

Improving Vernacular Aspects and Design Performance of Project Management through Building Information Modeling: Insights from the New Giza Project in Egypt

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Abstract

Building Information Modeling (BIM) is a potential solution to numerous challenges in asset management, including missing data, incompatible software, and unclear business processes. However, the current use of BIM in construction projects has focused on the application of technology and digital information delivery, neglecting system compatibility and information needs. This oversight can lead to a gap resulting in varying levels of implementation or even project failure. There is limited research on the social factors and challenges associated with the use of BIM in construction projects. This study examines the primary challenges and solutions related to BIM implementation.

It employs a case study: the New Giza project. Interviews were conducted with key stakeholders such as owners, designers, contractors, software vendors, and construction supervisors. The findings are utilized to revise the items pertaining to the social aspects in the Egyptian BIM code. The research also examines mechanisms for organizing the social roles of project stakeholders, specifically the use of advertising and suggestions as tools within a RACI (Responsible, Accountable, Consulted, and Informed) matrix. This tool helps in organizing the roles of individuals and activities for stakeholders.

Findings reveal the potential of BIM to enhance inter-organizational communication within BIM-enabled projects, and exhibit a higher density of communication, stronger connections, and shorter communication paths among project participants. These outcomes indicate timely access to higher-quality information. The findings also highlighted the significant centrality of the 'BIM manager' and 'BIM coordinator', underscoring the effectiveness of these newly established roles in managing the flow of communication within construction teams.

Keywords: Collaboration, BIM, Egyptian Code of Building Information Modeling, RACI Matrix.

Introduction

Building Information Modeling (BIM) represents a significant advancement in the traditional lifecycle stages of the construction system, integrating virtual aspects, systems, and concepts within a unified 3D environment throughout the project lifecycle. A wide array of applications supported by BIM allows for the simulation of time, cost, constructability, and activity sequences, thereby facilitating better management of information, enhanced collaboration and coordination, improved stakeholder engagement, and more informed decision-making. As the value of BIM becomes increasingly recognized worldwide, its adoption rates are on the rise (Constructing Excellence, 2008).

Egypt's construction industry, plagued by poor management resulting in wasted time, costs, and materials, stands to benefit significantly from the implementation of BIM technology. Various techniques and tools have been developed to enhance project management processes and address challenges to meet stakeholders' expectations. If construction processes are effectively linked to BIM concepts, BIM technology could prove highly efficient at any stage of the project lifecycle in Egypt (Egyptian Building Research Center, 2023). However, Egypt currently lacks a developed BIM code that incorporates the social aspect, which is crucial for improving project efficiency. Furthermore, existing market scale studies often overlook non-software aspects of BIM adoption, failing to identify market gaps or accurately reflect the specifics of BIM implementation in the Egyptian context. Recent publications have underscored the need for research, highlighting the global and local potential of BIM to enhance industry performance and advocating for its adoption to foster a new digital design and construction culture in Egypt (Elyamany, 2016).

Therefore, the implementation of BIM in the Egyptian construction industry requires a phased approach, transitioning to advanced digital models necessitates new information technology (IT) skills, coordination, and collaboration processes, in addition to investments in technology infrastructure and software. This transition may introduce uncertainty among industry stakeholders and clients.

In this context, the BIM implementation strategy developed by this research aims to address industry-specific needs, proposing a strategic approach to facilitate BIM adoption in Egypt's construction industry (Adama and Kouider, 2019). It offers various stakeholders the opportunity to query, simulate, and monitor required activities throughout the entire project lifecycle. The paper explores several key objectives within the context of Building Information Modeling (BIM) projects in Egypt, focusing on the integration of the social aspect into project management and BIM technology. They are as follows:

- To measure the extent of achieving the social aspect in BIM projects in Egypt: This objective seeks to assess how well the social dimensions, including stakeholder engagement, collaboration, and communication, are incorporated and realized in BIM projects within the Egyptian construction industry.
- To apply project management mechanisms appropriate to BIM technology: The goal here is to identify and implement project management strategies that are suited to the unique demands of BIM technology, with a particular focus on enhancing the social efficiency of individuals involved in the project. This includes fostering better collaboration, communication, and teamwork among project stakeholders.
- To highlight the benefits of integrating project management and BIM: This focuses on demonstrating the advantages of combining project management principles with BIM technology to enhance the social efficiency of projects. It shows how this integration can lead to more effective stakeholder engagement, improved decision-making processes and a more collaborative project environment.
- To analyze the Egyptian Code for Building Information Modeling: This involves a critical examination of the existing Egyptian BIM code, with a focus on its social aspects. It determines whether the code adequately addresses social considerations and aligns with the international code ISO 1950, which is applicable to the case study.

- To apply project management mechanisms in the social aspect of the BIM Project and human resource management: Using the responsibility matrix and applying it to an actual case study, this addresses the shortcomings that may occur in projects in Egypt in the future by enhancing human resource management and applying project management mechanisms tailored to the social aspects of BIM projects.

Theoretical Framework

The theoretical framework addresses the social aspect from the perspective of ISO 19560, focusing on the determinants it outlines for the social dimension in projects. These are represented in the organizational aspect of individuals and the relationships among all stakeholders, which include:

The Role of the Social Aspect in Organizing Roles Within the BIM System

This part of the research addresses an important question: What makes the societal aspect of the work environment under the framework of Building Information Modeling (BIM) distinct and of a special nature? The answer will depend on several determinants, including the nature of projects, especially large-scale projects that require collaboration among multiple parties. BIM enables the linking of system parties in a more organized manner, as mentioned in the ISO 19560 section, where it defines the relationships among parties based on theories and specific foundations (ISO 12006-3, 2007). The main hypothesis of the economist Adam Smith (1723-1790) is that individual rivalry and aspiration serve the public good; this implies that everyone seeks their own interest, and the public good is achieved through competition among individuals striving to achieve their aspirations. This pattern is clearly observed in the work style of the work group. The second hypothesis, by the mathematician John Forbes Nash (1928-2015), posits that the public good is achieved when everyone works for their own benefits without conflicting with the public good of the group, which is evident in the work team strategy.

To understand the difference between the two concepts (the work group and the work team), groups begin to form from a collection of individuals and maintain their unity and strength as their numbers increase, driven by the commitment to communicating with shared goals. This is precisely what occurred in BIM, where it utilized network communication, taking advantage of the social media revolution. However, communication remains an individual choice, depending on the level of organizing and centralizing of interests. Members of the team must have an inherent willingness to cooperate, as there won't be effective use of BIM without treating the team members as a family and an essential part of the system, regardless of how modern the devices and programs are, even with an implementation plan (BS1192:2007 + A2:2016).

The Social Part of BIM According to the ISO19560 Viewpoint

The ISO 19650 standard is an international benchmark for managing information throughout the entire lifecycle of a built asset using Building Information Modeling (BIM). It encompasses the same principles and high-level requirements as the UK BIM Framework and aligns closely with the existing UK 1192 standards. ISO 19650 outlines the process of organizing individuals within the BIM framework, categorizing them into groups, specifying the role of each person, the tasks assigned to them, and coordinating the work parties, whether it be between the client and the architect or during the phases of execution oversight. To successfully implement BIM projects, not only are BIM-capable software and new methods required, but also changes in the structural organization of the project, particularly with the introduction of new BIM roles. (ISO 12006-3, 2017)

The organizational chart depicted in Figure 2.2 presents a simplified, model project structure organization. It illustrates both the client as an organizational unit and one or more contractors, such as the overall planner with project control and each architectural/specialist planning area. Project management is typically accessible to (partially) every organizational

unit. Depending on the purpose of the organizational unit, this is complemented by additional positions, for example, a steering board at the client, project control at the general planner, planning team at the specialist planners, etc. The diagram in dark blue now illustrates the roles that are added by BIM. Each figure should have a caption. The caption must be concise and typed separately, not on the figure area. If figures have parts (for example, A and B), ensure all parts are explained in the caption. (BSI, "PAS 1192-2", 2013)

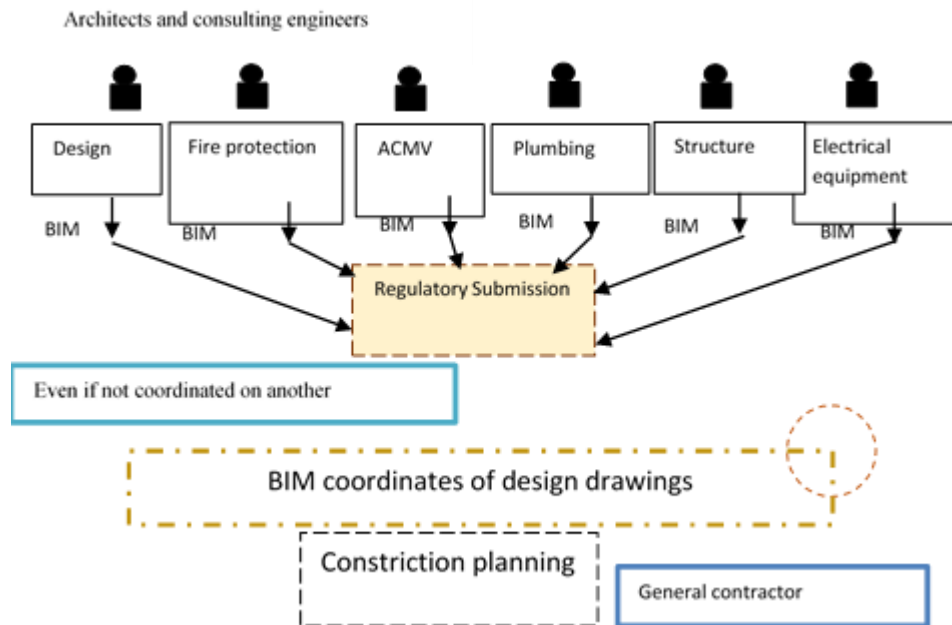


Fig. 1: "Status and role of the BIM projects Source: author based on ISO. ISO 12006-3, (2007). Building construction retrieved on 1-6-202."

Lead Appointed Party Related to the Project Stakeholders

In accordance with the contract (appointment) with the Lead Appointed Party, all parties accountable for creating and supplying information, work, or goods. The duties of an appointed party include: helping the lead selected party with making the BIM Execution Plan, concurring on which data and when ought to be created by each named party, establishing task data delivery plan(s) across the task group, collaboratively creating information according to the information standard and requirements, participating in the review of the information model (explained below). Team for the project: All parties involved in the asset's delivery process. (BSI, "PAS 1192-2", 2013) A part of the project team is both a party receiving information (Designating Party) as well as parties creating information (Lead Appointed Party and Appointed Parties). Delivery team: Everyone who is responsible for making the information. The delivery team comprises the Lead Appointed Party and their Appointed Parties. Depending on the contract type, it may be just a single delivery team or multiple. Task group: The group within the Delivery team (it may also be one individual) responsible for performing a specific task. For example, a primary planner or a contractor with its subcontractors and suppliers.

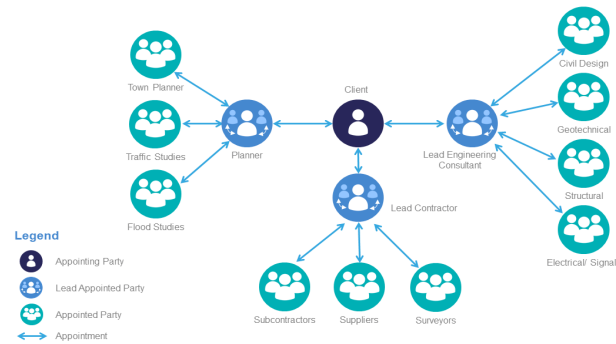


Fig.2: "ISO 19650 project team appointment relationships diagram for a typical civil project. Source: ISO 19650, Part 4, page 50."

Literature Review

Recent research has dealt with the introduction of BIM, its social aspect, strategies for developing BIM, and the challenges encountered at both human and economic levels. While the technical side of BIM is often studied, some researchers have recently presented BIM from a social aspect. Studies, including those by Wei Lu, Dan Zhang, and Steve Rowlinson (2013), argue that BIM introduces a new working logic in construction, emphasizing the degree of BIM collaboration. If a project team works more collaboratively and understands the value of BIM collaboration, they can perform more effectively in task delivery and information sharing. Greenwood and Wu (2012) has tested different degrees of collaborative working relative to project performance and identified that a higher level of collaborative working is likely to produce better project outcomes. Chen, Jingfeng Yuan, Tang, and Xiaer Xiahou argue that collaboration and social aspects are considered enablers for effective use of Building Information Modeling (BIM). However, the impacts of multiple collaborative behaviors on BIM effectiveness are less understood.

The results concisely show that, although numerous cooperative actions are deemed essential for BIM use, their execution does not directly contribute to the final effectiveness of BIM, suggesting that new interventions should be adopted to realize their positive impacts on BIM use effectiveness. This is supported by Yao Huang, Lufeng Wu, Jindao Chen, Hao Lu, Jiajun Xiang (2022) propose a social capital perspective that identifies inter- and intra-organizational connections from social commerce and common cognition to enhance communication networks, and the state of practice by suggesting strategies for strengthening organizational communication and collaboration in BIM-enabled network relationships. Similarly, Suwal, Jävåjä, and Porkka (2013) link BIM to social aspects to enhance end-user participation and social commerce, yet the mechanisms of its operation in case studies were not discussed. It's crucial to assess the long-term social impacts of adopting new technologies or systems (Xiahou et al., 2018) while relating social indicators to estimate and predict the system's performance and behavior in the social environment (Ahmad & Thaheem, 2017). Valdes Vasquez and Klotz (2013) link 50 indicators for social sustainability and performance assessment during the design and planning phases of construction systems. Zuo et al. (2012) have conducted a study assessing 26 criteria of social performance according to three domains: macro-level issues, internal stakeholders, and external stakeholders (Adamu, Emmit & Soetanto, 2015).

For example, Yarmo Hammadi (2017) et al. have analyzed log files from an architecture and design firm to investigate the presence of design patterns and characterize the performance of BIM modelers by identifying patterns of sequential commands and quantifying the time taken to execute them. Zhang et al. (2018) have focused on identifying patterns in designer behavior, finding three most-used commands that vary among designers and measuring the most efficient patterns for project work. Pan and Zhang (2020) have applied fuzzy clustering methods to explore a massive amount of BIM log files to identify productivity

patterns in modelers' behavior, revealing specific time periods of better performance and evaluating the benefits of grouping designers with similar productivity.

The research gap in Egypt includes the lack of application to existing projects, especially in the construction phase, which is essential to develop strategies for BIM in the Egyptian market, understand the reasons for shortcomings or failures in current projects, and focus on the human aspect, one of the most critical determinants of system success and improving the overall efficiency of construction projects in Egypt.

Research Methodology

The research methodology relies on the theoretical framework based on previous studies that link the social aspect to BIM, examining international code systems like the ISO 19560 code for BIM. It explores the use of the RACI and RASCI matrices as tools for defining responsibilities, employing a responsibility distribution matrix to delineate roles for completing a project, segmented into various tasks.

The research encompasses an examination of existing literature related to the social aspect of Building Information Modeling (BIM) and the mechanisms for its application, analyzing the outcomes of such research, and reviewing the key findings. It then delves into a theoretical framework centered on the social roles of individuals, their interrelationships, and the governing determinants, leveraging the ISO 19560 code for BIM as a foundational reference.

The practical component of the study focuses on the New Giza residential project in Egypt, an ongoing BIM initiative. This case study is divided into two segments. The first involves conducting questionnaires and open interviews with a sample of 10 individuals employed in various capacities within the project, alongside a review of project documents, including the BIM protocol and its evaluation, to ascertain whether the organization of social roles has been adequately addressed. The application of the RACI Matrix, a tool for defining responsibilities, will be explored as a means to enhance the social role in BIM projects involving multiple stakeholders, such as the New Giza project. Upon analyzing the findings, the study will propose the inclusion of provisions for organizing the social role within the BIM system in the Egyptian Code for Building Information Modeling.

The Egyptian Code and the ISO Code to Support the Social Aspect as a Local Code

Egypt's construction industry suffers from poor management, leading to wasted time, cost, and materials. Various strategies and tools have been developed to improve the project management process and address challenges to meet stakeholders' expectations. Linking construction processes to BIM concepts could make BIM technology effective in managing projects at any stage of the project lifecycle in Egypt. BIM codes and standards play a critical role in the process of integrating construction, yet Egypt lacks a developed BIM code that overlooks the social aspect, which is fundamental to enhancing the efficiency of the project. It is crucial to develop the Egyptian code for building information modeling to meet the social and humanitarian needs in the construction industry. (Egyptian Building Research Center, 2018) A comparison was made of the most important items to be mentioned or developed in the Egyptian BIM code, with reference to the international code, which is the ISO 19560 code, in Table 6.2. The items that have a direct impact on the social aspect of BIM were mentioned to maximize the application of the Egyptian code within the system.

Table 1: "A comparison between the Egyptian BIM code and the ISO 19560 code. Source: Researcher based on ISO 19560 and the Egyptian BIM code."

Items to be developed in the Egyptian BIM code	ISO 19560 BIM code	Egyptian code of BIM
Understanding the role and the team context	The ISO 19650 series refers to the appointing party, lead appointed party, appointed party, and the project team, delivery team, and task team.	This part was not clearly defined, being reduced to the cooperation part, and the role of each individual within the system was not defined.
The common data environment (CDE)	The ISO 19650 Part 1 Concepts guidance, available on the UK BIM Framework website, explains how the CDE is a combination of technical solutions and process workflows.	It was mentioned, but the methods used to exchange information were not detailed.
Information requirements	ISO 19650-1 defines the term "information requirement" in clause 3.3.2, with a more detailed explanation provided. According to the ISO 19650 series, information should be created for a specific purpose—to be utilized by someone.	It is mentioned, relying entirely on the ISO standards.
Hierarchy of Information Requirements	They are clearly stated, and all items are covered. ISO 19650-1 defines the term "information requirement" in clause 3.3.2.	It was mentioned but was not differentiated between the design and construction phases, being briefly and generally mentioned.
BIM execution plan	To satisfy the requirements of ISO 19650-2, a BIM execution plan (BEP) must be provided by the prospective lead appointed party in their tender response (see ISO 19650-2 clause 5.3.2).	It relied on the British code, the latest version, but was not updated according to the current Egyptian market requirements.
Collaborative production of information	Access to reference information and shared resources should be verified by each task team (appointed party) when the generation of information is about to begin.	Cooperation was extensively mentioned without specifying the role of each party within the collaboration.

The most significant aspects of the social dimension were examined in the preceding chapter. The focus will be on the ISO code, as it is the most recognized standard, and its adaptation with respect to the Egyptian market and the nature of construction projects in Egypt, before applying it to an existing project, which was discussed in the first chapter. Understanding your role and the team context: As touched upon by the ISO code and other international standards, this chapter will concentrate on developing a proposal to enhance the social aspect of BIM in the Egyptian BIM code. The Egyptian code reduced the social aspect to cooperation from the perspective of work techniques rather than the human aspect. Therefore, some titles will be proposed that emphasize the roles assigned to each individual. Subsequently, it will be applied to an actual ongoing project and tested using the Egyptian market. (Chen, G., Chen, J., 2022)

RACI Matrix as a Tool to Organize the Social Roles of All Parties Within the BIM System:

Project management is a complex process involving multiple stakeholders, tasks, and resources. To ensure the success of a project, it is crucial to assign clear roles and responsibilities to team members and accurately define their tasks. This may involve contending with matrix structures, rapid growth, mergers, multiple locations, virtual employees, and/or digital transformation. RACI (pronounced "ray-see") is a powerful tool that clarifies individual or group roles for each task in a project or business process, creating a simple language to discuss roles and responsibilities within an organization. First introduced in the 1950s, RACI was originally called the "Decision Rights Matrix" and is also known as "Responsibility Charting." There are also other RACI variations, like RASCI, ARCI, and

DACI. It is the only project management tool that specifically addresses people and roles. When team members are unclear about their responsibilities and accountabilities, conflicts develop, tasks are forgotten, time is wasted, and resentment builds. (ELHADY, ABOSHAMA, 2015) Alternatively, no one may focus on a critical project, leading to diminished accountability. Often, these problems are perceived as the faults of the individuals involved (the “jerk theory”), but they are frequently caused by communication gaps or misunderstandings between individuals or groups. Using the RACI language to clear up confusion or creating a RACI chart to clarify the team's roles and responsibilities helps create a shared, neutral project plan. Ensuring that the team is on the same page helps keep the project focused and on track. The RACI matrix charts project participants and activities, assigning one of four roles to participants on any given task or activity: Responsible (R), Accountable (A), Consult (C), and Inform (I).

Table 2: RACI matrix roles source : <https://www.racisolutions.com/blog/topic/raci-case-studies>

R	Responsible-person working on activity
A	Accountable-person with decision authority
C	Consulted-key stakeholder who should be included in decision or work activity
I	Informed-need to know decision or action

Methodologies for Applying RACI Matrix Within the BIM System:

For teams, RACI improves the flow of information and trust between members. For businesses, RACI leads to faster alignment, less churn, and a continuous push towards results. Not every project needs RACI, but many can benefit from the clarity and transparency the chart provides. Once you start using the RACI framework, Range becomes the simplest way to track project updates and keep everyone—R, A, C, or I—accountable and informed. (Bristol, 2020)

- 1) Assign clear project owners for goals and deliverables.
- 2) Share lightweight updates to keep every stakeholder informed.
- 3) Include context and links to your other tools, making it easy for Cs to provide feedback, Is to stay updated with your project one-pager, and more.
- 4) Organize tasks and sub-tasks, making them easily searchable with a Hashtag.

The Case Study: New Giza Project, Egypt

Case study of the New Giza residential project, which is a mega residential project in which BIM technology was applied from the design phase and feasibility studies to the construction and maintenance phase. The goal of applying BIM in the project was to create a digital simulation of the units so that the facilities management could maintain the units and for each residential unit to have all the necessary information. BIM is also used in the project to cost the price of materials, as the project has many subcontractors and a large number of parties and clients, as well as applying smart technology to the units, which makes it a project of a new nature to the Egyptian market. The main goal of the BIM system in the project is to create a digital information base for the project and calculate costs., the project has completed some stages, The study will analyze the project documents and the BIM protocol sourced by the project owner and identify the shortcomings in the application of the BIM system in terms of dealing with different parties within the multilateral system and using project management thought in developing the social aspect and the possibility of integrating it with technology.

Project Description

New Giza project One of Egypt's largest investments in the past ten years is the. It comprises of private, clubs, administrations, shopping centers and diversion regions. It is one of the main undertakings, with noteworthy vistas of the Pyramids of Giza and the city past, New Giza is situated on Cairo-Alexandria Desert Street (Kilometer 22). With an all-out developed area of 281,329 m² (New Societies in Egypt,2023).

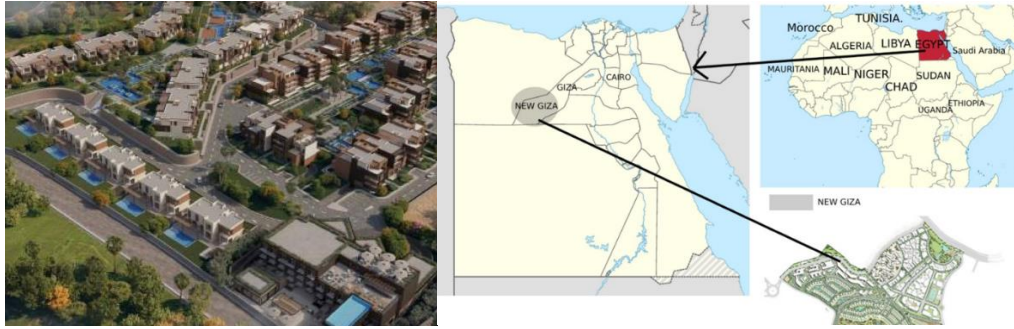


Fig. 3: A map of New Giza with the location and division of service

Sources: www.newgiza.com

Qualitative Analysis

The research involved a qualitative analysis approach, indicating that the observations were not solely quantitative but also focused on understanding the depth and nuances of the topic. Qualitative methods included thematic analysis, content analysis, and interpretative approaches to draw insights from the collected data.

Data Collection

The data was collected through the project documents, which are represented in the BIM Execution Plan for the project and analyzed, as it is subject to the ISO 19650 BIM code, and also through conducting open interviews with some parties from the project, which is a selected sample, and it is represented by the BIM Manager for all parties, the project consultant, the designer, the client, and the contractors. This was done by asking them questions about the social and organizational role of BIM within the New Giza project, and the results were as follows:

Open Questionnaire

This section applies expert non-probability sampling methods to provide detailed insights understanding of the topic studied. This research method has been developed since the early 1990s as a qualitative method that seeks to understand the knowledge of experts in a specific field site. This section focuses on assessing the current BIM dissemination status from the following perspectives: From the point of view of the most influential parties in the New Giza project. Interview questions are asked based on their situation Expectations and selected comments from expert interviews Three questions were asked to them based on their experience in the current project: Are the activities, role and powers that they carry out clear The following figure shows the results of the questionnaire.

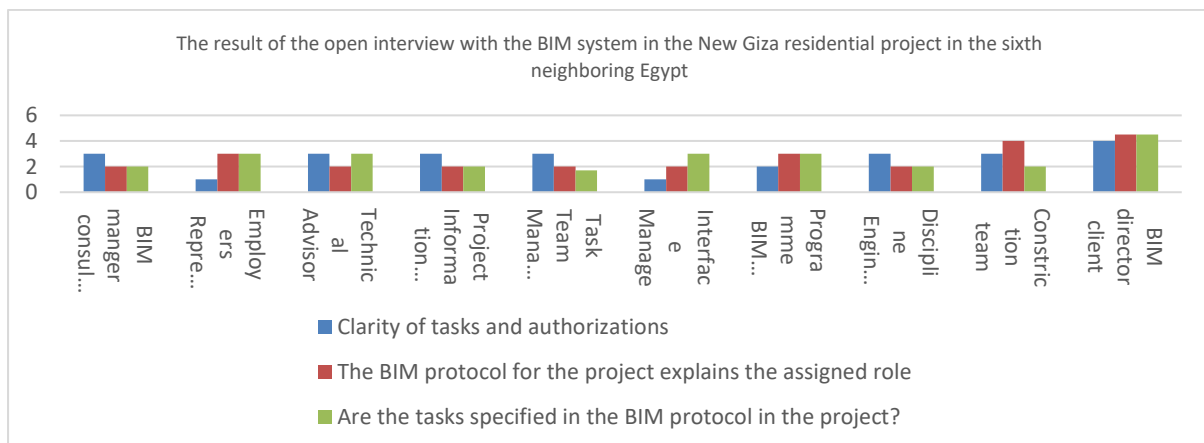


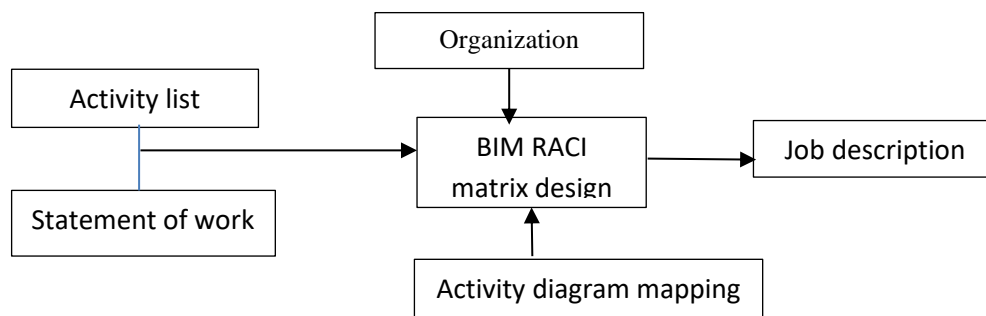
Fig. 4: shows the results of the questionnaire from 1 to 5 and 5 means the maximum score for the standard application

The results of the questionnaire were as follows: The results of the questionnaire show a lack of clarity of the social vision in the BIM protocol for the New Giza project and a lack of clarity of activities and their relationship with the stakeholder. This is due to the lack of a clear methodology for the BIM projects currently established because there is no specific body to refer to or a code that suits the nature of the project. Egyptian market for reference (BXP NEW GIZA, 2017), According to the questionnaire prepared for the method of working specific task rules for each person, where task rules are prepared according to the nature of the project, its condition, and the work environment, and to clarify interest regarding some information related to BIM, whether in design, work, or supervision of implementation. Project Resource Management is a stage in identifying, obtaining, and managing the resources needed to achieve project objectives. This stage aims to ensure that each project resource has been allocated to the right place. When resources are not managed and controlled properly, it will increase the risk that can hinder project completion. There are many methods of data representation used in resource management that aim to document and communicate the roles and responsibilities of team members. In comparison, the data representation is presented in a hierarchical, matrix, or text-oriented form.

Methodology:

The conceptual model is a framework that shows the relationship between several ideas to solve a problem. Conceptual models can explain the relationship between these concepts. Based on the conceptual model in above, it can be seen how the relationship between each data in this research process in designing the RACI Matrix. At the initial stage, identifying and collecting project data is carried out and describes the activities carried out on the project follow

Fig 5: The methodology of the responsible matrix.
Source: Researcher



RACI Matrix will be created in three ways:

1. The first method is all activities, stakeholders and parties in one matrix
2. The second method is dividing the stakeholders into internal and external stakeholders, separating the activities of each, and dividing the stakeholders from the consultant's point of view. Comparison will be made between the two parties, and the disadvantages and advantages of each method will be mentioned, but the steps for creating a RACI matrix will be the same according to the criteria for spreading the RACI matrix mentioned previously
3. The third method is to use the RASCI Matrix by merging a person who support with the person responsible for tasks RASCI stands for Responsible, Accountable, Supporting, Consulted and Informed. It's important to remember that one person could be more than one part of the RASCI Matrix on different tasks within a single project. The managers task and key decisions we use involve DACI MATREX
4. All the matrixes and the mechanisms used to raise the social efficiency of the project's BIM system are compared.

Stakeholder Register

A stakeholder register is a document used for project management in identifying, assessing, and classifying stakeholders involved in the project. The Stakeholder register can provide a sample of the stakeholder, as the project has a large number of stakeholders, but the sample was chosen and is directly affected BIM system.

Table 3: sample BIM Stakeholder Register New Giza project
Source: Author

NO	stakeholder	Stakeholders Classification
1	BIM manger consultant	Internal
2	BIM director client	External
3	Facility management and operation team	External
4	Technical design team	Internal
5	Project manager design	Internal
6	Project manger contraction	Internal
7	Contractor and sub-contractor team	External
8	Software developer	External
9	Management team	External
10	Construction supervision team	Internal
11	Project information manger	External
12	Systems Integration Engineer	External

Activity List

An activity list is data that contains a description of the project activities. The Activity List also explains the scope of work and job descriptions for each work package in detail, making it easier for the project team to understand the work completion. Table 4 has shown the activity list for the BIM tasks related to construction project. Some activities were also chosen to apply the matrix, which are activities related to the decision-making process and organizing the BIM system.

Table 4: sample of activity list New Giza project Source: Author

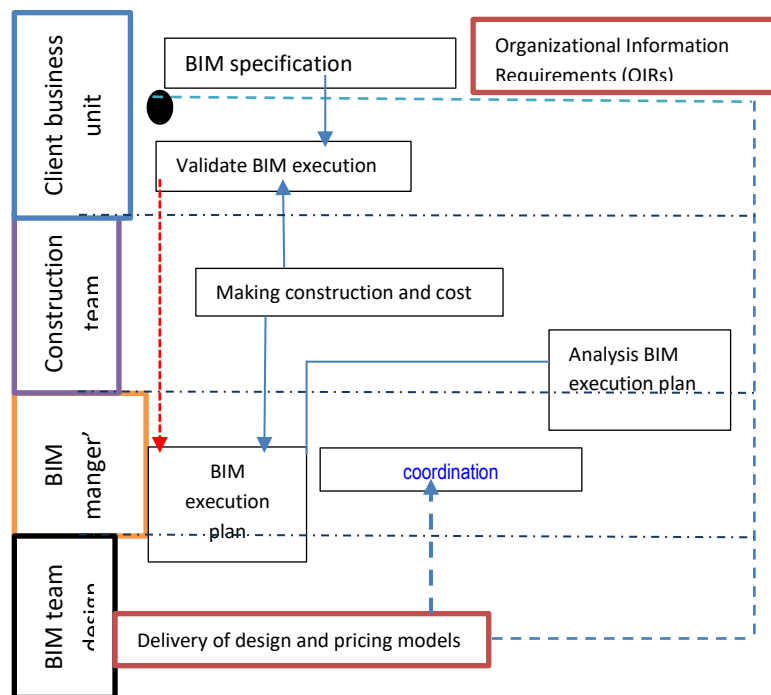
NO	Job description	Activity List
1	make and develop BIM execution plan and develop a project path plan	BIM Execution Plan is a document/resource that outlines how a project team will use BIM workflows, tools, and techniques to achieve the desired project outcomes. It includes details such as the roles and responsibilities of those involved, the timeline for the project, and the deliverables that will be produced.
2	Confirmation of Key Decision Points	Determine the purpose of your database, Find and organize the information required
3	Definition of Information Requirements	the role of BIM manager is to implement all the procedures in BIM and Digital Construction during the design, construction, and handover of a project. A BIM manager leads and supports the use of digital technology to create BIMs in the AEC sector
4	Provision of Guidance, Training and Mentoring to Project Team	An individual can discuss or develop ideas they have with a mentor. The mentor can provide unbiased advice or opinions based on their relevant knowledge and experience. With these insights, the mentee can more effectively choose what steps to follow and whether to pursue the idea or reconsider it.
5	Compliance to BIM Process Maturity	Software engineers apply engineering principles and knowledge of programming languages to build software solutions for end users. Software engineers design and develop computer games, business applications
6	Reviewing the models received from the contractor and verifying their compliance with the BIM protocol	The objectives of the model review are to verify that the current stage of the design meets the minimum project requirements for operability, maintainability, constructability, and functionality, and that it reflects every disciplines' input to the design to date

7	Compare models with design	M coordination is the process of bringing together BIM models across disciplines and resolving any conflicts that occur between them.
8	Confirmation of Supplier Capability to Deliver Information Requirements	It is reviewing the technical problems on the site and matching the models with the relevant programs
9	BIM for facility management	The Operation & Maintenance (O&M) phase spans a very long period. O&M costs far exceed those of any previous phase, averaging 70% of total life-cycle costs.
10	Provide Assurance to Employer that Agreed Information Exchanges have Ability to be Delivered against Agreed Program	Model validation refers to the process of confirming that the model actually achieves its intended purpose. In most situations, this will involve confirmation

Activity diagram:

An activity diagram is a chart with certain symbols representing the flow of a series of work activities in detail and describing the relationship between one process and another in an activity. An activity diagram is a tool used to describe a process in detail. Activity diagrams have symbols consisting of squares, and other shapes connected by arrows.

Fig. 6: A diagram of activities, source: Author according to NEW GIZA project activity list



5. 2 RACI Matrix

The following is a RACI Matrix table that has been adapted to the project business processes. Ten project activities have been adjusted to the activity list, and there are nine stakeholders involved in this case study project.

Table 5: RACI MATERX first way All activities and all stakeholder on one matrix

Project Deliverable (or Activity)	(BIM) Roles				Project Team					
	BIM manager consultant	BIM director client	System Engineer	Project information manager	Facility management and operation team	Technical design team	Project manager design	Project manager contraction	Contractor and sub-contractor team	Construction supervision team
Make a BIM execution plan and develop a project path plan for BIM	R	A	I	C	I	I	I	I	I	I
Confirmation of Key Decision Points	C	R	I	C	C	I	A	I	I	I
Definition of Information Requirements	R	A	C	C	I	I	I	I	I	I
Provision of Guidance, Training and Mentoring to Project Team	R	A	I	I	I	I	I	I	I	I
Compliance to BIM Process Maturity Mod	R	C	I	I	C	C	A	I	I	I
Reviewing the models received from the contractor and verifying their compliance with the BIM protocol	R	C	I	I	C	C	A	I	I	I
Compare models by design	C	I	I	I	C	R	A	I	I	i
Confirmation of Supplier Capability to Deliver Information Requirements	C	I	I	I	C	C	C	A	I	R
Authorization of Information as Contractual Documentation	C	A	I	I	R	C	C	C	I	i
Provide Assurance to Employer that Agreed Information Exchanges have Ability to be Delivered against Agreed Program	C	A	R	I	I	C	I	I	I	i

Following is a RACI Matrix table that has been adapted to the project business processes. Ten project activities have been adjusted to the activity list, and there are nine stakeholders involved in this case study project. It is also possible to use another type of matrix, which is RASCI, which is the same as RACI, but with the addition of a support field, which is S. It is more effective in projects with complex and multiple tasks that require support from more than one party.

Table 6: RACI MATERX second way dividing stakeholder internal and external source: author

RACI MATREX	External					Internal				
<div> <div>Role</div> <div>Project Deliverive</div> </div>	Facility management and operation team	BIM director client	Systems Engineer	Project information manger	Contractor and sub-contractor team	BIM manger consultant	Technical design team	Project manager design	Project manager contraction	Construction supervision team
Make a BIM execution plan and develop a project path plan for BIM	I	A	I	C	I	R	I	I	I	I
Confirmation of Key Decision Points	C	R	C	C	I	C	I	I	I	I
Definition of Information Requirements	I	A	I	C	I	R	I	I	I	I
Provision of Guidance, Training and Mentoring to Project Team	I	A	I	I	I	R	I	I	I	I
Compliance to BIM Process Maturity Mod	C	A	I	I	I	R	C	C	I	I
Reviewing the models received from the contractor and verifying their compliance with the BIM protocol	C	A	I	I	I	R	C	C	I	I
Compare models by design	C	A	I	I	I	C	R	I	I	I
Confirmation of Supplier Capability to Deliver Information	C	I	I	I	I	C	C	C	A	R
Authorization of Information as Contractual	R	A	I	I	I	C	C	C	C	I
Provide Assurance to Employer that Agreed Information Exchanges have Ability to be Delivered against Agreed Program	I	A	R	I	I	C	C	C	I	I

The Table 6 shows the results of the preparation of the assignment matrix based on internal stakeholders from the project owner point of view. Based on the results of the formation of the RACI Matrix in the table. 4-5. Determination RACI Matrix elements are formed based on the roles and responsibilities of each stakeholder that has been established in the business process. As for R (Responsible) Provides information that the team member is the person who

is responsible for carrying out a task that he gets to completion. A (Accountable) is information that this team member is responsible for all tasks assigned these team members. This person also has the authority to make decisions related to the assignment. This role is crucial because this person is responsible for every decision he has made. C (Consulted) is someone who gets this role and has expertise in their field. Usually, this role is often used as a consultant on project activities. I (Informed) is a person who always gets information on the project progress being carried out, and every decision taken must be communicated to the person assigned to this role.

A matrix can also be applied RASCI stands for Responsible, Accountable, Supportive, Consulted, and Informed. It is an extension of the RACI matrix and includes an additional role, "Supportive." The Supportive role represents individuals or roles that provide assistance or support to the Responsible party. The RASCI matrix is often used in complex projects or processes that require additional support or resources. It helps to identify individuals or roles that are crucial for the success of a task or activity, but may not have direct responsibility or accountability. The RASCI matrix provides clarity on both responsibility and support structures within a team or project.

Table 7: RASCI MATERX with adding support person

Source: Author

Project Deliverable (or Activity)	(BIM) Roles				Project Team					
	BIM manger consultant	BIM director client	System Engineer	Project information manger	Facility management and operation team	Technical design team	Project manager design	Project manager contraction	Contractor and sub-contractor team	Construction supervision team
Make a BIM execution plan and develop a project path plan for BIM	R	A	I	C	I	S	I	I	I	I
Confirmation of Key Decision Points	C	R	I	S	C	I	A	I	I	I
Definition of Information Requirements	R	A	C	C	I	S	I	I	I	I
Provision of Guidance, Training and Mentoring to Project Team	R	A	I	I	I	S	I	I	I	I
Compliance to BIM Process Maturity Mod	R	C	S	I	C	C	A	I	I	I
Reviewing the models received from the contractor and verifying their compliance with the BIM protocol	R	C	I	I	C	S	A	I	I	S
Compare models by design	S	I	I	I	C	R	A	I	I	i
Confirmation of Supplier Capability to Deliver Information Requirements	S	I	I	I	C	C	C	A	I	R

Authorization of Information as Contractual Documentation	S	S	I	I	R	C	C	C	I	i
Provide Assurance to Employer that Agreed Information Exchanges have Ability to be Delivered against Agreed Program	S	S	R	I	I	C	I	I	I	i

In case of knowing the power of each person, the Daci matrix can be used A Daci matrix, also known as a Daci chart or Daci framework, is a diagram that identifies the key roles and responsibilities of stakeholders and project team members for each major task within a project.

Table 8: Daci MATERX

DASI MATREX				
Role	BIM director client	BIM manger consultant	Project manager for consultant	Business Unit Manager for Client
Activity)				
Confirmation of Key Decision Point	I	A	I	D
Determine the workflow of the BIM system and asset management mechanisms	D	A	C	I
Define criteria of team that will work in the BIM system and determining the human resources for the project	D	C	C	A

Source: Author

The Daci matrix serves as a visual representation of the functional role played by each person on a project team. Creating this responsibility assignment matrix is also an excellent exercise to gain support for an agreed upon decision-making process for the project. Daci is an acronym for driver, approver, consulted, and informed. Each letter represents the role and level of participation for an individual or group for the corresponding task/milestone. Let's dive into the definition of each of the Daci roles. Driver (D) This role is generally reserved for the project leader or manager. While there are special cases where multiple Drivers are involved in a single project, particularly when heading up different tasks of a large or complicated project, this does complicate the process. In either case, the driver is accountable for overseeing an entire project's lifecycle from inception to completion. Some of the Driver's core responsibilities include:

1. Establishing and ensuring project deliverables
2. Assigning individual tasks and activities
3. Setting goals, milestones, and deadlines
4. Organizing and running meetings
5. Maintaining project documentation

Results Analysis

In all the previous matrixes, it is required that there be one person responsible and another person accountable, and not more than one person, so that tasks and powers do not overlap. In the event that more than one person is responsible for one activity, the activity is divided. Based on the Tables 5,6,7,8 RACI and RASCI and DAsCI Matrix above has formulated the roles and responsibilities for each stakeholder involved in the new Giza project. The management of the work assignment matrix using the RACI Matrix method has been formed. There are ten main stakeholders involved in the new Giza project which is classified

into four classifications according to the components in the RACI Matrix and has been adjusted to the roles and responsibilities of stakeholders sourced from business processes and activity list projects. The other method is to divide the stakeholder into internal and external. Comparing the two methods shows that there are several disadvantages and advantages.

The first method is more suitable for managing BIM projects in the implementation supervision phase, since through it it is possible to link activities to each other and link the stockholder to each other, as the BIM system is basically based on cooperation between... All parties and the second method are suitable if we manage a more classification of specific tasks in the project and tasks that are completely separated or restricted to a specific team. In the end, the project manager must adapt the vertical matrix tool in BIM projects to suit the nature of the projects, whether in the design stage or the construction supervision stage. the RACI matrix and the RASCI matrix are valuable tools for defining and clarifying roles and responsibilities within project management. The RACI matrix focuses on the primary roles of Responsible, Accountable, Consulted, and Informed. It helps establish clear lines of responsibility, decision-making authority, and communication channels. On the other hand, the RASCI matrix expands on the RACI matrix by adding the Supportive role, which recognizes individuals or roles providing assistance and resources to the responsible parties.

This extension is beneficial in complex projects that require additional support for successful outcomes. In the event that a decision is made among the highest stakeholders, a DACI is made. The benefit of it is that some tasks in the BIM system may be unclear, and program approvals and work sequences must be clearly. Who is responsible for these approvals, which requires the work of this matrix, but it is at the level of managers and stakeholders with authority. In the project, the result is that the BIM system needs clarity of tasks before starting so that there is no overlap of responsibilities, authorities, and activities, and it should be integrated with project management science to organize the work sequence in such projects.

Table 10: Comparison of the three matrices

Matrix name	RACI	RASCI	DACI
The differences	A matrix for determining responsibilities consisting of a responsible person, an accounting person, a information person, and a consulting person	Same RACI matrix with increased supporting element	Define responsibilities at the authority level DACI Decision Making Framework. Use this framework (stands for "driver, approver, contributor, informed") to make effective and efficient group decisions.

Discussion and Conclusion

There is a growing global interest in adopting BIM due to its tremendous potential in solving industry challenges and facilitating project implementation and operations. BIM introduces a new working logic in construction. The constructs capture the degree of BIM collaboration. If a project team is able to work more collaboratively and understand the value of BIM collaboration, they can perform more effectively in their task delivery and information sharing, resulting in projects being completed more efficiently. Consequently, all stakeholders can benefit from time savings, cost savings, and improved quality. The collaborative process within BIM implementation is essential for the exchange of project information and professional knowledge, ensuring all parties are satisfied with project performance due to such efficient and effective interaction. Given the essential role that collaboration plays in construction projects, it is important to understand the collaborative process within BIM-enabled projects that leads to higher efficiency and better performance.

The RACI matrix can provide convenience in managing stakeholders in construction projects. It groups the roles of each stakeholder involved in the project into four components: responsible, accountable, consulted, and informed. The design of the RACI Matrix for the case study project of New Giza began with conducting interviews and identifying stakeholders

involved. With the formation of the RACI Matrix, the roles and responsibilities of each stakeholder in the project will be more precise, and job description documents can be more easily determined.

The purpose of designing the RACI Matrix is to overcome the delay factor caused by stakeholder and resource aspects, positioning the project owner as a decision-maker. With the RACI Matrix, it is hoped that communication between the project owner and all stakeholders involved in the case study of New Giza will be facilitated, and the role for each stakeholder has been well managed, reducing the risk of obstacles caused by resource management factors at the next project stage. As for suggestions for future research, investigation into finding a mechanism to develop the Egyptian code for building information modeling to address the social aspect comprehensively is recommended, and the case study can contribute to this. It was applied to the New Giza project, which is one of the few projects in Egypt that applied BIM in the construction phase and throughout the project lifecycle.

Table 11: A proposal for next research to develop the social part of the Egyptian code
Source: Authors, 2018

Proposed Items to develop the social part of the Egyptian		
Item name according to the Egyptian BIM code	The most important thing mentioned on items	Proposal to develop the section
Developing the Collaboration section	The item explained the value of cooperation in the Egyptian code, but it did not explain its mechanisms or study them in the first place, which makes it ambiguous for BIM projects in Egypt.	Mention the mechanisms of cooperation It is possible to benefit from the case study of the New Giza project and other cases and research into other mechanisms
The section on the BIM Execution Plan	The components of the document were explained, but the part related to the social aspect and the relationship of the parties to each other was not mentioned	This part of the ISO19560 code can be quoted for BIM
Section on information exchange	Mechanisms and databases were mentioned, but it was not mentioned how the human and humanitarian element will be qualified and the culture of cooperation will be spread, which is the main purpose of these systems.	It is possible to benefit from BIM projects that applied Data Exchange in several ways and to benefit from them in a way that suits the Egyptian market and the BIM system in Egypt.

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