Global Scientific JOURNALS

GSJ: Volume 8, Issue 5, May 2020, Online: ISSN 2320-9186
www.globalscientificjournal.com

Information technology (IT) in the construction project management

Dr. Amjad Odeh Alshabatat

Abstract

This study explores the benefits of utilizing Information technology (IT) in the construction projects, the obstacles hindering the reasonable adoption (IT), and set some recommendations to overcome these obstacles as well to get the most benefit of IT.

The need for IT to manage construction projects' processes is necessary to enhance projects' output. However, the construction industry has not yet been able to gain the expected benefits from IT implementation. The focus of the study is on presenting the applying of IT in the three constrains areas in construction projects; cost, time, and scope which shape the quality of any project during execution. Also, In the world of Big Data, data visualization tools and technologies are essential to analyze massive amounts of information and make data-driven decisions, therefore this subject has been highlighted in this article. Furthermore, the obstacles to IT adoption in the construction projects will be identified and some proposed suggestions to overcome these obstacles as well as how to expand the use of IT in the construction industry.

Key words**:** Information Technology (IT); Construction Project management

1. Introduction

IT in the construction projects emerged from two fields. The first was related to the use of computers for creating drawings, making structural analysis, and carrying out time and cost calculations. The second was concerned with the use of computers to classify, store, and manage the construction information [1].

In this article, the definition of IT and some approaches to IT implementation in the construction projects as well as its benefits, obstacles to IT adoption in the construction projects, and recommendations are discussed.

2. Information Technology in construction industry

Information technology (IT) is a technology that "uses computers to gather, process, store, protect, and transfer information. It is common to use the term

Information and communications technology (ICT) interchangeably because it is unimaginable to work on a computer which is not connected to the network" [2].

Figure 1.1 shows the major components of ICT and how information flows through a medium of communication.

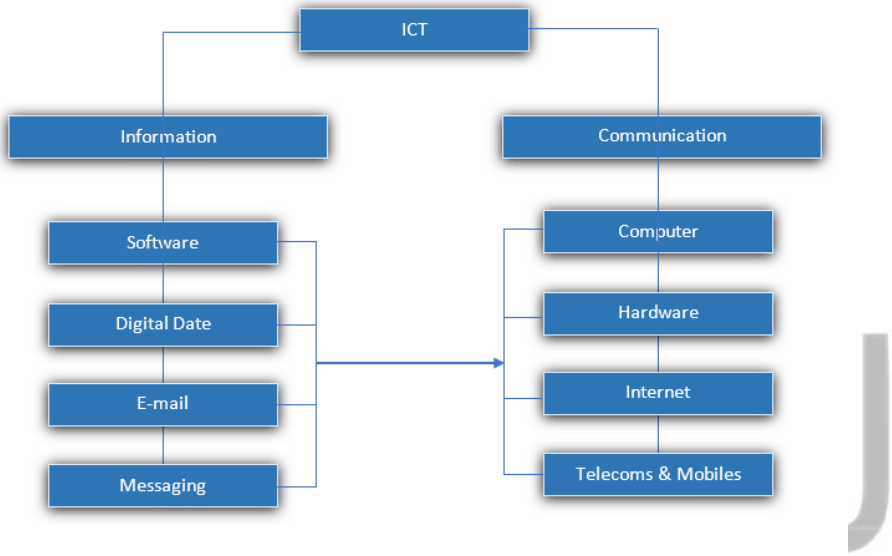

Figure 1.1 ICT and its components [3].

Adwan and Al-Soufi [4]. reviewed the literature about using ICT in the construction projects during the period 1996-2016. Eleven (11) categories of ICT applications were identified: BIM based ICT applications, modelling based ICT applications, computer based Training ICT applications, decision based ICT applications, mobile, wireless & tracking based ICT applications, miscellaneous ICT applications, knowledge management based ICT applications, virtual based ICT applications, project management based ICT applications, simulation based ICT applications, and web-based ICT applications.

Comparing the categories from Adwan and Al-Soufi with the categories mentioned by Sun and Howard [5], it is obvious that utilizing ICT and its solutions in the construction projects increases day by day. Sun and Howard grouped these solutions into the following categories:

Computer-aided cost estimation: contractors and sub-contractors should control cost in the construction phase. These applications allow them to perform cost estimation and monitor the project spending accurately, to reach to an accurate estimation, material quantities should be quantified with their dimension such as length, and lastly, area and volume. These applications read these data directly from drawings, also these applications are linked directly to a database that contains information about labor cost, material, equipment, and production rate, this will fasten the cost estimation procedure comparing to traditional methods.

Building engineering applications: changes that occurred lately or correcting design defects will be very costly. This contribute to developing building engineering applications. These applications simulate the building with aspects such as whether it is safely structured, have comfortable environment and consuming less energy, so these applications allow the users to try different designs to reach to the optimal one by investigating lighting system, structural analysis and energy analysis.

Computer-aided design and visualization: Computer-aided design (CAD) applications are developed to support experts about designing and drawing. The main benefit of CAD systems is to allow the designer to create drawings using circles, rectangles, lines, and text. Comparing to the manual design, the CAD can delete, move, copy and rotate any element in the design, these drawings can be developed more to produce 3D environment in which the client can view the final design of the building at the design stage.

Planning, scheduling and site management: intelligent utilization of computer programs can assist in the planning and management of human and organization resources in the construction projects, through advanced planning, evaluation of choices and aiding in the efficient implementation of the chosen design.

Computer-aided facilities management: facilities management represents the processes of operation and maintenance of the project and its impact cost of the project, also it aims to ensure functionality, comfort, safety and efficiency of the building and its environment, these applications integrate CAD drawings and database that contains information about people and their services.

Business and information management: Huge amount of data is sent and received during the construction stages by all stakeholders. Examples of these data are correspondences, site surveys, design drawings, cost analyses, bill of quantities and emails, therefore, electronic document management systems are developed to help achieving easy access and control within any business or project by merging various sources of information.

So, these solutions have been developed and become more comprehensive, also new methods and approaches are used to implement ICT in the construction projects, the author will explore four approaches and the benefits of applying them in the construction projects, building information modelling (BIM), web-based project management systems (WPMS), automated data collection (ADC), and business intelligence.

Building Information Modelling (BIM): Arayici and Aouad [6], defined BIM as: “the use of the ICT technologies to streamline the building lifecycle processes to provide a safer and more productive environment for its occupants, and to assert the least possible environmental impact from its existence, and to be more operationally efficient for its owners throughout the building lifecycle.”

As major shift in ICT for the construction industry has been the proliferation of Building Information Modelling (BIM) in industrial and academic circles as the new Computer Aided Design (CAD) paradigm [7].

BIM has a potential use at all stages of the project life cycle: the owner to understand project needs, by the design team to analyze design and develop the

project, and by the contractor to manage the construction of the project and by the facility manager during operation and decommissioning phases can use it [8].

BIM methodology presents four unique “D” feature, those features are:

The fourth dimension: this dimension related to time or schedule in which a 3D digital model is linked with time or schedule related information, in a traditional scheduling software, there is no integration between design and time, by linking them, the risk can be mitigated, the conflict can be detected, and the quality can be improved [9].

The fifth dimension: this related to cost estimation, since the information of building is computable, this in turn will lead to more accurate quantification, the quantification process is effortless, and the estimators concentrate on applying their time and knowledge to higher value estimating activities[9].

The sixth dimension: this dimension for sustainability which means meeting the needs of today without compromising the ability of future generations to meet their needs. In the construction it can be measured defining how green the building is in terms of energy and material consumption during its construction, usage, maintenance and demolition, the data needed for supporting green design is captured naturally during the design process and is extracted from the building information model as needed[10].

The seventh dimension: this related to facility and asset management in which building assets database can be linked to BIM record, BIM provides to feature geometry of building and bill of materials, the benefits is to reinforce the planning and decision making. [9].

Usually, most of the professionals who use BIM depends on standalone platform, the difficulty is that most of these platforms have limited resources to handle BIM software and to manage several projects concurrently, in such environment; the data sharing will be weak for all actors in the construction project to collaborate. In addition, the price of the BIM software is unaffordable [11], to face these issues, BIM and cloud-

computing has been integrated, cloud-computing definition is "enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g. Networks, servers, storages, applications and services)" [12], Figure 1.2 shows the integrated cloud-BIM framework.

There are many benefits of such integration, the environment will be Scalable since the data are virtualization and this leads to high levels of utilization, and shared capacity is pooled as the workloads are multiplexed. Moreover, this provides the ability to access the drawings from anywhere and to see the most updated one. Finally, it provides the ability to add or reduce resource according to the user's requirements, and

It is cost-effective that no need of buying several standalone platforms [13].

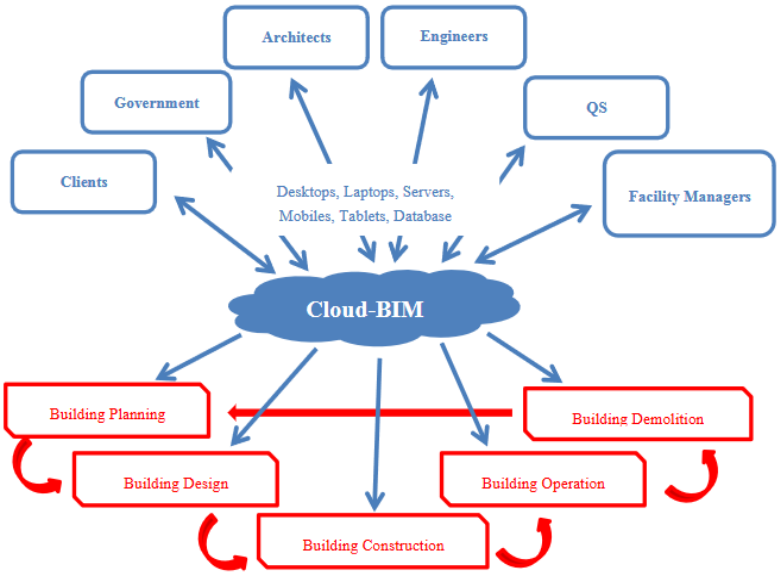

Figure 1.2 The integrated cloud-BIM framework Web-based project management system [14]

According to O'Brien [14], WPMS is "an electronic project-management system conducted through the Extranet, which is a private network that uses Internet protocols to transmit information. The system is only accessible by a project team, but team members can be in different organizations. It basically provides a centralized, commonly accessible, reliable means of transmitting and storing project information."

All data related to the Project such as drawings, recorders and submittals are stored on the server and a standard Web browser is used as a gateway to exchange all these data to all actors in the project, overcoming all the boundaries of the hardware platform. Figure 1.3 illustrates the basic functional scheme of WPMS [15].

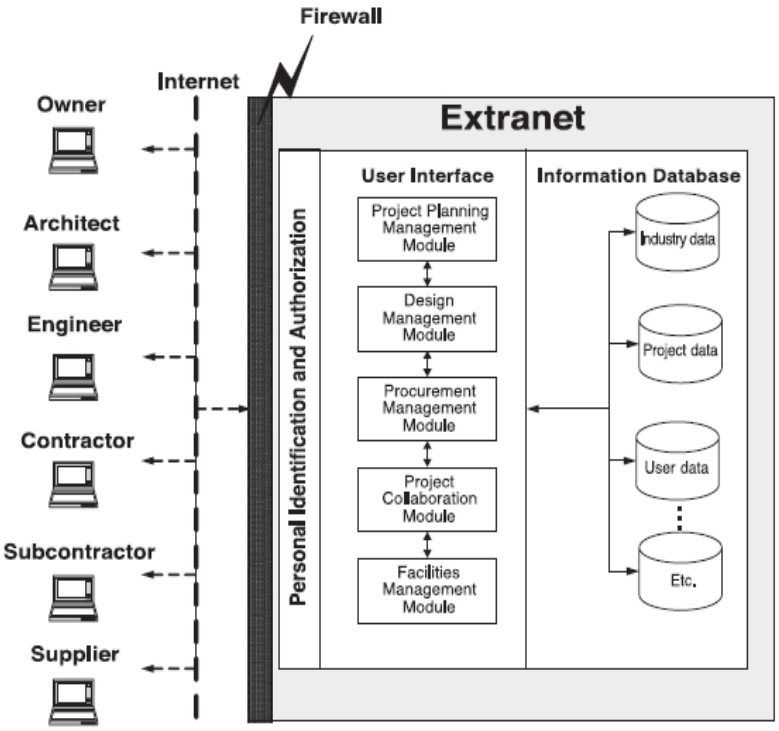

Figure 1.3 Functional schemes of WPMS [15]

For any construction project there are four general categories of information that are normally carried out through WPMS: project, design, management, and financial information [16]. Implementing WPMS solutions can be done using three methods; the first option is to build in-house WPMS by developers or consulting companies. The second is to purchase ready packages and install the system on the internal server of the company. The third option is to rent developed WPMS from an Application Service Provider (ASP), the company usually pay per the storage space needed or per the number of users. This system is rented for a single project and it is considered suitable for small company that cannot develop their own systems, the third one is called Project Management System-Application Service Provider (PM-ASP) [15].

Nitithamyong and Skibniewski [15] identified features of (PM-ASP) in the construction projects. For document management, a central location for the information related to the project such as contract documents, data for cost and time estimation, project photos are created to allow team members to retrieve and organize the files with advanced search feature. In addition, general information such as telephone numbers, e-mails and addresses of the team can be stored. Such a central storage will support information exchange between main stakeholders in the construction project such as progress reports and submittals, these information can be printed later to make a comprehensive record for all project's data and even though if the internet is disconnected, the team member can access the database, lastly this system makes the procurement processes easier.

In the same context, Ahuja, Yang, & Shankar [17] mentioned the benefits of using collaborative ICT system in the building project management based on the previous literature and discussion with experts from the industry as well as with academics, the identified perceived benefits are categorized under four groups as following:

1. Benefits related to project completion as per the estimated time & budget, such as less time spent in query and approval process, reduced risk of errors and rework on projects, a complete log of all communications maintained for tracking purposes and reduced administrative costs of document handling and distribution to multiple parties.
2. Benefits related to effective team management such as effective collaboration, coordination, communication between project team members, and effective joint decision-making.
3. Benefits related to effective use of technology such as reduced hard copy storage of documents/drawings, flow of accurate information, improved capability of the system to cross-reference to other correspondence, and multi-locational availability of information.
4. Benefits related to the increased organizational efficiency such as the increase in the overall organizational efficiency, better information

assessment, management within the organization, and useful information compiled and disseminated to other projects.

Automated Data Collection: Information is scattered in the construction project due to the fragmentation nature. The modern construction project management needs real-time information to share with all main stakeholders, one ICT technique to do so is automated data collection (ADC) technology or automated data capture. ADC is the use of automated advanced and data storage technologies for the identification, collection, storage, transmission, and presentation of information, global positioning system (GPS), and radio frequency identification (RFID) are examples of such kind of technologies [18].

RFID is a method of remotely storing and retrieving data by utilizing radio frequency in identifying, tracking, and detecting various objects which can help improve the effectiveness and convenience of information flow in the construction projects, this technology consists of tags (transponder) with an antenna, a reader (transceiver) with an antenna, and a host terminal[18].

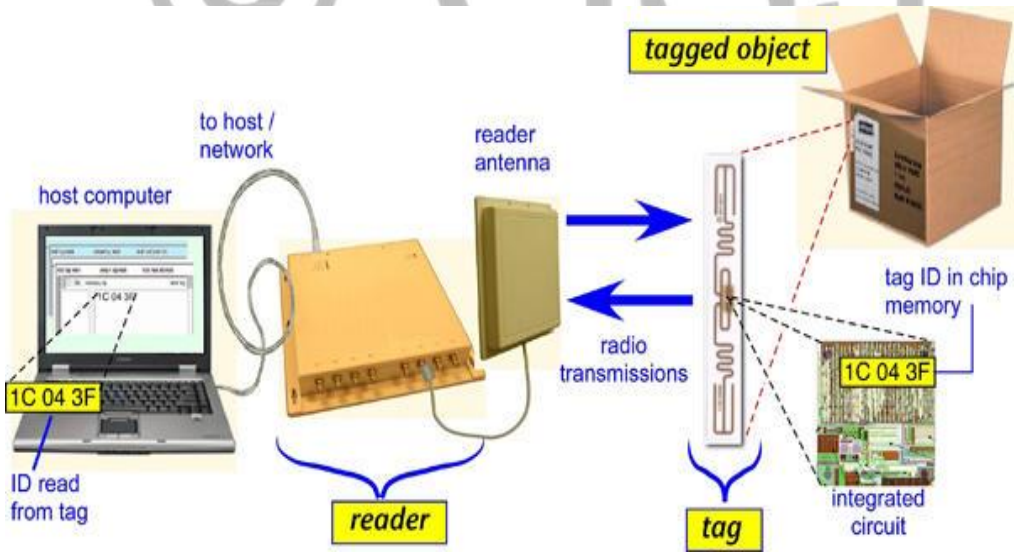

Figure 1.4 RFID system [19].

The use of RFID (see figure 1.4) is very wide in the construction projects and cover all project is life cycle and its processes. It provides solutions to monitor the workforce and equipment at the site so the project manager and supervisors can capture information about all labors and equipment enter or leave the site. In addition, it enhances the safety. For instance, by providing information to ensure that all individuals are evacuated during an emergency, preventing site access by unauthorized people, the control of drainage systems by means of balls equipped with RFID tags allows the evaluation, in a simultaneous manner, of several parts of the pipeline, reducing the operation time by 80% and the manpower by 50 percent.

Furthermore, the obtained results can be stored in RFID tags and PDA devices, reducing the human errors [20]. RFID can be integrated with other automated data acquisition technology such as laser scanner, CAD and Photogrammetry to collect data from construction sites required for progress measurement purposes, calculating quantities and site representation collecting working hours and information/updating planned data [21].

Business intelligence (BI) is a technology-driven process for analyzing data and presenting information which helps the concerned make business decisions. BI encompasses a wide variety of tools, applications and methodologies that enable organizations to collect data from internal and external sources, prepare it for analysis, create reports, dashboards, and data visualizations like charts, graphs, and maps. [22].

Power BI, Tableau, and Board are examples of business intelligence's software.

Power BI, for example is a collection of software services, apps, and connectors that work together to turn the unrelated sources of data into coherent, visually immersive, and interactive insights. The data may be an Excel spreadsheet, or a collection of cloud-based and on-premises hybrid data warehouses. Power BI lets you easily connect to your data sources, visualize, and discover what is important, and share that with anyone or everyone you want [23].

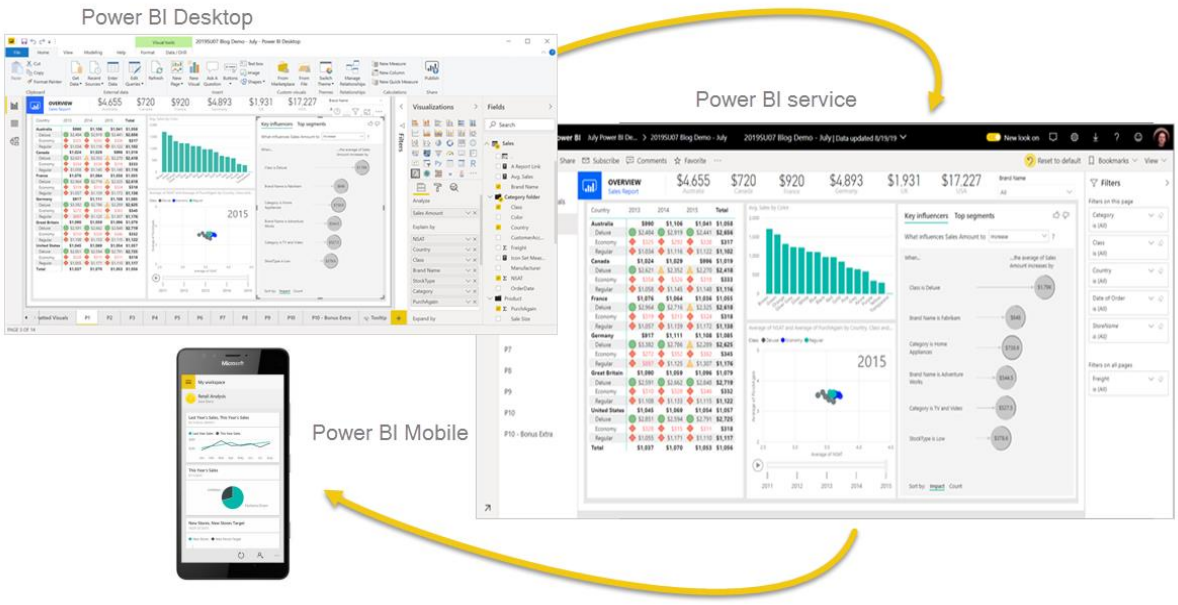

Figure 1.5 Dashboard by power BI [23].

3. Challenges to IT adoption in the construction projects

Information technology (IT) play a key role in supporting the development of the construction industry for improved performance. The need for IT to manage the projects' processes is necessary to enhance projects' output. However, the industry has not yet been able to gain the expected benefits from IT implementation

There are many obstacles that impedes comprehensive adoption of information technology in the construction projects. These obstacles include: Complexity, Lack of skilled staff and training, Comprehension, Awareness, Cost, Organization culture, Nature of construction projects and ICT tools reliability and interoperability [24].

4. Conclusion and recommendation

All the above stated benefits prove that IT plays an important role in the construction projects in all its levels and stages. IT may decrease the percentage of

failed projects, and for sure can enhance the performance of any project. So, utilizing IT in all construction projects is a necessity.

To expand the use of IT in the construction project management and to overcome the obstacles hindering or limiting utilizing all the benefit of IT, the following are some recommendations and suggestions which shall be taken into consideration, not at the organizations level only, but also at the state level to set an approach starting from the universities teaching engineering and construction management :

- At the university level for engineering and construction students, there should be a direct guidance within the syllabus to utilize IT and how to be agile with the market changes.
- Top management in organizations shall support utilizing IT and encourage research and development to customize software based on feedbacks and needs, this can be achieved by establishment of a special section for information technology to build in-house applications at the organization level.
- Using IT in general and any PMIS (project management information system) program, shall be made mandatory in all construction contracts. The requirements shall be put in the RFP (request for proposal) as mandatory to use some IT programs in the construction project.
- IT developers shall interact with the construction industry professionals to develop software which fits to the actual circumstances of the projects. The software shall be easily understandable and practical to use.

- IT companies shall arrange seminars, webinars, and other campaigns to educate the construction projects' stakeholders regarding the benefits of their specific programs in projects.
- IT developers shall be engaged with the construction industry' experts to let them understand the core needs of the construction project management industry. Also, shall carry out deep research regarding the practical needs of the construction industry to develop more efficient software packages and user-friendly.
- Organizations shall consider long term investment for the benefits of IT implementations instead of thinking short term revenues on investment.
- Organization shall select and conduct required IT software training for relevant project professionals.
- The projects shall have the mandatory skills for engineers regarding the IT so that job seekers get motivation.
- Creating positions for IT professionals in the construction projects.
- Trainings shall be provided on regular basis and to be updated with the changing of the market's requirements. The trainers shall have the required construction project management experience and the awareness of the international standards experience to deliver the training in the proper way.
- Rules and regulations related to the construction industry within a country can be revised to motivate the IT developers and companies to utilize their knowledge to enhance the processes of the construction project management by inventing new software and technologies. Local companies or associations, commercial

offices or chambers can be used for pilot studies for the evolution of these IT technologies.

- At the organization level, there should be some common standardized software for project management in the construction industry so that the staff do not suffer from changes when they are shifted from a project to another project.

- Lesson learned from the projects related to IT adoption and difficulties shall be communicated with the IT developers.

- Cost is a crucial issue (especially for SMEs), however; the cost should be justified against the benefits gained. Subsequently, managers (or project managers) should justify the cost of IT technology in terms of project profitability, efficiency, and effectiveness. Such approach might help get buy-in from the top management to invest in IT and technical software.

References

1. Isikdag, U., Underwood, J., Kuruoglu, M., Goulding, J., & Acikalin, U. (2009). Construction informatics in Turkey: strategic role of ICT and future research directions. *Journal of Information Technology in Construction*, *14*, 412-428.

2. Rendulić, D. (2011). *Basic Concepts of Information and Communication Technology* [Ebook] (p. 1). Zagreb: Open Society for Idea Exchange. Retrieved from http://www.itdesk.info/Basic%20Concepts%20of%20Information%20Technology%20notes.pdf

3. Onyegiri, I., & Nwachukwu, C. (2011). Information and communication technology in the construction industry. *American Journal of Scientific and Industrial Research*, *2*(3), 461-468.

4. Adwan, E., & Al-Soufi, A. (2018). A Review of ICT Applications in Construction. JOIV: International Journal on Informatics Visualization, 2(4), 279. doi: 10.30630/joiv.2.4.163

5. Sun, M., & Howard, R. (2004). *Understanding I.T. in construction*. New York, N.Y.: Spon Press.

6. Arayici, Y., & Aouad, G. (2010). Building information modelling (BIM) for construction lifecycle management [Ebook]. Nova Science Publishers.

7. Succar, B. (2009). Building information modelling framework: A research and delivery foundation for industry stakeholders. *Automation in Construction*, *18*(3), 357-375. doi: 10.1016/j.autcon.2008.10.003

8. Grilo, A., & Jardim-Goncalves, R. (2010). Value proposition on interoperability of BIM and collaborative working environments. *Automation in*

Construction, *19*(5), 522-530. doi: 10.1016/j.autcon.2009.11.003

9. Kushwaha, V. (2016). Contribution of Building Information Modeling (BIM) To Solve Problems in Architecture, Engineering and Construction (AEC) Industry and Addressing Barriers to Implementation of BIM. International Research Journal of Engineering and Technology, 3(1).

10. Moakher, E. (2012). Building Information Modeling (BIM) and Sustainability – Using Design Technology in Energy Efficient Modeling. *IOSR Journal of Mechanical and Civil Engineering*, *1*(2), 10-21. doi: 10.9790/1684-0121021

11. Chen, H., Chang, K., & Lin, T. (2016). A cloud-based system framework for performing online viewing, storage, and analysis on big data of massive BIMs. Automation In Construction, 71, 34-48. doi: 10.1016/j.autcon.2016.03.002

12. Wong, J., Wang, X., & Li, H. (2014). A review of cloud-based BIM technology in the construction sector. *Journal of Information Technology in Construction*, *19*, 281-291. Retrieved from http://www.itcon.org/2014/16

13. Abanda, F., Mzyece, D., Oti, A., & Manjia, M. (2018). A Study of the Potential of Cloud/Mobile BIM for the Management of Construction Projects. Applied System Innovation, 1(2), 9. doi: 10.3390/asi1020009

14. O'Brien, W. (2000). Implementation Issues in Project Web Sites: A Practioner's Viewpoint. *Journal of Management in Engineering*, *16*(3), 34-39. doi: 10.1061/(asce)0742-597x (2000)16:3(34)

15. Nitithamyong, P., & Skibniewski, M. (2004). Web-based construction project management systems: how to make them successful. *Automation in Construction*, *13*(4), 491-506. doi: 10.1016/j.autcon.2004.02.003

16. Mead, S. (1997). Project-specific intranets for construction teams. *Project Management Journal*, *28*(3), 44–51.

17. Ahuja, V., Yang, J., & Shankar, R. (2009). Benefits of collaborative ICT adoption for building project management. *Construction Innovation*, *9*(3), 323-340. doi: 10.1108/14714170910973529

18. Sardroud, J (2012). Perceptions of Automated Data Collection Technology Use in the Construction Industry. Journal of Civil Engineering and Management, *21*(1), 54-66.

19. Dobkin, D. (2013). *The RF in RFID* (2nd ed.). Kidlington, Oxford, U.K.: Newnes.

20. Kondo, T., Uchida, S., Kaneko, T., Hamada, K., Miyaura, S., & Okura, M. (2006). Development of RFID-Based Flow Examination System. *Proceedings of the 23Rd International Symposium on Automation and Robotics in Construction*. doi: 10.22260/isarc2006/0136

21. El-Omari, S., & Moselhi, O. (2009). Integrating Automated Data Acquisition Technologies for Progress Reporting of Construction Projects. *Proceedings of the 2009 International Symposium on Automation and Robotics in Construction (ISARC 2009)*. doi: 10.22260/isarc2009/0048

22. Rouse, M. (2019, September 04). What is Business Intelligence (BI). Retrieved May 12, 2020, from https://searchbusinessanalytics.techtarget.com/definition/business-intelligence-BI

23. MaggiesMSFT. (n.d.). What is Power BI? - Power BI. Retrieved May 13, 2020, from https://docs.microsoft.com/en-us/power-bi/fundamentals/power-bi-overview

24. Alshabatat, Amjad. O. (2020, April). Obstacles to Information Technology adoption in Construction projects in the Gulf Cooperation Council (GCC). Retrieved May 8, 2020, from http://www.globalscientificjournal.com/researchpaper/Obstacles_to_Information_Technology_adoption_in_Construction_projects_in_the_Gulf_Cooperation_Council_GCC_.pdf