Determinants of innovation through a knowledge-based theory lens

Daniel Arias Aranda
Management Department, Universidad de Granada, Granada, Spain
Luis M. Molina-Fernández
Management Department, Universidad de Granada, Granada, Spain

Keywords
Innovation, Management, Service industries, Spain

Abstract
In this paper, a model for determining innovation degree in service industries is presented. Such a model is developed under the knowledge-based theory lens. So, knowledge flows and knowledge integration capabilities of the organization's members are considered as crucial for the innovation processes to be successfully implemented. The model is tested in a sample of engineering consulting firms of Spain. Main results point out the strong explanatory power of innovation intensity with knowledge theory-based models. Final conclusions consider knowledge management policies as the main impellers of service innovation.

Introduction
Innovative management studies have endowed this discipline with a robust body of knowledge (Sundbo, 1997). Nevertheless, most of those studies have been developed for manufacturing firms, resulting in a lack of innovation studies in service firms (Martin and Horne, 1993; Amabile and Palombarini, 1986). In fact, the scarce studies performed in service firms have focused mostly on customer service innovations (De Brentani, 1989; Sirilli and Evangelista, 1998).

In this paper we intend to make a contribution to such lack of studies by identifying and analysing those relevant factors that foster innovation in service firms. For this study, a sample of Spanish engineering consulting firms is used for analysis.

Innovation in service firms
Measuring innovation outputs has been accomplished mainly through the relationship between innovation management and product design and development, especially for patenting (Pavitt, 1984). However, specific characteristics of service firms do not allow direct application of traditional models of innovation (developed for manufacturing firms) on service firms (Fitzsimmons and Fitzsimmons, 1996; Haksever et al., 2000).

Basically, services innovation literature assumes that service firms innovate (Barras, 1986; Normann, 1991) or at least develop R&D activities (Gallouj and Weinstein, 1997). Knowledge management literature reveals the increasing importance of innovation in those service firms in which knowledge turns into the main source of competitive advantage (Miles, 1963; Miles et al., 1994).

Both areas agree on the idea that innovation efforts need to be specially intensified in new information technologies-based services (Buzan, et al., 1995).

Innovation in service firms is progressively turning into a systematic process, especially for determined service industries such as electronic information services. For those industries, specific departments for management of R&D activities are created (Gadrey et al., 1994). Also, a higher contact with customers increases the role that customers play in the innovation process (Czepiel et al., 1985). Therefore, both R&D departments and customers become the main source of inputs for innovation.

However, innovation patterns in manufacturing and service firms are only similar for organisational and process innovations and not as much for technological innovations. The impossibility of patenting this kind of innovation and, therefore, protecting the returns generated out of these innovations shortens the life cycle of innovations dramatically (Barra, 1990). The product inverse cycle theory highlights the importance of new processes diffusion in the technological path of service industries (Barra, 1980, 1990). Hence, the innovation process must be intensive because innovations are implemented and copied at such a speed that continuous innovation efforts are required to keep up with a determined degree of differentiation in order to support the firm's strategy (Voss et al., 1992).

Traditional innovation theories consider innovation as a radical act generated by the introduction of a new element or a new combination of already known elements in a determined product (Kuhn, 1970; Schumpeter, 1934). For the technological-economic paradigm (Dosi, 1982; Dosi et al., 1988) the innovation process emerges in the R&D department from a scientific basis. On the other hand, the
entrepreneurship paradigm (Kent et al., 1982) considers entrepreneurship as the main innovative process (Kanter, 1983; Pinchot, 1985; Stewart, 1989). Finally, marketing science develops the strategic paradigm of innovation (Kotler, 1983) from which business strategy is considered the main determinant of innovation (Teece, 1987; Kanter, 1988; Nystrom, 1979; Porter, 1990; Rumelt et al., 1994). For this paradigm, innovations emerge not only from inside but also from outside the organisation. Also, incremental and radical innovations are distinguished in the innovation theory in order to consider organisational learning as a moderating and, at the same time, complementing variable of innovation (Abernathy and Utterback, 1978).

Service operation management literature emphasizes the role that back and front office activities play when adapting service to customer needs (Bowen and Youngdahl, 1998; Hart, 1996; Sampson, 1996). Therefore, these activities turn into a source for innovation in service industries subject to standardisation degree and technology dependence (Easingwood, 1986). Small adaptive changes configure the organisational learning, basic for managing individual variability of customers (Nelson and Winter, 1982). However, innovation and organisational learning are two different points of view of the same phenomenon. This way, organisational learning implies a continuous and progressive development, while innovation processes generate sudden developments with radical innovations based on preceding incremental innovations (Kanter, 1983, 1989).

In this study, we intend to increase knowledge about innovation management in service firms from a knowledge theory perspective. So, we will establish union links between both disciplines by explaining innovation through knowledge creation.

Knowledge in the innovation process

According to the resources and capabilities theory of the firm, knowledge is a source of competitive advantage (Connor and Prahalad, 1996). In fact, most tangible resources come from outside the organisation, so competitive advantages emerge from the way specific knowledge is applied to the production factors (Spender, 1996). Also, the importance of knowledge as a source of competitive advantage is still higher for those sectors on which innovations are being continually developed (Decarolis and Deeds, 1999; Pisano, 1994).

Knowledge-based theories are the key to explain determined firms’ behaviours such as:

- strategic alliances (Inkpen and Crossan, 1996; Kotug, 1988);
- mergers and acquisitions (Bresman et al., 1999);
- firms’ internationalisation (Johanson and Vahlne, 1977);
- diversification (Pennings et al., 1994); or

Also, knowledge management is crucial for successful launching of new products (Li and Calantone, 1998) and for the innovation process (Powell et al., 1996). Therefore, organisations base competition on efficiency when acquiring (Nonaka and Takeuchi, 1995), transmitting and integrating (Grant, 1996a; Zander and Kotug, 1995) and applying (Spender, 1996) knowledge. Next, a framework of how innovation capabilities of the firm are based on knowledge acquisition, integration and application is presented.

Knowledge acquisition

Innovation is partly based on finding new ways of combining production system outputs in order to increase efficiency (Schumpeter, 1934). This new combination implies a reconsideration of the firm’s inputs. Therefore, a new interpretation of the existing knowledge is essential for innovation (Galunic and Rodan, 1998).

New knowledge is supposed to be assimilated by the organisation members in order to become part of the organisation as a whole (Nonaka and Takeuchi, 1995). This acquired new knowledge interacts with the previous knowledge in order to modify total knowledge stock of the firm (Van den Bosch et al., 1999). Due to the existing relationship between all embedded knowledge in different levels of the organisation (Crossan et al., 1999), the generated knowledge will turn into the base to establish new routines and mental models. Therefore, knowledge flows coming from outside the firm become opportunities for service industries to recombine current stock of knowledge and create new knowledge. According to this idea, new ideas about new ways of developing processes and services will emerge from this new knowledge in order to, for example, improve customisation and/or process efficiency. Hence, the following hypothesis is formulated:
H1. Flows of knowledge on customers' needs increase the firm's degree of innovation

Knowledge integration
At the individual level, acquisition and use of knowledge requires specialization due to individuals' cognitive characteristics (Simon, 1991). Also, knowledge acquisition requires higher specialization than knowledge integration (Grant, 1996b). So, environments created inside the organisations generate the conditions that either foster or diminish knowledge application and integration when creating new and improved product and services. According to Demsetz (1981), the efficiency in knowledge acquisition requires individuals to specialize in knowledge specific areas, while knowledge application requires integration of different knowledge areas.

The nature of knowledge configures organisations' capability to transmit and integrate different knowledge efficiently. Many studies identify different knowledge characteristics that obstruct knowledge transfer and integration in an effective way. Zander and Kogut (1995) identified different factors such as codifiability, complexity, teachability, the extent to which knowledge can be observed when used and knowledge system-dependence. Szulanski (1996) identified causal ambiguity and novelty as the key factors when integrating new knowledge in the organisation. Simonin (1996a, b) identified the extent to which knowledge is tacit, specific and complex as impeders of knowledge integration in business strategic alliances. In fact, Hansen (1999) proved that communication and compromise levels among knowledge sharers also depend on knowledge nature. So, strong ties between knowledge sharers are crucial when knowledge is mainly tacit. However, weak ties work fine for explicit knowledge.

Active knowledge management fosters innovation by recombining current organisation knowledge (Galunic and Roldan, 1998). In this context, innovation transforms tacit knowledge into explicit knowledge (Zack, 1999). However, there is also loss of information during this process (Grant, 1996b).

There are also factors depending on the source and receiver of knowledge that affect knowledge integration and transfer. For instance, lack of absorption capacity of knowledge receivers (Cohen and Levinthal, 1990; Lane and Lubatkin, 1998) affects negatively organisational learning and innovation capabilities. Therefore, it is necessary to develop new techniques that improve knowledge communication and integration by providing new forms of knowledge sharer relationships (Szulanski, 1996). These new ways should remove cultural and organisational barriers (Simonin, 1999a) by developing a common mental code for all knowledge sharers (Hoopes and Postrel, 1999; Sackmann, 1992). In order to implement these techniques interpersonal relationships among members must be fostered to transfer and integrate tacit knowledge (Polanyi, 1966).

Innovation in the service industry requires the integration of different and highly specialized knowledge related to the service delivery system (Clark and Fujimoto, 1991; Leonard-Barton, 1992). Moreover, customer involvement in the service delivery system requires knowledge integration of front and back office activities. The following hypothesis resumes this idea:

H2. Improved techniques for knowledge integration lead to higher innovation levels.

Knowledge application
Knowledge by itself is not necessarily applicable to innovation. According to Chattopadhyay et al. (1999) managers' beliefs influence the strategic decisions of organisations. So, managers that foster organisational change tend to increase innovation efforts in organisations (Hage and Dewar, 1972). Moreover, organisational changes take place when current organisation turnover is compared to future and potential turnovers (Greeve, 1998). Positive feedback impulses innovation, creating what is called innovative inertia (Milliken and Lant, 1991; Miller and Chen, 1994). According to this idea, managers' perceptions about innovation needs affect the decision of compromising resources to either production or research efforts. The following hypothesis resumes this idea:

H3. Small perceptions of innovations needs lead to small innovation efforts.

Methodology
Sample
For this study, the service sector was chosen, particularly engineering consulting firms in Spain. This study was performed with a final sample of 71 firms over 127 questionnaires sent, which covers more than half of relevant existing firms according to Spanish Ministry of Industry data for 1998. Most of them are inscribed in TECNIBERIA (Spanish Association of Consulting Engineering Firms). Tables I and II show a description of
the sample by activity group, turnover and workforce.

Most sample firms are in the range of 50 and 500 million pesetas (€300,000 and €3,000,000) turnover (approximately 60 per cent) for the three activity groups. Civil engineering represents a higher percentage of the sample, 49 per cent, versus 17 per cent for industrial engineering and 34 per cent for natural environment engineering.

Operationalization of construct
Previous to the theoretical model analysis, goodness of the measurement model was analysed in order to assess reliability, unidimensionality and validity of the developed measurement instrument. Several items were designed to be reverse-scoring in order to avoid answer bias. Therefore, some items were modified to maintain consistency with the other items before performing the final analysis (Choi and Ebroch, 1998). So, for example, degree of product standardization was considered as negative according to the lack of necessity perception to carry out product innovation efforts, so it was reverse-scored.

Innovation
Innovation degree can be measured either by considering innovation inputs or outputs. On the other hand, this type of measures does not seem appropriate for service firms due to the service intangibility. For this reason, a three items scale was developed based on the work of Berry et al. (1991), Bowen and Youngdhal (1996) and Sampson (1996). These items are related to processes and products innovation, and use of resources specially dedicated to innovation. According to this basis the INNO variable was built.

Ensuring that the scale fulfills conditions of internal consistency, not only through reliability of linear combination of the variables (Nunnally, 1967) and Cronbach's alpha, but also through factor analysis to determine unidimensionality (Aragon-Correa, 1998) was performed to assess validity of theoretical results. A 0.92 alpha coefficient value was obtained. An exploratory factor analysis was performed, obtaining only one eigenvalue higher than the value of one, so unidimensionality was assured (Germain et al., 1994). A confirmatory analysis was not performed since shortage of degrees of freedom diminishes power of analysis (Parasuraman et al., 1994). In turn, the convergent validity of the scale is demonstrated through a high value of the factor scores (>0.90), as for the shared variance (0.80), above the recommended value of 0.50 (Hair et al., 1998).

Flows of external knowledge
In this paper only customer knowledge that is eminently tacit is considered. Due to tacit knowledge characteristics, such knowledge is the most likely to become a source of competitive advantage in the innovation process (Prahalad and Hamel, 1990). Since knowledge integration in the innovation process is complicated, this study focuses on those mechanisms that the organization uses to ensure that this knowledge is integrated in the innovation process. Although customers' knowledge is distributed in the organization among employees with a closer contact with customers (Lessard and Zaheer, 1996), employees in charge of integrating this knowledge in the development of new processes and services will not be able to use this knowledge due to organizational barriers (Shirley, 1982). A variable (barriers to external knowledge flow: BEKF) was developed that referred to:
1 the physical distance between back-office activities and customers;
2 access availability of customers to back-office activities; and
3 whether there is a clear delimitation among back and front-office activities. This indicator measures the way flows of customer knowledge are integrated with innovation workforce knowledge. Cronbach’s alpha value was 0.79. Unidimensionality of the measurement scale was assured through an eigenvalue higher than one. Convergent validity, measured through high factors score (> 0.65) and shared variance (0.66) was also assessed.

Integration capacity
Organization members’ stocks of knowledge should be overlapped, so integration costs were kept to the minimum. Therefore, knowledge integration is fostered by sharing “thought-worlds” among the members of the organization, based on common meanings for determined and widely-used concepts (Dougherty, 1992). In the same way, establishing mechanisms to share tacit knowledge in order to encourage worker participation in different tasks allows the creation of an intersection among the stocks of knowledge. So, integration capacity (INTCAP) is measured using the degree of workers’ ability to perform different tasks, the rotation degree between the workers’ tasks and the company’s expenses in specific formation. This way, while the first item measures the creation of common knowledge due to the interaction process among people with different backgrounds, the last item refers to the creation of a group of common meanings and beliefs in the company that allows effective communication. Cronbach’s alpha value was 0.82. Unidimensionality and the convergent validity (factor score > 0.87; shared variance: 0.66) were also assessed.

Manager perceptions of service adaptation
Managers are willing to invest in innovation once they consider that customers’ needs are not fully satisfied by current products. On the other hand, when they consider that the products are totally adapted to customers’ needs, services are completely customized, or when it is not necessary to increase current offered services because the company is focused on a small segment of customers, they might consider investment in innovation as not being crucial from a competitive point of view. This way, we developed a three items scale (LACKNEC) that measures the managers’ perception of the service adaptation to the customers’ needs. So, the higher the score of a company, the lower is the perception of improvement and innovation lack of necessity.

The lack of necessity measurement scale fulfills the characteristics of reliability (0.85), unidimensionality and convergent validity (factors score > 0.81; shared variance = 0.58).

Result
Previous to the hypothesis testing, the degree to which the multicollinearity among the construct can affect the analysis results was studied. The eigenvalue spectrum multicollinearity diagnostic was used (Myers, 1986). The condition number of this test, that is to say, the ratio between the highest and the lowest eigenvalues of the model have been calculated. In our model, this ratio was of 24.2. Myers (1986) suggests that researchers should keep in mind possible collinearity problems if the condition number is higher than 1,000. Further, if there were collinearity problems, then the model parameters values follow the lowest eigenvector pattern. This condition is not satisfied in our model, assuring that multicollinearity does not affect the coefficients’ values.

Data were analysed using ordinary least squares regression. Results can be observed in Table III. Three different models were built to verify the hypotheses. In the first model, only an exogenous variable measuring organizational barriers that impede customer knowledge to be incorporated in the innovation process was introduced. This model was significant and explained 39 per cent of the variance in the service firms innovation.

In the second model, the manager’s beliefs according to the service offered by the company were considered. Using both flows of external knowledge as much as the lack of perceived need to innovate, the model is able to explain 53 per cent of the innovation variance, being the $F$-statistic of 40.47 ($p < 0.001$).

In the last model, a variable that measures the knowledge integration capacity of the organization’s members was introduced. As in the second model, the explained variance increases regarding both previous models. This model explained 56 per cent of the total variance. In turn, in the complete model as well as in the previous models, external knowledge flows’ barriers ($p < 0.01$), the lack of necessity perception ($p < 0.01$) and the integration capacity ($p < 0.05$) are highly significant when explaining organizational innovation. All the casual relationships were as expected in the hypotheses formulation.

Therefore, the proposed model based on the knowledge theory demonstrates a strong
explanatory power about the innovation intensity, in support of the three hypotheses.

**Conclusions**

Innovation patterns vary in service industries versus manufacturing industries. Knowledge management plays a fundamental role when managing service innovation efforts. Service innovations remain a source of competitive advantage in the market for short periods of time. As soon as competitors detect that new successful behaviours or service-products are present in the market, they tend to imitate them. Also, customer needs and tastes are continually changing according to such service-product launching policies. Hence, service innovation efforts must be based on customers' knowledge of the firm in order to be competitive.

Knowledge management policies are the main drivers of service innovation. Design of new service delivery system must take into account possible customers' behaviours and perceptions. Therefore, the more flexible and versatile knowledge management policies are, the faster and more robust innovation efforts are. Service industries should use versatile human resources policies for easy and innovative knowledge sharing.

**References**


Kuhn, T. (1970), The Structure of Scientific Revolutions, Chicago, IL.
Miles, I. et al. (1986), Knowledge-intensive Businesses Services: Their Roles as Users, Carriers and Sources of Innovation, Prest, Manchester.
Stewart, A. (1990), Team Entrepreneurship, Sage, Newbury Park, CA.