

ADOPTING BUILDING INFORMATION MODELING IN CLAIMS MANAGEMENT IN CONSTRUCTION INDUSTRY

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Claims are one of the most important problems in construction projects that lead to conflicts between key stakeholders in the republic of IRAQ. Perhaps the main reason is the adoption of traditional systems in claims management, so the use of modern technologies in project management such as BIM technology can contribute to reducing these claims. The study aims to briefly shed light on the most important claims problems in Iraq, then this study attempts to address the claims problem through adopting BIM technology in developing a claims management prototype; This study highlighted 29 problems related to claims, and this model was evaluated by a group of experts and proved its efficiency in solving most of these problems. This study concluded that the model studied can contribute to addressing the problems of claims in Iraqi construction projects, and the results concluded for a set of research gaps that, if addressed, this model will become more accurate and comprehensive.

Keywords: BIM, claims, API, EOT, construction projects, management

1 INTRODUCTION

In the world of project management, the main objectives that determined the success or failure of a project were represented by the management triangle, which is time, cost and quality [1]. However, over time, other metrics for success appeared, which were waste-free construction, safety and dispute-free construction [2].

Claims are considered one of the most important means of adjusting economic and contractual relations as a result of the changing nature of construction projects [3]. The claim begins with a request submitted by the contractor to compensate him with an additional cost or period as a result of additional work not agreed upon in the contract or as a result of interruptions that were not established in the initial contract [4,5]. In most construction projects, claims are an inescapable fact [5,6]. According to construction there is a great number of types and could arise as a result of many different causes and reasons [7]. According to Arcadis [8], the financial claims are worth around 33 million and the time is taken to resolve claims can be up to 17 months. This highlights the importance of a proper claim management practice. Furthermore, the practices of current claims management face shortcomings [9]. In fact, most of the work details are saved by the staff heads, also construction contracts are managed manually [5]. Thus, when things go wrong and the parties have recourse to resolving differences [7], the problem stems from the ineffectiveness of the document management system, which is characterized by poor presentation and loss of the most important information, as well as a lack of evidence and communication, a prerequisite for winning a claim. Also, key employees leaving their jobs can exacerbate this problem [10]. This entails developing a central digital hub to assure easy access to the latest information for all parties.

Over the past decades, ICT has greatly contributed to the improvement of current management practices [11, 12]. The relationship between construction and information technology is dynamic, as changes in one result from developments in the other. One of these technological developments is the technology of Building Information Modeling (BIM) which is a digital work of constructed building, which facilitates the representation of the different phases of a project [13]. Data is collected and managed through a virtual model that is set up within the BIM environment, facilitating effective information management [14]. In general, BIM facilitates communication and collaboration between stakeholders in joint ventures, coordination and access to data and information transparently [15].

BIM plays a highly crucial role in developing various areas of construction management, including claims management [16]. The outcome of a claim is highly dependent on the claim report quality [17]. Evidence of claims can be submitted orally, through manual documentation, and in the form of digital data through computerized presentation [18]. If BIM is used at the beginning of the project and the suggested record-keeping mechanism proceeds, the critical data will be saved in a common main database with a 3D model capable of claim identification, visualization and estimation. This is why, BIM may be adopted as one of the vital tools for proactively resolving claims, for the purpose of avoiding disputes [17]. The authors aim in this study to shed light on one of the problems of Iraqi construction projects represented by claims and to demonstrate the role of modern technologies, such as BIM technology, in solving these problems and managing claims in an orderly and documented manner. The methodology

of this study is to conduct a systematic compilation of others studies related to the effect of the utilize BIM technology in claim management in the construction sector.

2 COMMON CAUSES OF CLAIM IN IRAQI CONSTRUCTION PROJECTS

In this section, the researchers review the most important reasons which have resulted in the emergence of claims in Iraqi construction projects. Table 1 shows the causes of claims. As shown in Table 1, 88.57% of Construction projects in Iraq suffered from the claim of time extension, whereas, claims associated with re-analysis tenders were the least demanding [19].

Table 1. Explains the main causes of the claims in the Iraqi project construction [19]

No.	Causes of Claim in Iraq	Frequent %
1	Claims associated with extending the bidding period	42.14
2	Bid re-analysis claims	10.5
3	Corporate breach of contract lawsuits	38.57
4	Claims to modify the terms of the contract	35.71
5	Cost overrun claims and change of purchase orders	65.71
6	Time extension claims	88.57
7	Liquidated damages claim	74.29
8	Poor performance, and quality claims	52.86
9	External damages claim	44.29

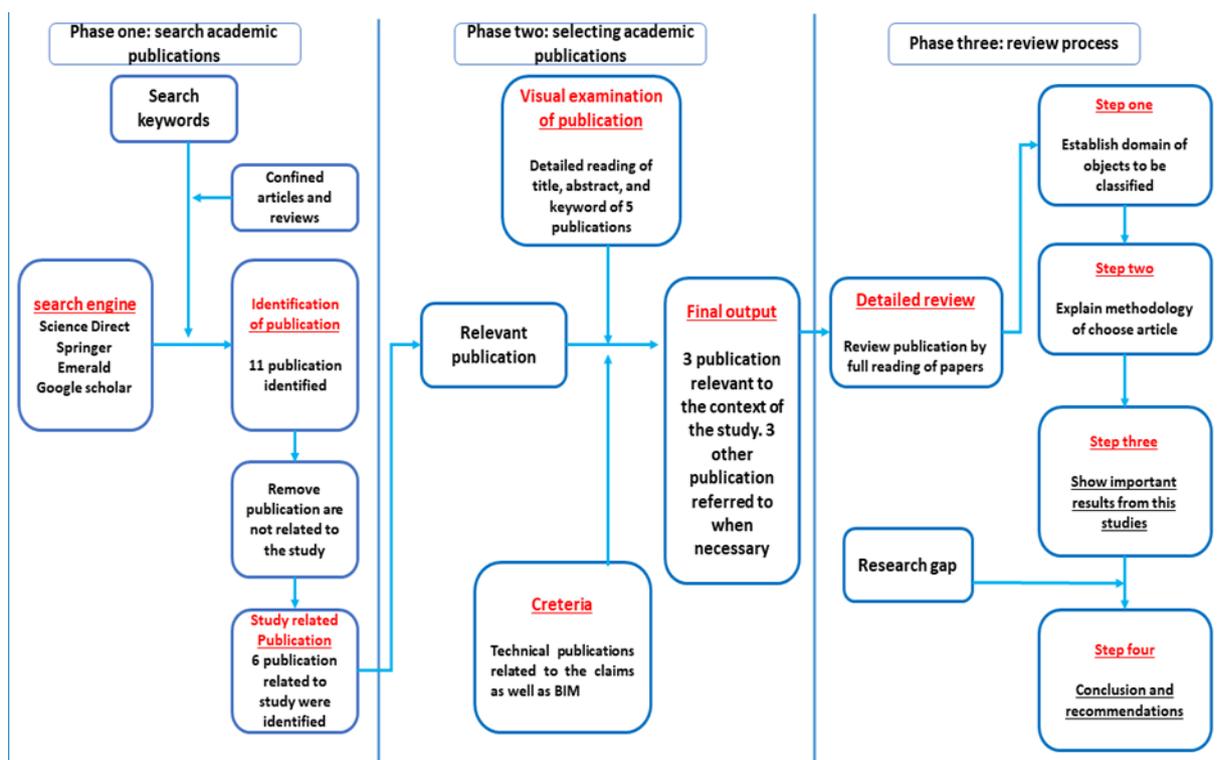


Fig. 1. Presents a summary of the methodology

3 LITERATURE REVIEW

"The BIM-based claims management system: A central data core for time extension claims" [20]. This study is considered one of the best that has provided a computerized model for addressing time-claim problems. The objective of this article is to use an innovative technique such as BIM technology, for creating a visual repository to solve problems specified in the EOT claims management operation. For that, a plug-in is generated, called the "The system BIM-Based Claims Management (BIM-CMS)", with all the available functions for managing claims of EOT. The sophisticated system (BIM-CMS) has been predicted in order to assist in a more rapid and transparent in settling of the claims of EOT. In addition to that, it will help in achieving the projects of the construction without any cost

overrun or unwanted delays, as well as, establish a perfect relationship between the parties of the contract. The proposed framework for this article is displayed in (Fig. 2). The article is managed in three phases that include:

- Identifying problems in EOT claims management through semi-structured interviews and literature review.
- Generating a plug-in (BIM-CMS) for the Revit software to manage EOT claims.
- Testing and evaluating the developed system utilizing expert reviews as well as industry comments using a questionnaire.

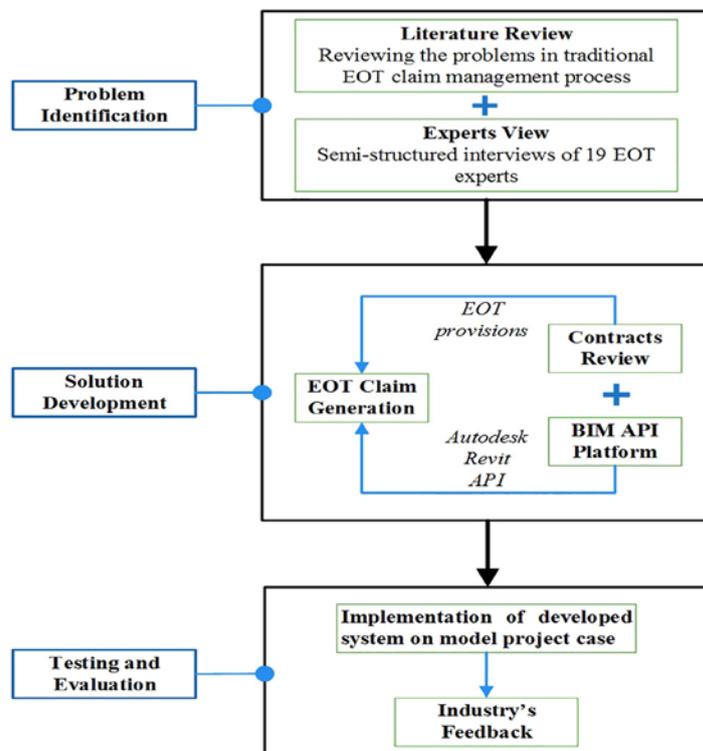


Fig. 2. Methodology Framework

4 CLARIFYING PROBLEMATIC ISSUES IN EOT CLAIMS MANAGEMENT

Firstly, three main steps were taken. The first step was a comprehensive literature review and clarifying problematic issues in the claims management process EOT. It is believed that the specific problematic nature of EOT claims will, in fact, matter to other claims as well [21]. The second step consisted of consulting 24 research papers related to claims management, 47 problematic issues in EOT claims management were extracted, and the third step was content analysis to assess the problems and merge problems that have different names but contain similar meanings. Finally, a shortlist of (35) problematic issues in the EOT has been identified.

After that, the compiled list was criticized by (19) contract experts through semi-structured interviews, and any new suggestions were presented. The sample size was met for qualitative research approaches, like interviews, meaning that additional interviews will not result in the production of any new data. The sample has been carefully selected and it has been verified that these experts have extensive experience in the construction industry on international and local projects, in addition, they must be responsible for EOT claims. The issues collected were posed to two main questions:

Do you believe that the construction industry is facing the mentioned issue during the process of managing an EOT claim?

Are there any other issues you would like to add?

In the event that there is agreement on a particular item in the questionnaire, the interviewees are asked to place this issue within an appropriate group from a list containing the names of groups. The results of the interviewees' observations were analyzed quantitatively and a set of groups was identified for each issue depending upon the frequent agreement amongst the experts. It's important to focus on the issue of 'awareness lack of the contract' which has been provided with a new name to the word 'education' by the candidates. It has not been included in a list of the groups that have been already given during semi-structured interviews.

5 PROTOTYPE DEVELOPMENT

After identifying the problems in the first stage, the second stage began with the creation of a prototype to solve these problems. Initially, the Claims Clauses (EOT) clauses were extracted by studying the criteria applied in the contracts, and these contracts include:

- FIDIC 1987 edition
- IDIC 1999 edition
- FIDIC/ world bank 2010
- New engineering contract (NEC)
- American Institute Architect (AIA)

The goal was to develop a prototype capable of managing all EOT claims events. Most BIM tools and platforms provide an API to add more extensions to their functionality [22] so a plugin (BIM- CMS) has been developed in order to manage claims EOT. Autodesk Revit Architecture 2017 and the BIM platform were utilized to represent the platform, and Visual Studio and SQL were used to represent the environment for software development.

6 PROTOTYPE EVALUATION

In the last stage, the developed model is assessed by examining the areas that have been optimized [23]. For the purpose of evaluation, an expert was carefully selected, eight of them (5 contractors, 3 engineers) and 3 experts with at least 12 years of experience in the claims department, and two experts in the field of BIM. The work of this tool was presented through presentations and animations, where the presentation was in two parts, the first section explains what BIM technology is, and the second section is a presentation of the developed model. The research idea was applied to a medical complex project, where various types of potential delay events were recorded.

7 RESULTS OF CHOSEN STUDY

The results are discussed according to the research sequence in the method section of the present study.

7.1 Problematic issue in EOT claim management process

In this section, 35 claims management issues are identified from the literature. But after interviews with experts/interlocutors, these cases were reduced to 28, and the rest were considered insignificant. In addition, after being mentioned by 8 out of 19 experts, a new issue titled "in and out of organization personnel" was added. Table 2 shows the final versions of 29 issues divided into eight groups.

Table 2. Shows finalized EOT problematic issues [20]

No.	Problematic issues in EOT claim management	Group
1	Too many documents	documentation
2	There are not enough contemporary records	
3	Inefficient method of keeping records	
4	Unstructured information for claim preparation	
5	Oral employer and engineer instructions	
6	There is no standard format	
7	Incomplete documents	Contractual
8	Failure to comply with contract requirements	
9	Bad papers by the contractor	
10	simultaneous delays	
11	Inability to access documents when needed	Procedure
12	The complexity of determining cause and effect	
13	Lack of communication	
14	Use of inappropriate techniques	
15	There is no updated software	
16	Insufficient staff to prepare the claim	Resources
17	Inadequate personnel to assess the claim	
18	Lack of experts	
19	There is no computerized documentation system	
20	Inside and outside the organization's employees	No group

No.	Problematic issues in EOT claim management	Group
21	Delay in returning the requested document	Time
22	timeout	
23	Timely notifications lacked by contractors	
24	Failure of the engineer to take timely decisions about delays	
25	High cost	Cost
26	Exaggerated claims by contractors	
27	Poor demonstration/presentation of the impact	Presentation
28	Ambiguities	
29	Lack of awareness of the contract	Education

7.2 BIM-CMS Framework

The proposed system framework for managing an EOT claim is depicted in (Fig. 3). The BIM platform and the created BIM-CMS for enrolment communicate with one other and link to a database such as SQL Server. To begin, the project's BIM model is opened in Revit software, and the EOT claimed event is determined to be a design difference or any other contract that allows for an EOT event. The BIM model has been adjusted for adjustments in circumstances of disagreement. The item to be claimed for the EOT is defined in a form that is used to record the EOT (change or delay) event after calling the BIM-CMS application. The required event information has been added then. For an EOT occurrence, all information that has been listed is correct. After then, the data from the BIM-CMS program was shown. The (letters, schedules and brochures) for all recorded events have been uploaded, and the material can be updated at any time.

If a claim is generated, the events that were recorded are selected, and the supporting files for the main claim, like schedules, etc., as well as information, are set against a certain claim. Event histories were understood on the basis of applying methods and utilized in order to run an EOT simulation in Navis works. This demonstration video has been utilized in order to reinforce the claim, by the vision effect of delays in 4-D. These added data for the EOT claim have been stored in a database and recalled throughout the evaluation and decision-making on the generated claim of EOT. The decision, in addition to any supporting file, as a basis and its consent documents, were stored as well in the database.

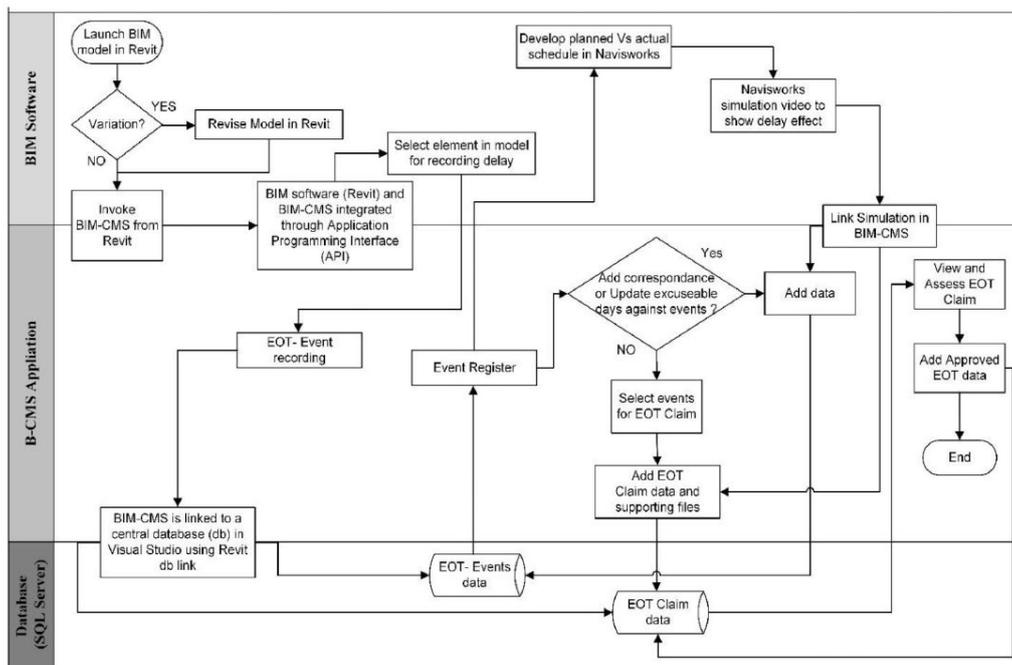


Fig. 3. BIM-CMS Framework - Multifunctional Process Map

7.3 BIM-CMS Prototype architecture

The prototype under investigation includes four modules, as shown in (Fig. 4) below.

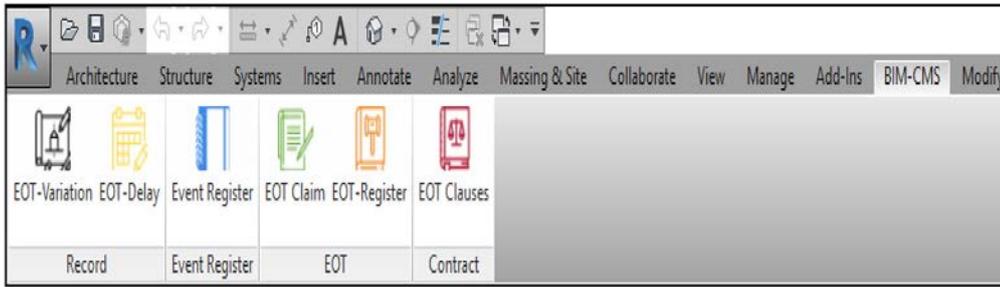


Fig. 4. Illustrates models of the developed prototype

7.3.1 Record module

The record model produces two options, the first option is EOT-Variation (handles changes in design and quantities) while the second is EOT-Delay (deals with other cases). This classification is depending on the different kinds of construction cases that are permitted for the EOT. During claim preparation, many contractors don't quote a contract clause due to the obvious lack of familiarity with a contract and its items. All applicable contracts internationally, and related EOT clauses have been embedded in each one of the templates as can be seen from (Fig. 5) where the EOT-Variation template have 15 categories, whereas, the EOT-Delay template have 12 categories:

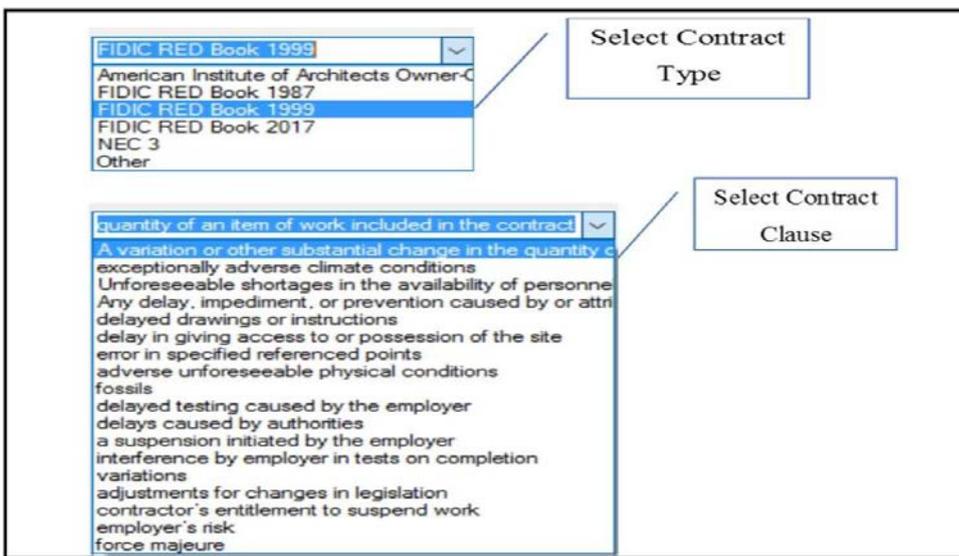


Fig. 5. Illustrates Module Template

7.3.2 Module of event register

Visual studio links the event registration module to the SQL database to save and remember data entered from the record model. Figure 1 shows the names of the build items (6). EOT-Variation and EOT-Delay are notified under distinct titles (tabs) for variation and delays. To build a compelling case and demonstrate the impact, the contractors can submit their evidence of occurrences against the elements, like drawing alterations, letters, timetables and weather reports. Similarly, the client/employer and engineer can click to download and inspect the evidence recorded against elements, analyze the situation, and provide responses in the form of a document. Figures (7) and (8) demonstrate this.

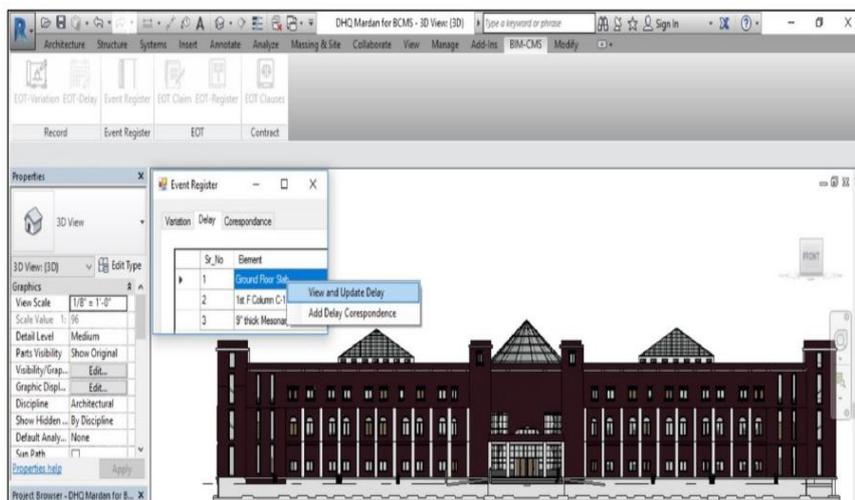
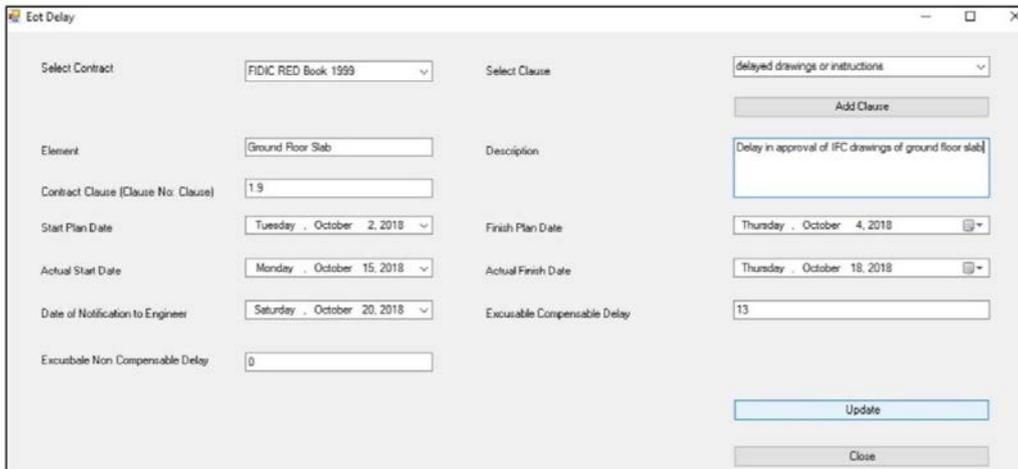


Fig. 6. The template of the event register

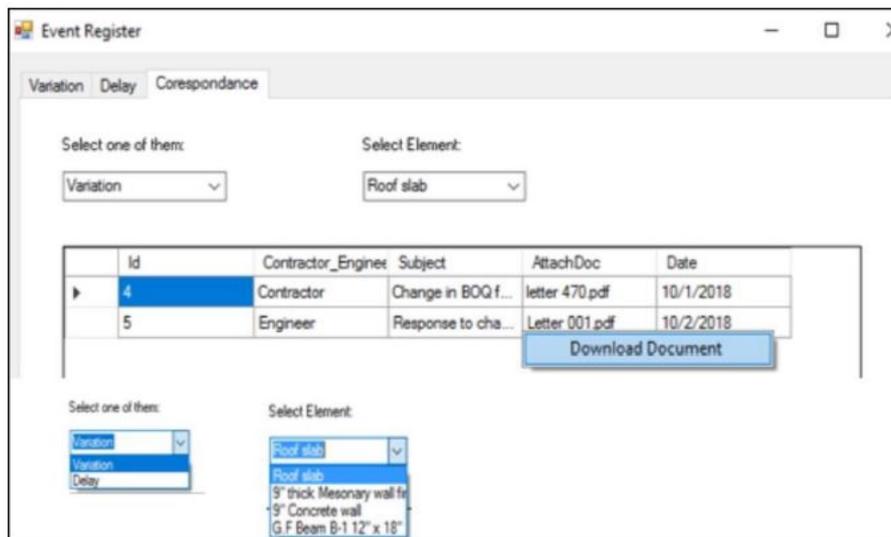


The screenshot shows a form titled "Eot Delay" with the following fields:

- Select Contract: FIDIC RED Book 1999
- Select Clause: delayed drawings or instructions
- Element: Ground Floor Slab
- Description: Delay in approval of IFC drawings of ground floor slab
- Contract Clause (Clause No: Clause): 1.9
- Start Plan Date: Tuesday, October 2, 2018
- Finish Plan Date: Thursday, October 4, 2018
- Actual Start Date: Monday, October 15, 2018
- Actual Finish Date: Thursday, October 18, 2018
- Date of Notification to Engineer: Saturday, October 20, 2018
- Excusable Compensable Delay: 13
- Excusable Non Compensable Delay: 0

Buttons: Add Clause, Update, Close

Fig.7. The template of information for the update event.



The screenshot shows the "Event Register" form with tabs for Variation, Delay, and Correspondance. The "Correspondance" tab is active.

Select one of them: Variation

Select Element: Roof slab

Id	Contractor_Engineer	Subject	AttachDoc	Date
4	Contractor	Change in BOQ f...	letter 470.pdf	10/1/2018
5	Engineer	Response to cha...	Letter 001.pdf	10/2/2018

Buttons: Download Document

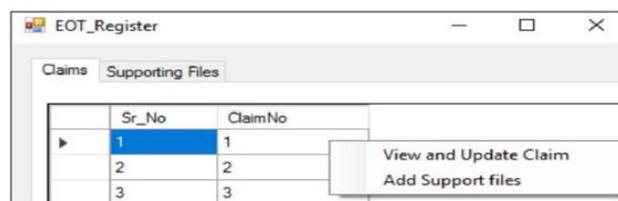
Select one of them: Variation, Delay

Select Element: Roof slab, 9" thick Masonary wall ft, 9" Concrete wall, G.F Beam B-1 12" x 18"

Fig. 8. illustrates the correspondence template

7.3.3 Module of EOT

The module of EOT consists of EOT-claim and EOT register. EOT-claim has been utilized in order to create a claim for EOT. Moreover, EOT-register is used to keep EOT claims and their events stored related to the SQL database. Under the claim tab, EOT-register presents a list of claims. On the other hand, EOT-register displays relevant files supported by the files tab. Figures (9) and (10) explain that.

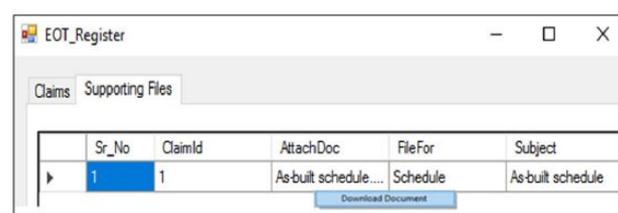


The screenshot shows the "EOT_Register" form with the "Claims" tab selected. It displays a table with columns "Sr_No" and "ClaimNo".

Sr_No	ClaimNo
1	1
2	2
3	3

Buttons: View and Update Claim, Add Support files

Fig. 9. EOT- register



The screenshot shows the "EOT_Register" form with the "Supporting Files" tab selected. It displays a table with columns "Sr_No", "ClaimId", "AttachDoc", "FileFor", and "Subject".

Sr_No	ClaimId	AttachDoc	FileFor	Subject
1	1	As-built schedule...	Schedule	As-built schedule

Button: Download Document

Fig.10. EOT-register supporting files

A video of the Navisworks timeline is normally created to generally show the impact of a project in a planned simulation versus an actual 4D simulation when events are delayed, using the BIM program, to solidify the claim after the visualization of the impact of the events in 3-D, as illustrated in (Fig. 11):

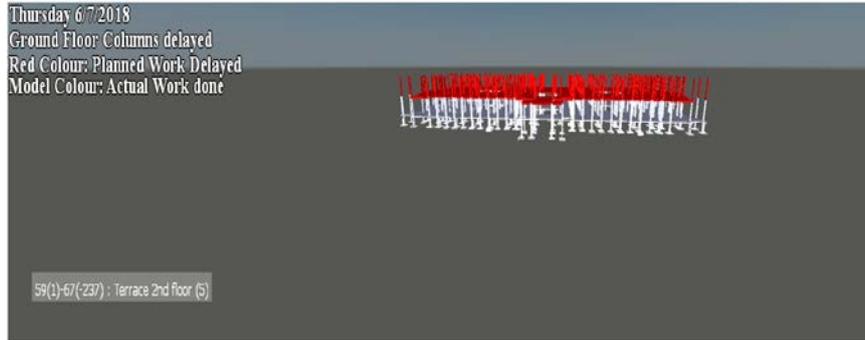


Fig. 11. Simulation by Navisworks timeline

The engineer will examine all construction parts for which the contractor has filed an EOT claim. The contractor's update claim form, on the other hand, comprises the specifics of EOT incidents and the day of EOT claimed. The engineer can make his decision for the rest of the entries of the update claim template, which has been illustrated in (Fig. 12) and detailed in the table after reviewing items supported by documentation and observing correspondence in the event register (3).

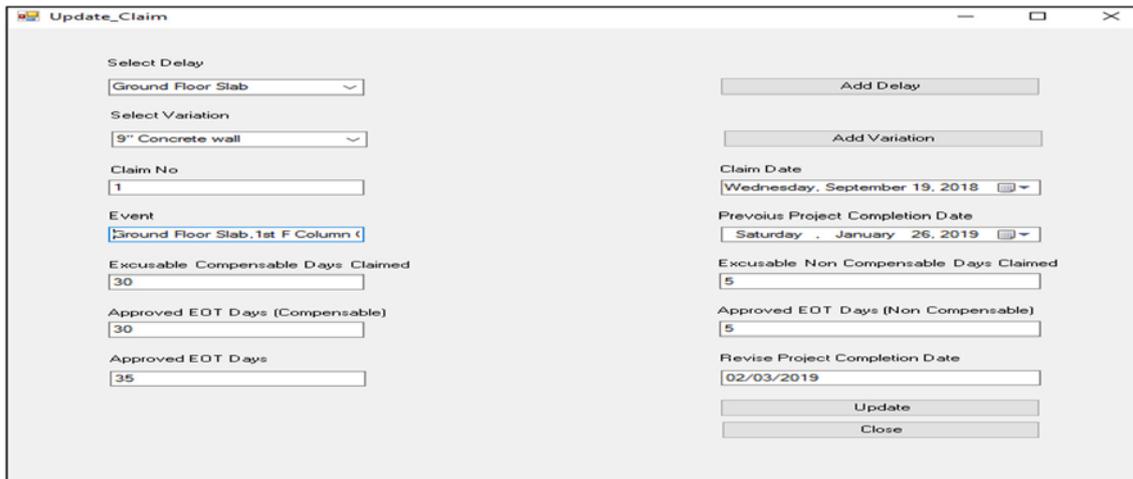


Fig. 12. Update claim template

Table (3) explains Update EOT-claim categories.

No.	Category	Description
1	Approved days of EOT (compensable)	Utilizers record approved compensable days of EOT after evaluated by the engineer
2	Approved das of EOT (non-compensable)	Users record approved non-compensable das of EOT after the evaluation by the engineer
3	Approved days of EOT	Summation of the above inputs for the total value of the EOT days
4	The revised date of project completion	Automatically adding approved EOT days to the previous project date of completion to the completion date of the new project with the EOT

7.3.4 Module of contract

The module of the contract is considered a reference for viewing the EOT clauses by users from standard international contracts.

7.4 BIM-CMS' ROLES AND RESPONSIBILITIES

The roles and responsibilities in this new system will be in accordance with standard practices in the construction industry. On the contrary, the contractor initially submits his claim to the engineer at a specified time. The engineer's role is to evaluate this claim and give a response within a specific time and as stipulated in the contract [24]. According

to this system, it is necessary to have a professional BIM manager or a private outsourced [25]. Figure 13 shows that:

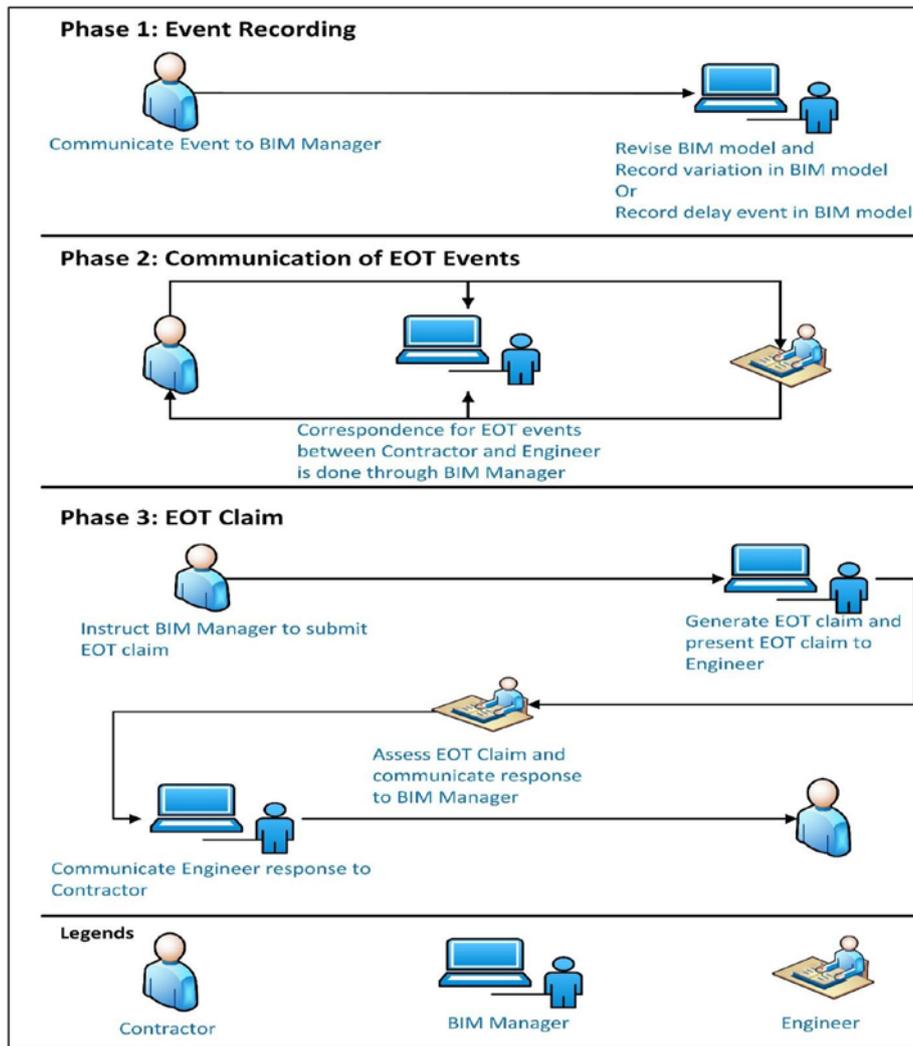


Fig. 13. shows roles and responsibilities in BIM-CMS

7.5 ASSESSMENT OF BIM-CMS

After completing the initially developed form and applying it to the selected case study and clarifying all the events that can happen to an EOT claim, a questionnaire was conducted by asking the following questions to the experts:

- The need for BIM-GMS in the industry of the construction
- Implementation of the BIM-GMS
- Usability of BIM-GMS interface
- Effectiveness of BIM-GMS to improve the EOT claim management process.

Expert opinions were obtained and collected according to the Likert scale [26]. Table (4) explains briefly the discussion for results.

Table 4. Discussion for results.

No.	Problematic problems in the claim management of the EOT	Group	Discussion
1	A great number of documents	documentation	The average expert score indicates that the majority of experts have positive scores (agree or strongly agree); Hence, it is possible that BIM-CMS largely replaces all relevant documentation in the EOT claims management process. Top Rank The problem of "not enough contemporary records" may be eliminated by BIM-CMS. According to the RII values, all of the cases belonged to one group and
2	Lack of sufficient contemporary records		
3	Ineffective system of record-keeping		
4	Non-ordered information for the preparation of the claim		

No.	Problematic problems in the claim management of the EOT	Group	Discussion
5	Verbal instructions by the engineer or employer		have been considered to be >80% reduced in comparison with the other matters. This is attributed to the fact that all of the events are connected and documents may be stored easily in a BIM-CMS database.
6	No standard format		
7	Incomplete documents	Contractual	The lower score is given by experts to the issue of "non-compliance with contract requirements." It is classified as being one of the last five editions as it has been indicated by its RII value. Throughout the interviews, most experts felt that this matter is dependent upon personal readiness and claim evaluation.
8	Non-compliance with contract requirements		
9	Weak paperwork of a contractor		
10	Synchronized delays		
11	Inaccessibility of the documents when required	Procedure	This type of problem is related to the inability of the people responsible for calculating the delay due to their poor experience and poor technology adoption. The experts explained that the engineer must adopt the protocols stipulated in the Building Code relating to the Second Edition of the Delay Analysis Guidelines. with a preference for average scores and RII values of at least 80%, and all other problems with the process may be minimized with the BIM-CMS.
12	Complex determined cause and effects		
13	Lack of communications		
14	Unsuitable techniques		
15	Lack of updated program		
16	Insufficient personnel to prepare the claim	Resources	The resource set consisted of the unranked and lowest-ranked 'expert shortage' problem of all mentioned problems, with a mean score less than 3 and an RII value in a 50% range. Experts firmly think that the system can't be considered a substitute for contractual knowledge
17	Weak personnel to assess the claim		
18	Lack of experts		
19	No computerized system of documentation		
20	In and out of organization personnel	No group	----
21	Retrieving overdue of the needed document	Time	The time needed to "retrieve documents," according to experts, might be reduced by using BIM-CMS to prepare claims, "notify the engineer" of the occurrence of the event and correspondence through the central database; So I ranked them among the top 10 problems to solve using BIM-CMS. On the other hand, "lack of timely notifications by the contractor" and "lack of timely decisions by the engineer on delay" among others were rated.
22	Time limit		
23	Timely notifications lacked by contractors		
24	Timely decisions lack by engineers concerning delays		
25	High cost	Cost	It may be resolved with the use of a central database/claims preparation by BIM-CMS. Importantly, given the accessibility to view the evidence for every one of the events and its effect, contractors will not be capable of overstating the impact of their claims.
26	Exaggeration of claims by contractors		
27	Insufficient demonstration/presentation of the impact	Presentation	Presentation problems, particularly the "poor presentation" issue, are no longer an issue. Ranked among the top 5 issues
28	Ambiguities		
29	Lack of the contract awareness	Education	This problem is substantially fixed

8 BARRIERS TO ADOPTING OF BIM-CMS PLATFORM

During the reviews with experts, a number of factors that impede the implementation of this procedure were identified, namely:

- Not knowing BIM
- The cost
- Unwillingness to innovate in traditional building practices
- Lack of a serious attitude to deal with claims
- the limitation of contracts
- Fragmented nature of the construction industry
- Security

9 RESEARCH GAP

This report provided a review of the literature related to one of the most important problems in construction projects, which is the claims. Based on the study identified, a number of research gaps were identified:

- The first gap: Whenever any change in designs is made, the change in quantities is manually entered into the proposed platform instead of being changed automatically. As we know that Revit software is characterized by its high ability to calculate quantities accurately, so the platform can be improved by linking the tool (Quantity takeoff) to the warehouse of materials quantities in the platform.
- The second gap: manually entering the date change into Navisworks software, and this may lead to the loss of information due to negligence. Therefore, the researcher suggests developing API-based interfaces in Naviswork software, so that a question appears when any time change is made (Are there any claims about this period), and if yes, a report is sent to the Revit software to install in the proposed platform. Figure 14 shows the proposed modification
- The third gap: The most important reason for poor claims is the lack of continuous documentation of delays, and therefore this platform needs a manual entry. This problem can be resolved by modifying the person requesting the entry. This can be explained as follows. In Iraq, for example, the employer requires engineers supervising projects to submit a monthly report on the percentage of completion of their projects, so that (phase1 "event recording") can be modified by making the engineer the person who starts addressing the BIM manager by clarifying a question within the monthly form on the topic of claims. Figure 15 shows the proposed modification.

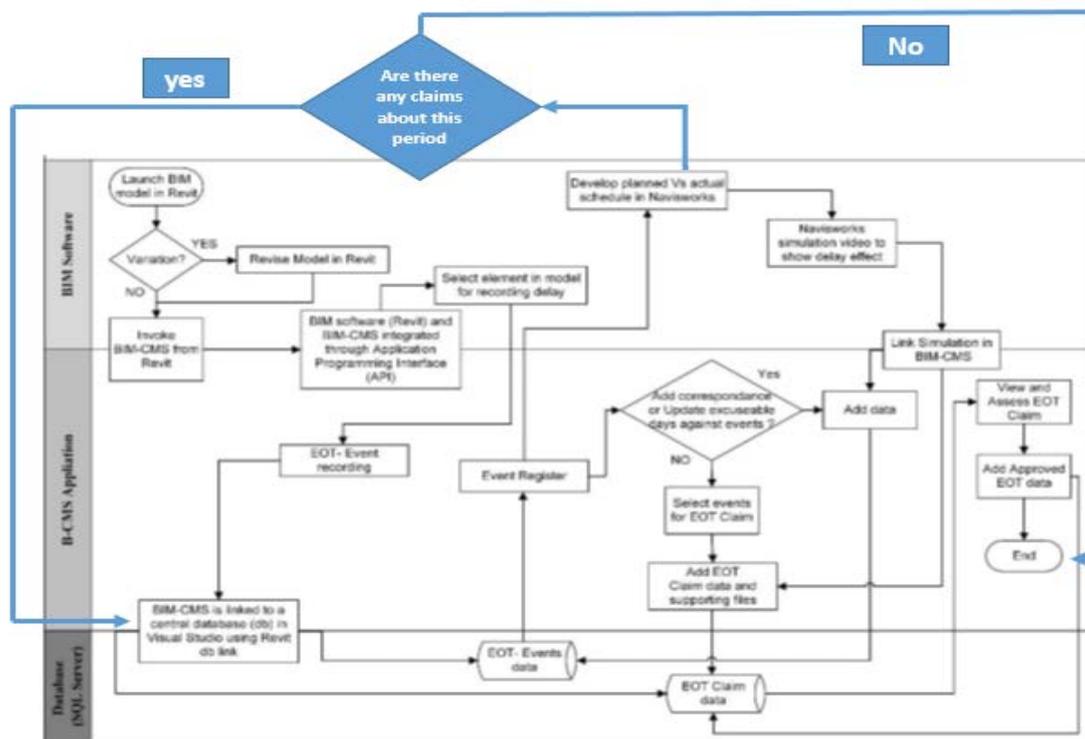


Fig. 14. shows corrective action in the framework

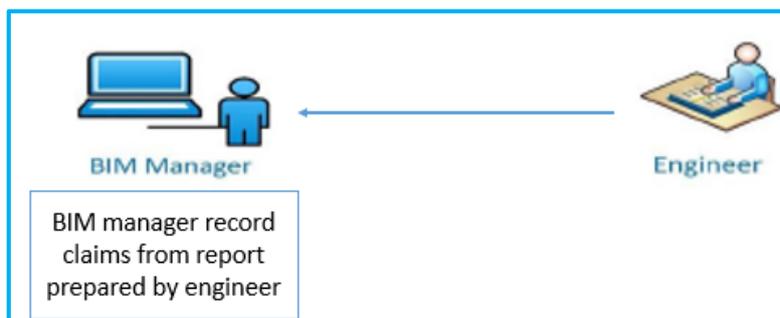


Fig. 15. shows corrective action in role and responsibilities

10 CONCLUSION

Construction projects become more complex over time and as projects become more complex and more problems can cause an increase in the construction claims. Construction claims have become a very common business that could be found in almost every construction project and is considered a very troublesome event due to their negative impact on the time, cost and quality of the project. Thus, it is always important to find new solutions and ways to reduce and prevent building claims.

BIM was developed as an invaluable technique architecture and construction industry. The use of ICT has greatly facilitated practitioners to achieve success in various projects and higher organizational productivity. This paper provides a model for the adoption of BIM technology in claims management. The study also addressed the main gaps identified in the selected study. The important results can be summarized as follows:

- The proposed model in the chosen study can be effective in addressing claims problems in Iraq
- The study claimed to have developed a claim management prototype by adopting the prototypes provided by BIM platforms using an API. In this study, Architectural Revit, version 2017, was used, linked to SQL Server, and the prototype was built using a common programming language (C#)
- The developed model was evaluated by a group of construction industry experts through semi-structured interviews and questionnaires, and the study explained that the results show that this model is capable of solving most of the problems identified in the claims management system.
- During the analysis of this study, a set of research gaps were installed that by addressing them the proposed prototype can become more accurate, as it was found that the change in the calculation of quantities when changing designs is entered manually; while the Revit software provide accurate automatic calculation of any change in the design and therefore this model can be linked to the tool (quantity takeoff) in Revit, in addition to the fact that the researcher found that entering dates into the Navisworks software is also done manually and this can cause an error, especially in the absence of accurate documentation, which is why the researcher suggests linking the Naviswork software with the proposed model and put a conditional question to indicate the reasons for the change in the time period of the project, and finally, the researcher proposes to make a modification to make the engineer the person who starts sending claims to the BIM manager through the monthly performance reports of the project.

11 REFERENCES

- [1] Noorzai, E. (2020), "Performance analysis of alternative contracting methods for highway construction projects: a case study for Iran", *Journal of Infrastructure Systems*, Vol. 26 No. 2, doi: 10.1061/(ASCE)IS.1943-555X.0000528.
- [2] Pishdad-Bozorgi, P. and de la Garza, J.M. (2012), "Comparative analysis of design-bid-build and design-build from the standpoint of claims", s.l., *Construction Research Congress 2012: Construction Challenges in a Flat World*, doi: 10.1061/9780784412329.003.
- [3] Parikh, D., Joshi, G.J. and Patel, D.A. (2019), "Development of prediction models for claim cause analyses in highway projects", *Journal of Legal Affairs and Dispute Resolution in Engineering and Construction*, Vol. 11 No. 4, doi: 10.1061/(ASCE)LA.1943-4170.0000303.
- [4] J. J. Adrian, *Construction Claims: (2019). A Quantitative Approach*, Prentice-Hall, New Jersey, 1988, ISBN: 9780835910217, Available at <http://www.worldcat.org/oclc/567973970>, Accessed date: 7 August 2019.
- [5] D.S. Barrie, B.C. Paulson Jr, (Accessed date: 6 August 2019). *Professional Construction Management: Including Contracting CM, Design-Construct, and General Contracting*, 3rd ed., McGraw-Hill, New York, 1992, ISBN: 9780070038899, Available at <https://trove.nla.gov.au/version/43579333>.
- [6] H.C. Tan, C. Anumba, (Accessed date: 25 July 2019). *Web-based construction claims management system: a conceptual framework*, In *Proceedings of 8th International Conference on Construction and Real Estate Management (ICCREM)*, Brisbane, Australia, 2010, pp. 130–134, Available at https://mafiadoc.com/web-based-construction-claims-managementsystem_59f49ef31723dd68dd7e36d7.html.

- [7] S. Koc, S. Skaik, Disputes resolution:(Accessed date: 2 July 2019). Can BIM help overcome barriers, In Proceedings of International Conference on Construction in a Changing World, Dambulla, Sri Lanka, May 4–7, 2014: pp. 1–4, Available at <http://dro.deakin.edu.au/view/DU:30065699>.
- [8] Arcadis (2019), Global Construction Dispute Report, s.l., available at: <https://www.arcadis.com> (accessed 17 March 2020).
- [9] Charehzehi, A., Chai, C.S., Yusof, A.M., Chong, H.Y. and Loo, S.C. (2017), “Building information modeling in construction conflict management”, International Journal of Engineering Business Management, Vol. 9, pp. 1-18, doi: 10.1177/1847979017746257.
- [10] Palaneeswaran, E., & Kumaraswamy, M. M. (2008). An integrated decision support system for dealing with time extension entitlements. Automation in Construction, 17(4), 425-438.
- [11] Jalali, Z., Noorzai, E. and Heidari, S. (2019), “Design and optimization of form and façade of an office building using the genetic algorithm”, Science and Technology for the Built Environment, Vol. 26 No. 2, pp. 128-140, doi: 10.1080/23744731.2019.1624095.
- [12] Taghizade, K., Heidari, A. and Noorzai, E. (2019), “Environmental impact profiles for glazing systems: strategies for early design process”, Journal of Architectural Engineering, Vol. 25 No. 2, doi: 10.1061/(ASCE)AE.1943-5568.0000343.
- [13] Faiq M.S.Al-Zwainy, Ibrahim A.M, Kamal A.K., Salah Kh. Z.(2017). BIM in Project Management. Iraq/Baghdad: AL-THAKERA.
- [14] D.G. Lee, J.Y. Park, S.H. Song, (2018). BIM-based construction information management framework for site information management, Advances in Civil Engineering, <https://doi.org/10.1155/2018/5249548>.
- [15] Dave, B., Buda, A., Nurminen, A., & Främmling, K. (2018). A framework for integrating BIM and IoT through open standards. Automation in Construction, 95, 35-45.
- [16] El Hawary, A., & Nassar, A. (2015). The effect of building information modeling (BIM) on construction claims. Int. J. Sci. Technol. Res, 5(12), 25-33.
- [17] Gibbs, D. J., Emmitt, S., Ruikar, K., & Lord, W. (2013). An investigation into whether building information modelling (BIM) can assist with construction delay claims. International Journal of 3-D Information Modeling (IJ3DIM), 2(1), 45-52.
- [18] A. Burr, (2016). Delay and Disruption in Construction Contracts. 5th ed., Routledge, New York, ISBN: 9781315673950, Available at doi:<https://doi.org/10.4324/9781315673950>, Accessed date: 26 March 2019.
- [19] Erzaj, K. R. (2020, March). Nature and Causes of claims in Iraqi turnkey projects. In IOP Conference Series: Materials Science and Engineering (Vol. 745, No. 1, p. 012181). IOP Publishing.
- [20] Ali, B., Zahoor, H., Nasir, A. R., Maqsoom, A., Khan, R. W. A., & Mazher, K. M. (2020). BIM-based claims management system: A centralized information repository for extension of time claims. Automation in Construction, 110, 102937.
- [21] Kululanga, G. K., Kuotcha, W., McCaffer, R., & Edum-Fotwe, F. (2001). Construction contractors' claim process framework. Journal of Construction Engineering and Management, 127(4), 309-314.
- [22] Akinade, O. O., Oyedele, L. O., Munir, K., Bilal, M., Ajayi, S. O., Owolabi, H. A., ... & Bello, S. A. (2016). Evaluation criteria for construction waste management tools: towards a holistic BIM framework. International Journal of Sustainable Building Technology and Urban Development, 7(1), 3-21.
- [23] T. Paek, (Accessed date: 29 November 2018). Empirical methods for evaluating dialog systems, In Proceedings of the 2nd SIGdial Workshop on Discourse and Dialogue, Stroudsburg USA, September 01–02, 2001, vol. 9(2): pp. 1–9, Available at doi:<https://doi.org/10.3115/1118078.1118092>,
- [24] El-adaway, I., Fawzy, S., Ahmed, M., & White, R. (2016). Administering extension of time under national and international standard forms of contracts: A contractor's perspective. Journal of Legal Affairs and Dispute Resolution in Engineering and Construction, 8(2), 04516001.
- [25] J. Joseph, (Accessed date: 10 July 2019). BIM Titles and Job Descriptions: How Do they Fit in your Organizational Structure? Autodesk University, 2011. Available at http://aocache.autodesk.com/au2011/sessions/4436/class_handouts/v1_DL4436_Joseph_BIM_Titles_Job_Descriptions_JJ.pdf,
- [26] H. Zahoor, A.P.C. Chan, W.P. Utama, R. Gao, S.A. Memon.(2017). Determinants of safety climate for building projects: SEM-based cross-validation study, J. Constr. Eng. Manag. 05017005, , [https://doi.org/10.1061/\(asce\)co.1943-7862.0001298](https://doi.org/10.1061/(asce)co.1943-7862.0001298).

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