RESPONDING TO GLOBAL ISSUES: SUSTAINABILITY AND INNOVATION IN THE AUSTRALIAN SME RESIDENTIAL BUILDING CONSTRUCTION SECTOR

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Abstract

The construction industry is a significant component of many economies and typically contains a high proportion of small and medium enterprises. However, it is generally understood that this industry is fragmented, adversarial, not highly innovative and not quick to respond to change. At the same time, the industry is under pressure to continue to embrace new technologies and methods, and to adapt better to current and emerging global issues such as sustainability. In order to meet these challenges, firms in the industry need to understand the issues involved and manage their practices accordingly. This paper describes exploratory research into the role of innovative and environmentally sustainable design and construction practices in one group of construction firms, viz., smaller residential building firms in Queensland, Australia.

Keywords: Innovation, sustainability, design, construction, building, residential, material, global, environment.

1. Introduction

The construction industry is a significant component of the Australian economy, which, in the five years to 2003, contributed an average of almost 6 per cent of Australia's gross domestic product and, in 2003-03, was Australia's fourth largest industry [1]. One of the features of this industry is that many of its member organizations are small and medium enterprises (SMEs). It has been noted, for example, that 94 per cent of Australian construction businesses employ fewer than five people each [2], a finding supported by the 1996-97 Australian Bureau of Statistics survey of the private sector construction industry, which stated that the average number of employees in the Australian construction industry was, at that time, 4.1 [3]. This large proportion of smaller businesses means that the SME sector is of considerable importance to the construction industry. Yet this also means that, on the whole, the industry is likely to be fragmented.

Reports on the industry have indicated that, although innovation occurs, the rate of innovation for the industry is not as high as in many other industry sectors. For example, the Australian Bureau of Statistics (ABS) conducted a survey of innovation in Australian industries for the period 2001 to 2003 and found that the construction industry, at 30.7 per cent, had one of the lowest proportions of innovating businesses [4]. In an international

context, previous research has indicated that the SME sector tends to not perform particularly well with respect to adopting and implementing innovations [5, 6]. This is not always the case, especially since it has been observed that the industry "is a lively source of new ideas" [7]. For example, innovative approaches were developed by design engineers to overcome computer software requirements in an integrated 3D CAD system [8].

One of the more salient issues in the construction industry is that industry research activity is not considered especially high. By way of example, Australia's Cooperative Research Centre for Construction Innovation, in developing a research and development vision for the industry, has reported that the Australian construction industry is cyclical in nature, suffers from a shortage of client and industry leadership, tends to be self interested, is unable to foresee the tide of competition, and tends to lack trust between industry and researchers [9].

This view is supported, in a global context, by the European Constrinnonet project, which investigated construction innovation in the European Union, with particular emphasis placed on the important SME sector. The report found that the level of investment in the industry on research and development was generally less than 0.5 per cent of company turnover. It also found that no simple solution exists with respect to addressing the problem of promoting greater innovation. This is pertinent to the present discussion since the European construction industry, with reference to its Australian equivalent, is of similar relative economic importance. Indeed, it accounts for about 7 per cent of the working population and contributes over 6 per cent to national gross domestic product [10].

Drivers that impact the construction industry include globalization of the business environment, demographic change, environmental sustainability and climate change, new materials and technologies, information and communication technologies, and governance and regulation [11]. Furthermore, it has been reported that the construction industry is being subjected to a paradigm shift, in which the awarding of contracts is moving from lowest price to multi-criteria selection processes. Incorporating sustainability in such a selection process has been claimed to reduce risk and improve the chances of obtaining value for money [12].

In view of the above considerations, this paper describes research in South-East Queensland, Australia, into innovative practices in 20 smaller residential building construction firms. In particular, this research, sponsored by the Cooperative Research for Construction Innovation, was aimed at better understanding and evaluating the views of SMEs on innovation-related issues, with particular focus on sustainable design and construction.

2. Innovation adoption

An innovation can be described as the introduction of something new or, more formally, "an idea, practice, or object that is perceived as new by an individual or other unit of adoption" [13]. Factors such as available time, resources and industry culture are likely to play an important role in the innovation development or adoption process. Drivers of change also need to be taken into consideration. In this respect, a previous study of the

Australian construction industry has found that the two main drivers of innovation were improving efficiency and productivity and responding to client/customer needs [14].

It is also well known that the market performance of technologies decreases with time. This is often shown with an "S" curve of performance over time [15]. Innovation adopters may themselves also be divided into time-related categories, viz., innovators, early adopters, the early majority, the late majority, and the laggards, each of which displays distinctive characteristics related to the risks involved and the resources available to adopt innovative products or practices [16]. A combination of these two concepts suggests that innovators and early adopters take more risks than others, but are also likely to reap the greatest benefits.

3. Importance of sustainability in the construction process

Globalization has removed or else minimized trade barriers, and has enabled firms to become more productive through better exploiting global resources. It has also allowed firms to interact with each other and potential clients on a global scale. However, this use of global resources has the potential, over time, to impact on the sustainability of the world's natural resources. This contradiction may be illustrated in the commonly held image of the "blue planet", which depicts the earth as a finite globe isolated in the universe, and at the same time as a single globe on which the frontiers between nations and polities disappear [17].

The construction industry faces a particularly significant challenge with respect to continuing to develop the natural environment for the benefit of humans, while at the same time conserving precious natural resources for future generations, as encompassed in the definition of sustainable development in the 1987 report of the World Commission on Environment and Development: "[sustainable development] ... meets the needs of the present without compromising the ability of future generations to meet their own needs" [18].

Sustainability is becoming an important focal point from a global construction perspective. This is highlighted, for example, by the significant impact of construction activities on waste, energy use and greenhouse gas (GHG) emissions. Furthermore, it has been reported that, in the United Kingdom, 17 per cent of wastes going to land disposal are directly related to construction activities [19]. Such impacts have led to a growing emphasis on corporate sustainability. This, in turn, is reflected by the mounting pressure exerted by clients, government and other stakeholders with respect to the construction industry becoming more accountable for its social and environmental impacts. Sustainability, it is reported, is now becoming more salient in the contract selection process. This is because, as previously indicated, the incorporation of sustainability into contract selection criteria can, it is claimed, reduce risk and improve the chances of obtaining value for money [20].

Regulatory authorities are also recognizing sustainable practices in construction. The United Kingdom, in 2000, implemented a strategy for more sustainable construction that packaged the traditional components of sustainability (viz., environmental, economic and social) into a single set of objectives that aim to make the construction industry more profitable and competitive, while also considering the requirements of stakeholders, the

natural environment, and energy consumption [21]. This strategy has recently been reviewed, with new targets and visions for 2015 and beyond [22]. In similar fashion, Australia has implemented new energy-efficiency measures for buildings [23].

Therefore, the concept of sustainable construction is clearly wide ranging and dynamic, and encompasses sustainable design and operations, in addition to the actual process of construction. While there are many positives, it is also important to consider the negative impacts of sustainable initiatives. In general terms, sustainable materials are relatively expensive compared to more traditional materials. Moreover, their life-cycle performance, while it appears to be sound, has not yet been fully tested. In addition, there can be environmental risks with some sustainable materials, such as potential leaching of contaminants from recycled materials used in road construction [24, 25]. These issues, and others, should be recognized and effectively managed in order to maximise the gain to the environment from using sustainable construction processes.

4. Research into innovation adoption and transfer in the Australian construction industry

The need to meet global issues such as sustainability, while remaining competitive, provides the construction industry with challenges that can only be met by the development and use of innovative materials, processes and practices. In order to establish a better understanding of the way in which innovation occurs in SME firms in the residential building construction sector, owners or senior management personnel of 20 smaller building construction firms in South-East Queensland (Australia) participated in a face-to-face interview. This took place in September and October 2006 and dealt with the interviewees' use and adoption of innovative materials and practices.

The firms contributing to this discussion responded to a request for interview made to 100 firms randomly selected from publicly available lists of residential property builders. Builders who agreed to take part were visited at their workplace or office and interviewed for an average of 45 minutes using a semi-structured questionnaire. The purpose of the research was to address the extent of innovation in these firms, assess why it occurred, establish the factors aiding or impeding its development, and learn what could be applied from this for the benefit of researchers, practitioners and the broader industry. An important section of the interview questionnaire sought views of builders with regard to new or improved environmentally sustainable design and/or construction practices. This paper concentrates on the responses to this section of the questionnaire.

Seven of the firms interviewed had four or fewer staff, 11 had five to 19 staff, and two had just over 19 staff. Of the firms, 18 were primarily constructors, and the other two primarily engaged in renovation and maintenance. Several firms undertook design as well as construction. All were involved in private sector residential work, with smaller projects (such as private dwellings) predominating. A number of firms also carried out larger projects.

It can be argued that since only 20 per cent of the firms contacted responded positively to the request for an interview, these would have skewed the research because they were the firms with the most interest in innovation. To counter this, it should be borne in mind that

at the time of the interviews the building industry in Australia was experiencing a period of high activity, and therefore a number of other builders with an interest in innovation may have been unable to spare the time for a reasonably lengthy interview (the authors were advised of this time constraint by several builders who were contacted). Low rates of response to research studies are not unusual in the construction industry. For example, a major Australia-wide mailed questionnaire on innovation in the construction industry recorded a comparable 29 per cent response rate [26].

5. Results of Research

The firms interviewed provided 50 examples of innovation, with incremental product and process innovations predominating. While 16 (80 per cent) of the builders interviewed had developed at least one innovation in their firm with minimal or no external input, all except a very few of the innovations could be considered new to the firm rather than new to the construction industry. The main primary business classifications of the innovations were sustainability and improved design practices.

Typical sustainability oriented innovations included:

- "green smart" design and construction, i.e., design and construction keyed to sustainable practices (firm focused on sustainable design and construction);
- orientation of buildings to maximize use of the natural environment (builder of larger homes);
- retrofitting solar passive principles to older buildings (builder involved in renovation);
- insulation, including use of suitable products (smaller builder);
- environmentally aware surface-water management (experienced builder);
- use of plastic downpipes and tanks to save water on site (builder committed to sustainable practices);
- use of new engineered products such as laminated veneer lumber beams (house renovator); and
- use of polystyrene blocks as substitutes for other materials (smaller builder).

Some of the sustainable design and construction innovations also impacted on project efficiency because the materials were lighter than the traditional materials that they replaced. For example, polystyrene blocks are lighter and easier to place than conventional bricks, while laminated veneer lumber products, on account of their relatively lightweight vis-à-vis conventional timber, save time with respect to handling and placing.

The typical innovation-adoption process used by the builders was to identify a need or business objective, develop an innovation or obtain knowledge of an innovation in order to meet that requirement, decide to use or evaluate the innovation, trial and test it, implement the innovation (staff training was often an important step in this process), fully use it in the business, and develop and improve it. The decision and implementation component of this adoption process is reasonably close to that expected by the literature, viz., the need to acquire knowledge about the innovation, be persuaded, make a decision to use the innovation, implement it, and confirm the results [27].

One of the findings from this research was that knowledge of innovations comes primarily from industry contacts rather than directly from research organizations such as research centres. Thus industry associations, training events, suppliers, journals, magazines and advertisements were the main sources of knowledge external to the firm. Employees, designers and subcontractors, it was found, were also important sources of information.

The firms in the study were also asked to identify the key issues in sustainable practices in the construction industry, evaluate the main benefits of using such practices, describe any changes they would have to make as a result of using them, rate the reasons why they might use them, and rank (if applicable) possible reasons why they might not use them. Only four (25 per cent) of the firms interviewed responded negatively with regard to sustainable construction practices. Seven responded positively, and the remainder were neutral. Typical positive comments were as follows:

- "Main driver for business" (firm committed to sustainable practices);
- "Competitive; a point of difference" (firm that considers client's lifestyle in design);
- "Good idea" (experienced builder);
- "Energy efficient" (builder committed to sustainable design and construction practices); and
- "Water efficiency" (the same builder).

Negative comments included the following:

- "Lack of innovative products that meet requirements or are costly" (experienced housing firm manager);
- "Some [sustainability] is being forced on firms" (design conscious firm building larger houses);
- "Will not do it unless required …. Margins are tight" (customer-oriented builder); and
- "Cost" (builder of more expensive houses).

Several of the above comments (e.g., energy and water efficiency, and cost) were reflected in comments from builders other than those quoted. A number of builders also commented on issues related to sustainable design and construction without offering a positive or negative point of view. These included areas such as drainage and site infrastructure, use of recycled water, use of suitable products, design and aspect of the house, and solar passive design. There was also some comment that the capabilities and capacities of approving authorities (i.e., local councils) may not yet be aligned properly with sustainable practices such as grey-water re-use.

Firms were then asked to rank the benefits of using sustainable design and/or construction practices. The criteria on which they provided ratings (on a 5-point Likert scale, with 1 being the least important and 5 the most important) were improved reputation in the industry, improved prospects for firms, improved productivity, improved profit, and less exposure to risk. The respondents were also invited to nominate other possible benefits.

While the relatively small size of the sample means that answers should be treated with caution from a statistical point of view, the main perceived benefit for adopting sustainable design and construction processes was improving the industry's reputation, with three-quarters of the builders interviewed giving this a rating of either 4 or 5 on the 5-point scale. Improved profit was the lowest-ranked benefit given by the builders interviewed.

Builders were then asked whether the use of sustainable design and construction practices required them to make significant changes to their business, management, or operational procedures. With regard to this, 12 (60 per cent) of builders in the sample responded negatively. Comments on the impact of sustainable practices on business included:

- "Introduces another step in the process" (experienced housing firm manager);
- "Culture change in sales and design" (larger customer-oriented builder);
- "Training of trades and contractors" (builder committed to sustainability);
- "Need to do more research on products" (builder of high-end homes);
- "Need to get to grips with the issues" (well-established larger builder); and
- "A lot of people do not know, including designers" (small progressive builder).

These comments indicate that, while sustainable practices are likely to be important in the building construction process, considerable work is still required with respect to integrating them more fully into design and construction procedures.

When asked to rate the reasons why they might use new or improved environmentally-sound design or construction processes, 19 (95 per cent) of the builders rated the question "you know it is good practice" at 4 or greater on a 1 to 5 scale, while 15 (75 per cent) rated requirement by legislation at 5.

Finally, builders were asked whether there was any reason why they would not use new or improved sustainable practices. In response to this, most builders answered this in the negative. Possible reasons for negative answers included lack of testing of a number of these practices, a lack of tradespersons with the necessary expertise, higher cost, and increased liability as a result of increased project complexity and competition.

6. Discussion

As the world moves towards a truly global economy, 'whole of planet' issues are increasingly impacting on all human endeavours. One of the most important of these issues is sustainability. This is particularly pertinent to the construction industry on account of its high use of finite resources, its development of structures that require energy and other resources, and its propensity to contribute to waste. Sustainability is therefore starting to take its place alongside efficiency, productivity and client needs as a driver of innovation in the construction industry.

While previous research has found that the construction industry is generally less innovative than a number of other comparable industries, the research described in this paper has shown that, at the very least, some smaller firms are quite innovative and, moreover, very interested in improving their performance. Such organizations are therefore

likely play an important role in sector leadership and driving change towards more innovative practices.

The study has also shown that the innovations nominated by the firms were typically new to their business rather than new to the industry. On the other hand, these firms have been quite original in their thinking. Indeed, they have developed solutions unique to their business in order to meet a specific need, or else to achieve a particular goal. For example, the desire to maintain good customer relationships has resulted in design innovations. Likewise, the desire to lead the industry in a sustainable-development direction has led to extensive use of sustainable practices as part of the normal business of some firms.

As evidenced by the responses provided, one of the main areas in which innovations have been made is in sustainable design and construction practices. Such innovations have not only resulted in benefits to the environment, but also have led to other positive outcomes such as improved liveability of housing and greater efficiency resulting from the use of lighter materials and better construction methods.

The main innovation drivers for sustainable building practices obtained from this survey were a) knowledge that it was good practice, and b) legislative requirements. At the moment, residential property owners; i.e., the main clients of the firms studied; do not appear to play an especially significant role in driving innovations of this type. This is likely to change over time given the efforts by government agencies to improve sustainability and energy efficiency in building construction (see Section 3 above).

While some of the firms in this research provided negative responses with regard to the impact of sustainability on their work practices, there was, on the whole, a reasonably good attitude displayed towards the adoption of sustainable practices and products. The study also made it clear that the more cutting-edge SMEs believe that the use of sustainable practices should be legislated if considered desirable, and that (paradoxically enough) approving authorities tend to lag behind what is now regarded as best practice.

7. Conclusion

This research into the SME sector of the Australian residential building construction industry has shown that firms in this sector can be quite innovative, particularly at the practical level, when responding to business needs or customer requirements, or else when they desire to achieve a particular outcome such as industry leadership. The commitment by this group of firms to innovation and long-term gains, and their generally positive view regarding sustainable design and construction practices, demonstrates that, in the residential building construction industry, there are indeed leaders committed to take the sector to higher levels of sustainability. The leadership of these proactive firms, whether located in Australia or elsewhere, will make the industry more competitive in an environment in which governments world-wide are increasingly required to balance sound economic management and social pressures with an ever-increasing demand on natural resources.

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