HOW COULD ICT BENEFIT DESIGN MANAGERS FOR ASSESSING SUSTAINABILITY OF THEIR PROJECTS?

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ABSTRACT

Sustainability in the construction industry is gaining increased attention which consequently shifted the modus operandi towards improving knowledge and practice. Amongst the key stakeholders involved in the delivery of sustainable buildings are design managers, who have a vital role in terms of managing and coordinating the design process and communicating design information. During this highly complex and iterative process, design managers also undertake tasks and activities which are related to sustainability and its assessment.

This study investigated the impact of sustainability assessment on the design managers' roles and responsibilities. The research specifically focused on ICT as an 'enabler' within the sustainability assessment process that aids design managers in achieving a better environment while carrying out their roles and responsibilities. Without an explicit understanding about how ICT can be effectively used within the sustainability assessment process, its impact will remain limited for design managers who are one of the key players in the strive for a sustainable design process.

A twofold research methodology was adopted within this project to achieve the primary and secondary research objectives, this included: an extensive literature review on the building design process, design management role and sustainability assessment; and, fieldwork, which consisted of questionnaires and series of interviews with design managers working for contractors in the industry.

The research concluded that there are several barriers to the effective management of sustainability assessment by design managers caused by two major factors: the late involvement in the projects and the lack of a structured approach for the sustainability management. The study concluded that in order for ICT to become an effective 'enabler' in the assessment process, barriers to effective management of sustainability assessment must be removed first.

Keywords: Design Management, ICT, Sustainability Assessment

INTRODUCTION

Over recent decades, sustainable development principles gained increased attention which is affecting practice in the construction industry to achieve the sustainability targets dictated by new policies for a low carbon economy. Consequently, buildings and associated processes are now becoming increasingly required to be delivered and implemented in a sustainable manner. The most important phase in delivery of construction projects is considered to be the design process where 80% of the project information is generated (Alshawi, 2007) and accounts for 70% of the final cost (Bibby *et al.*, 2003).

The implementation of sustainability assessment is most effective during the design stages, as building designs are developed in response to the preliminary assessment results (Kaatz *et al.*, 2006). As a result, unsustainable facets of design and construction are eradicated and altered to minimize changes to the outcome of cost, programme and quality.

The primary role of assessment in sustainable building projects is to measure and evaluate the sustainability performance of projects. The most widely used assessment tool in the UK is the BREEAM assessment method. The uptake of BREEAM by construction clients has been considerably high due to its simplicity in specifying performance requirements (Mistry, 2007). For example, the government who is the single largest client of the construction industry has legislated, through the Strategy for Sustainable Construction report, that all government projects must achieve an 'excellent' rating for new builds and 'very good' rating for major refurbishments (BIS, 2008).

Amongst the leading stakeholders within the building design process are design managers who undertake the responsibility for managing, coordinating and communicating the process and supporting information. Furthermore, design managers are considered to have a considerable influence on sustainability performance and play a key role in achieving the sustainability agenda within projects.

In order to reap the benefits of ICT during sustainability assessment process, design managers must recognize the potential of ICT and enhance their working methods so that ICT creates a synergy between sustainable design process and sustainability assessment. It is, therefore, the aim of this study to identify how ICT could benefit design managers in the sustainability assessment process.

Building Design Process

Design process is considered to have a major influence on delivering projects on time, to budget and specified quality (Bibby *et al.*, 2003 and; Yakubu and Sun, 2009*)*. Alshawi (2007) reported that 80% of the project information is generated during design stage. Research conducted by Yakubu and Sun (2009) has identified that the design is the single most important factor for programme and cost performance of projects; for both the contractors and consultants in the industry. According to Bibby (2003) the design accounts for 3-10% of the total project cost whilst the design process influences up to 70% of the overall cost (Bibby *et al.*, 2003); once the total

information for the project is generated and issued for the construction phase (Gray and Hughes, 2006).

However, findings from literature reviewed shows that design process has been seriously neglected (Bibby, 2003), inconsistently managed (Tzortzopoulos and Cooper, 2007), and rarely explored and exemplified (Freire and Alarcon, 2002). Furthermore, the 2006 data from the Construction Key Performance Indicators suggest that almost 36 per cent of projects overspend on design, and 42 per cent of the projects' design is delivered late (BIS, 2008).

Research by Austin *et al.* (2002) and Magent *et al.* (2009) illustrated that a poor design process is the result of poor communication between stakeholders; poor timing of decisions; uncertainty in the design brief; lack of relevant competencies among design managers; ineffective collaboration; little understanding of the interdisciplinary nature of design; and weak and unconsidered decision making. This is primarily attributed to the fact that design process is a very complex activity which requires co-ordination between many stakeholders; therefore problems are likely to occur during the implementation of this highly dynamic process (Tzortzopoulos and Cooper, 2007 and; Magent *et al.*, 2009).

Design Management

Historically, the design management role was undertaken by the architects who normally act as design leaders or lead consultants/designers and therefore responsible for coordinating and integrating the work of other design consultants and specialists (RIBA, 2008). However, the design management profession as a separate discipline has emerged in response to numerous issues and reports which highlighted its need in the construction industry (Latham, 1994; Egan, 1999).

As a result of new procurement routes, such as Design and Build, Design-Bid-Build, Public-Private-Partnership and Private Finance Initiative (Tzortzopoulos and Cooper, 2007), contractors are expected to have an increased responsibility for the control and management of the building design process (Bibby *et al.*, 2006). Originally contractors used to employ external consultant architects and engineers to develop the design, however in seeking to reduce wastage in the design and construction process and to maintain their competitiveness; design management has evolved as an important role for most contractors (Tzortzopoulos and Cooper, 2007).

According to Mills and Glass (2009), the isolated development of the profession, i.e. without a professional body solely for construction design managers, and the varied perspectives of the different professionals involved in design management has resulted in a fragmented evolvement of the profession. In fact, from the literature reviewed, the construction design management seems to be a 'developing' profession rather than a 'developed' one (Tzortzopoulos and Cooper, 2007 and; Mills and Glass, 2009), thus several definitions appear to be in circulation. From the reviewed literature on design management definition of design management can be: "*co-ordination, control and communication of the building design process whilst integrating with the project team to deliver a high quality building*"

There appear numerous drivers and barriers to design management practice within the literature. According to Bibby *et al.*,(2003) there are eight stimulus which resulted in

high demands to manage the process of design more effectively. These are (Austin *et al.*, 2000; Kagioglou *et al.*, 2000; Bibby *et al.*, 2003; Bibby, 2003a; Austin et al., 2007; Tzortzopoulos and Cooper, 2007; Magent *et al.*, 2009):

- the complexity of the design process due to its cyclic and iterative nature;
- high volume of information exchange, analysis and coordination;
- increasing complexity of the building and its contents as well as increasing number of stakeholders involved in the projects;
- design changes;
- unstructured and poorly defined/detailed design process and;
- poor information coordination.

It appears that there is a general consensus among scholars and practitioners that more clarity is needed as to what design management encompasses as well as what the boundaries are, as it requires a diverse range of skills (Cooper and Press, 1995; Tzortzopoulos and Cooper 2007 and; Mills and Glass, 2009). In addition, findings from the literature reviewed reveal that the current daily activities of design managers are too fuzzy to define. Furthermore, it seems that the tasks design managers undertake for any sustainability related issues are not well researched. This is an area where a further study is needed to identify their precise role, involvement in the process, and decisions which impact sustainability aspects of their projects.

Mills and Glass (2009) elucidates that the difficulties in defining the design managers' roles is due to deficiencies in current definitions of design managers' skills. In addition, the skills deficit, lack of authority which limits their potential influence on the processes, lack of consideration by stakeholders (particularly clients) and unwillingness of the construction industry to change, all form barriers to achieving a consensus on the role of the design manager (Bibby *at al.*, 2003, Mills and Glass, 2009).

Although there is a considerable amount of literature attempting to define, describe and understand the profession, it seems that the discipline is still developing. Hence, as also noted by Mills and Glass, (2009), attempts to propose solutions to the above problems is affected by the unstable foundations of a poorly defined and fragmented profession.

ICT Tools

There is a strong consensus that benefits of an improved or enhanced design process can only be realised if the roles are supported with the right set of ICT tools which are properly implemented and used efficiently (Cooper *et al.*, 2005). This point is also illustrated in Egan's *Rethinking Construction* report where it is stated: "*applying technology as a tool to support these process improvements*" (Egan, 1998; cited in Cooper *et al.*, 2005; pg.: 26). This implies that ICT should be effectively synchronised with the design process to enable the design management to reap the benefits of ICT.

Figure 1, below, illustrates the existing and emerging ICT tools which *could* be used by design managers (as well as other professionals) to carry out their roles and responsibilities. The majority of the tools encountered in the literature reviewed are

process-wide, meaning they could be used throughout a project and should be relevant to the design managers in the industry. Supporting technologies are considered to be 'diffused' technologies which are dependent on the personal/individual characteristics of users and their attitudes; training and technical support; technology characteristics and; company/project-wide ICT environment (Bibby *et al.*, 2003 and; Peansupap and Walker, 2005). The line between the 'core technologies' and 'supporting technologies' should be understood as transferable rather than restrictive (this means

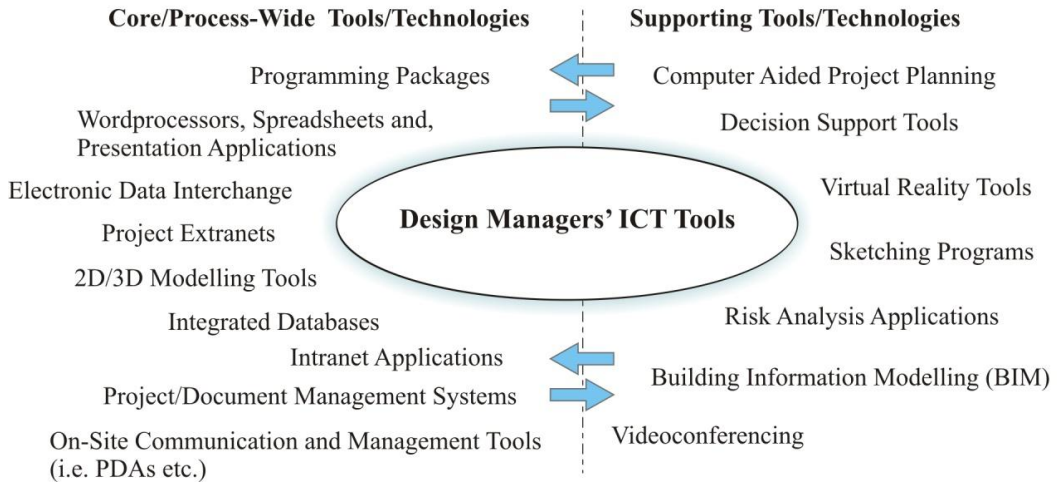

Figure 1: Design Managers' ICT Tools (Developed from literature)

that the diagram should not be seen as a fixed categories of tools/technologies).

However, one important point to be noted here is that the use of these ICT tools is significantly dependent upon the projects, processes, design managers themselves and the contractors who provide these tools/technologies to their employees (Cooper *et al.*, 2005). Therefore, it should be regarded as prescriptive rather than descriptive illustration of design managers' ICT tools.

Despite the significant changes in the construction industry brought about by the developments of ICT (Moum, 2006), the literature shows that there is a limited attention given to the impact of ICT on construction design management. Benefits and challenges of using ICT in the architectural process have been investigated by Moum (2006) who identified a wide range of impacts from an architectural design perspective. Similarly, Cooper *et al. (*2005) identified the benefits of using various ICT technologies relative to the design and construction stages in the *Generic Design and Construction Process Protocol* (GDCPP) (which derives its skeleton structure from RIBA Plan of Work). In relation to sustainability assessment, Lützkendorf and Lorenz (2006) suggest that if design process is to adequately encompass sustainability assessment, it requires ICT tools which are:

- readily available,
- adequately documented and explained,
- user-friendly and capable of delivering interpretable results,
- provides education and training for end-users,
- capable of referring the user to case studies for design optimization,

- able to generate documents and reports,
- adjustable to end-users' (designers or planners) working methods and,
- capable of processing design information generated during different design stages.

Sustainability Assessment

The range of environmental considerations is becoming increasingly covered within the responsibilities of a wide range of professionals (Cole and Pearl, 2007). Therefore, sustainability assessment is required to accommodate the participation of various stakeholders (including design managers in the design team) in order for them to be actively involved in the production of appropriate, sustainable solutions (Shelbourn *et al.*, 2006; Cole and Pearl, 2007; Ding, 2008 and; Thomson *et al.*, 2009). In sustainable design and construction process, the role of sustainability assessment is primarily focused on five objectives, which are:

- To assess the project's environmental, social and economic impact;
- To aid decision making process;
- To generate alternative options;
- To communicate the sustainability of the project with varied participants and stakeholders involved in the project;
- To provide information for optimization and improvement of processes.

The significance of sustainability assessment in aiding the delivery of sustainable building projects has been reported in numerous research papers and studies (Devuyst *et al.*, 2001; Cole, 2005; Kaatz *et al.*, 2006; Lützkendorf and Lorenz, 2006; Shelbourn *et al.*, 2006; Lord *et al.*, 2009 and; Thomson *et al.*, 2009). Cole (2005) sees the sustainability assessment as being increasingly used in construction projects to provide tangible information, structure and focus for design teams. In fact, sustainability assessment methods do not only measure the performance of buildings, they also influence the physical design and functions of the buildings (Cole, 2005). They are used to compare different options, identify key issues related to sustainable building design and hence optimize the design during the early phases of the project (Lützkendorf and Lorenz, 2006; Ding 2008 and; Thomson *et al.*, 2009). Furthermore, they can be used to identify the potential drawbacks and benefits of certain design functions (Lützkendorf and Lorenz, 2006); hence, they are generally used as a decision support tool to plan, process and approve design elements of a building.

In contrast with the above findings, the literature reviewed has also identified numerous issues related to limitations of sustainable assessment methods. For example, for the building sustainability assessment to be effective, it needs to be integrated to the building process from the early stages of the project (Cole, 2005; Kaatz *et al.*, 2006; Lützkendorf and Lorenz, 2006 and; Shelbourn *et al.*, 2006). However, literature review findings show that they are generally implemented after design/planning and/or construction stage (Lützkendorf and Lorenz, 2006 and; Ding, 2008).

Kaatz *et al.*, (2006) and Shelbourn *et al.*, (2006) argued that an integrated approach to sustainability assessment is required right from the appraisal to construction stages of

the project. In other words, separation of sustainability assessment from the decision making process will not be effective unless it is dynamically integrated with the building project life cycle (i.e.: right from appraisal, design, planning and construction to eventual de-construction) (Kaatz *et al.,* 2006). Several studies point to lack of understanding of sustainability assessment methodologies among practitioners and stakeholders (see, for example: Kaatz *et al.,* 2006; Khandokar *et al.,* 2009 and; Thomson *et al.,* 2009). Kaatz *et al. (*2006) highlights that there is a need for a better understanding of the role that building sustainability assessment plays within the project's life cycle. However, one of the key questions that arise from the early assessment is how to provide designers, planners, and other decision makers with right information so they do not rely on detailed/technical design information, which at later stages may be too late and expensive to consider any changes (Lützkendorf and Lorenz, 2006; Ding, 2008 and; Thomson *et al.,* 2009).

According to Cole, (2005) many of the existing assessment methods are also used as design tools to aid the generation of an optimized design process. This is considered to raise a number of potential problems including; limiting the creativity in the design process and exploration and innovation of new building practices; clients commanding designers to achieve high performance scoring buildings using a specific assessment method and; different interpretations of design requirements by design teams, for example cost vs. effectiveness (Cole, 2005 and; Ding, 2008). Moreover, typical assessment tools are not well integrated into the design and decision making process, making them difficult to apply during design phase (Lützkendorf and Lorenz, 2006 and; Lord *et al.,* 2009). For example, every small change in design will need re-evaluation which is time consuming (Loh *et al.,* 2009), making sustainability assessment cumbersome.

METHODOLOGY

The study employed a twofold research methodology: desk study and fieldwork. The aim of the desk study was to provide a coherent framework for further research. It had covered the three interrelated and interdependent concepts of Sustainability Assessment, ICT and Design Management. In order to collect sufficient data two instruments were utilised: self-completion questionnaires and follow-up interviews. Out of 120 personalized email invitations 36 Design Managers responded to the questionnaire survey (just over 25% response rate) and 5 semi-structured interviews were conducted with Design Managers (of which 3 were in Senior Design Managers) working for contractors in the UK construction industry. Questionnaires responses were analysed using variety of statistical methods (mean, mode and standard deviation) and interview data were coded and then analysed using a thematic matrix which noted the main points from each interviewee.

FINDINGS AND DISCUSSION

Analysis of the questionnaires and interview data revealed that influence of DMs (Design Managers) during the earlier stages is limited. This was attributed to the fact that all respondents worked for contractors and they were generally introduced to the project during 'D- Design Development' stage where most of the design information is already established. Therefore, there was little scope for making changes to the

design as most of the decisions affecting sustainability are usually made in the earlier stages. However the literature advocated that sustainability should be tackled in a much more richer, diverse and holistic context. Hence, DMs should be introduced to the project right from appraisal so that they are able to influence the design and contribute to the projects' sustainability.

Findings indicate that DMs role during the sustainability assessment is '*management of the assessment process so that project achieves the required rating*'. In order to carry out this task, their role involved providing information to sustainability assessors and other project participants; implementing the assessment results; and, making decisions based on the assessment results. DMs were also required to manage design changes taking into account the sustainability objectives, so that changes do not deviate from the required rating. Lastly, DMs were required to communicate the assessment results to other project participants. Therefore, it seems that the role of DMs is critical within the sustainable building design process and its assessment.

It was also established from the literature reviewed that in order for design process to benefit from sustainability assessment, sustainability must be introduced at the earlier stages of the project (Cole, 2005; Kaatz et al., 2006; Lützkendorf and Lorenz, 2006 and; Shelbourn *et al.*, 2006). Confirming the findings of the literature review, findings indicate that assessment is usually carried out between stages B- Design Brief and E- Technical Design. However, as outlined above, DMs do not get involved in a project until 'C- Concept' stage (See Figure 2, below) so complications arising at later stages were usually inevitable.

It was established from the interviews that the problems experienced by DMs during sustainability assessment are mainly associated with the management of the assessment process. This is caused by the following factors:

- Late involvement of DMs in the assessment process which hinders the effective management of sustainability.
- DMs are often given the burden of the information and decisions that was generated at the earlier stages.
- Critical decisions about the assessment methods, procedures, strategies, and alternative options were all made and already set by the time DMs are introduced to the project.

Furthermore, DMs do not have a structured approach to manage the assessment process. The majority of the interviewees indicated that when sustainability is given high priority, almost all projects were required to be assessed using the BREEAM assessment tool. Hence, they tend to use the categories in the BREEAM assessment tool to manage the assessment process.

During design changes re-assessment had to be carried out to ensure that target rating is still achievable. This complex and iterative task increased the difficulty of managing the whole process. Project participants were often required to meet occasionally in order to eradicate the design conflicts and errors, and to make decisions considering sustainability as well as cost, time, quality and value aspects of the project.

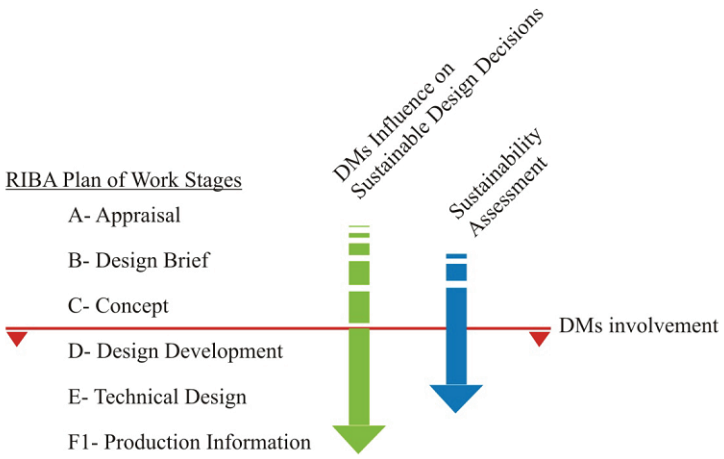

Figure 2: DMs involvement in projects and implementation of sustainability assessment

Another barrier to management of the assessment process was the lack of expertise and authority of DMs. Divergent suggestions was given by respondents, some criticising that DMs should not expected to be experts at everything, whilst other respondent suggested that skills are more appropriate to overcome these barriers. Concurring with Mills and Glass (2009), common skills mentioned by respondents include interpersonal skills, communication, knowledge, experience, and awareness as the core skills to manage the process.

In view of the above it is rational to advocate training on sustainability assessment so that DMs become more aware of the sustainability issues surrounding their project as well as aware of their potential influence on the project. In addition to this, their role in the assessment must be clearly established and acknowledged by other project participants to avoid conflict of powers and overruling of their potentially critical decisions.

In relation to sustainability assessment, the role of these tools/technologies is to aid *management, coordination and communication* of the assessment process. In general, most of the tools identified in the literature review provide a platform for collaborative working, generation of project drawings, sketches and models, management of documents, drawings and, organising and planning etc. Whilst the functionalities of these tools/technologies slightly vary, most of them facilitate an easy management of the assessment process by providing access to information; eliminating uncertainty; and, creating a dynamic environment for the assessment. Therefore, ICT has a crucial role in enabling sustainability assessment to be carried out in an efficient, manageable, transparent and speedy manner.

CONCLUSIONS

This study concludes that management of the sustainability assessment could be enhanced with the use of collaborative tools such as project extranets/intranets and

document management systems. However, *ICT could enable such process only if DMs employ a structured, systematic approach to manage the assessment*. Without an explicit, structured approach, the role of ICT in the management of assessment process will remain weak for DMs.

In order for ICT to become enabler, the BREEAM assessment tool must be integrated into the sustainable building design process first. Currently there is no structured approach to management of items/categories in the BREEAM assessment tool, which hinders its management by DMs. By incorporating the BREEAM assessment tool into the sustainable building design process, the management of the assessment process can be effectively and efficiently supported by appropriate ICT tools.

It is recommended that a separate component, which is integrated into the projects' extranet/intranet which oversees the sustainability activities of the project would be useful to coordinate the assessment process. This way, collaborative technologies can provide a platform for sustainability assessment and its management. The sub-system should allow input from all project participants involved in the project so that assessment is carried out in a holistic context. By incorporating a sustainability assessment component into the projects' main system, DMs can better manage and coordinate the assessment process not just through the design stage but also during the construction and subsequent post-occupancy evaluation stage.

ICT plays a crucial role in facilitating the communication of information amongst project teams who are geographically scattered. In the sustainability assessment process, ICT can support exchange of information amongst project participants at the right time, to the right people and with the right information. When communication is easily established between project participants, better access to information will be procured and 'push-or-pull' of information will be eliminated. It seems that mobile technologies, video-conferencing and collaborative tools are the best facilitators of communicating information. DMs can collaborate, share, and integrate valuable assessment information if they utilize these ICT tools effectively.

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