

Built Environment Journal

Faculty of Architecture, Planning and Surveying

Volume 14 No. 1

Jan 2017

ISSN 1675-5022

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Examining the Use of Theories in Construction Management Research: 2005 to 2014

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ABSTRACT

The use of theories in construction management research (CMR) is very important so as to generate an acceptable and generalizable construction management (CM) knowledge. This has generated a lot of research contributions that revealed the need to examine the use of theories and models in CMR by answering the following questions: (1) how often theories and models have been used in CMR?, (2) what are the types of, and the base disciplines of theories and models used in CMR? and, (3) what methodological patterns were followed by the theories and models used in CMR? In answering these questions, 846 empirical research articles published in Construction Management and Economics (CME) from 2005-2014 were quantitatively analysed using descriptive statistics such as frequency and percentage analysis, and statistical hypothesis tests such as chi-square and t-test. The 10-year period between 2005 and 2014 was demarcated into a 2 five-year periods (2005-2009 and 2010-2014), so as to ensure a clearer grasp of the trend of events over the period. The findings suggest that CMR continues to be generally atheoretical. The conclusion was made based on the findings, while the use of theories in future CMR was recommended.

Keywords: *Theory, model, construction management, research, review*

INTRODUCTION

According to Bhattacharjee (2012), theories are very instrumental to achieving the goal of building scientific knowledge through scientific research, and this is achieved in different ways. First, scientific research may progress from a theoretical proposition or to examine alternative explanations of two different theories (Lavee and Dollahite, 1991). In this type of research, explicit theories or theoretical explanations are input into an empirical research. The output from the empirical research is fed back to the theory for support, refutation or modification. Second, the research problem is processed through empirical research without input from theory. This is common in exploratory researches where existing theories are assumed to be irrelevant or that they are unable to guide the investigation (Mitchell and Cody, 1993). However exploratory studies are aimed at theory building, and feeding back empirical research's output to theory improves the knowledge generated (Lavee and Dollahite, 1991). The third way is the interplay between research problem and theories in scientific research. The research problem is processed through empirical research, and at the same time, there is input from, and control by, theory, and an output from empirical research which is fed back to the theory (Lavee and Dollahite, 1991). As a result the use of theories is increasingly encouraged in scientific research (See Runeson and de Valence, 2015; Glanz and Bishop, 2010; Venable, 2006; Friedman, 2003).

Harriss (1998) regarded the scientific research approach as ultimate in bringing about change and development to the world, and by extension, the best means of producing ideas of value in the field of construction management (CM). Within the frame of the scientific research approach, many researchers have advocated for the use of theories in construction management research (CMR) so as to generate the acceptable and generalizable knowledge (e.g. Voordijk, 2009; Harriss, 1998; Betts and Lansley,

1993). According to Voordijk (2009), the use of theories in CMR can help to predict or explain phenomena related to the design, production and operation of the built environment. Though less successful, others have attempted the development of an explicit theory of CM that can be used in CMR (Koskela, 2000; Li and Love, 1998). Koskela and Vrijhoef (2001) stated that construction management can be better understood if there is an explicit and a valid theory.

However, the use of theories in CMR has generated more interest as evidenced by the huge number of studies that focused on the subject. The study of Betts and Lansley (1993) emphasized on the theoretical position of the field of CM through the analysis of research conducted in the field. The study concluded that the field of CM is atheoretical because majority of CMR neither used theories nor contributed to theories. Others such as Chau, Raftery and Walker (1998), Seymour, Crook and Rooke (1998), Runeson (1997), Seymour et al. (1997), Raftery, McGeorge and Walters, (1997) and Seymour and Rooke (1995) debated the theoretical basis of CM, as well as the nature of CM theory, but later derailed to the methodological underpinning of CMR (Chau et al., 1998; Harriss, 1998). Nonetheless, in addition to the conclusion of Betts and Lansley (1993), one important finding from these studies is that CMR relies on the use of theories from other scientific disciplines. Another finding is that the use of theories in CMR follows a methodological pattern, that is, theories used in CMR are underpinned by applicable methodologies in scientific research.

The use of theories from other scientific disciplines is to an extent because there is no explicit theory of CM (Voordijk, 2009), and largely as a result of the multifaceted and multidisciplinary nature of CM problems (Chau et al., 1998; Li and Love, 1998). As a multifaceted phenomenon, a typical CM problem such as the inability of a construction firm to optimally cost-estimate for heavy engineering projects, thereby leading to loss of contracts and profits, has multiple sides to it. Possibly, this type of problem touches on the skill base of the firm, the knowledge and database management within the firm, the provision of IT-based technologies for effective cost estimation, motivation of employees for improved performance etc. According to (Voordijk, 2009), the solution to this nature of problem requires the input from different scientific disciplines outside the field of CM. For instance, a psychologist may be required to design strategies for motivating employees for improved performance in the firm, while the input of management consultants may be required to address the issues of skill base, and knowledge and database management of the firm. Seemingly, approaching any or all of the sides to this problem through scientific research draws on theories or theoretical concepts from different scientific fields because of the multidisciplinary nature (Love, Holt and Li, 2002).

Additionally, the use of theories in CMR follows methodological pattern. Theories can be used quantitatively (Runeson, 1997), qualitatively (Alley et al., 2010) and a mixture of both types (Hung, Smith-Jackson and Winchester, 2011). It is important to uncover the methodological pattern followed by theories used in CMR because different methodological approaches serve different functions or purposes in the knowledge discovery process (Love et al., 2002; Chau et al., 1998). In essence, uncovering the pattern of, or the dominant methodological underpinning for the use of theories in CMR serves to benefit the knowledge discovery process in the field of CM.

The subject of use of theories in CMR is long standing, and remains important, particularly to the discovery of, and determining the type of, knowledge produced in the field of CM. In the emphasis and discussions on this subject till date, particularly among researchers, two gaps that could add to the existing knowledge on the subject are yet to be empirically investigated. The first is the lack of knowledge of the types, and the base disciplines of theories used in CMR, while the second is the lack of information on the methodological pattern followed by the theories used in CMR. It is important to conduct an investigation in light of these gaps because the links between CM, and construction economics, and theory are not strong (de Valence, 2011). According to de Valence (2012), this may be the particular reason why the field of CM, and economics, have not gained total acceptability as academic disciplines and are not seen as distinct divides of management and economics respectively.

Therefore theories and models used in CMR were examined quantitatively by analyzing the articles published in Construction Management and Economics (CME) journal from 2005 to 2014. Models were

included because their use complements the use of theories in research (Alley et al., 2010). The other parts of this paper start with the literature review on what researchers think of the use of theories in CMR. This is followed by extensive description of the research method, analysis and presentation of results, the discussion and implication of results, strengths and limitations of study, and finally, the conclusions and recommendations.

LITERATURE REVIEW

The Use of Theories in Construction Management Research (CMR)

It is possible to carry out a research in an atheoretical manner, but the question of causal process is theoretical which requires *deduced* assertions about the phenomenon of interest (Baldwin, Persing and Magnuson, 2004). According to Friedman (2003), theory is what distinguishes science from craft. Craft involves doing, and sometimes some form of experimentation, but theory allows the framing, organisation and generalisation of human observations. In fact, theory and theorising have long played an important role in the evolution and practice of science (Venable, 2006). Basically, theories are statements about causal relationships, based on observation, experimentation or reasoning that help us explain or predict natural or social occurrences (Runeson and de Valence, 2015). The subject of the use of theories in CMR can be traced to Betts and Lansley (1993) who concluded after the analysis of all the articles published in the first ten years of Construction Management and Economics (CME) that research the field of CM was atheoretical because majority of CMR neither used theories nor contributed to theories. This generated a lot of research contribution, and critical issues relating to the use of theories in CMR were pointed.

First, the use of theories in CMR is unique and different from other fields of research. In contrast to many fields of research, there is no universal and/or explicit theory of CM (Voordijk, 2009; Harris, 1998). Meanwhile, the previous attempts at developing explicit theory of CM have been unsuccessful (Radosavljevic and Bennett, 2012; Koskela, 2000, Li and Love, 1998). For instance, the transformation-flow-value (TVF) theory conceptualised construction as a production activity which consists of the transformation of production factors into finished product following specific processes in order to deliver value to the end user (Koskela, 2000). However the two basic concepts of the theory – transformation, and flow and value, are dissimilar in contexts. The transformation of production factors is based on thing-metaphysics, while the flow-value generation is based on process metaphysics (Koskela et al., 2007). As a result, it is difficult to implement the theory in practice, and in some cases, the structure of the theory has been found to impede construction innovation (Koskela and Vrijhoef, 2001).

The use of theories in CMR is related to the nature of CM problems. CM problems are multifaceted, and therefore require the contribution of multiple disciplines within and outside the built environment for solutions (Voordijk, 2009; Chau et al., 1998). For instance, in order to achieve optimum cost in the fixing of lightning features in a building, the input of electrical engineers, cost consultants, builders, and energy consultant is required, and each of these disciplines may also require the use of relevant knowledge from other disciplines. Thus the cost consultant needs to be aware of energy ratings or electrical engineering specifications in order to provide effective cost management of the lightning features in the building. In addition, the management of CM requires the input of different firms who may view CM activity from different perspectives, thereby contributing to the multifaceted nature of CM problems (Harris, 1998).

In light of the multidisciplinary and multifaceted nature of CM problems, theories from different scientific disciplines are relied upon as explanatory and/or predictive frameworks in CMR (Voordijk, 2009; Love et al., 2002; Runeson, 1997). For instance, social exchange theory was used to explain the concept and importance of reliance in inter-organizational relationships among construction firms in the UK (Shiu, Jiang and Zaefarian, 2014), while the theory of planned behaviour (TPB) was used to analyse why scaffolders do not to use safety harnesses in construction in China (Zhang and Fang, 2013). Both social exchange theory and theory of planned behaviour are theories from the field of psychology, which are used as explanatory framework in CMR.

Furthermore, theories have an additional role of influencing a field of knowledge, particularly theories that gain recognition in a discipline can help shape the field, help to define the scope of practice, and also influence the training and socialization of professionals in the field (Runeson and de Valence, 2015; Glanz and Bishop, 2010). As stated by (Koskela, 2008), theory plays central and crucial roles in scholarly activities, defining research frontier, informing public policy, providing clarity in purpose and enabling a more general understanding by society. As a result, the field of CM is potentially subjected to the influence of theories from other scientific disciplines that are used in CMR. Considering that theories from different scientific disciplines are used in CMR, and the possible influence of the field of CM, there is currently no research that has provided any empirical explanation for this claim. Thus, it remains a research issue.

Second, the use of theory in CMR also follows methodological pattern, that is, theories can be used either qualitatively or quantitatively in research (Alley et al., 2010). In corroboration, Harriss (1998) stated that the theory chosen in a research can determine the methodology used its testing. For instance, in Sage et al. (2014), the choice of qualitative methodology was because the theory used in the study, i.e. Actor Network Theory (ANT), lends to the constructivist ontology that usually presents data as a narrative. In CMR, the use of theories quantitatively follows the scientific principles of establishment of causal and general relationships, verification of arguments and generalisations of findings (Runeson, 1997). Through this, existing theories can be tested, modified, refined and/or even build new theories. According to Chau et al. (1998), when theories are used quantitatively in CMR, the knowledge produced is generalisable to CM problems.

In contrast, the use of theories qualitatively in CMR involves the use of theories to select research questions and inductively interpret results (Alley et al., 2010). This is regarded as an interpretive process where the focus is not to achieve causality but to uncover the social reality 'as being constructed' by the subject of interest (Seymour, Crook and Rooke, 1998; Raftery et al., 1997; Seymour et al., 1997; Seymour and Rooke, 1995). In selecting research questions, this process helps to better identify, articulate and conceptualise construction management problems, especially from practitioners' viewpoint (Chau et al., 1998). In terms of inductively interpreting results, unique findings are pieced together within the frame of one or more theories, and even so, newer theories can be developed (e.g. Fernie and Tennant, 2013; Teo and Loosemore, 2011).

Theories in CMR can also be used qualitatively and quantitatively at the same time. In Hung et al., (2011), the theory of planned behaviour (TPB) was used to quantitatively inform the general safety problems of residential builders in Virginia and North Carolina, US. Having identified the problem, the TPB also formed the frame of reference for exploring the underlying causes of the identified problems. In research parlance, the combination of methodologies under any circumstances, including the circumstance where they are informed by theories, is regarded as pragmatism, which provides a rich and nuanced understanding of the industry practice (Dainty, 2008; Chau et al., 1998; Raftery, McGeorge and Walters, 1997).

Different methodological approaches serve different functions in knowledge discovery process. Hence, uncovering the methodological pattern followed by the theories used in CMR is important for knowledge discovery process in the field of CM (Love et al., 2002; Chau et al., 1998). Despite this knowledge, the common or dominant methodological pattern(s) followed by theories used in CMR is yet to be investigated in an empirical research, and hence, it remains a research issue. All in all, this study will examine the use of theories and models in CMR. Models

Models were included in the examination of the use of theories in CMR. In contrast to theories that attempts to explain observed phenomena and predict types of behaviour that are somehow connected, models are representation of all or part of a system that is constructed to study that system (Bhattacharjee, 2012). Models are not exactly fitting as explanatory framework of research as they can only explain and predict a *subset* of phenomena and behaviour (Li and Love, 1998). However their usage complements the use of theories in research, and they are also an opportunity for theoretical elaboration in any field of knowledge (Alley et al., 2010). For instance, the wave model of the behaviour of light and particle model are two models that are now subsumed under the theory of quantum mechanics. An

exemption to this was the exclusion of grounded theory because it reflects analysis-specific interpretive approach rather than a theory (Alley et al., 2010).

The specific objectives of this study will (1) determine how often theories are used in CMR, and (2) how this changes over the last decade. Both questions are in response to the conclusion of Betts and Lansley (1993). Other questions are to: (3) determine the types of, and the base disciplines of theories used in CMR, and (4) determine the methodological pattern of the theories used in CMR.

METHOD

The unit of analysis in this research includes articles published in the journal of *Construction Management and Economics (CME)*. CME is a pioneering and prestigiously learned journal in the field of CM with an age-long tradition of publishing articles which have strong theoretical positioning (Fenn, 1997; Betts and Lansley, 1993). Since the establishment in 1983, the journal has published many articles which employ theories as explanatory frameworks of research, thereby contributing more immensely to theoretical issues in the field of CM than other CM related journals. Therefore, all the empirical studies using quantitative, qualitative or mixed methods in CME were included, whereas letters to the editor, editorials, and book reviews were not included. Theoretical reviews were excluded because the focus of this paper is on the use of theories in empirical research. Additionally, given the time and resource constraints, only articles published in the last 10 years of CME were considered in this study. Nevertheless, it is believed that the last 10 years of publication in a leading journal can adequately inform on theoretical issues, particularly the use of theories in the CMR.

Correspondingly, a total of 846 articles published in 116 issues between 2005 and 2014 were identified for analysis. The 10-year period was demarcated into a 2 five-year periods (2005-2009 and 2010-2014), which allows a clearer grasp of the trend of events over the period. This is similar to Betts and Lansley (1993)'s analysis of the characteristics of the CME in a two five-year periods between 1983 and 1992. After that, an inclusive coding strategy was devised. It followed a brief review, and subsequently the selection and documentation of articles that used theories and models, either quantitatively (i.e. as a basis from which to develop and test hypotheses, interpret findings, and evolve further questions to advance knowledge), or qualitatively (i.e. selecting research questions and inductively interpreting results), or both (Alley et al., 2010). As stated earlier, models were included because they represent opportunities for theory development in a research field (Alley et al., 2010). An exemption to this was the exclusion of grounded theory because it reflects an analysis-specific interpretive method rather than an explicit theory (Alley et al., 2010).

Coding proceeded in three stages. The first stage was intended to determine how often theories and models were used in CMR as reflected in the reviewed articles published in CME, and how this changed between 2005 to 2009 and 2010 to 2014. The second stage was designed to determine the types of theories and models used in CMR. In this stage, coding involved the recording and tabulating the theories and models used in the reviewed articles, thereafter classifying them into respective fields of research (FOR) based on the Australian and New Zealand Standard Research Classification (ANZSRC) framework for measurement and analysis of research and experimental development (R and D). For articles using more than one theory or model, or a combination of a theory and model, each theory or model was recorded distinctly under their respective FOR. The implication of this is that the frequency of the theories and models will be more than the number of reviewed articles. The third stage of coding was the identification of the methodologies that underpin the use of theories. This seeks to verify the methodological pattern of the theories used in CMR (Dainty, 2008).

RESULTS

Table 1 shows the general trend in the use of theories and models in CMR from 2005 to 2014. It was found that 14% and 17% of articles used theories in 2005-2009 and 2010-2015 respectively. Also 4% and 5% of the articles used models/frameworks in 2005-2009 and 2010-2015 respectively. Clearly,

more articles used theories and models in the period 2010-2015 than in 2005-2009. Additionally, theories were used more often than models in both periods. The lesser use of models than theories in CMR, as reflected in the reviewed articles, may be due to their recognition by CM researchers as inadequate explanatory frameworks (or theoretical explanations) of research (Goldfarb and Ratner, 2008; Li and Love, 1998). That is, CM researchers consider models as sub-fitting to theories in theoretically grounding CMR.

Table 1 The frequency of theories and models used in CME papers (2005-2009 and 2010-2014)

Publication period	Number of publications	Number of publications using theories	Number of publications using models
2005-2009	385	55 (14%)	16 (4%)
2010-2014	461	77 (17%)	24 (5%)

Table 2 Comparison of the use of theories and models between 2005-2009 and 2010-2014

	Period	Number of publications	Average number each year	t-value	p-value
Theories	2004-2009	55	11.0	-1.305	0.228
	2010-2014	77	15.4		
Models	2004-2009	16	3.2	-1.167	0.277
	2010-2014	24	4.8		

Note: Statistical significance at 5%

Additionally, the independent-samples t-test was used to evaluate whether the average use of both theories and models in the reviewed articles published in the period 2005-2009 differ significantly from those published in the period 2010-2015. The result of the t-test analysis (see Table 2) shows that there is no statistically significant difference ($p > 0.05$) in the average use of both theories and models between 2005-2009 and 2010-2014. This suggests that the use of theories and models in CMR as reflected in the reviewed articles published in CME does not change in the last 10 years. Of all the 846 publications, 172 in total used theories or models. Thus the ratio of CME articles that used theories or models in the last 10 years is only 20%. Of all the papers reviewed, a total of 87 theories and 37 models were used from 2005-2014. As shown in Table 3, the most frequently used theories include the actor network theory (10 references), the institutional theory (8 references) and the innovation diffusion theory (7 references). Of 87 theories, only 31% (27 out of 87) were used in two or more articles in the last 10 years.

Table 3 Most frequently used theories in articles published in CME from 2005-2014

Rank.	Theories	Frequency
1	Actor Network theory	10
2	Institutional theory	8
3	Innovation diffusion theory	7
4	Real options theory	6
5	Organisational theory	6
6	Agency theory	6
7	Stakeholder theory	4
8	Production theory	4
9	Learning curve theory	4
10	Eclectic paradigm	4
11	Resource dependence theory	3
12	Decision theory	3
13	Location based management system theory	3
14	Information processing theory	3

Rank.	Theories	Frequency
15	Theory of planned behaviour	3
16	Option pricing theory	3
17	Internationalization theory	3
18	Control theory	3
19	Maslow need theory	3
20	Social exchange theory	2
21	Efficiency theory	2
22	Game theory	2
23	Activity theory	2
24	Stage growth theory	2
25	Conservation of resources (COR) theory	2
26	Structuration theory	2
27	Personal construct theory	2

Note: The complete list of theories is shown in Appendix 1.

Similarly, as shown in Table 4, the models commonly used in CMR include the resource based view (RBV) (9 references), the transaction cost economics (TCE) (8 times) and the porter's competitive strategy framework (5 references). Additionally, only 19% (7 out of 37) of the models were used in two or more of the reviewed articles in the last 10 years.

Table 4 Most frequently used models in articles published in CME between 2005 -2014)

Rank	Models/Frameworks	frequency
1	Resource based view (RBV)	9
2	Transaction cost economics	8
3	Porter's competitive strategies	5
4	Dynamic capabilities framework	4
5	Causality framework ConAC	2
6	Knowledge conversion model	2
7	The effort-recovery model	2

Note: The complete list of models is shown in Appendix 2.

In order to determine the base disciplines of the identified theories and models used in CMR, the field of research (FOR) of these theories and models was investigated according to the ANZSRC framework, which conforms to the Organisation for Economic Co-operation and Development (OECD) guidelines for classifying FOR (Australian Bureau of Statistics, 2008). As shown in Table 5, the theories and models fall into eleven (11) different FOR. The dominant base disciplines of the theories used in CMR are management, psychology and cognitive science, economics and studies in human society. While for the models identified, most of them fall into the field of Management. The theories from the field of management include organisation theory, innovation diffusion theory, stakeholder theory, location theory etc. The common theories from the field of psychology are learning curve theory, decision theory, and theory of planned behaviour, while the theories from the field of economics include agency theory, production theory, eclectic paradigm, stage growth theory etc. Finally, the theories from the field of studies in human society are the actor network and institutional theories.

Table 5 Frequency and classification of theories and models under different FOR between 2005-2009 and 2010-2014

ANZSRC Fields of Research (FOR)	Number of articles in which theories were used		Number of articles in which models were used	
	2005-2009	2010-2014	2005-2009	2010-2014
Management	20	20	20	16

ANZSRC Fields of Research (FOR)	Number of articles in which theories were used		Number of articles in which models were used	
	2005-2009	2010-2014	2005-2009	2010-2014
Psychology and cognitive sciences	13	24	1	1
Economics	10	24	4	5
Studies in human society	12	11	1	3
Language, communication and culture	7	4	2	4
Mathematical sciences	4	5		
Biological sciences		1	-	-
Information and computing sciences	1		-	-
Education	1	1	-	-
Law and legal studies		1	-	-
Philosophy and religious studies		1	-	-

By and large, theories and models from different FOR used in the reviewed articles remain stable in the last 10 years. However, the theories from the FOR of psychology and cognitive sciences, and economics increase in 2010-2014 compared with the 2005-2009 period. In the period of 2005-2009, the theories from the FOR of psychology and cognitive science and economics were used in 13 and 10 articles respectively. However the number of articles in which theories from both FOR was used in the 2010-2014 period increased to 24 respectively (Table 5).

Table 6 The methodological pattern of the theories and models used in CME papers (2005-2009 and 2010-2014)

Publication period	Number of publications using theories	Methodological underpinnings of the theories used			Number of publications using models	Methodological underpinnings of the models used		
		Quali	Quant	Mixed		Quali	Quant	Mixed
2005-2009	55	21 (38%)	23 (42%)	11 (20%)	16	3 (19%)	9 (56%)	4 (25%)
2010-2014	77	37 (48%)	15 (20%)	25 (32%)	24	10 (42%)	8 (33%)	6 (25%)

Note: Quali-qualitative, Quanti-quantitative. $\chi^2 = 9.547$ ($p = 0.008$, d.f. = 2)

The methodological pattern of the theories used in CMR was also investigated. From 2005-2009, the theories (N=55, 42%) and models (N=16, 56%) that follow the quantitative methodology were dominant in the reviewed articles. This is followed by the theories and models that follow the qualitative methodology, and lastly the mixed methodology. There was a shift in this pattern in the reviewed articles published from 2010-2014. During this period, the theories (N=77, 48%) and models (N=24, 42%) that follow the qualitative methodology were dominant in the reviewed articles. During the period, the theories that follow quantitative and mixed methodology patterns proportionately halved and doubled respectively over the 2005-2009 patterns. Also the models that follow quantitative and mixed methodology patterns proportionately steadied respectively for both periods. Aggregately, it could be seen that differences exist in the methodological patterns followed by the theories and models used in CMR from 2005-2009 and 2010-2014. Based on these results, the hypothesis that the methodological patterns followed by theories and models used in CMR as reflected in the reviewed articles is independent of the period time of publication is rejected ($p = 0.008$). This implies that the shift from the quantitative methodology pattern followed by theories and models used in the reviewed articles from 2005-2009 to qualitative and mixed methodological patterns in 2010-2014 is a function of the time that the articles were published.

DISCUSSION

The focal point of this research was to examine the use of theories in CMR with specific objectives to determine: how often theories are used in CMR, and how this has changed over a 10 year period, the types of theories and their base disciplines as used in CMR, and lastly, the methodological pattern followed by the theories used in CMR. The use of theories in CMR is rare, and it remained unchanged in the last 10 years. In the last 10 years, only 2 out of 10 CME articles use theories or models for explanatory framework of research. This ratio is even lower than that of the first 10 years CME publications (1983-1992). According to Betts and Lansley (1993), 3 out of 10 articles published in the first 10 years of CME used or contributed to theories. Even though the number of sample articles in the current study from 2005-2014 (N=846) is three and half times more than the number of articles (N=233) used in Betts and Lansley (1993), the use of theories in CMR has apparently reduced.

Majority of the theories and models were only used in one article in the last 10 years. A probable reason for this is the multifaceted nature of CM problems. The use of theories is related to the research problems to which they are applied (Li and Love, 1998), and as such, CM problems as a multifaceted phenomenon will require different theories and models for its different facets. Given this situation, it is difficult to have a preferred theory or model that is universal to CMR. Nonetheless, there are preferred or dominant FOR of theories and models used in CMR. These FOR mainly include management, economics, language communication and culture, studies in human society and psychology and cognitive science. One noticeable commonality of these FOR is that they relate with human aspects in various ways. For instance, management principles can be used to improve performance of employees in construction organisations, psychology principles to understand employee workplace relationships, and economic principles to explain contractors' bidding behaviour. In short, this implies that people (construction practitioners) are important unit of analysis in CMR (Love et al., 2002; Seymour et al., 1997).

Another noticeable phenomenon in construction management research is the lack of theories or models from any discipline in the construction sector, such as the FOR of Built Environment and Design in the ANZSRC framework. This may be due to the fact that there is not yet a generalizable and acceptable theory of CM (Voordijk, 2009; Harris, 1998). Previous attempts at developing theories that serves as explanatory framework of research and knowledge for construction related activities are less fruitful. Li and Love (1998)'s theory of construction problem solving remained at the "attempt" point even after many years of proposition, with no refinements, modifications, expansions, testings till date. The transformation-flow-value (TVF) theory of production portrayed significant contextual mismatch with real construction situations, and therefore not applicable (Koskela and Vrijhoef, 2001). Hence the field of CM continued to be haunted by lack of universal and explicit "own" theory.

In comparison to earlier studies, it reveals the recent popularity of using economics theories. In Betts and Lansley (1993)'s review of CM research articles published in the first 10 years of CME, the use of theories from economics FOR was almost anonymous in comparison to its management and psychology counterparts. According to Runeson and de Valence (2015), researchers on building (or construction) economics of CMR may not trust theories from the FOR of economics. According to them, the problem is that researchers are easily dissuaded from using economic theories once they realise that the underlying assumptions of these theories are different from practical reality. Because of the multifaceted nature of CM problems, it is not difficult to find practical realities in building economics that are not exactly fitting into assumptions of economic theories. Instead of being dissuaded and less trusting, CM researchers are encouraged to develop auxiliary statements that fit the theoretical assumptions (Runeson and de Valence, 2015). However the lack of trust in economic theories seems to have changed over time given the findings in this study.

Findings from this study also revealed that the use of theories in CMR follows different methodological patterns, changing from the quantitative methodological pattern in 2005-2009 to qualitative and mixed methodological patterns in 2010-2014. The dominance of the quantitative methodological pattern in CMR during 2005-2009 corroborated with the study of Dainty (2008, 2007), which revealed the dominance of the use of quantitative methodology in 2006. The reason for the dominance of the quantitative methodology during the period may be due to what Betts and Lansley (1993) termed "discipline in the making". The field of CM was regarded as developing during the period,

and subsequently, the nature of CM research was focused on laying down foundations of empirical data, testing general models and building new systems – all lending to quantitative methodological pattern.

At the same time during the period, many researchers were also promoting qualitative methodology on the grounds that it is more adequate, rich and expansive to capture the social nature of construction management practices (Seymour et al., 1997). A mixed-methodology, which provides a framework for utilising the plurality of methodologies that better captures the complexity of construction activities, was also promoted (Dainty, 2008). It was stated that the use of mixed methodology in CMR combines the advantages of multiple methodologies to improve the validity of research results (Abowitz and Toole, 2010; Love et al., 2002; Raftery et al., 1997). The ripple effect of the scholarly challenge to the dominance of quantitative methodological status quo in CMR could have resulted to the frequent use of qualitative and mixed methodological patterns in the period of 2010-2014.

CONCLUSION, IMPLICATION OF RESULTS AND RECOMMENDATIONS

The examination of the use of theories in CMR revealed that CMR continued to be atheoretical. The use of theories in CMR is still very limited and did not change significantly over the past 10 years. It is sparingly to notice that there is few, if not none, universal and explicit CM theories. In addition, majority of theories and models used in CMR are borrowed from research fields mainly in management, economics, language communication and culture, studies in human society and psychology and cognitive science, all related to humanistic or people aspects, which is the core of CM problems. Given that CM problems are multifaceted, CMR uses different theories from different disciplines that better characterise the multifaceted problems.

Currently, the methodological pattern underlying theories used in CMR is largely the qualitative methodology, followed by the mixed methodology. For the qualitative methodological pattern, theories are largely used in CMR to select research questions and inductively interpret results. Also for the mixed methodological pattern, theories are used to identify research problems, and at the same time used to generate generic solution to the problems. The current methodological pattern underlying theories used in CMR changed from the popular quantitative methodological pattern in the period 2005-2009.

The change in the methodological pattern followed by theories used in CMR to both the qualitative and mixed methodological patterns has implication for knowledge discovery process, or theory building. The use of theories in both methodological patterns follows an inductive process where existing theories can be refined, improved and expanded, or an outright development of a new theory can be achieved (Alasuutari, 1996). However knowledge discovery or theory building through the inductive process is limited in context, scope, application and generalization. In science the beauty of discovering knowledge or developing one or more theories is that it can be generalized broadly, and generally acceptable. Based on the conclusions, it is clear that there is need to increase the use of theories in CMR. It is therefore recommended that henceforth, scholarly publications in the field of CM should be theory driven. The editors and reviewers of journal and other scholarly articles published in the field of CM have a significant role in this regard, which is to prioritise the publication of theory driven CMR.

This study is characterised by certain strengths and limitations. Utilizing a structured coding scheme to review more than 800 articles published in CME from 2005 to 2014, the strength here lies in the quantitative manner of sample article selection and the use of statistical methods to generate and compare results. As CM covers a wide range of subject areas from different FOR, the coding scheme enables the selection of reviewed articles irrespective of subjects or FOR. However, given that this research only focuses on CME publications, the findings and the implications obtained may not reflect the totality of theories used in CMR, especially given that the field of CM has experienced growth over the years with the influx of many journals that shape, and publish on different aspects of construction. Nevertheless, considering CME is a prestigious leading journal in CMR, along with the selection of a considerably large number of papers in the last 10 years, this study has revealed important patterns and biases in the discipline of CM.

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