policy emphasis and the high level of innovation in this sector. The miscellaneous sector includes a heterogeneous

1 Novaction Company, a leading European consulting firm and a member of the Institute for the Study of Business Markets at the Pennsylvania State University, provided access to these data for this research.
set of new industrial products, ranging from computer
equipment, scientific
instruments to transport, services,
metal processing, metallurgy,
Food, agriculture,
and Miscellaneous.

### Table III

<table>
<thead>
<tr>
<th>Industrial Sector</th>
<th>Number of New Products</th>
<th>Percent of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electronics, electrical equipment</td>
<td>43</td>
<td>38</td>
</tr>
<tr>
<td>Chemistry, biochemistry</td>
<td>17</td>
<td>15</td>
</tr>
<tr>
<td>Construction, earth moving</td>
<td>15</td>
<td>14</td>
</tr>
<tr>
<td>Transport, services</td>
<td>11</td>
<td>10</td>
</tr>
<tr>
<td>Metal processing, metallurgy</td>
<td>10</td>
<td>9</td>
</tr>
<tr>
<td>Food, agriculture</td>
<td>9</td>
<td>8</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>7</td>
<td>6</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>112</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

### Table IV

<table>
<thead>
<tr>
<th>Product Category</th>
<th>Major Determinant</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>EXPPR</td>
</tr>
<tr>
<td>Original Products</td>
<td>.266</td>
</tr>
<tr>
<td>New Products</td>
<td>(31)</td>
</tr>
<tr>
<td>Reformulated</td>
<td>.335</td>
</tr>
<tr>
<td>New Products</td>
<td>(48)</td>
</tr>
</tbody>
</table>

1 Indicates that correlation is not significant at 0.10 level; () indicates the sample size in the analysis.

### B. Dynamics of Determinants and Managerial Implications

To test the dynamics of major determinants of new product success we examined the association (correlation coefficient) between success/failure determinants and launch time (the time lag between product development decision and market launch). Since a previous analysis with this data base [21] showed that original new products and reformulated new products are heterogeneous in many aspects of innovation activities, these two product categories were examined separately.

We found that for the original new products, the levels of production and marketing expertise increase, market growth rate becomes higher, and the degree of competition intensifies when the time lag to market launch becomes longer. In Table IV we observe that the correlation coefficients are statistically significant at the 10-percent level between the levels of a) production expertise (EXPPR), b) marketing expertise (EXPMK), c) number of competitors (NOCOM), and d) growth rate of market demand (GRWTH) and the length of time lag to market launch (in quarters) of a new product. These empirical results confirm that, in the case of the original new products, all the major R&D, marketing, and environmental determinants of new product success discussed in Section II change dynamically over the launch time of the new product.

For reformulated new products, the level of production expertise increases and the degree of competition intensifies as the time lag to market launch becomes longer, but the other

\[ \text{Compares with reformulated new products, original new products:} \]

a) are more diversification oriented/less expansion oriented,
b) have higher R&D cost for basic research and lower R&D cost for prototype development,
c) are in markets where potential buyers show lower satisfaction with existing products,
d) are developed by firms with higher production expertise/lower marketing expertise,
e) have a higher degree of innovativeness/lower market competition,
f) are in an earlier stage of the product life cycle, smaller number of competitors/lower market concentration ratio, and
g) use more direct selling/infrequently use a high price strategy.

The original and reformulated products are defined as follows: original new products (GRP's) are products that have undergone important technological changes that permit them to be competitive in new markets, or have applied a technology that has never before been part of the value of the product; whereas reformulated new products (RFP's) are products that have undergone important modifications which affect their use, lower their price, or make them more durable.
### Table V

**Innovation Success Studies**

<table>
<thead>
<tr>
<th>Product Type in Data Base</th>
<th>Analysis Methods</th>
<th>Key Determinants of Success</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glove, Levy &amp; Schwartz (1973)</td>
<td>R&amp;D history of 10 major industrial innovations</td>
<td>Frequency analysis of importance rankings</td>
</tr>
<tr>
<td>Roberts &amp; Burke (1974)</td>
<td>R&amp;D history of 6 relatively successful industrial laboratory materials in U.S.</td>
<td>Case study of innovation history</td>
</tr>
<tr>
<td>Rubinstein, et al. (1976)</td>
<td>103 consumer or industrial projects of 6 U.S. firms</td>
<td>Correlation analysis with Kendall Tau rank tests</td>
</tr>
<tr>
<td>Cooper (1984)</td>
<td>122 Canadian industrial firms active in new product innovation</td>
<td>Factor analysis and Correlation analysis</td>
</tr>
<tr>
<td>Yoon &amp; Lilien (1985)</td>
<td>112 industrial products of 50 innovative French firms</td>
<td>Group Mean Tests</td>
</tr>
<tr>
<td>ANOVA</td>
<td>Initial sales performance is related to marketing efficiency and market competition in both ORPs and RFPs.</td>
<td></td>
</tr>
<tr>
<td>Market growth and life-cycle stage are important for the success of ORPs, whereas the objective of product group expansion and buyers' dissatisfaction with existing products are important for the success of RFPs.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Regression analysis</td>
<td>For successful ORPs, first-year market share increases with delay of launch time up to a certain point and decreases thereafter, whereas for RFPs, first-year market share continuously decreases with delay of launch time.</td>
<td></td>
</tr>
<tr>
<td>Voss (1985)</td>
<td>16 shipping, documentation software innovations in U.K. computer industry</td>
<td>Spearman rank order correlation</td>
</tr>
</tbody>
</table>
determinants tend to be stable. In Table IV we observe that the correlation coefficients are significant at the 10-percent level only for production expertise (EXPPR) and degree of competition (NOCOM). Marketing expertise (EXPMK) and growth rate of market demand (GRWTH) do not show a statistically significant association with the time lag to market launch. These empirical results suggest that, in the case of the reformulated new products, some controllable determinants of new product success (i.e., production expertise and competition) change dynamically over the launch time of the new product, but other determinants (i.e., marketing expertise and the market growth) do not vary significantly.

One important managerial implication of these empirical results is that the controllable determinants (i.e., R&D and marketing investment) should be tuned to the uncontrollable determinants of success (i.e., market development) so that when the product is launched, the likelihood of new product success is maximized. This tuning is likely to be critical in the case of original new products in particular, because the dynamic evolution of the major determinants of new product success is intrinsic and significant through the innovation process.

IV. Summary and Directions of Future Research

Empirical research has identified the following factors as major determinants of new industrial product success: a) business, strategic, and organizational factors including top management's support and interdepartmental interaction, b) R&D and marketing factors including product's benefit, synergy, and interaction with customers, c) market/environmental factors including competition, market size and its growth, and d) launch timing which is dynamically associated with the other factors listed above.

Our empirical study of a French data base confirmed the dynamic relationship between these determinants and launch time, in the case of original new products, in particular. The levels of production and marketing expertise increase, market growth rate becomes higher, and the degree of competition intensifies as the introduction of a new product into the market is delayed longer. Thus the entry time of a new product should be determined so as to balance the positive and negative impacts of these major determinants to maximize new product success.

There are several limitations of this empirical study, which suggest future research directions. First, the launch time was measured by the time lag between the product development decision and its market launch only. We need to develop other measures of entry time, including the stage of the product life cycle and the order of entry. Second, since the data base includes several different industries, industry-specific influences on the innovation decision and their impacts on performance could not be removed in our analysis. A more homogeneous data base would lead to more reliable observations on the dynamic structure and behavior of the determinants of new product success/failure. Third, poor distributional properties of measures in the data base led us to use simple correlation analysis in examining the dynamics of major determinants over launch time. Future research will need to develop measures that will allow stronger statistical tests on new product dynamics.

Fourth, future research on entry timing should allow interactions among determinants, in particular between R&D and marketing, or between marketing and competition [22].

APPENDIX

Research on Industrial Innovation Performance

Studies on industrial innovation performance shown in Table I are also shown in Table V (innovation success studies), Table VI (innovation failure studies), and Table VII (studies
<table>
<thead>
<tr>
<th>Product Type</th>
<th>Analysis Methods</th>
<th>Key Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>SAPPHO (Rothwell et al., 1974)</td>
<td>Univariate analysis in chemical processes, 21 in scientific (instruments) of successful or unsuccessful U.K. projects</td>
<td>Successes and failures are different in 5 dimensions: strength and characteristics of management, marketing performance, understanding of customer needs, R&amp;D efficiency in development, and communications.</td>
</tr>
<tr>
<td>Utterback et al. (1976)</td>
<td>Frequency analysis of 59 European and Japanese firms in computer, consumer electronics, textiles, industrial chemicals, and automotive industries</td>
<td>Major differences of successful projects from unsuccessful ones are: no initial difficulty in marketing, product advantage, competitive stimulus, project customers, project urgency, patent protection, and top management's initiative.</td>
</tr>
<tr>
<td>Cooper (1979)</td>
<td>Factor analysis of 102 industrial products (103 successes and 93 failures) of 103 Canadian innovative firms</td>
<td>Identified 18 factors describing projects.</td>
</tr>
<tr>
<td>Calantone &amp; Cooper (1981)</td>
<td>Cluster analysis of 103 industrial products (102 successes and 93 failures) of 103 Canadian innovative firms</td>
<td>More successful product scenarios are in order of (a) synergetic, close to old, (b) innovative, superior, (c) old, simple, (d) synergetic, new, (e) innovative, high-tech.</td>
</tr>
<tr>
<td>Maltique &amp; Zirger (1984)</td>
<td>Binomial significance tests of 118 product innovations in U.S. electronics industry and Cluster analysis</td>
<td>Successful innovations are: better matched with user need, more effectively planned, more efficiently developed, closer to the firm's areas of expertise, and launched earlier.</td>
</tr>
<tr>
<td>Cooper (1985)</td>
<td>Factor analysis of 127 Canadian industrial firms active in new product innovation</td>
<td>A balanced, focused (technologically sophisticated, innovative, and strongly market oriented) strategy yields the best performance.</td>
</tr>
<tr>
<td>Yoon &amp; Lilien (1985)</td>
<td>Discriminant analysis of 112 industrial products of 52 innovative French firms</td>
<td>Life-cycle stage, expertise in marketing, and marketing efficiency are major determinants of success or failure.</td>
</tr>
<tr>
<td>Baker et al. (1986)</td>
<td>Discriminant analysis of 210 U.S. firm projects in four industries (steel, pesticides, food, and industrial chemicals)</td>
<td>Experience in production and marketing, top management's involvement, goal definition, and R&amp;D-marketing interaction are common determinants of success or failure.</td>
</tr>
</tbody>
</table>
comparing innovation successes and failures). The tables summarize the associated data bases, analytic methods used, and findings.

REFERENCES