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Toward Improving BIM Acceptance in FM: A Conceptual Model Integrating TTF and TAM

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ABSTRACT

Substantial research has been performed on Building Information Modeling (BIM) in various topics, for instance, the use and benefit of BIM in design, construction, sustainable environment building, and Facility assets over the past several years. Although there are various studies on these topics, Building Information Modeling (BIM) awareness through facilities management is still relatively poor. The researcher's interest is increased in BIM study is based heavily upon the perception that it can facilitate the exchange and reuse of information during various project phases. This property and others can be used in the Iraqi Construction industry to motivate the government to eliminate the change resistance to use innovations in the Iraqi construction industry. Even though many scholars and practitioners agree on the potential application and benefits of BIM in construction/ Facilities Management FM, it is yet unknown why BIM is used and what criteria facilitate BIM achievement in O&M. As long as the actual usage and acceptance of BIM in the Operation and Maintenance phase is still a central issue in practice, therefor depending on the extensive well ground literature review a conceptual acceptance model is proposed in this paper by applying the technology acceptance theories such as Technology Acceptance Model (TAM) and Task Technology Fit (TTF) to explore how the extent of facilities management staff going to accept and adopt the new international technology (BIM).

Keywords: Facilities Management (FM), Operation and Maintenance (O&M), Building Information Modeling (BIM), Technology Acceptance Model (TAM), Task Technology Fit (TTF).

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تحسين تبني تقنية وأسلوب BIM في FM: نموذج مفاهيمي يدمج نظريتي TTF وTAM

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الخلاصة

خلال السنوات القليلة الماضية تم أجراء بحوث كثيرة على موضوع نمذجة معلومات البناء (BIM) والذي يسمى "البيم" أختصارا. على سبيل المثال فائدة واستخدام نمذجة معلومات البناء في التصميم والأنشاء وأبنية البيئة المستدامة وكذلك في أدارة المنشأ , و على الرغم من وجود دراسات مختلفة حول هذه المواضيع , إلا ان الوعي بنمذجة معلومات البناء "البيم" خلال أدارة التشغيل والصيانة لايزال ضعيفا نسبيا. ولهذه الاسباب يركز الباحثين أهتمام متزايد بدراسة نمذجة معلومات البناء بشكل كبير. أن تقنية "البيم" يمكن من خلالها تبادل المعلومات وأعادة أستخدامهاخلال مراحل المشروع المختلفة , وهذه الخاصية وغيرها يجب الاستفادة منها في صناعة البناء العراقية لغرض منع الحكومات من مقاومة التغيير وأستخدام هذه التقنية في مختلف وظائفهم.
حقيقة أن العديد من العلماء والمستخدمين يتفقون على التطبيق المحتمل للتقنية و فوائدها في البناء / التشغيل والصيانة , لكن الى يومنا هذا لم يتم أيضاح بشكل كافي سبب أستخدام نمذجة معلومات البناء و المعايير التي تسهل تطبيق هذه التقنية في التشغيل والصيانة , بما أن الاستخدام الفعلي وقبول نمذجة معلومات البناء في مرحلة التشغيل والصيانة لايزال يمثل مشكلة مركزية في مختلف قطاعات صناعة البناء العراقية , لذلك اعتماداً على مراجعة الادبيات واسعة النطاق , يتم أقتراح نموذج مفاهيمي في هذا البحث وهي نظريات TFFوTAM لفهم مدى قبول واستخدام موظفي أدارة التشغيل والصيانة للتقنية العالمية الجديدة نمذجة معلومات البناء(BIM) وتبنيها في صناعة البناء العراقية.

الكلمات الرئيسية: أدارة التشغيل والصيانة , الصيانة والتشغيل , نمذجة معلومات المباني , نموذج قبول التكنلوجيا , تكنلوجيا ملائمة المهام.

1. INTRODUCTION

Avoiding failure in construction projects is not an easy task, which makes the failure of the construction project to achieve its objectives a major problem experienced by all countries in the world, especially Iraq **(Mohammed and Jasm, 2018)**. International industries use BIM to impact the acceleration of the design, construction, operation, and maintenance phase’s implementation **(Lee et al., 2012)**. In comparison with Iraqi projects that still now a day’s using paperwork and spreadsheets or even an information system to manage their task in operation and maintenance, this traditional interface makes the accomplishment of the work very difficult and complex for the facilities management staff.
In 2005, International Facility Management Association defined Facilities management as a’’ Profession that encompasses the integration of multiple disciplines activities to ensure the functionality of the integrated environmental management of human capital, work, process, and technology’’. Today, professionals do not use a particular definition regarding

implementing FM. **(Aziz et al., 2016)** FM often misunderstood that tasks are limited tactical level, but FM is competencies included at the strategic level. In 2009, the Global Job Task Analysis (GJTA) did a comprehensive survey that included facility managers in 62 countries and categorized 11 core competencies. **(Aziz et al., 2016)** declared that core competencies in facilities management are (Communication, Emergencies Preparedness, and Business Continuity, Environmental Stewardship and Sustainability, Finance, and Business, Human Factors, Leadership and Strategy, Operations and Maintenance, Project Management, Quality, Real Estate and Property Management, and Technology). Furthermore, **(Abdullah et al., 2014)** defined FM as "an integrated of a wide spectrum of organizational core business and support service devoted to coordinating people, property, business process, and technology in achieving sustainable facilities management best practice excellence."

Integrating 3P and 1T created a sustainable built environment by appreciating professionalism. This definition requires various interdisciplinary functions in a facility management organization and its business viewpoint. The ultimate aim of facility management is to cut operating costs, boost energy efficiency, support sustainability, and enhance the quality of the facilities **(Aziz et al., 2016).**

In addition, **(Pitt and Tucker, 2008)** outline FM as "The integration and alignment of the non-core services, including those relating to premises, required to operate and maintain a business to support the organization's core objectives fully."

The definition of Facilities management highlights a relatively similar tendency and repeated outline, which briefly clarifies the integration chain of the organizational core business. Also, coordinate support services of 3P (People, process, places) and 1T (technology), leading to workspace management.

With the rapidly increasing of BIM innovation studies over the past few years in the design and construction industry, the time to begin to understand their acceptance and actual use of new technology Building Information Modeling (BIM) for Iraqi facilities management staff along with the external variable that got an impact on the adoption of this Information System (IS).

Davis and his colleagues developed the first model of the Technology Acceptance Model (TAM). This model aimed to test user understanding and acceptance of the electronic mail system by predicting how the two constructs' perceived usefulness and ease of use with their analyzed scale item influence the adoption of this computer system. Thus, based on tracking the scientific principles, in this paper, the author proposed a conceptual model of TAM that refers to as "an information system theory that models how users come to accept and use a technology" **(Davis et al., 1989)**. Furthermore, the author implied (TAM) another theory, which is Task Technology Fit (TTF), developed by **(Goodhue and Thompson, 1995)**. The theory highlights the importance of the fit between technologies and users' tasks in achieving individual performance impacts from information technology. It also suggests that task-technology fit, when decomposed into its more detailed components, could be the basis for a strong diagnostic tool to evaluate whether information systems and services in a given organization are meeting user needs. The synthesis of the accepted theories is applied to test the facilities staff's acceptance of and actual usage of the new technology BIM in the Iraqi construction industry. Likewise, the theories with their relative factors and how will assist in adopting and accepting the Information system (IS). Essentially the integrated proposed model of TAM and TTF and hypotheses that have been developed depending on the result of the extensive well-grounded literature review, and it has been implemented to achieve the following objectives:

- To predict how the Iraqi construction industry can accept and perceive the actual usage of BIM technology in Facilities management.
- The relevance among the constructs and their impact on BIM adoption was determined by integrating TAM and TTF.
- Underlying assumption of facilities management staff interaction with BIM innovation in Iraqi industry.

2. THE DEFINITION OF BUILDING INFORMATION MODELING (BIM)

Many scholars have defined BIM in many ways, each describing the life cycle from a particular standpoint. However, according to **(Azhar et al., 2012),** the overall goal of BIM is to transfer the data into FM operations. Hence, BIM provides a repository model integrated with a database to store all the information. BIM functionalities cover all the applications in the life cycle that can exchange information between their different software platforms. We can assume that the 'collection' of the database known as the repository is specific for the final FM in the operational building. Therefore, BIM, and FM perspective, can be defined as a collection of living document tools in the repository to manage accurate building information over the whole life cycle that the owner can use at the FM stage to manage facilities **(Aziz et al., 2016)**.
(American Institute of Architects (AIA), 2007) Defined BIM as A project delivery approach that integrates people, systems, structures, and practices in the process and takes advantage of the views of all stakeholders to optimize the production of projects, increase value to the owner, reduce waste, and maximize efficiency through all phases of design, fabrication, and construction **(Abdullah et al., 2014)**.
(Kymmell, 2008) stated that BIM acts as a simulation project that consists of the components of a 3D model of a project that has to do with all the necessary information relating to project planning, design, construction, or operation **(Abdullah et al., 2014)**. They studied a novel approach to project delivery to integrate people, systems, business structures, and practices into collaborative processes to reduce waste and optimize efficiency through all phases of the project life cycle, which also supports the concept of Integrated Project Delivery (IPD)
The National Building Information Model Standard Committee defines BIM as a digital representation of a facility's physical and functional characteristics. According to the Definition above of BIM, throughout the project life cycle, relatively its refer to Architects, contractors, surveyors, designers, and stakeholders or owners are all connected through the BIM program, which allows them to collaborate on a shared information system **(Eastman et al., 2009)**. As a result, all parties can communicate information, enhancing their trust and consistency. BIM can compile comprehensive, reliable, accessible, and easily exchangeable building information for anyone who needs it throughout the life cycle of a building **(Smith and Tardif, 2009)**. To access the same information in real-time, BIM can make every team member clear to everyone responsible for what which team members are meeting their obligations **(Smith and Tardif, 2009)**.
BIM allows collaboration, improving communication, service delivery, and commutation among business partners, reducing cycle time, energy efficiency, cost efficiency, and workplace productivity **(Smith and Tardif, 2009)** after highlighting the comprehensive overview of the BIM definition by different scholars and international institutions. BIM can

also provide many aspects throughout the Facilities management that is explored furthermore among the benefit of BIM through the Facilities management side part.

3. KEY BENEFIT OF BUILDING INFORMATION MODELING IN FM

BIM to the operational team is a hot topic of discussion among academic researchers. Findings from the FM Awareness of BIM survey **(Ashworth and Tucker, 2017)** indicated that 74% of respondents believe "BIM will have a significant impact on the FM industry." Research by **(McGraw Hill Construction, 2014)** on the perceived value by owners of BIM for FM predicted that 98% of UK building owners would perceive high value from BIM **(Ashworth, 2019)**. The actual usage of Building Information Modeling (BIM) is growing, quickly becoming the industry standard for planning and executing building projects. BIM is gaining popularity since it offers more benefits to its vendor. In this case, the ability of BIM to improve cooperation and communication between designers, contractors, project developers, and facility managers is its most significant value. Various studies on the benefits of using BIM through Facilities management have been carried out in the literature review. **Table 2.** summarizes the key benefit of using BIM technology in FM in different counties.

Based on the aspect mentioned above, it can be concluded that BIM is not just a technology, but it also encompasses the process of using the product of the right kind of software **(Azhar et al., 2012)**. It can generally reflect the benefits of literature and the expert practitioners` perspective. After highlighting the key benefit of BIM in FM (applying the BIM platform), it can be compared with the problems faced by the Iraqi construction industry that does not use this technology system during construction.

A survey was done by the Iraq researcher **(Mohammed and Jasim, 2018)**; it was done with the engineers working in the field of maintenance and project management in the public sector of Iraq to investigate the issues that face Maintenance Management in Iraq projects. The following problem has been reached due to bad maintenance management (not applying any platform of BIM), as shown in **Table 3**.

Fig. 1 compares the key benefits of using BIM in FM against problems faced by Iraqi industries because of bad FM (Not using BIM innovation). This was conducted to encourage Iraqi facilities management to accept and use BIM in their project. Building Information Modeling (BIM) is becoming an established collaboration process in the Architecture, Engineering, and Construction (AEC) industry. Potential benefits and competitive advantages have been stated in many countries. However, despite the potential and benefits of BIM technologies, it is not applied in the construction sector in Iraq **(Erzaij and Obaid, 2017)**.

Adopting BIM and using the technology in the building can solve considerable issues confronting the facilities management in Iraqi construction projects, such as increasing costs, bad management, delays in maintenance work, and bad Communication and collaboration. Furthermore **(Al-Agele and Ali, 2017)** stated in their study the identified reasons which have a significant negative impact on the Iraqi management project: Inefficient decision-making process, Unrealistic project plan, and Inaccurate cost estimation. All these contexts can be because of the regular use of paperwork with the development and existence of innovations and techniques.

Table 2. Summary of the key benefit of using BIM in FM

Reference	country	The benefit of using BIM in FM
(Dixit et al., 2019)	USA	❖ Increases accuracy of data quality of the BIM. ❖ Enabling faster decision-making. ❖ Ensures standard information flow across FM players. ❖ Saves time and cost in the long run. ❖ Will prevent data fragmentation. ❖ Improves communication between stakeholders. ❖ Saves time required to access and track information.
(Wijekoon, 2019)	(Liverpool John Moore Univ.)	❖ Effective decision-making. ❖ Information availability. ❖ Smooth handover. ❖ Easy retrieve of information.
(Naghshbandi, 2016)	Iran	• Automating the process of data transfer and update. • A stronger role for FM. • Making sense of BIM data. • Improved Space Management through Visualization of Spaces. • Facilitating Maintainability. • Set-up Maintenance Activities Depend on Historical Trends. • Sustainability and Efficient Use of Energy.
(Abdullah et al., 2014)	Malaysia	• Building Lifecycle Management. • Faster, more effective, and more Efficient FM. • The Performance of a Simpler Simulation. • Better Space Management. • Building Equipment Management. • Streamlined maintenance. • Efficient Use of Energy and reduced waste. • More Economical and Easier Modifications. • Reduced Safety Risk.

Table 3. The problems that have been reached as a result of bad maintenance management

No.	Issues
1.	Increasing the cost of conducting maintenance work.
2.	Delays in the completion of maintenance work
3.	Increasing complaints by occupants of the building.
4.	Failure to maintain the material value of the building.
5.	Occurrence of accidents and injuries during maintenance work.

6.	Increased pollution of the environment surrounding the building.
7.	Occurrence of cracks in the building after the completion of maintenance work.
8.	Failure to maintain the life span of the building.
9.	Occurrence of frequent breakdowns in the equipment.
10.	Failure to maintain the material value of the building.

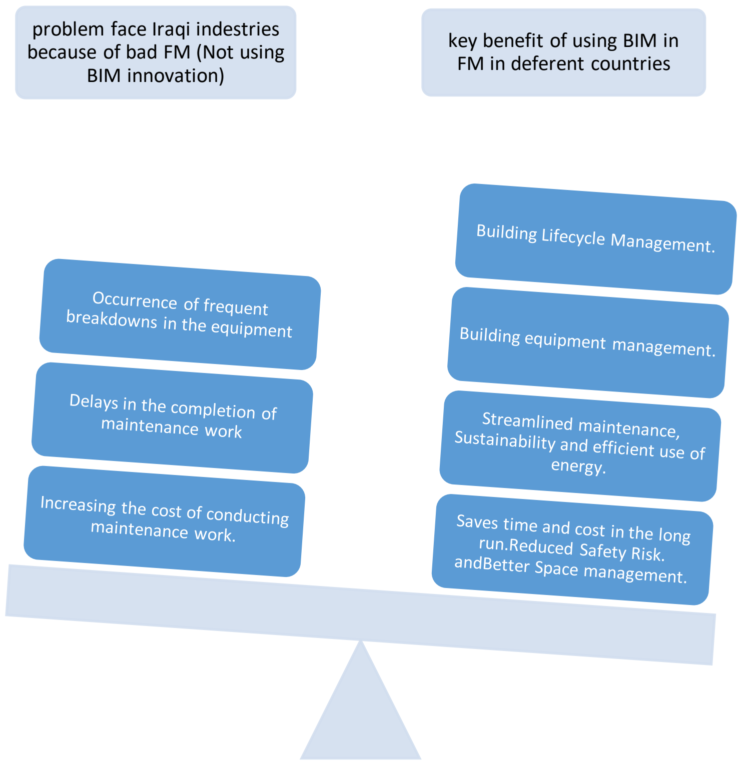

Figure 1. Comparison of key benefits of using BIM in FM in different countries against problems faces by Iraqi industries because of bad FM (Not using BIM innovation).

Thus, it is important to understand the appreciation and agreement of FM toward the BIM innovation in Iraqi projects, and it's been found that technology acceptance theories are the best theoretical election to predict the extent to which facilities management will likely adopt this technology information in their work. This will be explored furthermore in the next part.

4. HYPOTHESIS DEVELOPMENT OF MODEL ACCEPTANCE

Three primary types of innovation adoption or rejection decisions occur in a social system. The optional decisions, in which choices to adopt or reject an innovation are made by each independent of the decisions of other system members. The second type is collective decisions, in which adoption or rejection choices are made based on the consensus of the system members. The third is authority decisions, in which only a small proportion makes adoption or rejection choices of individuals in the system who are powerful or technically competent **(Wang et al., 2020)**. Using technology acceptance theories in this research gives us a comprehensive view of how much a team member and project manager of the operation and maintenance phase understands the BIM technology to adopt this innovation or make rejection decisions. Most Iraqi public and private construction sectors are accustomed to traditional methods using paper-based processes that include drawings and spreadsheets. They are not familiar with modern technology that could significantly accelerate asset tracking.

Another issue that will be discussed is why some users have a higher intention to adopt BIM in the field of FM while others are less willing to become BIM workers is the outline that needs to be explored. To appraise these responses and to predict how the facilities management staff and professionals come to accept the new technology building information model (BIM) in facilities management, both the technology acceptance model (TAM) and task-technology fit (TTF) model are important theoretical bases in information systems field. These two popular models have been used in considerable quantities of research to understand the determinants of user acceptance of information technology **(Davis et al., 1989; Goodhue et al., 1995; Goodhue, 1998; Zigurs and Buckland, 1998; Venkatesh and Davis, 2000).**

The technology acceptance model (TAM) is the most widely applied theoretical model for understanding users' acceptance and usage of innovative technologies, including information systems **(Venkatesh, 2000)**. (TAM) is a model developed by **(Davis et al., 1989)** to measure the acceptance of the technology (see **Fig. 2**).

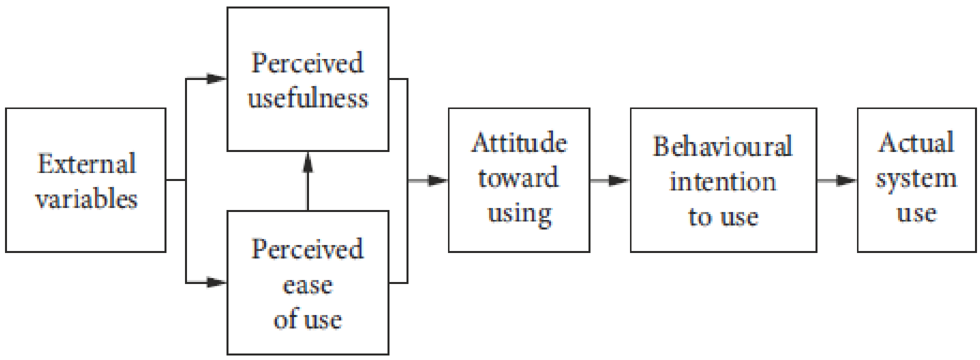

Figure 2. Technology Acceptance Model (TAM) by **(Davis et al., 1989).**

The original TAM model is designed to elicit likelihood ratings rather than the actual ratings because it predicts the future use of technology and no experience obtained after using it **(Lah et al., 2020). (Davis et al.,1989)** formulated TAM via the Theory of Reasoned Action (TRA). TAM uses two main external variables.

The first variable is Perceived Usefulness (PU). This construct plays a major role in measuring the users suppose that a specific system will promote their job performance or task productivity. The second external variable, Perceived Ease of Use (PEOU), deals with the extent of user supposes that a specific system will be free of effort, usability, and Ease of Use as determinants for user acceptance. The key element used in TAM is behavioral intent that leads to the desired behavior, namely the use of the system being tested. TAM evolved

from TRA with the aim "to explain the determinants of computer acceptance in general, able to explain the behavior of users of various computer technologies and user populations, which are simultaneously parsimonious and can be justified in theory. TAM itself assumes that the actual use of technology is determined by the Behavioral Intent (BI) to adopt Building information modeling (BIM) in FM **(Prihatono and Adi, 2021).**
The second theory that will be implemented is Task Technology Fit (TTF) **(Goodhue and Thompson, 1995)** (see **Fig. 3**) suggested a model named task-technology fit (TTF) understand the linkage between information systems and individual performance. TTF represents the level to which a specific technology supports a person's effort to perform a given job portfolio. It can generally be used when people use technology to perform specific tasks. Task -Technology Fit is the compatibility of technological functions with the requirements of a task or set of tasks that determine the technology's usefulness. Experienced and logical users will select tools and techniques offering the highest net gain to help them do their jobs. Technologies that fail to provide adequate value (e.g., enhanced productivity or better results) are cast aside **(Gikas and Grant, 2013).**

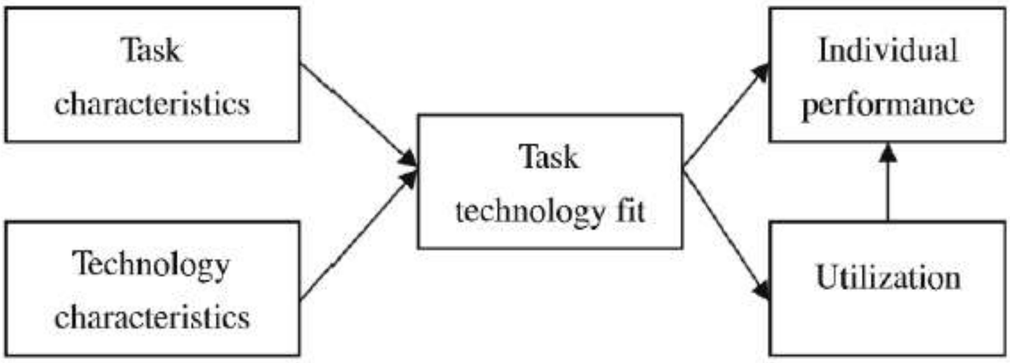

Figure 3. Task Technology Fit (TTF) (**Goodhue and Thompson, 1995).**

The TTF model considers the practical aspects of using technology daily and the fit between technology and task characteristics. Thus, even if a technology is perceived to be advanced, it will not be adopted by the users if it does not fit their tasks **(Zhou et al., 2010)**. Therefore this research proposed the model of Task Technology Fit to measure if the acceptance and use of technology of (BIM) fit the job task requirement to adopt this innovation by the facilities management staff.
Highlights the fitness between task and technology is particularly suitable in determining users' intention to adopt the technology. The TTF model suggests that users will be more willing to utilize a new technology if it fits better with their tasks. Thus, the second goal of the current study is to integrate TTF with TAM to investigate the determinants of user acceptance of technology. To reach the second objective, the current study adapts and validates the integrated model of TAM and TTF proposed by **(Dishaw and Strong, 1999)**.

5. INTEGRATED AND SYNTHESIS MODEL OF TAM AND TTF

As mentioned, TAM and TTF are two major models in the information system domain that explain the user behavior of an information system/information technology. The core of either model (beliefs in TAM and task and technology characteristics in TTF) is important in understanding why individuals choose one technology over another in their tasks.

(Dishaw and Strong, 1999) proposed an integrated TAM/TTF model in the context of software development and found that it provides a better explanation of information technology utilization with a higher predictive capability when compared to either of the models alone.

In the integrated model, the TTF constructs directly affect the adoption intention and indirectly affect adoption intention via the core explanatory variables of TAM: perceived usefulness and perceived ease of use **(Dishaw and Strong, 1999)**. **(Pagani, 2006)** combined TAM and TTF in a high-speed data services context and showed that the proposed model is workable.

(Al-Emran, 2021) In his study of Evaluating the Use of Smart Watches, he stated that there is a positive association between individual-technology fit and perceived usefulness and ease of use. It is suggested that the higher the individual-technology fit, the higher the ease of use and usefulness of the technology/information system, and this is posted in his proposed model. Similar integrated frameworks are proposed by **(Yen et al., 2010; Shih and Chen, 2013; Nai-Hua, 2019; AL-Maatouk, 2020; Pal and Patra, 2021; Tawafak et al., 2021)** in multiple contexts, and all cases, the integrated model provides a better explanatory power in understanding the adoption of various types of information technology services. The outcome of these studies helped pave the way for the suggestion that TAM and TTF models be combined in the adoption of building information modeling in Iraqi construction projects. These two theories play a primary function in measuring the extent to which workers in the management of operation and maintenance accept and use BIM technology. It also motivates the owner and project manager to decide to adopt this innovation, the suggested model (See **Fig. 4**).

The theoretical model proposed in the present study explores all construct relevant to the Technology acceptance model (TAM). These relevant external and internal constructs are (perceived usefulness, perceived ease of use, and behavior intention) beside the theory of TAM, the external construct of Task Technology Fit (TTF) as well, which are (Technology Characteristics and Task Characteristics). These factors influence the satisfaction and academic performance of the users and consequently towered their adoption of various information technology. Thus, this study has implemented it to assay the extent of Iraqi staff acceptance and use of the Building information modeling technology in FM. In any case, it has extraction of what each factor depends on from the construct has been identified by researchers, summarized in **Table 4**.

6. HYPOTHESIS DEVELOPMENT

BIM's benefit is not only limited to the planning and design stages of a project but also contributes during the project building life cycle, including cost management, construction management, project management, and operations and maintenance management. BIM's utilization in construction management is intended to address issues regarding project completion according to plan with budget constraints, human resources, schedules, and limited information. Various disciplines involved in a construction project, such as Architects, Civil Engineering, Finance, and others, are required to collaborate well to achieve project targets precisely in terms of schedule, cost, and quality. BIM in construction projects provides virtual construction that represents actual construction, intending to reduce uncertainty, increase safety, solve problems, conduct simulations, and analyze an event's impact.

With this available BIM software benefits developed by various vendors in the project lifecycle, the adoption is still the latest for facilities management. Because of this, the researcher proposed acceptance theories to study the FM participant's capability to respond to the adoption of BIM innovation.

Thus, successful BIM adoption, which leads to improved individual and organizational performance, should be further explored and justified by integrating TAM and TTF theories. The hypothesis for this study was derived from the model illustrated in **Fig. 4.** The relationships between the factors are incorporated in the proposed model to study how facilities management staff come to accept and use new BIM technology.

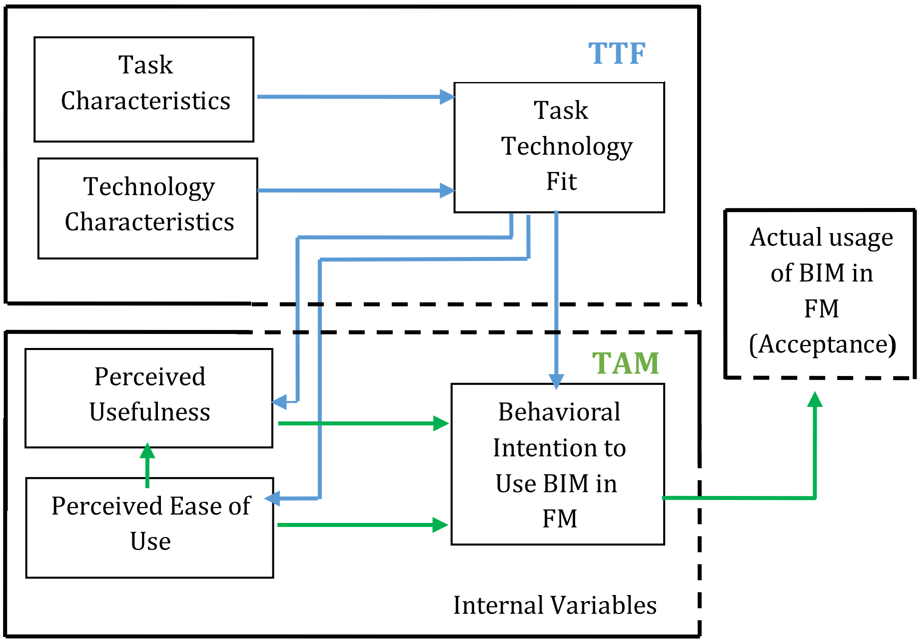

Figure 4. Proposed conceptual model of (TAM &TTF).

Table 4. Factors dependency of the proposed model

Construct	Factor depends on
Technology acceptance model	TAM is an information system theory that models how users accept and use technology **(Davis et al., 1989)**.
Behavioral intention	It depends on the following points: 1. Respondent evaluates their desire to use the system/technology**(Pal and Patra, 2020)**. 2. It also depends on the individual’s positive or negative feelings (beliefs), environmental factors, facilities, benefits, and other factors that impact behavior intention (BI) **(Hewavitharana et al., 2021)**.

Actual usage	It depends on the following points: 1. The measure of one's actual behavior to perform a specified usage behavior **(Hewavitharana et al., 2021)**. 2. It also depends on the Frequency of use and duration of system/technology usage **(Prihatono and Adi, 2021)**.
Perceived usefulness	It depends on the following points **(Davis et al., 1989)**: 1. The degree of belief in a particular system will make the user adopt this system/technology. 2. Also, the extent of this particular system will enhance their job performance.
Perceived ease of use	It depends on **(Davis et al., 1989)**: The degree to which a person believes using a particular system would be effort-free.
Task Technology Fit	It depends on the following points **(Hilal, 2020)**: 1. The logical view of what new technology can do to optimize a job. 2. And it is affected if new technology can competently carry out the user's regular tasks. 3. It also relies on the technology's applicability to finish the tasks.
Technology Characteristics	It depends on the following points**(Goodhue and Thompson, 1995)**: 1. Main determinant of the task technology fit theory. 2. It depends on the technology used by individuals to perform their task
Task Characteristics	It depends on the following points**(Goodhue and Thompson, 1995)**: 1. Main determinant of the task technology fit theory. 2. It also depends on the actions carried out by individuals in turning inputs into outputs

6.1 Hypothesis related to the TAM factors

6.1.1 Perceived Ease of Use (PEOU)

Ease of use is one of the key determinants that decisively affect the success of BIM acceptance. **(Davis et al., 1989)** Defined Perceived ease of use to the degree to which a person believes that using a particular system would be free of effort. It is referred to as ease of freedom from severe or great effort. It also confirmed that technology was observed to be easier to use than another and was more likely to be accepted. When a user of innovation finds it easy to learn and does not need any assistance, furthermore, that BIM is easy to handle and flexible to use, actual use or acceptance will likely be in BIM. The previous study stated that perceived ease of use (PEOU) is a significant determinate of the behavior intention (BI) and perceived of use (PU) of the technology **(Yen, 2010; Gao, 2014; Lee et al., 2015; Qin et al., 2019; Prihatono and Adi, 2021)**. Therefore, researchers assumed that the belief that BIM is easy to use would be directly related to the perceived usefulness (PU) and the intention to accept BIM, creating these two paths:

PEOU ⟶ PU PEOU ⟶ BI

Consider these observations as a guide to using this internal variable for ease of use in BIM adoption through FM. These findings lead to the hypothesis that there is a positive relationship between ease of use and intention of acceptance and a positive relationship between perceived ease of use and perceived usefulness.
The conceptual model has yielded the following hypothesis:

H1: Perceived ease of use positively impacts the behavioral intention in the actual usage of BIM in Facilities management.

H2: Perceived ease of use positively impacts the Perceived usefulness in the actual usage of BIM in Facilities management.

6.1.2 Perceived Usefulness (PU)

User perception of usefulness has been considered an important factor in technology acceptance. **(Davis et al., 1989)** defined user perception of usefulness as the degree to which a person believes using a particular system would enhance their job performance. This follows from the definition of useful, capable of being used advantageously. When the operation and maintenance staff believes BIM innovation will improve or facilitate their job performance, and they will do their work more accurately and promote their effectiveness, they will have a higher behavior intention to accept BIM. There will be Actual usage of the tool.
Researchers have been definite that perceived usefulness (PU) is a significant determinate of the behavior intention (BI) of the technology that postulates in their proposed conceptual model **(Yen, 2010; Lee et al., 2015; Qin et al. 2019; Prihatono and Adi, 2021)** creating this path.

PU ⟶ BI

Consider this observation as a guide to using this internal variable of perceived usefulness (PU) in behavior intention (BI) of BIM acceptance through FM. These findings lead to the hypothesis that a positive relationship exists between perceived usefulness (PU) and behavior intention (BI).
The conceptual model has yielded the following hypothesis:

H3: perceived usefulness positively influences the intention to use BIM in facilities management.

Behavioral intention measures the strength of one’s intention to perform a specified behavior **(Ajzen and Fishbein, 1975)**. It is the individual and organization respondents' evaluation of their desire to use and accept technology essential to justify the adoption of BIM in FM. **(Hewavitharana et al., 2021)** confirmed that behavioral intention is the

individual's positive or negative feelings. Environmental factors, facilities, benefits, and other factors affect behavior intention. The researcher proposed to model the factors that affect the BI (Perceived use (PU), Perceived ease of use (PEOU), and Task Technology Fit (TTF) as well).
Lee and others suggested that individuals must use BIM tools for their tasks to complete acceptance of BIM technology. A group must use BIM for compatibility and sharing of information throughout the project life cycle **(Lee et al., 2015)**. Therefore, they suggested Assessment Items of Individual Intention Accept BIM:

- Willingness to utilize BIM tools and information to fulfill his tasks.
- Willingness to spend time utilizing BIM.
- Willingness to recommend BIM to coworkers or other entities in a cooperative relationship.

(Lee et al., 2012) explored the extension of the Technology Acceptance Model TAM for BIM-based FM, four factors that affect the behavior intention (BI) (perceived ease of use, perceived usefulness, subjective norm, and perceived behavior control) were adapted from his posted model. He confirmed a positive relationship between BI and actual usage of BIM acceptance through facilities management.
All these multiple observations drove the researcher to hypothesize that three factors affect behavior intention to use BIM technology in FM (PU, PEOU, and TTF). Since these constructs influence the BI, there will be actual usage of BIM by the facilities management staff, which leads to the final path of BIM acceptance.

$$BI \longrightarrow AU$$

These findings are considered a scale leading to the hypothesis that a positive relationship exists between behavioral intention and BIM acceptance **(Yen, 2010; Lee et al., 2012; Lee et al., 2015; Prihatono and Adi, 2021; Qin, 2019)**.
The conceptual model has yielded the following hypothesis:

H4: Behavior intention has a positive relationship with the Actual usage of BIM acceptance in facilities management.

6.2 Hypothesis related to the TTF factors

The task technology fit measures the impact of technology use and assesses the match between the task and the features of the technology **(Vanduhe, 2020)**. Subsequently, researchers have widely used the TTF to forecast the acceptance and usage of new technology **(Aljukhadar et al., 2014)**. The efficacy of technology acceptance is based on user acceptance and how perfect the task it is. So, the model provides an empirical measure, and the user needs to accept the utility's fitness between the technology and the task.
(Yen, 2010) if the technology provides a good fit with the task, users should believe that the technology is easy to use and also should improve their work performance. Similarly, promoting users' behavioral intention to utilize the technology should also come from the fit between task and technology. If the reaction of FM staff against these constructs is positive, the adoption and acceptance of BIM will increase.
(Al-Maatouk, 2020) assumed that there is a significant relationship between TTF and behavior intention of use **(Tawafak et al., 2021)** also posted in his hypotheses path that

there is a relationship between TTF and perceived usefulness. In addition, **(Yen, 2010)** explored that The fit between task and technology characteristics will have an impact in determining subjects' behavioral intention to use the IS. It is also assumed that The fit between task and technology characteristics will have an impact in determining subjects' perceived ease of use and perceived usefulness of an IS. All these hypotheses are posted in his conceptual model.
These findings lead to the hypothesis that there is a positive relationship between task technology fit and perceived ease of use, perceived usefulness, and behavior intention toward actual usage of BIM acceptance creating these three paths.

TTF ⟶ BI TTF ⟶ PEOU TTF ⟶ PU

The conceptual model has yielded the following hypothesis:

H5: Task technology fit positively impacts subjects' perceived ease of use to the actual usage of BIM through facilities management.

H6: Task technology fit positively impacts subjects' perceived usefulness to the actual usage of BIM in facilities management.

H7: Task technology fit positively impacts subjects' behavioral intention to use BIM in facilities management.

Moreover, the External variables of the TTF theory are Task Characteristics (TCH) and Technology Characteristics (TECH).
Technology Characteristics refer to the technology used by individuals to perform their tasks. **(Yen, 2010)** performed that the characteristics of technology subjects used to perform their task will have an impact on determining the fit between task and technology. **(Al-Maatouk, 2020)** assumed that there is a significant relationship between TECH and TTF. **(Chen, 2019)** also posted that Technology characteristics have a positive effect on TTF. **(Hilal, 2019)** assumed that Technology characteristics positively influence the TTF, So this path is created:

TECH ⟶ TTF

These findings are considered a guide leading to the hypothesis that there is a positive relationship between technology characteristics and Task Technology Fit in BIM acceptance.
The conceptual model has yielded the following hypothesis:
H8: Technology characteristics positively impact task technology fit in the Actual usage of BIM acceptance through facilities management.
Finally, the second external variable of TTF is Task Characteristics, which refer to the actions carried out by individuals turning inputs into outputs. Other researchers suggest that the characteristics of the task the subjects performed will have an impact in determining the fit between task and technology **(Yen, 2010; Chen, 2019; Hilal, 2019; Al-Maatouk, 2020)**, so this path is created:

TACH ⟶TTF

The conceptual model has yielded the following hypothesis:
H9: Task characteristics positively impact task technology fit in the actual usage of BIM through Facilities management.

In multiple contexts, nine research hypotheses expressing the interaction among the proposed conceptual model elements were developed to attempt the research objective (1. predict how the Iraqi construction industry can accept and perceive the actual usage of BIM technology in Facilities management. 2. studying the relevance among the constructs and their impact on the adoption of BIM, which was determined by integrating TAM and TTF. 3. Underlying assumption of facilities management staff interaction with BIM innovation in Iraqi industry). Furthermore, **Fig. 5** exhibits the developed conceptual model and the hypotheses indicating the variables' connections.

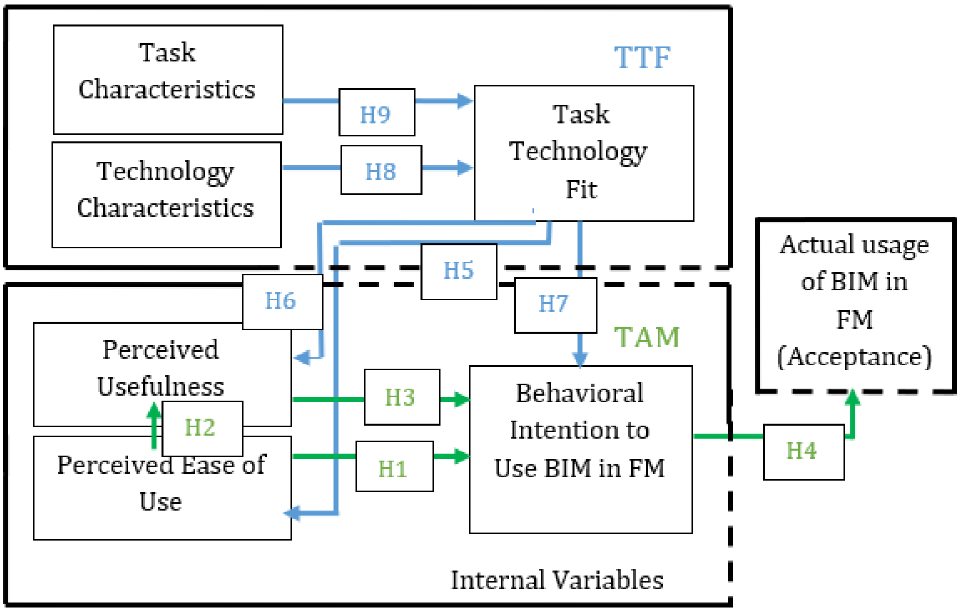

Figure 5. The conceptual model with the related hypotheses.

7. CONCLUSIONS

The most important deduced from the well-grounded literature review is the outline of Facilities Management and Building Information Modeling definition. The research also highlights the benefit of adopting BIM innovation compared to the problem that interfaces the Iraqi facilities management who did not use information systems in their maintenance management. According to this, it's been implemented Technology Acceptance theories to explore the extent of the use and acceptance of new technology BIM by FM users in Iraqi construction industries. In addition, to predict the key construct that impacts the actual usage of this technology, the rating of users' likelihood to accept the technology system in their future job, and to elicit if the technology application requirement fits the user task job. For the test validity and further statistical measurements of the developed hypothesis, a questionnaire form has been designed to elicit the functionality of this model and these processes applied in future research.

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