Exploring organisational attributes affecting the innovativeness of UK SMEs

Abstract

Purpose – The UK construction sector of Small and Medium Enterprises (SME's) has received criticism for a perceived lack of desire to innovate. Previous research has identified attributes such as company size and levels of research and development expenditure as being significant 'causal' variables determining this response. The aim of this research was to further explore organisational attributes that determine innovation likeliness within construction SME's.

Design/methodology/approach – Web based questionnaires were administered to 101 construction professionals. Responses from large companies and SME's were compared and data were analysed using descriptive and inferential statistical methods.

Findings – Findings indicate that SME's do implement a substantial amount of innovation in order to improve profitability. Both organisational maturity and in-house design capability were found to impact SME innovativeness.

Originality/value – The study provides further evidence that the UK construction SME sector is evolving away from traditional to more innovative practices.

Paper Type – Research paper.

Keywords Innovation, SME, Supply Chain Management, Organisational Learning, Statistics.

Introduction

Section F of the UK Standard Industrial Classification of Economic Activities categorises 'Construction' as an umbrella term for further divisions of economic activity including: Construction of buildings; Civil engineering; and Specialised construction activities (ONS, 2007). The UK economic recession of 2008-2009 negatively impacted productivity and profitability within this construction 'sector'. Inevitably demand for industry innovation has amplified in order to positively affect these measures. Research efforts have been pivotal in order to modernise this traditionally conservative sector, which is reticent to adopt new technologies (Shapira and Rosenfeld, 2011) and designates little expenditure on activities associated with innovation (Loosemore, 2014; Seaden and Manseau, 2001). This phenomena is believed to be particularly evident in the activities of small and medium enterprises (SME) operating in this sector (Czarnitzki, 2006; Hardie and Newell, 2011; Sexton and Barrett, 2003a). An SME is a company categorised as small or medium as defined by number of direct employees. In the UK a small company is comprised of 0-49 employees, whereas a medium enterprise has up to 249 employees. Construction is dominated by SME's (Yaxley, 2012), and estimates consider SME's to account for around 97% of all construction businesses throughout the EU (Dick and Payne, 2005). Consequentially, the perceived lack of innovation within this sub-sector provides genuine concern for the entire industry. Sexton and Barrett (2003b) stress the

importance of these businesses increasing their innovation practice in order for the entire industry to advance, and advise of a hierarchy of motivational drivers for SMEs in relation to innovation. Construction SME's are governed carefully within their financial limitations with company *survival* being the first immediate priority. It is only once *stabilisation* has been achieved that some of these firms then become motivated to develop and grow through the use of innovation (Barrett and Sexton, 2006). Within the literature the importance of innovation to construction SME's has been established, and the drivers and barriers have been explored, however there does remain sufficient opportunity to explore the innovation practices of UK based construction SME's. The aim of this research is to add to these studies by further exploring organisational attributes in order to determine how these affect the innovation likeliness of such organisations.

Innovation in construction

Innovation does not only imply invention. The plethora of meanings includes: *ingenuity*, *entrepreneurship*, *process improvement*, *development* and *growth*. For the purposes of this research, innovation is best defined as "*an idea, practice or object that is new by an individual or other unit of adoption*" (Rogers, 2003) as it is the 'newness' of the idea, which presents it as an innovation to a recipient (Lu and Sexton, 2007; Sexton and Barrett, 2003a). Receivers of innovation can range from individual entities such as a person or company to a wider population, such as an entire industry (Walker, 2016). Innovations create solutions to counteract problems and investment in innovation benefits customers and consumers through higher quality services (Staniewski *et al*., 2016). When made specific to construction, innovation can invoke the realisation of new processes in order to improve

organisational performance. Winch (1998) considers the ideals of ‘true innovation’ to be lucrative to construction. Here an issue is identified, a resolution is produced and implemented and it is then applied to future projects. In this process a continuous cycle of innovations are produced which subsequently diffuse across the wider population. This approach has not been well practiced in the construction sector and over the past decades, investigations have heavily scrutinised a perceived inability of the industry to innovate effectively (Harty, 2008). Significant absence of investment in research and development (R&D) combined with a project-based approach frequently dictated by prescriptive specifications have resulted in a stale industry with little apparent desire to evolve (Dubois and Gadde, 2002; Hardie and Newell, 2011; Manley and Mcfallan, 2006). There is sufficient continuing discussion in the literature over how innovation can be identified (both within the construction sector, and across the related but wider Architectural, Engineering and Construction ‘AEC’ industries), and if practitioners are actively seeking or practicing innovative technologies, suggesting the area remains worthy of investigation (Loosemore, 2014). Globally, innovation is the driving force for continual improvement. With improvement comes increased productivity leading to company growth and profit (Baldwin and Gu, 2004) before consequential transference of indirect benefits to society occurs. Many construction organisations however can find themselves bound with unskilled workers, producing poor output and limited investment, which results in low levels of profitability. Innovation can offer an opportunity to escape this cycle by improving existing processes and technologies, and by doing so it can lead to significant practical and commercial benefits (Seaden *et al*., 2003).

Measurement and comparison against other sectors

The manufacturing industry is often used to compare the construction sector against in terms of its innovation behaviour and record of continuous improvement (Reichstein *et al*., 2005). Manufacturing processes have evolved from labour intensive assembly lines to automation controlled via robotics. These innovations have been necessary in order to reduce manpower and increase efficiency, whilst ensuring the quality is to the highest standard. A direct benefit of this is improved productivity which increases profits, and as such, in contrast to construction, manufacturing is considered a value for money industry (Winch, 2003). These improvements have not been observed in the UK construction sector. This is because UK construction has retained the 'hands on' approach that demands high labour intensity carried out by a trade workforce on site. Possible consequences of this approach include variations in productivity and inconsistencies in quality, which result in perceptions of the industry providing poor value for money. There has been a long history of unsuccessful attempts to instil effective manufacturing innovations into the UK construction sector (Gao et al., 2013). Elsewhere, these efforts have been more successful. Linner and Bock (2012, 2013) describe how a combination of long-term learning and the development of continuous incremental and disruptive innovations have transformed sections of the Japanese building industry using such technology. Whilst Thuesen and Hvam (2011) report on a German case study organisation that was able to optimise the production of housing, reduce costs and increase customer choice adopting similar approaches, such as: continuous learning, a focus on standardisation and repetition, as well as effectively managing complementary aspects of off-site manufacture (OSM) and on site production. Despite such overseas successes, Reichstein *et al* (2005)

articulate reasons why the UK construction sector has low rates of innovation, and identify that, the ratio of construction professionals involved in product innovation is found to be substantially lower than other industries, specifically manufacturing. These researchers also identify that the nature of the UK construction market effectively creates a locked in system making it difficult to be compared to other industries such as manufacturing.

The construction sector performs consistently poorly in statistical analysis of cross sector innovation (Aouad *et al*., 2010). Researchers (Green and May, 2005; Loosemore, 2014; Winch, 2003) argue against the use of such standard industrial classifications (SIC) when undertaking cross sector comparisons. Designers, consultants and similar client representatives often select and confirm which product innovations such as materials or technologies will be used. As such these innovative solutions are included within Section M 'Professional, Scientific and Technical Activities' a distinct SIC division, separated from the 'Construction' division. Furthermore, a large ratio of the construction SIC comprises repair and maintenance work, both of which require little innovation. For these reasons, innovation studies on construction often report upon a low rate of innovation, which these researchers argue misrepresent the reality of construction.

Literature specifically focusing on the innovation performance of SMEs can be misleading and often contradictory. Previous studies have implied that SMEs are more innovative than larger corporations are. The comparative lack of hierarchy and quicker decision-making capability of SME's are an asset that helps overall innovative performance (Nooteboom, 1994; Rosenbusch *et al*., 2011; Vossen, 1998). Conversely other researchers depict SME's as slow decision makers, demanding

improvement after a problem has occurred (Nam and Tatum, 1992). Because of these conflicting interests relating to the innovation decision-making process, it is important to focus how innovative adoption decisions are formulated. Rogers (2003) theory describes the innovation-decision process that decision-making units go through when presented with innovation. There will be interest in pursuing a new method of working or technology if a favourable perception is formed toward the innovation. Positive opinions could arise due to an observed benefit such as; improved productivity, utilisation of fewer resources and improvements to quality. However, risks and uncertainty associated with the implementation of new methods of working or technologies are strongly considered by all construction professionals (Kuczmarski, 1996) and even more so by SME's (Kreiser *et al*., 2001), therefore the evidence of a successful innovations implementation must be coherent and widely accessible in order to improve innovation rates within the industry.

The preceding sections were useful for broadly identifying key issues surrounding innovation within the construction sector. The remaining sections of the literature review focus on several variables that were useful for question construction within the survey questionnaire research instrument.

Innovation type and classification

The Organisation for Economic Cooperation and Development (OECD) categorises innovations as either technical or non-technical. *Technical innovations* can be further categorised as *process* and *product* innovations, while *Non-technical* innovations are more commonly referred to as business improvement innovations, which are concerned with changes to organisational structure, culture, management techniques

and strategic direction (Blayse and Manley, 2004). A ‘product innovation’ can be defined as new or improved commercially available technology designed for permanent incorporation within the works and introduced to meet the needs of the market (Murphy *et al*., 2015). An example of a product innovation would be the introduction of supplementary agents and materials within a traditional concrete mix to generate desirable performance characteristics (e.g. adding rubber crumb to provide freeze–thaw protection, see Richardson *et al*., 2016). In construction, a process is a combination of technology and skill to produce a product, and ‘process innovation’ is the implementation of new or improved production or delivery method. A related example of such process innovation would be a company using robotics for the production of concrete, a process which is significantly less labour intensive and has also been found to produce an improved product of higher compressive strengthened concrete (Le *et al*., 2012) A further example would be the introduction of Building Information Modelling in order to improve project information management and project delivery processes (Gledson, 2016). Non-technical innovations enable an organisation to become better adapted to the changing commercial environment. These include changes to business operations and methods of marketing of which benefit the company. Such examples would include organisations obtaining health and safety or quality accreditations that subsequently improve the company profile (see Kale and Arditi, 2006 for evidence of organisational ISO process diffusion). Within the design of the questionnaire survey, questions were formulated that related to innovation type and frequency (see below section).

Innovation drivers and barriers

An investigation by the Chartered Institute of Builders (CIOB) into innovation revealed cost efficiency as the highest driver for innovation followed by sustainable processes as well as client demands (Dale, 2007). However, the research population for this study included only 17% of participants who operate within the SME market. Whilst it would be expected that cost efficiency would be highly considered in this market due to tight budgets and low margins, the development of new ideas around sustainability in order to improve the environment is considered to be of lesser importance to these organisations, than company survival. In contrast, in a study focusing on the factors that affected technical innovation adoption solely in construction SMEs, Hardie and Newell (2011) highlighted the primary importance of the regulatory climate in enabling or inhibiting innovations by SME followed by client and end user influence. This study did not find company resource level (money, time, skill level) to be of critical importance. Rosenbusch *et al* (2011) argued that the negatives associated with innovations such as risk, uncertainty and high installation costs are outweighed by the benefits, although this should be taken contextually and will not be suitable in all scenarios. Such drivers and barriers for innovation amongst construction SME's were used for the formulation of several research questions within the survey questionnaire (see below section).

Company attributes

In 2015, the UK construction industry was comprised of 273,775 construction related businesses, with 65,443 of these being registered contractors in the UK industry

(ONS, 2016). These organisations employ approximately 2.93 million people (BIS, 2013). There is diversity across company attributes and characteristics. Each company is defined by factors such as size and organisational maturity, which can affect innovation behaviours. As well as innovation types and the drivers and barriers of innovation, the review of the literature has also determined attributes of company size, organisational maturity and design capability as important variables for the design of the study. These attributes are now more fully considered and were also incorporated into the design of the research questionnaire.

Company size

In the results reported by the CIOB innovation survey (Dale, 2007) 100.0% of respondents believed that an improvement in innovation was vital for the future of construction. An effort to improve innovation requires strong financial backing, and 63.0% of respondents thought this did not represent their own companies spending commitments. These factors are more troubling for SME's as cost and resource availability is a significant burden compared to large companies. Reichstein *et al* (2005) identifies this as the '*liability of smallness*', which adds a significant burden on innovation. Many SME's have minimal financial or 'slack resource' capability ready to invest in innovation (Hardie and Newell, 2011; Sexton and Barrett, 2003a, 2003b). Liability of smallness is a major factor in a firm's ability to innovate thus associations between company size and the likeliness to innovate was explored in this study.

Organisational maturity

Literature identifies the issues associated with poor industry profit and subsequent low investment on Research and Development activities (R&D). SME's are committed to maximising profits on projects as oppose to investing in new methods of working or technologies. This thinking coincides with stage theory research whereby SME's pass through five stages: *existence, survival, success, take off and resource maturity* (Barrett and Sexton, 2006). It is once '*success'* or financial stabilisation has been achieved that they begin to consider improving, with R&D being a major characteristic of this next stage. R&D is imperative for improving performance and can lead to companies having a competitive advantage over their rivals (van de Vrande *et al*., 2009). The benefits of innovation to SME's has been well documented, a meta-analysis study of the relationship between innovative processes and performance in SME's (Rosenbusch *et al*., 2011) indicate that there is a relationship between the two factors, with the most significant improvement observed in newly established companies. Hsueh and Tu, (2004) consider the continuous cycle of newly established companies as a stimulus for innovations and later concludes that the establishment of a new enterprise is because of opportunities for innovation. Jung *et al* (2003) conclude that company maturity leads to wider innovation, although within the literature it was determined that mature companies as opposed to 'juvenile' companies have a well-established network of experienced managers whom instil an innovative culture within the company. A juvenile company is classified 5 years and less of operation, and a mature company as older than 5 years. There is a discrepancy in the literature regarding organisational maturity and innovation behaviours; therefore, associations between these factors were explored in this study.

Design capability

The construction sector is unique and each project is different and has its own characteristics and requirements (Alhazmi and McCaffer, 2000). A major factor to the success of a construction project is the selected procurement mechanism. The traditional procurement route is an approach that has been utilised in construction for over 150 years (Hampton *et al*., 2012) and has been criticised as a barrier to innovation. Research by Erik Eriksson *et al* (2007) identified the strict cost based nature of traditional procurement as a major downfall for potential innovations, as contractors will consider financial savings through tried and tested methods as oppose to risking new innovations. In this approach, the client holds the main responsibility for design and depicts workmanship and materials through a standard specification or schedule of works, and this procurement mechanism leads to low rates of innovation (Blayse and Manley, 2004). Innovation increases when more integrated procurement method is chosen, such as design and build (D&B) or similar methods. These approaches afford increased supply chain interactions between designers and constructors who have more involvement over materials and methods selections, thus increasing the likely use of innovative products or process. Conversely, SME's can struggle to adapt to these markets as increasing levels of design liability are placed onto the contractor, leaving them contractually liable for mistakes and errors. Large associated costs for insurances, better skilled employees and technologies result in a lower proportion of SME's having these abilities. These reasons made this subject matter also worthy of investigation and so associations between SME's that hold design liability and likeliness to innovate are also explored in this study

Summary

The review of the literature reveals conflicting evidence on the innovation performance of construction SME's. It appears that a major impediment of construction innovation is the ability to effectively diffuse within and across all of the related AEC industries. Diffusion is constrained by the temporary nature of projects and the segregation of trades. SME's within this sector are further hampered due to their lack of capability to invest in innovation. Procurement mechanisms that are dictated by cost and standard specifications and do not permit SME design input can discourage innovation. Alternative procurement options can encourage innovation, however the ability of an organisation to both provide in house design capability whilst accepting liability may not be as economically viable to SME's.

Key construction theorists have provided multi-faceted arguments regarding innovation within the sector, which has been directly compared to other industries. These studies have indicated that construction is less innovative than other sectors and a major hindrance to this has been the lack of ability to spend on R&D as freely as other sectors (e.g. manufacturing). Innovation in construction can be considered apart from other industries, and the focus of this study, innovation within the SME sector continues to be worthy of further research. This review of literature has helped formulate the following key research questions with regard to Construction SME's:

- *What types of innovations are implemented by construction sector SME's?*
- *What are the innovation drivers and barriers for construction sector SME's?*
- *Are there any associations between different company attributes and SME likeliness to innovate?*

Research Methodology

The research approach was informed by the epistemology of positivism and the ontology of objectivism. A quantitative research strategy was used to investigate innovation practice within construction SME's and empirical data was collected using a survey approach. A web-based questionnaire was designed and issued initially to a handful of purposively selected construction practitioners, known to the research team and well placed to be able to address the research questions. Thereafter a snowball sampling technique was employed, with the initial participants used to identify other individuals relevant to the research topic matching the population of interest. Because such a non-probability approach to sampling was used, it meant that any results could not be considered to be generalizable. Despite such concerns, it was also considered that administration of the research instrument in this way would produce findings leading to useful insights in this area. Bryman (2012) and Dillman *et al* (2014) provide excellent reference about the challenges and issues surrounding the collection of data using web-based questionnaires, which include concerns around potential lower response rates in comparison with the rates associated with hard copy postal questionnaires - particularly for poorly designed surveys. However, these researchers identify that such methods provide consistently more valid responses than other methods including telephone surveys, where participants are more prone to using response sets. The findings were analysed using IBM SPSS Statistics 22. The majority of the questionnaire was constructed using closed questions, which limited the respondent to a selection of standardised responses composed of categorical, ordinal and interval/ratio type responses suitable for statistical analysis, although a few open questions allowed additional qualitative data to be collected. Independent variables included aspects such as company age, organisational maturity and

confirmation of whether the company had in house design capability. Dependent variables were the confirmation by respondents of any company innovation adoptions over the previous two business years, and an assessment of the likeliness of their organisation to innovate in future years. Table 1 identifies the questions, question types, response options and provides further information around the questionnaire construction.

Table 1: Web-based questionnaire construction.

INSERT TABLE 1

Results and Analysis

101 responses were received. At individual level 60.4% (n = 61) of respondents were employed at middle management level, and 30.7% (n = 31) employed in a senior management role, with the remainder (8.9%; n = 9) in lower management positions. 65.3% (n = 66) of respondents identified that they were employed primarily in an office-based role, with 34.7% (n = 35) primarily employed in a site-based role. 86.1% (n = 87) of respondents identified themselves as working for an SME with the remaining 13.9% (n = 14) working for Large Companies. Organisational maturity was measured via a question that required the respondents to identify how many years their company has been in business thereby producing an interval/ratio variable. The minimum was 1 year; the maximum was 80 years, the mean 25.71 years, and the median 25.0 years, with a standard deviation of 18.8 years. Creating ‘maturity groups’

of ‘less than 5 years’,’6-10’,’11-20,’21-30 ‘and’31+’ years from the data also provided an assessment of organisational maturity. Accordingly, the largest proportion was the ‘*31+*’ years maturity group with 35.6% of responses. Immature organisations of less than 5 year accounted for 15.8% of responses. Filtering out the responses from large companies, the range of responses recorded for organisational maturity remained at 1-80 years; although the mean was now 23.82 years, the median 20.0 years, with a standard deviation of 17.8 years. The largest proportion remained the ‘*31+*’ years maturity group with 34.5% of responses. Immature organisations of less than 5 year accounted for 18.4% of responses. The results of other measures of interest such as ‘company likeliness to innovate’ will be detailed against the analysis of each of the relevant research questions below.

Which types of innovation are implemented by SME’s?

To address this research question, frequency analysis was undertaken to show which category of innovation occurs more frequently. 80.3% of respondents confirmed that they have implemented or adopted a technical innovation such as new product and process in the previous two business years, and 19.7% of respondents confirmed that they had adopted non-technical innovations.

This question was further explored by undertaking cross tabulation analysis to investigate if there is a relationship between the type of innovation implemented and company attributes, such as company size or organisational maturity. Findings indicted that both large companies (81.1%) and SME’s (76.9%) implement a higher rate of technical innovations than non-technical innovations. When maturity groups were tested, it was again found that all groups implemented or adopted more technical

innovations than non-technical innovations. Upon further review, it was observed that all organisational age groups over 5 years had at least one respondent who had adopted a non-technical innovation, whereas 100.0% of newly established companies had implemented technical innovations only.

One question required respondents to enter qualitative responses via an open textbox question in order to identify innovations that had been adopted or implemented over the previous two business years. Table 2 provides responses received against this question categorised, with the innovations then categorised as technical or non-technical innovations by the research team.

Table 2: Innovations implemented by respondents over previous two business years.

INSERT TABLE 2 HERE

What are the innovation drivers and barriers for construction sector SME's?

To address this research question, cross-tabulation analysis was undertaken to investigate the drivers and barriers of SME innovation, with responses from employees of large company filtered out from the analysis.

The most frequent response option selected as a driver for innovation was '*improving profitability on an existing process'* with 24.5% of SME's employees responding. The next most frequent response selected in the present study was '*improve company profile*' with 22.6% respondents selected this response option. The third highest

scoring category was '*Competitive advantage over rival companies*' with 18.9%. The two lowest scoring response options were '*client requirement'* and '*increased productivity'* which both scored 17.0%.

50.0% of SME's selected the response option '*lack of interest by client'* as the main barrier for innovation. The second most considered barrier with 17.6% of respondents was '*uncertainty as to whether the innovation will be successful'*. The lowest weighted response was '*risk of legal liability'* with only 2.9% of respondents selecting this response option. The frequencies of the remaining categories scored as follows '*lack of in-house expertise'* (11.8%); '*high costs associated with implementing the innovation*' (8.8%); and '*high continuity costs associated with the innovation'* (5.9%)

Drivers and barriers were further addressed by undertaking additional cross tabulations analysis using company attributes such as maturity and type. For attributes of 'organisational maturity' and 'company size', the most frequent driver overall *improving profitability on an existing process'* was selected by 24.6% of respondents. However, when isolating different groups variations emerged. It was found that 61.0% of respondents who worked for a juvenile company (defined as one that had been established less than 5 years) considered '*competitive advantage over rival companies'* as the biggest driver for innovation whereas the most frequent response option selected by those who work for mature companies (31 years +) was '*improve company profile'* with 33.3%.

Are there associations between different company attributes and SME likeliness to innovate?

Various company attributes are now considered including company size, organisational maturity, and in house design capability. These were all compared against organisational innovation likeliness. Similar to the previous research question, descriptive and inferential analysis was applied to companies of all sizes, and then with the large companies filtered out of the analysis.

Across all cases, organisational maturity was previously confirmed as 25.71 mean years, with the largest maturity group by proportion being the most mature group of '31+' years (35.6%). In response to the question, '*do you have in-house design capability*?' 50.5% of all respondents answered '*Yes*' and 49.5% respondents answered '*No*'.

Filtering out the responses from large companies, to focus on the responses recorded from SME's, organisational maturity was confirmed as 23.82 mean years. The largest proportion remained the '31+' years maturity group with 34.5% of responses (immature organisations of less than 5 year accounted for 18.4% of responses). This time in response to the question, '*do you have in-house design capability*?' 43.67% of respondents answered '*Yes*' compared with 56.3% of respondents who answered '*No*'.

Company size

The first relationship was then explored by formulating the following null hypotheses (H_0): *There is no relationship between size of company and likeliness to innovate.* Conditions for Chi-Square (X^2) were not met as one cell had an expected count of less than 5, therefore a Fisher's Exact Test was used, which gives a test statistic of .049 meaning that H_0 could be rejected in favour of H_A: *There is a relationship between size of company and likeliness to innovate.* When comparing size of company, it was found that 78.6% of large companies were '*likely to innovate*' in comparison to 14.3% who were unlikely. Conversely 42.5% of SME's were '*likely to innovate*' with 40.2% reporting that they were '*unlikely to innovate'*. This data also reveals that all companies are perceived to be more likely to innovative than not, although it appears that perceptions are that large companies are more likely to innovate than SME's.

An alternative way of testing likeliness to adopt future innovations, rather than measuring perception of organisational innovativeness is to assess against responses to the following question "*have you implemented or adopted an innovation within the last two years*?" The most frequent responses to this categorical question across all groups were 'Yes' (65.3%) compared with 'No' (34.7%). A Fisher's Exact Test was used, which gives a test statistic of .031 meaning that H_0 could be rejected in favour of H_A: *There is a relationship between size of company and likeliness to innovate.* Despite a perception that larger companies are more likely to innovate, interrogation of the largest proportion (52.5%) of data produced in the cross-tabulation about this relationship, suggests that SME's in this sample have more frequently adopted innovations over the past two business years.

Organisational maturity

The next relationship was explored by formulating the following null hypotheses (H_0)*: There is no relationship between organisational maturity and company likeliness to innovate.*

All companies

Both large companies and SME's were included in the first test. Conditions for Chi-Square (X^2) were not met as six cells had expected counts of less than 5, therefore a Fisher's Exact Test was used, which gives a test statistic of .001 meaning that H_0 could be rejected in favour of H_A: *There is a relationship between company maturity and likeliness to innovate.* Further interrogation of the data produced in the cross-tabulation about this relationship revealed that the highest proportion of data (20.0%) was recorded by companies most unlikely to innovate, these were also the oldest organisations, categorised as mature organisations of 31+ years. The second highest proportion of data (14.0%) was recorded for the organisations most likely to innovate, which were the youngest organisations of 5 years or less in age.

SME's

Rerunning this test, using only the 87 cases associated with SME's (i.e. filtering out all large contractors) gave similar results. A Fisher's Exact Test was used, which gives a test statistic of .000 meaning that H_0 could again be rejected in favour of H_A, and again the highest proportion of data (21.8%) was recorded by companies most unlikely to innovate, which were the oldest organisations, categorised as mature

organisations of 31+ years. The second highest proportion of data (16.1%) was recorded for the organisations most likely to innovate, and again these were the youngest organisations of 5 years or less in age. These results infer that within this sample mature companies are less innovative than newly established companies.

Design capability

The next relationship was explored by formulating the following null hypotheses (H_0)*: There is no relationship between a company having in-house design capability and organisational likeliness to innovate.*

All companies

Conditions for Chi-Square (X^2) were met and all 101 cases could be used. X^2 gives a test statistic of .000 meaning that H_0 could be rejected in favour of H_A: *There is a relationship between a company having in-house design capability and organisational likeliness to innovate.* Further interrogation of the data produced in the cross-tabulation about this relationship revealed that the highest proportion of data (38.6%) was recorded by companies who have in-house design capability and reported that they were more likely to innovate than not. The second highest proportion of data (28.7%) was recorded for the organisations that do not have in house design capability and reported that they were more likely not to innovate.

SME's

Rerunning this test, using only the 87 cases associated with SME's (i.e. again filtering out all large contractors) gave similar results. X^2 could be used, which gave a test statistic of .000 meaning that H_0 could be rejected in favour of H_A. This time the higher proportion of data (33.3%) was recorded for the organisations that do not have in-house design capability and reported that they were more likely not to innovate, with the second highest proportion (32.2%) recorded by companies who have in-house design capability and reported that they were more likely to innovate than not.

These results can be cautiously perceived as a consideration that holding design liability increases the likeliness to innovate, as companies would have an ability to design or select their own technologies and methods. It could also be suggested that companies that hold design liability e.g. PI insurances will be required to employ experienced personnel in design. This attribute will significantly benefit company innovation practice, as it will enable for new methods of working or materials to be utilised.

An additional test was carried out in order to find out where those organisations that do not hold design liability, subsequently limit this liability. 65.0% of all respondents identified that the client was responsible for design liability as opposed to subcontractor or supplier (68.4% of SME's also selected this response option as the most frequent response). This result suggests that companies typically consider the client responsible for the use of innovative products and processes.

Discussion

The subject of innovation is frequently concerned with the propagation of valuable ideas that benefit society primarily through social and economic development (Dodgson and Gann, 2010). The construction sector of today, making use of advanced information and construction technologies, would be unrecognisable to researchers and practitioners of yesteryear. The aim of this research was to further explore innovation practice within small and medium enterprise construction organisations and review a range of organisational attributes that may determine innovation likeliness within such firms. This was undertaken through questionnaire survey research, and although the method is repeatable, several limitations of the approach taken can now be discussed. First it is important to repeat that non-probability sampling was used and as such, the results cannot be generalizable to the entire construction population. When reflecting upon the research design stage, the research team now consider age alone to be too basic a measure of organisational maturity because any occurrence of rebranding, re-structuring, or any completed mergers, take-overs or acquisitions can affect this interpretation. During the analysis stage it became apparent that several of the tests of association undertaken did not allow for the effect of any moderating variables to be identified. Nonetheless, the analysis of results has revealed several areas of interest for practice and for further research efforts, which focus upon perceptions of innovation by construction actors, and the effects of organisational maturity and client behaviour upon innovation practices.

Secondly, it is important to highlight, that in this study, no definition of innovation was given to research respondents in the questionnaire instructions. Whilst this was intentional, to see what ‘things’ research participants would consider as innovations,

and how any innovation adoptions would be articulated, upon reflection, such interpretative flexibility was not beneficial to the study, and could have been prevented by providing an appropriate definition in the design of the research instrument. From the results however, it could be suggested that to construction practitioners, innovation is typically associated with the types of new products or processes, which are categorised in the literature as *technical innovations.* Research has identified that organisations with improving performance are more open to technical innovations in the first instance (Souitaris, 1999), and these results highlighted variations between the implementation of technical and non-technical innovations, across organisations of different maturities. Qualitative data provided identified a large variety of innovations adopted by the respondents over the two most recent business years, but again it was clear that technical innovations are implemented more frequently across all group types. An additional interpretation of these results could be that construction has reacted well to criticism of its ability to innovate, and evolved by adopting a great deal of what Loosemore (2014) calls '*invisible innovation*'. However, there is clearly a need to explore why non-technical innovations are not adopted as frequently as technical innovations in the construction sector.

In the literature it is clear that large companies are believed to be more innovative than SME's. Various researchers (Hardie and Newell, 2011; Reichstein *et al*., 2005; Sexton and Barrett, 2003a, 2003b) identify that SME's are discouraged to innovate due to a lack of 'slack resource', and in contrast, that large companies have comparatively more resources available to them in order to manage innovations into use. Barrett and Sexton (2006) describe the 'stage theory' of SME's where newer

companies are very much so in the '*existence*' or '*survival*' stages of their lifespan, and the newness of a company could be considered as a reason for a lack of implementation of *non-technical innovations*, which focus on organisational or business improvements in these organisations. Other research efforts (Jung *et al*., 2003; van de Vrande *et al*., 2009) identify that more established companies seek to invest in innovations in order to reinvigorate and rejuvenate a company, and subsequently increase demand for their services. However, the results of the present study indicate that newly established companies implement innovations in order to outperform competitors in attempts to position themselves within the market. SME's develop and adopt innovations primarily as methods to both increase efficiency, and to improve company performance and visibility. It could be suggested that mature companies use well founded, tried and tested methods based on past working experience with established methods and procedures and therefore are unlikely to innovate. In contrast, the characteristics of a newly established company can be related to an infant child learning new survival techniques every day. As a result, it can be hypothesised that as a company increases in maturity, after a certain point in time, it's likeliness to innovate decreases. As a reminder, it was found in the present study that despite a perception that larger companies are more likely to innovate, SME's in this sample were more likely to have adopted innovations over a recent business period. Furthermore, the study identifies that in terms of organisational maturity, the older organisations in this study were the most unlikely to innovate with the youngest organisations of 5 years or less in age being most likely to innovate.

Finally, it is worth considering the client effect upon innovation. Construction enterprises operate within environments of risk and uncertainty, which act as

deterrents of innovation adoption (Kreiser *et al*., 2001; Kuczmarski, 1996), SME's however, more frequently often operate on smaller value projects under conditions imposed through traditional procurement practices whereby clients depicts their requirements through the use of standard specifications and workmanship practices, and prescription of 'tried and tested' methods. It can be argued that in this manner construction clients hinder construction innovation generation and diffusion. Increased efforts to improve the working relationships between client, contractor and supply chain could consequently facilitate a more open innovation culture on construction projects.

Conclusions

In these results, the majority of innovations adopted across all company types and maturity groups were technical product and process innovations. Prominent drivers for SME innovation adoption include opportunities to increase profit and improve company profile. Innovation behaviour of juvenile SME organisations is driven by opportunities to generate competitive advantage over rivals. The largest innovation adoption barrier across all SME organisations was related to lack of client interest.

Various associations were found between attributes such as company size, organisational maturity, in-house design capability and organisational likeliness to innovate. The relationship between company size and likeliness to innovate provided contrasting results. There is a clear perception that larger companies are more likely to innovate, but a separate measure found that SME's in this sample had more frequently adopted innovations over the previous two business years. The relationship between organisational maturity and likeliness to innovate identified that regardless of

company size, the oldest organisations were the most unlikely to innovate with the youngest organisations of 5 years or less in age being most likely to innovate. Finally, it was identified that regardless of company size, organisations that have in-house design capability reported that they were more likely to innovate than not.

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