

Delineating links among dynamic capabilities, operational capabilities and firm performance

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Abstract

Dynamic capabilities influence firm performance by renewing operational capabilities but it is unclear from prior studies whether they actually influence firm performance through operational capabilities. Process-quality, process-efficiency and operational flexibility capabilities are three operational capabilities. It is also unclear whether a given dynamic capability influences firm performance by renewing a single operational capability or several of them. Using a firm's capability to learn from customers as a proxy for a dynamic capability, we find that it renews all three operational capabilities, but a firm's learning capability influences firm performance only through the process-quality capability. We theorize that renewal of former two capabilities serve to maintain existing operations, while renewal of latter capability helps a firm gain an advantage. We term the capability that can be used to simultaneously maintain existing operations and influence performance a dual-purpose capability. Future research should expand to understand how dual-purpose capabilities influence performance.

Keywords: Capability-based view; Dynamic capabilities; Operational capabilities; Firm performance; Firm efficiency

1. Introduction

The primary premise of the dynamic capability framework is that a firm has both operational and dynamic capabilities. It argues that dynamic capabilities renew operational capabilities which in turn influence firm performance (Helfat, 2007; Helfat & Winter, 2011; Teece, 2007; Teece, Pisano, & Shuen, 1997; Winter, 2003). While operational capabilities are directly involved in converting inputs into outputs, dynamic capabilities help a firm to gain a competitive advantage by recombining, updating and reconfiguring (renewing) operational capabilities (Eisenhardt & Martin, 2000; Teece, 2009; Teece et al., 1997; Winter, 2003). Prior studies investigate how a single dynamic capability directly influences firm performance, assuming that the relationship is mediated by operational capabilities (Ambrosini & Bowman, 2009; Drnevich & Kriauciunas, 2011; Helfat, 1997; Karim & Mitchell, 2000; Lee, Venkatraman, Tanriverdi & Iyer, 2010; Moliterno & Wiersema, 2007; Sirmon, Hitt, Arregle, & Campbell, 2010). Other studies examine the effects of a single dynamic capability on a firm

capability, assuming that firm performance is influenced when a dynamic capability renews another capability (Mahmood, Zhu & Zajac, 2011; McEvily & Zaheer, 1999). Therefore, it is unclear from these studies if dynamic capabilities are actually influencing firm performance through operational capabilities. Even if dynamic capabilities do influence firm performance by renewing operational capabilities, it is also unclear from these studies whether they do so by renewing a single operational capability or several of them. To close this gap, we investigate the following two questions:

1. Do dynamic capabilities actually influence firm performance through operational capabilities as argued by the dynamic capability framework?
2. Supposing that the answer to the above question is yes, do dynamic capabilities influence firm performance by renewing a single operational capability or by renewing several of them?

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With regard to the first question above, it is critical to establish empirically that operational capabilities mediate the relationship between dynamic capabilities and firm performance to solidify the basic tenets of the dynamic capability framework. With regard to the second question, there are two key reasons it is essential to know if dynamic capabilities influence firm performance by renewing a single operational capability or several of them. First, this knowledge can help a firm to determine which dynamic capability should be employed to renew a given operational capability in order to influence firm performance. If a firm employs a dynamic capability that is not associated with a given operational capability, then it will not achieve a desirable performance in the marketplace. This study contributes to the strategic management field by showing the importance of knowing which operational capability or capabilities can be renewed by a given dynamic capability.

Second, this knowledge will allow a firm to conduct a cost/benefit analysis of the development of a dynamic capability. An important question in the management field is whether benefits obtained by a firm from a given dynamic capability outweigh the cost of developing it (Ethiraj, Kale, Krishnan, & Singh, 2005; Helfat & Winter, 2011; Zollo & Winter, 2002). Without understanding which operational capability or capabilities are renewed by a specific dynamic capability, a firm will be unable to accurately ascertain the benefits of developing a particular dynamic capability. A firm may invest in new dynamic capabilities (resource leveraging and releasing capabilities) that contribute minimally to its existing operational capabilities (Danneels, 2011). This study may help managers to avoid making investments in dynamic capabilities that have little or no influence on their firm's existing operational capabilities, and ultimately on firm performance. Danneels (2011) shows that Smith Corona's performance did not improve even after the firm invested substantially to develop a new dynamic capability.

Empirical examination of the above two questions show that a firm's capability to learn from customers renews all three operational capabilities. However, in contrast to the existing implicit belief in the dynamic capabilities literature that any changed operational capability contributes to firm performance, we find that firm performance is influenced only through the renewal of the process-quality capability. Based

on the findings, we theorize that the renewal of the process-efficiency and operational flexibility capabilities serves to maintain a firm's existing operations. While the renewal of process-quality capability helps a firm gain a competitive advantage. A capability that is used to simultaneously influence firm performance and maintain existing operations is termed a dual-purpose capability (Helfat & Winter, 2011) and this study provides the first empirical support for the existence of dual-purpose capabilities.

2. Literature review and hypothesis development

Since the dynamic capabilities framework has been summarized in many studies (Barreto, 2010; Helfat, 2007; Teece, 2009), we will begin this manuscript by reviewing literature on operational capabilities. Literature in the operations management field has traditionally classified operational capabilities into 1) process technology capabilities and 2) systems/coordination capabilities (Ferdows & De Meyer, 1990; Hayes & Upton, 1998; Wheelwright, 1984). A firm's process-technology capability is comprised of the process-efficiency and process-quality capabilities. A process-efficiency capability defined as a firm's ability to maintain and properly operate equipment required to convert inputs into outputs at a low cost (Hayes, 2005; Hayes & Upton, 1998). This capability enables a firm to optimally use its manufacturing capabilities by reducing idle time due to equipment breakdowns, thereby enabling a firm to take advantage of economies of scale and production experiences. The term "economies of scale" refers to the condition where a firm can reduce its operating costs by spreading fixed costs among a large quantities product. A firm with process-efficiency capability and produce large volume of products would be more apt at spreading its fixed cost across large quantities of products compared to the firm lacking similar capability. In addition to lowering operating costs through economies of scale, the process-efficiency capability can also help a firm to accumulate production experiences quickly. Knowledge acquired through cumulative production experiences enables a firm to develop new product process and/or reorganize its production activities and resource to improve its production efficiencies (Arrow, 1962; Dierickx & Cool, 1989; Epple, Argote, & Devadas, 1991; Lieberman, 1984, 1987; Morrison, 2008; Plaza

& Rohlf, 2008; Rasmusen, Petrakis, & Roy, 1997; Spence, 1981). Efficient organization of production activities and resources is essential to gain a low cost advantage.

Similarly, the process-capability is defined as a firm's ability to manufacture products that meet customers' expectation. Products that meet customer's expectations are defined as quality products (Garvin, 1987). The process-quality capability enables a firm to differentiate its products from those of its competitors and a firm that competes by offering vertically differentiated products (i.e. high quality) faces inelastic demand, thereby enabling the firm to charge higher prices than the cost required to manufacture the given product (Barney & Hesterly, 2012; Lehmann-Grube, 1997; Porter, 1996). Although, the process-quality capability is required to produce quality products, it is important to understand that customers' expectations change over time and products that were deemed quality at one time may not be viewed as such in a different time. Danneels (2011) shows that Smith Corona, an established typewriter manufacturer, failed despite having had the capacity to produce reliable typewriters because the firm's offerings did not meet customers' requirements and expectations in the 2010s. Therefore, a firm's process-quality capabilities need to be renewed to reflect changes in the external environment.

Similarly, a firm's ability to coordinate interdependent activities among different departments within a firm and between suppliers and buyers is termed systems/coordination capability (Hayes and Upton, 1998). Systems/coordination capabilities are the basis for just-in-time and lean manufacturing that help firms to reduce production waste and meet heterogeneous customer demands effectively (Fullerton & McWatters, 2001; Womack, Jones, & Roos, 1990). Firms with the ability to coordinate interdependent activities can reduce operating costs through reduction in inventory costs and reduction in supply chain costs. In addition to integrating inter-firm interdependent activities, a firm with systems/coordinating capabilities can also coordinate inter-firm activities of the primary functions (operations, finance and marketing), thereby prompting the primary functions to work together. For example, if a firm's operations function invests in flexible manufacturing equipment that enables it to produce a variety of products, then the marketing

function also needs to develop the ability to sell a wide variety of products. Failing to integrate a firm's existing capabilities and coordinate the capability development processes could lead to the renewal of some capabilities, while leaving other complementary capabilities untouched, thereby leading to suboptimal firm performance. A firm's ability to integrate and coordinate are likely to be crucial when a set of capabilities, rather than a single capability, determine overall firm performance because the weakest capability could frustrate a firm's ability to exploit complementary capabilities to the fullest (Dierickx & Cool, 1989; Ichniowski & Shaw, 1997, 1999; Milgrom & Roberts, 1990). For instance, if a firm develops flexible manufacturing capabilities, but fails to develop the corresponding marketing capabilities, then weak marketing capabilities could act like a bottleneck.

Combining literature on dynamic capabilities (Nelson & Winter, 1982; Teece, Pisano & Shuen, 1997; Zollo and Winter, 2002; Winter, 2003) and operational capabilities (Hayes, 2005; Hayes, Pisano & Upton, 1996; Hayes & Upton, 1998; Hayes, Wheelwright & Clark, 1988), We can argue that dynamic capabilities act on operational capabilities to improve firm competitive advantage. Since Hayes and Wheelwright (1984) and Hayes and Upton (1998) suggest the existence of different types of operational capabilities, an examination of how a firm's given dynamic capability is linked to different types of operational capabilities will help us to uncover the mechanism by which a firm's dynamic capabilities renew different types of operational capabilities.

2.1. Dynamic capability and firm performance

According to the dynamic capability framework, firms that can renew their operational capabilities will enjoy a competitive advantage (Teece et al., 1997). A firm's dynamic capabilities, such as the capability to learn, do not directly influence firm performance because they are not directly involved in the conversion of inputs into outputs (Helfat & Peteraf, 2003; Helfat & Winter, 2011; Winter, 2003). Instead, dynamic capabilities renew operational capabilities, thereby changing them and these changed operational capabilities directly affect firm performance. According to the dynamic capability framework, a given dynamic capability indirectly influences firm performance by renewing its existing operational capabilities

(Helfat & Peteraf, 2003; Winter, 2003). In other words, the relationship between dynamic capabilities and firm performance is fully mediated by operational capabilities. However, it is unclear from current empirical studies whether dynamic capabilities are actually influencing firm performance through the renewal of operational capabilities. Hypothesis 1a represents the relationship that is empirically tested in this literature (see Figure 1 for schematic diagram).

Hypothesis 1a: A firm's capability to learn from its customers (dynamic capability) is positively related to overall firm performance.

This paper seeks to go beyond the assumption that dynamic capabilities affect performance through operational capabilities and propose to test the indirectly link between dynamic capability and firm performance. It is important to empirically test the following dynamic capability hypothesis 1b to solidify the basic tenets of the dynamic capability framework.

Hypothesis 1b: In general, a firm's operational capabilities mediate the relationship between a firm's capability to learn from its customers and overall firm performance (as predicted in Hypothesis 1a).

Supposing that Hypothesis 1b is supported, we extend the dynamic capability literature by examining whether a given dynamic capability influences firm performance by renewing a specific operational capability or several operational capabilities. We examine the extent to which a firm's capability to learn from customers influences firm performance by renewing a firm's process-quality, process-efficiency and operational flexibility capabilities.

2.2. Firm learning capabilities, process-quality and firm performance

The process-quality capability influences a firm's overall performance and is defined as a firm's ability to meet customers' requirements and expectations (Deming, 1986; Garvin, 1987; Juran, 1992); we adopt this definition in this study. Deming (1986, p. 176-182) argues that a firm's capacity to produce durable and reliable products does not constitute a process-quality capability unless those products meet or exceed customers' requirements and expectations. For example, a firm's ability to produce reliable and

durable typewriters cannot be seen as a process-quality capability in 2012 because typewriters do not meet customers' computing and word processing requirements. Danneels (2011) shows that Smith Corona, an established typewriter manufacturer, failed despite having had the capacity to produce reliable typewriters because the firm's offerings did not meet customers' requirements and expectations.

Customers often develop capabilities to use products efficiently and to their fullest extent only after prolonged trial-and-error, most products on the market are experience products whose quality can only be determined by customers through repeated experience (Brush, Dangol, & O'Brien, Forthcoming; Rosenberg, 1982). This concept is known as learning-by-using. In this case, since a customer develops the capability to use a given experience product incrementally over time and this capability is likely to be tacit, a firm cannot rely on prototype testing, inventory analysis or external market signals alone to determine the quality of that product (Rosenberg, 1982). Therefore, a firm must establish a long-term relationship with its customers in order to acquire knowledge incrementally relating to how they use its products, what they think of them and why some people buy them while others do not (Deming, 1986; Hippel, 1988; Slater & Narver, 1998). Incremental knowledge acquired by engaging in learning activities with customers can help a firm to design, through many iterative processes, products that meet customers' requirements and expectations and eventually influence a firm's overall performance. Therefore, a firm that has the ability to learn from customers is more likely to be successful at meeting customer's requirements and preferences compared to its competitors lacking such capabilities.

Operations managers have developed quality management tools such as quality function deployment (QFD) to learn from customers and to track changing customer requirements over time. Through the application of QFD, a firm can learn about the features/attributes customers want and value in a product and use that information to design products that conform to customers' requirements and expectations (Hauser & Clausing, 1988). Hauser and Clausing (1988) show that the use of QFD increases a firm's ability to incrementally change product designs to meet customers' changing requirements. Customer knowledge that is accumulated incrementally

helps a firm to modify and/or create new products to meet customers' expectations. This renewal of a firm's process-quality capability influences the firm's overall performance. Based on this logic, we present the following hypotheses:

Hypothesis 2b: A firm's process-quality (operational) capability mediates the relationship between a firm's capability to learn from customers and overall firm performance (as predicted in Hypothesis 1a).

2.3. Firm learning capability, process-efficiency and firm performance

A firm's process-efficiency capability influences firm performance and is defined as a firm's ability to produce goods and provide services at the lowest possible cost (Krajewski, Ritzman, & Malhotra, 2010). Management literature suggests two methods for selecting and adopting processes and technologies essential for achieving optimal process-efficiency. According to the first method, a firm achieves a low cost position when it successfully selects and employs processes and technologies that are most appropriate for its chosen competitive strategy (Dess & Davis, 1984; Hayes et al., 1996; Zahra & Nielsen, 2002). A firm can compete in the marketplace by offering either low cost standardized products or differentiated products (Kotha & Orne, 1989; Porter, 1980), but irrespective of its competitive strategy, the firm must have the capability to produce goods and provides services at the lowest possible cost (Porter, 1980; Hayes et al., 1996).

A firm that competes by offering low cost standardized products in the marketplace employs different types of processes and technologies than a firm that competes by offering differentiated products (Hayes et al., 1996; Kotha & Orne, 1989). The former invests in capital intensive processes and technologies comprised of specialized and automated production equipment essential to produce standardized products in large quantities (Dess & Davis, 1984; Krajewski et al., 2010; Porter, 1980; Zahra & Covin, 1993). In this case, optimal process-efficiency is achieved through economies of scale, which entails spreading fixed costs over large quantities of outputs (Silberston, 1972). On the other hand, the latter competes by employing generally-used production processes and technologies essential to differentiated produce

a wide variety of products in small quantities. In this case, a firm achieves process-efficiency by holding a minimum amount of inventory and having low set-up costs.

In the second method for achieving optimal process-efficiency, a firm bases their process and technology selection decisions on the degree of product innovativeness/newness. Abernathy and Utterback (1978) argue that production processes and technologies required to make innovative/new products differ from those required to produce standardized products. When a product is new, a firm has more opportunity for product modification and innovation. A firm's decision to modify/innovate its products could require it to make changes to its production processes and technologies frequently. Under this condition, a firm achieves optimal process-efficiency by employing less expensive and generally-used technologies to produce small batches of products. As product innovation slows down and the design becomes more standard, a firm could become more efficient by employing specialized processes and technologies to produce large quantities of the product.

By combining literature on competitive strategy and product innovation, we argue that a firm achieves optimal process-efficiency by selecting processes and technologies most appropriate to a firm's product offerings. In particular, literature in product innovation suggests that products and production processes complement each other and that a firm's decision to offer new products or modify its existing products requires a firm to select and adopt new processes and technologies to achieve optimal efficiency (Abernathy & Utterback, 1978). It is important to recognize that product innovation is necessary to remain competitive irrespective of a firm's competitive strategy (Damanpour & Gopalakrishnan, 2001). Damanpour and Gopalakrishnan (2001) show that product innovations and product modifications require corresponding modifications in production processes and technologies. Additionally, the simultaneous development of new products and new processes is necessary to gain a competitive advantage (Pisano & Wheelwright, 1995).

It is critical to this study for us to know if a firm can use knowledge gained by engaging in learning activities with customers to renew its process-efficiency capability. As argued above, when a firm decides to modify its products, it also needs to modify its existing processes

and technologies in order to produce them efficiently. Knowledge gained from customers is crucial for determining what modifications need to be made to existing products to increase their utility (von Hippel, 1986). Since a firm's products and production processes complement each other, any changes to products will require corresponding changes in processes and vice-versa. Von Hippel (1986) hypothesizes that "lead users" are more likely to have extensive knowledge about how a given product should be used and what modifications would make it more useful and this knowledge can be used to modify a firm's existing production processes or develop new ones. Therefore, if a firm uses customer knowledge to make changes to its existing products and/or to develop new products, then the same knowledge could also be used to select and adopt processes essential to make those products efficiently. For example, if a firm offers complex products and its customers develop the ability to use such products to their fullest only through prolonged trial-and-error, then a firm may need to modify its products frequently as it receives customer feedback (Rosenberg, 1982). To integrate this feedback quickly to reduce product defects and increase product utility, the firm will have to employ generally used processes and technologies to produce small batches of products. If a firm erroneously employs specialized expensive processes designed to produce large quantities of products instead, then production costs will increase substantially when large quantities of finished goods need to be modified based on customer feedback. This will cause the firm to become inefficient. Customer knowledge, therefore, can be vital to the renewal of a firm's process-efficiency capability. Based on this logic, we present the following hypotheses (see Figure 1 for schematic diagram):

Hypothesis 3b: A firm's process-efficiency (operational) capability mediates the relationship between a firm's capability to learn from customers and overall firm performance (as predicted in Hypothesis 1a).

2.4. Firm learning, operational flexibility capability and performance

A firm that produces a wide variety of products must be able to switch from performing a set of interdependent activities required to produce a given product to a different set of activities

essential to produce an entirely different product. The various activities required to produce a variety of products are performed by different departments and individuals, thereby requiring a firm to coordinate those interdependent activities effectively to gain a competitive advantage. To produce a variety of products, a firm must be able to effectively coordinate the completion of all the tasks and activities required to produce those products. A firm that can switch seamlessly from performing one interdependent task to another is said to have operational flexibility (Gerwin, 1993; March & Simon, 1958; Mills & Schumann, 1985; Nelson & Winter, 1982; Sanchez, 1995). A firm with the ability to switch from producing one product to another efficiently is in a better position to meet customers' heterogeneous demands compared to its competitors lacking such abilities. For example, Subaru's plant in Lafayette, Indiana, can manufacture Subaru and Toyota vehicles using the same labor and equipment, thereby enabling it to meet customers' heterogeneous demands. In contrast, GM's inability to quickly switch from producing pick-up trucks and sports utility vehicles (SUVs) to fuel efficient cars prevented it from taking full advantage of "Cash for Clunkers," the U.S. government's vehicle purchase incentive program (Press, 2009).

Knowledge acquired from customers can renew a firm's operational flexibility capability when the firm understands customers' expressed and latent needs (Day, 1994; Kohli & Jaworski, 1990; Slater & Narver, 1998, 2000). Expressed needs are those that can be articulated accurately by customers, whereas latent needs cannot be articulated (Slater and Narver, 1998). While a firm relies on customer surveys and focus groups to determine customers' expressed needs, it engages in close observation of how customers use their products to determine customers' latent needs. A firm with superior information about customers' expressed and latent needs has the ability to anticipate these needs more accurately than its competitors with inferior information (Day, 1994; Slater & Narver, 1998). Having superior knowledge enables a firm to develop production methods required to produce products that customers may want in the future before the actual demand for them occurs (Day, 1994). A firm that has a variety of production methods in place to produce multiple products can move efficiently from producing one product to another using the same labor and equipment

to meet changing customer demands. Japanese firms are operationally more flexible than their American counterparts even though American firms are more likely to employ the latest advanced technologies (Jaikumar, 1986). This is due to the fact that American firms have not developed the ability to anticipate customer demands in advance and to anticipate latent customer demands. Based on the logic developed above, we argue that knowledge acquired from customers by engaging in learning activities can be used to renew a firm's operational flexibility capability, which in turn influences firm performance (see Figure 1 for schematic diagram).

Hypothesis 4b: A firm's operational flexibility capability mediates the relationship between a firm's knowledge acquisition capability and overall firm performance (as predicted in Hypothesis 1a).

3. Research methodology

3.1. Sample

Plant level survey data of manufacturing firms located in the Midwest region of the United States is used to test the hypotheses presented in the preceding section. The manufacturing industry is appropriate for this study because prior literature that identifies types of operational capabilities essential for gaining a sustainable competitive advantage focus on this industry (Wheelwright, 1984; Ward et al., 1996; Swink and Way, 1995; Hayes and Pisano, 1994; Hayes et. al, 2005). Although other operational capabilities exist, there is a general consensus that the process-efficiency, process-quality and operational flexibility capabilities are the most important operational capabilities (Ferdows & De Meyer, 1990; Swink & Way, 1995; Ward, Bickford, & Leong, 1996; Wheelwright, 1984). As noted earlier, a firm's process technology capability is composed of the process-efficiency and process-quality capabilities, while the operational flexibility capability is a form of coordination capability.

Non-response Bias, Common Method Bias and Construct Validity

We use Chi-square to examine potential non-response bias. Since late respondents are likely to be more similar to non-respondents than to early respondents, a statistically significant difference between early and late respondents

would indicate the presence of non-response bias (Armstrong & Overton, 1977). No significant differences are found between early and late respondents in firm size based on the number of employees, sales volume, production systems or respondents' job titles. To ensure that responses are not influenced by respondents' duties and job status, we conduct ANOVA test using the three operational capability variables, the firm learning variable and the firm performance variable as dependent variables, and the job title variable as a factor. No systematic differences are found in responses across respondents' job functions and the operational capability, firm learning and performance variables (F-value range from 0.37-1.90, $p > 10\%$).

We test for common method bias using Harman's one-factor test and, as expected, an unrotated principal factor analysis of all measurement items yields five factors with eigenvalues larger than one. These five factors explain 65 percent of the variance. Common method bias variance is unlikely because no single factor emerges as a dominant factor (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003; Podsakoff & Organ, 1986). The largest factor (process-quality capability) explains 15.043 percent of variance, whereas the second largest factor (process-efficiency capability) explains 12.914 percent of variance. As suggested by (Kumar, Stern, & Anderson, 1993), we included informants' job title to further rule out potential common method bias.

We follow a two-step approach involving exploratory and confirmatory analysis to assess construct validity (Anderson & Gerbing, 1988). The first step involves running factor analysis of all measurement items and we retain the factors if eigenvalues are greater than 1. As expected, unrotated factor analysis for firm learning capabilities reveals five factors and these five factors explain 64.07 percent of the variance. The reliability values of all five factors are above 0.70 (Appendix A) and Cronbach's alpha 0.70 or above demonstrates satisfactory reliability (Nunnally & Bernstein, 1994). The second step involves confirmatory analysis to demonstrate adequate convergent validity. Indices for a firm's learning capability show a satisfactory construct fit [GFI = 0.99, AGFI = 0.97, RMSEA = 0.00]. Constructs with a RMSEA value of 0.08 is considered an adequate fit (Maruyama, 1997). We use a similar approach to determine construct validity for operational capabilities and overall

firm performance. Indices for the final construct fit for operational capabilities range from 0.97 – 1 for GFI, 0.97-.098 for AGFI and 0.00-0.41 for RMSEA. All factor loadings are highly significant ($p < 0.01$). Similar index results are also achieved for the firm's overall performance construct [AGFI = 0.99, AGFI = 0.96 and RMSEA = 0.05]. Overall, these results show adequate convergent validity and reliability.

3.2. Measures

Dependent variable

Firm performance. A firm's overall performance is used as a dependent variable and it is constructed using five items – customer retention rate, sales growth, market share growth, return on investment and overall competitive position (Appendix A). The average of these five questions is used to construct a single dependent variable.

Independent variable

Customer learning. This variable measures the extent to which a firm learns about changing market demands from its customers and works with them to obtain feedback about product offerings (Appendix A). We construct the questions relating to this variable based on interviews with the local practitioners and research on learning and knowledge transfer (Day, 1994; Dyer, 1996; Ferdows & De Meyer, 1990; Frohlich & Westbrook, 2001; Grant, 1996; Kogut & Zander, 1992).

Mediating variables

Process-quality capability. This variable includes questions relating to what extent a firm produces durable, reliable and defect-free products. It also contains a question relating to whether it produces products that conform to design specifications (Appendix A). We use interviews with practitioners and research on quality management (Frohlich and Westbrook, 2001; Garvin, 1987; Deming, 1986) to construct questions for this construct.

Process-efficiency capability. This variable is constructed by taking the average of four questions geared toward measuring the extent to which a firm can produce products at low costs (Appendix A). The questions relate to a firm's ability to reduce production costs, inventory costs, unit costs and to increase labor productivity and research on process efficiency (Frohlich &

Westbrook, 2001), (Hayes & Upton, 1998) and (Ward et al., 1996) to construct questions for this construct.

Operational flexibility capability. This variable is constructed by taking the average of five questions designed to measure the extent to which a firm can switch from producing one product line to another and the extent to which it can change the rate of production. The questions relate to a firm's ability to change product designs rapidly, change production volumes, reconfigure equipment, process large and small orders and produce a variety of products (Appendix A). We use interviews with practitioners and research on operational flexibility (Gerwin, 1993; Sanchez, 1995) to construct questions for this construct.

Controls. We also use two-digit SIC codes to control for industry effect and the number of employees to control for firm size effect.

3.3. Method

We use the mediation statistical method suggested by Baron and Kenny (1986) and MacKinnon et al. (2002). This method is used when a researcher believes that an independent variable causes a change in an intervening variable, which in turn produces changes in a dependent variable (Baron & Kenny, 1986; MacKinnon, Lockwood, Hoffman, West, & Sheets, 2002). Mediation shows that the effects of an independent variable (capability to learn in this case) on a dependent variable (overall firm performance) is transmitted through a third variable (operational capabilities) (Edwards & Lambert, 2007; Gómez & Maícas, 2011). The mediation method is appropriate to test the effects of dynamic capabilities on firm performance because the dynamic capability view predicts that a firm's dynamic capability first acts on an operational capability and this changed operational capability influences firm performance (Teece et al., 1997). Similarly, Winter (2003) and Helfat and Peteraf (2003) argue that dynamic capabilities are related to firm outcome only through operational capabilities. This theoretical literature suggests that the relationship between dynamic capabilities and firm performance is mediated by operational capabilities.

The mediation statistical method involves decomposing the relationship between independent variables and a dependent variable into two separate causal paths. One of these paths links independent variables to a dependent

variable directly and the second path links independent variables through a mediating variable.

4. Results

Table 1 (descriptive statistics) reveals that the operational capability (mediating) variables are positively related with each other and they are also positively correlated with the overall performance variable. The parameter estimates are likely to be biased if the regression model includes only one mediating variable in the model used for estimating the effects of operational capabilities on overall firm performance (Wooldridge, 2010). Therefore, as suggested by Pindyck and Rubinfeld (1998), we estimate mediating equations simultaneously by using the SUR method.

In Table 2, we present the estimated coefficients of the firm's capability to learn variable and the three operational capability variables on overall firm performance (Models 2 – 7). Model 1 includes control variables only. As predicted, the customer learning variable in Model 2 is positively related with the firm performance variable ($\lambda = 0.260$, $p < 0.01$). This finding supports Hypothesis 1a, which states that a firm's learning capability with customers is positively related to overall firm performance. The findings can be interpreted such that a unit increase in a firm's capability to learn from customers leads to 0.260 units increase in overall firm performance.

Testing for mediation requires performing two sets of regression analyses. The first test involves regressing the learning variable against each of the operational variables (process-efficiency, process-quality and operational flexibility). Table 3 shows that the capability to learn variable is positively related to the process-quality variable ($\beta = 0.220$, $p < 0.05$), thereby supporting Hypothesis 2a. This hypothesis states that a firm's capability to learn from its customers positively influences the process-quality capability. The capability to learn variable is also positively correlated with the process-efficiency variable ($\beta^1 = -0.254$, $p < 0.01$) and the operational flexibility variable ($\beta^2 = 0.212$, $p < 0.01$), thereby supporting Hypotheses 3a and 4a. These findings suggest that a firm's ability to acquire knowledge from customers by engaging in learning activities renews all three of a firm's operational capabilities.

The coefficient of the capability to learn

variable decreases and is no longer significant at a 0.05 significance level when we estimate firm performance with all three operational capability variables (Table 2, Model 7), thereby supporting Hypothesis 1b. The mediation results presented in Table 4 show that at least one operational capability variable fully mediates the relationship between a firm's dynamic capability (capability to learn) and performance. The coefficient of total mediation is 0.132 and it is significant at a 0.01 significance level. This finding shows that 46.15 percent of a firm's capability to learn from customers (indirect effect (=0.119)/ direct effect (=0.260)) is transmitted through at least one operational capability variable. We interpret this finding as 46 percent of knowledge acquired from a firm's customers by engaging in learning activities is used to renew at least one operational capability to positively influence firm performance.

We regress the process-efficiency, process-quality and operational flexibility variables separately against the overall firm performance variable to determine which operational capability variables are renewed by a firm's capability to learn in order to influence firm performance. The results are presented in Table 2. We enter the process-quality variable in Model 4 and find that, after controlling for a firm's capability to learn, the process-quality variable is positively related to overall firm performance ($\gamma_4 = 0.436$, $p < 0.001$). The coefficient of the capability to learn variable drops from 0.260 to 0.149 and the new parameter is not significant at a 10 percent level. The mediation effect test (Table 4) results obtained by using the process-quality coefficient from Model 7 of Table 2 and the capability to learn coefficient from the process-quality model of Table 3 show that the process-quality variable significantly mediates the relationship between the capability to learn and overall firm performance variables ($\beta_2^* \gamma_4 = 0.105$, $p < 0.01$). This finding supports Hypothesis 2b which states that a firm's process-quality capability mediates the relationship between a firm's capability to learn from customers and overall firm performance. We also find that approximately 90 percent of the mediation effect is explained by the process-quality capability variable. We interpret this finding as knowledge acquired from customers by engaging in learning activities is primarily used to influence overall firm performance by renewing its process-quality capability.

Table 1. Descriptive statistics

	Mean	1	2	3	4	5	6	7	8	9	10	11
1 Employee	N/A	N/A	1									
2 2-Digit SIC	N/A	N/A	0.073	1.000								
3 Interfirm Coordination	N/A	N/A	0.124	-0.046	1.000							
4 Production System	N/A	N/A	-0.130	-0.001	-0.033	1.000						
5 Manufacturing System	N/A	N/A	-0.149	0.173	0.018	0.616	1.000					
6 Job Title	N/A	N/A	-0.077	0.053	-0.065	0.856***	0.656	1.000				
7 Process Efficiency	14.579	2.879	0.065	-0.041	0.298***	0.042	0.079	0.088	1.000			
8 Process Quality	19.998	3.181	0.032	0.084	0.202	-0.024	-0.004	0.037	0.500***	1.000		
9 Operational Flexibility	18.999	3.371	-0.085	0.025	0.245	-0.009	0.117	0.060	0.382***	0.488***	1.000	
10 Learning Capability	19.708	4.247	0.007	0.074	0.342***	0.024	0.059	0.327***	0.3449***	0.326***	1.000	
11 Overall Performance	14.591	3.898	0.026	0.117	0.174	0.066	0.148	0.102	0.380***	0.445***	0.269***	0.282***
												1.000

Table 2. OLS and SUR estimates. Dependent variable - overall performance

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7 SUR Model
Constant	2.274	1.443	0.548	0.366	1.245	0.012	0.012
Interfirm Coordination	0.168	0.081	0.034	0.051	0.056	0.041	0.041
Employees	-0.021	-0.022	-0.025	-0.023	-0.022	-0.025	-0.025
2-Digit SIC	-	-	-	-	-	-	**
Production System	-	-	-	-	-	-	-
Manufacturing System	-	-	-	-	-	-	-
Job Title	-	**	**	**	**	**	**
Learning Capability		0.260***	0.205**	0.149+	0.232**	0.141	0.141
Process Efficiency			0.249***			0.152	0.153+
Process Quality				0.436***		0.416**	0.416**
Operational Flexibility					0.13	-0.094	-0.094
R-sq	0.21	0.25	0.29	0.34	0.35	0.35	0.35
F-Value	1.43+	1.75**	2.03***	2.54***	2.48**	2.48***	
n	220	220	220	220	220	220	
Chi-sq							94.27***

*** $p < 1\%$; ** $p < 5\%$; + $p < 10\%$

We enter the process-efficiency variable in Model 3 (Table 2) and the results show that this variable is positively related to the overall firm performance variable ($\gamma_4 = 0.249$, $p < 0.05$). However, the coefficient for the capability to learn variable remains significant ($\gamma_2 = 0.205$, $p < 0.05$), thereby providing an initial indication that the process-efficiency variable does not mediate the relationship between the capability to learn variable and the overall firm performance variable. Results of the mediation test show that the process-efficiency variable does not mediate the relationship between the capability to learn variable and the overall firm performance variable (Table 4: $\beta_2^* \gamma_4 = 0.034$, $p > 0.10$). Therefore, we fail to find support for Hypothesis 3b, which states that a firm's process-efficiency variable mediates the relationship between a firm's

capability to learn from customers and overall firm performance. The finding can be interpreted as a firm's capability to learn from customers does not influence overall firm performance by renewing its process-efficiency capability.

We replicate this statistical method to determine if the operational flexibility variable mediates the relationship between the capability to learn variable and the overall firm performance variable. The coefficient of the operational flexibility variable in Model 5 is positive but insignificant ($\gamma_4 = 0.13$, $p > 0.20$) and the coefficient of the capability to learn variable remains significant at a 0.05 significance level. The mediation test results presented in Table 4 show that the operational flexibility variable does not mediate the relationship between the capability to learn and overall firm performance

variables ($\beta_2^* \gamma_4 = 0.020, p > 0.10$). Therefore, we do not find support for Hypothesis 4b, which states that a firm's operational flexibility variable mediates the relationship between the capability to learn and overall firm performance variables.

In sum, this study finds that the customer learning variable is positively related to the overall firm performance variable, thereby supporting Hypothesis 1a. However, when we enter the three operational capability variables

Table 3. SUR estimates. dependent variable - operational capabilities

	Process Efficiency	Process Quality	Operational Flexibility
Constant	3.590***	2.467***	1.535
Interfirm Coordination	0.188***	0.069	0.192***
Employees	0.014	0.002	-0.001
SIC Code	-	**	+
Production System	***	-	-
Manufacturing System	-	**	**
Job Title	***	-	-
Learning Capability	0.220**	0.254***	0.212***
n	220	220	220
Chi-sq	74.74***	67.68***	72.37***

into the model, we find that the direct relationship between the learning capability variable and the overall firm performance variable became insignificant which supports Hypothesis 1b. This study also finds that the capability to learn from customers variable is positively related to all three operational capability variables and these findings support Hypotheses 2a, 3a and 4a. The effects of the capability to learn variable are transmitted to the overall firm performance variable only through the process-quality capability variable, thus supporting Hypothesis 2b and not supporting Hypotheses 3b and 4b. We interpret these findings to mean that a dynamic capability may renew an operational capability but not influence overall firm performance.

5. Discussion

In this study, we examine the extent to which a firm's operational capabilities mediate the relationship between a given dynamic capability and firm performance. We also examine whether a given dynamic capability influences firm performance by renewing a single operational capability or several of them. We find that a

firm's dynamic capability may renew several operational capabilities, but it may be appropriate for influencing firm performance only through a specific one. When a firm's given dynamic capability influences firm performance through the renewal of a specific operational capability, the firm may not improve its performance simply by investing in any random dynamic capability. Therefore, it is essential for a firm to understand how its dynamic capabilities are linked to its operational capabilities. A lack of such knowledge could prompt firm managers to invest in a dynamic capability that minimally influences firm performance.

The most interesting result of this study is that a firm's dynamic capability may influence a given operational capability, but the influenced operational capability may not influence firm performance. In this study, the capability to learn from customers influences all three operational capabilities, but only the renewed process-quality capability affects firm performance. The renewed process-efficiency and operational flexibility capabilities are not significantly related to firm performance. The traditional dynamic capability framework classifies firm capabilities as either

Table 4. Causal mediation significance test summary*

		Effects			
		Predicted Sign	Supported	Direct Effect	Mediation
H1a	Learning Capability --> Performance	+	Yes	0.260***	
H1b	Learning Capability --> All Operational Capabilities --> Performance		Yes		0.119***
H2a	Learning Capability --> Process Quality	+	Yes	0.254***	
H2b	Learning Capability --> Process Quality --> Performance		Yes		0.105***
H3a	Learning Capability --> Process Efficiency	+	Yes	0.221***	
H3b	Learning Capability --> Process Efficiency--> Performance		No		0.030
H4a	Learning Capability --> Operational Flexibility	+	Yes	0.212***	
H4b	Learning Capability --> Operational Flexibility --> Performance		No		-0.020

*A separate Sobel, Goodman and Aroian tests produced identical results

dynamic or operational, and the framework assumes that these capabilities influence firm performance differently. Operational capabilities directly influence firm performance by helping the firm to maintain its existing operations such as producing outputs using same technology and methods, while dynamic capabilities influence firm performance indirectly by helping the firm renew its existing operations by updating, recombining and reconfiguring its existing operational capabilities (Collis, 1994) suggest that some capabilities act as both dynamic and operational capabilities and they are used to renew operational capabilities to simultaneously maintain a firm's current operations and to positively influence overall firm performance. They term such capabilities dual-purpose capabilities.

When we consider dynamic and operational capabilities as two end points of the same continuum, a dual-purpose capability is a third point that rests in the middle of that continuum. Dual-purpose capabilities act as dynamic capabilities in the sense that they are involved in the discovery of new ways of performing tasks that lead to the renewal of operational capabilities. They also act as operational capabilities in the sense that they are involved in the maintenance

of existing operations.

Based on the findings, we posit that a firm's capability to learn from customers can be viewed as a form of dual-purpose capability. On one hand, knowledge acquired by engaging in learning activities leads to the renewal of the process-quality capability, which in turn positively influences firm performance. On the other hand, the same knowledge renews the process-efficiency and operational flexibility capabilities only to maintain a firm's current operations. The capability to learn variable is positively related to process-efficiency ($\beta'_2 = 0.221$, $p < 0.01$) and operational flexibility ($\beta'_2 = 0.212$, $p < 0.01$) capabilities, but the effects are not transmitted to overall firm performance.

In sum, this study contributes to dynamic capability literature by identifying a dual-purpose capability that renews operational capabilities to simultaneously influence firm performance and to maintain operational capabilities. A firm that understands how a given dynamic capability is linked to its existing operational capabilities will be more successful at renewing its operational capabilities and gaining a competitive advantage than firms that lack such understanding. Therefore, a firm should consider the type of operational capabilities

it wishes to renew prior to either developing or deploying its dynamic capabilities. We also contribute to dynamic capability literature by providing empirical support for the existence of dual-purpose capabilities that can be deployed to simultaneously to influence firm performance and maintain a firm's existing operations.

6. Conclusion

Although dynamic capability literature posits that dynamic capabilities influence firm performance through operational capabilities, prior studies examine the direct relationship between dynamic capabilities and firm performance rather than a relationship mediated by operational capabilities. Therefore, it is unclear from these studies if operational capabilities actually mediate the relationship between dynamic capabilities and firm performance. It is also unclear from these studies whether dynamic capabilities influence firm performance by renewing a single operational capability or several of them. Therefore, this study investigates whether dynamic capabilities actually influence firm performance through operational capabilities and whether dynamic capabilities influence firm performance by renewing a single operational capability or by renewing several of them.

Our mediation results show that a firm's process-quality capability fully mediates the relationship between a firm's capability to learn from customers and firm performance. We interpret this to mean that a firm's capability to learn from customers influences firm performance by renewing its process-quality

capability. This result shows that at least one operational capability fully mediates the relationship between a given dynamic capability and firm performance. Our results also show that while a firm's learning capability is positively related to the process-efficiency and operational flexibility capabilities, firm performance is not influenced by the renewal of these two operational capabilities. We interpret this to mean that a firm's capability to learn from customers can help the firm to maintain its operations. This suggests that a dynamic capability may renew several operational capabilities, but may only influence firm performance through the renewal of a single operational capability. Since a firm's capability to learn from customers can simultaneously renew operational capabilities to influence firm performance and maintain firm operations, we argue that it can be considered a dual-purpose capability. We provide the first empirical support for the existence of dual-purpose capabilities.

Like any other study, this study also has limitations. This study uses one period cross-sectional data to test hypotheses presented. Therefore, we cannot say for certain that a firm's capability to learn from customers does not influence firm performance by renewing its process-efficiency and operational flexibility capabilities over time. If a firm's capability to learn from customers influences these two operational capabilities incrementally then the effect of this dynamic capability on firm performance through these operational capabilities cannot be observed using cross-sectional or short-term longitudinal data. Therefore, future longitudinal empirical studies could provide additional support for the existence of dual-purpose capabilities.

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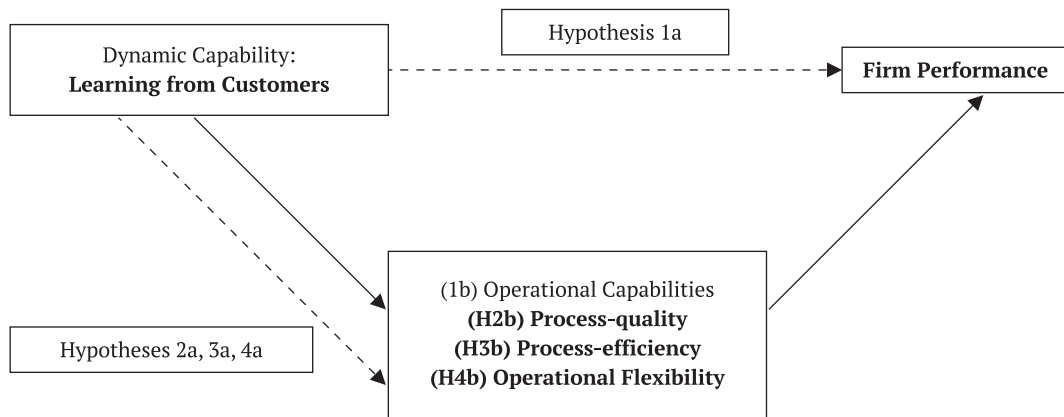


Figure 1. Schematic diagram of hypotheses

A dotted line represents the direct relationship between a firm's capability to learn (dynamic capability) and firm performance. A dashed line represents the direct relationship between a firm's capability to learn and each operational capability (Hypotheses 2a, 3a and 4a). Solid lines represent the relationship between a firm's capability to learn and firm performance mediated by each operational capability (Hypotheses 2b, 3b and 4b).

Appendix A

	Component				
	1	2	3	4	5
Describe the extent to which the manufacturing department involves customers in the following activities (1 = very low, 5 = very high)					
Share market demand information					0.733
Participate in product development					0.689
Participate in distribution					0.703
Involve in preparing business plans					0.734
Receive customer feedbacks					0.659
Participate in manufacturing processes					0.757
Cronbach's alpha					0.83
Describe the extent to which the manufacturing department can achieve the following operational objectives (1 = very low, 5 = very high)					
Make rapid product design changes			0.763		
Make rapid production volume changes			0.689		
Make rapid changes between product lines			0.769		
Process both small and large orders			0.678		
Produce variety of products			0.642		
Produce products at low cost		0.822			
Reduce production cost		0.835			
Reduce Inventory cost		0.844			
Reduce unit cost		0.794			
Provide better product performance	0.762				
Improve product durability	0.747				
Produce products that conform to specifications	0.764				
Improve product reliability	0.645				
Reduce defective rates	0.795				
Cronbach's alpha	0.91	0.87	0.82		
Circle the appropriate number that best indicates the level of your firm's overall performance (1 = very low, 5 = very high)					
Sales growth					0.848
Market share growth					0.845
Return on investments					0.674
Overall competitive position					0.764
Cronbach's alpha					0.86