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Toward Improving BIM Acceptance in Facilities Management: A Hybrid Conceptual Model Integrating TTF and UTAUT

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Abstract
Recent research has revealed the significance of Building Information Modelling (BIM) implementation in the asset and facilities management (FM) as much as in design and construction sectors. However, the implementation of BIM in FM is only minimal. Thus, BIM acceptance and adoption in FM is still one of main issues in this field. Accordingly, this research aims at: (i) identifying the key factors that influence the widespread acceptance and usage of BIM in facility management; (ii) developing a hybrid conceptual model integrating TTF and UTAUT for enhancing BIM in this sector. The methods that are being adopted in this ongoing research include comprehensive literature review, interviews and survey. In this paper, a summary of interim findings and an overview of the proposed conceptual BIM in FM are presented.

Key Words: Facilities Management, Building Information Modelling (BIM), Unified Theory of Acceptance and Use of Technology (UTAUT), Technology Task Fit Model (TTF)

1. Introduction

Facility management consists of wide range of activities and requires an enormous amount of information. Specifically, it requires a huge of readily available and relevant information for various stakeholders. Therefore, efficient access and provision of information is needed. According to Mendez (2006), the construction project delivery systems have enormous communication gaps especially between constructor and operator/owner. Consequently, the operator/owner has to spend time and money to overcome these gaps after the handover of project which mostly leads to loss a significant part of information and causes incompatibility among facilities management system (Lee et al., 2012). Building Information Modeling (BIM) has proven benefits to streamline the provision of the necessary information for the facility management practices and systems(Alvarez-Romero, 2014). However, despite these benefits, BIM adoption is still very low in many countries (Xu et al., 2014). Hence, the adoption of BIM remains a significant concern of BIM practice and research (Lee et al., 2013). In fact, it has been proven that IT adoption is a result of user acceptance of using that technology (Ammenwerth et al., 2006). Specifically, the technology acceptance theories have ability to model how users come to adopt and use a new technology. A number of research have been carried to measure the user acceptance and usage of new IT in different disciplines such as e-mail systems, word processing, personal computing, spreadsheet software, e-training, etc. Some of research have extended the constructs of those acceptance theories to enhance our understanding of the usage and adoption of new IT, and to be compatible with different contexts including the construction industry. In this ongoing research, there

are two research questions. Firstly, "Are technology acceptance theories applicable for FM context? ". The second question is "What should be included in an BIM acceptance model for FM?". To answer the first question, we should keep in the mind that first technology acceptance theories were designed to be used in IT context. However, after good results that have been achieved in IT field (Al-Gahtani et al., 2007), many researches have been conducted the acceptance theories successfully in other fields such as the construction industries (Cao et al., 2014, Davies and Harty, 2013, Son et al., 2012). Accordingly, the application of these theories can be applied whenever there is a new technology which should be adopted by the users. In order to properly answer the second question, the researchers have conducted a comprehensive literature review to establish a baseline reference point that can help to develop the conceptual BIM framework in FM which will be detailed in the following sections.
Briefly, this research aims at identifying the key factors that influence the widespread acceptance and adoption of BIM in facility management sector, and developing hybrid conceptual acceptance framework for BIM in FM.

2. Technology Acceptance Theories

Basically, there are various types of technology acceptance and behaviour theories such as technology acceptance model (TAM), theory of reasoned action (TRA), theory of planned behaviour (TPB), task technology fit (TTF), diffusion of innovations (DI) and unified theory of acceptance and use of technology (UTAUT). This research focuses on TAM, UTAUT and TTF in further details. The popular Technology Acceptance Model (TAM) has been derived from the theory–TRA (Davis Jr, 1986). As portrayed in Figure 1 representation of Davis (1986), a set of external variables of a system/ technology can influence corresponding user motivation levels through perceptions on usefulness and ease of use and attitudes of using leading to actual use/ user behaviour.

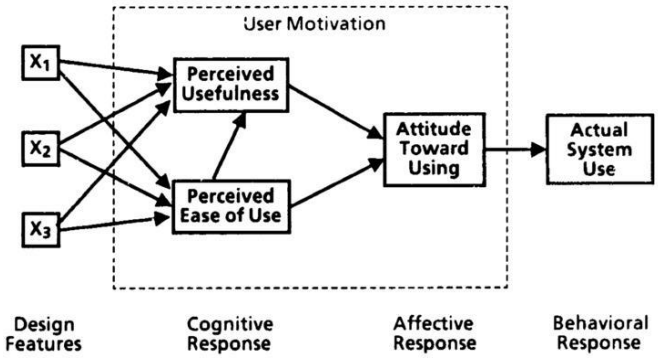

Figure (1) Technology Acceptance Model (TAM)(Davis Jr, 1986)

Furthermore, subjective norms can make a significant effect on intentions/ commitment levels in a non-voluntary/ compulsory environment for a system or technology use. Therefore, improved versions of TAM – known as TAM2 and TAM3 have included user behaviour factors and subjective norms additionally to envisage extent of intentions/ acceptance in the cases of mandatory system/ technology use requirements (Lee et al., 2013). While, the unified theory of acceptance and use of technology (UTAUT)model has been developed by Venkatesh et al. in 2003 based on the extension version of the TAM and other related theories. The model concluded that facilitating conditions, effort expectancy, performance expectancy and social influence have a direct and indirect influence on behavioural intention and use behaviour. Also, those relations are mediated by gender, age, experience and voluntariness of use which give the theory more reliability (Venkatesh et al., 2003). Figure 2 illustrates the UTAUT Model.

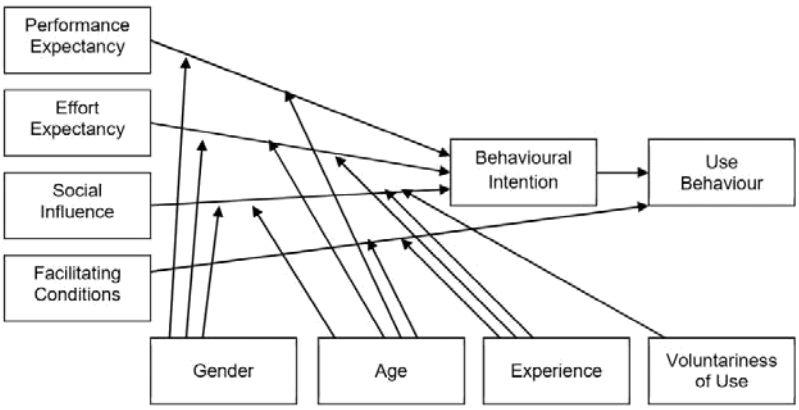

Figure 2: UTAUT Model by Venkatesh et al. (2003)

Moreover, Technology Task Fit Model (TTF) is another acceptance technology theory that came with new concept and determinant through its constructs. As many researches have been conducted mainly to explain user adoption of new technology from perceptions like perceived ease of use, perceived usefulness, and subjective norm etc. However, the adoption of certain technology by the users is not determined only by their perception regards it, but in addition, the aspect of weather that technology fits the tasks requirements. Thus, if the technology does not fit the task then why should the user adopt it (Zhou et al., 2010). Standing on this fact, the Technology Task Fit is a crucial determinant of the new technology adoption. Figure 3 illustrates the component of the Technology Task Fit Model (Goodhue and Thompson, 1995).

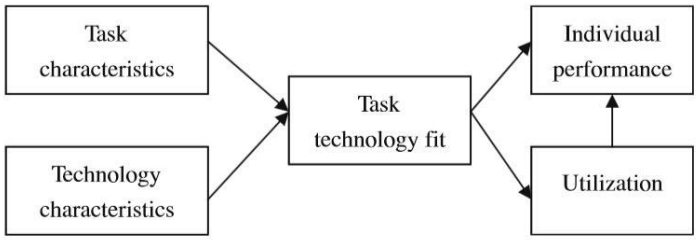

Figure 3. Technology Task Fit Model (TTF) by Goodhue and Thompson (1995)

3. Background on Key Factors that Influence the Acceptance of BIM in AEC/FM

Recently, the construction industry has benefited from BIM implementation in a way that reshapes the industry process itself for the whole project life-cycle including assets and facilities management. Many researches have been conducted to solve significant issues in this regards. Brooks and Lucas (2014) identified the successful key factors that streamlining BIM utilization in post-construction and revealed how BIM can benefit the FM in this aspect. Their study aimed to bridge the gaps between the owner and contractor and resulted in the development of a framework that aid the contractors in the process of hand-over the BIM to the owner in post-construction stage. Lee and Yu (2013) identified the main factors that affecting the acceptance of BIM in South-Korean construction organizations and analysed the effect of extrinsic and intrinsic motivation factors on BIM individual and organizational acceptance. Davies and Harty (2013) developed scales to measure beliefs related to BIM implementation by using questionnaire survey targeted employees of large construction organization in the UK. After a complex statistical analysis, the scales and constructs revealed acceptable measurement properties. Cao et al. (2014), and based on institutional theory, examined how three types of isomorphic pressures which are coercive, normative and mimetic pressures impact BIM implementation activities in the construction projects. Lee et al. (2012) presented conceptual acceptance model for BIM in FM based on TAM2 and TPB. However, the model was a theoretical only and has not been checked for validity and reliability. Accordingly, they made suggestions for completion these gaps in the future research. Xu et al. (2014) proposed an extensive model to examine the key factors that affect the implementation of BIM in China.

The model was based on TAM and innovation diffusion theory. Son et al. (2015) empirically examined the technical, individual, organizational and social factors that affecting the adoption of BIM in Korean design organizations. The finding highly supported the modified TAM in predicting the intention of architects' adoption of BIM and provided insight regard the role management that control the successful adoption of BIM among the Korean design firms.

Based on the literature review, the researchers found;

- The implementing of BIM in facilities management is still in its infancy and there are no clear studies that would encourage the industry stake-holders towards faster adoption
- Although the importance of the TTF model as a significant determinate of users' adoption of technology, no study has been conducted yet using TTF regards the adoption of BIM in FM
- Factors that influence the acceptance and implementation of BIM in facilities management is still a significant issue in this sector.

In this research, the hybrid model of UTAUT and TTF is being developed to measure facility management practitioners' perceptions regards BIM adoption in FM sector. The model is based on validated and reliable variables and items. In the other word, the model provides the rationale for the constructs (factors) relied on the theoretical background on TTF and UTAUT. Also, it includes additional constructs from IT acceptance studies in the construction industry sector and other related fields. It is worth to be mentioned that a number of research have been conducted successfully integrating TTF and UTAUT to measure the user adoption in the IT field, especially for mobile banking (Afshan and Sharif, 2016, Faria, 2013, Oliveira et al., 2014, Pai and Tu, 2011, Park et al., 2015, Tai and Ku, 2014, Vongjaturapat et al., 2015, Zhou et al., 2010) . The comprehensive literature review was the key component in this regards. Synthesis, criticize and comparison technique have been conducted to generate the model taking into account the suitable modification and wording aspects to be compatible with BIM adoption in FM. The following Table 1 shows the sources of the proposed model construct and their Sources;

Table 1. Factors Definition of the Proposed model

Factor/Construct	Definision	Source
Performance Expectancy	''The degree to which an individual believes that using the system will help him/her to attain gains in job performance"	(Venkatesh et al., 2003)
Effort Expectancy	''The degree of ease associated with the use of system"	(Venkatesh et al., 2003)
Social Influence	''The degree to which an individual perceives that important others believe he/she should use the new system"	(Venkatesh et al., 2003)
Facilitating Conditions	''The degree to which an individual believes that an organizational and technical infrastructure exists to support use of the system"	(Venkatesh et al., 2003)
Task Technology Fit	''Task technology fit is the rational perspective of what a new technology can do to optimize a job. It is affected by the nature of the task and practicality of the technology to complete the task"	(Oliveira et al., 2014)
Technology Characteristics	Main determinate of the task technology fit theory that considered the technology characteristics aspect	(Goodhue and Thompson, 1995)
Task Characteristics	Main determinate of the task technology fit theory that considered the task characteristics aspect	(Goodhue and Thompson, 1995)

4. Modelling BIM Acceptance in Facilities Management

A novel hybrid model integrating TTF and UTAUT has been conceptualised to consolidate factors influencing the acceptance of BIM in FM sector as shown in Figure 4. These factors have been extracted from the related literature with some rewording process to be compatible with the FM context as shown in Table (1). Specifically, the proposed model considers a hybrid integration of: (a) UTAUT based rationale for model parameters and variables, and (b) Technology Task Fit Model

Through an extensive literature review, a set of external and internal factors have been identified. By means of an intensive brainstorming exercise, the factors are fine-tuned and shortlisted. Accordingly, the conceptual model considers:

a- External factors such as performance expectancy, effort expectancy, social influence, facilitating conditions, task characteristics and technology characteristics. These variables can have some direct and/ or indirect influence on the internal and targeted factors of the model.
b- Internal factor includes Task Technology Fit.
c- Targeted factor includes User adoption of BIM in FM.

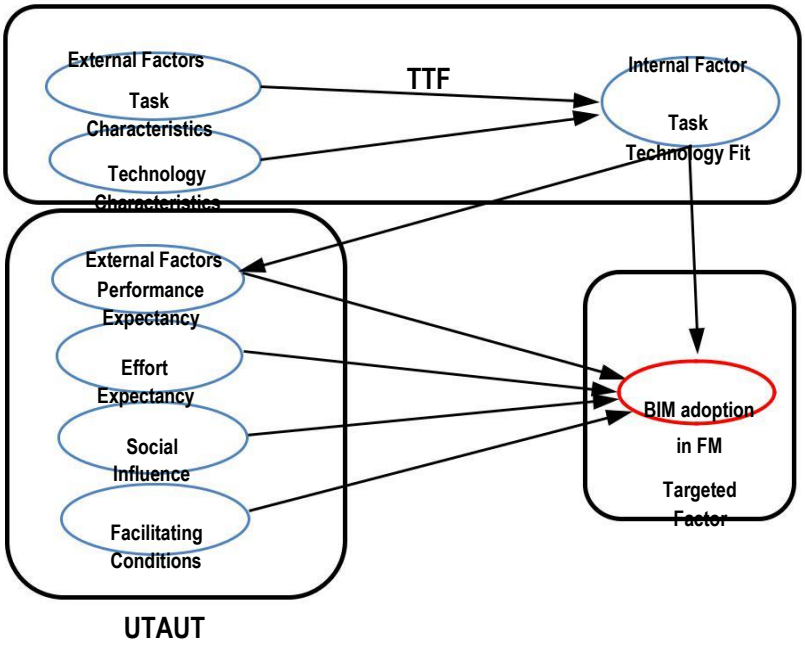

Figure 4. Conceptualization of the Model

The conceptual BIM acceptance framework will be useful to understand the influence of key factors related to the user behaviour and acceptance of BIM in the facilities management sector. Moreover, the research outcomes will reveal the prioritization by the sample set of surveyed stakeholders and also provide an assessment of BIM utilization in FM. Figure 5. illustrates the conceptual model taking into account all the measurement items of the factors using Amos user interface.

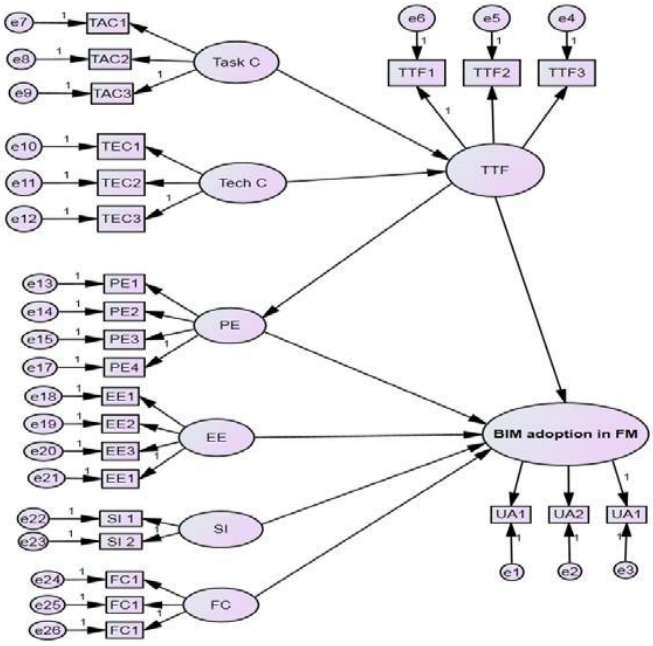

Figure 5. Research Model with the Measurement Items

5. Summary and Conclusions

A conceptual BIM acceptance framework has been proposed in this research. The aim is to identify the key factors that affecting the acceptance and implementation of BIM in FM. BIM as a new process and technology has proven to reduce cost, save time and enhance the collaboration among the project stakeholders. The proposed model consists of eight factors (variable). The external variables of the model are performance expectancy, effort expectancy, and social influence, facilitating conditions, task characteristics and technology characteristics. These variables supposed to have a direct and in direct influence on the internal and targeted variable of the model. The internal variable includes task technology fit, while the targeted variables includes user adoption of BIM in FM (4).
For the future of this ongoing research, the measurement model should be tested for the reliability and validity using Confirmatory Factor Analysis, while the structural model should be examined by Structural Equation Modelling to test the model relations and hypotheses after conducting an extensive survey that targeting the FM practitioners. Hence, this research is considered as a foundation for more mutual model.

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