THE NEED FOR EMBEDDING ‘LEARNING’ IN HEALTHCARE PROJECTS

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Service delivery in the healthcare sector is ultimately affected by the built infrastructure provided to support it. In order for a hospital environment to function optimally, there is a need to investigate how a learning culture can be nurtured within the design, construction and occupancy of healthcare facilities so that its effect on the healing process of patients can be managed. A large focus of attention currently within the research domain concerning knowledge management and organizational learning within construction is centred on learning from buildings in use and post occupancy evaluation (POE). Interestingly, however, there has been little focus on capturing lessons learnt from the construction phase of projects and even less on how these lessons can be fed back to form inputs into the design stage of future projects. Particular opportunities lie in capturing `lessons learnt’ from projects in relation to the build quality of the final product. This could be particularly important in informing the future buildability of healthcare projects. The aim of this research is to examine how lessons learnt arising from specifically the construction phase of healthcare infrastructure projects can be captured and fed back to designers in particular and in some cases the client. This is in order to create a learning culture and help improve the quality of future healthcare facilities/infrastructure. This paper reports on a critical synthesis of the organizational learning literature, primarily focusing on identifying the potential benefits for embedding such a learning culture in project-based environments specifically concentrated within a healthcare infrastructure context. Through this literature synthesis a significant case for improving project-based organizational learning within healthcare infrastructure is provided and recommendations for the need for further empirical investigation are made.

Keywords: buildability, feedback, healthcare, knowledge, learning, post occupancy evaluation.

INTRODUCTION

Recently there has been an increase in attention drawn to the recognition that the construction industry needs to better manage and share knowledge that resides in the supply chain, with the clients and internally within construction firms in order to improve both their efficiency and effectiveness (Hari *et al.* 2005). This drive to improve the management of knowledge within construction has stemmed particularly from the Latham (1994) and Egan (1998) reports that highlighted the industry’s underperformance.

This paper continues in the direction set out in the initial paper (see acknowledgements) which identified the main benefits and challenges of creating a construction-design feedback loop. However, more attention is focused within this

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paper on the reduction of rework within healthcare infrastructure projects and exploring how this can improve the quality of the built infrastructure.

A vast amount of academic and industrial attention regarding organizational learning is concerned with the drive to incorporate post occupancy evaluations as standard in order to assess buildings in use and inform the design of future buildings. Such research conducted by Cooper (2001); Zimmerman and Martin (2001); Bordass and Leaman (2005); Way and Bordass (2005); and Hadjri and Crozier (2009) has identified significant benefits that learning from existing buildings would bring; however, many of the benefits facilitated by post occupancy evaluation can arguably be attributed to generic knowledge management (KM) and organizational learning (OL). Therefore it is recognized that the omission of learning from all stages of the supply chain greatly restricts the degree to which we are 'knowledgeable' and as a consequence, is hindering improving built facilities. This has resulted in the call for a change in emphasis from solely being POE orientated, to the utilization of fee dback at all stages throughout the life-cycle of a building (Bordass and Leaman 2005).

ORGANIZATIONAL LEARNING AND KNOWLEDGE MANAGEMENT

Although broad in definition, organizational learning can be seen as "the process of improving actions through better knowledge and understanding" (Fiol and Lyles 1985). In order to better understand this concept other authors have narrowed down this breadth by attempting to provide answers to the question of, how can knowledge be captured and reused through the apparent consensus that it must be acquired, stored in some form of memory, and disseminated to others. In some instances, an additional stage of maintaining or validating the organizational memory is included. In the case of organizational memory, this research aligns with the notion that it is a construct and that it is the know-how of the business recorded in documents, reports, ideas, concepts etc.(Morschheuser 1997, cf. Lehner 2004).

Some authors have described the differing stages using varying terminology as well as deciding to merge complimentary stages in some cases in order to create a concise process. Through observing their differences, it is apparent that an amalgamation of the identifications of past researchers' KM lifecycles consists of a need to.

- Identify a learning opportunity
- Capture this knowledge
- Structure / formulize or codify this knowledge in order to
- Store the knowledge rationally in order to
- Share/Access knowledge; and
- Validate/Maintain knowledge to keep it up-to-date and relevant.

It should also be noted that some authors argue that the KM lifecycle should not be regarded as a linear process and that the stages may not be completed in sequence (Tan *et al.* 2006; Nissen *et al.* 2000, cf. Ruikar *et al.* 2007; Carrillo *et al.* 2000). For example, as cited in Carrillo *et al.* (2000), Demarest (1997) supports this non-linear view by suggesting that the process of identifying and structuring knowledge may be conducted simultaneously with the 'use of knowledge' stage, because sometimes people are required to put this knowledge into practice whilst it is being constructed.

Other authors have identified that there is an evident need for the capture of such knowledge to be as live as possible in order for the knowledge to not be lost as members of a project disperse to other projects, leave their organization, or continually defer knowledge capture to a later point in time (Kamara *et al*. 2003; Tan *et al*. 2006). The definition subscribed to in this research therefore is an adaption of that supplied by Gieskes and ten Broeke (2000) to include the need for a live capture element. This adapted definition of organizational learning mobilized within this research therefore reads.

> *"individuals should, (where possible) at the point of a learning opportunity being identified, use tools, mechanisms, methods, techniques and technologies provided by the organization to support the identification, capture, codification, storage and dissemination of different learning occurrences, in order to transfer individual learning into organizational learning".*

It has also been noted by authors such as Love and Smith (2003, cf. Love *et al.* 2004), that construction organizations overly focus on detecting errors, and then correcting them, w hilst maintaining their organizational norms. Similarly, Barlow and Jashapara (1998) identify that construction practice tends to be concerned with finding pragmatic solutions to problems as they arise. This clearly shows that construction organizations are currently conducting single-loop learning, which involves organizations responding to changes in their internal and external environment by detecting and correcting errors whilst maintaining the core organizational norms (Barlow and Jashapara 1998). However, the repetition of failing strategies is not a healthy course of action, but is still one that the construction industry often tends to follow (Love *et al*. 2000) and has thus resulted in the tendency to 'reinvent the wheel' (Keegan and Turner 2001; Carrillo 2005; Tan *et al*. 2006). This signifies that the desire held by healthcare providers to supply continuously improving healthcare facilities is being restricted due to the lack of learning during the construction stage.

DRIVERS FOR CONSTRUCTION-DESIGN FEEDBACK

As identified in the previous paper (see acknowledgements), knowledge management and learning attempts within healthcare infrastructure are predominantly focused around the evaluation of buildings in use (i.e. post occupancy evaluations). Such tools include; AEDET (Achieving Excellence Design Evaluation Toolkit) and ASPECT (A Staff and Patient Environment Calibration Tool). This section of the paper highlights a selection of benefits attributed specifically to incorporating an additional feedback loop within healthcare infrastructure in the form of capturing learning opportunities within the construction stage and feeding these back to the designers of future projects. Therefore these benefits are by no means a comprehensive list of the recognized benefits of knowledge management and organizational learning, nor are they seen as more advantageous than those attributed to the learning arising from POEs. These benefits are those that are viewed to offer the potential to provide the greatest degree of untapped added value to healthcare infrastructure projects of the future and thus, should be sought to supplement existing learning and feedback loops rather than replace them. Figure 1 illustrates the desired additional learning feedback loop between contractors and designers in particular, and in some cases, the clients and planning stage also.

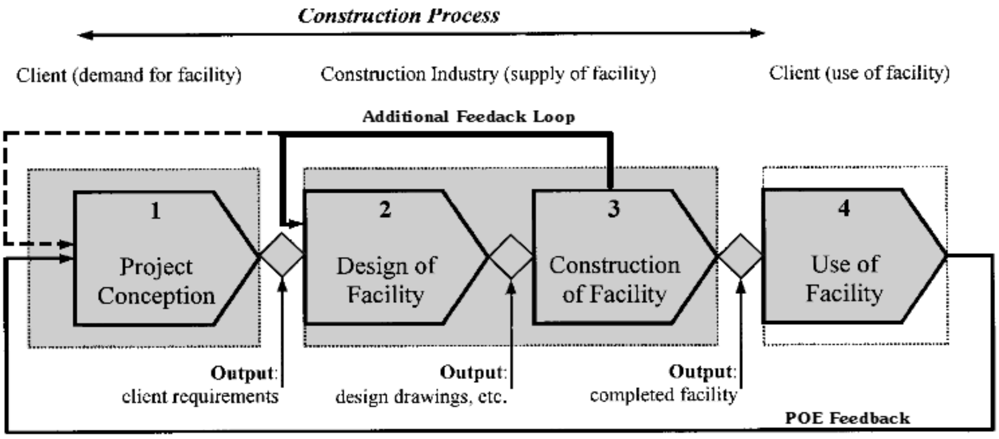

Figure 1: Construction Stage Feedback Loop. Source: Adapted from Kamara et al. (2002)

Improved design quality

One of the most significant reasons for construction knowledge to be captured and utilized within the context of healthcare infrastructure is that identified by Carrillo and Chinowsky (2006). They recognize that construction knowledge is often tied to issues such as constructability, material management, and design intent; each of which are closely related to the design input. In addition, a similar but more general view was previously voiced by Groak (1994, cf. Vakola and Rezgui 2000) who argued that the need for learning has increased in importance within the construction sector because the use of lessons learnt arising from projects affects the quality of the final product. Therefore, it is apparent that construction knowledge is important in all contexts in order to improve the design quality of buildings; however, it can be argued that this is of heightened importance within a healthcare infrastructure context due to the identification of de Jager (2007) that the delivery of the healthcare service is profoundly affected by the built infrastructure provided to support.

Alarcón and Mardones (1998) state that design quality issues arise from.

- A lack of completeness of the information necessary to complete the project e.g. inconsistencies, omissions, errors or a lack of clarity.
- Lack of design standards: A lack of standards in the design for similar projects, thus resulting in lower efficiency.
- A lack of constructability resulting in a high amount of problems being detected during the construction phase.

In many cases, such construction knowledge is currently being captured during processes such as snagging and inspections where errors of poor quality are recorded remotely and electronically using advancing snagging software and remote computing technologies. However, such knowledge which could potentially lead to a greater degree of attention being drawn to areas of high reoccurrences of rework, or used to supplement systems which aim to reduce design related rework such as building information modelling (BIM) is currently underutilized. This is due to it not being fed back to those that can potentially reduce the reoccurrence of rework in future designs; a scenario which Love et al. (1999) describe as being a symptom of a dysfunctional supply chain. Accordingly, it is an objective of this research to identify how such knowledge that is residing in the supply chain and is arguably already being captured, can be structured, stored, validated and shared in a framework which is mutually beneficial to designers and contractors, and thus greatly improve the utilization of such knowledge.

Reduced rework

Rework in construction projects is referred to by Palaneeswaren (2006), as an unnecessary effort of redoing a process or activity that was incorrectly implemented in the first instance. Cnuddle (1991, cf. Love and Li 2000), conducted a study which found the cost of non-conformance as being between 10% and 20% of the total project cost, with 46% of total deviation costs being created during the design stage, compared with 22% for construction deviations. Similarly, a more recent study observed that the average cost of rework was 12.4% of the total project cost (cf. Rhodes and Smallwood 2002). These complimentary findings of the substantial cost of rework within construction projects suggest that this problem is one that is not subsiding as time progresses.

Although the cost of constructing a new healthcare building is said to only constitute 2-3% of the total lifetime costs, the average cost of building a conventional hospital is in the region of £150million. Therefore the amount of funds exhausted on unnecessary rework could be as high as £18million per project. However, Burati *et al.* (1992), suggest that the increase in costs caused by rework may in fact be even higher because it is often the case that indirect costs such as schedule delays, litigation costs and other intangible costs of poor quality are not included. In addition it is also estimated that quality failures that occur post project completion can be as much as 4% of the overall project, with these failure costs being 51% design related, 26% construction related and 10% material failure related (Hammarlund and Josephson 1991 cf. Love *et al.* 2000). Consequently, post project quality failures could represent a further unnecessary cost of up to £37.5 million. These are substantial figures which could be allocated into the development of new facilities, equipment, additional research, or generally improving the level of service provided by the healthcare sector.

This signifies the importance of supplementing the current use of post project evaluations with that of a new framework to capture design related issues arising during the construction stage. This should therefore provide higher quality facilities to better support the delivery of the healthcare service and thus, improve the level of value for healthcare infrastructure/service stakeholders. For example, in the case of schedule delays, high levels of rework can have a detrimental knock-on effect to the occupant. Such negative experiences include; vital healthcare access unnecessarily being withheld from those that require it, increased noise and disturbance levels, and in general, heightening the levels of stress experienced by the patient.

The aforementioned findings of the potential unfavourable impacts of rework, combined with the healthcare infrastructure's desire to continuously improve the quality of their built facilities, indicates the criticality of reducing such instances as far as is reasonably possible. This opinion is complemented by Willis and Willis (1996) who state that doing the job right the first time is the single most important factor for minimizing the cost of designing and constructing world-class facilities. As a result, De Jager (2007) recognizes that mechanisms of systematic assessments and feedback loops where knowledge is fed back to those who can utilize and benefit most from it, are very powerful for learning from new facility developments, avoiding repeating mistakes, and using information to improve the quality of the built environment. This suggests that the creation of a feedback loop framework that builds upon existing knowledge capture processes (such as snagging and inspections), utilizing current technology adoptions (such as mobile snagging devices and remote networking), as well as incorporating the previously identified stages of the knowledge management lifecycle (see section 2) can assist in a move away from simply detecting and correcting errors at the point at which they are discovered (single-loop learning), to the development of a double-loop learning culture. Such a culture consists of organizations detecting symptoms as indicators of problems and focusing on addressing the root causes so that they can be overcome and thus establish new ways of working (Argyris 1992; Kululanga *et al*. 1999).Intellectual capital and innovation

Unlike one-off clients, healthcare providers can benefit greatly from the ongoing management of their intellectual assets in order to improve their knowledge and understanding of issues arising within one project and disseminating this knowledge to participants in future projects.

The collation of such intellectual assets has also been stated as enabling improved levels of innovation (Robinson *et al*. 2001), which is shown through Stewart's (1997) identification that an organization's ability to innovate depends on the knowledge and expertise possessed by its staff. Therefore, without the feedback of knowledge arising during the construction phase of a project, designers will be significantly restricted in learning from past projects, thus resulting in a lack of innovative designs in the future.

PROJECT DESCRIPTION AND OBJECTIVES

This project is concerned with investigating how a framework can be developed which promotes a learning culture between the construction and design phases of healthcare infrastructure projects. This proposed framework is foreseen to incorporate a socio-technical systems (STS) approach, which involves the interaction between people and technology to capture construction related lessons learnt. Such lessons of interest within this research are those that arise from the detection and correction of deviations from the initial design, plan, or procedures, and feeding these back to improve the knowledge base of designers. In particular, this research will observe and analyse what knowledge is currently being captured within processes such as snagging and inspections in order to assess what useful knowledge currently resides in the construction stage but is not being utilized to its full potential. Furthermore, it is anticipated that where possible, currently adopted technologies such as snagging software, mobile devices and remote networking will be utilized. This is foreseen to provide the added benefit of overcoming barriers such as a lack of time and resources as well as resistance to change.

It has also been a persistent identification of authors (McDermott 1999; Bordass and Leaman 2005) that the development of a learning culture through a new knowledge management programme should consist of identifying a key learning objective which is to provide the most significant increase of added value. This is in preference to attempting to collate a knowledge base consisting of multiple, unrelated learning instances as this inevitably results in the demise of such a knowledge management programme due to the lack of focus and inability to support such a broad learning initiative. Consequently it has been identified that a construction related learning objective which offers the potential to provide a high level of increased value within a healthcare infrastructure context is the main benefit of improved knowledge management identified in this paper; the reduction of rework. In addition to improving the value of healthcare infrastructures it has been identified as offering the potential to move away from the current construction focus of single-loop learning, towards a double-loop learning approach.

As such, this project aims to develop a framework which enables learnt experiences from one project to be applied to, and improve, multiple projects in the future. The framework aims to improve the integration between the two phases, whilst supporting the knowledge collated from post occupancy evaluations. This should assist in providing the feedback of a more complete, relevant and necessary knowledge base, which can then be utilized to continuously improve the quality of future designs.

Project aim and objectives

The overarching aim of this project is to investigate how a construction quality system can be used to capture construction related lessons learnt and feed them back into the design stage of future healthcare infrastructure projects. To satisfy this aim the following objectives are outlined.

- To identify the need/drivers for a design-construction quality loop.
- To identify the barriers of creating a design-construction quality loop.
- To investigate current practices (if any) designed to improve the feedback of poor design quality.
- To investigate what knowledge is currently being captured and assess its usefulness if fed back to the design stage.
- To identify the relevant techniques and technologies that assist the delivery of a design-construction quality loop.
- To identify the makeup of a new design-construction quality loop framework (e.g. what information should be captured, in what format etc.).

Proposed methodology

This paper has built on an initial review outlined in a primary paper (see acknowledgements), which explored existing literature surrounding the benefits, challenges and current state of knowledge management, organizational learning and feedback loops within a healthcare infrastructure context specifically, whilst being supported by a review of generic construction industry literature also. This paper however, has provided a greater focus on establishing the need for such a learning culture to be developed. This by no means undermines the complexity identified within the initial paper which highlighted the main potential challenges as being in the form of; short term client pressures, industry fragmentation, limited resources, unsupportive cultures and the difficulty in transferring tacit knowledge into explicit knowledge. In particular, the extent to which tacit knowledge can be converted into explicit knowledge is a highly contested issue and therefore it is an objective of this research to investigate in what format (text, picture, sound, video etc. the greatest degree of knowledge can be captured and disseminated to others.

The literature review has therefore provided the basis for a more empirical investigation into these areas to be conducted in order to further establish their influence on the development of such a proposed framework. This empirical research will be broken down into two distinct cycles. The first will consist of a case study approach comprised of interviews, workshops, shadowing and observations. It is anticipated that this approach will facilitate the formulation of a socio-technical framework which is based on the live capture and storage of rework related learning experiences within the construction stage, enabling them to be disseminated for reuse within the design stage. This development stage will then be followed by an additional research stage which aims to test and evaluate the effectiveness of the developed framework. Such a trailing stage is foreseen to consist of the feedback loop being applied to live cases of rework instances so that a greater degree of the learning instance and its context can be captured. This will offer the opportunity to develop a business case for its adoption, combined with the formulation of a recommended change strategy for the diffusion of this new approach.

DISCUSSION AND CONCLUSIONS

This paper is a continuation of the paper developed for the HaCIRIC conference 2010 which presented an initial exploration into the benefits of and barriers against the formulation of a feedback loop framework between construction organizations and design teams in order to improve the quality of future healthcare infrastructure designs. This paper concentrates a greater focus on the need for such research to be conducted in order to extract the evident benefits of improved learning such as; improved design quality, reduced levels of rework, and, improved intellectual capital. Although such benefits could be attributed to organizational learning within a generic construction context, it has been argued that the criticality of achieving such is heightened within a healthcare infrastructure context predominantly due to the acknowledgement made by De Jager (2007) that the quality of the built infrastructure within which the health service is provided has a detrimental effect on the quality of the service received. Therefore the benefits of organizational learning within this context offer the potential to provide increased levels of value to both healthcare infrastructure and service stakeholders.

This has led to an evident desire to continuously improve the quality of healthcare infrastructure; however, this paper has highlighted a distinct current lack of learning in practice between the construction and design stages of such projects. In addition, it has also been identified that there is a current gap in research literature regarding feedback loops that facilitate the capture of buildability issues surfacing during the construction stage and sharing these with design teams so that they can learn and extend their usable knowledge base.

It is therefore proposed that a greater degree of research is required in order to attempt to extract the positive implications for practice that have been outlined in this paper. Due to the embryonic nature of this research no findings have been presented at this stage; however a proposed research methodology which aims to satisfy such research needs has been provided. It is therefore foreseen that through conducting such research, progress towards continuously improving a wider range of aspects of healthcare infrastructure can be made, especially in terms of the value delivered to its extensive variety of stakeholders.

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