Advanced ICT Methodologies (AIM) in the Construction Industry

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INTRODUCTION

A wide range of advanced ICT methodologies (AIM) have made inroads in the construction market due to the conditions rampant in today's business environment. That is, the trend of globalisation, the fierce competition in the market and the need to deliver more complex projects have led leading construction companies towards adopting available technological innovations (Toole, Hallowell, & Chinowsky, 2013). As a corollary, the construction community has observed a rapid emergence of different AIM to improve communications, visualization, and foster collaboration among the parties involved in construction projects. Nevertheless, the overall rate of adoption within the industry has been slow, particularly in small and medium sized (SMEs) companies (Heydarian et al., 2015). Evidence shows that such slow uptake of cutting-edge methodologies is for the most part stemmed from a lack of support of practitioners in the construction industry exacerbated by clients being uninformed of the advantages of available methods for their projects (Cao, Li, & Wang, 2014). In essence, major barriers to widespread adoption of new technology in the construction industry have roots in lack of familiarity of clients, managers and company directors with AIM, and the potential benefits envisaged for utilizing such technology as observed by Van der Vlist, Vrolijk, and Dewulf (2014). As asserted by Williams (2007, p. 6) one barrier to adoption of AIM is "Lack of knowledge by people in the construction industry about what is possible.".

Therefore, the first step towards the enhancement of ICT adoption in the construction context includes generating the necessary motivation amongst practitioners and policy makers through disseminating the knowledge about currently-available methods and highlighting the potential benefits (Sarshar & Isikdag, 2004; Williams, 2007). To address such need, this chapter aims at introducing available cutting edge methodologies applicable to construction activities. The useful feature of this chapter is that it brings information about different cutting-edge methodologies under one cover. The content of the chapter is designed for readers who might not be specialists in ICT-oriented techniques while working within any domain of the construction industry. In the classroom, this chapter could be a supplementary source for courses on information systems in construction or lean project delivery.

The chapter starts with a brief discussion on the driving forces and root causes of rapid advances in the tools and technologies utilized in the con-

DOI: 10.4018/978-1-5225-2255-3.ch047

struction context. This is followed by describing the concepts of virtual design and construction (VDC). Afterwards, different aspects of building information modelling are discussed. The rest of the chapter is concerned with introducing various innovative AIM that are emerging within the construction industry.

BACKGROUND

The driving forces pushing the construction industry towards adopting AIM for the most part have roots in two main categories of drivers. These include the efficiency needed to proactively addressing internal process problems facing the industry alongside pressures from the external environment (Cao et al., 2014). In essence, the main reasons behind the interest of construction practitioners to adopt advanced ICT methods come from three main grounds under two categories:

1. External pressure
    a. Fierce competition of globalisation (external pressure)
    b. New requirements of projects (external pressure)
2. Internal problems
    a. Advantages of advanced ICT methodologies (efficiency needed to address internal problems)

As illustrated in Figure 1, the capabilities of AIM in terms of facilitating achieving efficacy in delivering projects by integration of design and construction phases as a main reason for construction companies (Aouad, Lee, & Wu, 2007). 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 construction industry on grounds of improving cost-effectiveness, scheduling and quality of products (Williams, 2007). 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). AIM are deemed the most promising tool for organisations in today's market. That is, they are regarded as a catalyst for process improvement through providing the ability for construction companies to share multi-disciplinary interests, goals, perspectives, and constraints in an accurate, timely and economical way (Aouad et al., 2007). As such, there is consensus regarding the positive effects of utilising AIM in construction organisations and on projects (Adriaanse, Voordijk, & Dewulf, 2010). Moreover, the cost of adoption AIM on construction projects is continuously declining (Sardroud, 2015). On top of that, technologies that support AIM are progressively advancing in other fields. These result in AIM redefining the methods and procedures in the construction context, thus brining a paradigm shift into the practices of the construction context (Hardin & McCool, 2015).

In this context, a wide range of AIM have emerged under the framework of VDC (Khanzode, Fischer, Reed, & Ballard, 2006) as will be described next.

Virtual Design and Construction

The VDC concept emerged out of the attempts to apply lean production principles to the practices of the construction industry in delivering projects. The birthplace for VDC was the Centre for Integrated Facility Engineering (CIFE) at Stanford University where VDC was officially introduced in 2001. CIFE has remained a magnet for research and teaching on VDC since then (Kunz & Fischer, 2012). As defined by CIFE, VDC is the application of multi-disciplinary performance models of design/construction, which include the *Product* (i.e., facilities), *Organization* of the design, and *Processes* referred to as POP in order to support business interests. In essence, VDC tools enable construction practitioners of simulating construc-