



**Arab American University
Faculty of Graduate Studies**

**Feasibility of Implementing Building Information
Modeling (BIM) in the Palestinian Construction
Sector: A Study of the Factors Leading to Successful
Adoption**

By
Mais Samir Wadea Alsalfiti

Supervisor
Dr. Khaled Rabaya

**This thesis was submitted in partial fulfillment of the
requirements for the Master's degree in
Strategic Planning and Fundraising**

March /2023

© Arab American University –2023. All rights reserved.

Thesis Approval

Feasibility of Implementing Building Information Modeling (BIM) in the Palestinian Construction Sector: A Study of the Factors Leading to Successful Adoption

By

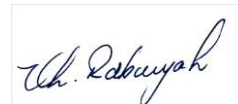
Mais Samir Wadea Alsalfiti

This thesis was defended successfully on 03/03/2023 and approved by:

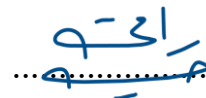
Committee members

Signature

1. Dr.Khalid Rabayaa: Supervisor



2. Dr. Rami Hudrob: Internal Examiner



3. Dr. Shaher Zyoud : External Examiner

Shaher Zyoud

Declaration

I, the undersigned, hereby declare that the thesis titled:

Feasibility of Implementing Building Information Modeling (BIM) in the Palestinian Construction Sector: A Study of the Factors Leading to Successful Adoption

is my original work, except where references are clearly provided. This thesis has not been submitted elsewhere, in whole or in part, for any other degree or qualification.

The Name of The Student: Mais Samir Wadea Alsalfiti

ID: 201812609

Signature: Mais Alsalfiti

A handwritten signature in blue ink that reads "Mais S. Salfiti". The signature is written in a cursive style with a long, sweeping underline.

Date: 28/05/2025

Dedication

This dissertation is dedicated to my first home and my last,
My beloved Gaza.

Acknowledgement

I would like to express my deepest gratitude to my supervisor, Dr. Khalid Rabaya', whose sincerity and encouragement I will never forget. He been an inspiration as I hurdled through the path of this Master's degree. He is the true definition of a leader and the ultimate role model. Also, other committee members who gave me their thoughtful comments and added so much to my knowledge.

This thesis would not have been possible without the support of my fellow engineers, their participation from the first step in research enabled me to develop an understanding of the subject. I am thankful for the extraordinary experiences they provided helping me with the questionnaire and the interviews that followed

I am grateful for my parents whose constant love and support keep me motivated and confident. My accomplishments and success are because they believed in me. Deepest thanks to my siblings Samar and Wadea, who keep me grounded, remind me of what is important in life, and are always supportive of my adventures.

Abstract

Building Information Modeling (BIM) is a relatively, a newly adopted technology/software in Architecture, Engineering and Construction (AEC) industry in the whole world. BIM virtually visualizes buildings, and all works/ stakeholders involved in the project. Engineers can continuously add layers of data into the model to modify/improve it and avoid clashes in early stages of the project. Integrating such technology in the Palestinian market, efficiently and effectively, will add a competitive value to the adopters in the local and international markets.

It was proven by many researchers that implementing such technology by the AEC industry will improve the quality of the final product and increase the effectiveness and efficiency of managing its projects. This can be realized due to the ability of BIM software technology to add cost and time data layers into the model and decrease the cost of the project by fixing potential clashes before they could happen at construction sites, as it provides potential benefits.

In Palestine, this technology has been used in big projects by only a few numbers of the AEC industrial companies. Studies in the Palestinian context have explained the barriers of implementing this technology as: lack of interest by clients and other contracting parties, the cost of adopting new technologies, organizational culture that resists change and lack of knowledge of the technology.

This study investigates the patterns of BIM adoption in the local market, focusing on, firstly, the empirical evidence of the significant factors that practically impact the adoption process, and secondly, providing a starting point of workflow change, thus helping the organization to plan its customized future strategies and goals.

The researcher conducted a quantitative research approach. An electronic survey was distributed to 168 local engineering consultant offices. The collected data was analyzed by SMART-PLS software using the partial least squares structural equation modeling (SEM-PLS) technique.

The results proved that the organizational factors ; top management support, organizational culture and the number of expert and technicians, directly affected the individual intention of BIM adoption. On the other hand, the environmental factors; national policies and requirements and competition within the industry, indirectly affected the individual intention of BIM adoption through perceived ease of use and perceived usefulness.

These results emphasized the vital role of the top management in providing a supporting atmosphere to adopt new technologies. Moreover, the collaborative, flexible and inclusive organizational culture is the most suitable environment to encourage adopting new technologies.

Keywords: BIM, organizational culture, top management support, AEC industry, SEM - PLS.

Table of Contents

Thesis Approval.....	I
Declaration.....	II
Dedication.....	III
Acknowledgement.....	IV
Abstract.....	V
List of Tables.....	X
List of Figures.....	XI
List of Abbreviations.....	XII
Chapter One Introduction	1
1.1 Overview on BIM Technology	1
1.2 Research objectives and significance	6
1.3 Research Problem and Hypothesis	7
Thesis structure	8
Chapter Two Literature Review	10
2.1 BIM Concept	10
2.2 Overview on Implementing BIM.....	12
2.3 Adopting BIM in Literature.....	18
2.4 Knowledge Gap.....	21
2.5 Defining Variables of BIM Adoption	23

Intention of Acceptance (Depending Variables).....	23
Internal Variables (TAM Based).....	23
External Variables	24
Chapter Three Environmental Impact and Technological Integration of BIM:	
Application Examples	26
3.1 Overview	26
3.2 BIM and Inclusive Buildings’ Design.....	28
3.3 National Policies and Requirements for Earthquake Codes in Buildings	29
3.4 Empowering Supervising Engineers through the Palestinian Amended Law and BIM Implementation.....	32
3.5 Synergy between BMS and BIM for Efficient Building Facility Management	34
3.6 Leveraging the Synergy of BIM and GIS for Enhanced Building Performance and Sustainability.....	36
Chapter Four Methodology.....	39
4.1 Overview	39
4.2 Research Design.....	39
4.3 Population and Sample.....	40
4.4 Data Collection Method	41
4.5 Research Tool.....	42
4.6 Qualitative Tool.....	48
4.7 Data Analysis Techniques.....	48

Chapter Five Data Analysis	50
5.1 Overview	50
5.2 Qualitative Analysis.....	50
5.2.1 Descriptive Statistics	50
5.2.2 Inferential Statistics	54
Stage One: Measurement Model Assessment	54
Stage Two: Structural Model Assessment	64
5.3 Discussion	69
5.4 Qualitative Analysis.....	72
Chapter Six Conclusions and Recommendations For Further Studies	78
6.1 Limitations of Study	78
6.2 Conclusions.....	79
6.3 Recommendations.....	82
References	85
Appendices	96
المُلخَص.....	105

List of Tables

Table 1.1 Research Hypotheses	7
Table 4.1 Internal Variables Indicators	43
Table 4.2 External Variables Indicators	45
Table 4.3 Leckert Scale	47
Table 5.1 Demographic Data	50
Table 5.2 Utilized Programs' Data	52
Table 5.3 BIM Using Data	52
Table 5.4 Convergent Validity Data	55
Table 5.5 Discriminant Validity - Cross Loadings	57
Table 5.6 Discriminant Validity - Fornell- Larcker	60
Table 5.7 Discriminant Validity - HTMT	60
Table 5.8 P- Values	61
Table 5.9 Hypotheses Testing Summary	62
Table 5.10 R Square Values	65
Table 5.11 Effect Size	66
Table 5.12 F ² Evaluation	67
Table 5.13 Predictive Relevance (Q ²)	67
Table 5.14 Goodness of Fit (GoF).....	68

List of Figures

Figure 1.1 BIM Acceptance Model (BAM).....22

Figure 2.2 BIM Acceptance Model (BAM).....24

Figure 3.3 Research Hypotheses25

Figure 5.1 Percentage of BIM Users53

Figure 5.2 Stages of PLS- SEM Analysis.....54

Figure 5.3 P-Value Shown on the Model63

Figure 5.4 Path Testing.....64

Figure 5.5 R Square Values.....66

List of Abbreviations

BIM	Building information modeling
AEC	Architecture, engineering and construction industry
OC	Organizational Culture
TAM	Technology Acceptance Model
FM	Facility Management
ICT	Information computer technology
PLS-SEM	Partial Least Square-Structural Equation Modelling
CR	Composite Reliability
VIF	Variance Inflation Factor
AVE	Average Variance Extracted
GDP	Gross domestic product

Chapter One

Introduction

1.1 Overview on BIM Technology

AEC sector is an important sector to many aspects, politically, socially and economically in the Palestinian context. The Palestinians are facing occupation that aims to take them out of the land and trying to limit their options in terms of land, legislations, and construction materials and heavy machineries. The importance of this sector stems from its role in providing safe investments for families and an income provider for many people. Moreover, its connection to other sectors as it contributes to developing them.

AEC industry is one of the vital sectors of the economic activities in Palestine. Construction sector contributed 4.5% to the Palestinian GDP and 18.8% of the workforce (MAS, 2022) (Ministry of Labor, 2022).

AEC in Palestine has many observed challenges that can be put in these points: poor performance in project delivery, inefficient coordination between stakeholders and low technology adoption level. Focusing on technology, most constructors do not care about innovation and technology due to lack of competition and low engineering fees which discouraged stakeholders from improving and trying to be creative to think out of the box (Abdallah, 2018).

On the other side, the absence of monitoring and controlling organizations that ensure applying construction codes and laws in all design and implement stages, from designing to safety assurance in construction sites.

Technology is rapidly developing worldwide in almost every industry; therefore, technology adoption management is a necessary skill that must improve in every

company and in every field, especially in a complicated and fast-growing industry such as the AEC industry.

Integrating technology, efficiently and effectively, and managing changes will definitely have benefits on the AEC industry. Researches have emphasized that using Computer Integrated Construction concepts will add competitive value to deliverables of the AEC industry (Miyatake & Kangari, 1993). Another research commended the benefits of integrating new technologies into the industry as they would improve productivity gains and add a new level of creativity in practicing and studying engineering (Howard et al 1989).

Digital technology has proven necessary in the AEC industry. one of the emerging technologies is BIM as Manzoor et al.(2021) investigated depending on the bibliometric analysis of 200 selected research in the domain of digital technology.

This issue is also applicable to (BIM). BIM is a newly adopted software technology used mainly in (AEC) industry in the entire world. BIM virtually visualizes buildings and integrates all works and designs of various stakeholders involved in a construction citation Azhar et al. (2012) Engineers can continuously add layers of data into the model to modify and improve it and avoid conflicts in early stages of the project, thus improve communication between all involved parties. A study by Newton& Chileshe (2012) explained the benefits that were highly desired when BIM was adopted in South Australia. These were: improved constructability', improved visualization', improved productivity', and 'reduced clashes'. Ibrahim et al. (2019) investigated the potential benefits of BIM in the Malaysian context and he concluded that among the life cycle of a project (which are Design Phase Construction Phase and Facilities, Operations and Maintenance Phase) BIM benefits can be obtained in the Design stage they tested 24 variables in this phase:

- Concepts become clearer and project conceptualization easier.
- Earlier and more accurate, visualizations of a design to the owner
- Support decision making regarding the design
- Improve feasibility studies
- Improve simulations and coordination
- Improve design quality
- Design and installation services coordination improved
- Building proposal capability analysis increase
- Improved lean in design
- Improve design effectiveness
- Save design time and cost
- Improve mistake identification thus reducing conflict
- Utilize the coordination resolution in pre-construction
- Ease communication
- Organization improvement
- Practicing current innovation
- Reducing the knowledge gap between senior and junior staff
- Improve collaboration between construction players
- Enhance and improve planning process
- Enhance accuracy of existing documentation
- Risk reduction
- Simultaneous access
- Increase attention to the selection of the components of
- construction at early stages

BIM detected potential clashes in the early design stage before construction process starts, and a similar study made in the Palestinian context Enshassi (2018) promoted the benefits of BIM in the developing countries which classified into four categories: life cycle cost control and environmental issues, effective construction process, design and quality improvement and decision-making support/ better customer service. Another study in the Saudi Arabian context as well Al-Yami & Sanni-Anibire (2019) discovered top three benefits of BIM in the ACE industry: conflict detection in engineering drawings, quality improvement of the drawings and documents and accelerating construction process.

Mentioning the benefits of implementing BIM, there some issues come along with it, Newton & Chileshe (2012) investigated some of the issues in the south Australian context such as were 'lack of understanding about BIM', 'education & training costs' 'start-up costs' and 'changing the way firms do businesses.

In the local Palestinian market, a limited number of the ACE industrial companies is using the BIM technology. Studies in the Palestinian context Enshassi et al. (2016) referred the lack of use of this promising technology to certain barriers, such as the lack of interest by clients and other contracting parties, the cost of adopting the technology, the existence of organizational culture that resists changes besides the lack of knowledge in the technology itself. The literature, in the Palestinian context, focuses on the benefits and barriers while a gap exists in the patterns of adoption that helps the implementation of strategies in the industry. The study, hence, discusses the adoption patterns of BIM in the Palestinian ACE industry, using the technology acceptance model (TAM), to investigate the adoption process.

The focus of the study will be on the design and planning stage of the construction project since it is widely implemented worldwide and is less implemented in the other phases of

the construction projects. Eadie et al. (2013) indicated that BIM should be used in the early stages of the project and less in later stages and Facility Management (FM), while Barlish & Sullivan (2012) recommended to use BIM more in the later stages of projects and investment decisions.

The research will be conducted on the local AEC market, and it targets engineers in various specialties; architecture and civil, mechanical and electrical engineers who are working at small/ large, new/aged, implementers of BIM/non- implementers and specialized (one specialty)/ nonspecialized companies.

The research will help organizations and individuals, working in the Palestinian local AEC market, who intend to adopt such technology, in order to focus on the most significant factors to consider in the “planning to adopt” process.

Research objectives and significance

1.2 Main Objective

To study and analyze the adoption patterns of Building Information Modeling (BIM) in the local Palestinian construction market.

1.1.2 Sub Objectives

1. Provide a reference for construction regulatory entities (government, Engineers Association, and local municipalities) to assess the potential of requiring the use of BIM for specific large-scale projects in the future.
2. Identify the key variables that organizations need to consider when changing their workflow processes to integrate BIM.
3. Assist consulting firms and engineering companies in setting strategic goals for implementing BIM based on their various types of projects.

4. Offer a starting point for organizations to adopt BIM, tailored to the size, function, and scope of their projects.

1.3 Research Problem and Hypothesis

The research question: what are the organizational and environmental factors that significantly affect the intention of adopting BIM on the organizational and individual levels?

The research hypotheses:

Based on the BIM acceptance model originally presented by Lee et al. (2015), they proposed several variables, and the researcher selected the variables and correlations shown below (Table 1) to be tested.

Table 1.1 Research Hypotheses

Hypothesis	Definition
H1	a: Top management support affects individual intention positively
	b: Top management support affects perceived ease of use positively
	c: Top management support affects the perceived usefulness positively
H2	a: Number of BIM experts and technicians affects individual intention positively
	b: Number of BIM experts and technicians affects perceived ease of use positively
	c: Number of BIM experts and technicians affect the perceived usefulness positively
H3	a: Organizational culture affects individual intention positively
	b: Organizational culture affects perceived ease of use positively
	c: Organizational culture affect the perceived usefulness positively
H4	a: The national policies and requirements affect individual intention positively
	b: The national policies and requirements affect perceived ease of use positively

	c: The national policies and requirements affect the perceived usefulness positively
H5	a: Competition within industry affects individual intention positively
	b: Competition within industry affects perceived ease of use positively
	c: Competition within industry affect the perceived usefulness positively
H6	a: perceived ease of use affects individual intension positively
	b: perceived ease of use affects organizational intension positively
H7	a: perceived usefulness affects individual intension positively
	b: perceived usefulness affects organizational intension positively
H8	Perceived Ease of use affects perceived usefulness positively
H9	Individual intention affects organizational intention positively

Thesis structure

Chapter One: Introduction

In this chapter, an overview on BIM technology that the study is addressing and its importance, the main objective, sub- objectives and practical implementations are stated, the research problem and hypotheses.

Chapter Two: Literature Review

In this chapter, BIM concept and technology adoption theories are discussed, previous BIM implementation experiences in different contexts are reviewed, previous research on the adoption and factors that affect the adoption process., defining the theory adopted by the researcher and the relevant variables.

Chapter Three: Environmental Impact and Technological Integration of BIM

In this chapter, we embark on a comprehensive exploration of the powerful potential of Building Information Management (BIM) in designing inclusive buildings.

Chapter Four: Methodology

In this chapter, the population and sample are specified, data collection method is selected, data analysis techniques are explained, and statistical analysis software is mentioned.

Chapter Five: Data Analysis and Discussion

In this chapter, primary data is analyzed using both descriptive and inferential statistics.

Chapter Six: Conclusions and Recommendations

In this chapter, conclusions are presented, recommendations are provided, some directions for future researchers are given, and limitations to the study are discussed.

Chapter Two

Literature Review

2.1 BIM Concept

BIM definition has developed drastically between 1975 and 2013, according to (Latiffi et al, 2014). It was originally introduced by Professor Charles Eastman (Eastman, 1976) as Building Description Systems (BDS) which is "a database capable of describing buildings at a detail, allowing design and construction". The BDS represents the design, including those of complicated buildings. The software was not popular among engineers because of the limited design choices it offered. In the late 1970s another technology called Graphical Language for Interactive Design (GLIDE) emerged which had more design elements and a tool to check data cost estimation. Both of these technologies offered limited contribution to the project at its design stage.

In 1989, a new software was developed; the Building Product Model (BPM). (Björk, 1989) described the model who produced it "The model is capable of containing all kinds of data describing a particular building. In current practice, these data are contained in drawings, specifications, bills of quantities, etc." The model did not fulfill the need of the AEC industry to have one complete integrated information of all the players of the project during the lifecycle of the project.

Therefore, in 1995, a Generic Building Model (GBM) came out, utilizing the concept of BPM as defined by (Eastman& Siabiris,1995):" Generic Building Model that represents both the physical and abstract information necessary to model basic knowledge about buildings and architecture". Consequently, project players were able to contribute to all the project stages, and this technology improved the construction activities. Despite that, the Information computer technology (ICT) was spreading widely in all areas.

Therefore, Building Information Modeling (BIM) was invented in 2000 and was previously used during and post construction stages. The concept of BIM improved rapidly during the 2000s but according to (Latiffi et al ,2014) the definition implied that BIM had six aspects which were design, estimation, construction process, building life cycle, performance and technology.

According to the National Building Information Modeling Standard (NBIMS), BIM is defined as the " horizontally integrated building information that is gathered and applied throughout the entire facility lifecycle, preserved and interchanged efficiently using open and interoperable technology for business, functional and physical modeling, and process support and operations." (NIBS (National Institute of Building Sciences) ,2007).

BIM handbook (Eastman et al, 2011) implied that BIM technology had different implementations throughout the project's life cycle: These were:

- 1- Visualizing tools to enable stakeholders walkthrough the model,
- 2- Clash detecting between different specialties before it is too late on the construction site,
- 3- Simple schedule of the project to simplify the phases to the owners and help marketing it,
- 4- Prefabricated units will fit perfectly using the model,
- 5- Construction management and schedule visualization by adding 4D(time) to the model,
- 6- Quantities estimation the 5D (cost) enables contractors and councilors to pin the material's quantities, sizes, cost and areas also conduct the project overall price,

- 7- Lifecycle management, having the model built and changing during the project lifecycle the owner already has an as built model that will help maintain, monitor and evaluate energy efficiency.

2.2 Overview on Implementing BIM

As mentioned in the introduction, BIM has many benefits and tools that can be implemented in different stages of the project, a study by Hartmann et al. (2012) proved that there is a chance to align organization activity and technology by fully understand the methods of management inside the organization, it also promote "technology pull" approach that implies to pull technology to current practices and in case of AEC industry, it is more feasible than "technology push" approach which is impose certain technology to the current market.

The implementation of BIM has many factors that affect it, according to Gu & London (2010) it can be classified into two groups: technical and non- technical strategic issues. The adoption levels vary from culture to culture and different working environments, fully integrated mode of operation in particular. The study also advised that there should be guidance on the starting point, the tools to use and finally overcoming the legal and cultural challenges.

The AEC industry is not flexible to adopt change due to the complexity of its work and the integration between the different specialties involved in the same project. A study in the Malaysian context found out that increasing the implementation of BIM comes from the top managerial level and the encouragement of the government and a strategic approach model is an essential need to implement BIM (Latiffi et al, 2015). Another investigation by Weippert & Kajewski (2004) supported the idea that change in the ACE

industry should be led by the top management and must be strategically oriented, moreover the change should be monitored regularly and effectively during the whole process. The same study indicates that single change will not be sufficient in existing dominant culture, so there is a need for continuing efforts to get over the resistance of change. This can be achieved by encouraging and improving the use of technology and align the technology with the users.

Moreover many studies investigated other aspects that affect the implementation of new technologies, there are other factors that affect the adoption of BIM as Liu et al (2010) contributed, these are: 1- perceived benefits the most important were quality and accuracy improvement less important was being competitive in the market, 2- internal readiness which was referring to top management role to adopt such technology, 3- external forces represented by the pressure of competitors and other parties in the industry.

A study in Bangladesh also studied the barriers to implement BIM, they were: organizational resistance to change, training expenses, high cost of technology, social resistance to change, lack of awareness and lack of experts in this technology (Ahmed, 2018). A similar study by Enshassi et al (2016) has investigated the Palestinian context assured the previous barriers and advised the government to take the first step to promote BIM, starting with the governmental projects.

Can BIM be implemented without governmental guidance? Turkey one of the countries that BIM was not obliged by the government even though there was no guidance nor standards to implement it, but a study by Gerçek et al (2017) facilitate the implementation procedure by providing a guidelines and a customized plan for companies to manage the execution process that being said an adoption decision should be done by the top management first. The study took a case study of a big local construction company and

proposed a customized execution implementation plan for only 6 projects from educational to commercial buildings, the implementation and improvement of the plan took 4 months. Finally, the collected information, communication and lesson learned were success keys. A similar article was published by Ramírez-Sáenz et al. (2018) indicates that, in Columbia, there is no BIM standards or guidelines, so every company improve their own BIM Execution Plan (BEP), the researchers proposed a template for large- scale companies to help them set their plan.

In contrast to the previous experience, in the UK the government set a goal by 2016 all governmental projects will be in Level 2 (Level 0 is low collaboration, it includes 2d drawings in the traditional method, Level 1 is partial collaboration, includes 3d models with shared information between stakeholders, Level 2 full collaboration, all participants are using the same 3d model with full access to information and work on it, Level 3 full integration and it may contain 4d) of BIM implementation and if the organizations did not commit to this goal they will lose the chance of being accepted on the projects held by the government and they will lose at tender stage (Government construction strategy, 2016-2020). Increasing demand on the organizations to adopt BIM they also face barriers to implement (Eadie et al, 2014). The same researcher Eadie et al (2015) conducted a survey to assess the adoption process. The study found out that most respondents used BIM in their projects, but few had used it for all their projects and these respondents did not implement BIM due to lack of incentive.

Technology adoption theories

Implementation of new technology must go through stages according to Succar & Kassem (2015). BIM implementation is a group of intended activities, undertaken by a single player (whether individuals, groups, organizational units, or whole organizations) where

it includes the adoption of a new system and new technology. Therefore, the organization needs to prepare for the adoption point, in reference to the same article, for the following three stages: organization's readiness to adopt; capability to perform; and its performance maturity.

Organization's readiness to adopt includes the level of preparation, the potential to adopt and the capacity to improve BIM deliverables.

Adoption of new technologies had been discussed heavily in the literature as many theories emerged according to Ullah et al. (2020). The widely used theories on BIM adoption are the Diffusion of Innovation Theory and the Technology Acceptance Model. Another study Ma et al. (2019), which supported the previous study, indicated that after reviewing literature some common characteristics were found in studying the BIM adoption process:

- 1- The TAM, innovation diffusion theory and key success factors are the base of the theoretical research on BIM adoption,
- 2- The structural equation model is the analytical tool regarding the theoretical base,
- 3- The main objective of the studies tackles one of the aspects or all of them, which are: individuals, projects, organization, industries and countries,
- 4- The previous researches validate either models, factors or framework impacting the adoption process through questionnaires. Moreover, these factors are not unified in one fits all models.

Where "Diffusion is the process through which an innovation (an idea perceived as new) is communicated through channels over time among the members of a social system" (Rogers, 1995), this theory prioritizes the spread of the technology and focuses on the

environment, social interaction with the technology, innovation lifecycle and organizational structure.

However, the TAM2 model, which was initially introduced by Venkatesh and Davis (2000) is an extension to TAM model which was published in 1989. The TAM model is based on two factors “Perceived Usefulness- PU” and “Perceived Ease of Use- PEU”. PU refers to “the degree to which a person believes that using a particular system would enhance his or her job performance”, whereas PEU refers to “the degree to which a person believes that using a particular system would be free of effort” (Davis, 1989).

The addition on TAM2 is the social influence processes (subjective norm, voluntariness, and image) and cognitive instrumental processes (job relevance, output quality, result demonstrability, and perceived ease of use) which significantly influenced user acceptance (Venkatesh and Davis,2000).

Ullah et al. (2020) made different points between the DOI and TAM models. The DOI investigated the BIM adoption process, digital innovation BIM diffusion across complicated firm structures and factors affecting BIM adoption. However, TAM was used to identify factors that affected BIM adoption.

In this study, the researcher will investigate the adoption pattern of BIM, using TAM based model, as it is more useful in the pre-implementation stage. The conducted study focuses on identifying the factors of successful adoption. The same model of BIM adoption process was used by Sanchís Pedregosa (2020) where the author investigated the factors that facilitated the adoption of BIM in Peru and proved that the use of TAM provided empirical evidence in BIM adoption.

Another article by Qin et al. (2020) used an integrated model between TAM (Technology Acceptance Model) and TOE (Technology Organization Environment) to identify the variables.

Although the TAM model claimed to have limitations, considering the cultural differences of contexts where the model is applied, according to McCoy et al. (2007), it should be subjected to the context and be cautiously applied. The model was successfully applied to five Arab countries and has been subjected to the Arab culture in many fields (Rose & Straub,1998). These were in the adoption of information and communication technologies in Palestine by Rabayah (2013), the use of internet banking in Jordan by AlKailani (2016), E-banking in Palestine by Khrewesh (2011) and investigating students' acceptance to E- learning in a Palestinian university Mahdi (2014).

An adoption model was suggested and tested by Lee et al. (2015) that was based on TAM model with many external variables pertaining to the organizational, environmental, personal and behavioral variables that would affect the perceived usefulness and perceived ease of use, that TAM suggested earlier to finally intend to accept BIM technology on the individual and organizational levels. The same authors Lee et al. (2016) conducted another research work that compares the acceptance by Lee et al. (2015) (Figure 1) in Korea and the USA patterns. They found out that the American users of BIM had higher adoption level, performance, and satisfaction than Korean users. In contrast, they found out that key factors are significant in both contexts and may be generalized. Another difference was the mechanism of adoption in both models especially in these in these aspects: The relationship between “individual intention of BIM acceptance” and “organizational intention of BIM acceptance”; the relationship between

“perceived usefulness” and “organizational intention”; and The relationship between “consensus on appropriation” and “BIM acceptance.”

2.3 Adopting BIM in Literature

Reviewing the literature of BIM adoption, the researchers tend to study the factors that will hinder or motivate the adoption of BIM and others tend to build models for successful adoption.

A study by Hong et al. (2018) on the Australian proposed an adoption model for small and medium organization, they found out that staff capability in using BIM will positively affects the adoption efforts, and they neglect the challenges that it comes with the adoption such as change resistance, in contrast the benefits gained from BIM is motivating the adoption.

According to a study made in Finland by Tulenheimo (2015) the study defined certain constrains for successful implementation, Divided to five categories:

- 1- Customer (need, demand, understanding- procurement skills- contracts)
- 2- Company (vision and strategy- management competence and will funding)
- 3- Social aspects (project organization- change resistance- timetables education)
- 4- Technology (competitiveness –capabilities –usability- modifiability – national applicability- prize- license models –records managements- vendor support)
- 5- Supporting elements (organizational and skills- ICT infrastructure – hardware and software).

Many researchers studied the factors of adopting BIM, a study held in China (Ding et al, 2015) found out that motivation, technical issues and BIM capability are significant factors for BIM adoption in contrary to management support and knowledge structure.

Another study by Mom et al. (2014) found out that the most significant factors are 'support from top management' and 'functionality' of BIM tools. Investigating the same critical success factors a study by Evans et al. (2020) indicates that among the extreme significant factors that encourage the combining of BIM along with other related technology are "top organizational management support".

Moreover, another study by Gokuc & Arditi (2017) suggested three models that examine the fit between BIM technology and another three elements will affect the performance of the organization and it concluded that the fit between BIM technology and organizational competence will probably has positive impact on project cost, time, and quality positively.

As explained above, TAM model will be used through the study, a BIM acceptance model (BAM) was introduced by Lee et al. (2015) based on TAM and they suggested other external variables other than TAM2 and TAM3 models, that are more relevance to the ACE industry, the most significant external variable that affects the perceives ease of use is the organizational competence which consists of:

- 1- Collective efficacy: This concept refers to the group of people who shared the same mutual belief and capability to manage and implement a set of actions that required achieving certain levels of attainment inside the organization.
- 2- Organizational innovativeness: it indicates that the organization is open to any new information technology. It also includes personal innovativeness and that should be noticed in the policies and the construction of the organization.
- 3- Top management support: as discussed earlier this part is heavily discussed as an essential variable in adoption technology and being committed to implement it by top management.

Another variable mentioned in the same model which is interesting to be tested is behavior control and it consists of two variables:

- 1- Internal pressure: which means the impact of the colleagues inside the organization on the adoption intention, TAM mentioned the social influence impact in the early stages of being introduced to the technology.
- 2- External pressure: This involves many external environment aspects such: the competitive environment around the organization and the governmental/ regulation authority encouraging the adoption.

Another study by Qin et al. (2020) mentioned environmental and organizational factors too, and they were explained as follows:

Organizational factors consist of four variables:

- 1- Organizational mode and workflow: the study indicates that the ACE industry's workflow and mode is known and fixed, there are almost certain duties every stakeholder is obliged to commit to which hinder the implementation of BIM due to the organizational change that it implies into the internal environment.
- 2- Traditional thinking mode: BIM is a revolutionary thinking paradigm, the adoption of it will get people out of their traditional way of thinking.
- 3- Support from senior management: it is agreed that this factor is a key in BIM adoption, it is important to truly understand the risks and benefits.
- 4- The number of BIM experts and technicians: lack of technical experts will hinder the adoption of it.

Environmental factors explain the BIM adoption at the industrial and national levels and they consist of three factors:

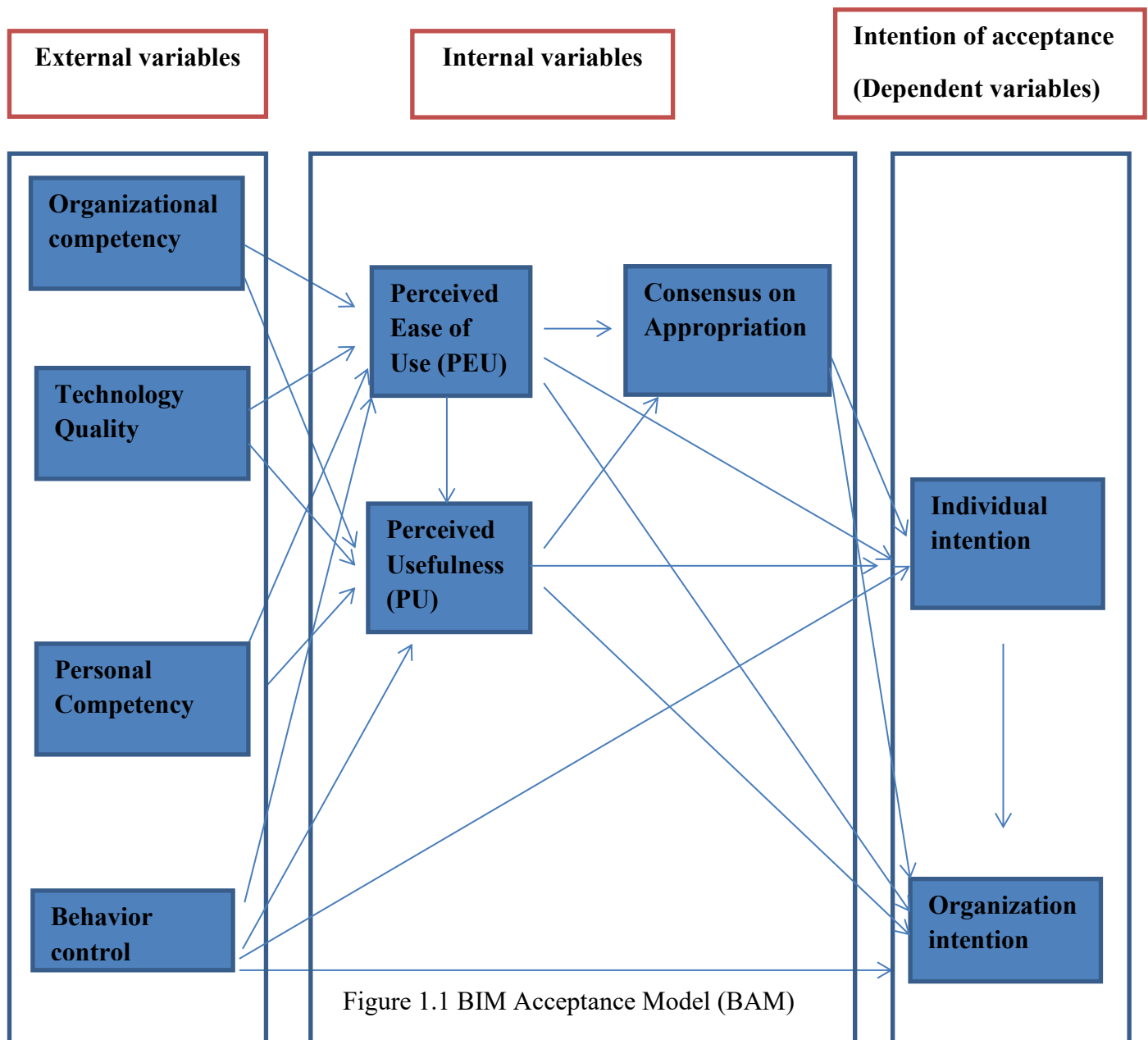
- 1- National policy requirements: of course, the promotion of BIM on the national level plays a key success factor in the adoption process as it was encouraged by the British government for example.
- 2- Popularity of BIM in the industry: companies, most of the time, follow up with the technological trends to keep themselves in the market and that also applied in the AEC industry and will affect BIM acceptance.
- 3- Competitions from other companies: as explained in the same study companies compete with two elements: cost and differentiation. The BIM adoption will give the implementers a competitive advantage; the competitors will find themselves adopting the technology to eliminate the difference factor.

Moreover, another study by Ullah et al. (2020) indicated the external factors of adopting BIM in Facility management area, and they viewed the factors they found in literature as: technological, organizational and environmental. For the organizational and environmental factors as they are the scope areas of the study, they indicated the organizational factors such as: Top management support, Behavioral intention, Training and learning, Leadership, innovativeness, awareness, motivation, trust and organizational culture, whereas the environmental factors are: client pressure, competitive pressure and partner pressure.

2.4 Knowledge Gap

Discussing previous ideas, BIM is becoming a new paradigm in the interactive models and cooperation with other stakeholders of the project in the AEC industry (Azhar et al,

2008). However, in the Palestinian context a few studies on this topic were conducted, mainly on the barriers and benefits of using BIM, where all confirmed the necessity of using new technology that improves the AEC industry. This study will discuss this topic from the managerial level especially the factors that will affect the acceptance of this technology then the adoption process in the local market, and provide them a guideline to develop their own BIM adoption plan that is customized depending on the external variables the research tested.



2.5 Defining Variables of BIM Adoption

Depending on BIM adoption acceptance BAM by Lee et al. (2015) and tailoring it to serve the research objectives and they are divided as:

Intention of Acceptance (Depending Variables)

As TAM suggested intention of adoption technology in their model, since the ACE work flow is complicated and it implies many stakeholders, and there will be information exchange between them, BAM model suggested two types of user's intentions of acceptance:

Organizational intention: where it is measured by: 1. Readiness to encourage BIM using among the expected group of implementers, 2. Readiness to encourage other partner organizations to use it, 3. Readiness to develop the technology and add different tools and means of use to the existing pattern of use.

Individual intention: where it is measured by: 1. Readiness to use BIM to complete the ordered tasks, 2. readiness to spend time being trained to new tools, 3. Readiness to encourage other colleagues in partner organizations to use it.

Internal Variables (TAM Based)

Perceived ease of use; it was previously explained; perceived ease of use is the extent which an individual believes that, using BIM will be effort-free and indicates that if the person believed so he would accept to use it and would feel positive about the perceived usefulness too, this variable will be measured by: 1. The degree of ease to learn using BIM 2.The degree of ease to interact with other users, 3.the degree of ease of using proposed guidelines from other partners.

Perceived usefulness; also was explained earlier; perceived usefulness is the extent which an individual believes that using BIM will be performance booster and

advantageous to the demanded tasks, this variable will be measured by: 1.the readiness of the person to use the tools, 2.the readiness of start a cooperation system with partner organizations.

External Variables

Organizational variables; literature had defined many external variables that related to factors in the same organization, the researcher chose to test: top management support, number of BIM experts and technicians and organizational culture.

Environmental variables; variables related to environment around the organization are defined here as: the national policies and requirements and competition with other companies (Figure 2) as suggested by the researcher and hypotheses (Figure 3).

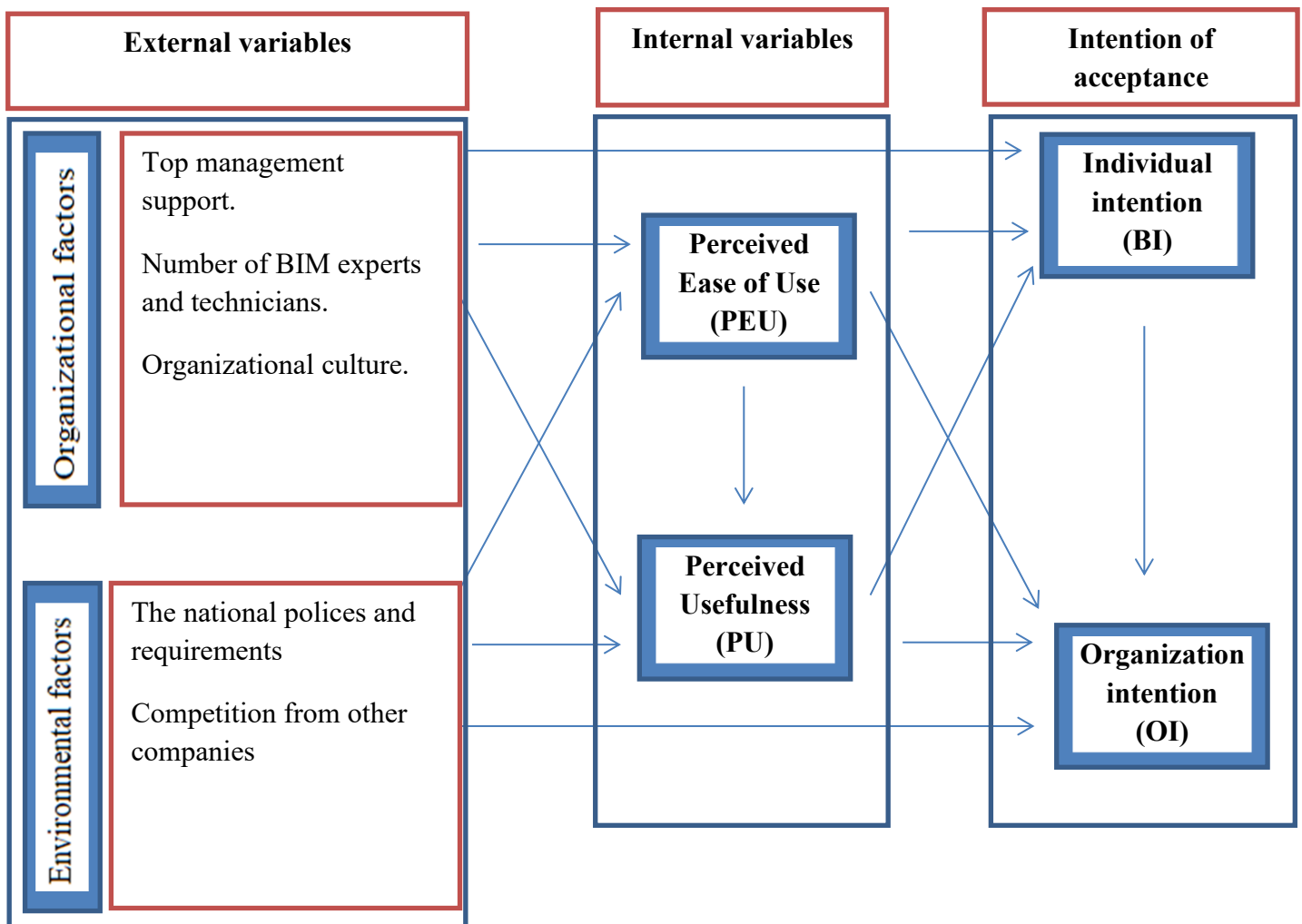


Figure 2.2 BIM Acceptance Model (BAM)

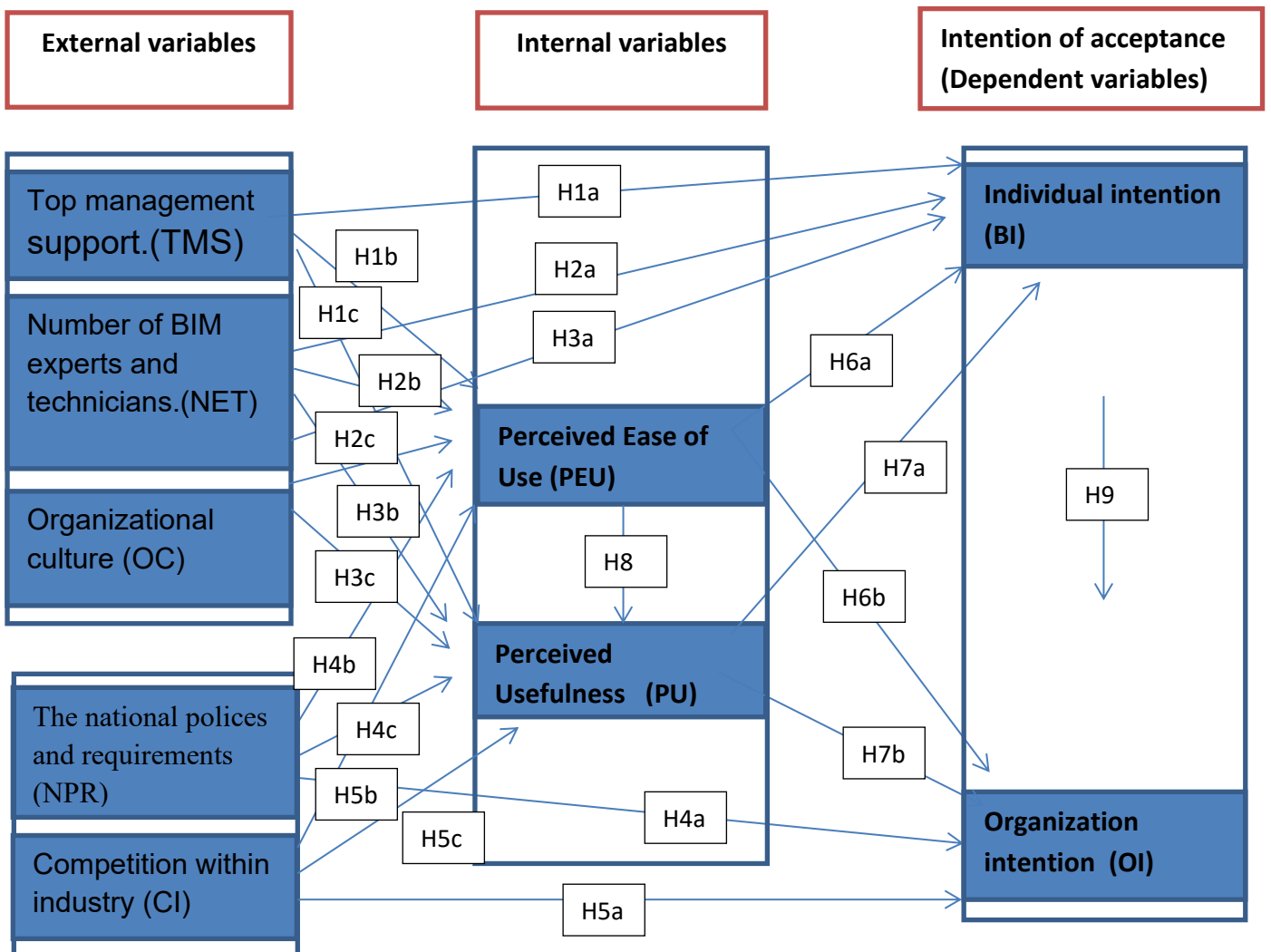


Figure 3.3 Research Hypotheses

Chapter Three

Environmental Impact and Technological Integration of BIM:

Application Examples

3.1 Overview

In this chapter, we embark on a comprehensive exploration of the powerful potential of Building Information Management (BIM) in designing inclusive buildings that prioritize accessibility and satisfaction for individuals with disabilities. Our focus extends beyond mere compliance with building licenses, aligning with the Palestinian law for the inclusion of People with Disabilities (No. 4, Article 14 & 15). By synergistically integrating BIM with advanced technologies and research, we aim to create environments that optimize comfort, accessibility, and overall satisfaction for all members of the community.

In section 1, we delve into how BIM serves as a game-changer in designing inclusive spaces. Through prominent studies like "A Method to Analyze the Living Spaces of Wheelchair Users Using IFC" by Emrah Türkyılmaz (2016) and "Reasoning about accessibility for disabled using building graph models based on BIM/IFC" by Barbara Strug and Grażyna Ślusarczyk (2017), we gain insights into leveraging BIM-based models to enhance accessibility and create seamless navigation for individuals with disabilities, fostering a truly inclusive environment.

Section 2 explores the significance of government guidance on implementing earthquake codes for government, public, and residential buildings. By adhering to national regulations and standards, building designs are fortified to withstand seismic forces, ensuring the safety of occupants and preserving critical infrastructure in earthquake-prone

areas. We also investigate how BIM implementation under government guidance enhances the credibility of earthquake code application for consulting companies.

Section 3, we analyze the pivotal role of supervising engineers empowered by the Palestinian amended law for building implementation and supervision. BIM technology enhances the efficiency and accuracy of supervising engineers' responsibilities, from mandatory supervision and verification to ensuring code compliance and quality assurance. The integration of BIM with the amended law promotes transparency, accountability, and adherence to national regulations and standards in Palestine's construction industry.

The integration of Building Management System (BMS) and Building Information Management (BIM) technologies is explored in section 4. The powerful synergy between these systems enables efficient building facility management. Facility managers benefit from real-time control and monitoring capabilities of BMS, combined with the comprehensive digital representation of the building offered by BIM. The integration empowers facility managers with data-driven insights, optimizing building performance, and implementing predictive maintenance strategies.

The integration of BIM with Geographic Information System (GIS) offers a host of benefits that can revolutionize the construction and management of complex building projects. In this section, we explore how GIS data, such as topography and environmental factors, informs site selection and decision-making for hospitals and airports. Combining BIM with GIS provides valuable insights for project management, enhanced sustainability, and efficient maintenance and operations of critical facilities.

By the end of this chapter, readers will have a holistic understanding of the groundbreaking applications and technological integrations of BIM. From designing

inclusive spaces to earthquake code implementation, empowering supervising engineers, enhancing building facility management, and promoting sustainable practices, BIM emerges as a transformative tool that reshapes the construction landscape to cater to the diverse needs of communities while fostering environmental stewardship and innovation.

3.2 BIM and Inclusive Buildings' Design

Optimizing Accessibility and Satisfaction for People with Disabilities

Designing an inclusive buildings for the disabled community using Building Information Management (BIM) goes beyond mere compliance with building licenses. BIM offers a powerful platform that enables architects, planners, and stakeholders to create an environment that optimally caters to the diverse needs of individuals with disabilities, ensuring their comfort, accessibility, and overall satisfaction. In general, BIM will offer the following services and advantages;

Accessibility-focused BIM Modeling: BIM can be used to create detailed 3D models of buildings, incorporating accessibility features such as ramps, elevators, wider doorways, and properly positioned handrails. By using BIM to accurately visualize and plan these elements, designers can ensure smooth navigation and easy access for individuals with disabilities.

Simulating Accessibility Scenarios: BIM allows designers to simulate different accessibility scenarios, considering various disabilities like mobility impairments or visual impairments. By analyzing these simulations, designers can identify potential issues and make necessary adjustments to provide the optimum level of satisfaction for disabled individuals.

Collaborative Design Process: BIM facilitates collaboration among stakeholders, including disability advocates, officials, and architects. Involving individuals with disabilities in the design process can offer valuable insights, ensuring that their specific needs and preferences are met.

Real-time Visualization and Feedback: BIM provides real-time visualization of the building design, allowing stakeholders to interact with the model and provide immediate feedback. This ensures that any required changes can be made early in the design process, leading to a more inclusive and satisfactory environment for disabled individuals.

Facilitating Universal Design: BIM can be used to implement universal design principles, ensuring that the campus accommodates all individuals regardless of their abilities. Elements such as well-planned pathways, adjustable workstations, and sensory cues can enhance the overall experience for everyone.

Case Study: University of California, Berkeley, USA

The University of California, Berkeley, embraced BIM to design a more inclusive campus. The project focused on providing better accessibility, navigation, and comfort for individuals with disabilities. By utilizing BIM, the university created digital models that simulated different disability scenarios, enabling them to optimize the campus design for all users. The collaborative process involved various stakeholders, including disability service providers and students with disabilities, to ensure a well-rounded and inclusive design.

3.3 National Policies and Requirements for Earthquake Codes in Buildings

In many countries, including seismic-prone regions, there are national policies and requirements for applying earthquake codes to government, public, and residential

buildings. These earthquake codes are designed to ensure that buildings are constructed to withstand seismic forces and minimize damage during earthquakes. The implementation of earthquake codes is crucial to safeguarding lives and preserving critical infrastructure in earthquake-prone areas. Here are some of the issues that can be facilitated using BIM.

National Earthquake Codes and Regulations: National governments typically establish earthquake codes and regulations that mandate specific design and construction requirements for buildings in seismic zones. These codes are based on extensive research, historical seismic data, and engineering expertise to establish standards that can effectively mitigate earthquake risks. They address various aspects of building design, such as structural systems, materials, foundations, and retrofitting of existing structures.

Importance of Earthquake Codes in Building Safety: The implementation of earthquake codes is vital to ensuring the safety and resilience of buildings during seismic events. By adhering to these codes, architects and engineers can design structures that can withstand ground shaking and lateral forces, reducing the risk of collapse and potential loss of life.

Integration of Earthquake Codes in BIM: Building Information Management (BIM) technology offers a valuable tool for the effective implementation of earthquake codes in building design. BIM allows for the creation of detailed 3D models that incorporate earthquake-resistant features, such as reinforced concrete walls, ductile steel frames, and energy dissipation systems. The use of BIM enables designers to simulate earthquake scenarios and assess the performance of the building under different seismic loads.

When government authorities guide the execution of earthquake codes in building projects, it enhances the credibility of the code's application, especially when consulting

companies use BIM technology. Several key factors contribute to this enhanced credibility:

Adherence to Regulatory Requirements: When government entities mandate the use of earthquake codes and oversee their execution, consulting companies are more likely to strictly adhere to the regulatory requirements. This ensures that the building designs are in full compliance with the latest seismic standards, reducing the risk of design errors and improving the overall safety of the structure.

Robust Structural Design: Government-guided execution of earthquake codes ensures that building designs are backed by extensive research and engineering expertise. Consulting companies using BIM can incorporate the prescribed seismic-resistant features into the digital models, resulting in structurally robust buildings that can withstand seismic events.

Quality Assurance and Accountability: Government oversight instills a sense of accountability in consulting companies. The assurance of compliance with earthquake codes backed by government inspection and approval provides stakeholders with confidence in the building's safety and resilience.

Performance-based Assessments: BIM facilitates performance-based assessments of the building's response to seismic forces. When guided by government earthquake codes, these assessments are aligned with national standards, providing reliable insights into the structure's behavior during earthquakes.

Efficient Collaboration: Government-guided execution of earthquake codes fosters efficient collaboration between consulting companies and regulatory authorities. BIM enables seamless communication and exchange of information, streamlining the approval process and ensuring that all stakeholders are aligned with the design intent.

The implementation of national earthquake codes is crucial for ensuring the safety of government, public, and residential buildings in seismic-prone regions. When consulting companies use BIM technology under the guidance of government earthquake codes, it enhances the credibility of the building design and construction process. Government oversight ensures strict adherence to seismic standards, resulting in structurally robust buildings that prioritize safety and resilience. BIM facilitates the integration of earthquake-resistant features into digital models, allowing for efficient collaboration and performance-based assessments. By combining government guidance with BIM technology, stakeholders can have confidence in the earthquake-resistant design and construction of buildings, providing a safer environment for communities in earthquake-prone areas.

3.4 Empowering Supervising Engineers through the Palestinian Amended Law and BIM Implementation

The Palestinian amended law for the implementation and supervision of buildings, enacted in 2019, plays a crucial role in empowering supervising engineers in the context of BIM implementation. The law outlines the responsibilities, qualifications, and legal obligations of supervising engineers, reinforcing their primary role in overseeing building projects and ensuring compliance with national regulations and standards. When companies use BIM technology, the law further enhances the importance of supervising engineers in the following ways:

Mandatory Supervision and Verification: The amended law mandates the appointment of supervising engineers to oversee construction projects. With the adoption of BIM, these engineers are tasked with verifying that the digital models align with the approved design

plans and comply with the seismic and safety requirements specified by the law. By leveraging BIM's collaborative features, supervising engineers can effectively communicate with project stakeholders and ensure that the project adheres to the approved plans.

Ensuring Code Compliance and Quality Assurance: Supervising engineers play a crucial role in ensuring that the building design adheres to the seismic and safety codes specified in the amended law. With BIM, they can conduct advanced simulations and analyses to assess the building's structural integrity and performance. This capability allows for early detection of design issues and potential non-compliance, enabling timely corrective actions to be taken before construction commences.

Real-time Progress Monitoring: Through BIM, supervising engineers can monitor the real-time progress of construction activities. They can review the BIM model to verify that the construction aligns with the approved plans and that quality standards are being upheld. This constant monitoring and collaboration with contractors and stakeholders enable swift decision-making and timely resolutions to any emerging issues.

Data-driven Decision-making: BIM provides supervising engineers with valuable data and insights during the construction process. The digital model contains a wealth of information on materials, quantities, and progress, enabling data-driven decision-making. This data-driven approach enhances the accuracy and efficiency of project supervision, leading to better-informed decisions throughout the building's lifecycle.

Legal Documentation and Accountability: The use of BIM in conjunction with the amended law allows supervising engineers to maintain comprehensive documentation of the entire construction process. This documentation serves as legal evidence of adherence

to the law's requirements, protecting supervising engineers from potential liabilities while ensuring accountabilities for all stakeholders involved in the project.

The Palestinian amended law for the implementation and supervision of buildings, combined with the adoption of BIM technology, reinforces the primary and legal role of supervising engineers. BIM empowers these engineers with advanced tools and data-driven insights, allowing them to fulfill their responsibilities with greater efficiency and accuracy. By ensuring code compliance, conducting real-time progress monitoring, and maintaining comprehensive documentation, supervising engineers play a critical role in overseeing building projects and safeguarding the safety and structural integrity of constructions in Palestine. The integration of BIM with the amended law not only enhances the building process but also strengthens the overall construction industry by promoting collaboration, transparency, and adherence to national regulations and standards.

3.5 Synergy between BMS and BIM for Efficient Building Facility Management

The integration of Building Management System (BMS) and Building Information Management (BIM) technologies offers a powerful synergy that significantly enhances the efficiency of building facility management. BMS provides real-time control and monitoring capabilities for various building systems, while BIM offers a comprehensive digital representation of the building's physical and functional attributes. By combining the insights and data from both systems, facility managers can make informed decisions, optimize building performance, and ensure sustainability throughout the building's lifecycle.

BMS and BIM play complementary roles in building facility management. A framework proposed by Oti et al. (2016) highlights the utilization of BMS data in building information models for both design and operation phases. BMS, with its real-time monitoring capabilities, focuses on controlling building systems such as heating, ventilation, lighting, security, and fire prevention. On the other hand, BIM, as described in the work of Khalid et al. (2017), offers a detailed and dynamic digital model encompassing architectural, structural, and MEP information.

The integration of BMS and BIM enables enhanced facility automation. By utilizing BIM's real-time data integration system, as developed by Khalid et al. (2017), facility managers gain valuable insights into building performance. This integration allows for more informed and efficient control of building systems based on actual usage patterns and occupancy levels. Facility managers can implement intelligent strategies to optimize energy consumption, improve occupant comfort, and reduce operational costs.

Integrating BMS data into the BIM model empowers facility managers with real-time information on building performance. Oti et al. (2016) emphasizes the use of BMS data during the operation phase, enabling facility managers to make data-driven decisions promptly. In case of system malfunctions or deviations from expected performance, the combination of BMS and BIM allows facility managers to pinpoint issues quickly and take proactive measures to resolve them.

The synergy between BMS and BIM supports lifecycle management and predictive maintenance strategies. BIM's comprehensive digital model, enriched with data from BMS, provides valuable information about the lifespan and condition of building components. Facility managers can leverage this knowledge to predict maintenance

requirements accurately, schedule maintenance tasks proactively, and extend the life of building assets, reducing downtime and operational disruptions.

The successful integration of BMS and BIM is exemplified in the case of Khalifa Tower. During the tower's construction, BIM was instrumental in coordinating complex systems, as demonstrated by Khalid et al. (2017). Post-construction, the integration of BMS into the BIM model allowed real-time monitoring and control of critical building systems, ensuring efficient operations and occupant comfort.

The integration of Building Management System (BMS) data into Building Information Management (BIM) models unlocks the potential for efficient building facility management. By leveraging real-time insights from BMS and the comprehensive digital model from BIM, facility managers can optimize building performance, make data-driven decisions, and implement predictive maintenance strategies. The frameworks proposed by Oti et al. (2016) and the development by Khalid et al. (2017) showcase the importance of integrating BMS and BIM to create a holistic and intelligent approach to building facility management. Through this integration, stakeholders can maximize building efficiency, reduce operational costs, and enhance sustainability, ultimately creating smarter and more resilient buildings for the future.

3.6 Leveraging the Synergy of BIM and GIS for Enhanced Building Performance and Sustainability

Integrating Building Information Management (BIM) with Geographic Information System (GIS) offers a host of benefits that can revolutionize the construction and management of complex building projects, such as hospitals or airports. The fusion of these technologies provides valuable insights, enabling informed decision-making and promoting sustainable building practices throughout the building's lifecycle.

GIS data, encompassing topography, soil composition, and other environmental factors, is instrumental in site selection for hospitals and airports. Integrating GIS data into BIM models allows architects and engineers to assess potential site challenges and opportunities more effectively. For instance, when designing a hospital, GIS data can help identify suitable locations with easy accessibility, minimal environmental impact, and efficient infrastructure connections.

Integrating BIM and GIS offers a holistic view of the project site and its surroundings, benefiting project management for hospitals and airports. By overlaying GIS data with BIM models, project managers can optimize logistics planning, material delivery, and construction scheduling. This integrated approach facilitates smooth coordination and timely execution of construction activities, ensuring the successful completion of the project.

GIS data provides critical information on local resources, renewable energy potential, and environmental considerations. By integrating this data with BIM models, architects and engineers can design hospitals and airports that prioritize sustainability. For instance, they can leverage GIS data to incorporate green building practices, optimize energy efficiency, and utilize renewable energy sources, thereby reducing the carbon footprint of these facilities.

Integrating BIM with GIS enhances maintenance and operations activities for hospitals and airports. BIM models can offer detailed insights into building components and systems, allowing facility managers to plan and execute maintenance tasks more efficiently. Additionally, GIS data provides valuable information on the surrounding infrastructure, transportation networks, and utility connections, aiding facility managers in optimizing day-to-day operations for these critical facilities.

Case Study: Integrating BIM and GIS for an Airport Terminal

Consider an airport terminal project where BIM is integrated with GIS. GIS data is used to analyze the airport's surroundings, identifying potential noise pollution sources and environmental constraints. This information is then incorporated into the BIM model, enabling architects to design the terminal with appropriate acoustic insulation and sustainable features. Throughout the airport's lifecycle, facility managers leverage the integrated BIM-GIS data to optimize maintenance schedules, analyze energy usage, and make data-driven decisions for more efficient operations.

In conclusion, the integration of Building Information Management (BIM) with Geographic Information System (GIS) unlocks a wide range of benefits for complex building projects such as hospitals and airports. By combining GIS data with BIM models, stakeholders gain a comprehensive understanding of the project site, leading to better-informed decisions during site selection, construction, and project management. The synergy between BIM and GIS promotes sustainable design practices, enhances facility operations, and empowers facility managers to maintain buildings more efficiently. As demonstrated by the airport terminal case study, this integration fosters smarter and more sustainable facilities that cater to the evolving needs of our communities while minimizing environmental impacts.

Chapter Four

Methodology

4.1 Overview

This chapter discusses the approach used to obtain data and analyze it, by dividing it into steps. Firstly, research design where the research method is explained, secondly, population and sample where the population is described in details to eventually determine the sample size of the research, thirdly, data collection method where collected data was reported, fourthly, research tools, questionnaire in this case where it is explained and encoded and finally data analysis techniques using the partial least squares structural equation modeling (PLS-SEM) using SMART-PLS software. Another tool was conducted which is qualitative questions to dig deeper in different dimensions that contribute to the national policies and requirements (NPR) variable, through the viewpoints of the same participants of the questionnaire.

4.2 Research Design

As described previously this research tested a model that was presented by the researcher depending on literature. The model tests the variables that affect the adoption of BIM in the Palestinian market.

This research used the quantitative hypothesis-testing empirical design. The data was collected using a questionnaire that was distributed among a convenient sample, of architects, civil, electrical, mechanical engineers who work for the private sector in, consultancy offices, real-estate development companies and contracting companies that exist in the Palestinian market. The electronic questionnaire form was distributed by email.

4.3 Population and Sample

The population of this study is offices that are ranked as Consultancy Offices according to the Engineers Association in the West bank and Gaza strip.

Engineering offices, according to the Engineers Association, are ranked depending on the staff number and qualifications, and the square meters quota, allowed for them. Thus, there are three ranks: Consultancy Office, Engineering Office (degree one, degree two, degree three) and Expert Engineer Bureau.

According to the last statistics that were published on the official website of the Engineers Association, the total number of engineering offices and companies that are working in the West Bank is 555, with total registered engineers of 2355.

The number of the consultancy offices which are working in the West bank's construction industry is only 209, the total number of engineers working for offices that are ranked consultants and meeting our interested specialties is 2010 engineer.

The researcher assumed that the number of consultancy offices that are working in Gaza Strip, since there are no official reports published by the engineer's association there, would be 41 offices, due to the retrograded economic situation and shortage of building materials supplies due to the continuing siege. To sum up the total number of registered Consultancy Offices of the research interest is 250 offices. The sample size will be 152 offices, where a margin of error =5% was taken into consideration.

Using the Steven K. Thompson's equation:

$$n = \frac{NZ^2p(1-p)}{d^2(N-1) + Z^2p(1-p)}$$

Where:

n: Sample size.

N: Population size (= 250).

Z: Confidence level at 95% (= 1.96).

d: Margin of error (= 5%).

p: Probability of an event (= 50%).

4.4 Data Collection Method

A structured questionnaire was developed to be the data collection tool for this research. The questionnaire was distributed and filled electronically using Google Forms and sent by email. The researcher found that this method is more efficient, more committed to social distancing regulations, more reachable to any city in the West bank and Gaza, less time consuming and less cost.

The questionnaire was distributed between 19/10/2021 and 3/12/2021 and 168 respondents were received, where all of them were valid, leading to a margin of error = 4.4%

The questionnaire was followed by qualitative questions concerning the different dimensions of the National Requirement and Policies (NPR). The dimensions that were discussed in these sections were:

- 1- Accessibility and BIM Adoption: under the Palestinian law of 1990 which require all buildings to be accessible and suitable for handicapped use.
- 2- Earthquake Codes and BIM: under the earthquake code that the Palestinian law and engineering association had adopted.

- 3- Amended Building Execution Law and BIM: the amended law requires the obliged supervision on executing buildings.
- 4- Building Management System (BMS) and BIM: in this question participants gave their thoughts on government-induced integration of BIM with BMS.
- 5- Geographical Information System (GIS) and BIM: in this question participants explained if government- driven integration of BIM with GIS by fosters adoption.

4.5 Research Tool

The quantitative tool, the questionnaire is based on the model that was suggested by the researcher. It was a TAM-based model, in addition to other external variables the researcher suggested. Therefore, the questionnaire was divided into three parts:

1- First Part:

Demographic information of the participants and it is as presented:

- Gender: (two categories)
- Profession: (four categories)
- Position: (three categories)
- Years of Experience: (open question)
- Scientific Degree: (three categories)
- Region: (eleven categories)
- Number of Employees: (open question)
- Working Domain (five categories)
- Programs used usually: (check list of 21 programs)
- Do you use BIM? (yes or no question)
- If Yes, add number of years you've been using it: (open question)

- If No, choose the reason (seven categories)

2- Second Part:

Constructs that represent TAM model (Table2), which are:

- Individual intention to adopt BIM
- Organizational intention to adopt BIM
- Perceived ease of use
- Perceived usefulness

The questions in this part of the questionnaire highly depended on the model that Lee et al. (2015) proposed and the questionnaire they developed to reinforce their hypotheses. Also Yuan et al.(2019) provided a measurement item that was used in this research (Table 4.1).

Table 4.1 Internal Variables Indicators

Variables	Code	Item	Reference
Individual intention to adopt BIM	BI1	I have the intention to use BIM to complete the tasks	Lee et al., 2015
	BI2	I have the intention to encourage my colleagues to use BIM	Yuan et al., 2019
	BI3	I have the intention to dedicate time to learn BIM	
	BI4	I have the intention to improve my skills and be an expert in BIM	
	BI5	I am interested in the projects and organizations that use BIM	
	OI1	My organization supports using BIM	

Organizational intention to adopt BIM	OI2	My organization encourages taking the projects that require using BIM	Lee et al., 2015
	OI3	My organization encourages our projects partners to use BIM	Yuan et al., 2019
	OI4	My organization has the intention to adopt BIM	
	OI5	My organization has the intention to improve the usage of BIM	
Perceived ease of use	PEU1	It is easy to use BIM	Lee et al., 2015
	PEU2	It is easy to learn how to use BIM	
	PEU3	It is easy to share project information between stakeholders	Yuan et al., 2019
	PEU4	It easy to interact with BIM	
	PEU5	BIM is flexible to use	
	PEU6	It is easy to become an expert in BIM	
Perceived usefulness	PU1	Using BIM will make coordination between stakeholders easier	Lee et al., 2015
	PU2	Using BIM will reduce the time to complete the task	Yuan et al., 2019
	PU3	Using BIM will improve the accuracy of the completed task	Evans et al., 2020
	PU4	Using BIM will make variations on the project easier	

	PU5	Using BIM will improve the stakeholders understanding of the project	
	PU6	Using BIM will reduce project risks	
	PU7	Using BIM will reduce project cost	

3- **Third Part:** external variables (Table3) that was proposed earlier Constructs that represent the external variables which are divided into two categories:

- Organizational variables: Top management support, the number of experts and technicians, and organizational culture.
- Environmental variables: competition within industry and national policies and requirements.

Table 4.2 External Variables Indicators

Variables	Code	Item	Reference
Top management support	TMS1	My organization provides the needed resources to use BIM	Yuan et al., 2019
	TMS2	My organization provides the needed training to use BIM	Lee et al., 2016
	TMS3	My organization encourages us to learn BIM	Evans et al., 2020
	TMS4	My organization offers incentives for the employees who use BIM	
	TMS5	My organization believes in the usefulness of using BIM	

The number of experts and technicians	TEN1	There is enough training in my organization to use BIM skillfully	Yuan et al., 2019
	TEN2	My organization provides enough budget to buy BIM tools and hardware	Evans et al., 2020
	TEN3	There are enough experts and technicians in our organization	
	TEN4	BIM team supports other team members to use BIM	
Organizational culture	OC1	My organization supports team works and a responsible leader for every team	Hofstede, 2011
	OC2	BIM adoption decision is top management decision and not an individual one	
	OC3	My organization supports the individual using of BIM and encourages employees to use it	
	OC4	My organization studies the BIM adoption decision to reduce risks	
	OC5	My organization invests in training employees	
	OC6	My organization supports long-term working contracts	
Competition within	CI1	Using BIM will improve the organization's completion in the market	Lee et al., 2016

industry	CI2	Most of our competitors use BIM in their projects	Lee et al., 2015
	CI3	Organizations using BIM will get better job contracts.	
	CI4	Organizations using BIM have the best reputation in the market	
	CI5	Using BIM will give the organization a competitive advantage	
	CI6	Using BIM will give the staff more ability to compete in the market	
National Policies and requirement	NPR1	Using BIM in governmental projects will encourage the BIM adoption in other organizations	Yuan et al., 2019 Qin et al., 2020
	NPR2	Regulating the usage of BIM in licensing construction projects will help adopt it.	
	NPR3	Regulating the usage of BIM in tender documents of construction projects will help its adoption.	

For the last two parts, the researcher used a 7-point Likert scale as shown; all indicators were phrased positively defending the hypotheses.

Table 4.3 Likert Scale

7	Strongly agree	4	Neutral	1	Strongly disagree
6	Agree	3	Disagree to certain extent		

5	Agree to certain extent	2	Disagree		
---	-------------------------	---	----------	--	--

4.6 Qualitative Tool

The questionnaire was followed with these open-end questions, and they were:

1. Will the Palestinian law 1999 encourage BIM adoption?
2. Will the governmental adoption of earthquake codes obligate BIM usage?
3. Can the amended 2019 law on building execution activate BIM in supervision?
4. Will government-induced integration of Building Management System (BMS) and BIM incentivize usage?
5. Can government-driven integration of Geographical Information System (GIS) and BIM foster adoption?

4.7 Data Analysis Techniques

Raw data needs to be processed to gain valuable information, and since we are in big data and smart machines era, many tools are consequently there to help extracting information from collected data. For this reason the researcher used more than one software like Excel to transform the questionnaire into an encoded spread sheet, SPSS to explain the descriptive data which includes frequencies and percentages to describe the sample regarding the first part of the questionnaire, and lastly, SMART-PLS to obtain the inferential analysis where in this part the SEM structure equation model was used to test the relationship with the different variables.

The qualitative analysis meticulously scrutinized five essential questions. Each question, crafted with precision, aimed to unravel the intricate tapestry of participants' viewpoints,

showcasing the symbiotic dance between regulatory frameworks, the integration of cutting-edge technologies, and the prospective adoption of BIM.

Chapter Five

Data Analysis

5.1 Overview

This chapter discusses the process of transforming the collected data into meaningful information by; firstly, taking an overall glance on the collected data in the descriptive statistics, secondly, the inferential data analysis by using SMART-PLS software which will test the hypotheses by applying the partial least squares structural equation modeling (PLS-SEM).

5.2 Qualitative Analysis

5.2.1 Descriptive Statistics

Demographic data

Demographic data refers to the characteristics of the studied sample as explained before the demographic data is the first part of the survey and it is presented as below (Table 5.1):

Table 5.1 Demographic Data

Variable		Frequency Total sample 168	Percent (%)
Gender	Male	102	60.7
	Female	66	39.3
Profession	Architect	90	53.6
	Civil Engineer	46	27.4
	Construction Engineer	8	4.8
	Electrical Engineer	18	10.7

	Mechanical Engineer	6	3.6
Position	Consultant	14	8.3
	Cost Control Engineer	2	1.2
	Office/Design Engineer	56	33.3
	Planning Engineer	4	2.4
	Project Manager	14	8.3
	Quantity Surveyor Engineer	4	2.4
	Sales Engineer	2	1.2
	Site Engineer/ Supervision	16	9.5
	Top Management/ Owner	56	33.3
Scientific degree	Bachelor's degree	124	73.8
	Master's degree	44	26.2
Work domain	Urban Planning	6	3.6
	Construction	128	76.2
	Infrastructure and Water	2	1.2
	Transportation	8	4.8
	Others	24	14.3
Number of employees	1- 10 employees	124	73.8
	11- 30 employees	34	20.2
	31-82 employees	6	3.5
	500- 3500 employees	4	2.4
Work region	Gaza	26	15.5
	Hebron	26	15.5

	Jenin	10	6.0
	Jerusalem	12	7.1
	Nablus	18	10.7
	Ramallah	76	45.2
Years of experience	1- 10	86	51.2
	11- 20	68	40.5
	21-45	14	8.3

Frequencies of the used programs (Table 5.2)

Table 5.2 Utilized Programs' Data

	Frequency	Percentage
AutoCAD alone	32	19.04
Revit with other programs	60	35.7
AutoCAD with other programs	160	95.2
AutoCAD and 3D MAX only	28	16.7
AutoCAD and Revit only	16	9.5
AutoCAD, 3D max and Revit only	12	7.14

Frequencies of using BIM (Table 5.3) (Figure 5.1).

Table 5.3 BIM Using Data

Answer	Frequency	Percent
No	126	75.0
Yes	42	25.0
Total	168	100.0

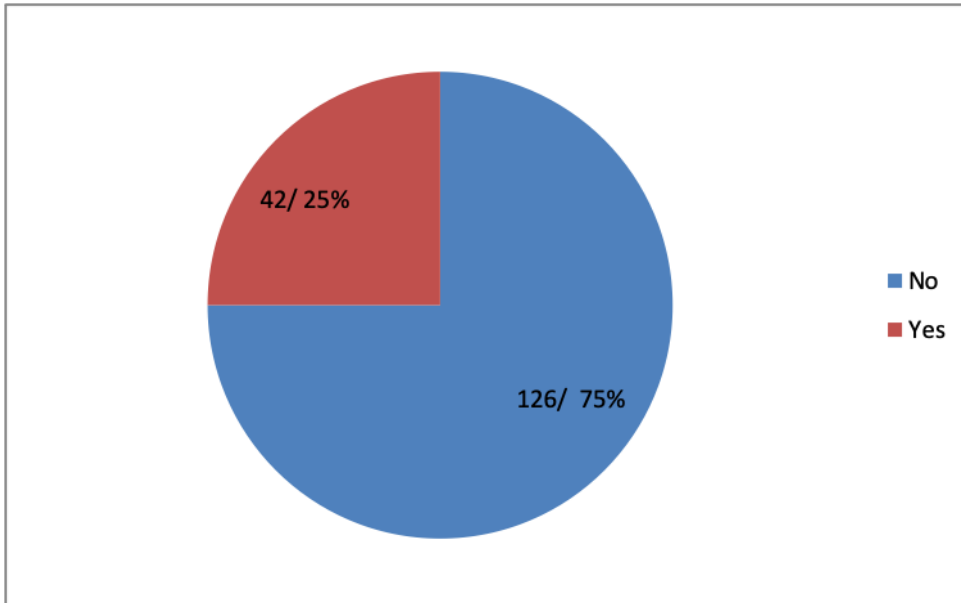


Figure 5.1 Percentage of BIM Users

In case of yes the years of experience using BIM was in the range between 1 and 16 years

Years of experience	Minimum	Maximum	Mean	Std. Deviation	Variance
	1	16	5.62	4.149	17.217

In case the answer is 'No' on whether they use BIM, the reasons were:

	Frequency	Percentage
It is a High cost technology	4	3.2
It has not been recommended to me	12	9.5
Lack of qualified staff	24	19
I've Never heard of it	28	22.2
There is No enough time to learn it	14	11.1
No need to use it	8	6.4
Our Projects do not require it	36	28.5
Total	126	100.0

5.2.2 Inferential Statistics

Researches recommend using PLS- SEM in cases such as testing a theoretical framework for complicated models that have many indicators and constructs, and for understanding the extensions of existing theory (TAM extensions in this case), small sample size limited by the small population and for models with one or more formative constructs (Hair et al, 2019). The same article suggested certain steps to analyze as shown in (Figure 5.2).

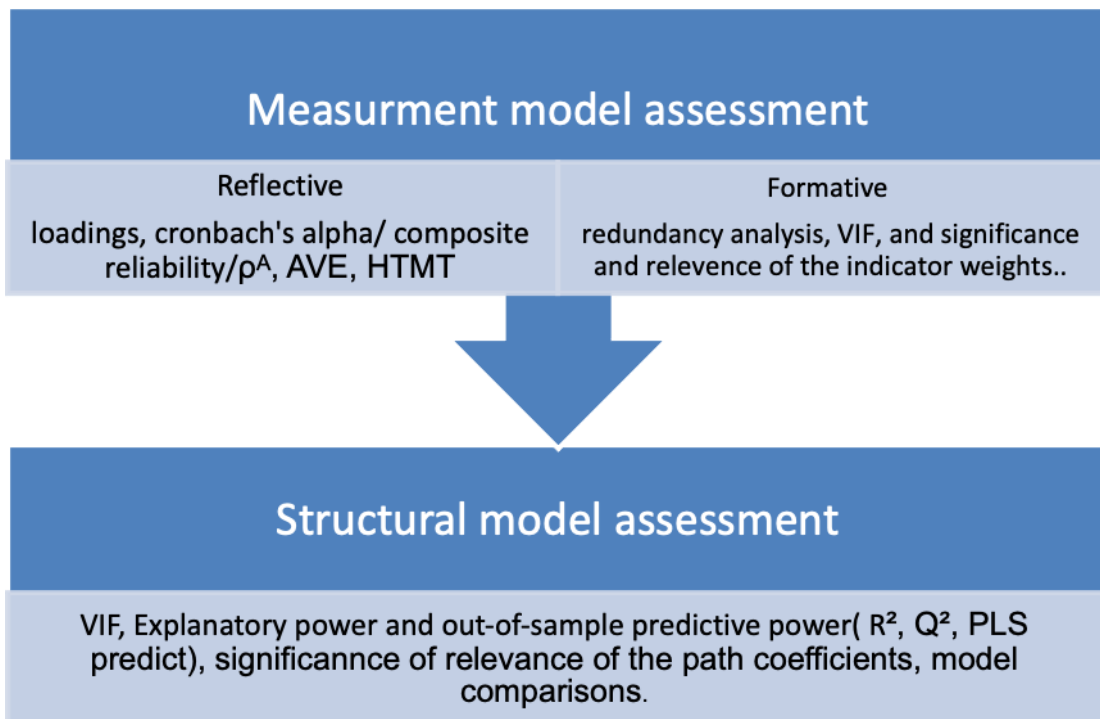


Figure 5.2 Stages of PLS- SEM Analysis

Stage One: Measurement Model Assessment

In this stage, the relationship between the construct and its indicators is tested to make sure that every indicator is a significant representative to its own construct, and it consists of two significant measures, reflective and formative: reflective measurements are for assessing the construct's reliability and validity.

Reliability assessments test the internal consistency of a construct, acceptable values preferably between 0.9 and 0.7 whereas values below 0.6 are a sign of weak reliability; the same works for indicator's reliability loadings should be higher than 0.7, loading's less than 0.4 should be removed from the scale. (Hair et al, 2011) (Hair et al, 2019).

The researcher eliminated two indicators that were below 0.4, CI2 and –PU8.

The validity assessments test the convergent (Table 8) and discriminant validity (Table 9) (Table 10) which is expressed by the average variance extracted (AVE); a value of 0.50 and higher is an indicator of sufficient convergent validity and indicates that the variable explains more than 50% of its indicators' variance. Also, to test the discriminant validity, two tests are applied, the Fornell-Larcker test and cross loadings, for first test, it should indicate that the square root of (AVE) of each construct is greater than the correlation between any other construct and the levels of the (AVE) for each construct is greater than the squared correlation between any other construct. On the other hand, the second test of validity should indicate that the loadings of an indicator with its construct are greater than its loadings with other constructs (Hair et al, 2011) (Hair et al, 2019).

Convergent Validity

Table 5.4 Convergent Validity Data

Construct	Indicator	Outer loading	Cronbach's Alpha	Rho_A	Composite Reliability	Average Variance Extracted (AVE)
BI Behavioral intention (individual intention)	BI1	0.904	0.924	0.932	0.943	0.767
	BI2	0.895				
	BI3	0.836				
	BI4	0.864				
	BI5	0.877				
CI	CI1	0.671	0.845	0.881	0.889	0.621

Competition within the industry	CI3	0.61				
	CI4	0.779				
	CI5	0.919				
	CI6	0.912				
NPR The national policies and requirements	NPR1	0.907	0.936	0.94	0.959	0.887
	NPR2	0.949				
	NPR3	0.968				
OC Organizational culture	OC1	0.731	0.869	0.888	0.901	0.603
	OC2	0.705				
	OC3	0.705				
	OC4	0.881				
	OC5	0.829				
	OC6	0.792				
OI Organizational intention	OI1	0.955	0.968	0.971	0.975	0.887
	OI2	0.958				
	OI3	0.932				
	OI4	0.951				
	OI5	0.911				
PEU Perceived ease of use	PEU1	0.83	0.898	0.904	0.922	0.663
	PEU2	0.793				
	PEU3	0.75				
	PEU4	0.869				
	PEU5	0.891				
	PEU6	0.741				

PU Perceived usefulness	PU1	0.832	0.903	0.919	0.925	0.642
	PU2	0.805				
	PU3	0.904				
	PU4	0.838				
	PU5	0.795				
	PU6	0.849				
	PU7	0.528				
TEN Technical Expertise needed	TEN1	0.92	0.938	0.978	0.954	0.838
	TEN2	0.933				
	TEN3	0.902				
	TEN4	0.908				
TMS Top management support	TMS1	0.913	0.958	0.975	0.967	0.855
	TMS2	0.915				
	TMS3	0.954				
	TMS4	0.928				
	TMS5	0.912				

Discriminant Validity

- Cross Loadings

Table 5.5 Discriminant Validity - Cross Loadings

		BI	CI	NPR	OC	OI	PEU	PU	TEN	TMS
BI	BI1	0.904	0.438	0.374	0.319	0.275	0.435	0.595	0.22	0.151
	BI2	0.895	0.434	0.5	0.35	0.349	0.523	0.659	0.231	0.178
	BI3	0.836	0.384	0.373	0.186	0.329	0.374	0.465	0.189	0.152
	BI4	0.864	0.383	0.377	0.27	0.366	0.376	0.521	0.242	0.236
	BI5	0.877	0.364	0.398	0.384	0.337	0.384	0.518	0.321	0.169

CI	CI1	0.472	0.671	0.436	0.136	0.316	0.353	0.404	0.154	0.163
	CI3	0.095	0.61	0.19	-0.022	0.001	0.193	0.167	0.028	-0.033
	CI4	0.271	0.779	0.345	0.225	0.204	0.353	0.314	0.128	0.21
	CI5	0.388	0.919	0.476	0.118	0.237	0.399	0.48	0.141	0.167
	CI6	0.427	0.912	0.483	0.162	0.347	0.399	0.456	0.188	0.245
NPR	NPR1	0.384	0.494	0.907	0.324	0.289	0.32	0.4	0.212	0.296
	NPR2	0.474	0.462	0.949	0.376	0.237	0.388	0.392	0.272	0.347
	NPR3	0.456	0.511	0.968	0.318	0.257	0.416	0.44	0.195	0.336
OC	OC1	0.206	0.173	0.387	0.731	0.243	0.088	0.13	0.447	0.54
	OC2	0.304	0.1	0.372	0.705	0.178	0.183	0.262	0.468	0.392
	OC3	0.151	-0.076	0.168	0.705	0.373	0.114	0.071	0.493	0.567
	OC4	0.304	0.156	0.239	0.881	0.461	0.22	0.122	0.65	0.701
	OC5	0.277	0.085	0.238	0.829	0.24	0.165	0.184	0.425	0.551
	OC6	0.308	0.269	0.254	0.792	0.274	0.254	0.243	0.433	0.525
OI	OI1	0.319	0.242	0.276	0.381	0.955	0.408	0.313	0.495	0.625
	OI2	0.337	0.277	0.269	0.331	0.958	0.407	0.34	0.531	0.589
	OI3	0.284	0.317	0.227	0.304	0.932	0.366	0.302	0.472	0.561
	OI4	0.386	0.294	0.215	0.367	0.951	0.386	0.393	0.535	0.586
	OI5	0.433	0.359	0.308	0.348	0.911	0.394	0.391	0.457	0.552
PEU	PEU1	0.249	0.324	0.122	0.064	0.191	0.83	0.354	0.103	0.172
	PEU2	0.294	0.344	0.214	0.161	0.336	0.793	0.343	0.114	0.218
	PEU3	0.426	0.353	0.454	0.209	0.351	0.75	0.561	0.216	0.293
	PEU4	0.427	0.315	0.299	0.215	0.355	0.869	0.419	0.312	0.273
	PEU5	0.441	0.347	0.313	0.238	0.432	0.891	0.432	0.278	0.327
	PEU6	0.44	0.477	0.436	0.209	0.31	0.741	0.429	0.163	0.22

PU	PU1	0.552	0.449	0.39	0.164	0.234	0.479	0.832	0.053	0.192
	PU2	0.503	0.415	0.417	0.176	0.286	0.353	0.805	0.123	0.15
	PU3	0.583	0.42	0.389	0.149	0.353	0.436	0.904	0.198	0.15
	PU4	0.548	0.424	0.327	0.222	0.362	0.572	0.838	0.044	0.136
	PU5	0.459	0.407	0.272	0.144	0.257	0.422	0.795	0.014	0.044
	PU6	0.561	0.445	0.416	0.309	0.356	0.382	0.849	0.31	0.259
	PU7	0.302	0.129	0.202	0.15	0.213	0.323	0.528	0.165	0.07
TEN	TEN1	0.243	0.152	0.256	0.519	0.461	0.27	0.155	0.92	0.641
	TEN2	0.252	0.189	0.203	0.605	0.476	0.228	0.101	0.933	0.701
	TEN3	0.162	0.067	0.091	0.512	0.422	0.066	0.094	0.902	0.56
	TEN4	0.3	0.193	0.253	0.611	0.539	0.274	0.196	0.908	0.679
TMS	TMS1	0.173	0.163	0.321	0.562	0.548	0.247	0.187	0.651	0.913
	TMS2	0.137	0.152	0.291	0.596	0.554	0.247	0.127	0.718	0.915
	TMS3	0.197	0.254	0.353	0.666	0.628	0.298	0.173	0.66	0.954
	TMS4	0.149	0.187	0.223	0.648	0.576	0.309	0.104	0.71	0.928
	TMS5	0.248	0.234	0.384	0.695	0.551	0.342	0.233	0.606	0.912

- Fornell-Larcker Criterion

Table 5.6 Discriminant Validity - Fornell- Larcker

	BI	CI	NPR	OC	OI	PEU	PU	TEN	TMS
BI	0.876								
CI	0.458	0.788							
NPR	0.466	0.52	0.942						
OC	0.351	0.175	0.359	0.777					
OI	0.378	0.318	0.277	0.369	0.942				
PEU	0.483	0.448	0.4	0.236	0.417	0.814			
PU	0.636	0.494	0.437	0.236	0.372	0.534	0.801		
TEN	0.276	0.178	0.239	0.622	0.529	0.254	0.16	0.916	
TMS	0.202	0.219	0.347	0.691	0.618	0.317	0.184	0.717	0.925

- Heterotrait-Monotrait Ratio (HTMT)

Another discriminant validity test is (HTMT) (Table 11) ratio of the correlations which is the "the mean value of the item correlations across constructs relative to the (geometric) mean of the average correlations for the items measuring the same construct" (Hair et al, 2019). HTMT should be lower than 0.90 for conceptually similar constructs and lower than 0.85 for conceptually different constructs (Hair et al, 2011) (Hair et al, 2019).

Table 5.7 Discriminant Validity - HTMT

	BI	CI	NPR	OC	OI	PEU	PU	TEN	TMS
BI									
CI	0.474								
NPR	0.496	0.552							
OC	0.365	0.221	0.395						

OI	0.396	0.321	0.29	0.412					
PEU	0.506	0.49	0.409	0.241	0.434				
PU	0.684	0.523	0.471	0.245	0.393	0.577			
TEN	0.279	0.176	0.235	0.681	0.543	0.245	0.175		
TMS	0.208	0.227	0.359	0.762	0.641	0.326	0.189	0.749	

Testing hypothesis

For the informative measurements p-value tests (Table 12) (Figure 6) were used where the p-value should be lower than 0.05 to be considered as a significant relationship.

Table 5.8 P- Values

	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (O/STDEV)	P Values
PU -> BI	0.489	0.485	0.061	8.041	0.00
PEU -> PU	0.37	0.361	0.059	6.316	0.00
CI -> PEU	0.316	0.325	0.088	3.604	0.00
CI -> PU	0.254	0.266	0.078	3.253	0.001
PEU -> BI	0.198	0.201	0.061	3.241	0.001
PEU -> OI	0.249	0.253	0.08	3.13	0.002
OC -> BI	0.256	0.253	0.09	2.83	0.005
NPR -> PU	0.153	0.144	0.064	2.39	0.017
TMS -> BI	-0.246	-0.237	0.105	2.345	0.019
NPR -> PEU	0.175	0.169	0.086	2.031	0.043
TEN -> BI	0.165	0.161	0.087	1.906	0.057

OC -> PU	0.153	0.164	0.087	1.763	0.079
TMS -> PEU	0.173	0.146	0.117	1.483	0.139
BI -> OI	0.15	0.151	0.107	1.399	0.163
TMS -> PU	-0.139	-0.142	0.12	1.166	0.244
PU -> OI	0.094	0.093	0.105	0.899	0.369
CI -> OI	0.078	0.067	0.098	0.791	0.43
TEN -> PEU	0.055	0.08	0.108	0.506	0.613
OC -> PEU	-0.036	-0.021	0.108	0.333	0.74
NPR -> OI	0.026	0.035	0.082	0.313	0.754
TEN -> PU	-0.011	-0.008	0.092	0.12	0.904

Summary of hypotheses testing (Table 5.9) (Figure 5.3)

Table 5.9 Hypotheses Testing Summary

Hypothesis	Path	Significance
H7a	Perceived Usefulness PU → Individual intention BI	Approved
H8	Perceived Ease of Use PEU → Perceived Usefulness PU	Approved
H5b	Competition within the industry CI → Perceived Ease of Use PEU	Approved
H6a	Perceived Ease of Use PEU → Individual intention BI	Approved
H5c	Competition within the industry CI → Perceived Usefulness PU	Approved
H6b	Perceived Ease of Use PEU → Organizational intention OI	Approved
H3a	Organizational culture OC → Individual intention BI.	Approved

H4c	The national policies and requirements NPR → Perceived Usefulness PU	Approved
H1a	Top management support → Individual intention BI.	Approved
H4b	The national policies and requirements NPR → Perceived Ease of Use PEU	Approved

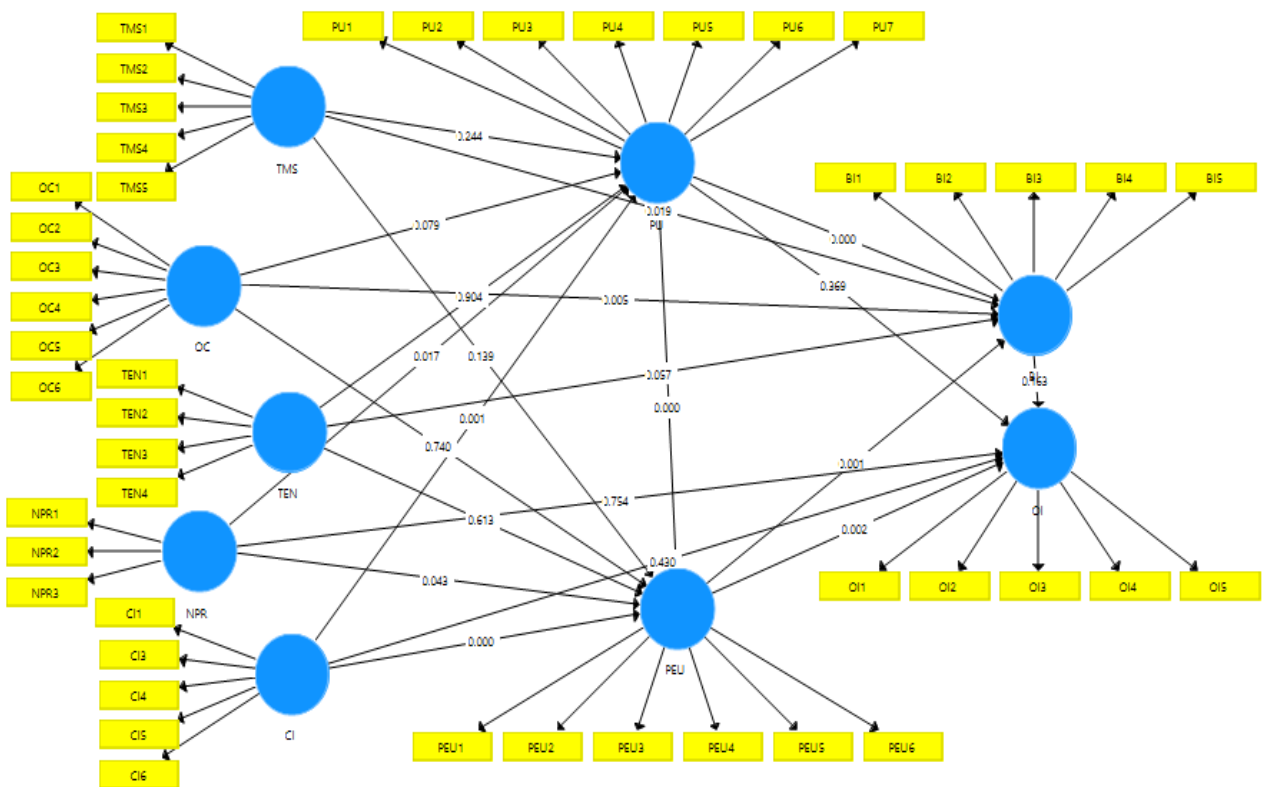


Figure 5.3 P-Value Shown on the Model

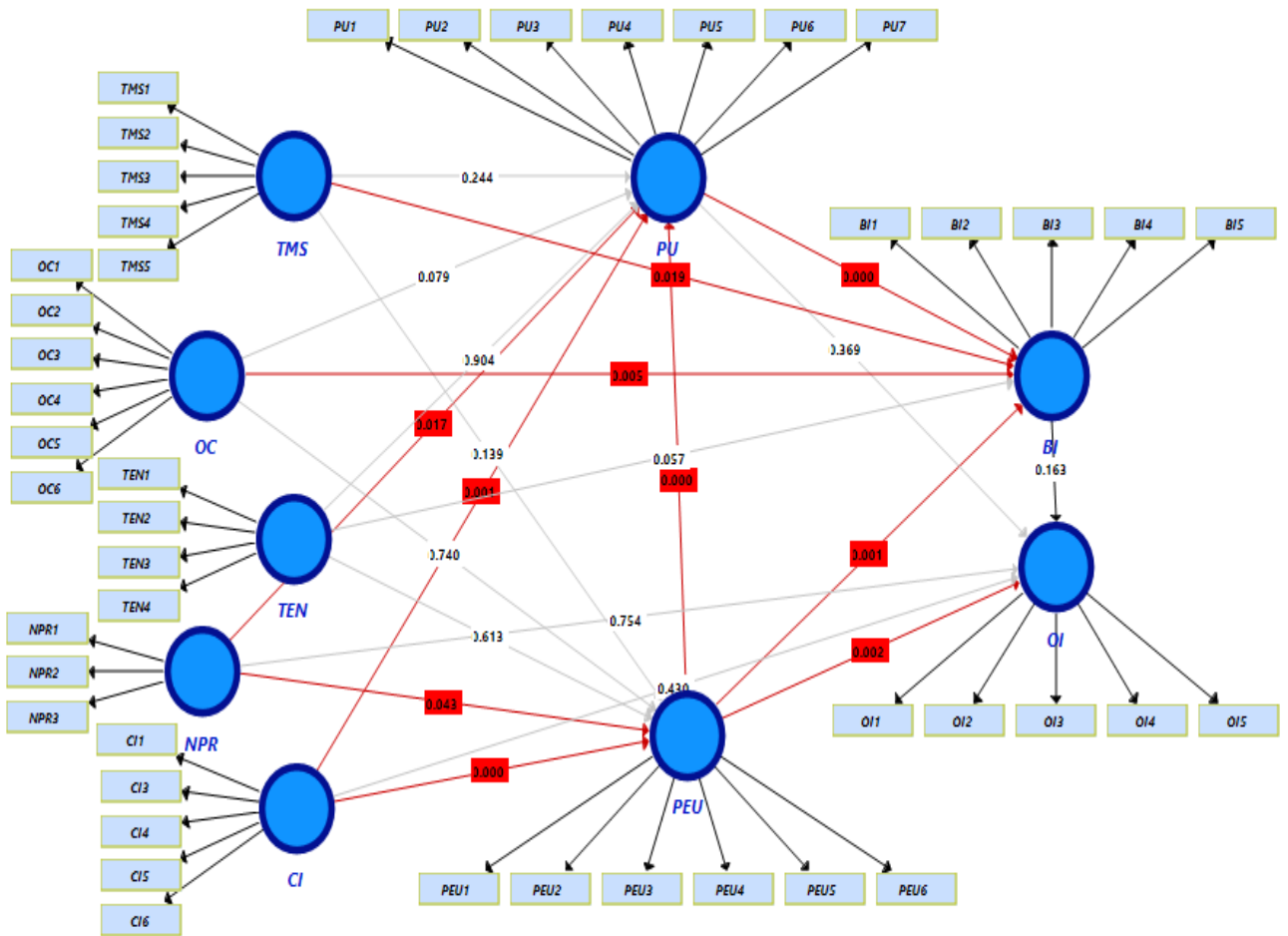


Figure 5.4 Path Testing

Stage Two: Structural Model Assessment

After making sure that every indicator represents its construct, this stage comes to examine the relationship between the constructs, thus the latent variables. The most basic test of the structural model is R^2 , the judgment on this value differs from one research to another (e.g. physical processes researches different than customers behaviors) but in this research the values of (0.75 - 0.51) are substantial, (0.50 - 0.26) are moderate, (less than 0.25) are weak. While R^2 measures the ability of the model to explain results, f^2 (Table 15) (Table 16) measures the effect size of the variable on a multivariate model, values (0.02-0.14) are small, (0.15- 0.34) are medium, greater than 0.35 are large effect size.

Another test is the assessment of the ability of the model to predict, for this purpose (Q^2) test (Table 17) is used; values greater than zero are meaningful, (0 -0.24) are small, (0.25-.49) are medium, higher than 0.50 are large predictive accuracy of the path model (Hair et al, 2011) (Hair et al, 2019).

1. Coefficient of Determination (R^2)

As shown in the (Table 14) (Figure 8), the results show that 47.6% change of Individual intention to adopt BIM can be explained by top management support, organizational culture, perceived ease of use and perceived usefulness.

However, the percentage of 20.4% change of organizational intention to adopt BIM can be explained by perceived ease of use only.

Moreover, 37.6% change of perceived usefulness can be predicted by the national policies and requirements, competition in the industry and perceived usefulness.

Finally, 24.9% of perceived ease of use can be predicted by the national policies and requirements and competition in the industry

Table 5.10 R Square Values

	R Square	R Square Adjusted	Judgment
BI	0.492	0.476	Moderate
OI	0.227	0.204	Weak
PU	0.398	0.376	Weak
PEU	0.272	0.249	Weak

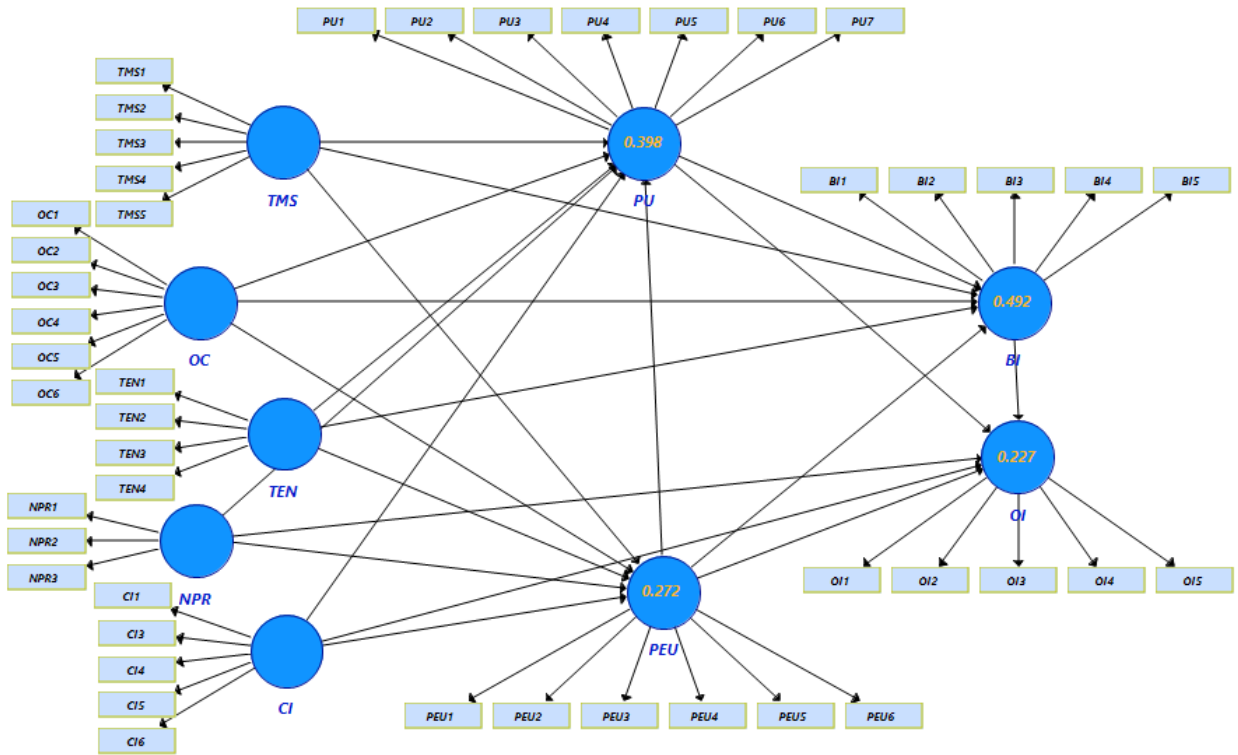


Figure 5.5 R Square Values

2. Effect Size (f^2)

Table 5.11 Effect Size

	BI	CI	NPR	OC	OI	PEU	PU	TEN	TMS
BI					0.015				
CI					0.005	0.099	0.071		
NPR					0.001	0.027	0.025		
OC	0.061					0.001	0.018		
OI									
PEU	0.051				0.052		0.165		
PU	0.328				0.006				
TEN	0.024					0.002	0		
TMS	0.045					0.015	0.012		

Summary of f^2 evaluation (Table 5.12)

Table 5.12 F^2 Evaluation

Path	f^2	Result
CI → PEU	0.099	Small
CI → PU	0.071	Small
NPR → PEU	0.027	Small
NPR → PU	0.025	Small
OC → BI	0.061	Small
PEU → BI	0.051	Small
PEU → OI	0.052	Small
PEU → PU	0.165	Medium
PU → BI	0.328	Almost High
TEN → BI	0.024	Small
TMS → BI	0.045	Small

3. Predictive Relevance (Q^2)

Table 5.13 Predictive Relevance (Q^2)

	SSO	SSE	$Q^2 (=1-SSE/SSO)$	Level of predictive accuracy
BI	840	541.962	0.355	Medium
PU	1176	893.02	0.241	Small
OI	840	692.819	0.175	Small
PEU	1008	855.452	0.151	Small

4. Goodness of fit:

Goodness of fit (GoF) measure was proposed by (Tenenhaus et al. 2005) and it is calculated by finding the square root of geometric mean of R^2 for endogenous constructs multiplied by the geometric mean of AVE in the PLS path modeling. GoF values should be between 0 and 1, where GoF is small between 0 and 0.1, GoF is medium between 0.1 and 0.25, and GoF is large when larger than 0.36 (Hair et al, 2011) (Hair et al, 2019).

Table 5.14 Goodness of Fit (GoF)

Construct	R^2	<i>AVE</i>
BI	0.476	0.767
CI		0.621
NPR		0.887
OC		0.603
OI	0.204	0.887
PEU	0.249	0.663
PU	0.376	0.642
TEN		0.838
TMS		0.855
Average	0.326	0.751

Using the equation:

$$GOF = \sqrt{((ave)R^2 \times (ave)AVE)}$$

Calculating the given GoF is 0.495, a large value as explained. This means that the sample data highly represents the actual population and can predict it.

5.3 Discussion

As presented in the previous chapters, this study aimed to investigate the factors that significantly affected the adoption of BIM technology in the Palestinian context.

The factors were divided into two categories: environmental and organizational factors, The environmental factors are the national policies and requirements (NPR) and competition within the industry (CI). On the other hand, the organizational factors are top management support (TMS), the number of BIM experts and technicians (TEN) and organizational culture (OC).

The external factors mentioned previously affected the adoption model that the researcher chose which is TAM - based that included the internal variables: Perceived Ease of Use, (PEU) Perceived Usefulness (PU), Behavioral intention (BI) and Organization intention (OI).

After testing the hypothesis, the study found significant correlations between the following:

1- The Relationship between the Internal Variables and the Intention of Acceptance

The results showed that Perceived Usefulness (PU) has one direct significant influence on the Individual intention (BI), whereas Perceived Ease of Use (PEU) has three direct significant influences on Perceived Usefulness (PU), Individual intention (BI) and Organizational intention (OI).

The results conformed with Qin et al.(2020) as they approved the significant relationship between Perceived Ease of Use PEU and Perceived Usefulness PU, in addition to their direct significant influence on the intention to use.

The direct relationship between Perceived Usefulness and Individual intention agreed with Lee et al. (2015). However, the article contradicted the results of this study in, the indirect relationship between Perceived Ease of Use and both of Individual intention and Organizational intention, since the relation is significant through Consensus on Appropriation, which is the level of agreement the individuals show to use advanced information technology.

2- The Relationship between the External Variables and the Intention of Acceptance

The results showed two significant direct relation between Organizational culture (OC) and Individual intention (BI), and Top Management Support (TMS) and Individual intention (BI).

On the other hand, there are four indirect significant relations between the intention of acceptance and both of the national polices and requirements (NPR) and competition within the industry (CI) through both Perceived Ease of Use (PEU) and Perceived Usefulness (PU).

These results were in contrast with Qin et al. (2020) where they approved the direct influence of the environmental factors (Requirements from national policies and Popularity of BIM in the industry). However, the organizational context variables (organizational mode and workflow, traditional thinking mode, top management support and number of BIM experts) have indirect influence on the intention to use BIM through the perceived ease of use only.

Moreover, competitions from other companies have direct influence on the intention to use BIM. Also, indirect influence through perceived ease of use.

Another recent article by Tavallaei et al. (2022) approved the positive relationship between institutional pressure and top management support on BIM adoption in the USA. The article investigated the difference influence on top management support in the engineering offices and construction companies. The finding indicated that top management support mediates the relationship between institutional pressure and BIM adoption, whereas, it has a direct influence on BIM adoption in the construction companies.

An article by Chen et al. (2019) in China approved the direct influence of the organizational factors especially top management support on the adoption decision, however, the environmental factors such as competitor's pressure and governmental pressure are not significant. The researchers indicated that the change in the Chinese construction industry stems from the firms' need for improvement and development rather than from external factors.

3- The Relationship between the External and Internal Variables

There are two external variables that the results approved significant relationships with them and the internal variables Perceived Ease of Use (PEU) and Perceived Usefulness (PU), they are the Competition within the industry (CI) and the national policies and requirements (NPR).

Thus, they affect the intention of acceptance indirectly through the internal variables.

The relationship between individual intention and organizational intention is not significant as the analysis approved.

This hypothesis agreed and disagreed with Lee et al. (2016) where the researchers made comparative research between the acceptance model in USA and South Korea and found out that the hypotheses was disapproved in the USA and approved in South Korea. Thus,

the acceptance of BIM should be based on individual recognition of the usefulness of BIM on their work.

Another study by Yuan et al. (2019) explained the significant relationship between national support and perceived usefulness, as the government support will reduce the cost of the technology by using subsidies also, will reduce the difficulty of spreading it among different organizations. Moreover, a study by Yuan & Yang (2020) proved that governmental subsidy can change the negative response of BIM adoption to a positive one.

Two studies implied that the role of government is a key factor in Palestine (Enshassi et al, 2016) and (Abu Hamra, 2015). In this study the national policies and requirements affect the acceptance process indirectly. That indicates that the government's role is significant in an indirect way, unlike the organizational factors.

5.4 Qualitative Analysis

1. Accessibility and BIM Adoption

The participant voices united in a clear and resonant chorus, unveiling a profound harmony between the revered Palestinian law of 1999, which stands as a steadfast advocate for the rights of individuals with disabilities, and the alluring domains of BIM adoption. In this symphony of perspectives, the integration of accessibility prerequisites within the expansive scope of BIM emerged as an essential and forward-moving trajectory, impeccably aligned with progressive values.

The marriage of accessibility mandates and the dynamic BIM framework was lauded not merely as a pragmatic step, but as a definitive stride towards a society that embraces inclusivity as a fundamental principle. This fusion of concepts not only caters to the

diversity inherent in the societal fabric but also charts a course towards crafting a built environment that embodies compassion, equity, and empathy.

As participants articulated their views, it became evident that this alignment isn't just a procedural match, but a convergence of ideologies that holds the potential to reshape the very foundations of architectural and construction practices. This profound synthesis promises to transcend the realm of compliance, evolving into a compassionate architectural paradigm that speaks to the needs and aspirations of all individuals, regardless of their abilities. In essence, the harmony between the tenets of the Palestinian law of 1999 and the innovative avenues opened by BIM underscores a journey of societal progress, where technology and empathy coalesce to create spaces that truly belong to everyone.

2. Earthquake Codes and BIM

Within the diverse tapestry of perspectives, a central motif came into focus - the intricate interplay between earthquake codes and the welcoming embrace of BIM. Amidst this varied chorus of voices, there were those who voiced a note of skepticism, casting doubt on a direct and unequivocal causal link. However, harmonizing within this rich spectrum were those who acknowledged a more harmonious resonance – the inherent synergy between these two realms.

The crescendo of discussions built around BIM's virtuosity in the realm of elevating structural analysis. As if painting a vivid musical picture, participants depicted BIM's artful simulations that skillfully captured seismic scenarios, offering a nuanced lens into the behavior of structures under duress. The potential for BIM to bolster the very

foundations of stability reverberated strongly, like the resonating notes of a well-tuned instrument.

In essence, while the path from earthquake codes to BIM may not be a straight line, the intertwining melodies of these concepts create a more intricate composition. BIM's ability to breathe life into structural assessments and its capacity to anticipate seismic challenges inject a new dimension of preparedness into architectural endeavors. The symphony of perspectives here is a reminder that progress is often composed of diverse notes, converging to craft a melody of innovation and resilience.

3. Amended Building Execution Law and BIM:

Within the intricate weaves of responses, the spotlight fell squarely on the amended 2019 law governing building execution and supervision. Amidst this vast panorama of insights, threads of optimism and caution were interwoven, creating a nuanced fabric of perspectives. The law itself, serving as a potential catalyst for the adoption of BIM practices, was greeted with approving nods. Yet, this canvas of opinions was far from monochromatic; it bore the brushstrokes of practicality in varying hues.

As the amended law took its place on this canvas, a vibrant interplay emerged. The potential of this legal framework to beckon the integration of BIM was met with hopeful enthusiasm. The law, in essence, stood as a guiding beacon for industry's evolution. Its presence was akin to a scene-stealer, drawing attention to a future where collaboration between regulation and technology thrives.

However, in this complex portrayal, realism also found its voice. While the stage was set for cooperation, the shadows cast by retrofitting challenges, considerations of cost-efficiency, and the nuances of project-specific demands prompted a more contemplative

stance. These shadows added depth to the narrative, reminding us that progress is often accompanied by practical hurdles that require thoughtful navigation.

In essence, the dialogue surrounding the amended building execution law and its interaction with BIM was not a simple monologue but a multifaceted conversation. It illustrated that the path to integration is not paved with certainty alone, but rather with a nuanced understanding of how aspirations align with practicality. This narrative speaks of the dynamic interplay between vision and reality, where a legal framework acts as a compass while practical considerations guide the journey.

4. Building Management System (BMS) and BIM

From the narrative's tapestry, a captivating tale unfurled—a tale that celebrated the seamless union of Building Management System (BMS) and Building Information Modeling (BIM), all nurtured under the guiding embrace of government motivation. This narrative resonated with a unanimous crescendo, akin to a symphonic movement, celebrating the integration of BMS and BIM propelled by government initiatives. This integration, like a skilled conductor, orchestrated harmonious notes that echoed with building management prowess.

The protagonists of this narrative, the voices of participants, spoke with a united vigor. They painted a vision where the marriage of BMS and BIM, orchestrated by government encouragement, stood as a catalyst for the adoption of advanced technologies. In this composition, streamlined maintenance and operational efficiency became the recurring motifs, creating an opera of optimized building management. As if composing a musical masterpiece, these voices harmonized to underscore the transformative potential that this integration brought forth.

As the curtain rose on this narrative, it revealed a landscape rich in promise and innovation. The storyline revolved around heightened competitiveness, where the fusion of BMS and BIM acted as a springboard for elevating industry standards. Collaborative notes rang out, painting a picture of cross-functional harmony that promised to bring architects, engineers, and facility managers into an exhilarating symphony of collaboration.

In essence, this narrative captured more than just the fusion of technologies; it illuminated a vision of orchestrated collaboration, where the government's guiding hand and technological prowess blended to create a harmonious melody of enhanced building management. Like a well-composed score, this tale sang of a future where innovation and government support entwined to shape a new chapter in the construction industry's journey.

5. Geographical Information System (GIS) and BIM

Amidst the diverse array of perspectives, a captivating narrative wove its way through the fabric - a narrative that unveiled the fascinating integration of Geographical Information System (GIS) and Building Information Modeling (BIM). Within this intricate tapestry, optimistic hues blended and swirled, reminiscent of a vivid painting capturing the symphonic fusion of geospatial prowess and BIM's robust architectural foundation.

As participants lent their voices to this narrative, the resonance of complementary capabilities reverberated strongly. The harmony created by merging the strengths of GIS and BIM empowered a new era of spatial analysis, urban planning, and project management. This dynamic synergy conjured a vision of a collaborative dance between geographic insights and architectural intricacies.

Yet, within this enchanting narrative, a whisper of caution lingered, offering a note of contemplation. The question of applicability across diverse scenarios cast a shadow, prompting a call for clarity in envisioning this fusion's practical outcomes. This spotlight on the nuanced interplay between GIS and BIM was a reminder that while the union of these technologies held immense promise, a deeper understanding of their adaptability and scope was essential.

In essence, the story of GIS and BIM was not just a tale of amalgamation, but a narrative of harmonious possibilities and prudent considerations. It unfolded as a dialogue between innovation and pragmatism, where the vibrant colors of optimism were tempered by the brushstrokes of thoughtful discernment. This narrative showcases the power of envisioning new frontiers while ensuring a solid foundation of understanding underpins each step forward.

Chapter Six

Conclusions and Recommendations For Further Studies

The researcher recommends to investigate the two significant external variables Organizational culture (OC) and Competition within the industry (CI), along with other external variables as the researcher chooses, and focus on their dimensions and scales ,moreover using second order SEM analysis or higher-order model.

Another variable that should be studied is the Consensus on Appropriation, which is the willingness of individuals of the organization to use new, advanced information technology, as a mediator between individual intention and organizational intention.

National policies and requirements constitute a major part of the environmental factors in the investigated model where it should be properly addressed. National policy refers to a broad course of action or statements of guidance, adopted by the government at the national level in pursuit of national objectives. Legislation, on the other hand, means the law or set of laws made by a government.

Also, choosing a qualitative study method is preferred. A sample of managers and employees of organizations that already use BIM will be more focused and straight to the point of the study. Moreover, qualitative studies are more able to confirm the findings of this study.

6.1 Limitations of Study

The researcher has key limitations that hinder the objectives of this study. These can be summarized by:

Firstly, the lack of research and studies that is available in the Palestinian context, the studies that are available investigated BIM from a very shallow perspective. Also, the available studies are conducted within the faculty of engineering; there is no mention of the administrative and planning perspective, unlike the international studies.

Secondly, the subject is relatively new in the world and certainly is in Palestine, the researcher found difficulty to collect data and actually find people who knows the technology and moreover people who uses it. Although BIM is instructed in Palestinian universities, the older generations' knowledge about it is lacked.

Thirdly, the rigidity of the construction industry of Palestine makes change very difficult and slow. The rigidity can be noticed in the material, the tools and machines used in the construction process. That affects the way these organizations perceived new technologies.

Fourthly, the suggested model is subjective; the selection of the external variables depends on the researcher's experience in the industry. There may be more significant variables that are recognized solely in the national or Palestinian context, that were not discussed in this study.

Fifthly, the lack of governmental interest in adopting new technology that's showed in the absence of policies and requirement that promote BIM adoption in consulting and construction firms, as in the UK, China and South Korea

6.2 Conclusions

There is rapid change in technology information field, that people have no doubts about its usefulness in their daily life. They frequently change appliances to get newer or more efficient ones. The decision to buy or not is almost individual and fast. Unlike the decision

an organization would take, organizational change needs discussion among the individuals and top management, also it needs to be considered in the strategic plan.

BIM is recently included as a subject in the undergraduate programs in the Palestinian universities, in the engineering faculties, that indicated its importance worldwide.

The BIM acceptance decision in Palestine is still vague, construction market is still using the same technologies for years.

Therefore, knowing the factors that are affecting the acceptance decision is a starting point to: promote the technology in the market, point out the factors that hinder its use and help in the planning for the acceptance decision.

The study used and integrated technology acceptance model (TAM) with external variables to examine the adoption patterns of the Palestinian market. Six external variables that affect the acceptance model were chosen, three of them were considered "organizational" which meant factors that internally affect the acceptance, and the other two are "environmental" which means factors that are connected to the environment that the organization is in, the external factors.

The study proved that TAM can be used to investigate the adoption patterns in the Palestinian construction industry. These findings can be summarized as:

- 1- The individual acceptance of BIM in the Palestinian construction market is affected by four factors which are: the top management support, the organizational culture, perceived ease of use and perceived usefulness.
- 2- The organizational acceptance of BIM in the Palestinian construction market is affected by perceived ease of use. The perceived ease of use is affected only by the national requirements and policies and competition within the industry.

- 3- BIM supporting policies and requirements of the governmental entities affect the perceived ease of use of BIM and the perceived usefulness. These two factors affect the adoption decision on the organizational level.
- 4- The increasing number of competitor companies using BIM in the market affects the perceived ease of use and the perceived usefulness of BIM. These two factors affect the adoption decision on the organizational level.
- 5- Individual BIM acceptance and adoption does not necessarily affect the adoption and acceptance on the organizational level.
- 6- The more the perceived ease of use is noticed or obtained the more the perceived usefulness of BIM.

The qualitative analysis revealed harmonized voices from the Palestinian construction industry. Participants who are already working in the field provided us with their unique perspective on BIM adoption.

Firstly, for the Palestinian law of 1999 which require the public and private buildings to be suitable for handicapped use, the participants show positive point of view on the fact that the law may encourage the BIM adoption.

Secondly, the code of earthquakes and BIM adoption had resonated with different voices, participants were both skeptic and recognized of the potential synergy between structural analysis and compliance.

Thirdly, the amended 2019 building execution law showcased both hope and practical contemplation, revealing the intricate balance between regulatory aspirations and real-world challenges.

Fourthly, the integration of Building Management System (BMS) and BIM emerged as a captivating shift in the participants' point of view, guided by the conductor of government

motivation. The collaboration between the two will lead to streamlined maintenance, heightened competitiveness, and more harmonious project governance.

Fifthly, the integration of Geographical Information System (GIS) and BIM contributed a dynamic element to the investigation, with visions of spatial analysis and urban planning harmonizing with cautionary undertones about adaptability across diverse scenarios.

Finally, as a summary of these diverse perspectives, responses underscore the complex interplay of regulations, technological advances, market forces, and industry evolution. The divergent voices illuminate the tapestry of factors that influence BIM adoption, revealing a rich yet deep understanding of the discourse about BIM within the Palestinian construction industry.

In closing, the qualitative analysis unveiled different insights and thoughtful considerations that shape the way change should work its way through the Palestinian construction industry.

6.3 Recommendations

The results confirmed the importance of the internal and external environments on the organization's adoption of BIM in the Palestinian context.

For the internal environment, we recommend:

- 1- Create an adequate organizational atmosphere for the employees to grow and improve by: supporting team work, encouraging employees to learn more, reducing risk on their work and ensure their job security.
- 2- Understand the high influence of top management support on BIM adoption decision.
- 3- Technology acceptance is a social feature, it needs to be discussed in an organizational context in order to adopt. The organization should include the

employees thoughts on BIM while planning on the adoption process, the individual acceptance is a key in the adoption process.

- 4- Facilitate the channels of knowledge and training of new technologies which could break the fear barriers of learning. Thus, this fear will be transformed to a challenge to master them.
- 5- Open new doors on the neglected usefulness of the new technologies, by building continuing learning unit with -separate budget to emphasis the seriousness- that is interested in searching new technologies and trying to encourage it to employees, also organizing training courses for them.

On the external environment level, we recommend:

- 1- Legalize policies and requirements that support BIM adoption. For that the governmental organizations could start encouraging using BIM in their construction tenders. As the role of national requirements and policies is significant, it would be encouraging for companies to start using it.
- 2- Support using BIM on big scale projects to reduce errors and clashes in the construction site. Big scale projects require qualified engineering team and it costs so much, so even small errors cost more than small projects do. Thus starting with them will build confidence in this technology and it usefulness in reducing clashes, though reducing cost.
- 3- Using BIM will give the company a competitive advantage in the market. This will encourage other competitors to use it. Most companies in our local market are on the same level regarding experience, executed projects and workflow method, so being one of few companies that uses this technology will help boost the companies'

reputation in the market, thus taking quality projects and increase benefit. Moreover, using this technology will reduce barriers to work as outsource design office as for example gulf countries attract such qualifications.

On the governmental level, we recommend:

We recommend the government and entities in decision making places to find a think tank for BIM adoption to discuss the insights and concerns of the consultant offices and organizations who work in the field and to put together a strategy that has gradual steps that led to a final complete adoption. As we noticed in the qualitative analysis, the participants were positive where the law is older and already been worked with, a little skeptical where the law is new and concerned where the integration with other technologies such as GIS and BMS is ambiguous.

References

- Ahmed, S. (2018). Barriers to implementation of building information modeling (BIM) to the construction industry: a review. *Journal of Civil Engineering and Construction*, 7(2), 107-113.
- AlKailani, M. (2016). Factors Affecting the Adoption of Internet Banking in Jordan: An Extended TAM Model. *Journal of Marketing Development and Competitiveness*, 10(1). Retrieved from <https://articlegateway.com/index.php/JMDC/article/view/1855>
- Al-Yami, A. and Sanni-Anibire, M.O. (2019), "BIM in the Saudi Arabian construction industry: state of the art, benefit and barriers", *International Journal of Building Pathology and Adaptation*, Vol. 39 No. 1, pp. 33-47.
- Azhar, S., Nadeem, A., Mok, J. Y., & Leung, B. H. (Aug., 2008). Building Information Modeling (BIM): A new paradigm for visual interactive modeling and simulation for construction projects. In *Proc., First International Conference on Construction in Developing Countries* (Vol. 1, pp. 435-46).
- Azhar, S., Khalfan, M., & Maqsood, T. (2012). Building information modeling (BIM): now and beyond. *Australasian Journal of Construction Economics and Building*, The, 12(4), 15-28.

Barlish, K., & Sullivan, K. (2012). How to measure the benefits of BIM — A case study approach. *Automation in Construction*, 24, 149–159. <https://doi.org/10.1016/j.autcon.2012.02.008>

Björk, B. C. (1989). Basic structure of a proposed building product model. *Computer-Aided Design*, 21(2), 71-78.

Chen, Y., Yin, Y., Browne, G. J., & Li, D. (2019). Adoption of building information modeling in Chinese construction industry. *Engineering, Construction and Architectural Management*. doi:10.1108/ecam-11-2017-0246

Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS quarterly*, 319-340.

Ding, Z., Zuo, J., Wu, J., & Wang, J. Y. (2015). Key factors for the BIM adoption by architects: A China study. *Engineering, Construction and Architectural Management*, 22(6), 732-748.

Eadie, R., Browne, M., Odeyinka, H., McKeown, C., & McNiff, S. (2013). BIM implementation throughout the UK construction project lifecycle: An analysis. *Automation in construction*, 36, 145-151.

Eadie, R., Browne, M., Odeyinka, H., McKeown, C., & McNiff, S. (2015). A survey of current status of and perceived changes required for BIM adoption in the UK. *Built Environment Project and Asset Management*.

- Eadie, R., Odeyinka, H., Browne, M., Mahon, C., & Yohanis, M. (2014). Building information modelling adoption: an analysis of the barriers of implementation. *Journal of Engineering and Architecture*, 2(1), 77-101.
- Eastman, C. (1976). General purpose building description systems. *Computer-Aided Design*, 8(1), 17-26.
- Eastman, C. M., & Siabiris, A. (1995). A generic building product model incorporating building type information. *Automation in construction*, 3(4), 283-304.
- Eastman, C. M., Eastman, C., Teicholz, P., Sacks, R., & Liston, K. (2011). *BIM handbook: A guide to building information modeling for owners, managers, designers, engineers and contractors*. John Wiley & Sons.
- Elghaish, F., Khalil, I., Al Raisi, A., & Lu, Y. (2022). Artificial intelligence-based voice assistant for BIM data management. *Automation in Construction*, 134, 103794.
- Enshassi, A. A., Hamra, L. A. A., & Alkilani, S. (2018). Studying the benefits of building information modeling (BIM) in architecture, engineering and construction (AEC) industry in the Gaza strip. *Jordan Journal of Civil Engineering*, 12(1).
- Enshassi, A., AbuHamra, L., & Mohamed, S. (2016). Barriers to implementation of building information modelling (BIM) in the Palestinian construction

industry. *International Journal of Construction Project Management*, 8(2), 103.

Enshassi, A., AbuHamra, L., & Mohamed, S. (2016). Barriers to implementation of building information modelling (BIM) in the palestinian construction industry. *International Journal of Construction Project Management*, 8(2), 103.

Evans, M., Farrell, P., Mashali, A., & Zewein, W. (2020). Critical success factors for adopting building information modelling (BIM) and lean construction practices on construction mega-projects: a Delphi survey. *Journal of Engineering, Design and Technology*, ahead-of-print(ahead-of-print). doi:10.1108/jedt-04-2020-0146

Gerçek, B., Tokdemir, O. B., İlal, M. E., & Günaydın, H. M. (2017). BIM execution process of construction companies for building projects.

Government construction strategy (2016-2020). Infrastructure and projects authority, the united kingdom government
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/510354/Government_Construction_Strategy_2016-20.pdf

Gu, N., & London, K. (2010). Understanding and facilitating BIM adoption in the AEC industry. *Automation in Construction*, 19(8), 988–999. <https://doi.org/10.1016/j.autcon.2010.09.002>

- Hair, J. F., Ringle, C. M., & Sarstedt, M. (2011). PLS-SEM: Indeed a silver bullet. *Journal of Marketing theory and Practice*, 19(2), 139-152.
- Hair, J. F., Risher, J. J., Sarstedt, M., & Ringle, C. M. (2019). When to use and how to report the results of PLS-SEM. *European business review*.
- Hartmann, T., Van Meerveld, H., Vossebeld, N., & Adriaanse, A. (2012). Aligning building information model tools and construction management methods. *Automation in Construction*, 22, 605–613. <https://doi.org/10.1016/j.autcon.2011.12.011>
- Hatem, W. A., Abd, A. M., & Abbas, N. N. (2018). Barriers of adoption Building Information Modeling (BIM) in construction projects of Iraq. *Engineering Journal*, 22(2), 59-81.
- Hong, Y., Hammad, A. W., Sepasgozar, S., & Akbarnezhad, A. (2018). BIM adoption model for small and medium construction organisations in Australia. *Engineering, Construction and Architectural Management*, 26(2), 154-183.
- Howard, H. C., Levitt, R. E., Paulson, B. C., Pohl, J. G., & Tatum, C. B. (1989). Computer integration: reducing fragmentation in AEC industry. *Journal of computing in civil engineering*, 3(1), 18-32.
- Ibrahim, H. S., Hashim, N., & Jamal, K. A. A. (2019, November). The Potential Benefits of Building Information Modelling (BIM) in Construction Industry. In IOP

Conference Series: Earth and Environmental Science (Vol. 385, No. 1, p. 012047). IOP Publishing.

Khrewesh, A. H. (2011). E-banking adoption model in Palestine (Doctoral dissertation).

Latiffi, A. A., Brahim, J., & Fathi, M. S. (2014). The development of building information modeling (BIM) definition. In *Applied Mechanics and Materials* (Vol. 567, pp. 625-630). Trans Tech Publications Ltd.

Latiffi, A. A., Mohd, S., & Rakiman, U. S. (2015, October). Potential improvement of building information modeling (BIM) implementation in Malaysian construction projects. In *IFIP International Conference on Product Lifecycle Management* (pp. 149-158). Springer, Cham.

Lee, S., & Yu, J. (2016). Comparative Study of BIM Acceptance between Korea and the United States. *Journal of Construction Engineering and Management*, 142(3), 05015016.

Lee, S., & Yu, J. (2017). Discriminant model of BIM acceptance readiness in a construction organization. *KSCE Journal of Civil Engineering*, 21(3), 555-564.

Lee, S., Yu, J., & Jeong, D. (2015). BIM Acceptance Model in Construction Organizations. *Journal of Management in Engineering*, 31(3), 04014048. doi:10.1061/(asce)me.1943-5479.0000252

- Liu, R., Issa, R. R. A., & Olbina, S. (2010, June). Factors influencing the adoption of building information modeling in the AEC Industry. In Proceedings of the international Conference on Computing in Civil and building Engineering (pp. 139-145).
- Ma, G., Jia, J., Ding, J., Shang, S., & Jiang, S. (2019). Interpretive structural model based factor analysis of BIM adoption in Chinese construction organizations. *Sustainability*, 11(7), 1982.
- Mahdi, H. R. (2014). Investigating Students' Acceptance and Self-Efficacy of E-Learning at Al-Aqsa University Based On TAM Model. *International Journal of Web-Based Learning and Teaching Technologies (IJWLTT)*, 9(3), 37-52.
- Manzoor, B., Othman, I., & Pomares, J. C. (2021). Digital technologies in the architecture, engineering and construction (Aec) industry—a bibliometric—qualitative literature review of research activities. *International journal of environmental research and public health*, 18(11), 6135.
- McCoy, S., Galletta, D. F., & King, W. R. (2007). Applying TAM across cultures: the need for caution. *European Journal of Information Systems*, 16(1), 81-90.
- Miyatake, Y., & Kangari, R. (1993). Experiencing computer integrated construction. *Journal of Construction Engineering and Management*, 119(2), 307-322.

- Mom, M., Tsai, M., & Hsieh, S. (2014). Developing critical success factors for the assessment of BIM technology adoption: Part II. Analysis and results. *Journal of the Chinese Institute of Engineers*, 37(7), 859–868. <https://doi.org/10.1080/02533839.2014.888798>
- Newton, K., & Chileshe, N. (2012). Awareness, usage and benefits of building information modelling (BIM) adoption—the case of the South Australian construction organisations. *Management*, 3, 12.
- NIBS (National Institute of Building Sciences). (2007). United States national building information modeling standard, version 1—Part 1: Overview, principles, and methodologies.
- Qin, X., Shi, Y. ., Lyu, K. ., & Mo, Y. . (2020). Using a TAM-TOE model to explore factors of Building Information Modelling (BIM) adoption in the construction industry. *Journal of Civil Engineering and Management*, 26(3), 259-277. <https://doi.org/10.3846/jcem.2020.12176>
- Rabayah, K. (2013). Adoption Patterns of Information and Communication Technologies by enterprises in developing countries (Case study Palestine).
- Ramírez-Sáenz, J. A., Gómez-Sánchez, J. M., Tienda, J. L. P., Cortés, J. P. R., & Bucheli, L. G. (2018). Requirements for a BIM execution plan (BEP): a proposal for application in Colombia= Requisitos para un plan de ejecución de BIM (BEP): propuesta de aplicación en Colombia. *Building & Management*, 2(2), 5-14.

- Rogers, E. M. (1995). Diffusion of Innovations: Modifications of a Model for Telecommunications. *Die Diffusion von Innovationen in Der Telekommunikation*, 25–38. doi:10.1007/978-3-642-79868-9_2
- Rose, G., & Straub, D. (1998). Predicting general IT use: Applying TAM to the Arabic world. *Journal of Global Information Management (JGIM)*, 6(3), 39-46.
- Sanchís Pedregosa, C., Vizcarra Aparicio, J.M. y Leal Rodríguez, A.L. (2020). BIM: a technology acceptance model in Peru. *Journal of Information Technology in Construction*, 25, 99-108.
- Strug, B., & Ślusarczyk, G. (2017). Reasoning about accessibility for disabled using building graph models based on BIM/IFC. *Automation in Construction*, 81, 273-283.
- Succar, B., & Kassem, M. (2015). Macro-BIM adoption: Conceptual structures. *Automation in Construction*, 57, 64–79. <https://doi.org/10.1016/j.autcon.2015.04.018>
- Tavallaei, R., Mashayekhi, A., Harrison, N., Talebian, M., & Moser, R. (2022). BIM Adoption: A Case of Institutional Pressures and Top Management Support. *Journal of Construction Engineering and Management*, 148(9), 04022084.
- Tenenhaus, M., Vinzi, V. E., Chatelin, Y. M., & Lauro, C. (2005). PLS path modeling. *Computational statistics & data analysis*, 48(1), 159-205.

- Tulenheimo, R. (2015). Challenges of implementing new technologies in the world of BIM–Case study from construction engineering industry in Finland. *Procedia Economics and Finance*, 21, 469-477.
- Tulubas Gokuc, Y., & Arditi, D. (2017). Adoption of BIM in architectural design firms. *Architectural Science Review*, 60(6), 483-492.
- Türkyılmaz, E. (2016). A Method to Analyze the Living Spaces of Wheelchair Users Using IFC. *Procedia Computer Science*, 102, 204-209.
- Ullah, K., Raitviir, C., Lill, I., & Witt, E. (2020). BIM ADOPTION IN THE AEC/FM INDUSTRY – THE CASE FOR ISSUING BUILDING PERMITS. *International Journal of Strategic Property Management*, 24(6), 400-413. <https://doi.org/10.3846/ijspm.2020.13676>
- Venkatesh, V., & Davis, F. D. (2000). A theoretical extension of the technology acceptance model: Four longitudinal field studies. *Management science*, 46(2), 186-204.
- Weippert, A., & Kajewski, S. (2004). AEC industry culture: a need for change. In *CIB World Building Congress 2004: Building for the Future* (pp. 1-10). CIB (International Council for Research and Innovation Building and Construction).

Yuan, H., & Yang, Y. (2020). BIM adoption under government subsidy: technology diffusion perspective. *Journal of Construction Engineering and Management*, 146(1), 04019089.

Yuan, H., Yang, Y., & Xue, X. (2019). Promoting owners' BIM adoption behaviors to achieve sustainable project management. *Sustainability*, 11(14), 3905.

. (1 B.C.E.). In *Ministry of Labor*. Ministry of *تقرير سنوي: تحليل واقع سوق العمل الفلسطيني*.
 Labor. Retrieved January 1, 2022,
 from <https://www.mol.pna.ps/uploads/REPORTS/16919147680.pdf>

عبد الله، سمير. (2018). نقص و فجوة المهارات في قطاع البناء و الإنشاءات في الأراضي الفلسطينية.

. (n.d.). MAS. <https://mas.ps/publications/8927.html> 72 *المراقب الاقتصادي العدد*

نقابة المهندسين- مركز القدس 2016 دراسة حول حاجة السوق للتخصصات الهندسية معدلات البطالة ومعدلات
 الدخل للمهندسين، اعداد دائرة التدريب والتشغيل

Appendices

استبيان بخصوص أساليب تبني تكنولوجيا نمذجة معلومات المباني BIM في قطاع الانشاءات
المعلومات الواردة في الاستبيان سيتم التعامل معها بسرية تامة ولن تستخدم الا لأغراض البحث
العلمي. شاكرين لكم حسن تعاونكم

الرمز	السؤال
Gender	<input type="checkbox"/> ذكر <input type="checkbox"/> أنثى
Profession	<input type="checkbox"/> مهندس معماري <input type="checkbox"/> مهندس مدني <input type="checkbox"/> مهندس ميكانيك <input type="checkbox"/> مهندس كهرباء
Position	<input type="checkbox"/> ادارة عليا / صاحب مكتب هندسي <input type="checkbox"/> مهندس تصميم <input type="checkbox"/> مهندس موقع
YrsExperience	سنوات الخبرة:
SciDegree	الدرجة العلمية: <input type="checkbox"/> دبلوم <input type="checkbox"/> بكالوريوس <input type="checkbox"/> ماجستير <input type="checkbox"/> دكتوراة <input type="checkbox"/> بلا
Region	مكان العمل : <input type="checkbox"/> القدس <input type="checkbox"/> رام الله <input type="checkbox"/> الخليل <input type="checkbox"/> بيت لحم <input type="checkbox"/> أريحا <input type="checkbox"/> نابلس <input type="checkbox"/> جنين <input type="checkbox"/> طوباس <input type="checkbox"/> طولكرم <input type="checkbox"/> قلقيلية <input type="checkbox"/> سلفيت
NoEmployees	عدد الموظفين في المؤسسة:
WorkDomain	مجال العمل: <input type="checkbox"/> أبنية <input type="checkbox"/> طرق <input type="checkbox"/> مياه ومجاري <input type="checkbox"/> تخطيط وتنظيم المدن <input type="checkbox"/> أخرى
UsedProg	استخدم البرامج الهندسية التالية في عملي: AutoCad <input type="checkbox"/> Revit <input type="checkbox"/> SAP <input type="checkbox"/> ETABS <input type="checkbox"/> CIVIL 3D <input type="checkbox"/> STAAD.Pro <input type="checkbox"/> Safe <input type="checkbox"/> tekla structures <input type="checkbox"/> WaterCad <input type="checkbox"/>

<p style="text-align: center;"> SewerCad ○ StormCad ○ PLANSWIFT ○ Primavera ○ Autodesk Robot Structural Analysis Pro ○ MS Project ○ ETAP ○ PLC ○ SolidWorks ○ MatLab ○ D MAX3 ○ Archicad ○ </p>	
<p style="text-align: center;"> هل تستخدم تطبيق ال BIM -نعم - لا </p>	BIMUsing
<p style="text-align: center;"> إذا كانت الإجابة بنعم، كم مدة استخدامك له: </p>	
<p style="text-align: center;"> إذا كانت الإجابة بلا، فما هو السبب (اختر كل ما ينطبق على شركتكم): - لا اعرف التكنولوجيا ولم اسمع به - التكلفة العالية - عدم توفر الكفاءات لاستخدامها - لم ينصحتي احد بأستخدامه - المشاريع التي انفذها لا تتطلب استخدامه - ليس لدينا الوقت الكافي لتعلم التطبيق - لا حاجة لنا به </p>	

الفائدة المتوقعة من استخدام تطبيقات ال BIM

حسب معرفتك بتطبيق ال BIM و في حالة قمتم باستخدام تطبيق ال BIM ما هي الفائدة المتوقعة من استخدامه

Perceived usefulness

الرمز	البند	أوا	أوا	أوافق	محا	أعار	أعار	أعار
		فق	فق	لحد	يد	لحد	ض	ض
		بشده	بشده	ما		ما		بشده
PU1	سيسهل التنسيق بين اطراف المشروع والعاملين به							
PU2	سيقلل الوقت اللازم لانجاز المهام							
PU3	سيزيد من الدقة في انجاز المهام							
PU4	سيزيد من سرعة اجراء التعديلات على التصميم							
PU5	سيزيد من سهولة تصور وفهم المشروع قبل البدء بالتنفيذ							
PU6	سيقلل عنصر المخاطرة							
PU7	سيقلل من التكلفة المشروع							
-PU8	سيعمل على تعقيد عملية التخطيط للمشروع							

السهولة المتوقعة : Perceived ease of use حسب معرفتك بتطبيق ال BIM ما هو
مستوى السهولة المتوقعة

الرمز	البند	أوافق بشده	أوافق ق	أوافق لحد ما	محايد	أعارض لحد ما	أعارض بشده
PEU3	من السهل استخدام BIM						
PEU1	من السهل تعلم BIM						
PEU2	من السهولة تبادل المعلومات بين اطراف المشروع عند استخدام BIM						
PEU4	التفاعل مع BIM سهل وواضح						
PEU5	النظام مرن للتفاعل معه						
PEU6	من السهل ان تصبح ماهرا باستخدام التطبيق						

النية لاستخدام BIM : Behavioural intention to use BIM

الرجاء الإجابة على الأسئلة التالية لتحديد مدى الاستعداد لاستخدام تطبيق ال BIM

الرمز	البند	أوافق بشده	أوافق لحد ما	أوافق	محايد	أعارض لحد ما	أعارض بشده
BI1	لدي النية لاستخدام BIM في انجاز المهام المطلوبة						
BI2	لدي النية لتشجيع زملائي على استخدام BIM						
BI3	لدي النية لتكريس وقت لتعلم استخدام BIM						

							لدي النية لتطوير مهاراتي واحتراف استخدام BIM	BI4
							لدي اهتمام بالمشاريع والمؤسسات التي تستخدم BIM	BI5

النية المؤسساتية لاستخدام BIM Organizational intention of BIM

acceptance:

الرمز	البند	أوافق بشده	أوافق	أوافق لحد ما	محايد	أعارض لحد ما	أعارض بشده
OI1	مؤسستي تدعم وتشجع استخدام BIM						
OI2	مؤسستي تشجع العمل في المشاريع التي تتطلب استخدام BIM						
OI3	مؤسستي تشجع المؤسسات الشريكة والمتعاونة معها على استخدام BIM						
OI4	لدى مؤسستي النية لتبني استخدام BIM						
OI5	لدى مؤسستي النية لتطوير وتحسين استخدامها لـ BIM						

مستوى دعم الإدارات العليا Top management support

الرمز	البند	أوافق بشده	أوافق	أوافق لحد ما	محايد	أعارض لحد ما	أعارض بشده
TMS1	مؤسستي توفر المصادر الكافية لاستخدام BIM						
TMS2	مؤسستي تزودنا بالتدريب اللازم لاستخدام BIM						
TMS3	مؤسستي تشجعنا لتعلم استخدام BIM						
TMS4	مؤسستي تقدم الحوافز لمستخدمين BIM						
TMS5	مؤسستي تؤمن بجدوى استخدام BIM						

المهارات والخبرات اللازمة Technical Expertise needed

الرمز	البند	أوافق بشده	أوافق	أوافق لحد ما	محايد	أعارض لحد ما	أعارض بشده
TEN1	يوجد تدريب كافي من قبل المؤسسة لاستخدام BIM بمهارة						
TEN 2	توفر المؤسسة رأس المال الكافي لتوفير الادوات والاجهزة اللازمة لاستخدام BIM						
TEN 3	يوجد عدد كافي من الخبراء في استخدام BIM في المؤسسة						
TEN 4	يدعم لخبراء BIM في المؤسسة باقي أعضاء الفريق لاستخدامه واحترافه						

الثقافة المؤسسية **Organizational culture**

الرمز	البند	أوافق بشده	أوافق	أوافق لحد ما	محايد	أعارض لحد ما	أعارض بشده
OC1	تعتمد مؤسستي نظام العمل ضمن فرق وكل قائد عليه مسؤوليه أمام الادارات العليا						
OC2	قرار استخدام BIM هو قرار من الادارات العليا وليس قرار فردي						
OC3	تدعم مؤسستي الاستخدام الفردي وتبادل الخبرات به بين الافراد						
OC4	مؤسستي تدرس استخدام BIM من كافة النواحي لتقليل الخطر						
OC5	تهتم مؤسستي بتدريب الموظفين والاستثمار بهم						
OC6	تهتم مؤسستي بالعقود طويلة الامد مع موظفيها						

العوامل البيئية Environmental Factors

المنافسة في القطاع Competition within the industry

الرمز	البند	أوافق بشده	أوافق	أوافق لحد ما	محايد	أعارض لحد ما	أعارض بشده
CI1	استخدام ال BIM سيسهل على المؤسسة المنافسة في سوق العمل						
CI2	اغلب الشركات المنافسة تستخدم ال BIM في تنفيذ مشاريعها						
CI3	الشركات التي تستخدم ال BIM تحصل على عقود عمل أفضل						
CI4	الشركات التي تستخدم ال BIM لديها سمعة أفضل في سوق العمل						
CI5	استخدام BIM سوف يوفر ميزة تنافسية للمؤسسة						
CI6	استخدام BIM سوف يجعل طاقم المؤسسة أكثر قدرة على المنافسة						

السياسات الوطنية والمتطلبات The national polices and requirements

الرمز	البند	أوافق بشده	أوافق	أوافق لحد ما	محايد	أعارض لحد ما	أعارض بشده
NPR1	استخدام الحكومة ل BIM في مشاريعها سوف يجعل استخدامه من قبل المؤسسات أكثر						
NPR2	تشريع متطلبات استخدام BIM في وثائق الترخيص سيساعد على استخدامه						
NPR3	تشريع متطلبات استخدام BIM في وثائق العطاء سيساعد على استخدامه						

الأسئلة الخاصة بالجزء الكمية من عملية جمع المعاومات وتحليلها

- 1- هل القانون الفلسطيني لعام 1999 والخاص بذوي الإعاقة وحقهم في توفير أبنية وخدمات لوجستية سيُسلمهم ويشجع مستخدمي BIM في تنفيذ القانون على أرض الواقع؟
- 2- هل تبني "كود الزلازل" للأبنية الحكومية والعامّة من قبل الحكومة ونقابة المهندسين سيسهم في إلزام المؤسسات باستخدام تقنية BIM ؟
- 3- هل النظام المعدل لتنفيذ المباني والإشراف عليها لعام 2019 سيسهم في تفعيل الإشراف الهندسي باستخدام BIM في المؤسسات؟
- 4- هل تحفيز الحكومة لتكامل تقنية نظام إدارة المباني (Building Management System) مع BIM سيُشجع استخدامها من قبل المؤسسات؟
- 5- هل تحفيز الحكومة لتكامل تقنية نظام المعلومات الجغرافية (Geographical Information System) مع BIM سيُشجع استخدامها من قبل المؤسسات؟

الملخص

نمذجة معلومات البناء (BIM) هي تقنية/برنامج حديث نسبيًا تم اعتماده في صناعة الهندسة المعمارية والهندسة والبناء (AEC) في جميع أنحاء العالم. يقوم BIM بتصوير المباني وجميع الأعمال/الجهات المعنية المشاركة في المشروع افتراضيًا. يمكن للمهندسين إضافة طبقات من البيانات باستمرار إلى النموذج لتعديله/تحسينه وتجنب التعارضات في المراحل المبكرة من المشروع. سيضيف دمج هذه التقنية في السوق الفلسطينية بكفاءة وفعالية قيمة تنافسية للمتبنين في الأسواق المحلية والدولية. وقد أثبت العديد من الباحثين أن تطبيق هذه التقنية من قبل صناعة الهندسة المعمارية والهندسة والبناء (AEC) سيحسن جودة المنتج النهائي ويزيد من فعالية وكفاءة إدارة مشاريعها. يمكن تحقيق ذلك بفضل قدرة تقنية برنامج BIM على إضافة طبقات بيانات التكلفة والوقت إلى النموذج وتقليل تكلفة المشروع من خلال إصلاح التعارضات المحتملة قبل حدوثها في مواقع البناء، حيث توفر فوائد محتملة.

في فلسطين، استُخدمت هذه التقنية في مشاريع كبيرة من قبل عدد قليل من شركات الهندسة والإنشاءات الصناعية. وقد أوضحت الدراسات في السياق الفلسطيني عوائق تطبيق هذه التقنية على النحو التالي: عدم اهتمام العملاء والأطراف المتعاقدة الأخرى، وتكلفة تبني التقنيات الجديدة، وثقافة المؤسسة التي تقاوم التغيير، ونقص المعرفة بالتقنية.

تبحث هذه الدراسة في أنماط تبني نمذجة معلومات البناء (BIM) في السوق المحلية، مع التركيز، أولاً، على الأدلة التجريبية للعوامل المهمة التي تؤثر عملياً على عملية التبني، وثانياً، توفير نقطة انطلاق لتغيير سير العمل، مما يساعد المؤسسة على تخطيط استراتيجياتها وأهدافها المستقبلية المخصصة.

أجرى الباحث منهجاً بحثياً كمياً. تم توزيع استبيان إلكتروني على 168 مكتباً استشارياً هندسياً محلياً. تم تحليل البيانات التي تم جمعها بواسطة برنامج SMART-PLS باستخدام تقنية نمذجة المعادلات الهيكلية للمربعات الجزئية الصغرى (SEM-PLS).

أثبتت النتائج أن العوامل التنظيمية، مثل دعم الإدارة العليا، والثقافة التنظيمية، وعدد الخبراء والفنيين، تؤثر بشكل مباشر على نية الأفراد لتبني نمذجة معلومات البناء (BIM). من ناحية أخرى، أثرت العوامل البيئية، مثل السياسات والمتطلبات الوطنية، والمنافسة داخل الصناعة،

بشكل غير مباشر على نية الأفراد لتبني نمذجة معلومات البناء (BIM)، من خلال سهولة الاستخدام المُدرَكة وفائدتها المُدرَكة. أكدت هذه النتائج على الدور الحيوي للإدارة العليا في توفير بيئة داعمة لتبني التقنيات الجديدة. علاوة على ذلك، تُعدّ الثقافة التنظيمية التعاونية والمرنة والشاملة البيئة الأنسب لتشجيع تبني التقنيات الجديدة.

الكلمات المفتاحية: نمذجة معلومات البناء (BIM)، الثقافة التنظيمية، دعم الإدارة العليا، صناعة الهندسة المعمارية والإنشاءات (AEC، SEM-PLS).