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ORGANIZATIONAL BARRIERS IN THE INNOVATION PROCESS:

BRIDGE OR BREAK DOWN?

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ABSTRACT

In a traditional functionally organized firm, innovation activities are typically fostered in a dedicated Research and Development (R&D) environment, i.e. an environment that facilitates learning and experimentation. The underlying assumption is that operational activities of these firms are of such a different nature than innovation activities that these cannot be combined within a single unit. However, in today's more agile and flexible organizations innovation and operational activities are likely more similar. This paper investigates the implications for innovation management theories when operational and innovation activities have more resemblances than in a traditional functionally organized firm.

INTRODUCTION

Traditionally, the focal firm within the innovation management literature has been the functionally organized manufacturing firm (Montoya-Weiss & Calantone, 1994), e.g. firms in the automobile and electronic industries that produce high volume goods. In the meanwhile, to fulfill the growing demand for customized complex systems (Berkun, 2005; Galbraith, 1971; Hobday, 2000; Starbuck, 2006; Whitley, 2006) or to survive in dynamic industries (Damanpour & Gopalakrishnan, 1998; Volberda, 1996) many firms have adopted more decentralized, or more project-based type of organizational structures (Hobday, 2000; Starbuck, 2006). Examples of the latter type of firms are firms like Microsoft, IBM, Boeing, Northrop Grumman, Raytheon, Bechtel, ABB, and CapGemini. These type of firms are sometimes referred to as knowledge intensive business service (KIBS) firms (Den Hertog, 2000; Greenwood, Li, Prakash, & Deephouse, 2005; Leiponen, 2008), or project-based firms (Davies & Brady, 2000; Gann & Salter, 2000; Hobday, 2000; Whitley, 2006), and are becoming increasingly important in Western economies (Hobday, 2000; Leiponen, 2008).

Organizations specialize to deal efficiently and effectively with particular tasks or environments (March & Simon, 1958; Tushman, 1977). For example for the production of goods in large volumes, functional specialization is needed to create efficiency and quality (Galbraith, 1971, , 1977; Mintzberg, 1980; Starbuck, 2006)[]. Such specialization however easily leads to silo thinking (Tushman, 1977), while sharing, reusing and recombining knowledge across functions leads to new insights and innovations (Dougherty, 1992; Hansen, 1999). Many papers in the innovation literature therefore addressing issues like: How to create a culture for innovation (Catmull, 2008; Stringer, 2000); How to transfer knowledge within the firm (Brown & Eisenhardt, 1995; Dougherty, 1992; Drach-Zahavy & Somech, 2001; Pinto, Pinto, & Prescott, 1993; Tushman & Nadler, 1978), How to absorb knowledge (Cohen & Levinthal, 1990; Jansen, Van den Bosch, & Volberda, 2005); How to balance exploitative and explorative innovation activities (Birkinshaw & Gibson, 2004; Ettlie, Bridges, & O'Keefe, 1984; Katila & Ahuja, 2002; Tushman & O'Reilly, 1996). The underlying assumption in most of this literature is that innovation is a process with its own characteristics, i.e. different than the day to day operational activities of the firm.

To deal efficiently and effectively with particular tasks or environments, functional specialization is not the only solution. In order to cope with complex and uncertain environments some firms have specialized in collaboration instead of functional expertise, as for example project-based firms (Galbraith, 1977). Such a project-based organizational structure enables firms to cope with complex and uncertain customer demands (Hobday, 2000). This makes the organizational characteristics of these types of organizations similar to those that are favorable for innovation, see Table 1. The question addressed in this paper is what the implications are for innovation management theories when the characteristics of the operational organization, i.e. organization of the day to day activities of a firm, start to resemble that of the innovation process.

When collaboration instead of efficiency is key (Galbraith, 1977; Hobday, 2000), and when the operational processes resemble the innovation process in terms of learning and experimentation, is it then possible to break down the traditional organizational barriers between the innovation and the operational processes in firms? The organizational barriers are the barriers that arise when operational and innovation activities are performed in physically and/or administratively different units as for example in a research and development (R&D) unit. What are the challenges with regard to innovation in organizations where the organizational barriers between innovation and operational activities are absent? Are the current imposed solutions like cross-functional teams and overlapping phases still effective?

That different types of operational processes call for different ways of organizing the innovation process is in line with (Pavitt, 1984)['] taxonomy. Whereas Pavitt identifies different technological trajectories for different industries, the focus in this paper is on differences in the organization of innovation on the basis of the operational process of a firm and not the industry in which it operates. Some industries may be more homogeneous than others, but for example in the software industry different business models are used by producers of professional software services, enterprise solutions and packaged mass-marked software (Hoch, Roeding, Purkert, & Lindner, 2000).

Insert Table 1 About Here

THE OPERATIONAL ORGANIZATION

“Operations is a set of activities concerned with transforming resource inputs into desired outputs i.e. goods or services” (Oxford dictionary, 2006)[]. I define the operational organization as the part of the organization that is occupied with the ongoing, recurring activities concerning the running of the current business. In line with contingency theory, I will use the complexity and uncertainty to characterize the operational organization.

Complexity of the operational process is defined as the amount of thinking time required to solve work-related problems and the body of knowledge that provides guidelines for the production (Van de Ven & Delbecq, 1974). With increased complexity also the amount of expertise needed increases, as well as the participativeness in decision making and coordination (Galbraith, 1977; Van de Ven & Delbecq, 1974). Complexity also impacts operating efficiency. “Increased complexity reduces the possibilities of process control, as performance standards become more subjective and measurement of deviations more imprecise. Feedback loops become less well defined and corrective action more instantaneous” (Chase & Tansik, 1983). Increased divergence in the range of products that are produced also contributes to complexity of the operational process (Bowen & Ford, 2002). When customers have no options, or can only choose between a few specific options, divergence is low. High divergence applies to customized products which offer the customer basically unlimited options (Shostack, 1984).

Uncertainty in the operational process depends on the unpredictability of demand (Bowen & Ford, 2002). Changes in demand due to seasonal influences or advertising campaigns can be predicted in advance. Alternatively, changes in demand can be damped by increasing product stock. However sometimes demand is very difficult to predict and not all products can be held in stock. For example, the execution of a large IT systems integration project largely depends on the number of projects that the IT firm acquires in its acquisition pipeline. It will be difficult to predict in advance which acquisition trajectory will be successful and which will fail. Moreover it is not possible to keep these projects in stock to dampen the fluctuations in demand. Uncertainty in the operational process is thus related to the extent to which the demand can be predicted and the production can be planned a priori and structured in a routinized, systematized or mechanized way (Van de Ven & Delbecq, 1974).

High complexity and uncertainty will often go hand in hand, with on one extreme an operational process based on high volumes (high volume production) like in oil refineries, consumer electronic producers, and pharmaceutical companies, and on the other hand an operational process that is geared at the production of complex systems by customer order (complex system production), such as engineering firms and information technology system integrators. The types of routines used in the operational process also differ for these extreme two types of firms. Within volume based operations, efficiency and low variability between the products is key; all cars of the same model should perform the same, similarly every pill in a prescription should be identical to every other pill (Moore, 2005). Deterministic processes and statistical quality control contribute to the efficiency of the operational process. Repeatable and consistent routines enable the firm to produce high volumes at low cost, which likely gives the firm a competitive advantage (Porter, 1980). At the other extreme is the production process of complex systems. In organizations with this type of production process efficiency is less of an issue as there are no truly repeatable processes. “No two pieces of heavy equipment or two projects are ever exactly alike. Continuity, predictability and reliability derive instead from consistent methodologies that adapt themselves to specific situations” (Moore, 2005). The routines used in the latter type of organization are therefore more like grammar; they guide regular patterns of actions, instead of mindless repetitions of the same action (Pentland & Rueter, 1994).

High volume production with its low degrees of task complexity and uncertainty resembles routinized manufacturing operations with high levels of specialization, standardization or formalization, and administrative intensity, and low decentralization (Mintzberg, 1980; Van de Ven & Delbecq, 1974). The meta-analysis of (Damanpour, 1991) shows that specialization and decentralization are organizational characteristics that have a positive effect on the innovativeness of organizations, standardization, specialization and administrative intensity have a negative effect. The characteristics of the operational organization in high volume producers are thus unfavorable for innovation, see Table 1. The high complexity and uncertainty of organizations that produce complex systems by customer order can be identified by organizational characteristics such as high specialization, low administrative intensity and medium standardization / formalization (Hobday, 2000; Mintzberg, 1980).

Although each integrated customized product is unique, similar patterns are used to create each product (Greenwood et al., 2005; Maister, 2001).

The existence of routines in patterns of actions make customized production generally more structured and bureaucratic than would be expected on the basis of the heterogeneity of the products they provided (Donaldson, 2001; Mintzberg, 1980). The characteristics of the operational organization geared at the production of complex systems are thereby more favorable to innovation than that of organizations having a high volume production process.

THE INNOVATION PROCESS

Innovation is a path dependent process (Tidd, Bessant, & Pavitt, 2005). This path is usually studied from the start to the end of the innovation process, i.e. from idea generation to implementation. However, rarely a new product or service will be entirely new; it usually has some commonalities with the current processes within the firm (Murray & O'Mahony, 2007; Wheelwright & Clark, 1992). This makes the implementation phase, when the innovation is taken into production, the anchor by which the innovation process links with the existing organization. The path dependency of the innovation process is therefore assumed to start from the existing operational organization. Although in the end the innovation project will alter the existing operational organization to a more or lesser extent (Danneels, 2002), at the start of the implementation phase the innovation encounters what already exists. The state of the operational organization during implementation is thereby more or less the same as that of the state of the organization when the innovation was initiated. Changes in the operational organization may have occurred during the period that the innovation was developed, but these changes will not be the result of the innovation that has yet to be implemented.

An innovation is defined as a project in which a new product, service or system is developed and commercialized for more than one customer, this can be an more incremental innovation or a more radical innovation. An example of an innovation project for a high volume production firm would be a significantly improved or new car or drug. For an organization that produces complex systems, examples would be CSC consulting's supply-chain management solution or the Rapid Application Development methodology developed by Cambridge Technology Partners (Hoch et al., 2000).

Other examples would be the development of a new soil cleaning technology, or a new dredging technology which subsequently can be applied and tailored in the projects executed to customer order.

Different stages can be identified in the innovation process - such as idea generation, development and implementation - regardless of the type of innovation, operational process, firm or industry (Tidd et al., 2005). However, for complex systems a customer needs to be found before the innovation can be implemented, because such systems often have a large service component and cannot be delivered without customer involvement (Hobday, 2000; Prencipe, Davies, & Hobday, 2003). For high volume production the implementation stage is less dependent of customer involvement.

THE NEED FOR ORGANIZATIONAL BARRIERS

Contingency theory states that the more complex and uncertain a process the higher the need for specialization, decentralization and a lower span of control (Burns & Stalker, 1994; Donaldson, 2001; Lewin & Volberda, 1999; Woodward, 1980). Operational activities, with low uncertainty and complexity are assumed to thrive better in a mechanistic organization and innovation activities, highly uncertain and complex, in a more organic organization (Burns & Stalker, 1994).

In the resource based view literature a distinction is made between capabilities and dynamic capabilities (Eisenhardt & Martin, 2000; Henderson & Cockburn, 1994; Teece, Pisano, & Shuen, 1997). Capabilities are the “local abilities and knowledge that are fundamental to day-to-day problem solving” (Henderson & Cockburn, 1994), dynamic capabilities are the abilities that enable the creation of new capabilities through integration, coordination and (re) combination of knowledge (Eisenhardt & Martin, 2000; Henderson & Cockburn, 1994; Teece, 2007; Teece et al., 1997). New product development is often viewed as an example of a dynamic capability (Eisenhardt & Martin, 2000). Both capabilities and dynamic capabilities consist of routines (Helfat & Peteraf, 2003; Winter, 2003).

Yet, the routines related to capabilities are typically assumed to be geared towards reducing variability and increasing efficiency (Benner & Tushman, 2002; Moore, 2005) and are consistent with our traditional perception of routines (Pentland & Rueter, 1994), whereas the routines used in the innovation process need to facilitate learning and change (Feldman & Pentland, 2003).

From the ambidexterity literature (Benner & Tushman, 2003; Gupta, Smith, & Shalley, 2006; He & Wong, 2004; Jansen, Van den Bosch, & Volberda, 2006; March, 1991; Tushman & O'Reilly, 1996) stems the notion that explorative innovation activities lead to more exploration, while exploitative innovation activities lead to more exploitation. Moreover, as both exploitation and exploration draw from the same resources, they are mutually exclusive within a single domain, unless resources are not scarce as is the case with knowledge (Gupta et al., 2006). It is therefore difficult to foster innovation activities focused on the short and long term within the same organizational structure (O'Reilly & Tushman, 2004; Tushman & O'Reilly, 1996). It is often assumed that within the operational process the focus is typically on minor incremental process related innovation activities with a direct benefit, i.e. the focus is on more exploitative innovations. While the focus within for example the R&D department could be on more major changes that enable the firm to take a leap forwards, i.e. more explorative innovation activities.

Together, these assumptions have led to a generally accepted model in which innovation activities are considered to be distinctly different from operational activities. Often innovation activities are therefore housed in a dedicated R&D department. Although the innovation process is not confined to such an R&D department and heavily depends on interactions and initiatives throughout each firm (Dougherty & Hardy, 1996; Gerwin & Barrowman, 2002; Tidd et al., 2005), within the innovation literature the innovation process is still typically studied as an isolation process (Cooper, 2001; Tidd et al., 2005), without taking the wider organizational context into consideration. That the organizational context may matter is recognized (Brown & Eisenhardt, 1995; Gerwin & Barrowman, 2002; Gupta, Tesluk, & Taylor, 2007), but still rarely addressed in the innovation literature .

The organizational barriers that arise as a result of the organizational separation between the operational and innovation processes are difficult to overcome. The interfaces that are needed to cross these barriers have been extensively studied, especially the interfaces between R&D and marketing (Griffin & Hauser, 1996; Gupta, Raj, & Wilemon, 1985), and R&D and operations (Gerwin & Barrowman, 2002; Vandervelde & Van Dierdonck, 2003). However, this research is often descriptive in nature and focuses on how the barriers can be overcome (Colarelli O'Conner & DeMartino, 2006; Gupta et al., 1985; Rice, Leifer, & Colarelli O'Conner, 2002; Vandervelde & Van Dierdonck, 2003).

Rarely is the need for the organizational barriers questioned, with the exception of (Gupta, Raj, & Wilemon, 1986) who discuss the organizational distance needed between marketing and R&D based on the environmental uncertainty and strategy of the firm.

Besides the R&D-marketing and R&D-operations interfaces, interfaces between the innovation process and the organization have also been addressed within the team literature, e.g. the boundary spanning behavior of teams (Ancona & Caldwell, 1992; Griffin & Hauser, 1992; Keller, 1994; Marrone, Tesluk, & Carson, 2007; Moenaert & Souder, 1990). From these studies it is known that teams should engage in various types of communication at different stages in the innovation process (Ancona & Caldwell, 1992; Tushman, 1977) and that barrier spanning should be an activity engaging the whole team (Marrone et al., 2007).

However, when there are no functional departments as is the case in project-based organizations (Hobday, 2000), and the complexity and uncertainty of the activities and the kind of routines used are similar for the innovation and operational process (Blindenbach-Driessen & Van den Ende, 2006), it could be questioned whether an organizational barrier between the operational innovation processes is still needed. From an organizational theory perspective separation may not be needed, as the organizational characteristics of a complex and uncertain production process are in line with those that are needed to foster innovation, see Table 1.

The absence of an organizational barrier between innovation and operational processes will likely improve the quality of decision making. Firstly, with the absence of interfaces and barriers it will be easier to oversee the whole picture and understand the consequence of the different trade-offs involved. Secondly, interfaces and organizational barriers often lead to sub-optimization, due to us versus them thinking between the sub-domains (Dougherty, 1992; Thompson, 2007).

The absence of an organizational barrier will also facilitate knowledge transfer. Upon separation, innovation teams are often cut off from downstream knowledge, hampering the transition from development to production in the later stages of the innovation process (Dougherty, 1992; Griffin & Hauser, 1996; Moore, 2007; Vandervelde & Van Dierdonck, 2003). The absence of organizational barriers likely leads to closer ties between innovation efforts within the firm and the downstream disciplines, which may also facilitate the transfer of more intangible knowledge (Hansen, 1999).

From an ambidextrous point of view, the flexible operational environment may be able to support more explorative as well as more exploitative innovation efforts, as such an environment will likely be more open for outside perspectives, learning and experimentation. However, the ambidexterity problem may shift from the organizational to the individual level. As without a dedicated innovation unit, all employees will be expected to be involved in exploration and exploitation type of innovation activities. Yet, it is also difficult for individuals to balance exploration and exploitation type of innovation activities (Birkinshaw & Gibson, 2004).

DIFFERENT CHALLENGES, DIFFERENT SOLUTIONS?

Insert Table 2 About Here

As functionally organized high volume good producers have been the more common firm studied in the innovation literature (Montoya-Weiss & Calantone, 1994). Current best-practices seem to best fit the challenges of this type of firm, see Table 2.

To facilitate exploration and search (Benner & Tushman, 2003; Gupta et al., 2006; Katz & Allen, 1985; March, 1991; Roussel, Saad, & Erickson, 1991; Tushman & O'Reilly, 1996), learning and experimentation (Burns & Stalker, 1994) innovation activities are often housed in separate units. To ensure the quality of decision making, cross-functional teams are used (Colarelli O'Conner & DeMartino, 2006; Gupta et al., 1985; Kessler & Chakrabarti, 1996; Sheremata, 2000; Swink, 2000) to overcome the organizational barrier that arises due to this separation.

To reduce the likelihood of late changes concurrent engineering (Terwiesch, Loch, & De Meyer, 2002), including overlapping phases, is applied (Brown & Eisenhardt, 1995). Integrated R&D-production teams (Vandervelde & Van Dierdonck, 2003), job rotation (Song, Van der Bij, & Weggeman, 2006), and tools and institutionalized disciplined reflection (Edmondson, 2008) contribute to the experimentation and learning capabilities of the operational organization and facilitate the implementation stage. In addition, senior management support can provide resources and a temporary relief from the usually tight targets of the operational organization (Bonner, Ruekert, & jr., 2002; Brown & Eisenhardt, 1995) during the implementation stage.

Whether the challenges of complex systems producers can be overcome with the same solutions is difficult to tell, as these types of firms are still less frequently researched. The characteristics of complex system producers (Greenwood et al., 2005; Hobday, 2000; Whitley, 2006), the transformation of functional organizations to project-based organizations (Bernasco, De Weerd-Nederhof, Tillema, & Boer, 1999; Lindkvist, 2004), and knowledge exchange within these organizations (Prencipe & Tell, 2001; Robertson, Scarbrough, & Swan, 2003; Salter & Gann, 2003; Werr & Stjernberg, 2003) have been addressed. The innovation process within these types of firms have only been addressed by a few (Blindenbach-Driessen & Van den Ende, 2006; Christensen & Baird, 1997; Gann & Salter, 2000; Keegan & Turner, 2002; Leiponen, 2008). The findings of these latter studies indicate that different solutions may be required.

For example, organizational separation between innovation and operational activities is often absent (Griffin, 1997; Sundbo & Gallouj, 2000), likely due to the similarity in organizational characteristics between the innovation and operational processes in these firms. This integration of innovation and operational activities may have the additional advantage that it facilitates the transfer of complex knowledge (Hansen, 1999; Sundbo & Gallouj, 2000).

While the benefits of cross-functional teams are lauded in most of the innovation literature, the benefit of such teams is unclear within industries where complex systems prevail such as the services industry (Henard & Szymanski, 2001), the IT industry (Den Hertog, 2000), and project-based firms (Blindenbach-Driessen & Van den Ende, Forthcoming). Could it be that due to the different organizational characteristic and capabilities of these firms, a different type of team and different type of boundary spanning behavior is needed? As collaboration between functions already abounds in these firms (Hobday, 2000), could it be that the sharing, reusing, recombining and accumulating of knowledge that lead to innovations (Murray & O'Mahony, 2007) occurs in teams with experts from the same discipline, instead of in more functionally heterogeneous teams (De Luca & Atuahene-Gima, 2007)? A mono-disciplinary team would allow experts to combine the knowledge each gained in different settings. Because of the extensive multidisciplinary collaboration on the projects executed to customer order, these experts are likely to possess intra-personal diversity traits (Bunderson & Sutcliff, 2002). Integration between the innovation and operational activities would force these experts to remain footed within the operational organization (Sundbo & Gallouj, 2000). In complex systems firms, a team of experts from the same discipline therefore is likely more familiar with the downstream processes, better qualified to oversee trade-off decisions, and better able to (re) combine new knowledge than a similar team of experts would in firms that produce high volume goods.

Concurrent engineering in the context of complex systems may also bring less benefit, as the challenges are more in balancing generic and specific solutions than in dealing with uncertain and incomplete information (Blindenbach-Driessen & Van den Ende, 2006). Moreover, it is easier to make late changes when the innovation is tailored to the customer's specific needs. Are overlapping phases than still going to be beneficial? Perhaps this will simply lead to more planned rework (Eisenhardt & Tabrizi, 1995; Terwiesch et al., 2002)? If development costs are relatively low such as in the IT industry, it may be better to develop multiple prototypes simultaneously in the development stage and select one of the designs during the implementation stage, instead of iteratively generating one best design (Sommer & Loch, 2004). Simultaneously developing multiple prototypes may also help to find a balance between the need for details to make the innovation concrete and attract a first customer, versus making the innovation generic enough to be suitably applied to a range of customers. Alternatively, modularization may provide a suitable solution to generate innovations at a more generic level.

At the same time, developing a modular system is generally expensive and complex (Baldwin & Clark, 1997; Sanchez & Mahoney, 1996). These higher development cost can easily be encountered when modularization enables sourcing to multiple suppliers at a low cost (Sanchez & Mahoney, 1996; Schilling, 2000) and when these higher development cost can be spread over many customers. For complex systems provides it is however questionable whether investing in a modular solution is rewarding. Only a few customers will be served and there is limited advantage of multiple sourcing due to the high interdependency of complex systems.

The role of senior management seems also to differ. Whereas creating slack capabilities and room for experimentation in the operational process is the role of senior management in high volume production firms, their tasks seems to more related to promoting the use of the innovation within the projects executed to customer order in complex systems firms (Christensen & Baird, 1997; Gann & Salter, 2000). Similarly, the tasks of heavyweight leaders seem to differ; coordinating and translating the needs of the different departments in high volume production organizations (Wheelwright & Clark, 1992) versus championing the use of the innovation in complex systems organizations (Blindenbach-Driessen & Van den Ende, Forthcoming).

Insert Figure 1 About Here

CONCLUSION AND DISCUSSION

The need for organizational barriers between the innovation and operational activities stems from both the organization and strategic literature and seems to be based on a traditional view of operational organizations; organizations geared toward the production of high volume goods in operational contexts with low complexity and uncertainty, and that are functionally specialized. Although these assumptions may still hold for many organizations, they may not hold for the operational organization of today's more flexible and agile firms such as system integrators and other knowledge intensive firms that operate in a more project-based manner.

Organizational barriers create challenges in the innovation process (Tushman, 1977). For firms with operational processes that are favorable for innovation, it may be possible to break down the traditional barrier between the operational and innovation processes within firms.

This will lead to different challenges in the innovation process that ask for a revision of the current innovation management theories. The model proposed in this paper suggests that the organization and management of innovation is dependent upon the characteristics of the operational organization of a firm, see Figure 1. This has implications for innovation management theory and practice and opens up interesting opportunities for future research.

Implications for theory

When it is sharing, reusing, recombining and accumulating knowledge that leads to innovation (Murray & O'Mahony, 2007), it will be important to consider the type of knowledge that needs to be shared or recombined and the organizational barriers that need to be crossed to achieve this knowledge sharing. In traditional functionally organized high volume production firms, it is the sharing and recombination of knowledge that resides within the different functional disciplines that leads to innovation. In these types of firms, crossing the organizational barriers between functional departments leads to novel ideas and innovation. The dynamic capabilities that enable these firms to renew themselves are thus focused on coordination and combining knowledge (Henderson & Cockburn, 1994; Teece et al., 1997), for which generic best practices exist (Eisenhardt & Martin, 2000).

There are no organizational barriers between functions in project-based organizations (Hobday, 2000) and there is no need for organizational barriers between the innovation and operational process, as the complexity, uncertainty and type of routines are similar in the innovation and operational process. What is then the kind of knowledge sharing and recombination that leads to novel ideas and innovations? Could it be that most of these firms use a supplier driven innovation model (Pavitt, 1984), because collaboration with suppliers enables these firms to share and recombine knowledge that leads to novel ideas and innovations?

When the capabilities of a complex systems producer are in coordinating and combining knowledge (Hobday, 2000), how are dynamic capabilities than distinctive from the firm's capabilities? Could it be that if coordination and combining are amongst the core capabilities of a firm, their dynamic capabilities need to be around creating a focus and creating specialized knowledge? Hence that new knowledge would not originate from coordination and combining knowledge that resides in functional silos, but instead would originate from fostering specialism. Fostering specialism is generally not amongst the capabilities of complex systems firms (Galbraith, 1977; Starbuck, 2006), and would require a distinctive process of coordination and combination. Yet, this process of coordination and combination would be clearly different from what is typically understood as dynamic capability within firms that produce high volumes.

70% Of the manufacturing firms, but only 30% of the service firms have a dedicated unit to foster innovation activities (Griffin, 1997). This paper provides arguments why from an organizational or strategic perspective it may not be necessary or desirable for firms to separate operational and innovation activities. The absence of an organizational barrier between the operational and innovation process will facilitate knowledge transfer (Hansen, 1999) and help to align innovation and operational activities (Van den Bulte & Moenaert, 1998). On the other hand, integration of operational and innovative activities may lead to less revolutionary exploration, as this will lead to more decentralized innovation efforts. In general, more centralized research and development leads to innovations with a higher impact, while decentralized research leads to more specific innovations (Argyres & Silverman, 2004). How can firms ensure that their innovation activities remain aligned and focused, upon the absence of a dedicated innovation unit? How do such firms remain ambidextrous, as it is difficult to combine exploration and exploitation efforts within a similar unit (Gupta et al., 2006)? Can these firms use instead a punctuated equilibrium model to alter exploration and exploitation? As most complex systems providers are high tech firms, would such a punctuated equilibrium model yield enough absorptive capacity to explore after a period of exploitation? Are these firms perhaps able to foster ambidexterity within the same unit, for example by replace structural ambidexterity with contextual ambidexterity (Gibson & Birkinshaw, 2004)?

The developed framework may also contribute to advance the service innovation management literature. Making a distinction between service and product innovation is cumbersome, as it is often difficult to disentangle the service and the product component of an innovation. Moreover, the results of these studies are often mixed (De Jong & Vermeulen, 2003; Henard & Szymanski, 2001). Instead of distinguishing between services and products, it may be better to take the organization of the operational process as the starting point. The innovation challenges within banks (Jansen et al., 2005, , 2006) seems to be very similar to that of the producers of high volume goods. Whereas the innovation process of an IT systems integrator may be more like that of a producer of lithography systems.

Using the characteristics of the operational process provides probably a sounder theoretical basis to study differences in the innovation management process than differences in the characteristics between goods and services.

Different disciplines use different theoretical lenses and methodologies when addressing innovation management (Brown & Eisenhardt, 1995). Without integrating the different perspectives of the innovation process, solutions provided within one perspective are likely to create challenges for another, i.e. the need for organizational separation between the innovation and the other activities of a firm from a contingency theory point of view (Burns & Stalker, 1994; Damanpour, 1991) leads to interfaces that are difficult to overcome at the project level (Colarelli O'Conner & DeMartino, 2006; Gupta et al., 1986; Vandervelde & Van Dierdonck, 2003). Integrating the different theoretical lenses and methodological approaches is therefore essential. This is also identified by others as one of the challenges for future innovation research (Gupta et al., 2007).

Implications for practice

The current innovation management literature is geared towards the challenges of firms that produce high volume goods in stable markets. The best practices that have evolved from this research stream (Brown & Eisenhardt, 1995; Gerwin & Barrowman, 2002; Henard & Szymanski, 2001; Montoya-Weiss & Calantone, 1994) are likely to be applicable in this context only.

Complexity, uncertainty and routines in the operational process and the dynamics of the markets in which complex systems firms operate lead to different challenges which likely call for different solutions and thus for a different innovation management approach than the best practices that are available for firms producing high volume goods. This may also help explain why it was difficult for Microsoft to come up with an new version of its office suite (MacCormack & Herman, 2000), or why engineering contractors in the Netherlands had difficulty to survive (Van Rooy & Homburg, 2002).

Limitations

The focus in this paper is on an innovation within an organization, while most firms have portfolios of innovation projects and collaborate with others. However, understanding the challenges of the innovation process of a single project in a single organization will be essential to understand the challenges of managing multiple innovation projects, or managing innovation projects among multiple firms. Moreover, this paper focuses on new product and new service innovations, process innovations or business model innovations are not considered.

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FIGURE 1

The need for organizational barriers in the innovation process

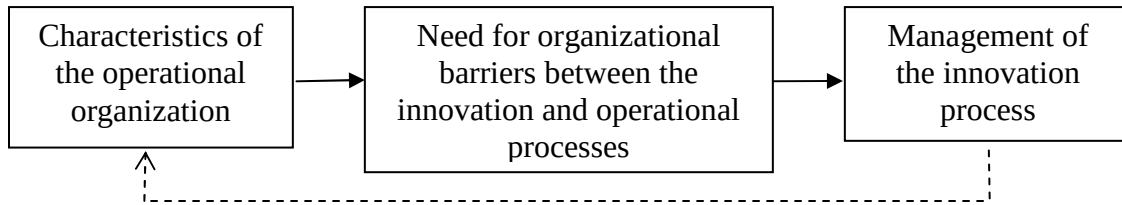


TABLE 1**Organizational characteristics of the operational organization**

Characteristics	High volume production^a	Complex systems production^a	Effect on innovation (Damanpour, 1991)
Specialization	High	High	Positive
Decentralization ^b	Low	High	Positive
Standardization / Formalization	High	Medium	Non significant
Administrative intensity ^c	High	Low	Negative

Note:

a) The characteristics for each type of production process are taken from Mintzberg (1980) and Van de Ven and Delbecq (1974).

b) Reverse of centralization

c) Administrative intensity is used by Damanpour, and is comparable to configuration used by (Child, 1972; Pugh, Hickson, Hinings, & Turner, 1968)[] and horizontal job specialization used by Mintzberg (1980).

TABLE 2
Challenges in the innovation process and proposed solutions

High volume producers			Complex systems producers	
Stage	Challenges	Proposed solutions	Challenges	Propose solutions
Idea generation	1. The operational characteristics reduce the possibilities for searching outside the firm's current comfort zone (Benner & Tushman, 2002)	1. Create an organizational barrier between the innovation and operational process (Benner & Tushman, 2003; Gupta et al., 2006; Katz & Allen, 1985; March, 1991; Roussel et al., 1991; Tushman & O'Reilly, 1996)	1. The high operational flexibility may make ideas outdated before they are developed (Hoch et al., 2000; Kessler & Chakrabarti, 1996)	1. Integrate the operational and operational processes (Griffin, 1997; Sundbo & Gallouj, 2000) ^a
Development	2. Functional specialization makes that information necessary for innovation is scattered over the functional disciplines. 3. The impact the innovation will have on the operational process is difficult to predict due to the complexity of establishing a high volume production process. This complexity makes it also difficult to evaluate design alternatives 4. Changes during the implementation stage are expensive (Buggie, 2002)	2. Cross-functional teams (Dougherty, 1992) 3. Cross-functional teams (Colarelli O'Conner & DeMartino, 2006; Gupta et al., 1985; Kessler & Chakrabarti, 1996; Sheremata, 2000; Swink, 2000) 4. Concurrent engineering (Brown & Eisenhardt, 1995; Terwiesch et al., 2002)	2. The project-based structure makes that specialist knowledge necessary for innovation is scattered over the projects executed to customer order (Galbraith, 1977). 3. It is relatively easy to predict the impact of the innovation on the operational process, as routines are more high level. At the same time it is difficult to find a balance between being generic, i.e. leave sufficient flexibility to facilitate the needs of the various customers versus being specific, reducing the flexibility due to the need to incorporate details to ensure the operability of the innovation 4. Finalization of details can be postponed to the implementation stage, when customer requirements are known	2. Expert teams of the same discipline (Blindenbach-Driessen & Van den Ende, Forthcoming) 3. ? 4. Simultaneous prototyping (Sommer & Loch, 2004) or modularity (Baldwin & Clark, 1997; Sanchez & Mahoney, 1996) ^a
Implementation	5. The organizational characteristics of the operational organization are unfavorable for innovation and the production organization lacks capabilities in experimentation and trial and error learning	5. Cross-functional teams, heavyweight project managers, job-rotation, start up teams, senior management support (Bonner et al., 2002; Brown & Eisenhardt, 1995; Edmondson, 2008; Song et al., 2006; Vandervelde & Van Dierdonck, 2003)	5. The organizational characteristics of the operational organization are favorable for innovation, experimentation and trial and error learning exist throughout the firm. Extreme decentralization reduces the commitment to take up the burden of implementing an innovation for the benefit of the organization as a whole. Limited room for failure when implementing an innovation on a project executed to customer order (Keegan & Turner, 2002).	5. Senior management support and heavyweight project leaders (Blindenbach-Driessen & Van den Ende, Forthcoming; Christensen & Baird, 1997; Gann & Salter, 2000)

(a) Concept could work but is not tested in this specific context.