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Strategic Ambidexterity in Innovation: An Indispensable Capability in the Face of Change

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Abstract-Ambidexterity is a dynamic capability that may be fulfilled through prudent implementation of organizational processes necessary for product innovation. In this research, a model is tested using data collected from US high technology manufacturers. Results indicate that firms interested in pursuing strategic ambidexterity in innovation should implement all the studied processes in order to improve radical and incremental innovation output. Furthermore, post hoc exploratory analysis suggests that US high technology industries appear to be divided as to the levels of exploration, exploitation, and ambidexterity that they attain.

INTRODUCTION

Despite the importance and challenges of ambidexterity, there have been very few empirical attempts to test conceptual arguments of industry leaders and academicians on organizational ambidexterity and implications for sustainable competitive advantage [23]. Prior empirical research, albeit limited, has focused singly on the influences of organizational structure [8] and culture [9] on ambidexterity, leaving a deep research gap addressing the impacts of organizational processes where, some argue, the foundation of ambidexterity now lies. Ref. [8, p. 200] state that “We do not believe that ambidexterity is rooted in an individual’s ability to explore and exploit...; nor is ambidexterity simply a matter of organizational structure....Rather, as a dynamic capability ambidexterity embodies a complex set of routines....”

This research effort studies ambidexterity in strategy as a result of this “complex set of routines” in terms of organizational processes. It is an extension of previous research conducted by the author that found support that strategically ambidextrous firms were shown to have multiple processes in place that impact exploration and exploitation and that these firms implement the studied processes to a greater extent than those firms operating in the more extreme positions [27]. This exploratory study’s purpose is to develop a fuller understanding of the influence of organizational processes on the ability of firms to achieve strategic ambidexterity in exploration and exploitation in innovation and to understand the ultimate performance impacts in terms of number of innovations, especially in light of dynamic environmental conditions of high technology industries.

Specifically, this research seeks to answer the following questions: *How do opposing organizational processes influence strategic ambidexterity in innovation? And what, if any, processes play a dual role in exploration and exploitation?*

BACKGROUND

Processes are those “routines or patterns of current practice and learning” [26, p.518]. Depending on their characteristics, processes can either advance exploration, advance exploitation, or, more uniquely, both. Once implemented, they display a high level of coherence and stability by becoming “embedded” in the organization. If the embedded processes are more oriented towards exploration, firm competence in exploitation is significantly reduced and vice versa [11]. Thus, they play an influential role in strategic choice [17].

Ref. [26, p. 516] defines dynamic capabilities as “the firm’s ability to integrate, build, and reconfigure internal and external competences to address rapidly changing environments.” With the arrival of this framework in the late 1990s, researchers began to look at activities and routines as elements in organizational renewal [6]. Focus shifted from a more static viewpoint of competences and assets to the dynamic nature of capabilities, the evolution of capabilities over time, and the impacts of changing environments on firm survival.

Within the dynamic capabilities framework, organizational processes are classified into three roles: coordination/integration, learning, and reconfiguration and transformation.

Coordination/Integration: Customer relationships and interorganizational collaborations on technology development are examples of organizational processes of coordination and integration. It is well understood that higher degrees of interfirm coordination and integration promote strategic advantage [26], and can influence both exploration and exploitation.

Learning: For an organization, learning is more important than integration and is defined as “a process by which

repetition and experimentation enable tasks to be performed better and quicker” [26, p. 520]. The organizational knowledge generated by learning results in new routines, new processes, and new organizational logic [26].

Reconfiguration and transformation: These processes include those that the organization employs to sense external changes in markets and technology, as well as to transform the organization to be in concert with competitive conditions. Environmental scanning, evaluation of customers, technology advances, and competitors, and the capacity for transformation are necessary reconfiguration processes to retain strategic advantage [26].

As shown in Table I and Fig. 1, this research concentrates on five organizational processes that are embedded in each of the roles outlined above. Several of these processes fall into multiple role categories. Those processes that play a role in gathering information about technology and customers, specifically, technology monitoring, current customer knowledge process, and those that involve collaboration, such as that of lead users, are instrumental in both organizational learning and in reconfiguration and transformation. However, working with current and future customers also involves coordination and integration. Quality process management activities are directly related to the production of products and the knowledge acquired through learning how to produce more efficiently in a cost effective manner and subsequently transforming processes for continued improvement. Technology competence, clearly a learning capability, is a result of knowledge obtained through skills, experimentation, experience and earned wisdom. These processes, whether they fulfill the role of integration and coordination, learning, or transformation, influence the subject innovation strategies with varying levels of intensity.

TABLE I
ORGANIZATIONAL PROCESSES IN A DYNAMIC CAPABILITIES FRAMEWORK

Process	Coordination/ Integration	Learning	Reconfiguration/ Transformation
Technology Monitoring		√	√
Technology Competence		√	
Quality Process Management		√	√
Current Customer Knowledge Processes	√	√	√
Lead User Collaboration	√	√	√

CONCEPTUAL MODEL AND HYPOTHESES

The conceptual model of Figure 1 identifies the influences of the chosen organizational processes on exploration and exploitation in innovation and the outcomes of these strategies on innovation performance.

Influences of Organizational Processes on Innovation Strategies

Technology Monitoring

Technology monitoring is defined as the process in which an organization acquires knowledge about and understands new technology developments in its external environment [25]. In order for exploration to take place, firms must make a conscious effort to monitor new technological developments outside the organization. Technology monitoring is a search process necessary for learning and transformation, enabling the business to compete by sensing new technologies fundamental to radical innovation development. On the other hand, this process also enables firms to compete in exploitation as it aids firms in acquiring the latest information on incrementally innovative technologies that are fundamental to new paths of exploitation. Without employing this process key to innovation in general, exploitation will be limited to the firm’s prior efforts and experience. This limitation begets incremental improvements that eventually cease or become obsolete unless new information on innovative technologies outside the firm is acquired. Therefore,

H1: a) The greater the degree of technology monitoring, the greater the degree of exploration with radical product innovation. b) The greater the degree of technology monitoring, the greater the degree of exploitation with incremental product innovation.

Technology Competence

Technology competence is defined as the set of technological skills, knowledge, and experience resident within the firm that is necessary to design the product innovation [10]. In this research, it is defined relative to the frontier such that organizations with high technology competence are technologically closer to the technology frontier than those with lower technology competence. Considered an intangible process [10], technology competence plays a significant role in the development new radical product innovations.

Technology competence has tremendous weight in directing innovation strategy. It has been noted that exploitation builds on a firm’s prior technology competences while exploration changes the technological trajectory, often forcing firms to acquire new competences if they cannot compete based on their resident technological know-how [7]. Unless carefully watched and managed, capabilities and investments from the development of a radical innovation will become obsolete or migrate over time towards core rigidities and away from the technological frontier [13]. A firm rich in exploration builds technology competences that facilitate ongoing radical product development pushing state of the art, while a firm that consistently employs its prior technological knowledge and experience on former radical innovations will tend toward more exploitation [13]. As such, it is proposed that

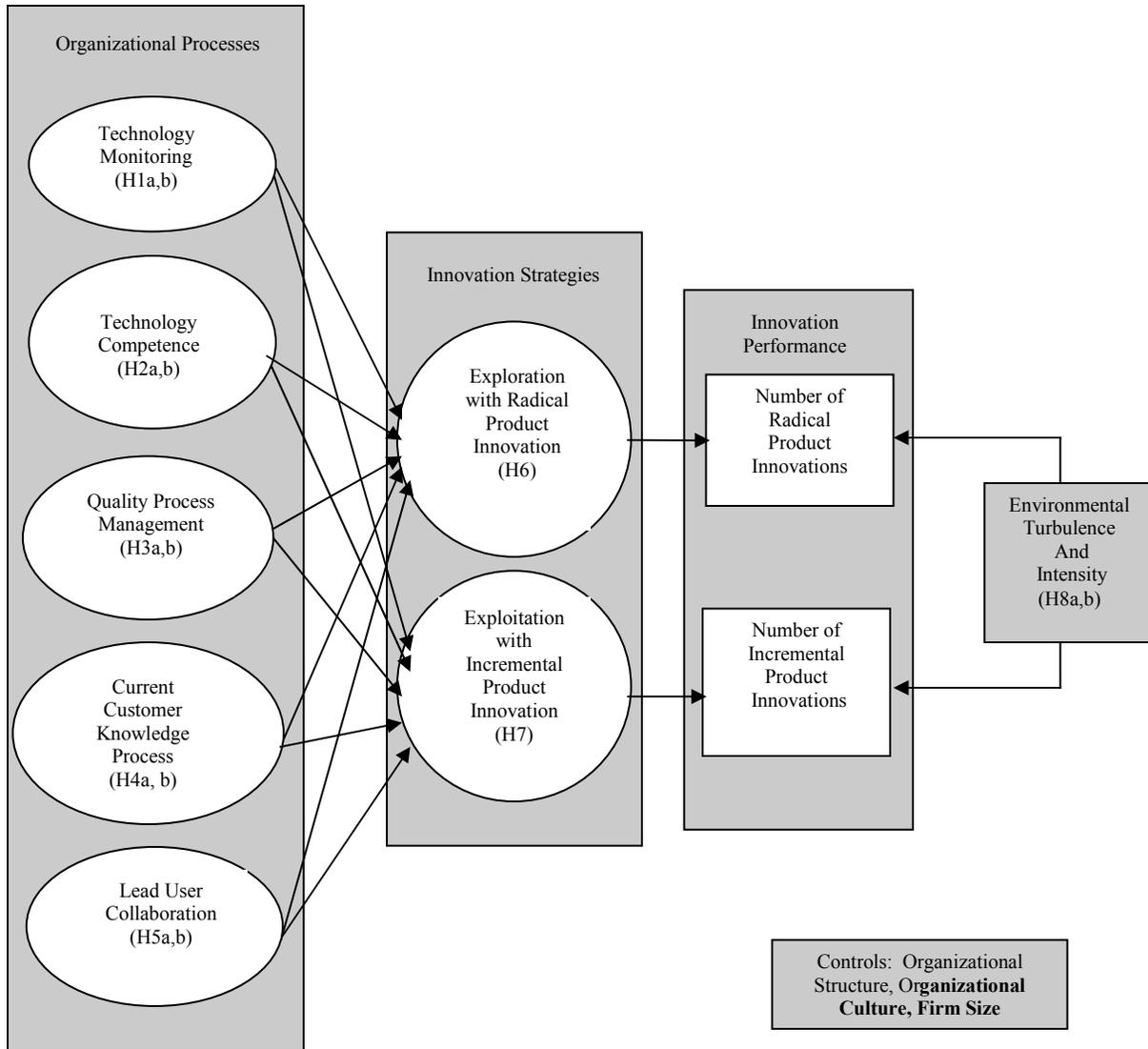


Fig. 1. Model of organizational process influence on innovation strategies and innovation performance consequences.

H2: a) The greater the degree of technology competence, the greater the degree of exploration with radical innovation. b) The greater the degree of technology competence, the lesser the degree of exploitation with incremental product innovation.

Quality Process Management

Quality process management is defined as process management techniques, such as ISO9000, employed to improve the efficiency of operational processes and reduce variance [2]. These techniques allow for higher quality and more reliable products and for standardization of products.

Past research indicates that increases of efficiency associated with process management also may reduce exploration as they elicit internal firm biases for certainty, predictability, and reliability [3]. Process management techniques that improve efficiency and decrease costs are prevalent in manufacturing operations, visibly evident in statistical tools and techniques [3, 24]. Repeatable processes allow organizations to easily create incremental improvements, faster and more cost effectively. The committed use of quality process management directs innovation strategy to greater exploitation and reduces overall exploration efforts [2]. Hence, it is posited that

H3: a) The greater the degree of quality process management, the lesser the degree of exploration with radical innovation. b) The greater the degree of quality process management, the greater the degree of exploitation with incremental product innovation.

Current Customer Knowledge Process

Current customer knowledge process is defined as a “set of behavioral activities that generates customer knowledge from current customers pertaining to their needs for new product innovations” [14, p. 14]. Customer involvement is critical to new product development (NPD). However, firms often rely too heavily on too few segments. Current customers, those in the center of the target market, are too familiar with existing products which impedes the ability to envisage exploratory attributes and uses [15]. Information collected and knowledge generated from current users, if implemented, often leads to R&D development based on the current firm technological trajectory, resulting in new product innovations that are highly incremental in nature while development of radical innovations is largely ignored.

H4: a) The greater the degree of current customer knowledge process, the lesser the degree of exploration with radical innovation. b) The greater the degree of current customer knowledge process, the greater the degree of exploitation with increment product innovation.

Lead User Collaboration

Lead user collaboration is defined as a set of behavioral activities that generates knowledge from lead users pertaining to their current and potential needs for new product

innovations [33]. Lead users are highly motivated to initiate development of or to co-develop an innovation that meets their futuristic needs and one that they believe will ultimately lead to their own profit or gain. Second, they experience product needs ahead of the majority market [31, 32]. Accordingly, lead users are known to be best at stretching the firm with new ideas for radical innovation [15]. It is proposed that lead user collaboration increases exploration, but has a negative impact on exploitation.

H5: a) The greater the degree of lead user collaboration, the greater the degree of exploration with radical innovation. b) The greater the degree of lead user collaboration, the lesser the degree of exploitation with incremental product innovation.

Influence of Innovation Strategies on Performance

The overwhelming majority of innovation research indicates that innovation is good for a firm [18]. While incremental innovation increases short term gains, radical innovation increases long term gains. In a previous study, the author found a positive interaction between exploration and exploitation in product innovation on financial firm performance which supports the notion that strategic ambidexterity leads to greater firm performance than firms operating in exploration or exploitation [27]. This study looks at firm performance in terms of number of respective innovations that each strategy, that is, exploration and exploitation, reaps. Logically, each innovation strategy should have a positive relationship with the related number of innovations.

H6: The greater the degree of exploration with radical product innovation, the greater the number of radical innovations.

H7: The greater the degree of exploitation with incremental product innovation, the greater the number of incremental product innovations.

Environmental Turbulence

In this study, market turbulence is defined as the “rate of change in the composition of customers and their preferences” [12, p. 57] while technological turbulence is the “rate of technological change” [12, p. 57]. Competitive intensity is the degree of competitiveness with respect to competitor ability, resources, and behavior to differentiate their products [12]. Environmental turbulence highly impacts innovation, particularly turbulence in markets and technology [1, 5]. Additionally, competitive intensity impacts innovation and performance by propelling firms to increase innovation efforts [27, 28, 29].

Industry life cycle research [28, 29] recognizes the strong connection between environment and type of innovation, noting that early in the industry life cycle when technological turbulence is high, the market is uncertain, and competitive intensity is increasing, more radical innovations enter the

market. However, when the industry cycle is characterized by low turbulence in market and technology and a reduced competitive intensity, successful firms often turn to incremental innovations such as product improvements, product line extensions, and imitations [16].

H8: a) The greater the degree of environmental turbulence and intensity, the greater the number of radical product innovations. b) The greater the degree of environmental turbulence and intensity, the lesser the number of incremental product innovations.

RESEARCH METHODOLOGY

Data collection

Survey research was chosen as the most appropriate avenue for this study. Considering the need to understand firm survival through exploration and exploitation of product innovation, the sampling frame consisted of manufacturers, with a minimum firm age of five years, from industries in the environmentally dynamic US high technology sector. Using the American Electronics Association (AEA) definition of a high technology industry [21] and the corresponding North American Industrial Classification System (NAICS) codes for manufacturers, nine high technology manufacturing industries were chosen for this study (photonics, computer and peripherals, communication equipment, consumer electronics, electronic components, electromedical equipment, defense electronics, and measuring/control).

Both public and private corporations for the sampling frame were drawn from CorpTech, Directory of Technology Companies. The intended respondents were upper echelon chief executive officers and vice presidents at the corporate level. Common method bias was controlled by surveying two respondents per firm (where possible), by using the suggested questionnaire improvement techniques described in [27] and by collecting secondary data on firm-specific variables.

All scales had a five-point scoring format (1=strongly disagree; 5 = strongly agree) and were chosen based on their relevance to this research and their successful use previous research in terms of reliability and validity. Specifics on scales used and questionnaire development, pretest, and implementation are outlined in [27]. Ref. [4] was also employed for questionnaire construction and implementation targeting executive populations.

Methodology

At the firm level, 1000 corporations were contacted via a three-wave mailing. 123 firms were not available or could not participate. From the effective sampling frame of 877 firms, 246 firms responded for an effective firm response rate of 28%. Although attempts were made to contact two executives per firm, surveys from both the CEO and second-level executive were received from only 11 firms.

The measurement model was assessed by examining factor loadings, individual item and composite reliability, and discriminant validity. Item reliabilities were assessed by examining loadings of the measures on their respective constructs. Items less than .7 were reviewed for theoretical importance and retained if appropriate. Measurement statistics included a measure of composite reliability, internal consistency (ρ_c), to assess construct validity. Overall, the measures demonstrate good reliability with composite reliabilities range from .77 to .96. With respect to discriminant validity, the square root of the average variance extracted was greater than all corresponding correlations for the construct being assessed. Second, examination of the factor loadings indicated that no item loaded more highly on another construct than it did on its associated construct. Refer to [26] for details on and references for item loadings, internal consistency and average variance extracted calculations.

Tests of Hypotheses and Results

Hypotheses were tested by ordinary least squares (OLS) regression for the dependent variables of exploration and exploitation and by negative binomial regression using log-link function for the dependent variables of radical and incremental innovation count. Results of the hypotheses tests using OLS are reported in Table II and those of the negative binomial regression in Table III.

Results supported the hypothesis that technology monitoring led to greater exploitation (H1b: $\beta = .310$, $p < .01$) and weakly supported that it also led to greater exploration (H1a: $\beta = .109$, $p < .10$). Technology competence led to greater exploration (H2a: $\beta = .190$, $p < .01$) and also led to less exploitation in incremental product innovation (H2b: $\beta = -.169$, $p < .01$). These results verify earlier research efforts that firms with a high technology competence that approaches and pushes the technological frontier are less apt to exploit with incremental product innovation.

Quality process management was proposed to positively impact both types of exploitation, but negatively impact exploration. Results supported the hypothesis that quality process management led to greater exploitation with incremental product innovation (H3b: $\beta = .227$, $p < .01$). Results did not support the hypothesis that it led to less exploration although the direction held (H3a: $\beta = -.054$, $p > .10$). Results supported the hypothesis that current customer knowledge process led to greater exploitation (H4b: $\beta = .136$, $p < .05$) but did not support that it decreased exploration (H4a: $\beta = -.032$, $p > .10$) although the direction held. Lead user collaboration led to greater exploration (H5a: $\beta = .200$, $p < .01$) but not to less exploitation in incremental product innovation (H5b: $\beta = .050$, $p > .10$). Lastly, the adjusted R^2 for each endogenous construct was .13 for Exploration with Radical Innovation and .18 for Exploitation with Incremental Product Innovation.

TABLE II
SUMMARY OF HYPOTHESES TEST RESULTS BY OLS

Exogenous Variables	Endogenous Variables	Hypothesis	Beta Coefficient (t-value)	Result
Technology Monitoring	Exploration of Radical Innovation	H1a	.109 (1.436)*	Weakly Supported
	Exploitation of Incremental Product	H1b	.310 (4.225)***	Supported
Technology Competence	Exploration of Radical Innovation	H2a	.190 (2.520)***	Supported
	Exploitation of Incremental Product	H2b	-.169 (-2.32)***	Supported
Quality Process Management	Exploration of Radical Innovation	H3a	-.054 (-.829)	Not Supported
	Exploitation of Incremental Product	H3b	.227 (3.614)***	Supported
Current Customer Knowledge Process	Exploration of Radical Innovation	H4a	-.032 (-.432)	Not Supported
	Exploitation of Incremental Product	H4b	.136 (1.921)**	Supported
Lead User Collaboration	Exploration of Radical Innovation	H5a	.200 (2.649)***	Supported
	Exploitation of Incremental Product	H5b	.050 (.683)	Not Supported

*p<.10 (one-sided), **p<.05 (one-sided), ***p<.01 (one-sided); R²: Exploration (.13); Exploitation (.18)

TABLE III
SUMMARY OF HYPOTHESES TEST RESULTS BY NEGATIVE BINOMIAL REGRESSION

Exogenous Variables	Endogenous Variables	Hypothesis	B Coefficient [Standard Error]	Results
Intercept	Number of Radical Product Innovations		-3.233 [.7139]***	
Exploration of Radical Product Innovation		H6	.342 [.1086]***	Supported
Environmental Turbulence and Intensity		H8a	.270 [.1179]***	Supported
Organizational Structure (Control)			.189 [.0957]**	
Organizational Culture (Control)			.075 [.1262]	
Firm Size (Control)			.647 [.1039]***	
Intercept	Number of Incremental Product Innovations		-3.073 [.7130]***	
Exploitation of Incremental Product Innovation		H7	.799 [.1297]***	Supported
Environmental Turbulence and Intensity		H8b	-.084 [.1164]	Not supported
Organizational Structure (Control)			.131 [.0956]	
Organizational Culture (Control)			.002 [.1209]	
Firm Size (Control)			.935 [.0988]***	

*p<.10 (one-sided), **p<.05 (one-sided), ***p<.01 based on Wald chi-square with 1 df.

The negative binomial regression model predicting number of radical product innovations was statistically significant with a likelihood ratio chi-square of 82.541, $df = 5$; p -value of $<.0001$. Similarly, the negative binomial regression model predicting number of incremental product innovations was statistically significant with a likelihood ratio chi-square of 190.733, $df = 5$; p -value of $<.0001$. The hypotheses that the exploration strategy has a positive impact on number of radical innovations was supported (H6: $B = .342$, $p < .01$) and exploitation strategy of incremental product innovation has a positive impact on number of incremental innovations was supported (H7: $B = .799$, $p < .01$). The impact on environmental turbulence and intensity on innovation performance in terms of number of radical innovations was positive and significant (H8a: $B = .270$, $p < .01$) but not significant for a lesser number of incremental product innovations (H8b: $B = -.084$, $p > .10$), but the direction held. For controls, the influence of firm size on innovation performance was significant for both innovation count dependent variables and the organizational structure in terms of a looser, informal environment had a positive significant impact on the number of radical innovations.

Post hoc testing to assess the impact of each industry studied was critical to assess which industry exhibited elements of both exploration and exploitation. A statistically significant relationship between industry and both types of innovation in terms of count should be an indicator of strategic ambidexterity at the industry level. The industries of semiconductor, communications equipment, electronic components, electromedical, and defense electronics had statistically significant positive links to the number of radical innovations, however had lesser numbers relative to the reference category of measuring and control. Consumer electronics and electronic components had statistically significant links to the number of incremental innovations and greater number relative to the reference industry of measuring and control. Furthermore, the electronics components industry had both radical and incremental innovations. Due to cell size differences, these results should be considered exploratory in nature, but are a first step toward providing an industry view of ambidexterity.

DISCUSSION AND MANAGERIAL IMPLICATIONS

The ability of firms to accomplish both exploration and exploitation in innovation is challenging, but rewarding. The accomplishment of ambidexterity in innovation, was, and remains today, a perplexing and challenging task for many firms in the competitive high technology climate. This is made apparent by the continued multidiscipline calls by academia and practitioners for further study of this area.

The fact that the majority of firms in this study are between 5 and 49 years old is indicative of firm survivability in a turbulent and competitively intense environment. One route to increase survivability is via ambidexterity in exploration and exploitation. Both structure and culture have been shown to positively influence organizational

ambidexterity, however no research has been conducted with respect to impacts of organizational processes on ambidexterity. As such, two key research questions drove this empirical study: *How do opposing organizational processes influence strategic ambidexterity in innovation? And what, if any, processes play a dual role in exploration and exploitation?*

As this research indicates, technology monitoring positively impacts not just exploration, but also exploitation. As such, this process is extremely invaluable to ambidexterity. Firms that actively incorporate this process in their activities will not hinder ambidexterity in innovation, but help it. On the other hand, firms high in technology competence that push the technological frontier without considering smaller incremental technology advances will hinder exploitation efforts, thereby deterring ambidexterity efforts in its wake if leadership is not conscious of its impact. Lead user collaboration increased exploration but current customer knowledge process increased exploitation. Because of this, management must take a proactive approach with the firm's customer base and address the product needs of its current customers, but prepare for the future by collaborating with lead users concurrently. Quality process management positively influenced exploitation and remains a necessary process for increased effectiveness and efficiency.

As aforementioned, technology monitoring likely plays a dual role in strategic ambidexterity. However, managers will find that the remaining processes will push and pull for resources as they are a means to different innovation ends. High technology firms desiring strategic ambidexterity in innovation should first examine organizational processes that aid in critical dynamic capability roles of coordination and integration, learning, and reconfiguration and transformation. Firms should employ high levels of all processes studied but must also be savvy as to which processes naturally oppose and be prepared for the tension it creates in strategy and decision-making, in resource allocation, as well as firm competences.

Environmental turbulence and competitive intensity had the greatest positive impact on radical innovation. Future tests can include separation of competitive intensity, market uncertainty, and technology uncertainty to study which of these environmental issues were of greatest importance to innovation in these industries. Lastly, post hoc tests revealed a potential industry bias toward exploration or exploitation. Only the electronic components industry showed a positive significant influence on both radical and incremental product innovation. However, additional testing is prudent before more stable results can be discussed. Cell sizes were uneven and alternate distributions for innovation count, such as Poisson, should be addressed.

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