Urban construction management: the role of ICT and emerging technologies in external stakeholder management
URBAN CONSTRUCTION MANAGEMENT: THE ROLE OF ICT AND EMERGING TECHNOLOGIES IN EXTERNAL STAKEHOLDER MANAGEMENT

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ABSTRACT

Urban construction projects are renowned for their dynamic complexities, which can adversely affect the external stakeholders surrounding the project. Complex collaboration and communication amongst stakeholders has resulted in the fast development of ICT in the construction industry, which tends to lag behind other industries considering technological advancements. Therefore, this paper aims to identify and document methods of ICT and emerging technologies used in the management and engagement of external stakeholders on urban construction projects. In addressing this aim, the core objective is to identify what methods of ICT are involved in the management and engagement of the stakeholders in these inherently risky environments. The methodology undertaken is qualitatively based, encompassing a descriptive literature review and four exploratory cases study interviews with project managers in an Irish construction company. The data accumulated is examined using mind mapping software, and cognitively summarised, which identified the Internet in particular, BIM, VR / AR and 3D Laser Scanning as methods of communicating with stakeholders. This research demonstrates and strengthens that when face-to-face communication is unavailable, the Internet, through Email and Social Media usage, can be implemented as a suitable method of ICT in the management and engagement of external stakeholders on urban construction projects.

Keywords: community engagement, emerging technologies, external stakeholder management, information and communications technology (ICT), urban development.

INTRODUCTION

According to Keivani (2010), the urban population is continuing to outgrow the rural population, and Yang, et al. (2017) estimate that the global urban population will reach 67% by 2050. Urban areas are classed as being complex and dynamic systems (Roberts and Sykes 2000), where construction sites are typically commonplace (Spillane, et al. 2013). Rapid urbanisation has seen construction projects grow in increased size and complexity (Luo, et al. 2017), requiring multi-disciplinary collaboration among project participants and stakeholders (Jiao, et al. 2013). Furthermore, stakeholder concerns in this area are interconnected with complex and dynamic interdependencies (Mok, et al. 2017), and as a result of increased project

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complexity, Information and Communications Technologies (ICT) have had to develop at a very fast pace (Taxén and Lilliesköld 2008). However, the construction industry tends to lag behind other industries when taking advantage of new technologies and innovative practices (Peansupap 2012), and it is slow to integrate technological advances (CICA 2002). Although information technologies are universal, they remain elusive in construction management (Lee, et al. 2013), due to the complex processes of construction projects and their large numbers of participants and stakeholders (Wang, et al. 2007). Hosseini, et al. (2013) note that many studies have focussed on the potential for harnessing new ICT technology, for the good of the construction industry. However, research on how ICT and emerging technologies can assist in the management of stakeholders in complex urban projects is scant, in particular the external stakeholders who can have both a positive or negative effect on the overall success of a project (Nash, et al. 2010).

Therefore, to address this issue and to fulfil a concise but prevalent gap in the research area, it is necessary to recognise and present results, based on the actuality of events that emerge when constructing in such surroundings. To approach an intriguing facet of interest, this research aims to establish and document, within an urban context, how ICT and emerging technologies can assist on-site project managers in the management and engagement of external stakeholders, during the whole lifecycle of a construction project. This is realised by undertaking a sequential mixed method approach, encompassing qualitative techniques for analysis including a literature review and semi-structured interviews, and using mind mapping software which can be cognitively summarised. From this research, the core objective is to identify what methods of ICT are involved in the management and engagement of the stakeholders in these inherently risky environments. In addressing this aim, it is anticipated that this study will assist and aid project managers in identifying suitable methods of ICT and emerging technologies, in the management and engagement of external stakeholders on urban construction projects.

**URBAN CONSTRUCTION AND EXTERNAL STAKEHOLDER MANAGEMENT**

Cicmil and Marshall (2005) consider construction projects to be complex and uncertain in nature, with the element of risk being greater in urban projects (Jung, et al. 2015). Construction sites are a common feature within urban areas, and the number and variety of stakeholders involved in construction projects can make effective and efficient collaboration difficult (Marshall-Ponting and Aouad 2005). Stakeholders are viewed as individuals or groups who can affect or be affected by a construction project (Yang 2010), and their interests are considered by Bal, et al. (2011) to be the most important for the overall success of a construction project. A popular categorisation is to distinguish between internal and external stakeholders (Zedan and Miller 2016). Internal stakeholders are those who are formally members of the project coalition and hence usually support the project (Winch 2004), whereas external stakeholders are those who are not formally members, but can affect or be affected by the project in a significant way (Chinyio and Olomolaiye 2010).

Even though external stakeholders have no contractual relationship with the project (Elmahroug, et al. 2014), their expectations are considered to be comparatively more critical and pressing than their internal counterparts (Chan and Oppong 2017).
al. (2013) support that failure to accommodate the concerns of the public and other external stakeholders in large construction projects can lead to severe resistance, and may eventually kill the project (Mok, et al. 2017). Furthermore, the consideration of external stakeholders is important because it extends stakeholder concerns from being mainly organisational and business driven towards being more globally orientated (Feige, et al. 2011), with a wider sense of social and environmental responsibility (Pivo and Fisher 2010). Nevertheless, both internal and external stakeholders are important considerations in construction project development (Oppong, et al. 2017), thus making stakeholder management an essential concept for the successful completion of construction projects (Collinge and Harty 2013). Also, Widén, et al. (2013) emphasise that a structured process of stakeholder engagement is an integral part of the construction innovation process, as Yang and Shen (2015) advocate that engaging stakeholders in the construction sector is an important consideration for stakeholder management. Yu, et al. (2017) affirm that stakeholder management can be used to deal with complex stakeholder issues surrounding urban projects.

**Ict and emerging technologies in the construction industry**

Mak (2001) observes that the construction industry is seen by many as being backward in deploying technology, in particular ICT. In recent times, ICT has been adopted for construction project management, and its introduction and development has influenced project management practices to take a new turn, taking advantage of newly developed management tools and the latest technologies (Ahuja, et al. 2009). Adriaanse, et al. (2010) define ICT as a digital coordination and collaboration tool, used for communicating and sharing project information between participating organisations in a construction project. ICT facilitates communication and improves integration (Peansupap and Walker 2006), and Ahuja, et al. (2010) agree that ICT provides opportunities for real time access of information, and improves coordination and collaboration between project stakeholders.

However, the construction industry is still confronted with great communication difficulties in sharing information among participants (Voordijk and Adriaanse 2016). Information produced by too many sources can contribute to industry fragmentation (Jaafar, et al. 2007), and numerous participants using different technologies can actually hinder the adaption of ICT and technology (Arslan, et al. 2005). Nevertheless, Goulet (1977) stresses that technology is critical for development, and the adoption of emerging technologies is an important challenge for the future of construction (Cook and Chatterjee 2015). Holt, et al. (2015) support that emerging technology offers the best opportunity to improve the construction process, through better integration and efficiency. Some current and emerging technologies in the construction industry that have the potential to assist with stakeholder management include the Internet, Building Information Modelling, Virtual Reality / Augmented Reality and 3D Laser Scanning.

**Internet**

Although not necessarily an emerging technology, using the Internet to exchange information remains a very important method of communicating (Chan and Leung 2004). Nitithamyong and Skibniewski (2004) claim that the Internet is the technology that best facilitates a collaborative working environment in a construction project. A project manager can share information electronically at a very low cost using the
Internet, compared to other communication means (Ahuja, et al. 2009), and the use of the Internet as a communication platform can help information transfer more effectively during the construction process (Deng, et al. 2001).

**Building Information Modelling (BIM)**

BIM technology is changing the construction industry (Sun, et al. 2017), and it is gaining popularity across the globe (Dutta, et al. 2016). BIM involves building a digital prototype of a model and simulating it in a digital world (Collins 2013), and as a result buildings can be inspected from various angles (Crotty 2012). Azhar, et al. (2015) believe that BIM encourages integration of the roles of all stakeholders on a project, and represents a new paradigm within the construction industry. Bryde, et al. (2013) concur that BIM has the potential to be the catalyst for project manager's to better integrate the different stakeholders involved in modern construction projects.

**Virtual Reality / Augmented Reality**

Virtual Reality (VR) technology is a computer generated simulation of the real world, where the user is able to both view and manipulate the contents of that simulated environment (Goulding, et al. 2012). Augmented Reality (AR) is a variation of VR that creates an environment in which digital information is inserted in a predominantly real-world view (Wang, et al. 2013). VR immerses the user in a completely virtual world without any contact from the surrounding real world (Izkara, et al. 2007), whereas AR allows the user to see the real world with virtual objects composited into the real world (Azuma 1997). Woksepp (2007) describes how VR generates efficient communication between stakeholders, and AR technology can enable all project members to collaborate in an efficient way throughout the construction process (Jiao, et al. 2013).

**3D Laser Scanning**

3D Laser Scanning can produce information rich 3D digital models of objects without physical contact with the objects (Vosselman and Mass 2010). Wood and Madgwick (2016) note that 3D Laser Scanning links well with BIM and VR/AR, but the main difference is that laser scanning systems need an existing building to produce a model, whereas BIM produces a model before it is built (Alomari, et al. 2016). 3D Laser scanning has a variety of applications on construction projects, and the captured data can be useful to the entire project team (Shanbari, et al. 2016). It has been one of the most popular recent measurement tools in the construction industry (Kim, et al. 2016), and using this technology to build a model and capture data is beneficial to all project stakeholders (Eastman, et al. 2008).

**METHODOLOGY**

This study is at the inception of an introductory piece of research, which intends to contribute to both academia and industry. The subject being considered is at the elementary stage of an extensive topic, and it is anticipated that the preliminary findings of this paper will be used to further supplement the results at the conclusion of the whole study. Taking the theoretical position this paper and subsequent research is founded upon into consideration, a critical realism approach is contemplated and adopted. As the nature of this study primarily addresses the opinions of human participants, a subjectivist approach is applied to the ontology, providing a basis for the case study methodology. A qualitative methodology encompassing an informative
A literature review is undertaken, followed by four exploratory case study interviews with construction professionals within a large construction company. The subject of theory in the context of the interactions between construction projects and their physical and social environments is also worthy for consideration; however, this is beyond the scope of this paper due to the preliminary nature of the study in question.

**Literature Review**

A literature review is the foundation of any research (Saunders, et al. 2003), and an extensive desk based literature review is undertaken in this study, with literature considered from a range of sources including journal articles, conference proceedings and academic reports. The literature is assessed and a thorough insight into the research is gained, whilst also obtaining possible factors for inclusion in the subsequent analysis. This provides a core basis of information and supporting material, which can be included for consideration and discussion during the interview process, and also pave the way for further study where necessary.

**Case Studies**

Merriam (1994) states that qualitative case studies are based on information collected from interviews and observations, and Yin (2014) argues that it is the most suitable approach for investigating the 'how' and 'why' research questions. Thus, in this study, case study interviews incorporating individual data collection is applied qualitatively. The identification and selection of case studies for inclusion in this paper is based on selective and convenience sampling, to ensure that the participants have the sufficient knowledge to discuss the research topic in question, and also in relation to their accessibility to the researcher. However, due to the study's preliminary nature, further investigation on the subject will use different selection techniques such as quota and random sampling, incorporating a sequential selection strategy. Also, it is anticipated that a much wider audience will be contacted during further research, until saturation of the data instrument has been achieved. Four interviews are undertaken to complement the literature review, and also to verify the factors identified. The format of the interviews were semi-structured, as this form uses open and closed ended questioning, but questions are asked in no specific order or schedule (Naoum 2007). This method allows questions to lead from one to another quite easily, enabling interviewees the opportunity to provide as much information as possible.

Due to accessibility to the researcher, a large construction company based in the north of Ireland was identified for participation, and the case study interviewees were selected from within the company. Four Project Managers (PM) formed the basis for the individual interviews, and they were identified with respect to their availability for interview, and the current project they were working on, relevant to urban construction site environments. Considering the issues surrounding ethics, each participant selected was informed of the nature of the research, its purpose and what will happen to the resultant data. The identities of those involved will remain strictly private, and confidential information (company name, client details etc.) is not disclosed to maintain anonymity. The case study participants include a PM with eight years experience working on a student accommodation scheme; a PM with twenty years experience working on a private residential scheme; a PM with fifteen years experience working on a hotel scheme; and a PM with 10 years experience working on another student accommodation scheme. All four case studies are live projects and new urban developments, located in various cities across the UK and Ireland.
QUALITATIVE ANALYSIS

The interview questions commenced with the researcher gaining general background information on the participants and the case study in particular, with an emphasis on stakeholder issues. This was followed by identifying what methods of communication they use with external stakeholders throughout the entire project lifecycle, and what methods of ICT and emerging technologies (if any), they use to communicate, engage and manage external stakeholders on the project. The data gathered from the case study interviews is then qualitatively assessed and cognitively summarised using mind mapping software. A mind mapping software application called Banxia Decision Explorer® is used for this research, which builds a visual representation of ideas and can provide a focus for debate, reflection and progression. It clarifies thinking and can be used to map thoughts and ideas gathered from interviews, acting as an effective stimulus to focus on paramount issues (Brightman 2002).

Decision Explorer® can undertake three forms of analysis; Central, Domain and Cluster. They logically express how each factor or 'concept' is linked and interpreted, and each concept was discussed in some form by all of the interviewees. Central Analysis calculates a score to determine how central a concept is in the model, Domain Analysis shows concepts which have many links, and Cluster Analysis finds groups of closely linked concepts and the results are then placed into sets. Combining the data from the four interviews, the Internet, BIM, VR / AR and 3D Laser Scanning were all identified and discussed as methods of ICT and emerging technologies, used to manage and engage external stakeholders on urban construction projects. However, the research establishes that the Internet, through its different mediums, is the main method extensively used by the interviewees, followed by the recent introduction of BIM within their company. Due to limitations on space, the concept analysis results have been omitted, but the methods identified by each interviewee are illustrated below in Table 1.

Table 1: Methods of ICT and Emerging Technologies for External Stakeholder Management

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DISCUSSION – METHODS OF ICT AND EMERGING TECHNOLOGIES IN EXTERNAL STAKEHOLDER MANAGEMENT

Internet

Using the Internet as a method of managing and engaging with external stakeholders was discussed extensively by all four interviewees. Sarshar and Isikdag (2004) consider the Internet as a very cost effective solution to communication problems, coupled with the increased speed of information transfer (Ahuja, et al. 2009). When face-to-face meetings with stakeholders were not easily arranged, the interviewees noted that emails were the next best method to use. Emails remain a very popular form of communication over the Internet because they are free and easy to use, reference and prioritise (Wilson 2014). Furthermore, two of the interviewees spoke about the use of Social Media in the form of Twitter. Social Media is characterised by interactivity, where participants can freely send, receive and process content for use by others (Aula 2010). Its services include social networking websites such as Facebook and Twitter, messaging applications such as WhatsApp and Microsoft Teams, and diary-type websites such as Blogs. Regular Twitter updates such as photos of each site and succinct comments on the project's progress are frequently posted, however, both interviewees noted that this is done by the company IT Manager who is based in the head office, and not by them.

The interviewee on the first student accommodation scheme discussed how he is implementing a Blog on the company website throughout the duration of the project, with monthly progress reports and photo updates of the site. Also, he stated that this platform is used to highlight fundraising events and community initiatives that he and his site team are involved in, which he feels improves the corporate image of the company. The interviewee on the hotel scheme mentioned a new instant messaging application that he uses called Microsoft Teams, which works like a group email to keep in regular contact with local residents and other external stakeholders. Waters, et al. (2009) believe that interactivity plays an important role in developing relationships online with stakeholders, and Manetti and Ballucci (2016) corroborate that social media and social networks are powerful mechanisms for reaching and keeping in touch with a large number of stakeholders, thus guaranteeing an interactive dialogue with them at a very low cost. Derks, et al. (2015) also acknowledge that devices such as smart phones and tablets afford greater flexibility in working behaviours and sharing of information. Moreover, Saxton and Guo (2011) conclude that through strategically targeted content, firms can mobilise stakeholders, build meaningful relationships and ultimately foster increased accountability and public trust.

BIM

The interviewee on the hotel scheme discussed BIM in detail, but pointed out that it is very client driven and only a handful of projects throughout the company are implementing BIM at present. He believes that it is a very expensive tool to work with, but he can see its benefits in possibly showing external stakeholders potential models of future projects at public consultation meetings. The interviewee also recognises that the company will probably have no other choice but to phase BIM in all of their future projects, to keep up to date with government policies and other technological advances. The awareness and usage of BIM amongst construction
practitioners is increasing (NBS 2014), and as construction projects become more complex, new technologies including BIM have been proposed for tackling the construction industry's production problems (Gledson and Greenwood 2014). In the UK, BIM has emerged at the forefront of the Government's agenda, with the publication of the UK Government Construction Strategy (HM Government 2013). This strategy has mandated the compulsory use of collaborative BIM on all public construction projects by 2016 (Georgiadou 2016), which reflects the challenging issues regarding stakeholder collaboration and the manner of managing information (Sebastian 2011).

VR / AR

The interviewee on the private residential scheme stressed that VR and AR is not being utilised within the company at present. However, he is aware of another ongoing project in the same city as his own scheme, consisting of a sports stadium redevelopment, where club supporters and other interested stakeholders have been given the opportunity to view the new stadium before it is built, through the use of VR and AR. Whyte (2002) concurs that short videos or virtual walkthroughs which simulate the view of a person walking through the building can rapidly improve stakeholders understanding of the project.

3D Laser Scanning

The interviewee on the second student accommodation scheme recognised the concept of 3D Laser Scanning and how its data capture could be beneficial to project stakeholders. However, he admitted having little knowledge of it, due to it not being implemented within the company at present, and further stating that BIM was the main technology being phased on other company projects.

CONCLUSION AND RECOMMENDATIONS

In essence, the focus of this study considers the methods of ICT and emerging technologies used to manage and engage external stakeholders on urban construction sites. Urban construction projects are renowned for their dynamic complexities, requiring collaboration and communication amongst all stakeholders. As a result, ICT in the construction industry has had to develop quickly in recent years, and project managers are tasked with ensuring that the management and engagement of external stakeholders is carried out accordingly, through appropriate implementation of ICT and emerging technologies. Considering the results captured from the literature review, case study interviews and cluster analysis, the Internet, BIM, VR / AR and 3D Scanning were all identified as methods of ICT and emerging technologies used to manage and engage external stakeholders on urban construction projects. In particular, Emails, Social Media, Blogs and Instant Messaging Applications via the Internet were established as the most popular methods of managing and engaging external stakeholders.

However, the relevant methods identified from the interviewees are case study specific, and only a concise, subjective view of the topic is produced, not a generalised view. Nevertheless, this study provides a foundation to advance and expand into more detailed research, and supports continuous research on a largely neglected area. It is recommended that future case studies are identified using other methods of sampling, and include companies that are actively using some of the emerging technologies. It would also be beneficial to garner the opinions of the external stakeholders.
themselves, and to verify if communication and engagement with them through ICT and technology is a sufficient method to meet stakeholder needs. Also, additional case studies that are considered for qualitative analysis can be developed quantitatively through the use of questionnaire surveys, introducing another method to the area of research. Nevertheless, this research demonstrates and strengthens to project managers, that when face-to-face communication is unavailable, the Internet, through the use of Email and Social Media, can be used as a suitable method of ICT in the management and engagement of external stakeholders on urban construction projects.

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