Impact Of Building Information Modeling on Design and Construction Firms in Arab Gulf Region (Public Building of Iraq as Case Study)

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ABSTRACT

The impact of building information modelling (BIM) on construction methods and architectural design in the Arab Gulf region is examined in this research. It is essential to deal with the difficulties brought on by this development given the rapidly increasing population in the area and the accompanying needs. The study focuses on Gulf BIM clients' utilization of BIM tools, primarily Autodesk Revit. According to the research, 70% of architects and building industry experts use Autodesk Revit. Additionally, 45% of businesses use information sharing to improve design cooperation and guarantee verifiable results through organized and reusable digital commerce. Additionally, 56% of businesses let staff members to change shared models, which improves collaborative workflows. Notably, 3D perspective views are extensively used in Arab Gulf public building plans to understand spatial arrangements and constraints. BIM implementation makes it easier to organize designs, lowering errors and disagreements while speeding up planning procedures in Gulf nations. Comparing actual and projected timelines is made possible by using visual scheduling tools for construction, which also makes earned value analysis and effective resource management possible. These developments in BIM technology help governments in the Gulf area handle architectural design processes with varied partners more effectively.

Keywords: Bim, Building Construction, Arab Gulf, Technology, Autodesk Revit.

1. Introduction

An industry that requires a lot of labour and hasn't changed much in hundreds of years is construction. A building project typically starts with drawings and specifications that architects and engineers deliver to the owners or clients of the proposed project in order to ensure that the submitted design is free from errors and problems. After that, the project is handed off to the general contractor, and once he receives the project's documents and drawings, a relationship between the contractor, the engineer, and the architect is established. Typically, this connection is limited and remote. Any alterations or discrepancies in the right designs are often communicated through a protracted process of paperwork to a contractual deadline for each information request. Because of the intricate communication system and the time lag between responses from the two sides, this can decrease productivity, drive up expenses, and degrade the quality of the work. The technology between the architects/engineers (A/E) and contractors has advanced significantly, but information is still frequently shared between the two on paper using a two-dimensional (2D) representation. Because the architect or engineer presents the plans or drawings in a two-dimensional format that results from an imagination of a three-dimensional for the contractor or builder, who in turn builds on the imaginary capabilities of this form, there is a loss of importance of the perfect communication of the information transferred from the architect or engineer to the general contractor as a result.

Population growth and the need for infrastructure development have propelled the growth of the construction sector in the Arab Gulf. Rising sea levels, seasonal fluctuations, a lack of water, and greenhouse gas emissions are all effects of this rapid growth and increased energy usage. Furthermore, the International Energy Agency (IEA) predicts a 30% increase in energy demand by 2030, particularly in emerging nations like those in the Gulf region. This highlights the significance of fostering a more effective and productive business environment in order to achieve the best results and capabilities for this number of projects [1].

The engineer, architect, and contractor must take advantage of technological advancements in the construction and design industries and work to address the aforementioned issue in order to meet the growing infrastructure demand in the Gulf countries. Engineers are thus encouraged to create novel ideas for environmentally friendly and energy-efficient structures [2].

BIM is a system that unifies all of a structure's virtual attributes, ideas, and operations in a single setting. It makes it possible to produce a digital model that contains all necessary information from the design stage to the actual transfer [3].

Before a building is built, architects, engineers, and customers can see and understand it. BIM also makes it easier to include sustainable practices throughout the building's lifecycle. Due to their ability to create plans, sections, and elevations and immediately alter the papers as a result of these changes, architects and engineers have a significant degree of creative flexibility. Reduced radio interference will lead to reduced coordination problems, which will boost throughput. The general contractor on site must be familiar with the program in order to advise architects and engineers on unforeseen field conditions. This will decrease wasted time on the project site and boost the effectiveness and productivity of construction activity. BIM is usually suggested as a solution, but there are challenges, particularly with regard to energy efficiency. The lack of ecologically sustainable design in Gulf nations has not been sufficiently addressed by the use of BIM [4].

This article examines the potential of BIM and identifies additional strategies to accomplish environmentally sustainable practices in an effort to address the issues related to productivity issues in design and construction organizations. By doing this, we may aid in the Gulf region's transition to ecologically responsible and energy-efficient construction.

2. Methods

2.1 Research Design

A questionnaire was based on present status of BIM and its effect on design process and construction technology of public buildings in context of Iraqi construction industry. During the information approval process, the appropriate responses gathered from the survey were analysed for accuracy and appropriateness with regard to the purpose of this study.

2.2 Data Collection

Information about the research subjects was gathered from any and all relevant sources. Two different methods for collecting the data were used. A secondary qualitative data collection method was used for this research, and in order to get the questions and factors prepared, primary data was gathered through questionnaire survey which were distributed toward project owners, project managers, architects and contractors.

2.3 Design of Questionnaire Survey

The questionnaire was divided into following portions to accomplish the aim of this Research

• Personal Profile

• The second portion (The primary survey) consisted of the following parts

1. Current status of BIM
2. Impacts of BIM in design process and Construction technology

2.4 Sample Size

The sample size for this study was 100 people, carefully selected from the Iraqi construction sector. This sample focuses on persons with expertise working especially on public structures in Iraq. Participants come from a variety of backgrounds, including project managers, architects, contractors, and engineers.

2.5 Data Analysis

The data that was collected were examined using. Cronbach's Alpha, Microsoft Excel and the (SPSS) for the purposes of this investigation. These materials are beneficial to us, and their implementations are not restricted in any way by the authorization of the researcher, dissemination date, type of gathering, information about the research, development in case study, and so on. Descriptive statistics, the ranking procedure, and factor analysis were the research approaches that were used.

3. DATA Collection & Analysis

3.1 Determination OF RELIABILITY test

Reliability for the identified factors was calculated by the software SPSS through Cronbach Alpha Method. Cronbach's alpha measures the degree of consistency within a group of test items. Obtained values from Cronbach alpha ranges from 0 to 1, 0.70 and above 0.7 indicates acceptable level of reliability above 0.80 to 0.94 indicates very good level reliability, 0.95 or above 0.95 indicates redundancy. For this study, the value of the cornbach alpha coefficient was found to be 0.813 for BIM Impact factors on the Design process for the public building of Arab gulf region construction sector shown in table 4.2.1 and 0.702 for BIM Impact factor on the Construction technology in public building of Iraqi construction sector shown in table 4.2.2.

3.2 General information of Survey

General details on the questioner survey form included elements like the sort of company, years of expertise in the building industry, degree of schooling, etc. The charts and diagrams below display the findings in relation to the basic information.

3.2.1 Designation of Respondents

The questionnaire survey was conducted to 100 responses. Out of these 31 respondents were Civil Engineer, 24 were contractors, 18 were project managers, 24 were architects and 3 respondent had other background.

Table 1: Position in the Organization

Sr. No	Position in the Organization	Frequency
1	Engineer	31
2	Contractor	24
3	Manager	18
4	Architect	24
5	Other	3
Total		100

Figure 1: position in the organization

3.2.2 Experience of respondents

The respondents had different years of experience in their fields. Most of them had experience of more than 10 years. In short, 22 respondents had experience between 1 and 5 years, 17 had experience between 6 and 10 years, 27 had between 11 and 15 years, 16 respondents had experience between 16 and 20 years, 11 respondents had experience in their fields between 21 and 25 years and only 7 respondents had experience of more than 25 years. Indeed, 61% respondents had experience of more than 10 years.

Table 2: Years of experience

Sr. No	Years of experience	Frequency
1	1-5 years	22
2	6-10 years	17
3	11-15 years	27
4	16-20 years	16
5	21-25 years	11
6	more than 25 years	7
Total		100

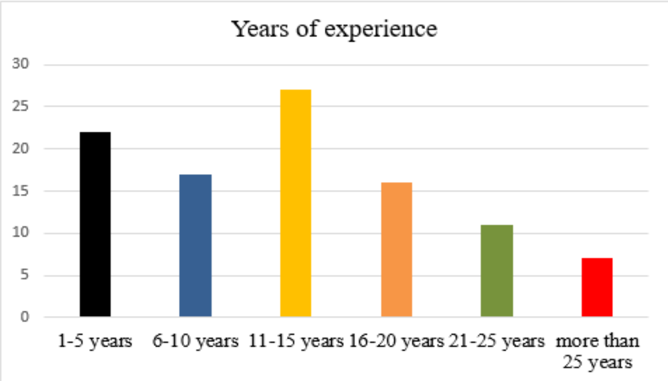

Figure 2: Years of experience

3.2.3 Number of years Respondents using BIM

The respondents had different years of experience in using Building information modelling. Mostly had experience between 10 years. In short, 33 respondents had experience between 1 and 3 years, 18 had experience between 4 and 6 years, 28 had between 7 and 10 years, 14 respondents had experience between 10 and 11 years, and only 7 respondents had experience of more than 11 years. Indeed, 79% respondents had experience between 10 years.

Table 3: Number of years using BIM

Sr. No	Number of year Using BIM	Frequency
1	1-3 years	33
2	4-6 Years	18
3	7-10 years	28
4	10-11 years	14
5	more than 11 years	7
	Total	100

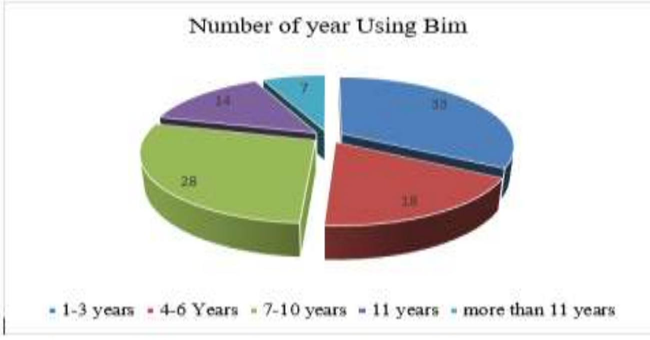

Figure 3: Number years using BIM

3.3 To assess the current status of BIM

Building information modelling has different levels. Different countries use different types of levels of BIM according to their country's construction policy. To check level of building information modelling in gulf countries, the simple questionnaire survey was carried out. 100 participants practices in the survey having different views about current level of BIM practicing in gulf countries.

3.3.1 Demographic Data

The first question comprises of list of building information modelling softwares such as 2D auto CAD, 3D Auto CAD, Autodesk Revit, Autodesk Navisworks etc. it was find out that BIM is practiced in gulf countries with 70% users use Autodesk Revit. In brief, 33% user use 2D auto CAD, 20 % also uses 3D Auto CAD, 70 % uses Autodesk Revit, and only 5% operate Autodesk Navisworks. Also it was discovered that no other software of program is operated in gulf countries to use BIM other than listed in below table.

Table 4: Frequency of software's used in construction industry

Software's that companies are using	Frequency
2D Auto CAD	33
3D Auto CAD	20
Autodesk Revit	70
Autodesk Navisworks	5
Other	0

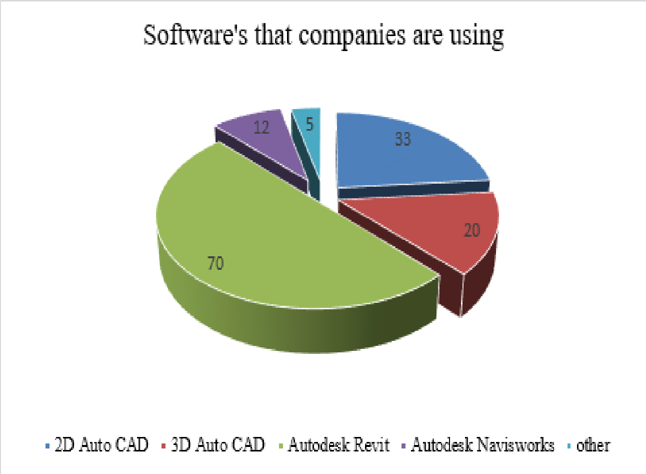

Figure 4: Software's that companies are using

The second question was about common data environment (CDE). It was discovered that at 32% of construction workplaces in gulf countries, there is common data environment that the information of 3D project model is shared among all members of the project by using BIM technology. On the other hand 68% construction workplaces don't have common data environment at all.

Table 5: CDE

Common Data Environment	Frequency
Yes	32
No	68

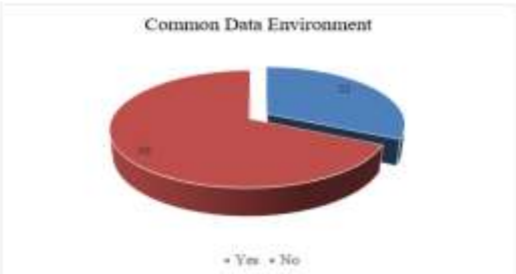

Figure 5: CDE

The third question about collaborative approach in construction organization using BIM. It was find out that 50% organizations have collaborative approach at workplaces while 50% don not have that environment.

Table 6: collaborative approach/ environment

collaborative approach/ environment	Frequency
Yes	50
No	50

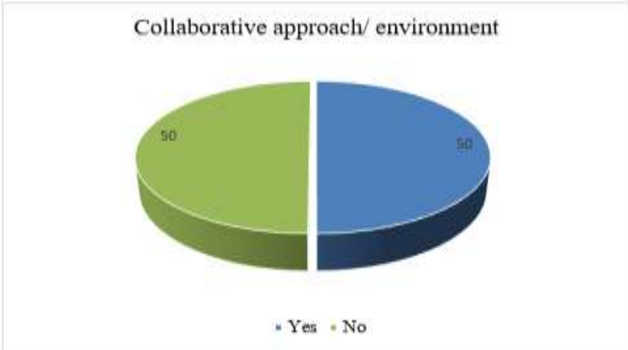

Figure 6: collaborative approach/ environment

The fourth question about co-ordination of the design in construction organization using BIM, It was find out that 45% organizations have information exchange process which provides a platform to improve the co-ordination of the design and provide validate outputs via digital transaction in structured and reusable form at workplaces while 55% don not have that collaboration.

Table 7: improve the co-ordination of design.

Platform that improve the co-ordination of the design	Frequency
Yes	45
No	55

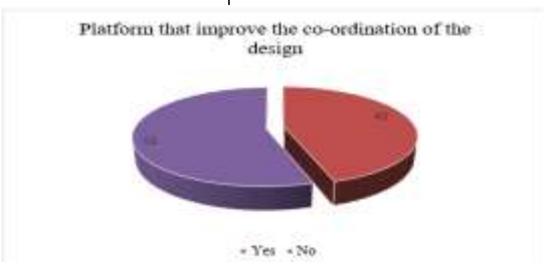

Figure 7: improve the co-ordination of design

The fifth question about shared model in construction organization using BIM. It was find out that 56% organizations have single shared model that can be accessed and modified by everyone at workplaces while 44% don not have that shared model.

Table 8: SSM

Single shared model	Frequency
Yes	56
No	44

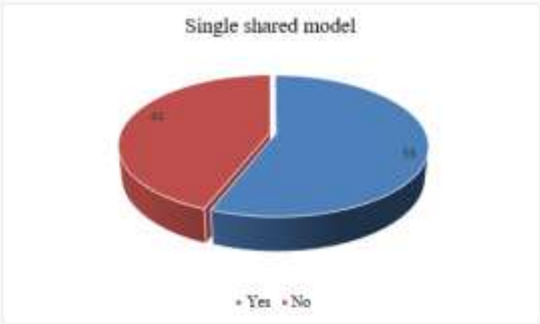

Figure 8: SSM

Building information modelling technology can be used at different stages in construction process. The sixth question was about usage of BIM in stages of construction such as planning, design, execution and maintenance etc. it was discovered that 61% organizations or individuals uses BIM in planning phase of construction, 53% uses in design process, 29% uses in execution process, and only 7 % operate in maintenance phase.

Table 9: Stages for BIM

stage of project, the BIM is adopted	frequency
Planning	61
Design	53
Execution	29
Maintenance	7

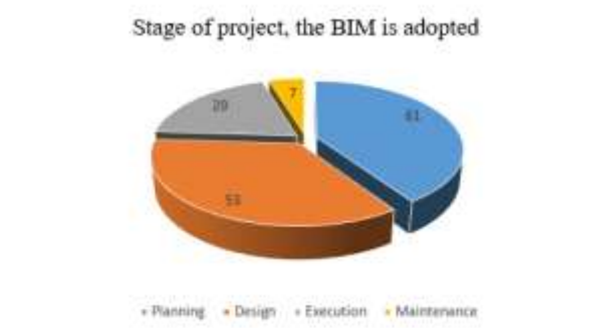

Figure 9: Stages for BIM

Building information modelling technology can be used at different types of structures. The seventh and final question was about usage of BIM in types of structure such as Buildings, Highways, houses, bridges etc. it was discovered that 65% organizations or individuals uses BIM in construction of Large buildings, 46% uses in construction of highways, 36% uses in construction of houses, and only 3 % operate in construction of bridges.

Table 10: BIM adoption

Types of projects in which BIM is adopted	Frequency
Buildings	65
Highways	46
Houses	36
Bridge	3

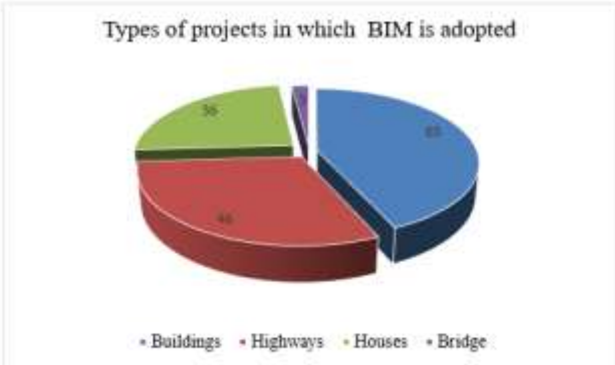

Figure 10:-BIM adoption

3.4 Impact of BIM in the design process of public buildings

To check impact of building information modelling in the design process in gulf countries, the simple questionnaire survey was carried out. 100 participants practices in the survey having different views about the impact of BIM practicing in gulf countries.

3.4.1 Ranking of Impact Factors of Design Process of Public Buildings of Arab Gulf Region

The building information modelling has numerous impacts on design process. This study identifies and analyses significant impacts on design process using BIM. Field engineers, architects, managers and contactors provided their opinions shown in Table and figure below:

Table 11: Impact factors of Design Process

Means, Standard Deviation and Ranking of factors				
S No.	Impact Factors Of Design Process	Mean	Standard Deviation	Rank
1	A design's 3D perspective views are generated with ease for a clear understanding of spaces and their limitations in public building designs in the Arab Gulf region	4.040	0.9203	1
2	Designs can be fully coordinated in a BIM environment, reducing errors and clashes	4.0	1.0636	2
3	BIM technology helps advance the drawing process	3.930	0.9348	3
4	Architects can use BIM technology to ensure design integrity for the public buildings in the Arab Gulf region	3.890	1.0239	4
5	The 'Options' tool in BIM software helps with the easy and efficient design development of the public buildings in the Arab Gulf region	3.890	0.9417	5
6	In a BIM environment, it is easy to detail the design. Details can be monitored for design development, and project stakeholders can review the design details	3.830	0.9540	6
7	In the BIM environment, filters can be applied to an element type to check its fire rating, acoustic rating, insulation, protection, signage, etc. and quickly scan the model's accuracy	3.750	0.9468	7

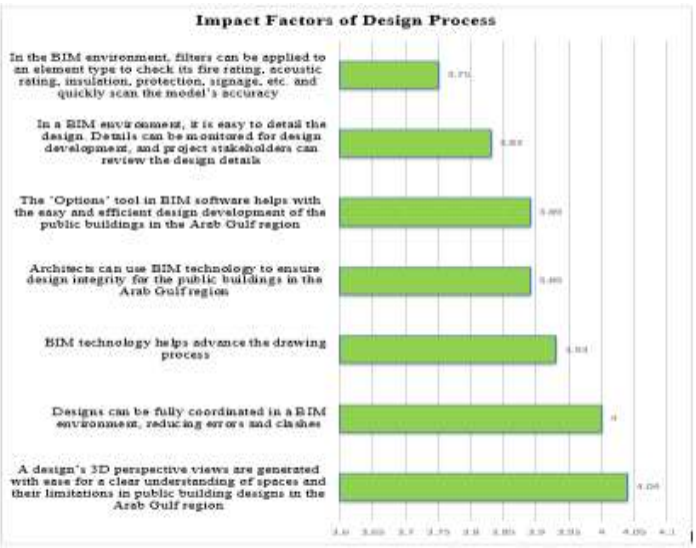

Figure 11: Impact factors of Design Process

The discovered effects were ranked according to what field engineers, architects, supervisors, and contractors working in the construction industry thought about the matter. It was listed based on their Mean Values (MV) and Standard Deviations (SD). The findings of observational research revealed that the five most significant effects of BIM on design process are: A design's 3D perspective views are generated with ease for a clear understanding of spaces and their limitations in public building designs in the Arab Gulf region (MV = 4.040; SD = 0.9203), Designs can be fully coordinated in a BIM environment, reducing errors and clashes (MV = 4.0; SD = 1.0636), BIM technology helps advance the drawing process (MV = 3.930; SD = 0.9348), Architects can use BIM technology to ensure design integrity for the public buildings in the Arab Gulf region (MV = 3.890; SD = 1.0239), and The 'Options' tool in BIM software helps with the easy and efficient design development of the public buildings in the Arab Gulf region (MV = 3.890; SD = 0.9417).

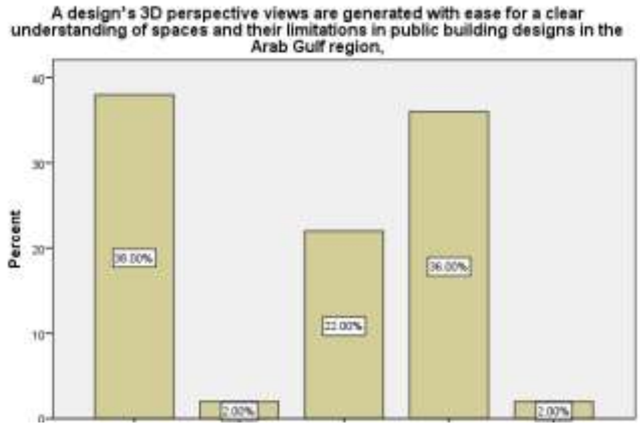

Figure 12: Design's 3D perspective views

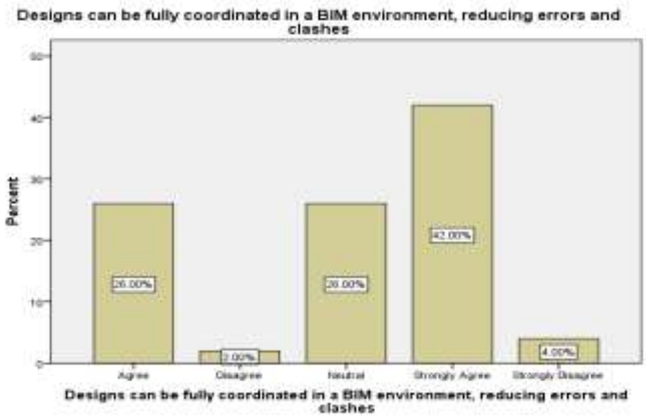

Figure 13: Design coordination in BIM environment

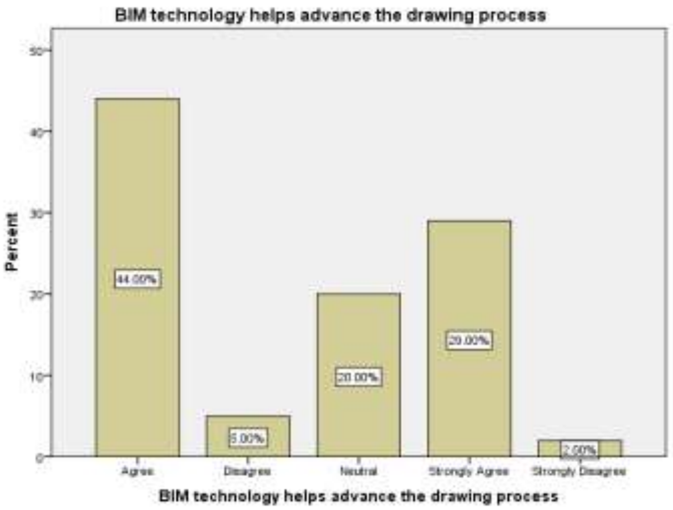

Figure 14: BIM technology in drawing process

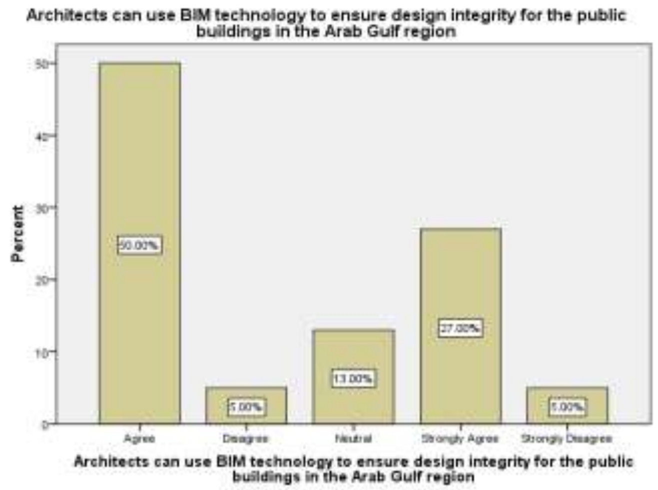

Figure 15: Design integrity using BIM

3.5 To assess the impact of BIM on the Construction technology IN THE public buildings

The building information modelling has numerous impact construction technology. This study identifies and analyses significant impacts of BIM on construction technology in the gulf regions. Field engineers, architects, managers, and contactors provided their opinions shown in Table and figure below.

3.5.1 Ranking of Impact Factors of Bim on the Construction Technology

Table 12: Impacts factors of Construction Technology

Means, Standard Deviation and Ranking of factors				
S No.	Impact Factors of Construction Technology	Mean	Standard Deviation	Rank
1	A design's 3D perspective views are generated with ease to for a clear understanding of spaces and their limitations in public buildings designs	4.060	0.9081	1
2	Visual scheduling of construction work enabling earned value analysis and resource management via understanding actual versus planned schedule effectively	4.01	0.7316	2
3	Managing collaboration between architectural design practices with multiple design partners in public buildings of Arab gulf region	3.910	0.9545	3
4	Improving the flow of design, planning, supply chain, and construction processes in the public buildings of the Arab Gulf region	3.79	0.9979	4
5	Unified platform approach to connect projects teams and data in real time throughout project life cycle	3.67	0.8768	5
6	A systematic approach to optimizing the design of fragmented construction processes and achieving reduced lead times, reduced cost, and improved quality by enhancing the integration of design and fabrication activities for public buildings in the Arab Gulf region	3.62	0.9077	6
7	Automating monitoring of project delivery processes in real time via enabling openness and transparency of project data for all project participants	3.60	1.0249	7
8	Automating quantification of project elements to enhance sharing of cost-related data	3.58	1.055	8

	among project participants and facilitating benchmarking of costs for future development			

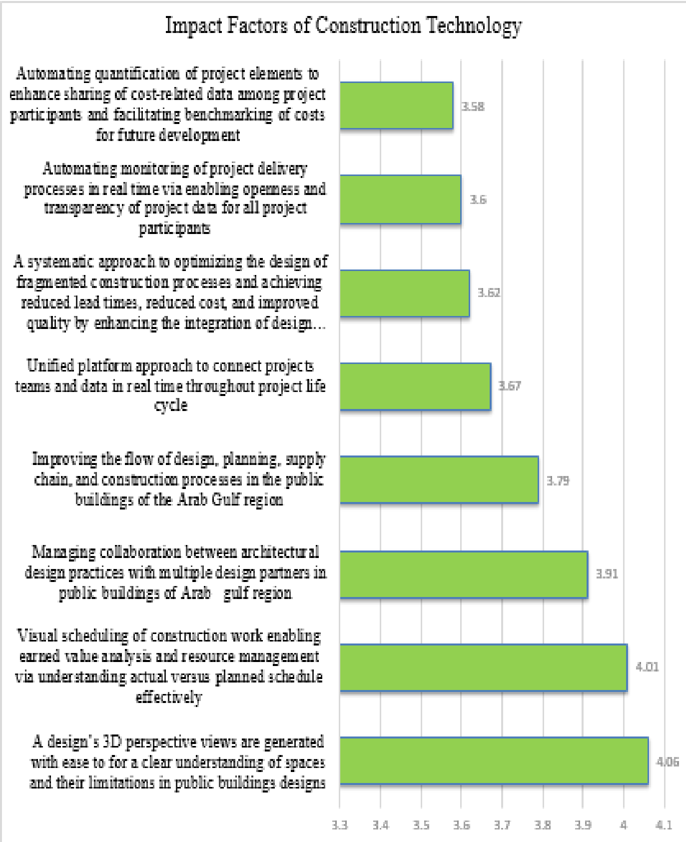

Figure 16: Impact factors of Construction Technology

The recognised effects of building information modelling (BIM) on construction technology were ranked according to the opinions of field engineers, architects, supervisors, and contractors working in the construction industry. It was listed on the base of their Mean Values (MV) and Standard Deviations (SD). According to the findings of observational research, the five most significant effects of BIM on technological advancements in the construction industry are as follows: A design's 3D perspective views are generated with ease to for a clear understanding of spaces and their limitations in public buildings designs (MV = 4.060; SD = 0.9081), Visual scheduling of construction work enabling earned value analysis and resource management via understanding actual versus planned schedule effectively (MV = 4.01; SD = 0.7316), Managing collaboration between architectural design practices with multiple design partners in public buildings of Arab gulf region (MV = 3.910; SD = 0.9545), Improving the flow of design, planning, supply chain, and construction processes in the public buildings of the Arab Gulf region (MV = 3.79; SD = 0.9979), and Unified platform approach to connect projects teams and data in real time throughout project life cycle (MV = 3.67; SD = 0.8768).

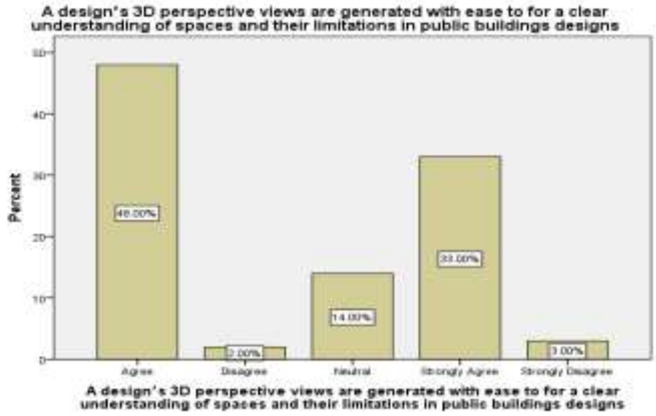

Figure 17: Design's 3D perspective

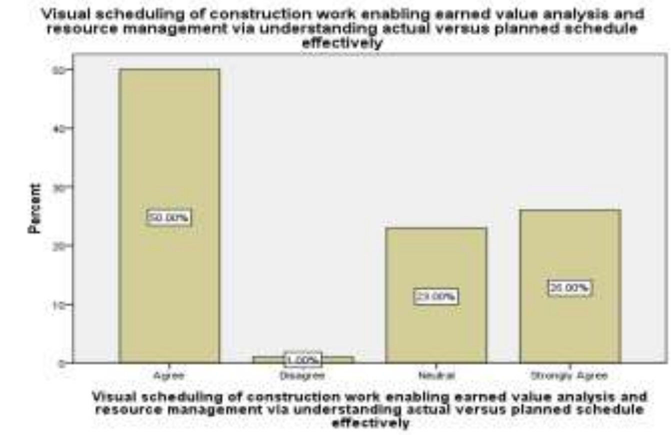

Figure 18: Visual scheduling of construction

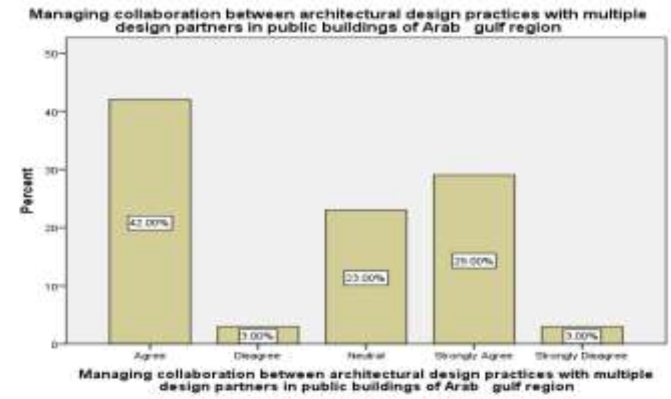

Figure 19: Architectural design practices with multiple design partners

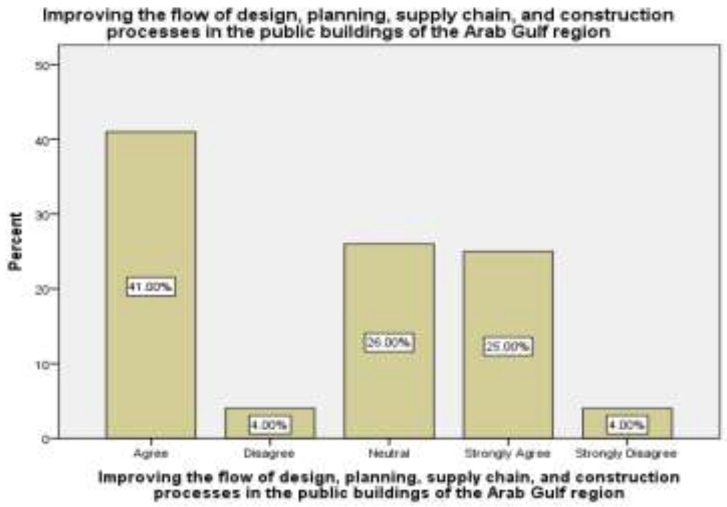

Figure 20: improving flow of design flow

4. Conclusion

The current article described the state of BIM today and how it has an impact on both the design process and construction technologies. The main conclusions of this article were that BIM is used in the gulf countries, with 70% of users using Autodesk Revit, 45% of organizations having information exchange processes that offer a platform to improve design coordination and provide validate outputs via digital transactions in structured and reusable form at workplaces, and 56% of organizations having a single shared model that can be accessed and modified by everyone there, In public building designs in the Arab Gulf region, 3D perspective views of a design are easily generated for a good grasp of spaces and their constraints. BIM technology advances the drawing process in gulf nations. Visual scheduling of construction work enables earned value analysis and resource management by effectively comparing the actual schedule to the planned schedule. Managing collaboration between architectural design practices with multiple design partners in public buildings of the Arab gulf region.

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