



A Proposed Framework for the Integration of BIM Models in AEC Companies in Syria

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Abstract

Recently, AEC companies in Syria have realized the importance of adopting BIM in their system, especially in the next phase of reconstruction in Syria. However, due to the recent experience, the BIM process is still in its early stages and needs a lot of efforts to overcome the technical and administrative obstacles in front of it. The research methodology is based on analyzing models of organizational structures for AEC companies operating with BIM technology around the world, and studying their strengths and deficiencies in order to extract the most important factors for improving the performance of BIM in the Syrian construction industry companies. The study concluded with proposing a framework for the integration of BIM models in the structure of AEC companies, and companies that do not use BIM or that operate partially according to BIM can adopt it in developing their administrative structure in accordance with their own characteristics and the requirements of applying BIM in them.

Keywords: AEC companies; BIM maturity; BIM adoption; Organizational BIM models

1. Introduction

The past ten years have witnessed rapid growth and a remarkable global demand for adopting BIM technology [1] for its significant role in developing construction projects Where it has become more productive and rationalize resources [2], and has led to more in-depth collaboration among project stakeholders [3] [4] [5]. However, it is still considered a new approach in Syria and has not been widely adopted still now [6], due to the lack of experience, and the inadequacy of standards and protocols that must be developed to keep pace with BIM technology [7], in addition to personal issues associated with resistance to change and lack of proper BIM awareness [8].

In any case, the challenges related to adopting BIM are not only related to technical and legislative issues but also other organizational changes that need to be changed in the AEC companies to keep pace with the successful implementation of BIM technology [9]; However, there is still limited knowledge on what types of change are required in an organization as a whole in relation to BIM implementation [10].

And while many Syrian engineering companies have preserved their traditional organizational structure and culture without any significant change, and projects are usually implemented either in the traditional manner without the desire to use BIM technology, or they are satisfied with using Cal

Rift or the competitor program as a marketing promotion that they work according to BIM, on the other hand, there are companies that want They actually work according to BIM technology, but the change they make is often limited to allocating a special or independent section of BIM within the lower administrative levels of the company and not systematically starting from the upper managements in it, and these companies still lack the courage to make a comprehensive organizational change that meets the requirements of adopting BIM Real and effective.

This research studies the best ways to facilitate the task of adopting BIM by engineering companies working in the field of construction in Syria by integrating the basic roles and operations of building information management within the organizational structure of the company and developing the integration of BIM models in the structures of construction industry companies in Syria.

2.0 Literature Review

2.1 BIM Definition

Building Information Modelling (BIM) has been crystallized as a new technological concept in the construction industry [11], Thus there is still no specific definition agreed upon unanimously among them. (Eastman 2006) defined it as “the process of generating and organizing the components of a building during its life cycle during the design process” [12]. Similarly, BIM technology was defined according to ISO (ISO 16757-1: 2015) as “constructing a model that contains information about the building at all stages. building life cycle [13]. while Succar considers BIM to be a set of technologies, processes, and policies that enable multiple stakeholders to collaboratively design, construct, and operate a facility in a virtual space [14]. According to the National Institute of Building Science (NIBS 2015), BIM is a digital representation of the physical and functional characteristics of a structure. As such it serves as the common knowledge source of information about a facility that forms a reliable basis for making decisions during its life cycle from inception onwards [15]. Building Information Modelling (BIM) can also be defined as a business methodology that seeks to connect people, processes and digital models in construction and infrastructure projects, allowing for fluidity in information transmission and communication [16].

Although the previous definitions are somewhat different from each other, they generally agree that BIM aims to simulate the building process from design to construction through a virtual model rich in information and details of each element of the building, allowing collaborative work for the various parties to the construction project, and achieving coordination Effective between various disciplines, which reduces waste, conflicts and large delays suffered by traditional construction projects that operate according to the CAD.



Figure 1: BIM life cycle, Resource: Creations by authors (2023).

2.2 BIM maturity in Syrian companies

While some studies have confirmed that the majority of AEC companies in Syria are already at zero BIM level [17], there are other studies that found that BIM level 1 dominates the largest number of them; Considering that the recent period witnessed the introduction of some BIM software such as architectural and construction Revit, in addition to the adoption by corporate employees of a teamwork culture that is at the core of BIM technology [18].

So, on the basis of the aforementioned maturity levels, and taking into account the current reality of the performance of companies operating according to BIM technology in Syria, it seems appropriate to introduce an average level between 1 and 2 which is 1½ as a strategic objective for construction industry companies in Syria so that a complete 3D model of an object is presented with some information from level 2.

2.3 Challenges of BIM implementing BIM in Syria

Studies focusing on the challenges of implementing BIM in the Syrian construction industry are still limited, and this is due, according to (Shaban & Elhendawi, 2018), to the lack of an actual and complete application of the BIM system in the Syrian construction industry. In their study, they classified the most important factors that impede the application of BIM in the Syrian construction industry According to their importance and the most prominent of which is the issue of the absence of BIM culture among stakeholders, and the need to develop a BIM-compliant code, in addition to the cost of training on BIM technology [19]. Another researcher attributes the difficulty of implementing projects according to BIM technology to the absence of laws that help in planning, studying and implementing these projects [20].

Accordingly, it can be concluded that if the Syrian engineering companies wish to switch to the BIM system, they must focus on spreading awareness of the importance of implementing projects according to the BIM technology, while clarifying the desired benefits for the various stakeholders, and they must raise the capacity and competence of their employees in order to enable them to work on programs The various BIM, in addition to developing its systems and procedures in line with the requirements of work according to the new system, and above all, it must be aware of the current reality of the Syrian construction industry and make gradual shifts towards adopting BIM, and it does not have to be rapid or radical, so it develops its own codes and protocols until the government and institutions Associated with the adoption of a complete shift towards BIM technology and the development of national codes for the adoption of BIM at the level of the construction industry in Syria.

2.4 BIM requirements in Syrian AEC companies

Integration of BIM throughout the project phases has become essential, given that BIM helps in conducting a building life cycle assessment, and many AEC companies in Syria have begun to rely mainly on 3D models in their projects [21] [22]. but still now there are no binding standards that stakeholder may adhere to [21]. The government and its related departments should work to adopt BIM on a large scale in order to keep pace with the rapid changes in digital building technology [23]. and in order to accelerate the process of digital transformation in the construction sector, BIM should be integrated into the engineering education sector [24]. Syrian universities should also pay more attention to training Syrian engineers and helping them keep pace with digital technology in the construction industry [25] [26]. Accordingly, the Syrian educational bodies need to allocate more time and effort to qualify engineers and help them keep up with the latest technologies [27] [28]. Moreover, Elhendawi et al. proposed a 6-step framework for implementing BIM, this proposed methodology can be used in the Syrian context, and it includes: 1) increasing awareness, 2) understanding the advantages, the 3) readiness of the AEC sector, 4) and organizational capacity; 5) figuring out the obstacles; 6) and removing the obstacles and identifying the important elements affecting the implementation [29].

3.0 Research Methodology

The descriptive approach will be relied on by the method of content analysis to obtain a deeper understanding of the extent of BIM adoption by the most prominent international and Arab companies that say that they apply BIM technology in their projects and how its application is reflected in their organizational structure and organizational structure chart. The research included companies that share their structure on their website to the public.

Diversification was taken into account among the models of administrative organizational structures for the selected sample of companies, as huge and large foreign companies and four Arab companies ranging from small consulting to medium and large contractors were selected. The results of the analytical study of the organizational structures of the selected sample of companies will also be utilized to come up with a proposed framework for the integration of BIM models in the structure of AEC companies in Syria.

4.0 Presentation of organizational structures for Arab and international companies that use BIM technology

Each company has its own goals and strategic vision that is unique to it, and knowledge of the size of the company and the diversity of its business plays the largest role in shaping its structure. Its organizational structure is a reflection of corporate governance systems and the nature of relationships prevailing in them. Accordingly, the researcher reviewed and analyzed several administrative structures for different companies working with BIM technology around the world to understand how the application of the technology reflected their organizational structure.

4.1 Dura Vermeer Bouw Zuid West: a Dutch contracting company

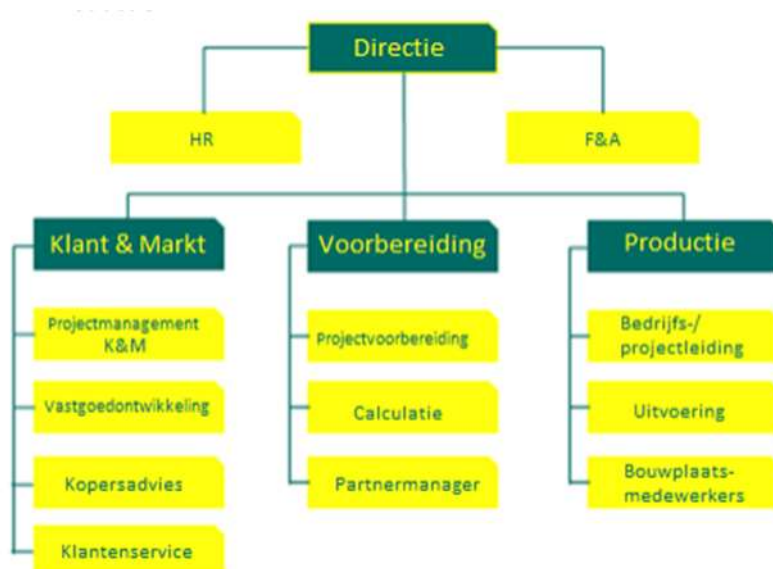


Figure 2: Organizational Structure of Dura Vermeer Bouw Zuid West [30]

The unit (Voorbereiding) in the middle, which means preparation, is concerned with planning and designing / redesigning the projects that the company is implementing and the following figure (Figure 3) shows the nature of BIM's work in the preparation unit.

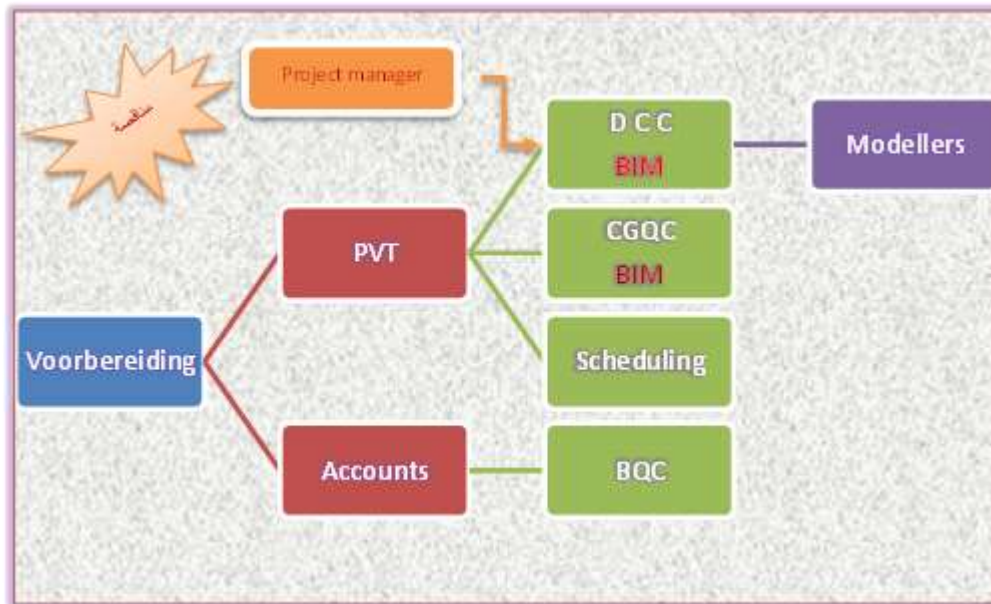


Figure 3: BIM departments at Dura Vermeer Bouw Zuid West
Resource: Creations by authors (2023)

It is worth noting that the construction schedule department (although it belongs to the project preparation team) does not perform the 4D scheduling process even though they use a sophisticated scheduling program Asta Powerproject and the schedule on this program can be linked with the 3D BIM model, but the company so far does not do that.

According to the same scheme 3, it is also noted that in the accounts unit of the project preparation unit, the detailed quantities of the project are calculated traditionally according to the old mentality, and this means that the application of the BIM methodology in the company is related to the first dimension only, i.e. 3D BIM modelling, coordination, and conflict detection.

The most important observations that can be taken on this structure is that there is no BIM manager, but rather the company suffices with the position of the digital construction coordinator who manages the modelers and coordinates between the different specializations. Thus, the project manager is the one who actually manages the preparation stage in the absence of a BIM manager, which is what the researcher finds wrong. In the event that the company does not want to appoint a BIM manager and the situation remains as it is, it is suggested that it at least follow the sections of the construction schedule and general and direct quantities calculation to manage the digital coordinator / in the absence of a BIM manager position / so that BIM technology can be used as 4D scheduling and cost calculations Based on BIM 5D.

4.2 Tri Viet Hoi An Resort Project Descon: The figure 4 shows the organizational structure of the Tri Viet Hoi An Resort project in Quang Nam Province, Vietnam.

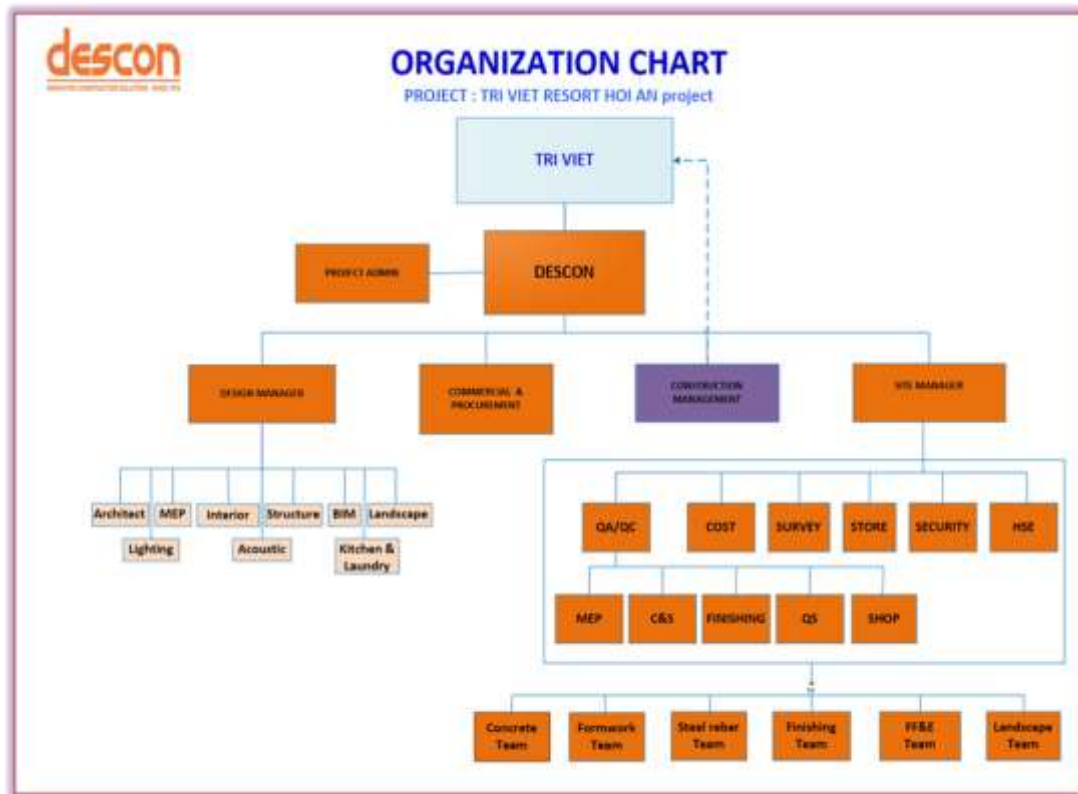


Figure 4: Tri Viet Hoi An Resort Project Organizational Structure

Source (<http://descon-triviet.weebly.com>)

The company shall appoint a project manager who will supervise all design, procurement and construction processes as indicated in the Figure 4 and the design, procurement and site managers will report to him. The structure reflects the significant role of the site manager during the construction phase, who undertakes the direct supervision of the implementation work and submits his report to the project manager. This role intersects with the same previous role of the site manager at Dura Vermeer Bouw Zuid West.

The BIM unit is located within the design departments that report directly to the Design Management Unit, and its mission is to coordinate between the various engineering specialties during the design phase in order to deliver the plans according to BIM technology and with minimal errors or design conflicts between the various specialties and ensures the delivery of design work according to the protocol and the agreed upon BIM implementation plan between the company and its customers.

By checking the design manager unit and its affiliated departments, the presence of the following departments (architecture, construction, MEP, interior design, lighting, acoustics, kitchens) separately from the BIM department indicates that either the design department in the project structure is managed according to the traditional method CAD and BIM is considered an integral unit (A software unit in which 3D modelling is done after the plans have been studied with CAD mentality). Or, the company does not implement all of its projects using BIM technology, and therefore it has allocated a separate section for it from the rest of the design departments in the event that the tender / client requires that, or perhaps the company runs the business with a BIM mentality, but it did not reflect that in the best way on its structure.

And in the event that the company actually adopts BIM / at least in the design phase of the project / then it is appropriate to reflect this clearly on its structure, for example, to show that the BIM manager is the one who supervises the work and study of the rest of the engineering plans and coordination between them, and not the other way around. Thus, all stakeholders in the project will be able to familiarize themselves with the workflow mechanism and the method of implementing BIM in the company, and this will constitute a promotional and marketing addition to it.

4.3 El Hazek Construction

Al-Hazek Construction Company is an ancient Egyptian real estate company based in Cairo. It is considered one of the most important companies in the Middle East and has covered a range of projects throughout Egypt and the Arabian Gulf region. Its annual turnover is about ten billion pounds



Figure 5: Organizational Structure of EL HAZEK Construction

Source (<https://www.elhazek.com>)

The BIM unit follows the management of the technical office, which works collaboratively with the project management and undertakes the task of coordinating with the rest of the various engineering specialties to implement the project according to the protocols, specifications and quality standards adopted by the company and signed by the client. In their turn (project managers and the director of the technical office), they report to the director of operations in the company, who in turn submits his report directly to the general manager.

In this, the BIM model in this structure is similar to its predecessors, in that it appears as a technical unit whose goal is coordination and 3D modelling, and it is separate from the rest of the other engineering units and is not considered a leader and director. The same previous analysis that dealt with the legal structure of DESCON applies here; That is, either the department of studies is managed according to the traditional CAD method, while BIM is considered a complementary unit (a software unit in which 3D modelling takes place after the plans have been studied in CAD mentality). Or the company does not implement all of its projects using BIM technology and therefore allocated a separate section for it from the rest of the design departments in the event that the tender / client requires that, or perhaps the company actually runs the business according to the BIM methodology, but it did not reflect that in the best way on its structure.

On the other hand, the company's structure indicates a clear maturity of the company's management in terms of financial, legal, HR and the overall supply chain, as well as its interest in allocating an independent unit for development, digital innovation and technical operations.

4.4 FACTUMOA Company: It is specialized in providing integrated services of architectural and structural engineering, electrical and mechanical engineering (MEP), based in Doha, Qatar



Figure 6: FACTUMQA Organizational Structure
 Source (<https://factumqa.com>)

What is distinctive about this structure is that the company has separated the traditional engineering units from the engineering units that will operate according to BIM technology. That is, it was not satisfied with the existence of a BIM team that follows the traditional specialized departments, but rather made it separate and supervised by a central BIM manager who derives his authority from the technical / technical director directly. This indicates that the company is gradually and systematically adopting BIM in the company and attaching special importance to it, and the day will come when it will dispense with the study department according to CAD in the event that the adoption of BIM matures in the local and regional environment and in the company itself.

4.5 IVC Engineering Consultants: It is a small engineering consulting firm in Nasr City, Cairo. specializes in providing integrated engineering services such as architectural design, planning, urban design, landscape design, structural, electromechanical and visual offers.

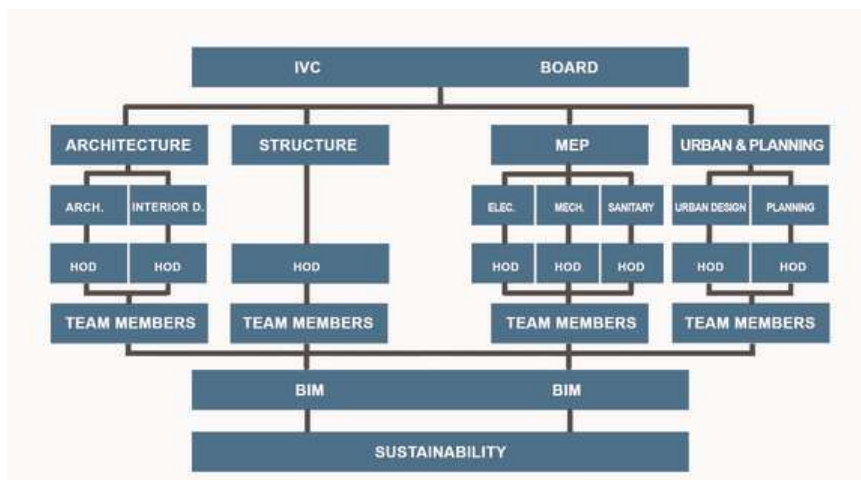


Figure 7: IVC organizational structure
 Source (<http://www.ivc-co.com>)

In this structure, the BIM team branches out from the rest of the engineering teams and specializations and coordinates between them. It is also noted in this structure that the BIM team is located at the lowest administrative level of the company, and this also often indicates that the company provides BIM services according to the investor's desire and does not commit itself to applying it in all its projects.

And if the company implements all its designs according to BIM technology or wanted to go for that, the researcher believes that it must restructure it so that it reflects the role of BIM in the higher administrative levels of the company, such as replacing the architectural studies unit with the BIM unit for architectural studies, and the same applies to the construction department, MEP and urban planning, and clarifies the position that supervises on all of these modules and he is the BIM manager in this case.

4.6 Dar Damec Company: A private engineering company located in Kuwait established in 2003, it is a multi-disciplinary consulting firm specializing in planning, architecture, engineering, project management and construction supervision.

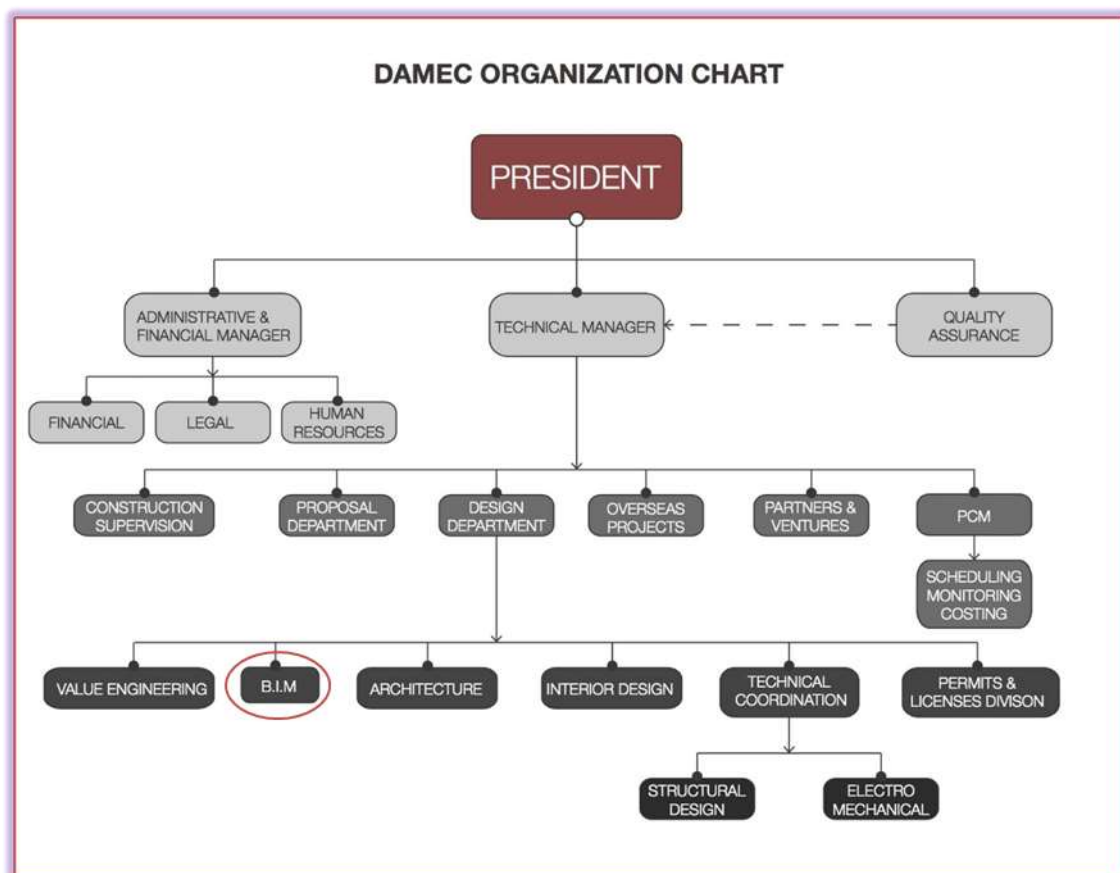


Figure 8: Dar DAMEC Organizational Structure

Source (<http://www.damec.net>)

The structure of the company is traditional and hierarchical. Three main units branch out from the authority of the president (or the CEO), which are the financial and legal departments, under which fall the Human Resources Department, the Quality Assurance Unit, and the Technical Department, which bears the bulk of the company's work, the most important of which is the design department.

The design department has a BIM unit in addition to many other engineering units such as the architectural department, interior design, technical coordination, licensing.

It is noted here that the company has not only separated the various specialized studies departments from the BIM department, but also separated the technical coordination department between the structural and mechanical/electrical disciplines from the BIM department. This is usually done by companies that still mainly use CAD in their work, and their projects vary between Traditional CAD work or work with some BIM software at the request of the investor

5.0 A proposed framework for the integration of BIM models in the structure of ACE companies

based on the results of analyzing the organizational structures of six international and Arab companies of various sizes and specializations that apply BIM technology in their projects, a classification of BIM organizational structures can be proposed according to the size of AEC companies according to the following

5.1 BIM models for small businesses (less than 50 employees)

5.1.1 consulting company only (design + supervision)

Figure 9 shows a proposal for a BIM model for small consulting companies. In this model, BIM is applied starting from higher administrative levels, reporting directly to the CEO or whoever acts on his behalf to manage technical affairs in the company, who is the technical director. One BIM manager with high technical and administrative experience is appointed whose role revolves around the BIM implementation plan at the company level and the management of the entire studies department according to BIM technology from scheduling time and cost and interacting with other departments and departments with regard to contracts, finance and human resources, as he chooses the employees of his department (coordinator and modelling team), supervising and evaluating them and providing them with the necessary support and training.

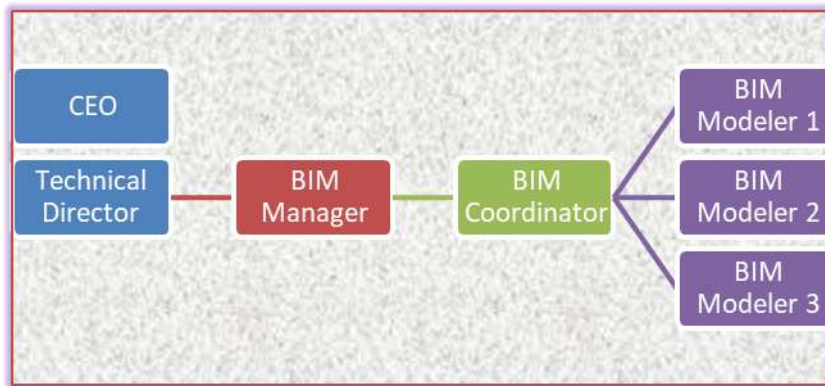


Figure 9: BIM Model No. 1 for Small Consulting Firms
Resource: Creations by authors (2023)

The company may have modest capabilities and cannot, at the present time, bear the burden of hiring more managers. In this case, it can reduce the previous model and combine the functions of BIM coordinator and BIM manager in one job title (BIM coordinator or digital construction coordinator) as in the figure 10:

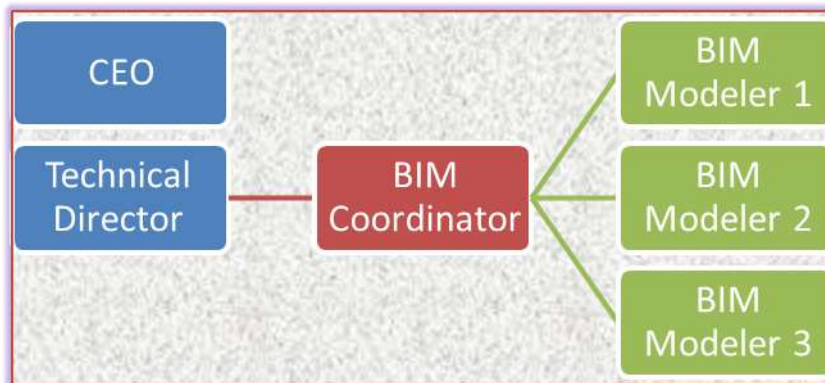


Figure 10: BIM Model No. 2 for Small Consulting Firms
Resource: Creations by authors (2023)

Or it may relinquish the portfolio of technical director and distribute his duties between the BIM manager and the CEO, as in the figure model 11:

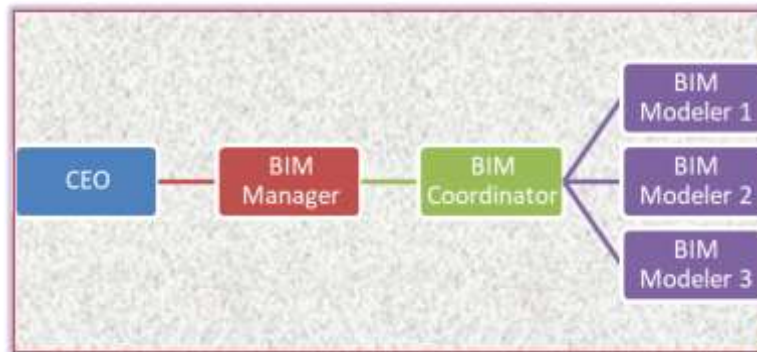


Figure 11: BIM Model No. 3 for Small Consulting companies

Or it may resort to merging the two solutions together, as in the figure 12:

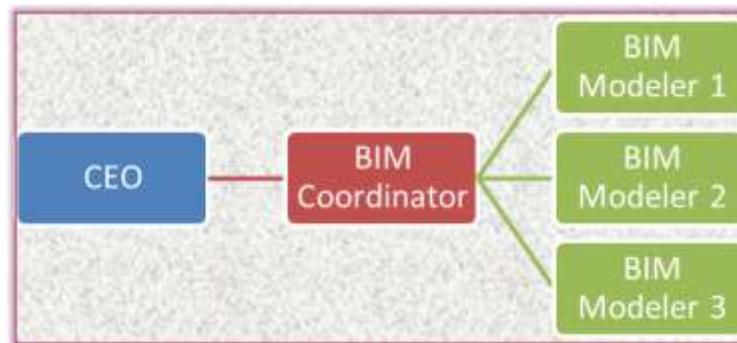


Figure 12: BIM Model No. 4 for Small Consulting companies
source: Creations by authors (2023)

5.1.2 Contracting company (studies & construction)

Figure (13) shows a proposed BIM model for small construction industry companies. In this model, there is one BIM manager with high technical and administrative experience who works at the company level and supervises the studies and implementation departments at the same time. In the event that the company is new to adopting BIM, the BIM manager can hire a BIM Application technical developer who is responsible for developing and customizing programs to support the integration of the BIM process and works as a specialist and trainer for new teams and individuals to use BIM at the same time.

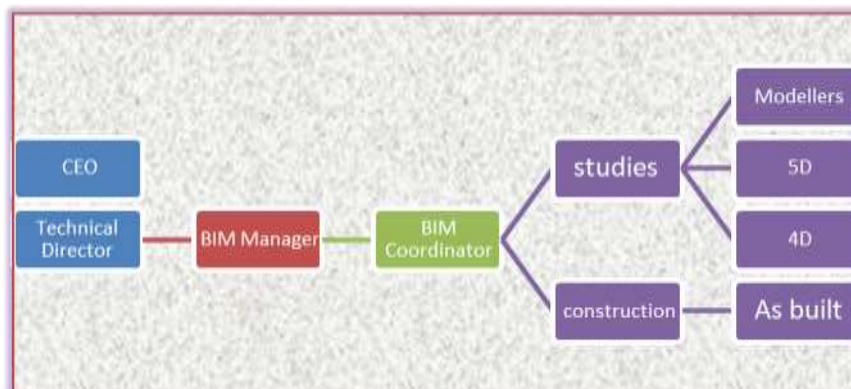


Figure 13: BIM model for small construction companies
source: Creations by authors (2023)

In the event that the capabilities of the company (due to the small size of its business) do not allow the appointment of all the managers and roles shown in Figure 13, then the role of the BIM coordinator and manager can be assigned to the BIM coordinator only, as well as giving up the portfolio of the technical manager and distributing his duties between the BIM manager and between CEO, or combine the two solutions together, similar to the scenarios in figures 11,12,13. The BIM manager also appoints a person responsible for modelling the As built diagrams in the implementation projects, and he is selected in coordination with the project manager, and his role can be dispensed with if the owner / customer does not wish to do so.

5.2 BIM for medium companies (between 50-500 employees)

For companies of this size, it means that it has a relatively large business volume and may be divided into branches or other sectors, and therefore it will need more BIM roles in the company. In this model, we assume that there is a central BIM manager at the company level with several BIM managers or coordinators reporting to it. The central BIM manager can have assistants with specific BIM roles such as specialist, developer, and consultant as in the figure 14.

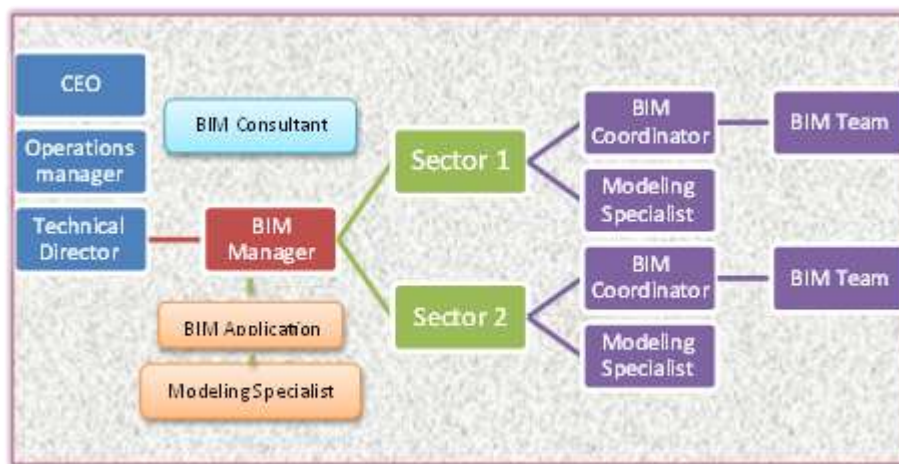


Figure 14: BIM model for medium AEC companies
source: Creations by authors (2023)

The CEO may appoint a director of operations at the level of the company and its divisions/projects and thus in this case the technical director will report directly to him and report to him. In each department, a BIM sub-manager or BIM coordinator is appointed, and he is supported by a Modelling Specialist expert according to the technical need of the department. The role of the operations manager here is to reduce the administrative burden on the CEO, and one of his tasks is related to coordinating the project implementation requirements according to BIM technology, according to the reports received from the senior BIM manager. Or the technical director and between the supporting administrative units, such as finance, human resources, contracts, and others.

It is important to clarify that there is a large discrepancy between 50 to 500 employees, and therefore this model cannot be generalized to all companies within this field, and it may be necessary to include more tasks and roles related to the BIM system, or on the contrary, two roles may be assigned to a functional role, and thus it is generated. There are many scenarios that stem from this model (for example, the company may not need to seek the help of a BIM consultant because it has become a professional in this field, or there is no need for an operations manager if the company is medium to small, and in this case the role of the technical director and manager is sufficient Executive, or the company may need a BIM coordinator for each department to report to a sub-BIM manager to increase the company's business volume and growth and thus a central BIM manager supervises the work of the sub-BIM managers who report to him, or the work may require the presence of more than one BIM coordinator for each department They assist the BIM sub-manager in his duties and so on..).

5.3 BIM models for large companies (500+ employees)

In this proposed model, the roles associated with BIM technology increase, and the role of the senior BIM manager revolves around developing general strategies and plans for implementing BIM technology at the entire level of the company's regions and branches around the world. A BIM specialist and developer reports to him, in addition to a central BIM support unit (may be one person or more) that performs with the task of contracting with trainers (BIM Facilitator) for new employees in the various branches of the company under the supervision of the BIM manager and in coordination with the human resources unit in the company

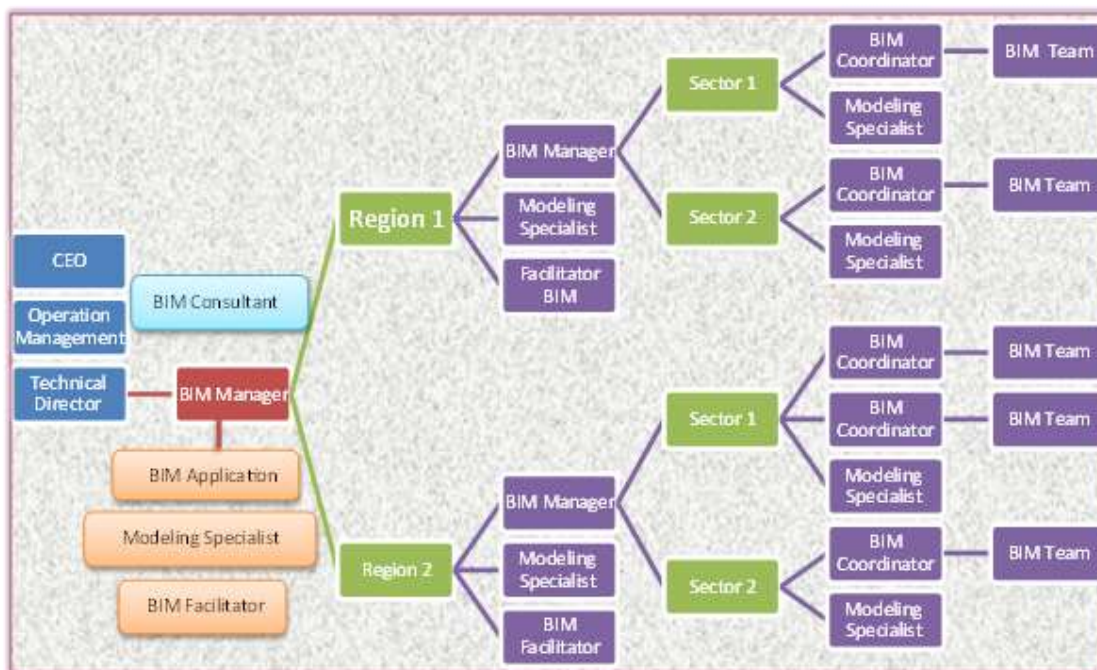


Figure 15: BIM model for large and mega AEC companies
source: Creations by authors (2023)

Each BIM Regional Manager is assisted by a BIM Specialist and a BIM Facilitator/ Support, and the BIM Regional Manager oversees the work of all departments within the region in which he/she manages the BIM system. The structure of the sub-sections becomes very similar to the structures of BIM models that have been proposed for medium-sized companies. At the level of work team members, detailed roles can be added to the BIM work teams in the project, such as the BIM Technician, who facilitates the workflow in a typical way and solves problems and small details without the need to call on special expertise for daily and repetitive tasks. The estimate of the need for it is up to the BIM coordinator for each department or project. The same previous scenarios that were discussed in the models of medium and small companies apply to us, that is, according to the growth or shrinkage of the company, it can expand in allocating new BIM positions or vice versa.

6.0 Discussion and results

- Many construction industry companies around the world never refer to any BIM module or model in their structure, although they are in countries that adopt BIM and implement their projects according to BIM technology. Therefore, it was not easy to find organizational models for companies that include a BIM module in their structure.
- Most of the companies analyzed did not clarify the BIM model and its associated functions within the organizational structure, e.g., who runs the business according to BIM? Instead, it has limited to represent the BIM unit at lower administrative levels of the structure without referring to any roles associated with it, which the researcher considers wrong, because working with the BIM methodology requires that the necessary changes be made to the organizational structure of the company so that the roles associated with the BIM system are represented in it, starting from higher administrative levels structure.

- FACTUMQA is the only company in the selected sample of companies that has explicitly integrated BIM into its structure.
- Most Syrian companies do not share their organizational structure on their website or social media, which makes the process of collecting and analyzing data more complicated than companies outside the country
 - Although successful and large companies are supposed to reflect the quality of their administrative performance on their organizational structure, on the other hand, it was observed that many of them do not have an ideal organizational structure that befits their reputation and name in the market.
 - Many large companies have been observed that are still keen to retain large engineering expertise even if it is difficult to develop them technologically, which indicates that the element of experience is still the basis for the success of any engineering work.
 - Transparency plays the most important criterion in judging the company's performance through its organizational structure. Not every good administrative structure necessarily means good company performance.

7.0 Conclusion

The research presented a proposed framework for the integration of BIM organizational models in the construction industry companies in Syria. During the study, he reviewed several administrative structures for companies around the world that apply BIM technology to benefit from their experiences in this field. The results of the study showed a weak representation of BIM models in the global AEC structures, as the work of the BIM methodology requires representation of the roles and levels of authority entrusted to it at higher management levels, and most of the companies included in the study did not do that. Thus, most of the AEC companies, even the global ones, need to adjust their structures to clearly reflect the integration of the BIM organizational model. It also recommends more research and case studies on the remaining aspects of BIM at the policy, operations and technology levels.

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