Emerging ICT–Based Methods in the Architecture, Engineering, and Construction Context

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INTRODUCTION

The profound impacts of globalisation within the AEC industry would lead a wide range of organisations towards adopting various technological innovations for improving performance and enhancing competitiveness (Azhar, Lukkad, & Ahmad, 2013). Such foresight was previously endorsed by Blayse and Manley (2004, p. 1) as they claimed that "the higher the levels of innovation in the construction industry, the greater the likelihood that it will increase its contribution to economic growth." Nevertheless, the AEC industry has fell behind other production-based industries in terms of adopting innovations and increasing the innovativeness level (Forsman et al., 2012; Hosseini, Chileshe, Zuo, & Baroudi, 2014). This calls for promoting adoption of Information and communication technology (ICT) methods in the field, for which the first step appears to be acquiring a deeper appreciation of the major aspects of ICT methods within the AEC industry.

In essence, adopting ICT methods has become imperative for AEC organisations due to the conditions rampant in today's business environment such as globalisation, the fierce competition and the need to maintain high levels of productivity to survive (Toole, Hallowell, & Chinowsky, 2013). The foregoing challenges facing the AEC industry in recent years have led AEC organisations towards attempting to tackle the issues by harnessing the advantages offered by various ICT-based innovations (Budde, 2012). Likewise, due to a wide range of developments in the business environment (Akintoye, Goulding, & Zawdie, 2012), future of the AEC industry has become poised to gain enormous advantages of ICT by-products (Hoang,

2005). As such, ICT is regarded as the platform for many innovations within the AEC industry.

There is consensus within literature vis-à-vis the prominence and vital role of ICT innovations for the AEC context as some authors have described the deficiencies of the AEC industry in implementing ICT innovations as the major problem affecting the performance throughout the whole industry (Rezgui & Zarli, 2006). Even more, some researchers have postulated that the trend of adopting ICT within the AEC industry should not be an incremental change, but it must be a revolutionary movement towards ICT permeation in all elements of the industry (Brandon, Kocatürk, & Foundation, 2008). Such huge alterations within the industry take strong support from managerial levels, cooperation to make the necessary changes by all the involving practitioners in the industry and regulatory and financial incentives introduced by policy makers and authorities.

To this end, the first step towards the enhancement of ICT adoption in the AEC context includes generating the necessary motivation amongst practitioners for adopting ICT through highlighting the potential benefits (Sarshar & Isikdag, 2004). In response to such need, this article aims at introducing some advantageous ICT innovations and their unique capabilities in facilitating enhancing the performance within the AEC industry. Hence, the main objective of this article is gathering successful cases of ICT implementation from the fragmented structure of the AEC industry along with presenting their advantages.

BACKGROUND

The driving forces pushing AEC sector towards adopting ICT have roots in various realities dominating the business environment. These include but not limited to the fierce competition between corporations to tap into global markets, the trend of globalisation and attempts to overcome the lifelong issues of AEC sector such as low performance through deploying technological innovations. In summary, the main reasons behind the interest of AEC practitioners to adopt ICT come from three main grounds:

1. The trend of globalisation.
2. Specific idiosyncrasies of the AEC context.
3. Proven advantages of ICT.

As illustrated in Figure 1, the benefits associated with implementing ICT in the AEC industry largely concern the capabilities of ICT in terms of facilitating achieving the main objectives of AEC projects. In this regard, enhancing collaboration level, facilitating accessibility and exchange of information and enhancing the effectiveness of communications has been acknowledged (Nitithamyong & Skibniewski, 2004). Besides, many studies have attested to the positive impacts of utilising ICT in the AEC industry on grounds of improving cost-effectiveness, scheduling and quality of products (Griffis, Hogan, & Li, 1995; Thomas, Macken, & Lee, 2001; Yang, 2004). In the same vein, ICT implementation has far-reaching positive impacts on all major aspects of AEC projects including time, cost, competiveness enhancement and information exchange (Hosseini, Chileshe, Zuo, & Baroudi, 2012).

ICT methods are deemed a competitive tool for organisations in today's market. Moreover, they are regarded as a catalyst for process improvement through deploying workflow tools and process modelling (Sarshar & Isikdag, 2004). As such, there is consensus regarding the positive effects of utilising ICT in AEC projects (Adriaanse, Voordijk, & Dewulf, 2010). However, the same literature postulates that the level the AEC industry has harnessed the advantages of ICT has still remained unacceptably low (Hjelt & Björk, 2006; Nitithamyong & Skibniewski, 2004). Such low level of ICT adoption stands in contrast with the fact that the necessary technology is already available and capable enough to fulfil the requirements pertinent

to adoption and implementation of ICT in the AEC context as endorsed by Hosseini et al. (2012).

Against this backdrop, it is suggested frequently in many studies that the main barriers to adoption of ICT in AEC context have roots in the lack of awareness of practitioners about the benefits of adopting ICT in AEC projects, which has resulted in the lack of support from managers and primary decision makers. As a result, many research projects have been conducted to create and disseminate the relevant knowledge by the aim of enhancing the level of ICT adoption within the AEC industry as will be discussed briefly in the following section.

PROGRAMS TO ENHANCE ADOPTION OF ICT

Many organisations have attempted to develop a roadmap for the specific purpose of enhancing the level of adoption of ICT through creation of knowledge regarding the associated benefits. The programs as described in following are amongst some of the main AEC industry's ICT development programs.

ROADCON funded by the European Commission under the IST program (Information Society Technologies) is geared towards developing a research and development roadmap for ICT within the AEC context. It largely encourages adopting ICT on grounds of effectively realising main industrial, and business opportunities and priorities (Rezgui & Zarli, 2006).

ELSEWISE as an EU funded research project is a user reference project directed at defining the information technology and product data technology requirements of the European large-scale engineering industry particularly in building, civil engineering, and construction fields (Sarshar & Isikdag, 2004).

Information Technology in Construction – Making IT Happen outlined the NSW Government (Australia) strategies to improve construction processes vis-à-vis ICT. This strategy aimed at improving the level of productivity, reducing cost and time of delivering buildings and facilities. This was pursued through defining a Research Agenda for AEC context as described by Sarshar and Isikdag (2004).

Think Lab is a cutting-edge facility established by the University of Salford for conducting research studies on ICT areas, including construction. It provides a

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