AN ANALYSIS OF CONSTRUCTION INNOVATION LITERATURE

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ABSTRACT: The importance of innovation in construction has been widely advanced. This paper analyses the most recent research in the field of construction innovation and offers an overview of what and how aspects of innovation have been studied in different construction contexts. Peer-reviewed journal articles from the last decade are coded and analysed to reveal the construction focus, innovation fundamentals and prominent research features of the literature. A research agenda based on the findings of the analysis and the future research suggestions of the journal articles reviewed is presented to extend and enhance construction innovation research.

KEYWORDS: construction; innovation

1. INTRODUCTION

The importance of innovation in construction has been widely advanced. Innovation can be a key source of competitive advantage for construction companies, offering the means through which a firm can achieve a client’s objectives in a specific project, or its own objectives over a range of projects (Slaughter, 2000). Innovation also enables firms to successfully contend with major changes occurring in the industry. These changes include increasingly competitive and global markets, demand shifts, and client expectations for capital and operating costs to fall (Seaden and Manseau, 2001a).

Slaughter (1993) suggests that innovation has always occurred in construction and Seaden and Manseau (2001a) assert that in most countries there are construction companies that have been able to achieve superior market positions through innovative practices. However, despite these indications there is great concern regarding innovation in the construction industry. The general rate of innovation in construction is argued to be low in comparison to other industries and this low rate has been advanced as the major explanation for poor industry performance in terms of productivity and quality (Winch, 1998; Gann, 2000; Koskela & Vrijhoef, 2001). The low rate of innovation in the industry (which is especially disappointing given the potential benefits of innovation) has made innovation in construction a compelling research topic.

Early research focus on innovation in construction can be traced back to seminal work by Bowley (1960; 1966) however, innovation in construction received scant attention from researchers for many years after this, seldom being studied with the same thoroughness as in sectors such as aerospace, telecommunications and biotechnology (Manseau, 1998). Over the last decade research has gradually increased and reached the point where a multitude of construction innovation books have been produced including Gann (2000), Seaden and Manseau (2001b), Jones and Saad (2003), and Miozzo and Dewick (2004). In addition, two international construction journals published special issues on innovation, Construction Management and Economics (September, 2003) and Engineering, Construction and Architectural Management (May, 2004).

This paper sets out to reflect upon the most recent research in the field of construction innovation and offer an overview of what and how aspects of innovation have been studied in different construction contexts. Although we acknowledge the construction innovation research base is not complete and that future research is required we believe that this analysis...
of recent research has value. The literature consists of many individual studies that are inevitably limited by time and sample constraints and of restricted usefulness to scholars and practitioners when considered alone. By combining recent research in the field this analysis can take a holistic view of the subject area to identify trends and knowledge gaps. Integrating the previous research and comparing key aspects studied will subsequently be useful in generating an agenda for future research and guiding PhD research.

1.1 Objectives

The objectives of the analysis are:

1. Identify the innovation focus of the research including definitions of innovation and innovation assessments and indicators;
2. Identify the construction focus of the research including level of analysis, lifecycle stage and industry sector;
3. Identify key research issues including author background and source of the research;
4. Reflect on the results of the analysis and future research suggestions of other authors to present an agenda for future research.

2. METHOD

References to innovation in construction were found in a wide variety of sources including academic journal articles, conference papers, government reports, trade magazines and company websites. The quality and reliability of these different sources varied. To ensure that the literature analysed in this paper was of a high academic standard the criterion of including only peer-reviewed work was adopted. This meant that only conference papers and journal articles could be included in the analysis. The decision was made to concentrate on journal articles because of their higher standing in the academic community over conference papers and the additional difficulty in accessing many conference papers.

To collect journal articles on innovation in construction the following search criteria were used. The keywords “innovation” and “innovative” were searched for amongst leading international journals in the field and major research databases (where “construction” was added to the search). To limit the results to most recently completed peer-reviewed work a ten-year period (1995-2004) of publication was deemed appropriate. The articles returned from the search were then verified to contain either the words “innovation” or “innovative” in the title and as a keyword.

All of the construction innovation articles retrieved within the ten-year period were then analysed. Figure 1 shows the factors that the collected articles were analysed against. The journal articles were categorised by one of the constructs of each factor. This coding process sought to precisely identify the particular focus of each paper for each factor analysed. Where a journal article could be argued to fall into more than one construct for a particular factor the main construct examined by the article was selected. After coding the data collected was organised and then analysed for trends and knowledge gaps.
Factors Examined  Constructs

Construction
Level of analysis *  National/industry, Firm/Multi-Project Organisation, Project, Individual/Professional, Product, Client, Various
Stage of lifecycle *  Design, Prepare, Construct, Post-Construct, Several, N/A
Sector *  Building, Civil Engineering, Home, General

Innovation
Definition of innovation  Yes or No
Research stream ^  Determinants of innovation, Diffusion of innovation, or Process of innovation
Innovation assessment (or measurement)  Self identification by practitioners, R&D expenditure, Professional journals, or New product development (NPD)

Research
Author(s) background  Academic, Practitioner, Academic and Practitioner, Academic and Government (Acad, Prac, A/P or A/G)
Source of article  Empirical or Review (Emp or Rev)
Future research proposed  Yes or No

Fig 1 Factors the journal articles were analysed against

* = Adapted from Betts and Lansley (1993), ^ = Adapted from Wolfe (1994)

3. RESULTS

The search resulted in the discovery of fifty-two journal articles published on the subject of construction innovation in peer-reviewed journals between 1995-2004. Table 1 breaks down the publication years of the journal articles. The results highlight the recent rise in construction innovation research. The last two years have seen a significant increase in the number of journal articles published on construction innovation. The two special editions of journals on construction innovation will have contributed to this but the increase will also be an indication of the recent completion of publicly sponsored research projects that have been funded to improve the innovation performance of construction industries.

Table 1 Publication years of the journal articles

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After the main results are presented in Table 2 a discussion of the findings follows. Firstly, key innovation factors of the articles are discussed and then the construction aspects studied in the journal articles are examined. Key research issues are then presented and this section ends with an agenda for future research that takes into account the results of the analysis and future research suggestions made in the journal articles.
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4. INNOVATION FOCUS

4.1 Definitions of innovation

Defining the subjects and issues investigated by research provides precision and clarity. Definitions of innovation are notorious for diverse conceptualisation between studies and frequent confusion with related concepts of creativity, invention and organisational change.

Despite the entire collection of journal articles examined in this research containing the word innovation in the title of the article and as an article keyword, less than half of them actually define innovation. The failure of journal articles to clarify the content and dimensions of innovation does not assist comparing and generalising between studies. Critics might suggest that some authors simply use the innovation buzzword to attach themselves to a popular and fashionable research field, when their research is perhaps more relevant to other areas. Alternatively, it might be argued that some innovation studies are so complex that attempting to create an appropriate innovation definition for them would be impossible.

Twenty out of the fifty-two journal articles analysed do define innovation. Amongst these definitions several similarities and distinctions exist. Common throughout all of the definitions is the notion that innovation involves the implementation of something new or novel to the unit of adoption. The most popular definition of innovation identified is derived from the work of Freeman (1989). Koskela and Vrijhoef (2001) and Slaughter throughout her work (Slaughter, 1998; 2000; Slaughter and Shimizu, 2000) have used the following:

Innovation is the actual use of a nontrivial change and improvement in a process, product, or system that is novel to the institution developing the change (Freeman, 1989).

Blayse and Manley (2004) and Kumaraswamy et al. (2004) have also quoted Freeman indirectly through reference to Slaughter’s definitions. Elsewhere in the construction literature Sexton and Barrett (2003b; 2004), in a definition developed with practitioners, emphasise that the outcome of innovation should enhance overall organisational performance. Ling (2003) extends description of the outcomes of innovation by clarifying that although innovation will have the intention of deriving benefits, risks and uncertainties will be associated with the implementation of a new idea. The most detailed construction specific definition is offered by Toole (1998) in defining innovation in house building as the:

“application of technology that is new to an organisation and that significantly improves the design and construction of a living space by decreasing installed cost, increased installed performance, and/or improving the business process, e.g., reduces lead time or increases flexibility” (Toole, 1998: 323).

4.2 Research streams

Wolfe’s (1994) influential review of generic innovation literature exposes an underdeveloped understanding of innovative behaviour in organisations because of a disjointed research base containing many inconclusive and inconsistent results. One solution proposed by Wolfe to improve future research is for researchers to minimise ambiguity by clearly addressing which specific stream of innovation research their work is relevant to. Wolfe suggested this strategy would provide innovation studies with greater generalisability and, thereby, contribute to the development of a more cumulative knowledge base.
After reviewing the innovation knowledge base Wolfe (1994) identified three research streams. The three research streams all concern the general phenomenon of innovation but have different units of analysis and research questions. The diffusion of innovation research stream has ‘an innovation’ as the unit of analysis and questions concern diffusion patterns of innovations through populations of potential adopters. The second research stream concerns determinants of innovativeness, with the unit of analysis being organisations and key influences on innovation being examined. The third research stream refers to process of innovation research, with the innovation process being the unit of analysis and research questions concerning the processes organisations go through in implementing innovations.

As the results in Table 2 reveal the vast majority of the construction innovation research is most closely related to the determinants of innovation research stream. Potential determinants of innovation are discussed in the literature at every level of analysis. So much research has been carried out in this area and so many influences on innovation identified that a number of models have already been produced that attempt to organise different groupings of construction innovation determinants. Bossink (2004a) distinguished four categorises of innovation drivers: environmental pressures; technological capabilities; knowledge exchanges; and boundary spanning drivers. Blayse and Manley (2004) divided influences on innovation into: (i) the clusters of clients and manufacturers; (ii) the structure of production; (iii) relationships between individuals, firms within the industry and between the industry and external parties; (iv) procurement systems; (v) regulations/standards; and (vi) the nature and quality of organisational resources.

Compared to the determinants of innovation research stream, the diffusion of innovation and innovation process research streams have received limited attention. Where conducted diffusion of innovation research has examined different issues. The rate of innovation in the construction equipment industry has been studied (Arditi et al., 1997), the adoption of innovations by SMEs in the house building sector has been examined (Toole, 1998) and one paper (Steele and Murray, 2004) has adapted seminal work by Rogers (1995) to the construction industry. With the exception of Slaughter (2000) and Halim and Haas (2004) innovation process research in the construction domain has been negligible.

Several speculations can be made as to the reasons for the supremacy of determinants of innovation research over the other two research streams. To begin researchers might have been motivated to pursue investigations into the determinants of innovation in a construction context as a priority because there is patent and unambiguous justification for such work. Construction industry peculiarities and institutional factors make research into specific construction innovation determinants necessary (Winch, 1998; Koskela and Vrijhoef, 2001). Moreover, the usefulness to construction of the existing determinants of innovation theory that is based on research from other industries has to be questioned. As Barrett et al. (2001: 2) have suggested specific research into innovation in construction must be undertaken and all generic innovation research be “envisioned, embedded and evaluated in a construction context to form a robust body of construction innovation knowledge in its own right”.

As well as an obvious justification for research into the determinants of innovation that the other research streams might not so noticeably possess, there are other reasons to explain the disparities between the research streams. Conceptual and accessibility issues might have influenced the deficiency of innovation diffusion studies in a construction context. For a diffusion of innovation study to be undertaken researchers need to be confident that they will be studying an actual innovation and that they will be able to obtain considerable adoption data from a population set.

Accessibility issues might have also influenced the paucity of innovation process work in construction contexts. Firstly, it might be difficult for researchers to discover innovations to study and secondly, for reasons of confidentiality and competitive intelligence most
construction companies might be reluctant to cooperate in research and grant study access to researchers. The most likely explanation for the significant shortage of innovation process research is however, methodological.

Innovation process research is best served by longitudinal studies that involve frequent data collection over long periods of time to fully observe the way in which the process unfolds (King and Anderson, 1995). Longitudinal studies are very resource intensive though and often demand teams of researchers. In generic innovation research the lack of rigorous empirical studies into the innovation process is also a concern (Wolfe, 1994; King and Anderson, 1995). Exemplary research has been carried out in the Minnesota Innovation Research Program (Van de Ven et al., 2000), proving the development of innovations can be studied successfully. Similar research would be valuable in different construction contexts.

4.3 Assessing innovation

One debate that is prominent in mainstream innovation fields is how innovations and innovative activities are indicated and measured in empirical studies. There is divergence in the factors studied to identify innovation between objective and subjective indicators. The problem for scholars relates to the fact that some of the ways of assessing innovation, that include practitioners identifying innovations or expert opinion, rely too much on personal assessments that can be subjective and open to bias. On the other hand regularly used indicators of innovation that are perceived to be objective are not complete indications of innovation. These objective indicators include the number of new products or services developed, research and development expenditure and the number of patents registered.

Close examination of the construction innovation articles reveals that not all authors are explicit about how innovation is indicated in their research projects. Comparing those studies that do reveal their strategies for identifying innovation several techniques have been used. Toole (1998) studied innovation in construction equipment by using the variables of the number of new models introduced every year over a 30-year period and the technological life of particular equipment. Some researchers have carried out projects that have relied on practitioners reporting innovations that they are familiar with (Ling, 2003; Sexton and Barrett, 2003b). Slaughter and Shimizu (2000) also used practitioners to identify innovations and obtained additional innovations from design and construction experts.

In addition, innovations have also been identified through reviews of professional construction journals. Bossink (2002) studied professional journals, university reports and newsletters of construction firms to identify innovative practices related to sustainability. Nam and Tatum (1997) selected projects for study because they were recognised for their innovativeness by more than two trade publications during the period 1985-1990. Pries and Janszen (1995) completed an analysis of 46 years of publication of two Dutch professional journals and identified 290 innovations that were verified by experts before analysis.

5. CONSTRUCTION FOCUS

5.1 Levels of analysis

The research into construction innovation spans levels of analysis, project lifecycle stages and industry sectors. Betts and Lansley (1993) classified papers from the first decade of Construction Management and Economics at one of six levels of analysis. At least one construction innovation journal article was identified at each level of analysis in this review. At the individual level (e.g. Nam and Tatum, 1997), project (e.g. Ling, 2003), firm (e.g.
Sexton and Barrett, 2003b), client (e.g. Ozaki, 2003), product (e.g. Burford and Smith, 1999), and industry/national (e.g. Pries and Janszen, 1995). From these levels of analysis the firm level has received most attention in the analysed literature; this might be because the principal drivers for innovation are often created at the firm level (Seaden and Manseau, 2001a). The product and client level of analysis received the least attention over the last decade. More academic articles focusing on the product level of analysis would complement and add research rigour to the many product level articles that are published in professional journals. Research that focuses on the influence of clients on innovation would also be positively received. The influential work of von Hippel (1988) has shown the potential power of customers in innovation and in the limited construction research Ozaki (2003) reveals that customer participation can bring about innovation in house building.

It is encouraging that a number of the articles analysed have studied innovation at more than one level of analysis (e.g. Gann and Salter, 2000; Blayse and Manley, 2004; Winch, 1998; Bossink, 2004a). Adopting multi-level approaches to studying innovation has been demanded in mainstream innovation research for sometime (King, 1990) and construction innovation research must make further progress with regard to this issue. For example, research that only focuses on the influence of a firm’s structure or climate on the development of a construction innovation, failing to investigate relevant project factors and interfaces with the external environment, would not be very useful.

5.2 Stage of project lifecycle

Only a small minority of the research articles have considered innovation at a specific stage of the project lifecycle or from the point of view of the project lifecycle in general. Salter and Gann (2003) and Salter and Torbett (2003) have considered the design stage of construction, working closely with major design firms. Elsewhere Sidwell et al. (2001) and Kumaraswany and Dulaimi (2001) have considered the preparation stage of construction. The lack of research from the perspective of the project lifecycle might be expected given the developing state of the construction innovation knowledge base. There have been more pressing research needs in other areas. To advance construction innovation research more research that examines innovation from the perspectives of distinct projects stages is necessary. Using the project lifecycle as a framework to organise the many innovation drivers and obstacles that have been identified thus far is one potential research project that might prove valuable to practitioners.

5.3 Sector

In similarity with the lack of focus on specific project stages there is also a lack of specific focus on different construction sectors. With the exception of research conducted by Toole (1998) and Ozaki (2003) which considers the house building sector the other authors do not make explicit reference to their research concerning specific construction industry sectors. The inference could be made from this finding that different construction sectors do not present markedly different contexts for innovation and do not therefore require specific investigation. However, this might be short sighted because even subtle differences between sectors could present diverse contexts for innovation. For instance, the regulatory frameworks in different sectors have been identified as being so distinct that they could have significantly different influences on construction innovations (Gann et al., 1998).
6. RESEARCH ISSUES

6.1 Author background

One of the most striking results identified in the analysis of the construction innovation literature is the publication dominance of academic authors. There is only one paper out the collection without any academic authorship (Cousin, 1998). In addition, out of the fifty-two articles there are only seven papers that can claim collaboration in authorship between academic and non-academic authors. Scrutiny of the seven articles that include collaborative efforts with non-academic authors reveals that three of the articles have collaboration with authors based in management and research consultancies (Davey et al., 2004; Edum-Fotwe et al., 2004; Steele and Murray, 2004) and two of the papers are written in collaboration with government employees (Brochner et al., 1999; Salter and Torbett, 2003). The Kangari and Miyatake (1997) and Slaughter and Shimizu (2000) articles are the only two out the fifty-two that have practitioner co-authorship and of curiosity to some might be the fact that in both of these papers the practitioner concerned is based in the Japanese construction industry.

The significance of only one solely practitioner authored article and very low levels of collaboration in authorship can be debated. Some researchers might argue that these findings are unimportant and if anything are positive in demonstrating the quality of academic journals if only professional scholars get published. On the other hand, considering the current academic climate where industrial collaboration is so highly desired by research councils, other researchers might find the results disappointing, especially in the research field of innovation where close relationships between academics and the ‘innovators’ in industry should be expected. A number of commentators might also use the findings to argue that the publication trends indicate the disturbing irrelevance of academic journals to practitioners and provide further evidence of an academic-practitioner divide that has been suggested in construction management research (Barrett and Barrett, 2003) and industrial research in general (Anderson, 1998; Starkey and Madan, 2001). In the discipline of organisational psychology publication trends have revealed a decline in the involvement of practitioners (Sackett et al., 1986; Anderson et al., 2001) and this has been identified as a key indicator of the breakdown of the scientist-practitioner connection (Anderson et al., 2001).

6.2 Journal article content

A further research aspect of the journal articles that was analysed was whether the journal articles were based on empirical work or simply reviews. There were seventeen papers that were classified as being review-based articles. In an emerging or re-emerging research field a high number of review papers based on accepted facts and academic experience can be expected to precede empirical studies because of the inevitable extra time it takes to complete empirical work. Two of the most frequently cited journal articles in the sample analysed were both review based (Winch, 1998; Slaughter 1998). Although it may partly be the case that these two particular articles have been so frequently cited because they pre-date the recent boom in innovation research, the prominence of these review contributions does demonstrate to some extent that non-empirical papers can offer value and indispensable insights into a research field.

The majority of the journal articles examined in this analysis did contain some empirical work. A variety of research techniques were used to collect the data. The techniques included case studies (Kangari and Miyatake, 1997), surveys (Dulaimi et al., 2003; Ling, 2004), interviews (Nam and Tatum, 1997; Gann et al., 1998) and historical analysis (Pried
and Janzsen, 1995). Some papers used several techniques to collect data (e.g. Slaughter and Shimizu 2000; Bossink, 2002; Dulaimi et al., 2002) and this is one strategy that has the potential to improve the robustness of innovation research.

When the motivation behind many of the empirical studies is considered, evidence of the undeveloped state of the construction innovation knowledge base is found. Few of the empirical studies attempt to test and validate theory and none of the studies are replication or extension studies of other construction innovation research. To develop the research field the insights and results that have been collected up to now need to be tested and organised in terms of significance. For example, the numerous innovation drivers and obstacles that have been suggested need to be confirmed for validity and prioritised through empirical tests to become most useful to construction industry stakeholders wishing to facilitate innovation.

6.3 Future research

The following section presents a future research agenda that is based on a combination of the results of this analysis and the future research suggestions made in the fifteen journal articles out of the collection of fifty-two that offer future research directions. The research agenda is divided into the three key issues of (i) research addressing gaps in the knowledge base, (ii) research testing and improving existing theory, and (iii) all future research being more explicit in conceptualisation.

As a result of analysing the content of the journal articles it is apparent that some aspects of construction innovation research are more examined than others. Investigations are required to redress the imbalances and fill the knowledge gaps. To enhance and extend the construction innovation knowledge base future research must consider different construction constituents. Complementing the generous research carried out at the firm level of analysis research targeting the seldom investigated client and product levels of analysis is requested (Slaughter, 2000; Sidwell et al., 2001).

Trends identified over the last decade reveal construction innovation research has tended not to concentrate on separate construction industry sectors or project lifecycle stages. It might be interpreted therefore that innovation research in different construction sectors or discrete lifecycle stages is not necessary. However, certain innovation determinants and stages of the innovation process do demand detailed examination in individual sectors and project lifecycle stages. For example, Gann et al. (1998) suggest that future investigation is required on how the distinct regulatory frameworks in the unrelated markets for hospitals, offices and housing influence product innovation differently.

In the discussion of research streams the supremacy of the determinants of innovativeness research stream was evident. Research that focuses on the diffusion of innovation and process of innovation research streams in construction is necessary. As Winch (1998) affirms innovations are a most appropriate object of inquiry given the poor state of innovation process research. Case studies that follow the trajectory of particular construction innovations and identify who generates new ideas and how ideas are implemented are essential (Winch, 1998).

Future studies of innovation processes must be extended to consider post-implementation factors. The most prominent future research suggestion in the journal articles is the need for study of the results and outcomes of the innovation process. Slaughter (2000) notes that further research is needed to fully assess the performance of innovations within their operating context and she highlights that particular focus must be on the secondary and tertiary system impacts of innovation. Ling (2003) adds that studying innovation implementation in full will enable robust models to be developed that can predict potential outcomes and the success levels of innovations. Furthermore, Seaden and Manseau (2001a)
and Blayse and Manley (2004) point out that how innovations impact on the productivity of the construction industry is poorly understood and that this is an area for future research.

Research that produces hard facts about the positive construction outcomes that have been achieved through innovation, such as reductions in costs and project delivery time, will have constructive impact on courses of action that can facilitate more innovation. For instance, Egbu (2004) desires greater education and training of construction personnel in the area of innovation management, but this is unlikely to happen unless firms have obvious incentive to invest in such schemes.

As well as future research examining gaps in the research literature, work should also be completed that aims to test and improve the existing research. The lack of replication and extension studies amongst the empirical articles analysed was noted. The most pivotal issue that can be examined involves achieving greater validity in the determinants of construction innovation research. The specific construction peculiarities, institutional factors and organisational characteristics identified as innovation drivers and obstacles throughout the construction innovation literature need to be clarified more thoroughly (Koskela and Vrijhoef, 2001). The relationships between the innovation influences must also be explored (Blayse and Manley, 2004).

In some innovation fields systematic reviews have been championed as a promising technique to validate determinants of innovation and to measure their impact (e.g. Damanpour, 1991; Anderson et al., 2004). However, a truly systematic review, involving a meta-analysis of research findings, would be very difficult to complete in the context of the construction innovation research. Few of the journal articles have similar characteristics and the conceptual frameworks used by researchers are either incompatible or not made explicit. This problem leads on to the final recommendation for future research.

It is vital that key factors explored in this analysis are made explicit in future construction innovation research. If researchers define innovation in the context their research, refer to the most applicable research stream (Wolfe, 1994) and describe how innovation is indicated and measured in their studies, the quality of the construction innovation knowledge base will improve. Clarity will be provided for readers and the studies will become more easily comparable. To develop the knowledge base even further it would be of immense value if different studies could also adopt similar conceptual frameworks. This would allow greater integration of research results and enable more quantitative approaches to analysis (Winch, 1998).

7. CONCLUSION

As well as limitations found in the construction innovation research base, there are limitations to this paper. The literature sourced for the analysis being of only international peer-reviewed journal articles standard means that not all the recent construction innovation research was examined. Work not analysed includes conference papers, academic books on the subject (e.g. Gann, 2000; Miozzo and Dewick, 2004), reports for industry groups (e.g. CIC, 1993; Barrett et al., 2001) and journal articles more than a decade old (e.g. Nam and Tatum, 1992; Slaughter, 1993). A further limitation to this work is its reliance on personal assessment when classifying the individual articles by the different constructs. Differences of opinion and different interpretations on some classifications can be expected, however, it is also expected that these differences would not be of the quantity to produce greatly different results overall or alter the general sentiments of this paper.

In summary, this research analysis has shown that innovation in construction research has attracted great interest and resulted in considerable peer-reviewed work in the last decade.
The amount of published work on construction innovation has increased significantly and this is very positive for an industry where innovation has become a key concept for firms, clients and governments alike. Analysis of the results revealed areas where construction innovation research was strong including the determinants of innovation research stream and the fact that construction innovation research was carried out at every level of analysis. However, shortcomings of the research were identified. The shortcomings include the failure of many papers to define innovation, the absence of practitioner involvement in the publication process, and the lack of research testing existing theory. The weaknesses identified indicated that there is an incomplete picture of innovation in construction. This paper suggested future research directions that would address neglected topics and test existing theory to produce a more comprehensive knowledge base. In addition, key conceptualisation issues that can improve the usefulness and integration potential of new work were offered.

Reflecting on the results of this research it useful to borrow a metaphor from Sexton and Barrett’s (2003a) review of the innovation in small construction firms literature and apply it to the construction innovation research base in general: “Pieces of the research jigsaw are well developed, while other pieces are not – and all the pieces lack the overall picture to make sense of where the individual pieces fit into the broader portrait” (Sexton and Barrett, 2003a: 620).

8. REFERENCES


