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A Qualitative Investigation of the Obstacles Inherent in the Implementation of Building Information Modeling (BIM)

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Abstract: The Middle East construction industry is fragmented, which makes project data inaccessible and underutilized. Building information modeling (BIM) provides innovative solutions to the AEC industry. Due to a lack of awareness of BIM's successful processes, protocols, and workflows, some Middle Eastern organizations have tried to create their own systems but have not always chosen BIM. Some users did not comprehend BIM's benefits, and the construction business was not ready for BIM technology. Furthermore, BIM's benefits were not well known. This study intends to investigate construction practitioners' awareness of the BIM field, the BIM adoption situation, and procedures in Middle Eastern design companies, by identifying and assessing construction professionals' perceptions of impediments to BIM implementation in Middle Eastern construction. This research conducted a semi-structured interview to collect data and information from design teams currently adopting BIM at the project design stage. Thirteen of thirty-nine accepted to participate, with four invalid samples. Data collection reached a saturation point after the fifth interview. The descriptive and empirical analysis showed few BIM studies, lack of knowledge, insufficient government policies, high implementation costs, inadequate contractual coordination, lack of specified standards, cost of data and information sharing, technological availability issues, stakeholder reluctance, business and cultural changes, data and intellectual property issues, and interoperability issues. The factor analysis identified three main BIM implementation difficulties in Middle Eastern construction. These factors are training, cost, and economic constraints.

Keywords: building information modeling (BIM); construction projects; Middle East; design firms; qualitative analysis

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1. Introduction

To accomplish a one-of-a-kind project, any construction project involves a large number of players, including architects, engineers, contractors, subcontractors, and suppliers. This involves several companies that should work together throughout the project's life cycle. These companies differ in terms of size, capability, skills, procedures, information technology (IT) systems, and other factors. Furthermore, firms are typically placed in various regions. They must, however, collaborate and share the same project information. This presents some considerable difficulty in reaching the project's objectives in terms of time, cost, quality, and, most significantly, customer needs, via enhancing communication among project stakeholders. The gap between project stakeholders as well as the lack of effective communication channels have a negative impact on project quality and result in significant financial losses. As a result, building information modeling (BIM) is one

of the latest technologies that introduces magnificent solutions to the architecture, engineering, and construction (AEC) industries. The definition of BIM is changing constantly according to the rapid development of IT in the AEC industry [1] BIM refers to a set of technologies and solutions aiming to increase interorganizational collaboration in the construction industry by increasing productivity while improving design, construction, and operation practices [2]. However, greater benefits can be achieved if organizations embrace BIM development in their work practices, leading to higher levels of collaboration among stakeholders [3].

On the other hand, it is not easy to achieve full BIM adoption or implementation over a project lifecycle without understanding the BIM aspects [4,5]. Similarly, despite several trials by companies to manage BIM, they are facing many barriers, such as lack of management support, cost of training, cost of software [5], absence of government support, lack of demand for BIM, the resistance to change, and cost of implementation [6].

Nowadays, the implementation of BIM in a projects' design stage is seen as one of the most effective ways of reducing construction problems. Even though most design teams face difficulty implementing BIM [7]. Ref. [8] mentioned the barriers to adopting BIM, such as the construction market is not ready for the BIM technology, or the poor awareness of BIM benefits. According to [9], the construction process is divided into eight phases, namely: strategic definition, preparation and briefing, concept design, spatial coordination, technical design, manufacturing and construction, handover or closeout, and use, where among them four are related to the design process. Models and drawings are design products that are important in the construction process. Therefore, it is necessary to develop the process of design to overcome problems. A lot of studies have been conducted this way in Europe and the Middle East, which we will discuss briefly in the next section. Unfortunately, all of these research dealt with the problem as a survey or depended on some questionnaires without any analysis or introduction to any solutions. This research deals with the problem through another philosophical lens by using semistructured interviews and then qualitative analysis using the NVIVO software. Moreover, the cost of change at the design stage is low, which makes it the best project stage for value realization.

Findings from this research shed light on the challenges that the Middle Eastern construction industry has been dealing with when trying to use BIM. One novel component of the research is the identification of a ranked and clustered (composite) collection of obstacles to BIM that can be utilized to create effective mitigation strategies.

The main aims of this study are:

- Investigate the awareness of construction practitioners in BIM fields.
- Investigate the BIM adoption situation and processes in Middle Eastern design firms.
- Propose future research opportunities.

2. Literature Review

Adoption is the decision to use an innovative idea or technology using the available actions in a certain context. The decision-making for adopting innovation requires knowledge, persuasion, implementation, and confirmation. The BIM adoption process is a challenge for professionals in the construction industry [10].

According to [11], BIM technology contributed to the construction industry's efficiency through increased collaboration and fewer corrections and adjustments. The case study presented by [12] showed that approximately 20% of the time was saved for planning and viewing drawings with AutoCAD and time for redrawing with mistake corrections when changes occur. BIM has the potential to offer its skilled proponents substantial and diverse benefits. These include client satisfaction, enhanced team collaboration, improved data sharing, information control, and the delivery of green buildings [4]. All these benefits call for an urgent need for BIM adoption.

There are several studies on BIM implementation in the Middle East and the North Africa region. For example, Ref. [5] presented a case study of BIM adoption and implementation within a Saudi Arabian AEC firm, while Ref. [13] illustrated the barriers to BIM

adoption in construction projects in Iraq. In addition, Ref. [14] discussed the barriers to adopting BIM in the Jordanian building industry. Although BIM has been widely adopted in many advanced countries, its adoption and implementation in the Middle East are still immature. In addition, only 20% of the AEC organizations are using or in the process of adopting BIM in the Middle East [15]. Moreover, it is confirmed that the Middle East has the lowest BIM implementation rate due to a lack of awareness and understanding, as professionals only see BIM as a tool for 3D modeling. Therefore, it has been recommended that more research is needed to facilitate BIM.

An advanced workflow has been developed that could assist the design teams in adopting and implementing BIM more easily and clearly, in addition to stating the benefits achieved in the design coordination platform after the transition from CAD to the BIM methodology and processes.

The implementation of BIM practices highlights many benefits for all members of a project team; nonetheless, current practices within the AEC industry are not formatted to facilitate integration between the distinct project phases (design, construction, and facility management). Moreover, Figure 1 clarifies the potential that BIM has in the movement from one stage to another, such as "3D coordination", which is very important for moving from the design stage to the construction stage [16].

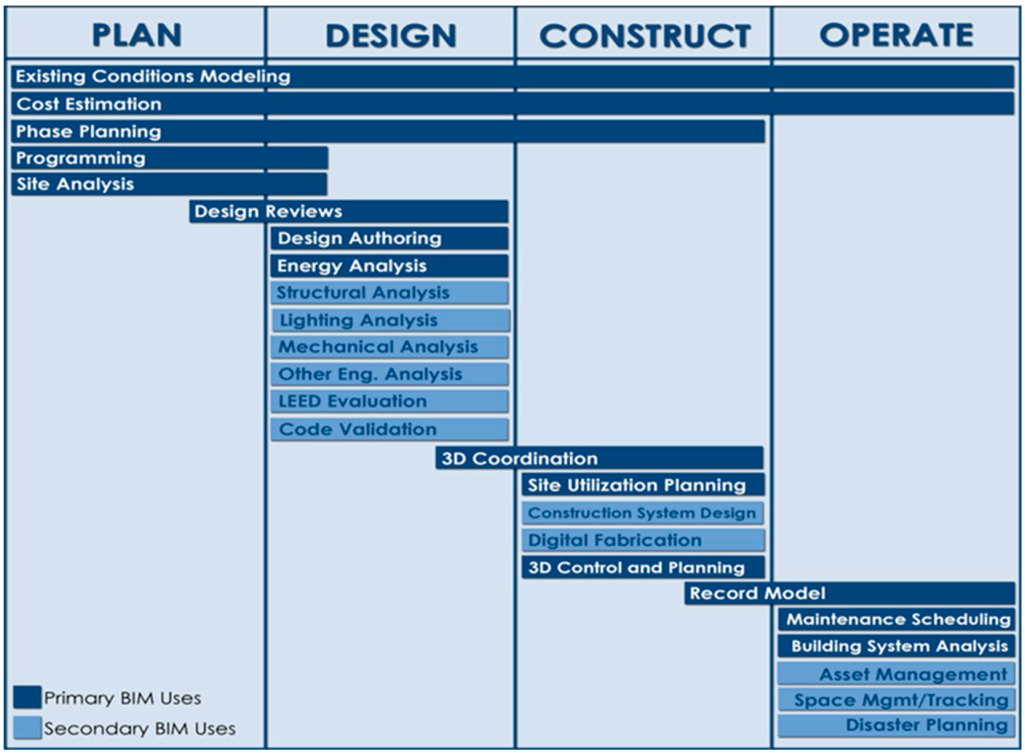

Figure 1. BIM Project Execution Planning Guide [16].

Some research studies focused on the BIM design phase, such as [16] suggestion for a novel approach that would involve the creation of industry foundation classes (IFC) and model view definition (MVD) to thoroughly explain the necessary data for creating modular structures. An illustration example concentrating on the autonomous generative design of modular buildings is used to develop and assess a prototype system. [17] proposed a BIM approach to assist with the precise geometry design and digital manufacture of modular housing. A flexible strategy for creating 3D-printed modules or components was investigated using robotic simulation. The interoperability of computerized design and computer-aided manufacturing, as well as the expansion of the Internet of Things and artificial intelligence to gather data, perform predictive analysis, and optimize control decisions, are the main areas that need to be the focus of future study. In order to discover

the synthesis between BIM and OSC, identify research trends, and fill knowledge gaps, Ref. [18] investigated the state-of-the-art in BIM for OSC. Future research is suggested to focus on BIM-based generative design for prefabrication, cloud storage, data exchange, robots, 3D printing, and big data analytics.

The focus of this study is the design stage, and one of the most important BIM privileges at this stage is the design reviews and design authoring, which can be called "Constructability Reviews".

3. Qualitative Data Analysis Methods

This research uses qualitative data analysis as a technique of data collection and analysis to address the research objectives. The use of a series of procedures based on coded retrieval as key tools of qualitative analysis, which are called coding processes and theoretical sampling, defines grounded theory qualitative analysis, which is a highly effective methodology for analyzing and thinking about social realities. According to [19], grounded theory provides not just a set of processes but also a way of thinking about social reality. In this way, grounded theory research goes beyond the description by focusing on conceptual ordering, the creation of categories, properties, and dimensions, as well as their relations, to form a theoretical structure that explains some relevant phenomena.

According [19], qualitative analysis requires three steps: observation, interpretation, and selection. Data can be gathered through a variety of methods, including observation, interviews with practitioners, and written discourses. As a result, because interviews are the most common qualitative research method, they were used in this study. Semistructured interviews are considered compatible with the grounded theory strategy. To gather more focused information, persuasion words were used to guide the conversation. Then, data analysis started with the coded retrieval of the key tools (coding) in the conversation text using different types of coding as shown on Figure 2.

- Memos are the answers and observations from the participants that are prepared and translated as transcripts for the next step.
- Open coding is the process of generating abstract categories from data, serving as the theory's building blocks. Open codes are more descriptive than inference codes.
- Axial coding connects the generated codes in the next qualitative data analysis step.
- Selective coding is the third stage of qualitative data analysis, which entails focusing on a single core category.

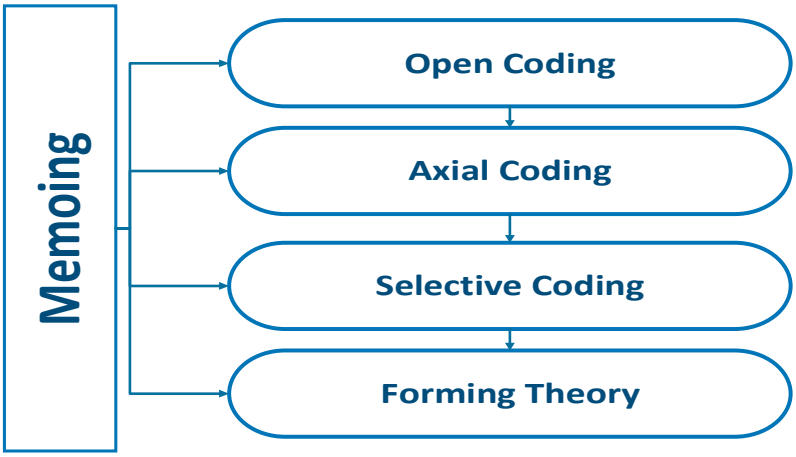

Figure 2. Steps of grounded theory analysis [19].

4. Methodology

This study uses a grounded-theory-inspired inductive qualitative data analysis to learn more about the challenges of cooperation in the design process in the context of actual design environments for building projects. A semistructured interview was used to gather information and data from the design teams currently utilizing BIM during the

project's design phases. Respondents were chosen based on whether or not they had utilized BIM methodologies at work, in accordance with the goals of this study. Whether or not they had extensive familiarity with BIM technology, all engineers were included in the pool of potential respondents. Without any kind of apprehension, we have no idea how many people in the Middle East actually utilize BIM. The semistructured interview examples suggest that all participants should be BIM specialists with extensive experience in the deployment of BIM inside their respective enterprises. After checking that the sample's LinkedIn profile satisfied the requirements, it was chosen. Due to the difficulty in selecting the sample, the snowball method was chosen, in which each respondent encouraged another interviewee to participate in the study. Thirty-nine people were invited for interviews, and 13 agreed to take part in the research; four others were thrown out as invalid since they did not match the selection criteria. All interviewees were instructed to speak in the name of their respective companies, and the coding system was used to clearly label and date all records and notes pertaining to individual interviewees. After the interviews were taped, they were transcribed in full before being analyzed. Thus, in order to learn how BIM might aid in the design process, interviews were conducted based on the responses to an initial questionnaire. As a result, 13 semistructured interviews were conducted with engineers at BIM-using companies. The goal is to learn about the challenges inherent in the design process and establish whether or not adjusting to BIM may alleviate such challenges. Interviews with the participants were scheduled to take place in person wherever possible and over the phone in all other cases. All interviews were recorded with the participants' consent and transcribed for analysis. The questions were uniformly asked to ensure reliable comparison data was collected. Each participant had an opportunity to speak, but the focus of the conversation was on analyzing, reporting, and summarizing the results. After the sixth interview, there was a completeness to the data, and no further information could be gleaned from the interviews.

Each interview consisted of 8–13 questions split over five sections that probed respondents' familiarity with BIM, the state of BIM adoption, and the procedures used by design firms in the Middle East. In the first part, we asked the interviewee some basic questions about themselves. The second part of the paper discussed the current design process. In order to gauge the engineers' familiarity with BIM, a variety of questions related to the various stages of the design process and its primary difficulties, the tools employed, and the present utilization of BIM were introduced. The third component aimed to collect information on how design documentation is produced and on the challenges that exist with the current methods of documentation. In addition, this component is intended to learn how interviewees felt BIM helped them with documentation issues.

The obstacles in the communication process and the methods that the project partners used to communicate were discussed in the fourth section. This section also explores the coordination process by looking at the roles of other engineering disciplines, such as electrical and mechanical, in the design procedure. The potential of building information modeling (BIM) is explored in further depth in the fifth section. There is some talk about how BIM can be used effectively, and at what point in the design process it makes the most sense to start using it. Feedback on BIM's usefulness as a design tool and suggestions for enhancing the design process were also collected in this section. According to the interview samples, all participants were BIM experts with a high level of professional experience in BIM implementation at their organizations, as shown in Figure 3. The snowball technique is used, in which an interviewee recommends another interviewee to participate in the study. Interview requests were sent to 39 people, and 13 of them accepted to participate in the study (Table 1). In addition, four samples were invalid because they did not meet the criteria.

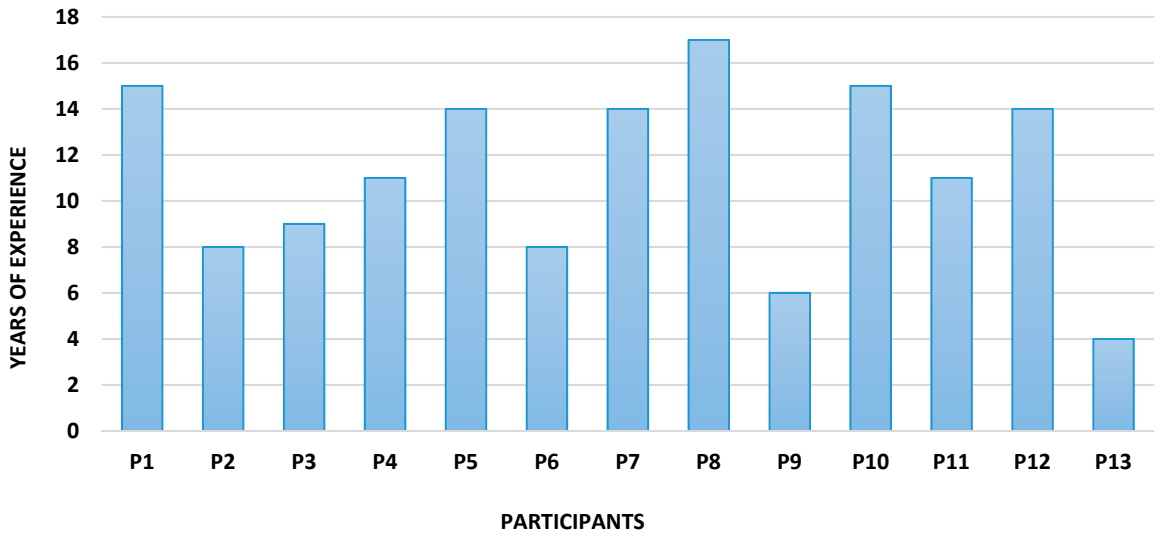

Figure 3. Participants' years of experience in dealing with BIM.

Table 1. Participant's profiles.

Participant	Construction Field	Interviewee Position	Interview Duration
P1	Contractor	BIM Unit Manger	120 min
P2	Design firm	BIM Specialist	50 min
P3	Consultant	BIM Junior Engineer	69 min
P4	Design firm	BIM Manger	45 min
P5	Consultant	Manager, BIM Management	50 min
P6	Consultant	BIM Designer	30 min
P7	Contractor	Project Manger	53 min
P8	Consultant	Project Manger	45 min
P9	Contractor	BIM Senior Engineer	47 min
P10	Design firm	BIM Arch. Manger	68 min
P11	Consultant	BIM Manger	50 min
P12	Design firm	Architect and BIM Specialist	40 min
P13	Consultant	Technical Office Manger	66 min

All participants were asked to speak on behalf of their companies, and interview recordings and notes for each participant were labeled and dated using the coding scheme. Once the data collection was completed, all recorded interviews were transcribed thoroughly before any analysis. Figure 3 showed the Participants' years of experience in dealing with BIM.

5. Results and Analysis

This section includes the data analysis of BIM adoption using the NVIVO software.

5.1. BIM Technology Adoption

After reading extensively the interview transcriptions, the opening codes were identified. Then, the relationships among those codes were stated, as they were linked with each other. As shown in Figure 4, the "Software tools" and "Network" are axial codes generated from the relations of the opening codes. Based on Bilal's classification, "BIM technology" has been chosen as a selective code to include all the codes [3]. The data gathered covered the software tools being used during the design stages to assess the current level of technological advancement and the network systems of BIM implementation during the design process.

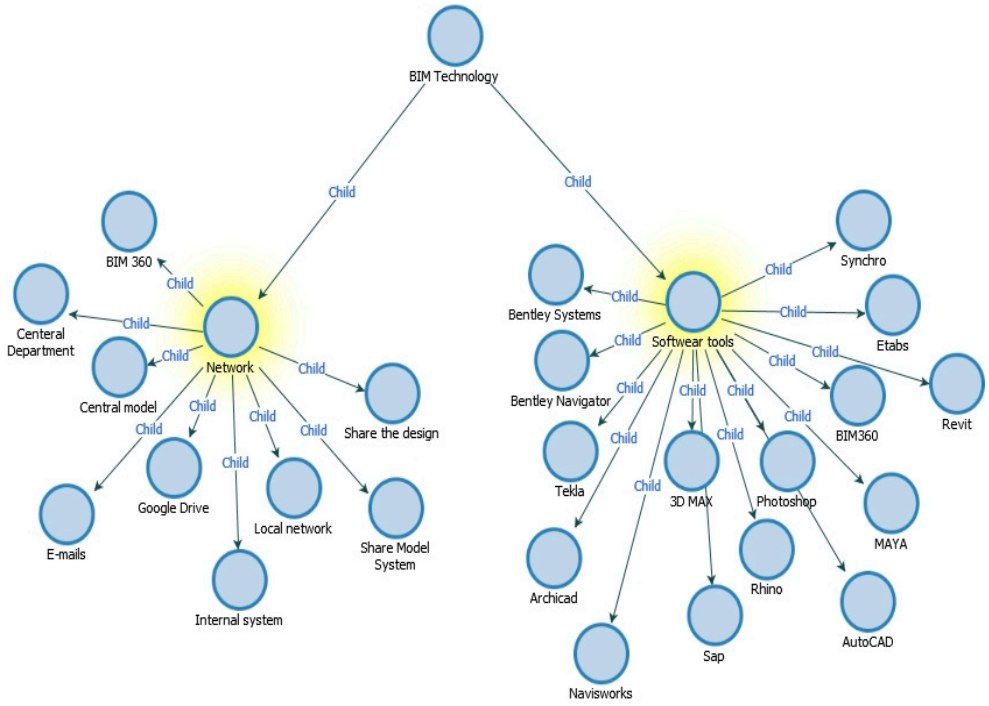

Figure 4. The coding nodes of "BIM technology" after obtaining the selective and opening codes.

5.1.1. Software Tools

Three-dimensional MAX, Archicad, AutoCAD, Bentley Navigator, Bentley Systems, BIM 360, Etabs, MAYA, Navisworks, Photoshop, Revit, Rhino, Sap, Synchro, and Tekla are software tools used by participants during the design stages. Nevertheless, a large number of respondents used Revit and Navisworks, Figure 5. An explore diagram was generated separately for each node in NVIVO to identify the most frequent codes used by the participants. It revealed that the highest frequency of reference codes are Revit and Navisworks. The reason behind choosing Revit and Navisworks is mainly due to their interoperability. Navisworks is a very useful software, whereby it provides visualization walkthroughs, clash detection, and also allows tolerance to be set to filter soft clashes.

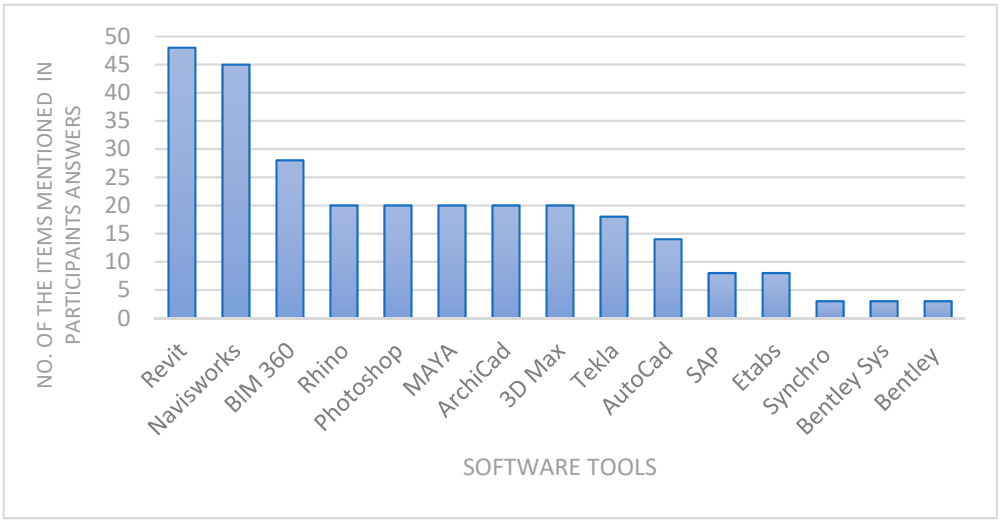

Figure 5. The most common "Software tools" coding references.

5.1.2. Network Adopted

It is observed that each participant has adopted different kinds of collaboration platforms, such as local networks, internal systems, e-mails, central models, BIM 360, and share model systems. Participants (13 and 3) claimed that there is no common BIM collaboration platform. The software has been rejected due to the reluctance of the team members to change their operating system. Nevertheless, the team has developed its management system to suit its own needs. While four firms stated that their network platform consists of the cloud, email, or Google drive, where all projects' data is stored on the server, and is only accessible within the firm's premises. In addition, the cloud has been used for information exchange among the disciplines for external projects. Furthermore, major clashes or modifications highlighted during the meetings are sent to all relevant parties through email. Finally, nine firms uploaded information to the company's intelligence system's project portal to enhance better collaboration among project stakeholders. The project portal is accessible by project stakeholders from anywhere, at any time. The central model is the most common network platform between all parties due to its accessibility (Figure 6).

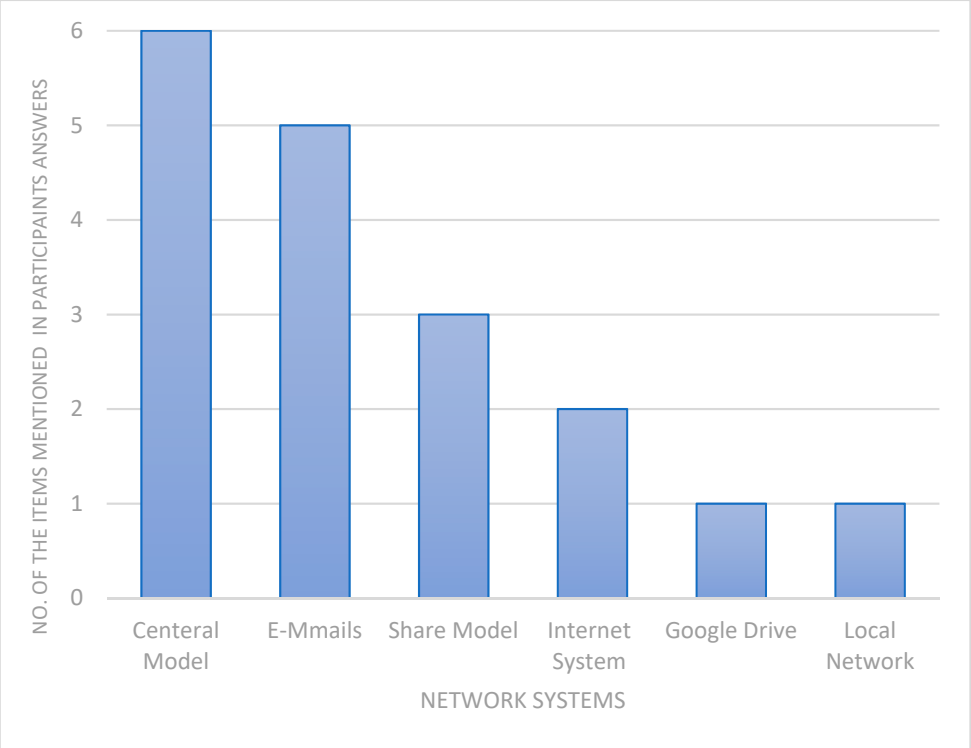

Figure 6. The most common "Network Systems" coding references.

5.2. BIM Process Adoption

The analysis of the data in this section focuses on the BIM adoption process. The opening codes were generated after reading the transcriptions of the interviews. After linking the opening codes with each other, four axial codes were developed from the relationships between the opening codes represented in the design process flow, communication time, collaboration, and resources. According to [3] classification, the BIM process was selected to include all the mentioned codes, as shown in Figure 7.

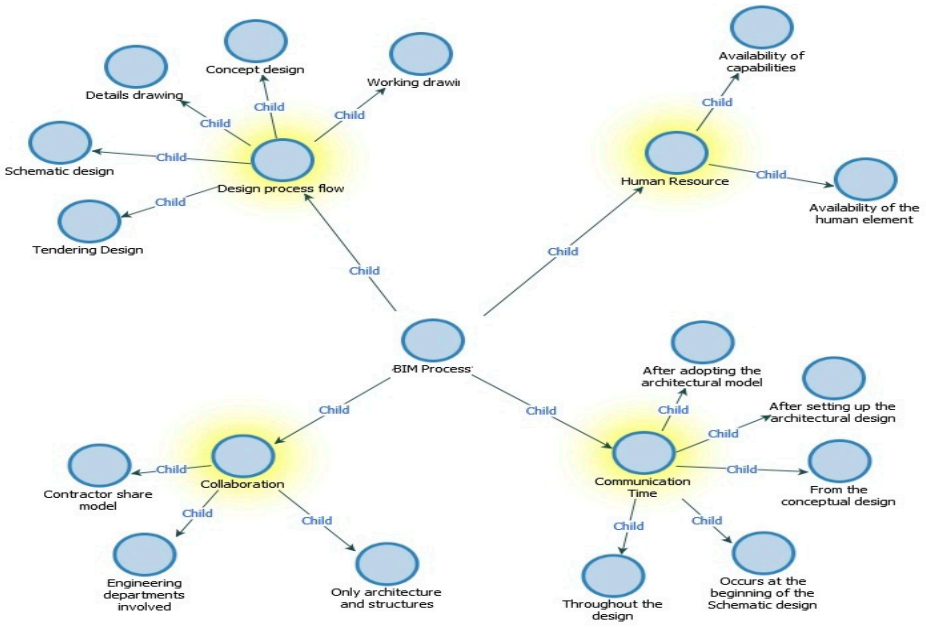

Figure 7. The coding nodes of the "BIM Process" after obtaining the selective and opening codes.

5.2.1. Design Process Flow

The interviewees, in their answers, identified five design stages: conceptual design, schematic design, detailed design, tendering design, and working drawings. As shown in Figure 8, the most common reference code items identified are conceptual, schematic, and detailed designs.

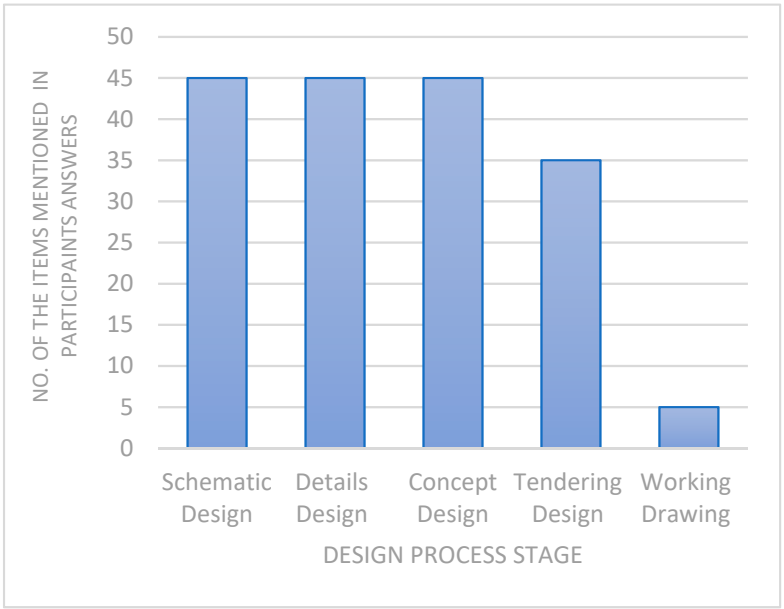

Figure 8. The most common "Design Process Stages" coding references.

In addition, there are two complementary stages, according to some participants, represented in detailed drawings and tendering designs. In general, the design stages depend on the nature of each participant's firm and the timeshare in this process. For example, Participant 1, who is a contractor, stated that his role begins late in the design stage, during the tendering stage. Therefore, he believes that it is better to participate early in the design stages from the beginning to enhance his ability and avoid many problems related to the lack of information during the construction phase.

5.2.2. Communication Time

Communication time refers to the coordination between different project parties to share their model during the design process. Based on the participants' answers about their communication time with each other, all participants confirmed the involvement of all parties from the early design stages. Participant (12) stated that during the design stage, they share all files through the central common data created by the BIM manager, and this occurs from the conceptual design to the detailed design. Participant (4) stated that communication takes place after adopting the architectural model. In addition, other participants mentioned that communications take place after setting up the architectural design and starting the rest of the designs, whether structural or electrical, etc. (Figure 9).

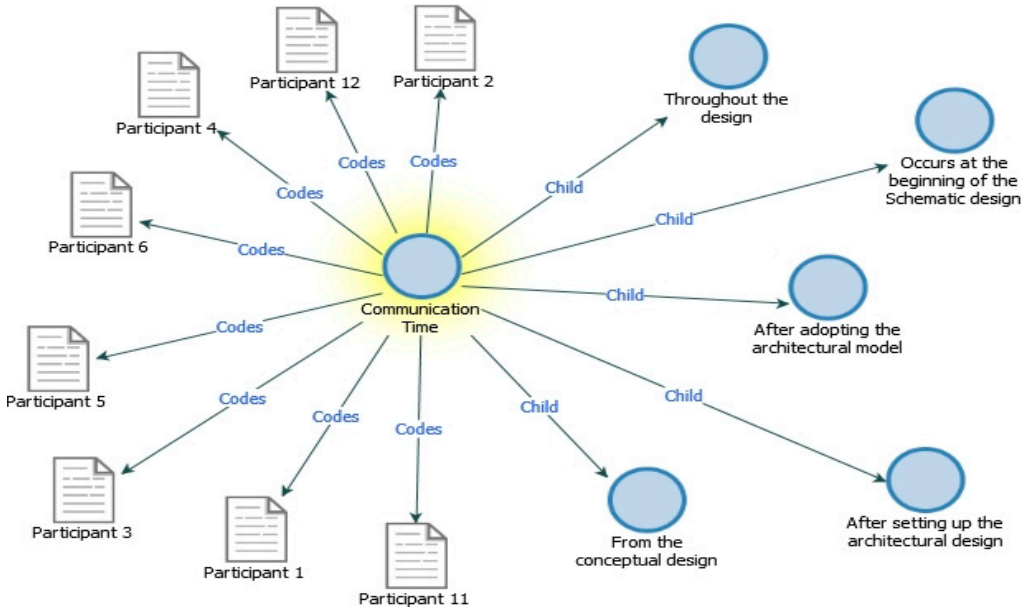

Figure 9. Different coding levels of the communication time.

5.2.3. Collaboration

Three methods of collaboration have been identified: all engineering is involved, the contractor shares his model, and only the architecture and structure departments collaborate, as per the participants' narratives.

Table 2 shows that all involved engineering departments (83.33%) was the most common answer to collaboration, which was supported by all participants. This allows involving all engineering departments, which leads them to reach and detect conflicts early. On the other hand, Participant (6) mentioned that contractors have the primary priority in sharing their models as they are consulting on petroleum projects. Finally, Participant (2) mentioned that collaboration only occurs between the architecture and structures departments in his firm.

Table 2. Collaboration types by nodes.

Collaboration Types	Number of the Item Mentioned in Participants' Answers	Percentage %
Nodes\BIM Process\Collaboration\All Engineering involved	10	83.33%
Nodes\BIM Process\Collaboration\Contractor shares his model	1	8.33%
Nodes\BIM Process\Collaboration\Only architecture and structures	1	8.33%

5.2.4. Resources

Participant P1 does not find it difficult to implement BIM in his company under the current conditions of the available capabilities and the availability of human resources. The trained and qualified engineers that are sufficiently familiar with the concepts of BIM helped the company reach the required level in the application of BIM. Therefore, it is essential to reach this goal by seeking assistance from those who support the adoption of BIM in its early stages to maximize its benefits. In addition to the existence of the capabilities within the company to overcome all obstacles that the work team faces.

5.3. BIM Policy Adoption

This section reviews the BIM policy implementation through the participants' responses. Opening codes were created for each other, and the relationships between the open codes were identified. Two axial codes were developed from the relations of participants' responses represented in benchmarks and controls and preparatory to adopting BIM, as shown in Figure 10.

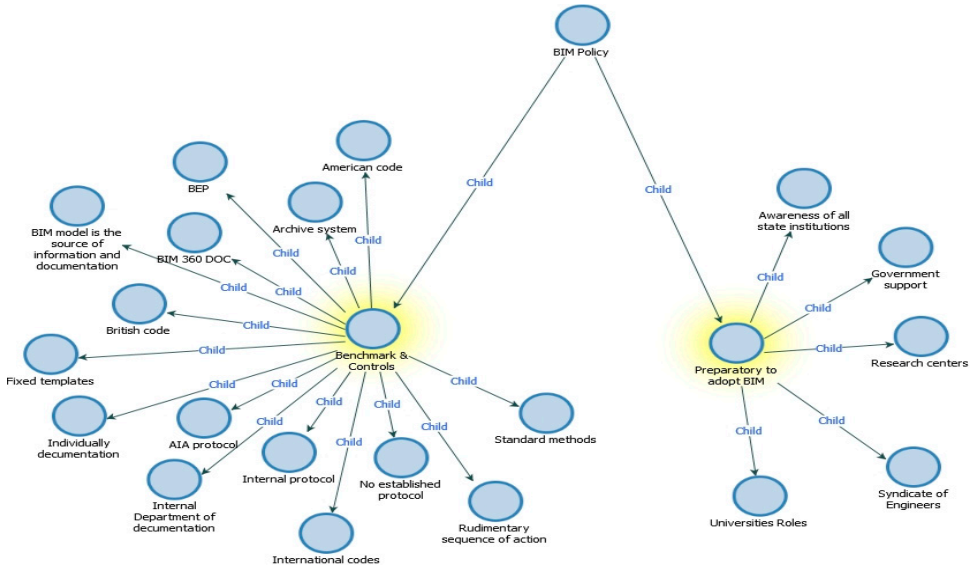

Figure 10. The coding nodes of BIM policies after obtaining the selective and opening codes.

5.3.1. Benchmark and Controls

Document control and information management were very important processes to avoid adverse effects on the project. The interviewees' answers revealed that not all of them have a documentation system in their firms or a specific protocol. Participants 1, 2, 4, 10, 11, and 13 stated that internal protocols and individual methods of documentation were used. Moreover, Participant 5 stated that BIM models were the source of information and documentation, which ensures a maximum degree of communication between all parties. Meanwhile, Participant 12 stated that documentation was performed according to international codes, such as the British code or the American code, with some modifications to match the nature of work in the Middle East. Participants 3 and 9 mentioned that the AIA and BEP protocols were used as documentation methods for all drawings, memos, and other project documents. As shown in Figure 11, the internal protocol is the most common coded reference used by different firms.

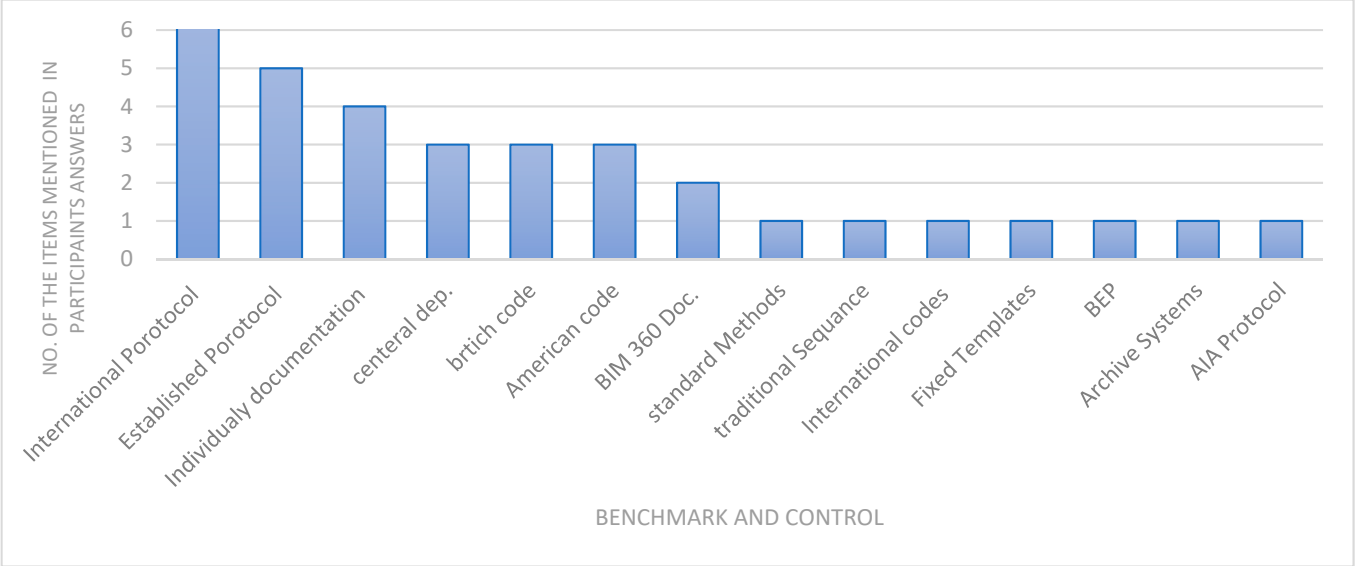

Figure 11. The most common "Benchmarks and Controls" coding references.

5.3.2. Preparatory for Adopting BIM

For BIM adoption, the interviews assured the necessity of an effective role for all institutions to raise public awareness of BIM, especially the role of the government and the Syndicate of Engineers. Furthermore, the results indicated that educational institutes have an important role in BIM implementation. Table 3 shows that the awareness of all state institutions, government support, and the Syndicate of Engineers have the same priority of 23.07%.

Table 3. Preparatory types by references.

Participants Answers	Axial Code	No. of the Item Mentioned in Participants' Answers	Percentage %
It is the government's role to direct the field in the right path. Additionally, the absence of references or protocols, in addition to the lack of support of projects' owners, in addition to the absence of an adequate budget make it more complicated. I think that associations and unions can play their role by spread awareness regarding this field. amimiThe universities must do their part to develop special curricula for this, and the research centers must hold conferences at the Syndicate of Engineers and begin to spread and introduce people to BIM.	Awareness of all state institutions	6	23.07%
	Government support	6	23.07%
	Syndicate of Engineers	6	23.07%
	Research centers	5	19.23%
	Universities Roles	3	11.54%

5.4. BIM Adoption Barriers

This section aims to find out the barriers to adopting BIM during the design stage. The interviewees, in their answers, described the design barriers they face based on their specialties. It is observed that similar design problems were stated by 10 participants. Opening codes were created and linked to each other; the relationships between the open codes were identified. Three axial codes were developed from the relationships represented in the technology barriers, process barriers, and policy barriers to adopting BIM, as shown in Figure 12.

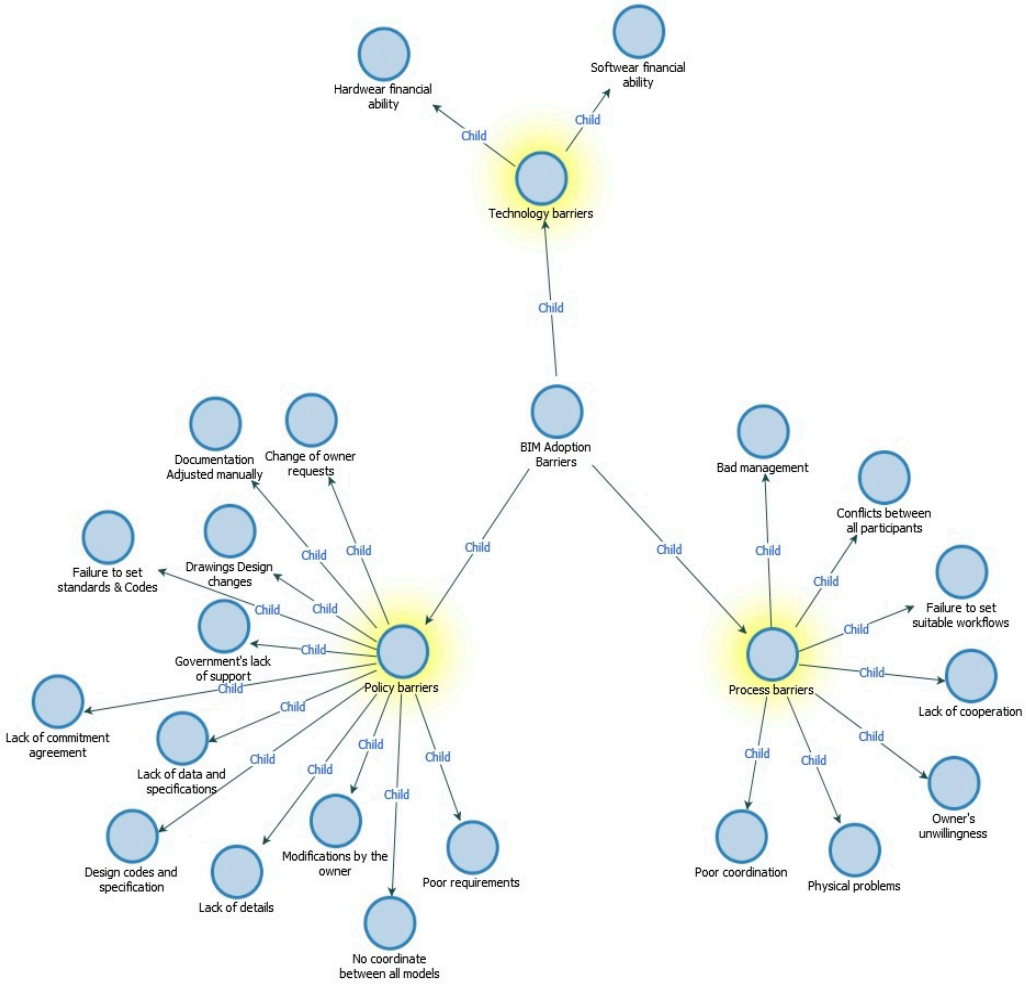

Figure 12. The coding nodes of "BIM Adoption Barriers".

5.4.1. Technology Barriers

The interviewees, in their answers, described the technological barriers to BIM adoption in their firms. Hardware and software financial abilities are the most referenced codes, with an equal percentage (50%).

5.4.2. Process Barriers

Participants (3, and 11), and P8 identified that poor management and specifications were the biggest problems that occurred during the design process, in addition to the lack of coordination between departments. Participant (12) stated that the problems related to conflicts were the reason for work disruption, especially during the construction phase. Furthermore, the failure to organize the delivery of files between the different sections of the project. Participant (13) also mentioned that the challenges during the design process were poor management and poor requirements, as well as a lack of cooperation between departments. Participant (4) faced clashes and mentioned the importance of enrolling mechanical and structural engineers early in the design process. As shown in Figure 13, the highest frequency of reference codes is "poor management".

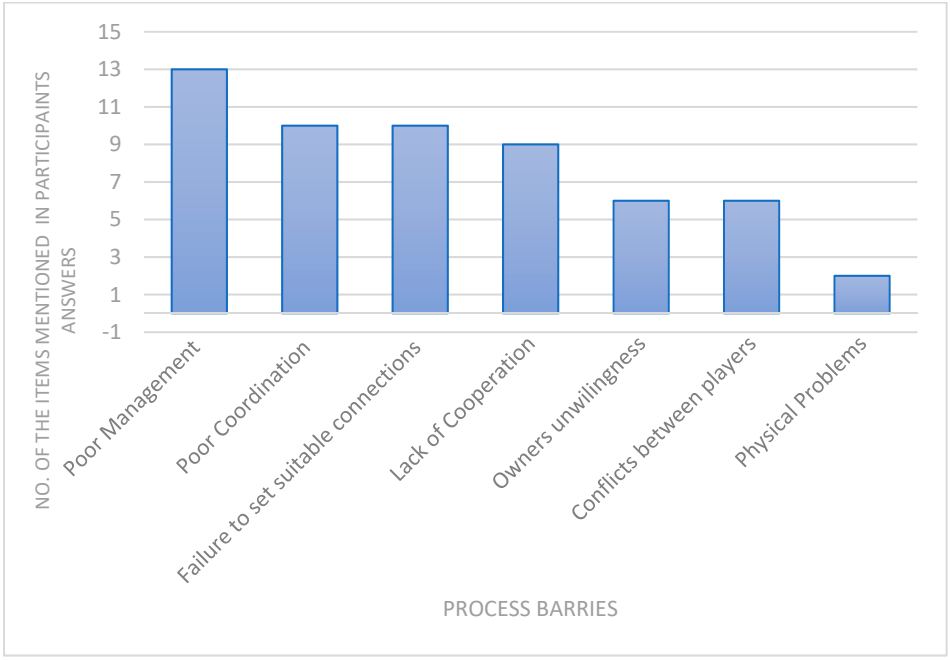

Figure 13. The most common "Process barriers" coding references.

5.4.3. Policy Barriers

The results obtained from the participants' responses in this section showed a lack of commitment to the BIM policy across the Middle East construction industries (Table 4). The results indicated that failure to set standards and a specific protocol by all parties resulted in many problems during the construction stages. In addition, the government's lack of support is one of the main problems that face BIM adopters. Participant P10 highlighted the problems that existed during the design process, as owners might not be fully aware of the requirements at the beginning of the project. Such problems lead to insufficient information about the design, in addition to a lack of knowledge of the total cost of a project. In addition, Participant (6) thought that the problems in the design stage were worse when there was a lack of data and specifications required from owners. While Participant (2) stated that the lack of details during the design stage requires a lot of time in the construction phase to amend the drawings. Finally, Participant (5) believed that the constant change in owner requests was the main problem in the design process.

Table 4. Policy barriers by number of references.

Barriers Name	Number of the Item Mentioned in Participants' Answers	Reference Coverage %
Failure to set standards and Codes	9	31.03%
Government's lack of support	5	17.24%
Lack of data and specifications	3	10.34%
Poor requirements	3	10.34%
Lack of details	2	6.89%
Change of owner requests	1	3.45%
Design codes and specification	1	3.45%
Documentation Adjusted manually	1	3.45%
Drawings Design changes	1	3.45%
Lack of commitment agreement	1	3.45%
Modifications by the owner	1	3.45%
No coordination between all models	1	3.45%

5.5. Concluding the Interviews

The remarks and comments explained by the participants align with what was reported in previous literature on the benefits of BIM. After reading the transcripts of the interviews extensively, the opening codes were created and linked with each other. Two axial codes were developed from the relationships of previous opening codes, as represented in the BIM benefits and enhancement suggestions. The interview conclusion was selected as a selective code according to the acceptable classification to include all the above codes, as shown in Figure 14.

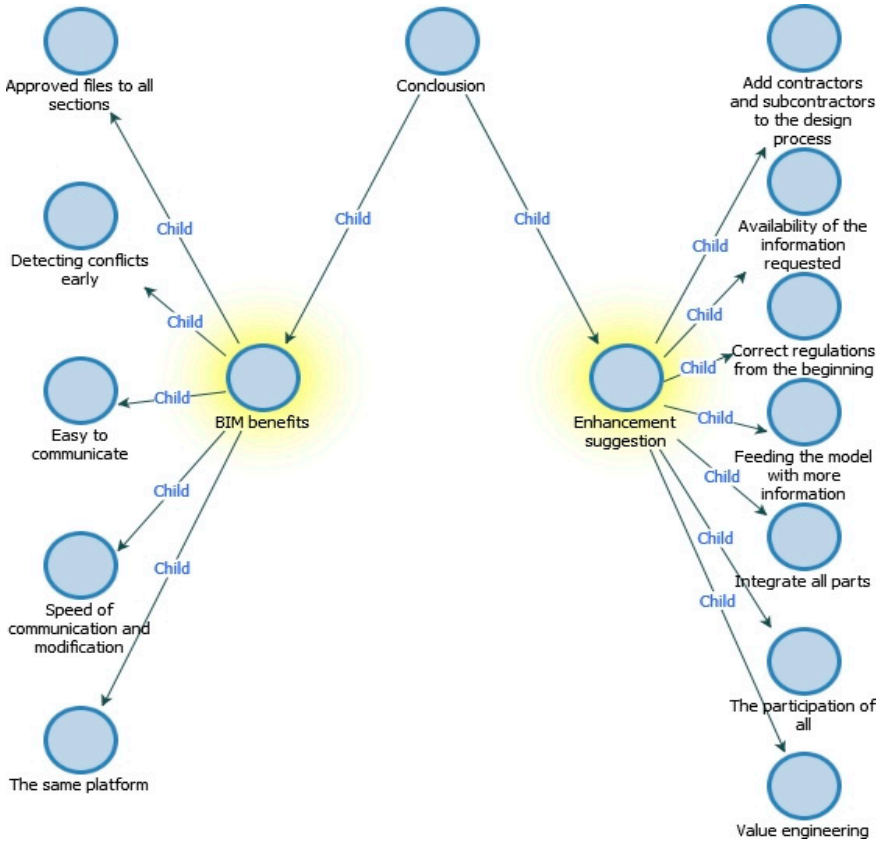

Figure 14. The coding nodes of "Interview concluding" after obtaining the selective and opening codes.

5.5.1. BIM Adoption Benefits

The benefits of BIM adoption were gathered from interviews and answers based on their practical experience with BIM. Table 5 presents the BIM benefits according to the participant's answers.

Table 5. BIM benefits by number of references.

Participants Answers	Axial Code	Number of the Item Mentioned
Of course, there are other engineering departments involved in the design process, and this sharing influences the design for early conflict detection.	Detecting conflicts early	7
BIM technology has provided ease of communication between the parties of a single project by having a single model that all project members work on, in addition to sharing data.	Easy to communicate	7
The presence of BIM facilitates communication between project parties. Additionally, the use of BIM 360 has the advantages of speeding up communications and ease of modification among all departments.	Approved files to all sections Speed of communication and modification	2 1
BIM has made it easier for parties to connect with each other using the same platform, in which all team participants work together, in addition to data sharing.	The same platform	1

5.5.2. Enhancement Suggestions

This research aims to enhance the adoption of BIM during the design stage by assessing the problems of the current work system and providing a solution for them. The respondents' suggestions to enhance the adoption process were captured. In the code's frequency diagram, the highest frequency of reference codes is the participation of all project departments, as shown in Figure 15.

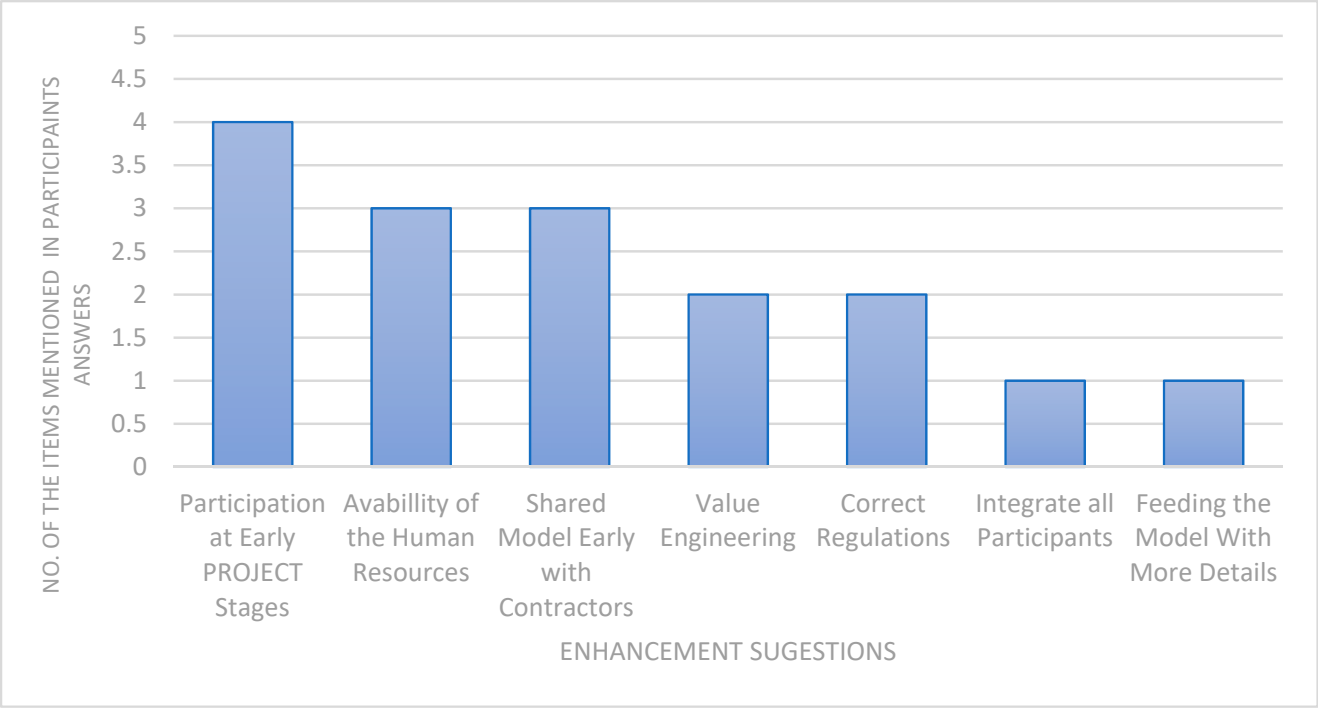

Figure 15. The most common "Enhancement suggestion" coding references.

6. Discussion

BIM Implementation Gaps and Classification in the Middle East Design Firms

The study that was conducted on the responses that respondents gave is outlined in Table 6, which provides a summary of that research. This study examined a wide range of themes, including technology, methodology, and policy. It is essential to have an understanding of the methods that the members of design teams are utilizing in an effort to implement BIM in order to develop a model that could assist design teams in implementing BIM. This understanding is necessary in order to develop a model that could assist design teams in implementing BIM. As a consequence of this, we created a report that details all of the participant strategies and recommendations, irrespective of whether or not these participant strategies and recommendations have been implemented. It has been shown that these findings are composed of two primary components, and it has also been shown that each of those core components is composed of three primary domains. It was found, in the first part of the survey, that the majority of participants utilized not only comprehensive programs, such as Revit, Navisworks, and BIM 360, but also the most recent strategies that have been developed in the field of technology. This was a discovery that was made possible due to the fact that the majority of participants were involved in the construction industry. This was uncovered as a consequence of the findings that the initial portion of the survey produced. This information was discovered by us as we were conducting the earliest stages of the inquiry. Despite this fact, some of the antiquated procedures are still being carried out because transitioning to the new system is such a difficult process. Individuals who took part in the process fields commented and made it abundantly clear that designs are discussed across all departments at the very beginning of the design processes, and that

cooperation on designs also takes place across all departments. This was made clear by the individuals who participated in the process fields. Another aspect that contributes to the overall expansion of this industry and helps to promote the introduction of new techniques is the availability of human resources. This component is one of the most important factors. In conclusion, it was noted in the discussion regarding the policy that the majority of the participants were still dependent on the regional protocol in their individual organizations; furthermore, some of them did not have a protocol that was adequate. The ability to pay for the necessary hardware and software, in addition to the expense of implementing BIM, is the primary challenge that people working in the technology field are obliged to face. This is especially true for younger workers. On the other side, there are other players that have no problems at all when it comes to equipping their businesses with suitable software and hardware. According to the evaluations that were supplied by the participants, the most significant challenges that were present in the process sectors were a lack of an acceptable workflow, inadequate management, and a lack of coordination among the parties that were engaged. These were the three most significant problems that were present. Inadequate requirements for definition, a lack of data, a failure to set standards and norms, and a lack of cooperation from the government are other key obstacles in the policy area. Nonetheless, one of the primary challenges that the policy sector faces is the inability to successfully set standards and norms.

Table 6. Summary of the interview results.

	Technologies	**Process**	**Policies**
The most mentioned references codes in all previously mentioned nodes	• Central model • BIM 360 • E-mails • Revit • Naviswork • BIM360	• All Engineering departments involved • Occurs at the beginning of the Schematic design • Throughout the design • Availability of the human and capabilities	• Internal protocol • No established protocol • Government support • Awareness of all state institutions • Syndicate of Engineers
The most mentioned references codes related to BIM adoption barriers	• Hardware financial ability • Software financial ability	• Failure to set a suitable workflow • Poor management • Lack of cooperation	• Failure to set standards and codes • Government's lack of support • Lack of data and specifications • Poor requirements

There are a few research studies dealing with the obstacles inherent in building information modeling (BIM) implementation in the Middle East. According to the findings of this research, the use of building information modeling (BIM) software in the Middle East is growing and is already being implemented in certain aspects of construction projects. In addition to utilizing BIM applications, such as Revit, Naviswork, and BIM 360. Due to the difficulties in making a full shift, some of the outdated techniques are still in use. Regarding the process dimension, the participants made it apparent in their comments that shared designs occur across all departments in addition to the designers' involvement right from the start at the early stages of design. The execution and growth of this component are also supported by the availability of human resources. However, when it comes to the policy dimension, the majority of participants still rely on local procedures inside their companies, and some of them do not even have a proper protocol in place. This study offered a qualitative approach to BIM adoption in order to minimize the shortcomings and drawbacks of the current BIM status at Middle Eastern construction enterprises. These findings compare the data collected by Building SMART [7]. The UAE has the most BIM projects of any Middle Eastern nation. The following country is Qatar, then Saudi Arabia.

Due to the political and financial risks involved for contractors, Oman and Bahrain were ranked higher, while Lebanon and Jordan are currently at the bottom of the list for the adoption of BIM on projects. Despite this, there are still a considerable number of businesses participating in the testing phase. In addition, enterprises in the Middle East have begun experimenting with BIM on projects of a more modest scale. They have noticed the benefits that it provides throughout the process of designing or constructing a structure.

Studies in other comparable developing countries, such as the studies carried out by [5] identify the obstacles to BIM implementation in the construction industry. The key factors that have the greatest impact on the adoption of BIM in the sector were technology and business-related barriers, training and people-related contexts, cost and standards-related bodies, and process and economic-economic barriers. These elements combine to create the main obstacles that adversely affect the adoption of BIM while also allowing for the analysis of the factors to be performed thoroughly.

7. Limitations

Collecting data for this analysis is a very complex process because of the different countries that the research deals with in the Middle East. Cultures, type of work, different nationalities of people who took the semistructured questionnaire, multiexpertise and other reasons let the authors spend a lot of effort at this step and also at the analysis phase. In another way, the research and authors focused on the work environment in the Middle East, which is totally different from the work environment in Europe and the United States of America. Finally, as it can inherit the learning capability from past experiences, one can easily predict that improvement of the workflow of BIM is going to be one of the pillars of enhancement and improvement of the work environment at construction sites and buildings in the Middle East.

8. Conclusions and Recommendations

Semi-structured interviews were used to get deeper information about BIM use and implementation. After the qualitative analysis of the results, it is noticed that, regarding the technology dimension, the majority of the participants used the latest advanced methods, in addition to using BIM programs such as Revit, Navisworks, and BIM 360. However, some of the old methods are still in use in addition to using BIM programs such as Revit, Naviswork, and BIM 360. However, some of the old methods are still in use due to the difficulty of the complete transition. Regarding the process dimension, the participants, in their responses, stated clearly that shared designs between all departments occur, in addition to the participation of the designers from the very beginning at the early design stages. The availability of human resources also supports the implementation and development of this dimension. In addition, concerning the policy dimension, most of the participants still depend on local protocols in their firms, and some of them do not have a proper protocol. This paper introduced a qualitative approach to BIM adoption to avoid the weaknesses and disadvantages of the actual BIM status at the construction companies in the Middle East now.

- The work detailed in this study might be expanded to include the following:
- More research in the Middle East market is recommended, focusing on firms that have completely implemented BIM in their projects, to investigate the potentials, challenges, and motivators of BIM data from real cases.
- Obtain a holistic view of the BIM adoption with similar research work to determine the development of the driving forces of BIM within the Middle East AEC sector.
- A more in-depth analysis of construction projects in the Middle East where BIM will be used would assist the implementation process by determining how the process is being used and what measures should be taken.

9. Further Work

The work detailed in this study might be expanded to include the following:

- A social network analysis in the Middle East market is recommended, focusing on firms that have completely implemented BIM in their projects, to investigate the potentials, challenges, and motivators of BIM data.
- A more in-depth analysis of construction projects in the Middle East and the difficulties implementing BIM from both the academic and industry perspective.
- A deep analysis of the implications for practice, particularly for the design managers practically and theoretically.
- Create a unified tool or a scale to measure the BIM adoption at construction companies in the Middle East, which helps to determine the maturity of BIM at these companies.

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References

1. Kassem, M.; Iqbal, N.; Kelly, G.; Lockley, S.; Dawood, N. Building information modeling: Protocols for collaborative design processes. *J. Inf. Technol. Constr.* **2014**, *19*, 126.
2. Hochscheid, E.; Halin, G. A model to approach BIM adoption process and possible BIM implementation failures. In *Creative Construction Conference 2018*; Budapest University of Technology and Economics: Budapest, Hungary, 2018; pp. 257–264. [CrossRef]
3. Succar, B.; Sher, W.; Aranda-mena, G.; Williams, T.; Eastman, C. A proposed framework to investigate Building Information Modelling through knowledge elicitation and visual models. In Proceedings of the Conference of the Australasian Universities Building Education Association (AUBEA), Melbourne, Australia, 3 July 2007.
4. Ghaffarianhoseini, A.; Tookey, J.; Ghaffarianhoseini, A.; Naismith, N.; Azhar, S.; Efimova, O.; Raahemifar, K. Building Information Modelling (BIM) uptake: Clear benefits, understanding its implementation, risks, and challenges. *Renew. Sustain. Energy Rev.* **2017**, *75*, 1046–1053. [CrossRef]
5. Almuntaser, T.; Sanni-Anibire, M.O.; Hassanain, M.A. Adoption and implementation of BIM—Case study of a Saudi Arabian AEC firm. *Int. J. Manag. Proj. Bus.* **2018**, *11*, 608–624. [CrossRef]
6. Hatem, W.A.; Abd, A.M.; Abbas, N.N. Barriers of adoption building information modeling (BIM) in construction projects of Iraq. *Eng. J.* **2018**, *22*, 59–81. [CrossRef]
7. Enegbuma, W.I.; Aliagha, U.G.; Ali, K.N. Preliminary building information modeling adoption model in Malaysia A strategic information technology perspective. *Constr. Innov.* **2014**, *14*, 408–432. [CrossRef]
8. Al-Hammadi, M.; Tian, W. Challenges and Barriers of Building Information Modeling Adoption in the Saudi Arabian Construction Industry. *Open Constr. Build. Technol. J.* **2020**, *14*, 98–110. [CrossRef]
9. RIBA. RIBA Plan of Work 2013 Overview. In Royal Institute of British Architects. 2013. Available online: http://www.ribaplanofwork.com/Download.aspx (accessed on 27 February 2023).
10. Kassem, M.; Succar, B. Macro BIM adoption: Comparative market analysis. *Autom. Constr.* **2017**, *81*, 286–299. [CrossRef]
11. Ahmed, S. Barriers to Implementation of Building Information Modeling (BIM) to the Construction Industry: A Review. *J. Civ. Eng. Constr.* **2018**, *7*, 107–113. [CrossRef]
12. Kharboutli, L. *Using Building Information Modeling Systems (BIM) in Construction Projects*; Halab University: Aleppo, Syria, 2014.
13. Wadhah, A.; Abd, A.M.; Nagham, N. Motivation Factors for Adopting Building Information Modeling (BIM) in Iraq. *Eng. Technol. Appl. Sci. Res.* **2018**, *8*, 2668–2672. [CrossRef]
14. Matarneh, R.; Hamed, S. Barriers to the Adoption of Building Information Modeling in the Jordanian Building Industry. *Open J. Civ. Eng.* **2017**, *7*, 325–335. [CrossRef]
15. Gerges, M.; Ograbe, A.; Jaeger, M.; Asaad, A. Building Information Modeling and Its Application in the State of Kuwait. *Int. J. Civ. Environ. Struct. Constr. Archit. Eng.* **2016**, *10*, 81–86.
16. Soediono, B. PENN State PXP Guide. *J. Chem. Inf. Model.* **2010**, *53*, 160.
17. He, R.; Li, M.; Gan, V.J.; Ma, J. BIM-enabled computerized design and digital fabrication of industrialized buildings: A case study. *J. Clean. Prod.* **2021**, *278*, 123505. [CrossRef]

18. Yin, X.; Liu, H.; Chen, Y.; Al-Hussein, M. Building information modelling for off-site construction: Review and future directions. *Autom. Constr.* **2019**, *101*, 72–91. [CrossRef]
19. Bryman, A. Integrating quantitative and qualitative research: How is it done? *Qual. Res.* **2006**, *6*, 97–113. [CrossRef]

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