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Challenges affecting efficient management of virtual teams in construction in times of the COVID-19 pandemic

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ABSTRACT

Team development is critical to the success of any organization, especially in construction projects. If the team includes members from diverse locations, it brings diversity to the team. In recent times, a new breed of virtual teams has evolved in various construction organizations. However, coordinating such virtual teams on building projects remains a difficult challenge. Therefore, this research aims to identify the factors affecting efficient virtual teams to manage and tackle the challenges of virtual teams in construction projects in Egypt. To achieve the research aim, a combination of comprehensive research methods is adopted, in addition to the applied study that includes the distribution of the questionnaire survey among 55 members working in virtual teams in the field of the construction industry. The findings of this research contribute to identifying the challenges of virtual team management during the project lifecycle and studying the strategies and technological tools to deal with these challenges.

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1. Introduction

The construction industry has unique characteristics and structures that differ from other industrial sectors [10]. These characteristics have been summarized in complexity and challenges to achieving acceptable, sustainable, and effective quality products. One of the most important process enhancements that the construction industry has to undertake is in the area of communication to enhance knowledge transfer across teams and projects [27]. When comparing the advancements of other industries, the construction industry is hesitant to incorporate these modern technologies into its standard processes, despite the significant developments displayed by the other industries [26]. In the future, it will be increasingly difficult for the industry to rely on the tacit knowledge of organizations or people in virtual settings. Global tendencies to outsource labor and reduce employee pools, along with the broad availability of telecommunications devices, are driving firms to investigate virtual team employment [16]. Despite the fact that more full-time workers generally result in larger negative utility, the construction industry continues to lag in the use of communication technologies and the formation of virtual teams [20].

2. Research problem and objective

The COVID-19 epidemic has impacted several nations, affecting both persons and companies. As a consequence, a wide range of involvements and recommendations were undertaken and presented in a variety of sectors [2]. With the onset of the COVID-19 epidemic, the rate of change from traditional teams to virtual teams hit a new high. For the first time in history, some organizations were obliged to form virtual teams as a result of the crisis [32]. Even though it is expected that the impact of this epidemic will lessen in the future, many organizations have made remote working permanent. All of these changes indicate that in the future, both organizations and management researchers will place a greater emphasis on research relating to virtual teams [29].

The objective of this research is to determine the factors affecting efficient virtual teams in the construction industry through dis-
covering challenges and issues in project management when virtual teams are utilized and how technology tools and software may assist in handling the challenges.

2.1. Literature review

The literature study attempted to focus on studies that are concerned with the challenges of virtual teams. The aim of the literature review is to identify and analyze the challenges that virtual teams face, as well as the factors that influence team efficiency throughout the project life cycle.

2.2. Definition and classification of virtual teams

Virtual teams are groupings of working professionals who are geographically, psychologically, and temporally separated [27]. To meet the commercial needs of working toward and accomplishing shared objectives, these organizations employ telecommunications systems for business and social communication. Communication is described as the major envelope of information that is acquired, processed, and exchanged among team members when doing business activities. Virtual teams may operate on unstructured or organized job sets to do basic or sophisticated work on short- or long-term projects [30].

Virtual teams are classified into many forms based on characteristics such as the number of people on the team and their engagement with one another [6,11]. As shown in Fig. 1, virtual teams are grouped into four types based on two key variables: the number of locations and the number of managers.

Virtual teams are classified into six types that commonly exist [8]. This classification is according to the structure, function, and challenges faced by the team during project activities as shown in Fig. 2.

This research area is focused on virtual teams in the construction industry. Therefore, project development teams will be highlighted in this research, which is involved in developing and launching services. These teams consist of architects, managers, specialists, and developers.

2.3. Potential of virtual teams in the construction industry

Virtual teams add economic benefit by lowering the expense of travel, accommodation, daily allowance, relocation time, and unnecessary meetings. These teams allow information and communication technology to coordinate the interconnected tasks [30]. Information and communication technologies enable all employees to participate in the operations of other teams to improve and expand their expertise. These types of teams rely on technology for everyday communication and interaction among team members [1]. Virtual teams provide several benefits to organizations, including enhanced knowledge sharing, employee job satisfaction and dedication, and improved organizational performance. The benefits of virtual teams are classified into five areas based on a review of the literature and past research: economic value; competitive advantages; flexibility; employee satisfaction; and research and development efficiency [19].

2.4. Virtual teams’ project life cycle in the construction industry

Building construction projects consist of phases starting from planning, designing, construction, and closing, as shown in Fig. 3 [3]. The differences between a face-to-face team and a virtual team in terms of project lifecycle and deliverables are the same. However, differences may emerge in terms of how the virtual team communicates and manages to achieve the assigned goals [15]. Therefore, a communication plan, technology requirements, project mission, and success criteria should be created by virtual team managers from the early stages of the project. In addition to the agreement on ways to share information through file sharing tools and team strategies for managing team conflicts through the design phase, it is essential to ensure that the methods of communication and coordination are approved, especially in the virtual teams that are likely to include members from different countries [23]. During the construction phase, monitoring and control are essential for workflow analysis and managing conflicts. Then, during the closing phase, at the end of the project, lessons learned are documented and measured for project success.

2.5. Challenges of virtual teams through the project life cycle

Although there are many benefits of using virtual teams, as mentioned in subsection 3.2, virtual teams might face a variety of different challenges that frequently hinder them from achieving successful outcomes [14]. In virtual team arrangements, organizations structure their tasks via networks of teams, which creates management difficulties that are unique from those observed in traditional hierarchical relationships [31]. Because of the participation of entities such as the customer, contractor, subcontractors, and other stakeholders in a separate location, the communication system is crucial. The communication system of the team members consists of technological tools, agreement on ways of sharing information, and response guidelines [22]. It also deals with the time differences for geographically distributed team members and the training required for them [1]. The effective use of communication during the early stages of team development plays an essential role in building trust between team members [24]. Trust development is associated with the increase of communication between members, especially in the design phase.

Based on literature review, more than 30 research were conducted via online research using terms most relevant to the field of research on virtual teams (i.e., Virtual Teams, Challenges, and Construction industry). But there is a lack of virtual team challenges in construction industry articles, so these articles include challenges from other industries. Articles were selected based on their year of publication starting from the 21th century to nowadays, and the type of article included published thesis, journal article, and conference article. These are the challenges mentioned in the articles: distance, time differences, communication, cultural diversity, trust, technical management, team cohesiveness, and leadership as shown in Fig. 4.

Fig. 4 Challenges of virtual teams’ publications; Source: Authors.
As shown in Fig. 4, a percentage of each challenge is mentioned in these articles. It turns out that communication, trust, and cultural diversity are the most essential challenges, but not the only ones based on the project scale and degree of virtual.

2.6. Effectiveness of virtual teams

In general, as teams become more virtual, they are forced to contend with an increase in uncertainty and complexity as a result of distance, time, and cultural differences [7]. This results in an increase in the amount of difficulty experienced by the teams in the areas of information processing and communication as they attempt to complete their work tasks. Being nearly entirely virtual might magnify some of the obstacles that teams face, but it can also magnify the advantages that come from working together in a variety of different ways, as mentioned in subsection 3.2. A supportive corporate culture, certain aspects of the job at hand, the use of technology, team member qualities that are supported by train-
ing and development, and work and team procedures are the components that might contribute to the effectiveness of a virtual team [18]. It is possible to complete relatively simple organizational work or team tasks virtually without the presence of higher-level collaboration skills and trust [20]. However, in order to achieve the highest levels of effectiveness, it is necessary to possess these characteristics, in addition to leadership and the support of systems [29]. According to Jarvenpaa & Leidner [17], organizational-level support may consist of standards designed to foster a good culture of virtual teaming. Formation activities such as establishing easy communication, understanding the technology to be used and technology training, and creating explicit start-up norms and expectations for team members are more critical in the beginning stages of a virtual team than they are in the beginning stages of a team that has members in the same physical location [15]. This preliminary work establishes a common ground that is necessary for bridging the differences that exist among the members of the team. It also contributes to the development of a fundamental operating structure that helps in the creation of stability and shared expectations so that tasks can be carried out [4].

3. Methods

A mixed methodology approach was employed through data collection and data analysis. A systematic literature review and case studies were used in this study to assess the current level of knowledge in the field of study, identify gaps in knowledge, and provide results in this area. In addition to a survey questionnaire that was distributed among a number of virtual team members in the construction industry, the collected data was analyzed by using quantitative and qualitative analysis. This method was used in this study to achieve the research aim through the following:

- Identifying concerns and challenges in project management when virtual teams are employed, as well as how tools and software might assist in dealing with them.
- Identifying the factors affecting virtual project team management.
- Identifying common communication challenges encountered by the virtual project team.

4. Results and discussion

4.1. Case studies

Through case studies, which is an empirical investigation of a contemporary issue in its real-life setting. The different approaches to managing virtual teams that were found in different projects, as well as other important success factors found in the findings of the literature and the projects that were looked into, were used to come up with general rules for managers of virtual teams.

4.1.1. Selection criteria

Firstly, the criteria for selecting the case studies are based on the types of projects, which are construction projects, and the types of teams, which are virtual teams during pandemics and other situations that lead to working virtually. Secondly, these cases should be in developing countries that face different challenges in managing virtual teams, which is suitable for circum-

![Fig. 4. Challenges of virtual teams' publications; Source: Authors.](image-url)

Table 1
Case studies general information Source: Authors.

| Case studies | Mumbai international airport (Case 1) [25] | Nigeria's construction industry (case 2) [11] | GRAND MUSEUM in Egypt (Case 3) |
|--------------|------------------------------------------|---------------------------------------------|----------------------------------|
| Introduction | Mumbai international airport is an actual executed case study from documentation and media reports from the project itself. This case study aims to identify the virtual team’s challenges and technological tools used during the project. | Nigeria’s construction industry has increased its use of information and communication technology in recent years. | The museum is included in the 2030 master plan for Giza. This entails rehabilitating the Pyramids Plateau in order to promote tourism at the site. Approximately two kilometers separate the Grand Egyptian Museum from the Giza Pyramid complex, a UNESCO World Cultural Heritage site that includes the Giza Necropolis and the Great Sphinx. During the construction of the project, the Corona pandemic broke out, resulting in the project’s suspension and the return of all foreign employees to their home countries. |
| Needs of virtual team | Gathered all of the best talents from the world. There were about 200 national and international specialized agencies working on the project. | As a result of the Corona Virus (Covid-19) epidemic, the new trend has allowed teams from all around the world to work using internet-connected computers. | |
stances similar to the Egyptian context. Additionally, selection has been done based on cases that proposed new approaches to solving these challenges with new technological tools and management approaches.

4.1.2. Background of case studies

Table 1 shows background information about case studies and the reason behind using virtual teams.

4.1.3. Findings of case studies

These case studies analyzed discussed how virtual teams may be more advantageous than traditional teams through different communication tools and approaches for tackling the challenges and increasing team efficiency listed in Table 2.

According to the findings of this study, managing virtual teams in any construction project is always difficult. However, with the aid of BIM (Building Information Modeling) technologies, file sharing tools, and new management strategies, the project’s key problems may be overcome. However, there are limitations to directly resolving cultural and political concerns with the use of a BIM tool. Such obstacles, however, can be addressed via good collaboration among virtual team members in the development of strong bonds, trust, and cooperation.

Table 2
Case studies findings Source: Authors.

| Case studies                        | Approaches used                              | Approaches Proposed                                                                 |
|-------------------------------------|----------------------------------------------|--------------------------------------------------------------------------------------|
| Mumbai international airport (Case 1) [25] | Electronic data management system Email communication Skype meeting AutoCAD File sharing tool | BIM proposed as a solution of the challenges of virtual team’s management Navisworks Solibri model checker Horizontal Glue COBie GoToMeeting 3D ICC Terf |
| Nigeria’s construction industry (case 2) [11] | Telephone calls Video conferencing call (Zoom, Go-To meeting, Skype, etc.) Internet chatting Memos/letters Grouping decision making software Social networking tools Electronic data management system Email communication Skype meeting AutoCAD File sharing tool | Lean management Interface management Leadership techniques Develop a breakdown structure Develop new communication tools Develop operation agreement management Leadership Techniques |
| GRAND MUSEUM in Egypt (Case 3)  | Electronic data management system Email communication Skype meeting AutoCAD File sharing tool BIM tools | Develop new communication tools Schedule regular meetings Overlapping working hours |

4.2. Application of questionnaire survey

This research conducted a well-structured online survey utilizing Google Forms software, which was then distributed to the respondents for data collection and analysis. The survey was given directly to the engineers and managers of the major construction industry and distributed to participants working in the Grand Egyptian Museum who worked virtually during the pandemic COVID-19 to ensure authenticity and data integrity. The questions within the questionnaire will focus on three aspects: (1) challenges facing virtual teams during construction projects; (2) factors affecting efficient virtual team management; and (3) methods of communication tools used by project team members. And that subsection 5.1, 5.2, and 5.3 are the results of the questionnaire.

To facilitate the number of responses, approximately 100 questionnaires were distributed during the months of October and November 2021, 55 responses were returned, which represents a response rate of 55 %.

The research used a cross sectional model, with 55 participants in the questionnaire, of which 38 % held managerial positions, 18 % were contractors, 16 % were consultants, 12 % were architects, and 16 % were others in the field of the study, which includes other disciplinary engineers, quality engineer, and HR (Human Resources) employees as shown in Fig. 5.

The participants were asked by Likert scale questions; it measures attitudes by assessing the extent to which respondents agree with the statements.

![Fig. 5. Affiliation of participant; Source: Authors.](image-url)
or disagree with a given statement. The Likert scale questionnaire allows for both qualitative and quantitative examination of survey data.

4.2.1. Challenges faced virtual teams during construction projects

The importance of each challenge while working in a virtual team in the construction industry was extracted from the literature review and case studies. All the participants answered this question. They are ordered in ascending order from the most impactful to the least according to their means as shown in Table 3.

Table 3 shows the importance of challenges according to their experience during working in virtual teams. Leadership and trust were shown to be among the most important during the results analysis, followed by team cohesion, technical management, and communication.

4.2.2. Factors affecting efficient virtual team management

All the participants answered this question. They are ordered in ascending order from the most impact of each factor on the virtual team’s efficient management in the construction industry, extracted from the literature review to the least according to their means as shown in Table 4.

Table 4 shows the mean and standard deviation analysis of factors affecting efficient virtual team management. There were main factors revealed as to the efficiency of virtual team management. Ranking these statistical values in ascending order, the major factors were setting clear goals and objectives, followed by respect and teamwork, which are important in the team forming in the planning phase. The results also indicated that communication quality and trust have a significant impact, which reflects the same literature review findings.

4.2.3. Communication tools used by project team members

All the participants answered this question, the communication tools used by virtual teams in the construction industry extracted from the literature review. Ranking these statistical values in ascending order as shown in Table 5.

Table 5 shows the mean and standard deviation analysis of communication tools used to assist virtual teams. It is not surprising that emails and phone calls emerged initially as the most commonly used communication technologies because they are simple.
and do not need staff training, followed by file sharing tools. This is compatible with international best practices, which require important facts to be documented for future use, reducing the possibility of disagreement. In addition to Skype, Zoom, Viber for meetings and AutoCAD 2D and 3D documentation, as well as the cloud-based storage, received a high rating as they contribute to facilitating communication. Although EDMS (Electronic Document Management System) and BIM (Building Information Modeling) technologies received a lower rate than others, they were recommended as desirable tools in the analyzed case studies.

The research findings are addressed, with an emphasis on the potential advantages of virtual teams in the construction industry. Virtual teams may be a highly effective means of bringing together the most appropriate mix of abilities and expertise to fulfill project objectives without the expenses and logistical issues that come with having a team of employees regularly gather around the same table. According to the findings of this study, virtual teams in the construction industry have many challenges that organizations must be aware of and actively handle in a proactive manner. Leadership and communication must be shown to be among the most important during the results analysis, followed by team cohesion, technical management and communication which shows a discrepancy between literature review findings and survey findings, this leads us to conclude that this topic should be further researched. In addition to the effectiveness of virtual team management, which was determined by a number of factors. The findings indicated that the most important factor was establishing clear goals and objectives, followed by communication quality and trust, which had a significant influence.

Teams can communicate using a variety of technologies, including email and chat platforms, as well as web conferencing and videoconferencing. Team members frequently choose the tool that is suitable or known to them, but certain technologies are more suited to specific jobs than others, and selecting the wrong one might lead to problems. Communication technologies differ in a variety of ways, including information richness (or the ability to transmit nonverbal and other clues that aid in meaning interpretation) and the amount of real-time engagement that is feasible. The complexity of a team’s communication activities varies as well, depending on the requirement to reconcile opposing ideas, provide and receive feedback, or eliminate the possibility of misunderstanding. The delivery mechanism should be determined by the objective of the message. Involve the entire team in critical communications and decisions. To exhibit openness to alternative ideas and methods to a problem, actively gather opinions and viewpoints from all team members, particularly those in remote locations. It is important to create a team charter that outlines how they will collaborate. Specify which technology the team will or will not employ for various tasks. Standard forms and etiquette for written communications plans, expected time to react to requests, and categories of communication that should always be shared with every-one.

5. Conclusion

Teamwork is crucial to the success of any organization, particularly in construction projects. In many construction enterprises, a new breed of virtual teams has arisen in recent years. The purpose of this study to determine the factors affecting the efficiency of virtual teams in the construction industry by identifying the issues and challenges that arise in project management when virtual teams are utilized, as well as the ways in which technological tools and software can assist in overcoming these issues. The cases show the challenges that the virtual team faced and how, by utilizing various communication technologies and tactics, it could be more beneficial than traditional teams. Statistical data showed that the most important factor was establishing clearly defined goals and objectives. Then, respect and collaboration, which are crucial to the formation of a team during the planning phase, were tested. The results suggested that communication quality and trust had a substantial influence, consistent with the findings of the literature study. An evaluation of the communication technologies used by a virtual team reveals that email and phone conversations have emerged as the most popular forms of communication because they are easy to use and do not require staff training. They are followed by tools for file sharing. This is consistent with international best practices, which demand the documentation of significant facts for future use, thereby lowering the likelihood of conflict. In addition to Skype, Zoom, and Viper for meetings, AutoCAD 2D and 3D documentation, and cloud-based storage obtained a good grade since they facilitate collaboration. Even though they got lower scores than other technologies, EDMS and BIM were suggested as useful in the case studies that were analyzed.

Lastly, the most important approaches for managing a virtual team well are: being able to see the big picture and have clear goals; being able to depend on each other as a team; having an effective communication loop and choosing the right channels; having reliable technology; building trust; and knowing how to lead.

6. Future research

For future study, the research suggests conducting a more comprehensive investigation into the selection of project-specific technical tool applications, and investigating other techniques and obstacles by interviewing industry practitioners with extensive expertise in construction projects.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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