ENHANCING USER-INVOLVEMENT THROUGH A MULTI-CRITERIA DECISION AID: A LEAN DESIGN RESEARCH AGENDA

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ABSTRACT

User-involvement in design process is an important practice of the emergent area of lean design management. Decision-making is a key step in design process and the method by which decisions are made, in the involvement of users in design, is equally important. Even though some work has been carried out in relation to user-involvement in design process, little attention has been paid to the incorporation of lean decision tools in use-involvement frameworks. The focus of this paper is to set out an agenda for a research into the application of a lean decision tool, such as the Choosing by Advantages (CBA) multi-criteria decision system, to enhance user involvement in design process. Largely based on reference to relevant literature, the issues addressed in this paper include the background of the proposed research, description of some relevant concepts, relevance of the proposed research, and the methodology for the proposed research.

KEYWORDS:

Lean design management, user-involvement, design decisions, choosing by advantages

INTRODUCTION

The delivery of construction products, particularly in Ghana, has been observed to be associated with waste, delays and poor quality standards (Kpamma and Adjei-Kumi, 2011; 2003; Nicco-Annan, 2006; World Bank 1996). This situation could be traced back to activities at the design stage. Several studies (Ballard, 2008; Tunstall, 2006; Tilly, 2005) point to the impact of the design process to the problems of low quality, increased cost and waste in construction process.

Notwithstanding the significant contribution of the design stage to the success of construction project delivery and the importance of managing this stage effectively, much effort, with initiatives such as lean thinking, have been and continue to be concentrated on the construction phase to the neglect of the design phase (El. Reifi et al. 2013; Jørgensen, 2006). It has been established that within the literature of lean

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thinking, the design stage is under-researched compared to the construction phase (Lee et al., 2012; Arayici et al., 2011; Jacomit and Granja, 2011). The need therefore arises for more research in the area of lean design management.

One dimension of the pursuit of lean thinking in design management is the generation of value for clients and users through the involvement of users in the design process (Caixeta et al. 2013; Hansen and Olsson, 2011). However previous user-involvement and value generation frameworks (Oijevaar et al., 2009; Zwemer, 2008; Emmit et al., 2005; Kjølle, 2005) fall short of incorporating a lean decision-making tool, such as CBA, to ensure sound decisions. In the view of Björnfot and Bakken (2013), no method of "best practice" seem to exist to aid designers to translate construction end-user needs to physical design parameters.

This paper proposes a study on the application of the CBA decision system in the design process in Ghanaian firms. The proposed research is expected to culminate in the development of a user-involvement framework that incorporates a lean decision system such as CBA.

THEORY

LEAN DESIGN MANAGEMENT

Problems with design management have a link with the fact that the design process has generally been managed by the traditional project management methods (Tilly, 2005; Lahdenperä & Tanhuanpää, 2000). According to Ballard & Koskela (1998), the traditional project management approach fails to provide a workable solution to the challenges of managing the design process due to the fundamental principles of project management being based solely on the transformation model/theory of production.

Lean design management considers not only the transformation of inputs to outputs, but also the material and information flows as well as value generation for the customers and end-users (Ballard and Zabelle, 2000; Koskela & Howell, 2002). Whilst improving design process efficiency is important from an internal design team perspective, the ultimate aim of any lean design management strategy should be to maximise overall client and end-user value (Hansen and Olsson, 2011; Tilly, 2005; Emmitt et al., 2004).

A holistic approach to lean design management includes some additional significant factors to design management such as sustainable development and ways to achieve it (Green, 1994; Huovila and Koskela, 1998; Garnett, 1999; London, 2002). It is believed that while traditional design and construction focuses on cost, performance and quality objectives, sustainable design and construction, by comparison, focuses on value generation, minimization of resource depletion, minimization of environmental degradation and the importance of information flow management (Kestle, 2009). Emmitt et al. (2004) argue that moving lean thinking upstream – at the briefing, conceptual and detailed design stages – should create significant potential to deliver value throughout the whole construction process by creating a synergy between design, manufacturing and construction. The ultimate result of lean thinking in design is the usability of the completed construction product and how it supports the core business (Hansen and Olsson, 2011).

USER-INVOLVEMENT IN DESIGN

The basic notion of everything lean is to be conscious of the value to the end customer, as it is the end customer that ultimately decides if what is produced is actually of value (Björnfot and Bakken, 2013; Pasquire and Salvatierra-Garrido., 2011). In line with this argument, poor integration of specialist user knowledge, according to Kestle (2009), can have serious consequences, such as inappropriate synthesis of the needs, leading to low value generation for the client and end-users. Tilly (2005) in making a case for the relevance of user-involvement in lean design indicated that lean thinking in design and design management improves the design process through customer and end-user involvement. A lean design manager should have an end-to-end view clearly recognizing when and how to engage stakeholders, such as end-users, in the design process (Pasquire and Salvatierra-Garrido., 2011).

The value of the product of design, according to Jensen (2005), arises out of a joint creation process between the designer and the customer or user. This position is in line with the idea that design is not only a value-generating process, in terms of translating predetermined wishes and demands into building specifications, but also a value-discovering process (Allinson, 1997) in which case the involvement of clients and users in the design process to assist in discovering value is pertinent. Even though some attempts have been made previously to develop some frameworks for user-involvement in design (Oijevaar et al., 2009; Zwemmer, 2008; Emmitt et al., 2005; KjØlle et al., 2005), little attention has been given to the incorporation of a decision-making system that meets the tenets of lean thinking in those frameworks to enhance the participation of users in the design decision-making process. The need therefore arises for a research leading to the development of a user-involvement framework that incorporates a multi-criteria decision system, such as CBA.

DECISION-MAKING IN DESIGN PROCESS

One of the most active and important stages of decision-making in the construction industry is pre-construction (Abraham et al., 2013). Designs in the architecture, engineering and construction (AEC) industry could be viewed as graphical crystallines of an array of interconnected decisions. This is supported by Lawson (2006) map of the design process as shown in Figure 1.

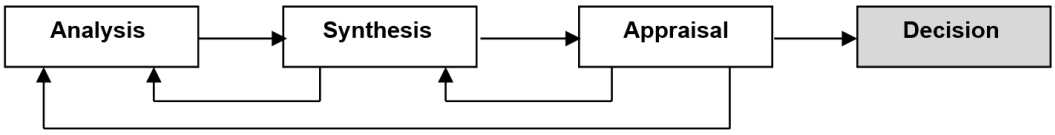

Figure 1: Map of the Design Process (Lawson, 2006)

In Lawson's design process map, there are 4 stages which start with analysis and end with a decision. The analysis stage involves exploration of relationships and patterns of the available information, oganising and ordering them to create a problem. The synthesis creates the response to such problems, and the appraisal evaluates the solution against the objectives found in the analysis stage for a decision or several ones to be finally made. Rosas (2013) describes the stages of analysis, synthesis and appraisal as sub-processes towards making a decision.

Literature is replete with indications of the critical place of decisions and decision-making in design process (Hansen and Olsson, 2011; Kestle et al., 2011; Kestle, 2009; Emmitt et al., 2004; Whelton et al., 2001). Emmitt et al. (2004) for instance observed that lean design management is, among others, also linked to the improvement in the decision-making process. Kestle et al. (2011) also observed that in the Lean Project Delivery System (LPDS^{TM}), the job of the project delivery team is not only to provide what the customer wants, but to first help the customer decide what they want. In their analogy of manufacturing process and design process, Bølviken et al. (2010) indicated that whereas the manufacturing process is completed with a physical action, the design task or process ends by means of a decision. Decision-making has also been found to play a crucial role in the management of the reciprocal interdependencies found in design process. It has been observed by Koskela et al. (2013) and Bølviken et al. (2010) that in the management of the reciprocal interdependencies in design, *decisions* are required to be made in ending design as an inherently expandable task, making trade-offs during design, as well as making or ending progress in negotiations and dialog in design process. It therefore follows that decision as a product and decision-making as a process, are critical elements of the design process and has tremendous impact on the outcome of construction projects. This establishes the basis for the argument that, beyond providing a space for users to be involved in the design process, there is a need for an elaboration of a sound decision-making system in the user involvement framework.

The multi-disciplinary nature of decision-making in the AEC sector and the involvement of multiple stakeholders, such as designers and users, often result in decision tasks with multiple objectives. The nature of these decision tasks call for a set of approaches known as multi-criteria decision-analysis (MCDA) (Abraham et al., 2013). In the application of MCDA methods, the imprecise goals of multi-dimensional problems are structured and modelled in terms of a set of individual decision criteria, where each criterion characterizes a single dimension of the problem to be evaluated (Abraham et al., 2013). The general framework for most MCDA, according to Seppälä et al. (2002), involves decomposing the decision problem into components, evaluating each component individually, and reassembling the components to provide overall insights and recommendations.

CBA is a value-based MCDA system that supports sound decision-making based on the comparisons among the advantages of alternatives (Suhr, 1999). CBA has been embraced in the construction industry, particularly by the lean construction community, as an appropriate decision support tool because it creates participatory, transparent, collaborative and auditable decision process in design and construction (Arroyo et al., 2012a, 2013; Mossman, 2012; Parrish and Tommelein, 2009; Macomber et al., 2006). Even though some studies have been conducted in the application of CBA in AEC, little attention has been given to the application of CBA in preliminary design activities such as briefing and conceptual design.

RELEVANCE OF PROPOSED RESEARCH

The outcome of the proposed research is expected to make a contribution to the theory of lean design management. Paucity in the theoretical work of lean design management has been acknowledged by several researchers (Emmitt, 2011; Arayici et al., 2011; Sacks et al., 2010; Jacomit and Granja, 2011; Lee et al., 2012). The need

for theory (in lean design management) has been outlined by Koskela (1999) to, among others, include: providing an explanation and understanding to an observed behaviour; providing a prediction of future behaviour; providing a basis for building tools for analyzing, designing and controlling; giving direction in showing the source of further progress.

Even though some work has been carried out in the application of CBA in the choice of some building materials and components (Arroyo et al., 2012a, 2013; Nguyen et al., 2009; Parrish and Tommelein, 2009; Grant and Jones, 2008), little work has been done in the application of CBA at the design stage, especially for briefing and conceptual design. The outcome of this research is expected to provide empirical evidence, generally on lean design management practice which has been observed by Emmitt (2011) to be lacking, and specifically on the application of CBA, as a lean tool, in design process.

Within the context of the construction industry in Ghana, while Kpamma and Adjei-Kumi (2011) observed a low level of diffusion of lean practices among Ghanaian firms, Ayarkwa et al., (2012) discovered a myriad of obstacles that could obstruct lean thinking implementation. There has, to date, been little (if any) empirical documentation on the application of emergent lean tools, such as, last planner system (LPS), building information modelling (BIM) and choosing by advantage (CBA) in Ghana. The process and outcome of this research will contribute to a diffusion of knowledge on the application of CBA, as a lean thinking principle, in Ghana.

The enhancement of user-involvement in design process towards value generation is a key focus of this research. The need for user-oriented research in the construction industry is evidenced in a recent initiative by the international council for research and innovation in building and construction (CIB) to increase research focus on clients and users by establishing a new working commission, W118. Jensen et al. (2011) in their paper: "towards an agenda for user-oriented research in the built environment" also indicated a strong need for a further user-oriented research in the built environment, and recommended that the research should focus more on direct interactions with, and involvement of users.

PROPOSED RESEARCH STRATEGY

This research is concentrated on studying a case application of the CBA decision-making system in the design process of some selected building projects in Ghana in order to eventually develop a framework for its successful application to enhance user involvement in design process. Case-study research and action research are therefore going to be employed within the context of a design science research (DSR) approach to achieve the aim of the research (Figure 2).

The situation of this research as a DSR is inspired by the fact that DSR is described as a research method for producing innovative constructions to solve problems faced in the real world, thus making contributions to the theory of the discipline within which it is applied (Lukka, 2003; Formoso and Tzortzopoulos, 2013; Koskela, 2008). These constructions, according to Lukka (2003), are all the artefacts produced by man including models, diagrams, plans, organisational structures, commercial products and project information systems. In relation to this research, the main objective is the development of a construction in the form of a use-involvement

framework that incorporates the CBA decision system towards ensuring value generation in design process and contributing to the theory of lean design management. Data for the development of the construction will mainly evolve from interviews, case studies and literature.

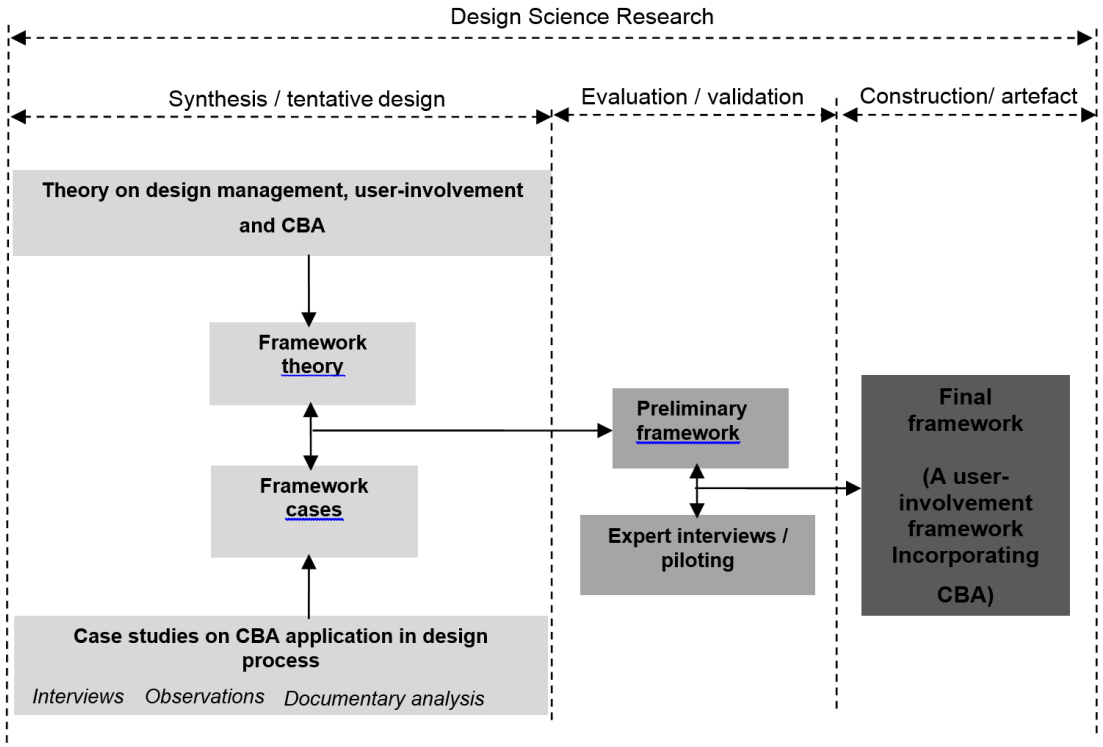

Figure 2: Scheme of Proposed Research Strategy (Based on Verschuren and Doorewaard, 2007 cited in Zwemmer, 2008)

CONCLUSION

The need for further research in lean design management is supported severally in literature. The generation of value, through the involvement of users, in design process has also been cited in several works as a key component of lean design management. Even though there has been some attempts to develop frameworks for user-involvement in design process, those framework fail to incorporate decision systems which agree with the tenets of lean thinking. Owing to the critical place of decisions in the design process, this paper concludes with a proposal for a research culminating in the development of a user-involvement framework that incorporates a lean decision system such as CBA. It is therefore recommended for an empirical study involving cases of CBA application in design process to obtain data. The empirical data from the case studies could then be combined with theories of participatory design and CBA to formulate the proposed framework.

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