Managing innovation in new product development: reviewing the performance of small and medium-sized enterprises

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Abstract
This paper reviews some aspects of the performance of small and medium-sized enterprises (SMEs) in responding to innovation and technological change when undertaking new product development. Focusing on the management of technology, it considers the role of interaction and collective learning in building firm competencies. Through the development of new or existing technologies, firms aim to improve quality and cost-efficiency and to out-innovate their rivals. This is far from straightforward. Innovation is a complex process shaped not only by the firm's internal environment, but also by the interactions that occur between the firm and the many different actors and institutions that make up its external environment. Many SMEs appreciate the value of these interactions in promoting innovation. However, for those involved in innovative new product development they also bring with them associated risks such as, for example, a lower proportion of return on their technologies brought about by imitation by their rivals.

Keywords: competences, new product development, innovation, technological systems

Introduction

Unlike large firms, SMEs do not have the means or resources to protect their innovation activities. Yet, by avoiding interaction with other actors such as firms and external research centres, they risk not only technological lagging, but also losing out on the services provided by their regional innovation support infrastructure. As a result, they must consider a trade-off between an expansion of their resources through, for example, access to new knowledge and support, against these risks.

This paper will explore how this affects the accumulation of competencies within new product development. The emphasis will be on the following aspects of new product development: the actors involved; the organisational characteristics; the risk elements; and the decision-making process. An understanding of these key factors may not only improve the process of design innovation, but may also increase the returns from these innovations through enhanced technology management.

The paper adopts a technological systems approach as a framework for analysis. By doing so, it will explore the nature of the interactions, exchanges and boundaries that occur between the different agents that make up a technological system. It will draw on its findings to develop some conclusions for entrepreneurial strategies as well as for policy-makers.

Research suggests that a cultural barrier exists that may impede the rate of design innovation (Filson and Lewis, pending). This extends beyond the level of the firm to include business culture, research culture, regional culture and national culture. Using the approaches mentioned above, this paper will provide a review of these matters rather than an attempt to resolve them.

Innovation and the small firm – the role of the external environment

The heightened awareness of the contribution of SMEs to economic growth over the past 20-30 years has been accompanied by an abundance of related literature. In recent

years, the focus has been on the significant role of innovation in promoting and sustaining this growth. The innovativeness of SMEs is widely recognised. For instance, a study carried out by the OECD (1998) found 50–60 per cent of SMEs regularly innovate. Indeed, some studies suggest that the innovative activity of SMEs has surpassed that of large firms (Rothwell, 1983; Chanaron, 1991; Khalil and Bayrakatar, 1994).

Inter-firm co-operation has been highlighted as one of the key determinants of successful innovation (During and Oakey, 1998). Such co-operation aids and promotes the transfer of knowledge, and information. With respect to technology, it is the transfer of tacit knowledge that is of particular importance. Such knowledge gradually builds up within the firm through experience and 'learning-by-doing'. It is not easily transferable and is highly dependent upon interactive linkages in aiding its dissemination.

As a result, networking and partnership play an intrinsic role in promoting the development of the firm's knowledge base. These are important elements during the process of innovation and suggest the existence of a *socio-economic* dimension influencing the innovation process. This goes beyond the assumption that market forces and economic efficiency are the key drivers of technological change and highlights a wide range of social, cultural and political forces at play.

The various different agents involved act together to form an innovation system that can be at the national, regional and / or sectoral level. The concept of technological systems is a useful tool, which permits closer examination of the relationships. In this context a technological system can be defined as:

> "a network or networks of agents interacting in a specific technological area under a particular institutional infrastructure to generate, diffuse, and utilize technology. Technology systems are defined in terms of knowledge and competence flows rather than the flows of ordinary goods and services. They consist of dynamic knowledge and competence networks," (Carlsson and Stankiewicz, 1991: 111).

Using this definition, a technological system can be viewed as constantly changing and evolving as knowledge and information flows (diffuses) throughout it. Although such a system may be international, evidence suggests otherwise, especially with respect to SMEs, firms limiting their interactions to a more regional or local level (Patel, 1993).

The importance of the firm's external environment is now commonly acknowledged, particularly with respect to its external linkages. These are often perceived as a prerequisite for successful innovation (Rothwell and Dodgson, 1993) promoting, for instance: shorter development processes; common standards; access to new knowledge; the development of technological capabilities or competencies; co-operative training; reduced risk; access to new markets, reduced competition and enhanced flexibility (During and Oakey, 1998). For the purpose of this paper however, we shall focus on the accumulation of technological capabilities relating this to the field of new product design.

The development of technological capabilities

At the heart of a firm's competitiveness are its *core capabilities* or *competencies*. These capabilities are firm-specific, built up over time from the firm's knowledge base and skills and are shaped by management and experience. These core capabilities contribute to variety, differentiating one firm from another. They are highly dependent upon the tacit knowledge that has developed within the firm and the way in which this is organised and managed through the firm's *routines* (Nelson and Winter, 1982), these being the forms, rules, procedures, conventions, strategies and technologies, beliefs and cultures that exist within an organisation (Dodgson, 1992).

Through learning, the firm is able to enhance its set of core capabilities and so increase or sustain its competitive position. The network (ie, buyer-seller, academic-industry) within

which a firm operates will strongly influence the level of knowledge and skills it is able to obtain from its technological system. In an effective technological system this exchange of knowledge and information is strongly dependent upon positive exchanges amongst its various agents. As Carlsson and Jacobssen (1996) point out, the sharing of information may give rise to a shared technological "vision" which may result in a reduction of perceived risk and co-operation between previously independent actors. This, in turn, may lead to the development of technological capabilities that can be transferred throughout the system. Through this, innovation is no longer singular to the firm, but becomes an interactive and co-operative process from which the firm benefits through the development of an enhanced set of knowledge and skills (capabilities).

However, such co-operation and interaction is very difficult to put into practice. Issues of trust, intellectual property ownership, the absence of formal agreements, cultural differences and opportunistic behaviour all serve to hinder the dissemination of knowledge and information (During and Oakey, 1998). SMEs, in particular, are often confronted by such issues. It is clear that if a firm wishes to innovate successfully it must interact with other organisations or institutions. The way in which the firm manages this will be strongly dependent upon its background and culture. This paper considers this further using the management of product development by SMEs as an example.

The management of new product development within SMEs

For successful firms innovation is a major issue. This paper has already highlighted the role played by the firm's external environment in providing knowledge and information. It is suggested that the design engineer plays a crucial role here, assimilating this knowledge into new products. According to Bailetti and Guild (1991), product designers can make three major contributions. Firstly, designers expand the firm's exposure to its external environment and are important in identifying knowledge and information that may be of potential benefit to the firm. Secondly, designers' experience and understanding of the core capabilities of the firm enables them to exploit them to their competitive advantage and develop a well-informed product specification. Finally, the inclusion of designers during the formulation stage may reduce the development stage of the product life cycle since they may be encouraged to work within the organisational restraints of the firm rather than against them as is often the case. It is widely accepted that significant cost-benefits can be achieved with the integration of design at the earliest stage of the development process.

However, in many firms designers are not always involved during the formulation of new products. Traditionally, their role is perceived as being that of a translator, transforming ideas into specific products by means of drawings, working models and the designing of products (Hise *et al*, 1989). Within SMEs, this is exacerbated further through a lack or shortage of design skills. In their study of 76 UK SMEs, Blessing and Yates (1999) found that people-related issues acted as a major obstacle to new product development, not only in terms of a shortage of designers but also in terms of poor communication both internally and externally. Unfortunately, senior management is unable to confront this issue since it is too preoccupied solving more immediate, short-term problems (Filson and Lewis, *pending*)

The strategic importance of tacit knowledge has already been underlined. Unlike explicit knowledge this cannot be easily codified and transferred. Mascitelli (2000) recently highlighted the need for managers to recognise the strategic importance of tacit knowledge with regard to new product development and to harness it to develop commercially viable products. However, to do so, tacit knowledge must be encouraged to flow if not freely throughout the firm, then at least amongst the design team. Mascitelli suggests a number of methods of accomplishing this: the development of a culture of innovation that will inspire the generation of new ideas and develop a "deep personal commitment"; the encouragement of risk-taking and experimentation, and the

creation of unique team identities.

Yet, if a firm wishes to build and develop its core capabilities it may need to look beyond the knowledge and skills that already exist within the firm. Interaction with other members of its technological system such as customers, firms and institutions are an important means of achieving this. Such co-operation requires an element of trust. This does not come naturally to SMEs, especially for those involved in new product development. It has been suggested that this may stem from a high level of conceptual rather than technical novelty being contained within design innovations. Such 'concept-based innovations' are more open to imitation by rival producers and may discourage interaction between firms (Tether and Massini, 1998).

The institutional environment

The institutional set-up of the firm's technological system also exerts a strong influence upon the innovative activities of the firm. Adopting Douglass North's (1991:97) definition:

> "Institutions are the humanly devised constraints that structure political, economic, and social interactions. They consist of both informal constraints (sanctions, taboos, customs traditions and codes of conduct), and formal rules (constitutions, laws, property rights)."

This suggests that an institute can act in one of two ways: either as a governing body or, less formally, along a set of behavioural norms. Institutions such as the educational system, bridging institutions and financial systems all have an important role to play in aiding the process of learning and competence-building. A comparative study of Danish and American wind energy technology between 1975 and 1990 found that firms in each nation adopted very different approaches on account of their institutional set-ups. According to Karnøe *et al* (1999:141):

> "The Danish and American entrepreneurs constituted their technological learning processes according to an "institutional logic" of innovation practices in each business system based on how engineers and workers enacted their social roles, skills and attitudes in relation to innovation and production….these business practices have co-evolved with the historical formation of the educational system and the technology and science policy system in Denmark and the United States."

In America, the approach to innovation had become more theoretical by the 1950s and was very much top-down and government led. A change in the engineering education system had resulted in design engineers who were more skilled in research and theory rather than practical design (Seely, 1993). This had an impact on the engineering practices at the time resulting in design engineers who were removed from the production process and a weakening of the mechanical skills base (Hayes *et al*, 1988).

In Denmark, the approach was much more 'bottom-up', hands on, and learning-by-doing. In terms of engineering there were two levels of education: the technical universities that produced academic engineers, and the advanced technical colleges that produced skilled workers. This resulted in the skilled workers competing with the academic engineers for managerial positions and maintained communication between the shop floor and management.

In terms of communication and interaction, this was strongly discouraged within the American firms both internally and externally. An extreme stance on secrecy discouraged co-operation and collaboration amongst engineers of the same firm, let alone with other engineers outside the firm. Although, there was some government support for the wind turbine industry by means of a test and research centre, SERI, there was little interaction between the two parties. Furthermore, the industry had little trust in SERI, which was not aided by SERI's futile attempts to keep up with the latest technological developments.

Conversely, in Denmark interaction and communication were much more open. The development process was more integrated

than American. Although it was led by the design engineers, all employees were encouraged to provide some input. This promoted co-ordination, communication and respect amongst the different groups and was highly productive. Furthermore, despite being rivals, Danish firms formed a "community of practitioners" (Karnøe *et al*, 1999) through which they developed informal relationships. They also co-operated formally with the Danish Wind Turbine Test Station (DWTS), developing a research agenda. In turn, the DWTS contributed greatly in promoting the transfer of knowledge throughout the Danish technological system and in sustaining and enhancing it's technology base.

Of the two technological systems discussed here, the Danish turned out to be the more successful (Karnøe *et al*, 1999). Regardless, this case study serves to illustrate the influence of the institutional set-up upon innovation within the firm and, also on the technological system within which the firm co-habits. The actors in each system developed their own approaches to learning, shaped by the socio-cognitive beliefs built up within the different institutional environments.

This case study also demonstrates how a more open approach to new product development may in fact promote innovation. However, this is very much dependent not only upon the culture inherent to the firm, but also to that of its technological system. Thus, a move to a more interactive approach to learning and technological development does not simply imply changes in the practices of the firm, but also of the various other actors within the system and is, therefore, a complex affair.

Conclusion

Although innovation is a path-dependent process built up from the capabilities inherent to the firm it is strongly influenced by its external environment. If a firm wishes to be competitive, it should consider enhancing and developing its skills and knowledge base. However, to do so it must consider co-operating and collaborating with other actors within its technological system.

In practice, this may be highly problematic, the willingness of the firm to engage in the transfer and knowledge being highly dependent upon a range of issues such as its institutional set-up and culture. In order to translate innovation successfully into marketable products, firms need to develop a well-informed management support infrastructure and, also, to recognise the importance of design during the development and production of new products.

As this paper has emphasised, such an infrastructure must recognise the value of tacit knowledge and the contribution that it can make to new product development. Successful firms need to develop and build their stock of tacit knowledge and this is most easily achieved through interaction with other members of its technological system. Studies show that informal interaction through events such as trade association gatherings, is a key means of promoting the transfer of tacit knowledge (Fritsch and Franke, 2000).

However, as the case study of the wind turbine industry in America and Denmark displayed, the national and regional support infrastructures also have an important role to play. Through frequent informal interactions, the Danish design engineers were able to develop a research agenda with their corresponding national research centre and also advance the technological frontiers of the Danish wind turbine industry. It is suggested that if national and regional infrastructures intend to support the process of innovation and new product development within firms they should encourage such openness.

The paper has also highlighted the importance of the design engineer in promoting innovation within the firm. Through the design engineer the firm is able to expand its exposure to its external environment. Also, the design engineer's understanding of the firm's capabilities places him/her in an ideal position to identify and exploit new product development opportunities of relevance to the firm. Through the full integration of design at the earliest stage of the development process, managers will not only achieve potential cost-benefits and an informed

product specification, but they may also promote a stronger sense of commitment amongst the design team.

Finally, from this paper it is evident that frequent interaction and communication are essential factors in the acquisition of knowledge, both within the firm and also its technological system. It is of particular relevance to SMEs who, in general, do not have sufficient resources to acquire new knowledge through conventional means; many relying upon their network linkages for the transfer of new knowledge and information. Although such knowledge may come with associated risks, the Danish case study shows that it is possible to interact with other actors of the same technological system without hindering the innovative performance of the firm. As this paper mentioned, such sharing of information may give rise to a shared technological vision. This may result in an actual reduction of perceived risk and the development of technological capabilities that can be transferred throughout the system.

Within the firm, communication and interaction may help in the development of a clear strategic vision. Such a vision is important in providing a long-term perspective. This is of particular relevance to SMEs, where short-term problems often prevent managers from thinking beyond the immediate future. Such short-termism is not conducive to promoting idea generation and risk-taking within the firm, both of which are important elements of the innovation process.

This paper has considered a range of issues. However, fundamentally, should a firm wish to innovate successfully managers must recognise the value of tacit knowledge and its contribution to the core capabilities of the firm. Should they wish to sustain or increase the firm's innovative potential, managers must consider ways in which they can enhance these capabilities. Adopting a systems perspective has helped to underline the importance of the firm's external linkages in achieving this. It has also identified the important role of the design engineer in providing an *interface* between the firm's internal and external environment, helping the firm to find a match between the firm's core capabilities and new product development opportunities. Only through recognising and raising awareness of this role during the development and production of new products can firms truly hope to innovate successfully.

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