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**Role of Innovative Behavior and Bricolage in New Product
Development Process within Hi-Tech Firms**

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ABSTRACT

The purpose of this study was to examine the role of bricolage in new product development (NPD) within organizations. The results of a survey carried out among 117 product development managers from 3 organizations in hi-tech domain demonstrated that innovative behavior was positively related to performance (outcomes and efficiency) but via positive mediated effect of bricolage within new product development projects.

The contribution of the study is threefold, being the first of its kind to test linkages between innovative behavior and performance, to test empirically and quantitatively the role of bricolage in established firms and third by providing evidence in NPD processes through an individual perspective. This research shows how crucial innovative behavior and bricolage are for performance within firms in creative processes of NPD. The results highlight importance of merging behavioral perspective with resource-based perspective within NPD, and the importance of selection and utilization of available firm-resources.

Keywords: New product development, bricolage, innovative behavior, structural equation model

INTRODUCTION

New products fuel organization's competitive advantages and profitability (Leonard-Barton, 1992). Within the developing literature of new product development, scholars have explored personality traits, perceived creativity, identities on individual levels and organizational support, capabilities, culture, and routines on the firm levels (Sivasubramaniam et al., 2012; Gupta & Wilemon, 1990). However, how behavior translates to actual activity and performance within NPD remains scholarly unexplored. There is a dearth of studies that link behavioral perspective with actions and performance blurring the understanding of this core underlying process of creation. How many resources are available for product development has been highlighted in earlier research (Brown & Eisenhardt, 1995). How resources were chosen and utilized to create value, though, still remains much unexplored.

This study examines the NPD process within which we study how individual innovative behavior impacts performance (efficiency and outcomes) through bricolage. Bricolage is defined as creating newer combinations and resources out of available things at hand (Fisher, 2012). We explore, within the context of R&D divisions in new product development processes in large firms: (1) how innovative behaviors, through idea generation and idea facilitation, invoke bricolage actions and (2) how bricolage influences the performance in NPD and (3) impact of innovative behavior of employees on NPD performance via mediating role of bricolage. These explorations also lead us to in-depth examine bricolage, a construct that describes resource set invoked by improvisation. Studied extensively within entrepreneurship and young firms, this research examines the role of bricolage within the setting of established large firms.

THEORETICAL BACKGROUND

Although management scholars agree that technological developments have major social and economic effects, the actual processes through which they evolve still remain unclear (Miner et al., 2001). What is challenging for scholarship in the area of technology innovation and management is viewing the process of developing new products through a plan-and-execute perspective (Cooper, 2001). However, NPD is explored further to be found far more complex and non-linear in nature where there are political, controversial and uncertain dimensions associated to it (Gokpinar, Hopp

& Irvani, 2010). The importance of NPD in organizations remains undisputed but hard pressed now more than ever due to overall economic scenario.

Scholarship shows that in organizations with abundant resources available for their innovation activities, innovation may be hindered due to too much available out there to work with and resources get wasted (Hippel, 2009; Lee, Park, Yoon and Park, 2010). On the other hand, too many constraints and lack of resources in organizations hinder and slow down innovation as well, hence, making it important for firms to focus on the middle path (Lee et al., 2010). Hence, on that middle, though unarticulated, path of development, the scholars have been emphasizing so far on the extent of availability of resources for innovation. Though availability of resources plays a role in innovation, the process underlying how and which resources were utilized to create the new product has remained opaque so far.

Organizations play a key role in providing the resources but it is the individuals who choose and utilize those resources to actually break and cross the existing firm routines for creation of newer patterns. This transformation of existing firm resources into unique and novel solutions is what creates value and is the key to new product development. Hence, the process of transformation starts with individuals, travels through the labyrinth of organizational dimensions when the idea is created and developed. And finally, the process ends with the idea being realized into a form of an actual product output. Since this process of development is non-linear, uncertain and emerging, it is unnatural to segregate role of individual innovative behavior from role of resources.

Applying bricolage perspective, we study new product development process in established firms with focus on individual employee behavior and resource utilization. NPD performance is an interesting setting to study effects of employee behaviors and organizational resources due to its dimensions of uncertainty and required novel creation. This research setting is, in particular, interesting to study bricolage because (1) “re-invention” of resources is crucial in developing new products in established firms and (2) creation of value from existing resources is important to both young and established firms to be competitive.

This research aims to contribute to the field of NPD and growing literature in bricolage by providing a cross-sectional view using both behavioral and resource perspective. The study uses empirical and quantitative methodology to test hypotheses and exploring the unique setting of established firms and NPD to study bricolage. Earlier bricolage studies were focused solely on entrepreneurs, young small firms and entrepreneurs. This study has a novel approach to explore the role of resources in NPD with unique perspective of utilization of resources rather than extent of resource constraints.

HYPOTHESES DEVELOPMENT

New product development and innovation require complementary resources (Teece, 1986), specialized knowledge and absorptive capacities (Cohen & Levinthal, 1990), and organizational as well as systemic support for creation and facilitation (Olson et al., 2001). Established and resource-rich firms do not necessarily reflect on organization's ability to develop innovations (Enkel, Gassmann & Chesbrough, 2009). Scholarship in the field of new product development and innovation represents a curvilinear relationship between resource availability and ability to develop innovation (Geiger and Cashen, 2002). But there is an acute shortage of studies on the question of how resources are selected and utilized rather than merely extent to which they are being made available. For example: large established firms operating in similar industry contexts will have similar resources available to them (Ndofor & Sirmon, 2011). However, not necessarily, they will produce and have similar innovations (Geiger and Cashen, 2002).

Further looking into the process of selection and utilization of resources, intentional initiatives and efforts of employees involved are required to convert existing assets at hand, through novel ideas and to reinvent those assets, into innovation. Such intentional efforts may include (not limited to) searching out new technologies and current market trends, ability to suggest or develop new work methodologies and investigating, choosing and applying resources for new idea implementation (Yuan & Woodman, 2010). This complex behavior has been conceptualized as individual innovative behavior consisting of actions pertaining to generating/introduction and realization or implementation of new ideas (Scott & Bruce, 1994). A related construct called creative behavior has been explored in scholarship previously, which refers to

behavior pertaining to generation of new and useful ideas (Oldham & Cummings, 1996). However, creative behavior can be considered as a subset of innovative behavior as the later extends itself to include both generation and implementation of novel and useful ideas (Shalley et al., 2004). Much out of the limited literature in the area of selection and utilization of resources discusses routines and capacities in organizations.

For performance related gains at workplaces, employees at workplaces innovate. On the other hand, in organizations, employees working within NPD are hired to think and behave innovatively. Either way, the novel ideas and newer working methods are expected to improve performance, efficiency and overall work outputs. This efficiency-oriented perspective has been so far dominating the field in innovation literature (Wolfe, 1994; Yuan & Woodman, 2010). So far, in existing literature, very few studies explain effects of innovative behavior and improvisation. Their effects on performance, efficiency and outcomes have been implicitly assumed to be positive rather than explicitly studied through empirical evidence. This is especially true for NPD literature where expected gains are assumed and innovation gains are perceived.

There are many ways to measure NPD performance in academia and industry such as number of publications and patents (Yuan & Woodman, 2010). NPD outcomes are “benefits in terms of newly acquired experiences and competencies and the perceived value and future potential of the output” (Brettel et al., 2012). We adopt this broader definition to study NPD outcomes in this study. While developing new products, daily activities of employees and their behavior are supposed to result in value creation and novel products. The importance of employee’s intentional efforts to innovate can be explored in previous studies (Janssen, 2000). Behaving innovatively results in indulging in newer work patterns and constantly rethinking what can be done differently to create value. Now each new product requires a new workflow in terms of actual development. The workflows maybe similar in cases of similar products but they require slightly different approaches and resource-sets. These activities require employees in NPD to be intensively knowledgeable about their work-domain.

As similar sets of resources are available to them within the organizational boundaries for value creation, this knowledge helps the employees to progress in development process. Innovative behavior also provides the employees with ideas about how to re-

use resources over and over again. Employees, hence, not only require work-domain knowledge for product development, they also are required to improvise and re-invent their bundle of resources constantly to continue to develop new products. Obviously, without actions and actual work progress, the innovative behavior might not always result in value creation. Hence, we contend that, actual re-inventing of resources, also known as bricolage, ability to generate newer ideas and ability to facilitate those ideas in NPD, the employees are much likely to product “better” results in terms of NPD performance.

Hypothesis 1a. Idea generation behavior of NPD employees will positively affect on NPD outcomes.

Hypothesis 1b. Idea facilitation behavior of NPD employees will positively affect on NPD outcomes.

Hypothesis 1c. Bricolage actions will positively mediate the effect of idea generation behavior of NPD employees on NPD outcomes.

Hypothesis 1d. Bricolage actions will positively mediate the effect of idea facilitation behavior of NPD employees on NPD outcomes.

NPD efficiency “assesses the level of success in meeting schedule and budget goals, as well as the operational and technical performances of the process” (Brettel et al., 2012). All three dimensions of efficiency in this definition require effectively maintaining regular progress of workflow in NPD along with realistic use of budgets and allotted resources. To comply with them, employees of NPD need to be work creatively but practically. However, in pursuit of novel products, the development and implementation processes within NPD might not always conform to the target deadlines.

For any innovation, the firm may end up creating a product that is unique and has not existed before. In case of NPD, this is especially true and new products generally will provide either a novel solution to an existing problem or a new application. However, pre-existing organizational benchmarks including technical and operational standards might not be applicable to a new product as the benchmarks are based on existing products and products similar to them. Apart from behavior alone, the more the

employees engage in bricolage, the more the chances are that employees are unable to stick to pre-defined deadlines and operational and technical standards. Hence, we argue that innovative behavior, idea generation and idea facilitation, of employees in NPD should have negative impact on efficiency and bricolage will further strengthen that effect.

Hypothesis 2a. Idea generation of NPD employees will negatively affect on NPD efficiency.

Hypothesis 2b. Idea facilitation of NPD employees will negatively affect on NPD efficiency.

Hypothesis 2c. Bricolage actions will positively mediate the effect of idea generation behavior of NPD employees on NPD efficiency.

Hypothesis 2d. Bricolage actions will positively mediate the effect of idea facilitation behavior of NPD employees on NPD efficiency.

MODEL

INSERT FIGURE 1 HERE

INSERT FIGURE 2 HERE

INSERT FIGURE 3 HERE

INSERT FIGURE 4 HERE

METHODS

Sample and Procedures

We surveyed 250 full time employees from 3 multinational companies who are managers and key decision-makers in NPD in Research & Development divisions of the organizations. Their NPD offices were based in India and their R&D centers developed products for telecommunication, gaming products, networking and hardware industry sectors. Questionnaires were administered via company mail and completed surveys were mailed back directly to us. In total, we received 143 surveys constituting a response rate of 57%. Our final sample of $n = 117$ includes managers and decision-makers of NPD who have successfully developed at-least one product. The average age range of respondents was 34.75 years and 82% of the respondents were men. 76.5% respondents had higher graduate degrees (Master's and PhD) while rest of the respondents had bachelor's degrees. Their average tenure in their current organizations was 4 years 5 months; their average tenure in their current job position was 1 year 8 months. Their average work experience for their careers was an average of 12 years.

MEASURES

All the measures used a response scale in which 1 indicated strongly disagree and 7 indicated strongly agree, unless otherwise indicated in the scale. Appendix C (table 5) gives all the items for measurement scales.

Idea generation and Idea facilitation - Innovative Behavior. This variable was measured by 9-items ($\alpha = 0.84$ and 0.89 respectively) innovative behavior scale given by Janssen (2004). Each participant reported how characteristic each behavior is to their own behavior, being rated on a scale ranging from 1, not at all characteristic, to 7, strongly characteristic. Following Janssen (2004), we initially combined all 9 items to create an overall scale of innovative behavior. However, we kept in mind that the original scale was intended to capture three different behaviors but Janssen's original study loaded all items on one single factor. The different behaviors highlighted by Janssen within innovative behavior were idea generation, idea promotion and realization. Through literature, we were able to see several overlaps between the latter two behaviors in NPD. During exploratory and confirmatory factor analyses, we

continued our analyses with idea generation and idea facilitation, instead of combining all items and loading them on a single factor of innovative behavior. Hence, we were able to highlight idea generation and idea facilitation as two distinct behaviors that form innovative behavior.

Objective measures of innovative behavior were not obtainable as several of the indicators (for example: number of publications, reports and patents) were largely unavailable for the diverse employee sample used in this study.

Bricolage. Bricolage has been measured by bricolage scale by Senyard et al. (2010) with 8 items ($\alpha = 0.79$) asking the NPD employee to highlight the extent to which they were indulged in bricolage activity during the process of their last completed new product development project. We requested the organizations to provide us access to all the employees of NPD who were in leadership or decision-making positions within NPD. This way, our entire sample had responses by those who were involved in development process and who had knowledge about how resources were allocated, requested or utilized in the last completed NPD project.

New Product Development Performance - NPD Efficiency and NPD Outcomes. We measured efficiency and outcomes in NPD using 3 items and 6 items ($\alpha = 0.75$ and 0.86 respectively), scale given by Brettel et al. 2012. Both of these performance measures were requested on the basis of their last NPD project, the same way as responses to bricolage scale were requested. This way, we had responses from employees in NPD reporting about their last completed NPD project only, instead of multiple or ongoing projects that were due for completion in future.

Control Variables. We controlled for age and gender of employees in NPD along with their formal educational backgrounds, total work experience, total organizational tenure and their tenure within NPD of the firm. We measured education level, organizational tenure, and NPD tenure to control for the knowledge the employee can draw on to innovate (Scott & Bruce, 1994). Table 1 shows coding of data for education level. Several respondents in the sample had NPD experience in multiple organizations apart from their present organization. Hence, we controlled for their total work experience as well to control for the knowledge that the respondent can draw upon to innovate from earlier experience.

RESULTS

Table 1 reports the means, standard deviations and correlations for all variables. The numbers in parentheses on the diagonal represent cronbach alpha for the scales wherever relevant. We tested the hypothesized paths in our theoretical model (see figure 1 and 2) with structural equation modeling by submitting raw data to IBM AMOS software, version 20.

INSERT TABLE 1 HERE

We find support for hypotheses 1c and 2c but we do not find support for hypotheses others in our analyses (see Table 2). With and without mediation paths in the model, hypotheses 1a, 1b, 2a and 2b were not supported meaning that idea generation and idea facilitation behaviors do not impact NPD efficiency and NPD outcomes. However, we did find the impact of idea facilitation behavior on NPD efficiency is positive at significance level of 0.10. The significance level is quite low but clearly, the idea facilitation behavior has little positive influence on NPD efficiency. This can be mostly because facilitation behavior improves efficiency by providing support for the development process in keeping up with timelines, budgets and keeping up with technical and operational standards.

INSERT TABLE 2 HERE

When our results showed us that 3 main direct effects were not significant, we ran our model again through the AMOS software to see what changes in the model for the mediated relationships when we remove the direct effects (see figure 3 and 4). As direct effects were not significant, we further explored indirect-only mediation effects Zhao et al. (2010) which is a form of mediation that is consistent with full mediation in Baron and Kenny's (1986) procedure. In short, indirect-only mediation is exactly what its name suggests; the mediated effect exists but no direct effect. Table 3 and Table 4 provides us with details of indirect-only mediated effects with significance levels using product of coefficients test based on MacKinnon et al., 2002. This is done to supplement the test of joint significance of alpha and beta. The control variables did not affect the findings for direct effects as well as indirect-only mediated effects.

INSERT TABLE 3 HERE

INSERT TABLE 4 HERE

With hypotheses 1d and 2d, our analysis showed the exact opposite and significant results. Similar to impact on NPD outcomes, we found that idea generation and idea facilitation behaviors had positive, indirect-only mediated effects through bricolage on NPD efficiency. These effects clearly show that innovative behaviors mediated through bricolage activities have positive influence on NPD efficiency. This is because NPD employees behaving and working innovatively in the process are able to do well in terms of budgeting, timelines and performance standards in the organization. These results did not change and had no influence from control variables, age, gender, work experience, organizational tenure and NPD job experience. Hence, we now clearly see from our analyses that innovative behaviors influence NPD outcomes as well as efficiency through indirect-only mediation effects of bricolage. Innovative behaviors, alone, are not seen to be influencing NPD performance until and unless supported by bricolage activities during NPD process.

DISCUSSIONS & CONTRIBUTIONS

This study is the first attempt to examine how the innovative behaviors in firms influence actions and performance. We found that the innovative behavior mediated by bricolage actions support performance in NPD within firms after we controlled for age, gender, educational background, work experience, organizational tenure and NPD tenure within the present firm where the respondent is still employed. In particular, we brought together two major theoretical perspectives (behavioral and improvisation perspective) to examine the NPD process and antecedents of NPD performance.

The evidence and results in this research clearly challenge the assumptions behind efficiency perspective in literature where organizing, routines and standardized processes are supposed to be the most efficient way of working in firms. Our study clearly indicates that in contexts of NPD, novel ways of thinking and working support efficiency as well as outcomes. The study also clearly shows that without bricolage

actions, the behaviors solely do not influence performance. Earlier scholarship has studied the impact of bricolage and how bricolage can enhance organizational resources and entrepreneurial performance. Other roles of bricolage have not been explored previously. Bricolage has been studied extensively in entrepreneurship and young organizations. However, no previous work extends theory of bricolage to the context of NPD and innovation. This study is the first attempt to study innovative behaviors and bricolage actions in product development processes in established firms. Along with this, there is a dearth of quantitative studies in the field of bricolage. This study is one of the first ones who quantitatively explore the role of bricolage.

This study also further explores and argues about the dimensions of innovative behavior. Since it's a multi-dimensional construct, our analyses showed the relative strengths of impact of idea generation behavior and idea facilitation on NPD performance. We see that idea generation behavior has a bit stronger impact when compared to idea facilitation behavior. We see the need for further empirical works required to explore NPD processes and performance to get holistic understanding about the area. The scholarship also needs to bring more quantitative evidence and in-depth qualitative works to highlight success and failure factors within NPD. Due to the nature of its relationship, NPD area will directly impact our understanding about innovations within firms.

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APPENDIX A

Figure 1. Model for dependent variable, NPD outcomes, with direct effects

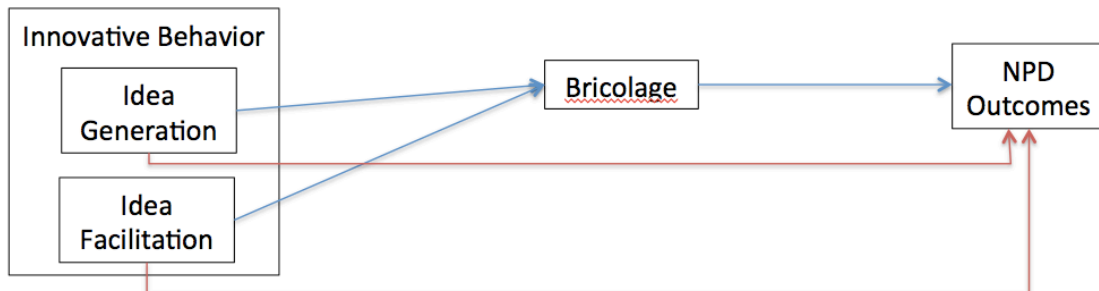


Figure 2. Model for dependent variable, NPD efficiency, with direct effects

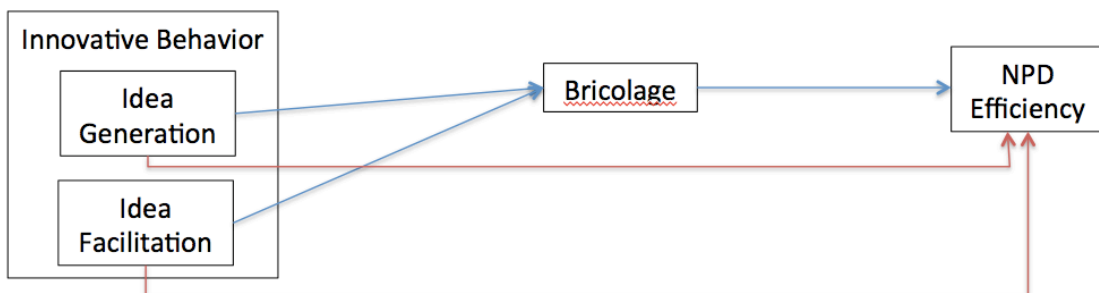


Figure 3. Model for dependent variable, NPD outcomes, with no direct effects

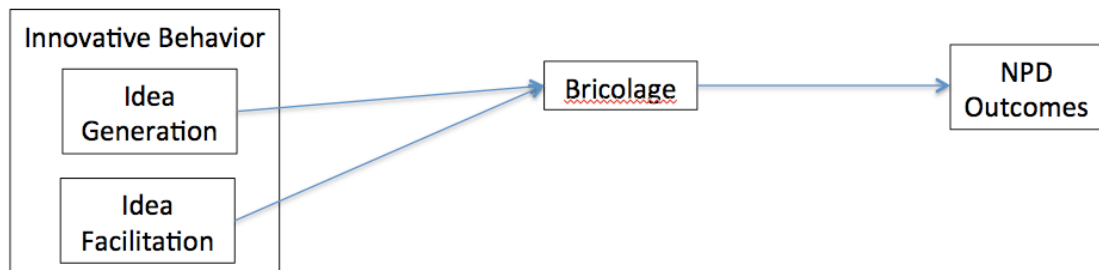
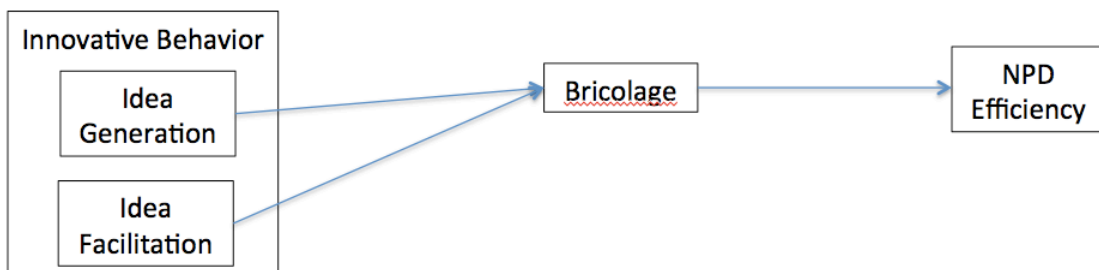


Figure 4. Model for dependent variable, NPD efficiency, with no direct effects



APPENDIX B

TABLE 1. Means, Standard Deviations and Correlations^a

	Variable	Mean	S.D.	1	2	3	4	5	6	7	8	9	10
1	NPD Efficiency	15.44	2.81	(0.75)									
2	NPD Outcomes	32.05	4.61	.540**	(0.86)								
3	Bricolage	5.55	0.78	.397**	.562**	(0.79)							
4	Idea Generation	5.48	0.85	0.11	.291**	.475**	(0.84)						
5	Idea Facilitation	5.12	0.87	0.14	.327**	.394**	.530**	(0.89)					
6	Age	34.75	5.55	0.09	0.14	.231*	0.19	0.15					
7	Gender	0.82	0.38	0.15	0.15	.260**	.207*	0.12	.302**				
8	Education ^b	1.93	0.76	0.00	-.25**	-.35**	-.37**	-.28**	-.44**	-.19*			
9	Total work experience	149.00	56.33	-0.06	0.01	0.10	0.18	0.16	.889**	.297**	-.414**		
10	Organizational tenure	52.93	30.27	.207*	.282**	0.07	-0.05	0.04	0.05	0.10	0.05	0.01	
11	Current job tenure	21.20	16.97	0.04	0.08	-0.01	-0.17	-0.17	0.11	0.10	.206*	0.08	.310**
	n			117	117	117	117	117	99	112	115	113	114

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

a. n = 117. Where relevant, Cronbach's coefficient alphas are given on the diagonal in parentheses

b. Education was coded as follows: 1: PhD, 2: Master's, 3: Bachelor's and 4: Others

TABLE 2. Standardized Estimates and Significance level – Model with direct effects using joint significance of α and β test

Path	Hypothesis	Standardized Estimate
<i>Main Effects (see figure 1 & 2, main effect relationships are highlighted in red color)</i>		
Idea Generation ® NPD Outcomes	H 1a	0.03
Idea Facilitation ® NPD Outcomes	H 1b	0.07
Idea Generation ® NPD Efficiency	H 2a	-0.02
Idea Facilitation ® NPD Efficiency	H 2b	0.15†
<i>Model with direct effects (see figure 1 & 2)</i>		
<i>Mediator: Bricolage</i>		
Idea Generation ®Bricolage	H 1c	0.26*
Bricolage ®NPD Outcomes		0.43***
Idea Generation ®Bricolage	H 2c	0.26*
Bricolage ®NPD Efficiency		0.40***
Idea Facilitation ®Bricolage	H 1d	0.17*
Bricolage ®NPD Outcomes		0.43***
Idea Facilitation ®Bricolage	H 2d	0.17*
Bricolage ®NPD Efficiency		0.4***

† represents $p < 0.10$
 * represents $p < 0.05$
 ** represents $p < 0.01$
 *** represents $p < 0.001$

**TABLE 3. Standardized Estimates and Significance level – Results of Hypothesized paths
Model with direct effects**

Path	Hypothesis	Standardized Estimate
<i>Model with no direct effects (see figure 3 & 4)</i>		
Mediator: Bricolage		
Idea Generation ®Bricolage	H 1c	0.26*
Bricolage ®NPD Outcomes		0.50***
Idea Generation ®Bricolage	H 2c	0.26*
Bricolage ®NPD Efficiency		0.42***
Idea Facilitation ®Bricolage	H 1d	0.17*
Bricolage ®NPD Outcomes		0.50***
Idea Facilitation ®Bricolage	H 2d	0.17*
Bricolage ®NPD Efficiency		0.42***

† represents $p < 0.10$
 * represents $p < 0.05$
 ** represents $p < 0.01$
 *** represents $p < 0.001$

TABLE 4. Results of the Product of Coefficients Test on Indirect Effects Mediated through Bricolage^a

Mediator	Independent Variable	Dependent Variable	Indirect-Only Mediated Effect^b	P
Bricolage	Idea generation	NPD Outcomes	0.11 ^{*c}	13.80
		NPD Efficiency	0.10 ^{*c}	10.51
	Idea facilitation	NPD Outcomes	0.07 ^{*c}	9.02
		NPD Efficiency	0.07 ^{*c}	6.87

^a The MacKinnon et al. (1998) distribution of products $P = z_{\alpha}z_{\beta}$ method is used to test the significance of mediated or indirect effects as recommended by MacKinnon and colleagues (2002); z_{α} = path coefficient for path α divided by its standard error; z_{β} = path coefficient for path β divided by its standard error. The distribution of P follows the distribution of the product of two normal random variables from Craig (1936). The critical value is 2.18 for the .05 significance level.

^b The $\alpha\beta$ product.

^c Mediation effects found to be significant by both the joint significance of α and β test (see Table 2) and the product of coefficients test.

* $p < .05$

APPENDIX C

Table 5. Measurement scales used in this study*

Bricolage

We were confident of our ability to find workable solutions to new challenges by using our existing resources. We gladly took on a broader range of challenges than others with our resources would be able to. We used any existing resource that seemed useful to responding to a new problem or opportunity. When dealing with new problems or opportunities, we took action by assuming that we will find a workable solution. By combining our existing resources, we took on a surprising variety of new challenges. When we face new challenges, we put together workable solutions from our existing resources.

Idea generation and idea facilitation - Innovative Behavior

My attempt is to create new ideas for improvements and difficult issues. I get involved in searching out new working methods, techniques, or instruments. I attempt to generate original solutions to problems. I mobilize support for innovative ideas. I work towards acquiring approval for innovative ideas. I place efforts in making important organizational members enthusiastic for innovative ideas. I work towards transforming innovative ideas into useful applications. I introduce innovative ideas into the work environment in a systemic way. I evaluate the utility of innovative ideas.

NPD Efficiency

Meeting module schedule, Staying on budget, Meeting operational and technical performance of the R&D process

NPD Outcomes

Learning and expertise that can be leveraged in other modules, Generation of new ideas as starting point of potential future modules, Enhancement of competencies and capabilities, Perceived value of the R&D output, Opportunities to market R&D output, Quality and performance of the R&D output

*All the original scales were used during the pilot study and then exploratory factor analyses was used to identify the items that did not load. This table provides all the items after exploratory factor analysis. All items in all scales were retained except for two dropped items in bricolage.