

Implementation of Building Information Modeling in Turkish Government Sector Projects

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Abstract—In recent years, the Building Information Modeling (BIM) approach has been developed expeditiously. As people see the benefits of this approach, it has begun to be used widely in construction projects and some countries made it mandatory to get more benefits from it. To promote the implementation of BIM in construction projects, it will be helpful to get some relevant information from surveys and interviews. The purpose of this study is to research the current adoption and implementation of BIM in public projects in Turkey. This study specified the challenges of BIM implementation in Turkey and proposed some solutions to overcome them. In this context, the challenges for BIM implementation and the factors that affect the BIM usage are determined based on previous academic researches and expert opinions by conducting interviews and questionnaire surveys. Several methods are used to process information in order to obtain weights of different factors to make BIM widespread in Turkey. This study concluded interviews' and questionnaire surveys' outcomes and proposed some suggestions to promote the implementation of BIM in Turkey. We believe research findings will be a good reference for boosting BIM implementation in Turkey.

Keywords—Building Information Modeling, BIM, BIM implementations, Turkish construction industry, Turkish government sector projects.

I. INTRODUCTION

ALTHOUGH the BIM approach has become a prevalent discipline for modeling, building, and managing construction projects, as BIM tools have become more accessible with accessing and monitoring construction data with increasing computer technology, the first usage of BIM is quite old and not new as is known to all [1]. In order to support the design of architects and engineers in construction projects, 3D modeling in the construction sector by using the BIM approach was first used in the early 2000s [2]. Center for Integrated Facility Engineering (CIFE) gave another name to it "3D Virtual Design and Construction (VDC)", which was first introduced in 2001 at Stanford University and set up a substructure for BIM. According to this definition by CIFE, Virtual Design and Construction uses integrated and multi-disciplinary performance models of design-build projects to

support obvious and public business goals [3]. Eastman defined BIM in his "BIM Handbook" as "a common digital representation of the physical and functional characteristics of a building that is a reliable basis for all decisions" [4]. This general definition is accepted by most of the international community.

Unfortunately, the Turkish government construction industry has long been dependent on traditional 2D computer-aided design (CAD) designs although many industrial economists have developed integrated analysis tools and object-based parametric modeling that form the core concept of BIM. Nevertheless, despite growing awareness of the benefits of BIM in Turkey, usage habits are not focused on different areas and this is why users do not discern benefits of BIM such as clash detection, producing alternative designs and plans, and spotting design error at early stages of the projects. However, the BIM approach should be able to merge with construction techniques that are being currently developed. For this purpose, in countries like Turkey, BIM should be a primer trend in the construction sector and should start to synchronize with BIM for execution and project management and should be mandated by the Turkish government, institutes, and industry councils, etc. [5]. In the statement of Turkey, BIM adoption and implementation are quite low despite some awareness of BIM of mostly academicians and 3D software companies [6]. There are many challenges that prevent BIM adoption because of lack of skills and knowledge of personnel as well as contractual issues etc. [7]. Despite various frameworks and implementation models available all over the world, there are still inadequacies on practical BIM adoption and usage in Turkey. In order to overcome these challenges and obstacles, the practical benefits of BIM should be clearly defined instead of listing the potential advantages of the implementation of BIM in Turkey.

This paper aims to examine the challenges and/or obstacles regarding the BIM implementation approach in government/public projects by focusing on Turkish public construction projects considering the gaps in current academic literature as well as the need to study the relationship between the BIM approach and Turkish government construction projects. Here, information management and interoperability issues will be most challenging amongst the other issues. Therefore, this paper seeks to investigate challenges, obstacles, as well as critical success factors in Turkish government construction projects implementing BIM and afterward, finally reach a recommended conceptual dissection for the strategic management of public construction procurement systems implementing BIM.

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II. LITERATURE REVIEW & PROBLEM STATEMENT

In the past, the use of BIM has focused on infrastructure and pre-planning, design, construction, and integrated project delivery of buildings. However, in recent years, professional expertise tools have been carried out in this area such as preliminary design, work-planning, progression (track) follow-up, structural analysis, clash detection, visualization, quantification, better data and cost management, energy analysis, and construction health & safety [5]. Nowadays, researchers have concentrated more on maintenance, modification, restoration, destruction, and end of life considerations [6]-[11].

Although some countries have recognized the advantages of BIM usage and its usage has increased and popularized in recent years and even it has been a mandatory tool for a variety of projects as well as for their approvals and certifications in some countries, BIM is still mostly used for only early-stage designing of projects in some countries like Turkey on the other side [2], [4], [12].

Although BIM has the potential to add value to public projects, it also contains some risks that may affect businesses and the working relationships of the parties of the project [13]. For the implementation of BIM in the construction industry, many pieces of research have focused on construction projects procured through public construction procurement systems [14]-[16]. Besides, researches conducted on government projects that study the impact of BIM implementation on public projects are very rare [17], [18]. Moreover, in the Turkey context, there is not any protocol, standard, contractual document, and/or guidelines that are specifically designed to support the implementation of BIM in public construction procurement systems. Even though some advantages of BIM are emphasized by academicians/researchers, there are not many practical/experimental studies that critically investigate the challenges/obstacles of BIM in the context of Turkish government construction projects [17], [19], [20].

Although the BIM approach helps improve data sharing and interoperability as well as reduce potential risks in public construction projects of Turkey, the problems surrounding the implementation of the BIM approach are still a serious challenge [21]. This BIM approach allows all parties of the project to actively participate in some stages in which they were not or could not be in traditional project management approaches. If we give an example to this; in this approach, it can be demonstrated that contractors and/or facility managers can exist as early as the design stage and might be strongly affecting this stage. In addition to this, in this approach, the fact that the design responsibilities and/or obligations are not directly imposed on the design team (even though their assets are very much needed) and may pose various potential risks [18]. Besides, in the BIM approach, which party/parties of the project will have the ownership of the main model may pose a serious problem since the main model is developed in cooperation by all the parties of the project. Therefore, Chao-Duivis suggests that in the BIM approach, new contract documents should be developed, covering the relations between the parties working on the project team [22].

Moreover, the BIM information manager to be designated for the party/parties to be held responsible for the errors that may occur at various stages of the project, and the main model must be clearly and correctly identified.

Even more; the delivery of minimum protocols and standards regarding accessing to the model, security of the model, the content of the model, how information/data should be archived, model level of detail (LoD), model formatting rules, project coordination systems, and such other processes should be determined from the beginning of the project. And finally, possible/potential risks that may arise after the completion of all the works in a public construction project should also be taken into account. Therefore, even though the BIM approach has the potential to add value to Turkish public construction projects, it also brings (out) to all the parties to possible/potential risks that might affect relationships of the project [23].

In the academic literature, studies conducted on Turkish public construction projects that investigate the impact of the implementation of the BIM approach are very limited. There are very few studies on the implementation of the BIM approach in the Turkish construction industry and these have mostly focused on construction projects procured through non-public Turkish construction projects [21]. Moreover, especially in the context of Turkey, there are not many contractual documents, protocols, and/or standards that have been specifically designed to support the implementation of the BIM approach in Turkish public construction projects, which is available yet. Furthermore, although the benefits offered by the BIM approach are very much defined by academic researchers, as long as we know, there are not many known experimental studies yet that research the possible/potential challenges of BIM in the context of Turkish public construction projects. Considering such gaps in the academic literature and the need to study the connections between BIM and Turkish public construction projects, our paper seeks to examine the challenges associated with the implementation of BIM in public construction projects, especially Turkish government construction projects.

III. RESEARCH METHODOLOGY

Some researchers defined that studies can be conducted by using techniques such as questionnaires, interviews, focus groups, and mixed-mode techniques [24]. In order to achieve our research's aim, our study employed an interview strategy as the research technique.

Some researchers mentioned that different methods of information collection have different impacts on the researcher's interference/involvement [25]. And so, it is clear that on the internet and/or postal survey, the researcher has minimum interference/involvement since the researcher does not exist in the question-answer process. Besides, the researcher and/or the interviewer has much more impact in the face-to-face interview rather than in telephone interviews as the researcher will find the opportunity to motivate interviewers to deliver and clarify questions when necessary. Moreover, the researcher will also find the opportunity to

answer interviewers' inquiries, to explore/analyze after inadequate answers. Furthermore, the researcher will also find the opportunity to interpret interviewers' nonverbal manners/expressions like smiles and head-nods. This also depends on the researcher's consideration/significance of the quality of the time, cost as well as data management such as deciding which data collection method to be used for. Every data collection technique has its own pros and cons, hence sometimes, mixed-data collection methods are being chosen to counterbalance each other's restrictions, strengths, and weaknesses [25].

In this research paper, the "interview technique" has been chosen between the above-mentioned questionnaire survey, interviewing, and focus group techniques in order to measure the industrial as well as personal effects of implementing the BIM approach to Turkish public construction projects. This is chosen since it is one of the qualitative research methods in order to obtain semantic data and evaluate the data objectively. This qualitative research is a method that takes into account the way people interpret and comment on their different experiences in order to cover a wide range of behaviors of individuals. "Interview technique" has been well-known with many benefits and its practicality in the field of academic literature. There are several advantages of the "interview technique" which are as follows;

- The participant of the interview can be selected based on his/her background, and the distribution of backgrounds gives variable results to produce statistically significant results.
- The interview questions can be organized to catch some important and exceptional comments during the interview depending on the participant of the interview's answers.
- The "interview technique" contains relatively rich data as it includes written and verbal sections.

On the other hand, there are several disadvantages of the "interview technique" which are as follows;

- All interviewees cannot be anonymous also they can prefer not to be mentioned in the research.
- Evaluation of the interview requires much more time compared to some other methods.
- The "interview duration" may not be sufficient to collect all the necessary data and therefore it can only be applied for small-scale researches accordingly.

IV. RESULTS AND DISCUSSIONS

The main purpose of these interviews is to determine the status of construction companies implementing the BIM approach as well as to identify the preventive and challenging situations arising from the use of the BIM approach in Turkish public construction projects. The duration of meeting with managers working at different levels of companies applying BIM in their projects varies between 20-30 minutes.

In this interview technique research method; firstly, a series of questions to be asked to the interviewers were prepared and asked. In the second stage, the data obtained in the interviews were analyzed. Finally, in the third stage, content analysis was conducted in the interview notes in order to make inferences

from the common opinions of the interviewees.

TABLE I
CHALLENGES OF IMPLEMENTATION OF BIM IN TURKISH PUBLIC
CONSTRUCTION PROJECTS

<p>The construction sector is different in developing countries than others'. Because nobody knows the BIM and therefore nobody wants to pass to it. Knowledge is less, resources are very limited, software usage is very few. Passing to such a system like BIM has a big cost at the beginning. There is quite much learning/training cost. You cannot control or avoid indirect and/or overhead costs etc. It is not possible to get a big benefit in the first job; it may take a long time. The period of settlement may take too much time and money. You must have skilled, equipped people/companies, which are very limited. We tried many different people and companies to find the correct one for us. We had to build a new I.T. Team by strengthening our infrastructure. We didn't know which software from which companies to buy from. If we make a bad choice, it is waste of time and money. There are many protocols/standards. You must decide which one to use. There are not any such Turkey's protocols/standards yet in this regard. We had to create a new protocol/standard which is different than others. There are issues, which are not certain in the contract about BIM. There is a missing BIM integrated contract that all the parties agree on it. Integrating all the protocols and standards into a contract is very difficult. Every project is unique, and its contract is self-inflicted/idiosyncratic. The parties are not speaking the same language. Blame each other. Contractors always want to take advantage of open issues in the contract. BEP is now seen as a compulsory procedure on theory/paper. If "cloud" can be open to everyone and its security becomes questionable. It is very difficult to combine everything and keep them in a specific place. There's a lot of difference between public projects than private sector projects. LOD standards of each project are very different than each other. We cannot value the exact BIM cost before offering the tendering price. Some abnormal price movements are seen in the exchange rates and prices. Growths and retreats in the projects cannot be accurately measured. The parties do not share the same transparency with other parties. People prefer to hide things at first and try to fix them on the back (precautions). Transparency. What are the limitations? How much/far are the borders? Would the contractors and the employers want this transparency or not? Employers may not want to see any record and/or history out of it. The biggest challenge is brains and mental structures are not ready for this. How do you protect "intellectual property rights" and prevent copyright? Who is going to own this model as a single model is in BIM Level 3? Who is going to prevent other people to take it or partly use it and How? They can also be passed on to malicious people (thieves, terrorists, etc.). It has so many risks (fire, sabotage vital, etc.), especially for some projects. Some parties did not trust the cloud system and use a server of their own. Some things should be known and completed before work. BIM requires documentation, distribution, control, and integration, etc. BIM cannot be operated by the contractor as desired by the employer. After the tender, the production and design often change continuously. The contractor has usually limited human power and cannot rework the project. The contractor often starts without being prepared and/or confirm the models. The contractor may have to run the same model in 3-5 different versions. The borders/boundaries of the business are not clear on the BIM contract. Employers often do not make any extra payment over the contract prices. It's very hard to keep the entire team and all the disciplines in this process. The wrong perception that BIM is all about 3D architectural pollution. The exchange of information is a system that brings information pollution. Most of the software does not have much of the infrastructure and support. Construction companies haven't completed their digital transformation yet. The digital data cannot be always accessed properly and correctly. BIM is a management issue, but it's not something that we are doing now. Things must always be in coordination/cooperation with all the parties.</p>

First, in this section; the participants were asked questions about their personal work experiences. The main goal was to

prepare the participants of interviews before they move on to the main questions and to make the interviewees feel more comfortable by creating a warm environment. Then, a list of questions has been prepared in order to gain the personal challenges and difficulties of interview participants in-depth. The main purpose here is to try to get the maximum information/data from the experiences of the interviewees regarding the implementation of the BIM approach in Turkish public construction projects.

The data obtained through the interview were analyzed to identify the difficulties and challenges of BIM applications for the Turkish public construction sector/industry. As a result of the interviews, the most discussed issues about the difficulties of BIM applications are given in Table I.

In our study, although many of the people interviewed are aware of the potential benefits and advantages of the implementation of the BIM approach to Turkish public construction projects, such as; time savings, cost savings, improving the quality of the products, improved coordination, communication and collaboration for the management and design, being more visible and reliable, being independent of location/environment since all the data are securely stored (BIM360, Cloud, Drive, etc.), there are many difficulties, obstacles and challenges to adapting to BIM and/or integrating BIM into Turkish public construction projects.

BIM is a relative approach to the Turkish public construction sector and has not yet begun to be used frequently in Turkey. The Turkish public construction sector is very different from the developed countries in which the BIM approach is used. Parties of the project do not believe that it is possible to use the BIM approach in their projects, as they already experience many problems in many traditional processes. Besides, project parties always prefer to go the traditional way they know as there is serious confusion about what they should do to use the BIM approach. They think that the BIM approach is very complex and confusing. They stated that most of the information available about the BIM approach is mostly of theory and far from practice. Nobody wants to switch to this approach because nobody knows it. They strongly think that their existing/traditional project management systems in the Turkish public construction sector are not yet suitable for the BIM approach. Moreover, they think that brains and mental structures must be ready for it before moving on to the BIM approach. This poses one of the biggest problems. For all these reasons, the BIM approach has only recently been used (which is enforced by the government) for large-scale and complex structured projects such as airport, metro projects, etc. It can be added that the required information is very low, the resources are very limited, and the use of the necessary software is very constrained. Unfortunately, there is not enough infrastructure support by most of these software companies in Turkey. 90% of construction companies have not completed their digital transformation yet.

There is a fact that unrealistic project work-schedules, which are very often in Turkish public construction projects, can pose serious problems in the BIM approach. All parties

are trying to do different things based on their knowledge and experience. There is another fact that every project is unique and can also pose serious problems in the Turkish public construction sector. In addition to that, each project's contract is unique in the Turkish public construction sector. Many things differ depending on the size of the project.

The projects in the Turkish public construction sector are very different from the private sector projects where the BIM approach is more widely used. Project growth and changes in the Turkish public construction sector are often not accurately can be measured. There is always uncertainty about this. It is very difficult to implement the BIM approach to a project, which has a direct supply/procurement contract provision in tenders in the sector.

The parties do not want to share the transparency for the other parties, which they desire for themselves. It is not clear what limitations exist and where they are, how you guarantee "intellectual property rights" or protect "copyright of information" in a way that one party will not infringe on the other's right, how the changes will be monitored and tracked by all parties as well as how you prevent everyone from accusing each other as the model is open to everyone in any problem. Some parties do not trust BIM's cloud system, prefer to use their own server, and want to keep their data there and think that they should not allow anyone to access them. Some vital risks may apply to some private/critical government projects such as fire risks, sabotage risks, etc. in particular, which can be abused by malicious people (thieves, terrorists, etc.).

In projects in the Turkish public construction sector, the administration (government) generally sets the contract and standards. However, BIM, which is a transparent and objective approach, cannot always be operated on the scale required by the administration (government). The constructor company that won the tender will request a progress payment and/or allowance according to BIM. However, they cannot provide any control over the model. The administration generally assists in extending the duration of the project but does not agree to overpay on contract prices. The administration may want to see different versions of BIM models together at the same time. In this case, the contractor company may have to run the same model in several different versions. The administration (government) asks the contractor to use the BIM approach; however, they are generally reluctant to make any additional payment for it. The administration always wants to get the job done cheaper. The administration usually needs to appoint a BIM manager for the project, but often they do not have qualified administrative/technical staff. Traditional/conventional contracts allow the administration to request anything they want, unlike the BIM approach. Long test times due to the administration (government)'s hypersensitivity to quality may also pose some serious problems.

The BIM approach is necessary and legalized as a mandatory component in contracts in developed countries. Based on interviews and literature research, the necessity of BIM usually comes from government powers. BIM has

become an important element in public construction projects. Therefore, here the main motivation is that construction companies adapt faster to meet the legal requirements of projects.

V. CONCLUSION

In the public construction sectors of developing countries, usually, it is the employer who determines protocols, standards, and contracts. The BIM system cannot usually be operated exactly as desired by the employer. The employer will usually require allowances and/or progress payments according to the BIM system. However, it does not mean that it provides any control over the model. It is the employer who usually wants to see the different versions of the models altogether, which means that the contractor must run the same model in very different versions. The employer usually does not want to pay anything extra to the contractor for implementing the BIM system. The employer usually does not make any extra payment over the contract prices even though he/she sometimes gives the extension of project duration as the employer/consultant always wants to get the job done cheaper.

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