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A Hybrid Conceptual Model for BIM Adoption in Facilities Management: A Descriptive Analysis for the Collected Data

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Abstract. Despite the approved benefits of Building Information Modelling (BIM) for the whole project life cycle, the adoption of BIM in facilities management(FM) is only minimal. Still, BIM adoption and implementation in FM is unclear. Thus, this ongoing research aims at identifying the main factors that affect the acceptance of BIM in facility management. Also, it aims to framework a hybrid conceptual model that integrating Task Technology Fit (TTF) and Unified Theory of Acceptance and Use of Technology (UTAUT) for better understanding the use of BIM in FM. The methods that are being adopted in this research include a comprehensive literature review, interviews and survey. The proposed conceptual model for BIM in FM was already developed in the previous paper. In this paper, a summary of interim findings and an overview of the online survey and data collection procedure are presented. Also, a descriptive analysis for the sample size of 134 responses are discussed. The general results showed an interesting findings and acceptable level of participants' qualifications to answer the online survey. The future work will include the model constructs' validation and test of the research hypotheses

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

1 Introduction

There has been no specific and clear definition for FM until now. Thus, there are a number of definitions of FM from different viewpoints [1]. For example; the

International Facility Management Association defined FM as “A Profession that encompasses multiple disciplines to ensure functionality of the built environment by integrating people, place, process, and technology”. Infact, FM requires a huge amount of information. The reason is that FM consists of wide range of tasks and activities. Available and relevant information for various facilities stakeholders is required. Hence, the efficient access of information are very crucial for successful FM paractices.

At the end of the construction project, the constructor has to handover a huge amont of information and data to the operator/owner. Then, the operator/owner has to spend a great time and costs to specify the useful and relevant information [2, 3]. Research has revealed the proven benefits of BIM and how it organizes and streamlines the provision of the necessary information for the whole project lifecycle including FM sector [4, 5] . However, the adoption of BIM is still very low in many countries [6], and even the analysis studies on the status of BIM is scarce, specifically in the FM sector [7].

In fact, technology adoption is a result of users acceptance of using that technology [8]. Technology acceptance theories like TAM, TTF, UTAUT, etc. have the capacity to model how users come to accept new technology. Briefly, this research aims at identifying the key factors that influence the widespread acceptance and adoption of BIM in facility management sector, and developing a hybrid conceptual acceptance framework for BIM in FM. The proposed conceptual model was already developed in the previous paper. In this paper, a summary of interim findings and an overview of the survey and the descriptive analysis of the collected data are presented.

2 Technology Acceptance Theories

Technology acceptance theories are an information systems theories that model how users come to accept and use new technology. There are diffrent types of technology acceptance and behaviour theories such as technology acceptance model (TAM), theory of planned behaviour (TPB), task technology fit (TTF), and unified theory of acceptance and use of technology (UTAUT). This research applies the light on TAM, TTF and UTAUT as they are considered more related to this research. Technology Acceptance Model (TAM) has been derived from the theory–TRA [9]. Acoording to [10], 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. The updated versions of TAM which known as TAM2 and TAM3 have included user behaviour factors and subjective norms [11]. The Unified Theory of Acceptance and Use of Technology (UTAUT) has been developed by Venkatesh, Morris [12] based on the updated version of the TAM and other related theories. The model has revealed 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 [12]. TTF is another technology acceptance theory that came up with new concept and determinants. Many researches have been done mainly to explain user adoption of new technology from perceptions like subjective norm, perceived usefulness, and perceived ease of use [13-15]. However, the adoption of certain

technology is not determined only by their perception regards it, but in addition, the aspect of weather that technology will fit the tasks requirements. Thus, if the technology does not fit the task then why the user need to adopt it [16]. Standing on this fact, the TTF is a crucial determinant of the technology adoption[17].

3 The Developed Conceptual Model and their components

In the previous paper [18] , the researchers have found the following key points : 1) The implementing of BIM in FM is still in its infancy and there are no clear studies that would encourage the industry stake-holders towards faster adoption, 2) 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, and 3) The factors that influence the acceptance and adoption of BIM in FM is still a significant issue in this sector.

Accordingly, a hybrid model of UTAUT and TTF was developed to measure facility management practitioners' perceptions regards BIM adoption in FM sector. The model was based on validated and reliable variables and items. In the other word, the model provides the rationale for the constructs relied on the theoretical background on TTF and UTAUT. 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[18] shows the sources of the proposed model construct and their Sources;

Table 1. Factors Definition of the Proposed model [18]

Factor	Definision	Ref.
Performance Expectancy	''The degree to which an individual believes that using the system will help him/her to attain gains in job performance"	[12]
Effort Expectancy	''The degree of ease associated with the use of system"	[12]
Social Influence	''The degree to which an individual perceives that important others believe he/she should use the new system"	[12]
Facilitating Conditions	''The degree to which an individual believes that an organizational and technical infrastructure exists to support use of the system"	[12]
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"	[19]
Technology Characteristics	Main determinate of the task technology fit theory that considered the technology characteristics aspect	[17]
Task Characteristics	Main determinate of the task technology fit theory that considered the task characteristics aspect	[17]

Based on that, 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 Fig. 1 [18]. 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.

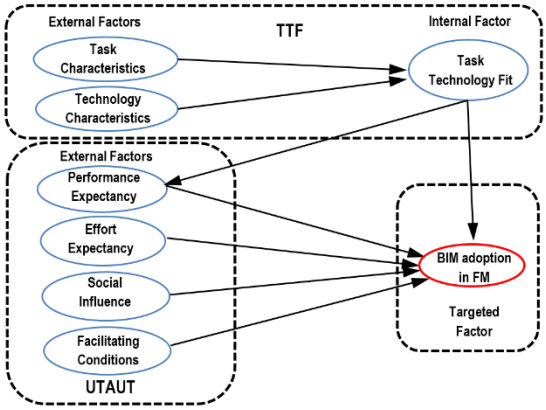

Fig. 1 Conceptualization of the Model [18]

Each factor above has its own items (scales) that measure the related factor as shown the following Table 2, which was developed by the authors.

Table 2. Items Measurement used in the Conceptual Model

Construct	Item / measure	Ref.
User adoption	USE1: I often use BIM to manage my FM tasks USE2: I often use BIM to optimize the cost USE3: I often BIM to optimize the time	[12]
Performance Expectancy	PE1 I would find BIM useful in my job. PE2 Working with BIM enables me to accomplish tasks more quickly. PE3 Working with BIM increases my productivity. PE4 If I work with BIM, I will increase my chances of getting a raise.	[20]
Effort Expectancy	EE1 My interaction with BIM would be clear and understandable. EE2 It would be easy for me to become skilled at working with BIM. EE3 I would find BIM easy to use. EE4 Leaning to operate BIM is easy for me.	[20]
Social Influence	SI1 People who influence my behaviour think I should use BIM. SI2 People who are important to me think that I should use BIM. SI3 The senior management of this business has been helpful in the use of BIM. SI4 In general, the organization has supported the use of BIM.	[20]
Facilitating Conditions	FC1 I have the resources necessary to work with BIM. FC2 I have the knowledge necessary to work with BIM.	[20]

	FC3 BIM is not compatible with the work tools I use. FC4 A specific person (or group) is available for assistance with BIM difficulties.	
Task Characteristics	TAC1: I need to manage FM tasks efficiently TAC2: I need to export accurate and actual information to FM systems TAC3: I need to acquire FM information in real time.	[16]
Technology Characteristics	TEC1: BIM provides ubiquitous services. TEC2: BIM provides real-time services. TEC3: BIM provides reliable services.	[16]
Task-Technology Fit	TTF1: In helping complete my FM tasks, the functions of BIM are enough. TTF2: In helping complete my FM tasks, the functions of BIM are appropriate. TTF3: In general, the functions of BIM fully meet my task context.	[16]

4 The Research Survey and the data collection

The data collection through a questionnaire survey was carried out between Nov 2017 to Dec 2018 in Australia. Prior to data collection stage, human research ethics clearance was first obtained from the Human Research Ethics Committee of Swinburne University of Technology (SUHREC). Ethic clearance from SUHREC for the study number SHR Project 2017/131 was obtained in Aug 2017. Then, an expert judgment procedure was conducted between Aug and Nov, 2017. The objectives of the expert judgment procedure was to explore whether the questions and the instructions of the questionnaire survey were clear and understandable. Also, to make sure that the questions conveyed consistent meaning for all respondents.

Two of the experts in BIM-FM area were chosen to this issue. The experts have been requested to give their general judgment of the questionnaire regarding of the format, length and any language/ terminology issues. They emphasized that the questionnaire was simple, easy and well designed, except some changes that would help to make the questionnaire more understandable. After doing all the required corrections, the questionnaire was designed through Opinio and published online in Nov, 2017 in different platform like LinkedIn, CNBR of yahoo group, and have been sent to many persons who are interested in BIM-FM. However, the rate of responses were quite low within 11 months. Accordingly, the researchers have changes the strategy of getting the possible respondents by targeting every single event and conference related to BIM-FM in Australia, where the study was. The new strategy was to ask every interested expert during and after the end of the event, and explain the purpose of this research, gaols and the possible contribution by doing an online survey within 15-30 min. By getting the participant's acceptance to participate in this online survey, the researcher would send them the online link so they can do the survey at the same time by using the researchers' platform devices or the participants own mobile devices. Although, the new strategy was very costly and effort consuming, as the researcher had to travel around all over Australia targeting the related and interested experts, it was very successful and achieved high rate of participations during about four months only. Accordingly, the participants were 134 in total.

5 Descriptive analysis : general characteristics of data

The objective of this descriptive analysis is to describe the general information with regard to the responses of participants who were actually engaging in the survey of this research, and the characteristics of them. It provides a comprehensive information and a better understanding of the survey data, including information concerning: the gender and the age of the participants; the level of education of the respondents; the Job experience; and the degree of implementation of BIM practices in the company. Table 3, which was developed by the authors, shows general characteristics of the respondents.

Although women make up a good proportion of the community, their participation in the survey was 29.9 % only, and 70.1 % for the men. Age of respondents was categorized into four clusters. The first cluster was under 30 years, and that was 35.1%, the second cluster was 30-39 years which made 38.1%, the third cluster was 40-49 years and that made 17.9 %, and the last age cluster was 50 years and over which made 9%.

Regarding the level of education of the respondents, the first level was is undergraduate that made(23.9%), and the second level was postgraduate that made (50.0%), others level was certificate or associates degree / licensure that made (26.1%) from respondents were the part of research study.

The largest percentage of Job experience was (1-3) years that made 45.5%, while the category (4-6) made 11.2% which was the lowest category. The category (7-9) was 13.4% and the category (10 and over) was 29.9%.

Regarding the company using BIM, the largest percentage was (1-3) years that made 50.7%, while the category (4-6) made 20.9% the lowest category.

The category (7-9) made 9.7% and finally, the category (10 and over) made 18.7%.

Generally, the participants in this research provided reliable and useful information because the participants were well informed and within the targeted community.

Table 3. The general characteristics of the respondents

Variable	Category	Frequency	Percentage(%)
Gender	Male	94	70.1
	Female	40	29.9
Age of	Under 30	47	35.1
	30-39	51	38.1
	40-49	24	17.9
	50 and over	12	9.0
Education	Undergraduate	32	23.9
	Postgraduate	67	50.0
	Others certificate or associates degree / licensure	35	26.1
Job Experience	1-3	61	45.5
	4-6	15	11.2
	7-9	18	13.4
	10 and over	40	29.9
Company using BIM	1-3	68	50.7
	4-6	28	20.9
	7-9	13	9.7
	10 and over	25	18.7

6 Summary

A conceptual BIM-FM framework has been proposed in this ongoing research. The aim is to identify the key factors that affecting the acceptance and implementation of BIM in FM. The proposed model consists of eight constructs. In order to validate the model factors, an extensive online survey that targeting the FM practitioners in Australia has been conduted. In this paper, the research survey and the data collection procedures are presented. Also, a descriptive analysis and general characteristics of participants are discueed. For the future work, 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. Hence, this research is considered as a foundation for more mutual model.

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