Characteristics of the Innovation Process in French SMEs of the Construction Industry

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Abstract

The paper aims at presenting how SMEs of the French construction industry innovate. The paper focuses on the nature of the innovations (product, process, organisation, marketing), the way firms use internal and external resources to innovate. SMEs usually represent around 90% of the firms of the construction industry. Understanding how SMEs manage innovation can help public authorities who aimed at supporting innovation in construction and promoting new building regulation. To fulfil these goals, the paper defines innovation in construction and SMEs. The empirical analysis draws upon face-to-face and telephone interviews with general managers of SMEs and executives of large groups. Results indicate that most contractors use their own resources to innovate whereas suppliers appear more opened to external knowledge. This is probably due to the nature of the innovation process followed by contractors and to the fact that contractors invest less in R&D. This reduces their ability to identify and apply external knowledge.

Keywords: innovation, SMEs, collaboration, absorptive capacity
1. Introduction

The construction industry is often criticized for its inability to innovate, to improve its practices and to provide value for its clients. The low level of R&D, the fragmentation of the industry, the inability to learn from one project to the other, the procurement process mainly based on tendered price and the conservatism of employees of the building site are often put forward to explain this situation. In the Egan report (1998) construction was considered “as a business that is unpredictable, competitive only on price not quality, with too few barriers to entry for poor performers”.

But construction is also praised for its ability to achieve complex and exciting projects such as the Sydney Opera and the construction of Terminal 5 at Heathrow Airport (Brandon, 2006).

Critics concerning the poor level of innovation in the industry are also biased as it was indicated by Winch (2003). Reports usually tend to present a narrow definition of construction. Architectural and engineering consulting firms are usually excluded from this definition while they carry out most of the design and research activities. Including upstream (e.g. manufacturing), parallel (e.g. architectural and technical consultancy) and downstream (e.g. facility management) activities would give a more innovative image of the industry (Sexton et al., 2007).

One element really differentiates construction from all other sectors. It is the high number of very small firms. In France in 2007, among the 369 100 firms of the industry, 339 900 (92.1%) employed less than 10 employees and contributed to 33.44% of the production (Commissariat Général au Développement Durable, 2009). Conversely the number of firms employing more than 250 people is limited. They were about 300 in 2007 representing less than 0.1% of the firms of the industry. Their contribution to the production reached 20.2%. Similar results were found for Finland, Poland and Spain (BUILD-NOVA, 2006).

The way these small firms innovate has benefited from a growing interest. Lu and Sexton (2006) focused their research on small construction knowledge-intensive professional service firms. Manley (2008) examined the case of small Australian firms through five in depth case studies. Barrett and al. (2001) also based their research on a limited number of cases (seven) to determine the meaning of innovation for small firms and to understand how SMEs from the construction industry manage and exploit innovation.

The aim of this research paper is to contribute to this ongoing interest for innovation in SMEs. This issue is particularly acute within the context of the new building regulations and the ambitious targets set up by the French government for the construction industry. The aim is to

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1 The Commissariat Général au Développement Durable distinguishes three categories in its classification: building construction, installation and finishing and civil engineering.
reduce drastically the energy consumption and the level of greenhouse emissions of buildings. By 2015 low energy buildings have to become the standard for new buildings and by 2020 all new buildings have to be “zero energy”. The success of this policy partly relies on the capacity of SMEs to propose new products and services and to change their habits to improve project quality.

The paper exposes the innovation process adopted by small contractors of the French construction industry. The situation of suppliers is also presented as a comparison. The second and third sections define innovation and SMEs. The following sections focus on the method and results of the empirical analysis. The conclusion summarises the results, allows some recommendations to public authorities and sketches out directions for further research.

2. Innovation

According to the Oslo Manual which becomes the reference for analysis dealing with innovation, “An innovation is the implementation of a new or significantly improved (good or service), or process, a new marketing method, or a new organisational method in business practices, workplace organisation or external relations. (…) The minimum requirement for an innovation is that the product, process, marketing method or organisational method must be new (or significantly improved) to the firm. This includes products, processes and methods that firms are the first to develop and those that have been adopted from other firms or organisations” (OECD, 2005, p.46).

Overlapping between products, process, marketing and organisational innovations may exist. For services innovations the separation between product and process innovation is quite difficult because "the term 'product' frequently includes a process: a service package, a set of procedures and protocols, an 'act’” (Sundbo and Gallouj, 2000, pp.45).

Innovations can also be classified according to their impact which is linked to the degree of novelty. Incremental innovation introduces minor changes to existing goods and services. It tends to reinforce the competitive advantage of established firms. Defaults of implementation are also less risky. Conversely radical innovation “has a significant impact on a market and on the economic activity of firms in that market” (OECD, 2005, pp.58). Radical innovation has more pervasive effects. It also generates new behaviours and resistances to changes.

The notion of architectural innovation introduced by Henderson and Clark (1990, pp13) indicates that innovation may be radical when it modifies the link between the component of a system: “The use of the term architectural innovation is designed to draw attention to innovations that use many existing core design concepts in a new architecture and that therefore have a more significant impact on the relationships between components than on the technologies of the components themselves.” This type of innovation is particularly important in construction. For example if one considers the case of photovoltaic membrane system, it
comprises several components: one photovoltaic cell, one roof deck and one roof membrane layer. The membrane can be disposed between the photovoltaic cell and the roof deck. The overall architecture of the system lays out how the component works together. The aim of the system is to provide a system for producing energy but also for creating a thermal barrier, isolating the building and bringing watertightness. Each component of the system performs distinct functions: the photovoltaic cells produce electricity and the roof membrane layer isolates the roof deck from the photovoltaic cell. One of the issues is to be sure that the actors in charge of incorporating a photovoltaic membrane system into the building have the competencies to do it. It is necessary for the performance of the system that the implementation of one component is done in such a way that it does not modify the performance of another component.

3. Small construction firms and innovation

3.1 SME: a definition

According to the European Commission (2005, pp.13-14) “the category of micro, small and medium-sized enterprises consists of enterprises which employ fewer than 250 persons and which have either an annual turnover not exceeding 50 million euro, or an annual balance sheet total not exceeding 43 million euro. Within this category:

- Small enterprises are defined as enterprises which employ fewer than 50 persons and whose annual turnover or annual balance sheet total does not exceed 10 million euro.
- Micro enterprises are defined as enterprises which employ fewer than 10 persons and whose annual turnover or annual balance sheet total does not exceed 2 million euro.”

The question of the autonomy of the firm is also important because it means that the firm is not linked to another enterprise.

3.2 Innovation propensity of SMEs

The question of the relation between firm size and the propensity to innovate has been widely examined in the economic literature. Most of the empirical results which tried to appreciate the roles of both small and large firms have been inconclusive. The controversy was already present in the work of Schumpeter (1935). In the early version of Schumpeter's theory, the innovating entrepreneur appeared to be at the core of the economic development. Then he suggested that "formally organized R&D labs administered by large corporations are the source of most innovation in modern capitalist society" (Cohen and Levin, 1989, p.1071).
The advantages of large firms are usually ascribed to their greater financial resources and their ability to benefit from complementary resources (large distribution and commercial facilities). They benefit from their market power to establish high barriers to entry and destabilize smaller firms (Rothwell and Dodgson, 1994). They also gain from economies of scale and scope in R&D thanks to their portfolio of products and their broad technological base (Nelson, 1959).

However large firms are often locked in to well-established routines and unable to adapt their structure to unstable and unpredictable environments (Darréon and Faiçal, 1993). Small firms have greater incentives to develop new activities and to pursue new approaches which go beyond the boundaries of large and established firms. The absence of hierarchical levels and horizontal communications favours quick reaction to keep abreast of environmental disturbances and fast changing market requirements. The inconclusive nature of these arguments suggests the existence of complementarities between small and large firms (Rothwell and Dodgson, 1994).

### 3.3 Innovation in construction SMEs

Researches on innovation in SMEs have benefited from a growing interest over the last few years. Seaden et al. (2003) point out that small firms of the construction industry are usually more risk averse and record lower intensity of use of innovative practices. Sexton et al. (2007) also consider that the structure of the industry inhibits innovation. Most firms employ less than five people. These firms “have limited capacity to innovate due to their management abilities, limited resources and reduced opportunities for supply chain driven innovation because of their inability to form long-term relationships with other firms”.

Sexton and Barrett (2003) distinguish two types of small construction firms according to their modes of innovation. Under Mode 1, the firm has a limited influence on its environment. Innovation is driven by “cost oriented relationships between the client and the firm” (idem, p.629). Under Mode 2, the firm is proactive. It has the ability to influence its external environment because of its innovation capabilities (its organisation, its human resources). “Mode 2 innovation concentrates on progressing multiple project, value-oriented relationships between client and the firm.” Under Mode 2 firms are involved in networks that help them to exploit the external knowledge stock. Networks reinforce SMEs' competitiveness by providing them with a window on technological change, sources of technical assistance, market requirements and strategic choices made by other firms. According to Cohen and Levinthal (1990), firms’ ability to exploit external knowledge depends on their “absorptive capacity”. Reichstein and al. (2005) suggest that construction firms are characterised by a low level of “absorptive capacity”.

Manley (2008) shows that small and innovative construction firms were able to establish relationships with external actors such as research centres. These links were considered as one key element in the success of the innovations. Those firms were evolving in Mode 2.
Pries and Dorée (2005) indicate that small Dutch construction firms are more involved in process innovation than large ones that tend to favour product innovation. Their analysis also shows that “most innovations are the result of enterprises operating individually” (pp563).

Lu and Sexton (2006) examine the nature and process of innovation for small construction knowledge-intensive professional service firms such as architects. A single case study is used to understand how a small architectural firm innovates, develops and manages knowledge. It shows that these firms and small contractors do not follow the same innovation path. Innovation in knowledge-intensive service firms is co-produced by knowledge workers and clients.

According to the fourth Community Innovation Survey (SESSI 2006)\(^2\), 39.4% of the firms from the French construction industry declared that they were innovative between 2002 and 2004 (this is less than firms from industry and services). Firms employing between 10 and 49 employees (38%) were less likely to engage innovation activities than firms employing more than 250 people (70.1%). Innovative products represented about 12% of the turnover of these firms. Financial factors were considered as a barrier by about 43.6% of French innovative construction companies. The lack of competences, marketing factors and the lack of incentives respectively only concern 31%, 30.3% and 13.3% of the firms. The three sources of information considered as important for innovation by construction firms are the firm itself, suppliers and clients / customers. University is the less important (it is quoted by 0.4% of innovative firms) than fairs, press and professional association.

However the Community Innovation Survey has two limits. Firstly it presents a narrow definition of construction. Such a definition does not integrate all the activities and the services provided by the built environment (Carassus, 2002). Secondly it excludes enterprises with less than 10 employees that represent the bulk of the firms of the construction industry.

4. Data and method

In 2000 a National Innovation Award concerning construction firms was launched in France. Every two years until 2006, companies were invited to present innovations that have been successfully implemented. Innovations were classified into four categories (table 1): building techniques; safety & work conditions; methods & organizational schemes and environmental approaches. Contractors were mainly targeted. Applications were judged by a jury of people working for the construction industry.

Table 1: Categories of innovations according to the activity

\(^2\) For the first time firms from the construction industry were surveyed. 25,997 firms working for the construction industry were identified. 1616 firms from the construction industry employing more than 10 employees received the postal survey and had to answer about their innovative activities during the period 2002-2004. About 86% replied.
The aim of the committee which organises the awards was mainly to promote the image of the construction industry and the diffusion of innovation within the industry. Indeed construction is often characterised by its inability to learn from one project to the next and to re-invent the wheel (Winch, 1998; Gann and Salter, 2000).

In 2003, CSTB was commissioned to examine the impact of the awards granted in 2000 and 2002. Firms were questioned about the origin and the diffusion of the innovation, the organisation of the innovation process, the results of the innovation and the impact of the award.

Sixty-three face-to-face and telephone interviews with general managers of small companies and technical executives of large groups were carried out by CSTB. This represented 77 innovations awarded out of 97. The difference was mainly caused by the unavailability of executives and the bankruptcy of some construction companies. In four cases, enough information about the firms and the innovation was available. Consequently 81 innovations constitute the sample of analysis. Sixty-four of these innovations were developed by contractors, fifteen by suppliers and two by firms working for civil engineering.

The analysis will mainly focus on the nature of the innovation and the way contractors organise the innovation process.

5. The nature of the innovations and firms motivations

Table 2 reveals that product innovation is dominant for all firms but mainly for suppliers. Data from SESSI (2006) indicates that product and process innovations respectively represent two-third and one third of the innovations introduced by suppliers and general contractors. Conversely organisation innovations mainly concern contractors who tend to innovate by focusing their resources on the effective management of the building site which can be considered as their core activity. The importance of organisation innovation in the construction industry indicates that construction firms are quite innovative and may not be “last among equals” as it was exposed by Reichstein et al. (2005).
Table 2: Distribution of innovations according to the activity

<table>
<thead>
<tr>
<th>Sub-sectors</th>
<th>Product</th>
<th>Process</th>
<th>Organisation</th>
<th>Process and organisation</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Building and construction</td>
<td>30</td>
<td>15</td>
<td>13</td>
<td>6</td>
<td>64</td>
</tr>
<tr>
<td>Civil engineering</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Suppliers</td>
<td>13</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>15</td>
</tr>
<tr>
<td>Total</td>
<td>43</td>
<td>17</td>
<td>13</td>
<td>8</td>
<td>81</td>
</tr>
</tbody>
</table>

The nature of the innovations is strongly influenced by the motivations of the firms. Innovative contractors who were interviewed were pursuing three objectives:

1. Improving the performance of their company;
2. Following new regulatory constraints;
3. Creating a new market.

Most organisation and process innovations aimed at improving the performance of the enterprise by increasing the productivity, mitigating the pain supported by the workers, ameliorating the safety and the working conditions of the building site.

Product innovations are mainly developed by contractors who intend to create a new market or to adapt products to new regulatory constraints. This is particularly the case for environmental innovations that often aimed at reducing / recycling wastes emanating from the building site and improving the energy consumption of the building.

6. Sources of innovations

Pavitt (1984) who was the first to put ahead the existence of sectoral patterns of technical change categorised general contractors as “suppliers dominated firms”. Firms from this category devote few resources to R&D. They focus their innovative activities on processes. “Most innovations come from suppliers of equipment and materials, although in some cases large customers and government-financed research and extension services also make a contribution” (Pavitt, 1984, p.356).

Most firms of our sample (table 3) use their own resources to innovate (57 out of 81). For small firms the manager is always at the origin of the innovation. In SMEs, the manager bears the responsibility of taking the decisions regarding all aspects of technical change. The dominant role of the manager in small construction firms can be either an advantage or a barrier to innovation. It is a source of flexibility and adaptability to any changes in market conditions and client demands. But it “can constrain innovation activity if the owner does not have the
necessary vision and systemic thinking when diagnosing and progressing innovation activity” (Sexton and Barrett, 2003, pp.631-632).

Many managers are too busy with their day to day activity to spend time to exploit their innovative ideas. In many cases only few ideas are developed during managers’ spare time. Thus some innovations may take several months before being implemented. Conversely innovations aiming at solving recurring problems which disrupt the daily activity of the operatives working on the site are developed immediately during the course of the project. Many managers frequently even consider that they do not innovate. The empirical results of Slaughter (1993, pp.86-87) confirm this idea. User-builders’ innovations “were ad hoc responses to problems encountered in the course of a construction project that an innovating builder was engaged in.”

**Table 3: Origin of innovations according to firm size**

<table>
<thead>
<tr>
<th>Origin of innovation</th>
<th>Within the firm</th>
<th>Client(s)</th>
<th>Regulations</th>
<th>Cost-oriented procurement process</th>
<th>Other</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sub-sectors</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Contractors</td>
<td>47</td>
<td>5</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>64</td>
</tr>
<tr>
<td>1-49 employees</td>
<td>23</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>31</td>
</tr>
<tr>
<td>50-249 employees</td>
<td>4</td>
<td>2</td>
<td>0</td>
<td>3</td>
<td>0</td>
<td>9</td>
</tr>
<tr>
<td>250 and more employees</td>
<td>20</td>
<td>1</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td>24</td>
</tr>
<tr>
<td>Civil engineering</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Suppliers</td>
<td>9</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>15</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>57</td>
<td>9</td>
<td>6</td>
<td>4</td>
<td>5</td>
<td>81</td>
</tr>
</tbody>
</table>

As indicated by Pavitt most contractors innovate without relying on a R&D department as they do mainly project specific innovations. Innovations are developed during the course of a project and are frequently used for one project. Most of them are incremental. For example 75% of the in-house innovations promoted by one of the major French contractors concerned improved methods (Cousin, 1998).

Table 3 also indicates that regulations and cost-oriented procurement process are sources of innovations for contractors. It stimulates innovation by changing the rules of the game. Cost-oriented procurement process particularly concern contractors. Organisation and / or process innovations are one way to be more competitive and productive and to satisfy clients who tend to select enterprises almost exclusively on the basis of tendered price. Using SESSI’s data, Tessier (2008) indicates that organisational innovations are for contractors the main way to improve the satisfaction of clients.
7. Innovation and collaboration

To innovate firms can less and less rely on their own resources. Technology has become so complex that it can rarely be handled by individual corporations. Even the biggest companies are touched by this phenomenon. Successful innovations appear heavily dependent on collaboration between several actors. However it appears from our sample that most contractors (62.5%) did not collaborate with any external partners to develop their innovation. These results are similar to those detailed by Pries and Dorée (2005) for the Netherlands. The fact that many innovations concern the organisation of the firm and that these innovations do not require large amount of money to be developed may explained this situation. But table 4 also reveals that when collaborations are established, firms will look for suppliers. This result is consistent with Pavitt’s classification. Suppliers as providers of technology are regular partners who take part to the development of innovations conceived by contractors. In many occasions they have strong interests in participating to this process. Once the project is over they can benefit from the innovation by developing it and commercialising it to other users. Conversely contractors are not interested in spending resources to the development and commercialisation of products that are not connected to their core business. Such a diversification would be risky. As indicated by Slaughter (1993) contractors develop innovation on the building site in order to use it but not to sell it. Cooperation between contractors and manufacturers appears as a win-win situation.

Cooperation between contractors and clients are limited. When clients are the end users and can benefit from the innovation then they have an incentive to be involved during the innovation process (Bougrain, 2008).

Table 4: Collaboration during the development of the innovation process*

<table>
<thead>
<tr>
<th>Origin of innovation</th>
<th>No collaboration</th>
<th>Supplier</th>
<th>Client</th>
<th>Research institutions (R&amp;D lab, university)</th>
<th>Other</th>
<th>Number of firms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sub-sectors</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Contractors</td>
<td>40</td>
<td>12</td>
<td>2</td>
<td>4</td>
<td>8</td>
<td>64</td>
</tr>
<tr>
<td>1-49 employees</td>
<td>19</td>
<td>4</td>
<td>0</td>
<td>4</td>
<td>4</td>
<td>31</td>
</tr>
<tr>
<td>50-249 employees</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>3</td>
<td>9</td>
</tr>
<tr>
<td>250 and more employees</td>
<td>17</td>
<td>5</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>24</td>
</tr>
<tr>
<td>Civil engineering</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>2</td>
</tr>
</tbody>
</table>

5Slaughter (1993) indicates that the total cost of innovations introduced by residential builders was very low, averaging $153.

4 “Manufacturers and suppliers who are unaware of the changes required to implement their innovations, either in the links to other components, processes, or systems or in the product itself are likely to meet resistance in the spread of their products” (Slaughter, 2000, p.15).
Despite its limited size the sample of analysis shows that a majority of suppliers (9 over 15) established partnerships with other actors. Five cooperative agreements involve research institutions. Conversely it seems that contractors are less able or eager to exploit knowledge developed by formal research institutions. They may not need such external knowledge. But such a situation may also result from the lowest level of R&D expenditures spent by contractors. According to Tessier (2008) R&D intensity is 2.2% for construction (broad definition). But without upstream activities R&D intensity drops to 0.5%. To collaborate with university and R&D centres firms must be able to recognise the value of external knowledge flows. It can be done only if firms have developed “absorptive capacity”. Contractors who do not spend high level of expenditures in R&D are probably less able than suppliers to identify, assimilate and use the external knowledge generated by research institutions.

8. Conclusion

The paper aims at presenting how SMEs of the French construction industry innovate. It points out that organisation innovation is quite important for contractors. It results from the project-based nature of the construction activity. It also implies that most studies focusing on product and process innovations tend to underestimate innovations within building firms. To innovate most contractors use their own resources whereas suppliers appear more opened to external knowledge. This is probably due to their lowest level of R&D expenditures that limit their ability to identify and apply external knowledge. However the study is subject to some limitations. It was not possible to precise whether the low number of cooperative agreements between contractor and external actors was due to their low “absorptive capacity” or to the fact that they do not need as much external knowledge to innovate as suppliers.

These results have some implications for the French environmental policy dedicated to the construction industry. Many actors considered that the new regulation and the ambitious targets set up by the French government will considerably modify firms’ business environment. According to Escribano et al. (2009) in turbulent knowledge sectors the “absorptive capacity” plays a crucial role. This means that firms with low absorptive capacity such as contractors will be less able to innovate and to implement new solutions that comply with regulatory standards. The development of training programmes that raises the absorptive capacity of small contractors would probably be a first step towards a better implementation of the regulations concerning low energy buildings. But further research should be done at this level to

<table>
<thead>
<tr>
<th>Suppliers</th>
<th>6</th>
<th>2</th>
<th>3</th>
<th>5</th>
<th>1</th>
<th>15</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>46</td>
<td>15</td>
<td>5</td>
<td>11</td>
<td>9</td>
<td>81</td>
</tr>
</tbody>
</table>

* Several partners can be involved in one project.

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5 «Turbulent knowledge environments are those where the underlying knowledge base is subject to a process of continuous evolution and change» (Escribano et al., 2009, pp.100).
understand better the link between the “absorptive capacity” of small contractors and their ability to innovate and cooperate. It is quite well recognised that most contractors employing less than ten employees lack competences to innovate but nothing proves that they need to establish better links with research institutions to innovate. Not all external sources of knowledge are a source of competitive advantage.

Many innovations developed by contractors are non-technological while most public programmes supporting innovation aim at fostering technological innovation. Consequently public authorities tend to neglect contractors. Further research should also be done to find appropriate tools to support and stimulate innovative contractors. A first consideration would be to take into account the specificities of the project-based activity.

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References


