

# Information communication technology in construction management

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## ABSTRACT

*Innovation in construction is crucial to improving construction efficiency. Through the use of information and communication technologies (ICT), clients can be better satisfied by lowering coordination errors and fostering better communication between project participants so that challenges and requirements can be handled more effectively. To build a building faster, it is necessary to increase efficiency. In addition to addressing the dynamism and ambiguity of the environment, there are wicked challenges in determining how one decision will affect judgments in other areas, as well as resolving conflicts when opposing claims may have both positive and negative effects under the same value system. If necessary, this can be done by using cutting-edge techniques like ICT and software programs. Building a project with the greatest efficiency and the lowest cost is the aim of a construction project engineer. The advantages of implementing ICT have been made clear; when done properly, ICT enables contractors and subcontractors to complete projects more rapidly, precisely, and economically. We have seen very little improvement in worker productivity in the construction sector compared to other sectors, such as manufacturing, therefore there is a strong drive to embrace more technology. As the industry tried to adapt to these changes, it encountered several difficulties that caused it to lag in terms of ICT, which decreased the effectiveness of construction projects. Latest innovation techniques are continually being discovered in all spheres of life and enhance the effectiveness and quality of work.*

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## 1. INTRODUCTION

The construction industry must adopt ICT technologies to increase its efficiency (Vasista and Abone, 2018). Utilizing information and communication technology will help improve construction efficiency and address unique problems like sustainable construction and its management. Construction is a highly fragmented industry known for having a highly competitive landscape. Most construction projects today hardly ever include communication and information transfer infrastructure (Vasista and Abone, 2018). The architecture, engineering, and construction sector are demonstrating a growing interest in adopting new technologies so they can facilitate visualization, data analysis, information sharing, communications, and collaborative activities. Nouban and Abazid (2017) opined that construction companies need to improve on quality and be consistent to compete in business. This is in line with the use of ICT in the construction industry.

The relevance of information technology and communication to people's daily lives is growing. Due to its widespread use, this has completely changed both individuals and organizations. The introduction of the

"INTERNET," a network of interconnected computer networks, which transmits and exchanges data and information between individuals, businesses, and institutions worldwide, has particularly facilitated globalization (Onyegiri et al., 2017). This growing speed of IT has also made it possible for individuals, businesses, and institutions to share and exchange information and data.

ICT refers to the storage, retrieval, management, transmission, or receipt of information through electronic means (Adwan and Al-Soufi, 2018). Usually, ICT is used in place of information technology (IT), as an expanded term for information and communication technology. In recent decades, developments of ICT had steadily expanded throughout numerous nations due to the growing export rate of ICT components in the 1990s. In turn, this development contributed significantly to global trade in ICTs, including telecom equipment, semiconductors, office equipment, and IT products. Using ICTs increases the competitiveness of organizations (Paudyal and Prakriti, 2016). To successfully manage a building project, the entire project team must be involved. However, it is the project manager who is

responsible for planning, tracking, and monitoring the project. As part of the construction process, effective communication is widely viewed as crucial for effective efficiency gains. In crucial areas such as engineering, construction planning and control, cost control, financial planning, and computer-aided facilities management, ICTs have made a significant contribution; as a result, projects are being implemented more efficiently and effectively in the sector.

## 2. ICT APPLICATIONS USED IN THE CONSTRUCTION INDUSTRY

Moshood, Nawanir, Sorooshian et al. (2020) are of the view that ICT's function is to relieve project managers of these duties so they may focus on decision-making analysis and enhancing data flow. Different applications have been programmed to help managers in their different tasks. Below are just a few software programs used by construction managers.

### 2.1. Computer-Aided Design (CAD)

Many Architectures, Engineers, and Constructors (AEC) use CAD for their day-to-day drawings. This is the most common office application used globally. Mayer et al. (2018) are of the view that CAD helps AEC to draw and design their plans in either 2D or 3D. The software program enables its users to modify and optimizes the design process. Plans a drawing can be accessed anywhere anytime by contractors, subcontractors, and team members since they can be stored in the cloud. This also means any modification done to the plans can be viewed by the works. These will lead to immediate correction and adjustment to the construction.

### 2.2. Web-Based Project Management SYSTEM WPMS

WPMS is an online application that stores and transmits project information through private networks. The system allows only the members of the AEC and even clients who are part of the team to access the information. The internet is used to exchange data such as drawings and submittals to the other parts and data is stored on the server. The WPMS system provides design to engineering and construction firms with online project management and information. As a result, construction projects can be completed on time and within a budget with the help of specialized tools (Ding et al., 2014). This system makes the procurement process easier because team members can access the database even if the internet connection is down. All project information can be printed later for a detailed record of all project information. Additionally, the team can store general information such as telephone numbers, e-mail addresses, and other contact information.

### 2.3. Building information modeling (BIM)

BIM has transformed planning and execution in construction projects. It is one of the most popular applications used by AEC (Hoseini et al., 2017). Before any physical construction work begins, construction managers can analyze and modify a virtual project model. BIM allows for considerably more effective communication and information dissemination. Information is exchanged between AEC, clients, and legal agencies engaged in the project. Project management in construction uses BIM to design, schedule, estimate, allocate resources, manage supply chains, keep track of deliveries during construction, monitor structural health, manage information, and conduct structural analysis (Hoseini et al., 2017).

BIM comes with special features such as 4D, 5D, 6D, and 7D, these fourth, fifth, sixth, and seventh dimensions are Time, Cost, Sustainability, and Building Maintenance. These are listed below:

#### 2.3.1. Fourth dimension Time

Collaborate design in 3D visuals and time simultaneously. Before the introduction of BIM the scheduling software could not be linked with design, but by linking them made the quality of the project can be improved and risk can be reduced.

#### 2.3.2. Fifth dimension cost

Owners are provided with cost information in advance of the project, which facilitates decision-making. Onungwa et al. (2020) are of the view that by using this software BIM professionals can focus on more value-added estimating tasks, like identifying construction assemblies, generating prices, and factoring in risks, which are all extremely beneficial for accurate estimates.

#### 2.3.3. Sixth dimension sustainability

BIM collaborated with green buildings, making it possible to measure how green a structure is during construction. In the likeness of energy and material used throughout the construction, upkeep, and destruction, the building information model is used to gather and analyze the information required for green design during the design process.

#### 2.3.4. Seven dimension facility management

It makes changing building parts and basic building or project repair relatively simple over its full life cycle. Its building assets database is connected to the BIM record model.

### 3. ADOPTION OF ICT IN CONSTRUCTION

Alshabatat (2020) grouped the benefits of using ICT into the following computed aided design cost estimation, building engineering application, computer-aided design and visualization, planning scheduling and site management, computer-aided facilities management, and business and information management.

#### 3.1. Computer-aided design cost estimation

Cost estimation should be done by contractors and subcontractors throughout the construction phase. Materials are quantified with their length, area, and volume so that accurate cost estimation is calculated by the application. The database of these applications contains information such as labor cost, material cost, equipment cost, and production rate; the cost estimation procedure can be made much faster than by using old methods (Alshabatat, 2020).

#### 3.2. Building engineering application

In these applications, building structures are simulated with features such as safety, comfort, and energy efficiency. Rectifying design problems or correcting any changes is usually quite expensive which contributed to the creation of these applications. These applications help by investigating the lighting system, structural analysis, and energy analysis, which will assist the engineers to reach the optimal design by trying out different techniques (Alshabatat, 2020).

#### 3.3. Computer-aided design and visualization

CAD is used for drawing and designing. This application helps users to design using rectangles, circles, lines, and text. (Alshabatat, 2020) noted that, compared to manual design, CAD is capable of removing, moving, duplicating, and rotating any part of a design. Further, these drawings can be expanded to create a 3D environment so the customer can visualize the building's final design throughout the design process.

#### 3.4 Planning scheduling and site management

(Alshabatat 2020) notes that using computer programs can help in building project planning and administration, including advanced planning, option evaluation, and effective execution.

#### 3.5. Computer-aided facilities management

Management of facilities refers to the operation and maintenance processes of the project, as well as the costs associated with those processes, as well as ensuring the

building and its surroundings are functional, comfortable, safe, and efficient (Alshabatat, 2020). There are several types of applications that integrate CAD drawings with databases that contain information about people and services.

#### 3.6. Information and business management

There is always a lot of information documented during the construction phase by all stakeholders, including correspondence, site surveys, design drawings, cost assessments, bills of quantities, and emails (Bai, 2022). As a result, electronic document management systems are designed to combine diverse sources of information to facilitate easy access and control of any organization or project.

### 4. ADVANTAGES OF ICT IN THE CONSTRUCTION INDUSTRY

As a result of the introduction of ICT to the building industry, AEC has benefited greatly. This is a result of ICT tools' extensive automation. Even though ICT is a useful tool to speed up work, archives and information management still follow traditional practices. ICT has several key benefits, including increased productivity, financial control, better information exchange, reduced complexity, and faster access to information, as well as a reduction in errors and identifying unrecognized concerns in many tasks (Onyengiri et al., 2011). In addition, construction industries can benefit from ICT by being able to handle their information more effectively and accelerating the sharing of data. ICT enhances effective communication and coordination between the various stakeholders involved to increase construction profitability. The following explanations highlight some benefits of using construction tools. Nouban et al. (2020) argued that there are various tools for construction management such as cost, quality, risk, and communication. These are important to attain project success and high standards.

#### 4.1. Collaboration improvement

ICT tools are frequently utilized to enhance collaboration between experts and project participants. Since they mold the suppliers into a common manner of functioning, specialized procedures like electronic information exchange (EDI) are required for the flow of information between organizations inside and outside the company (Onyengiri et al., 2011). Electronic information management innovation supports new forms of collaboration in a variety of ways by coordinating, streamlining, and simplifying exchange between organizations.

#### 4.2. Diversification

Simply put, diversification is the expansion of an organization's markets, goods, and services for competitive reasons. An organization can grow by expanding internationally or geographically to several different countries or nations. By preparing for various environmental changes, the construction sector utilizes ICT to prevent construction interruption due to external factors.

#### 4.3. Internet as an exchange tool

There are many advantages and benefits of using the internet as a communication medium, especially in the construction industry. Taher (2021) noted that cost-effectiveness, quick data transfer, and the need to move a sizable amount of data across offices and sites are some advantages. To improve project sharing and spur better project activities, ICT websites must provide widely used, centralized, reliable means for storing and transferring project data. Such web-based technologies include benefits such as reduced manual expenses distribution, project data integration, simple access rights control, data capture and documentation, consistent access to additional data, and a few programming requirements.

#### 4.4. Innovation

The remodeling or innovation of the construction industry presents the opportunity to develop business practices. Utilizing ICT provides the construction industry with a variety of business-related chances and promotes the creation of fresh and novel ones. The advancements in data industry technologies will assist businesses in developing low-cost inventions (Bai, 2022). ICT increases an organization's productivity and innovation.

#### 4.5. Improved performance

Virtual construction is incorporated into the design or planning stages, which serve as the phase before construction and serve to assess the project's productivity. The design phase is one of the key phases that contributes to and facilitates the performance improvement of building projects. Structural Analysis And Design Pro (STAAD Pro), Structural Analysis Program 2000 (SAP2000), and Extended Three-Dimensional Analysis of Building Systems (ETABS), among others, are useful for reducing errors and the risk of losing crucial documents, saving time, and enhancing productivity with ICT tools (Taher, 2021).

#### 4.6. Effective communication management

Continuous data exchange with quick access is required during the construction phase. It has become a critical issue

to increase data transfer support for project tasks at construction sites to increase proficiency and efficiency in the construction process. For a project to be successful and productive, contractors and project managers must manage and regulate the document exchange between the parties involved. Bernstein (2020) noted that ICT benefits the construction phase of the building industry by increasing work productivity, maintaining all current and previous versions in one location reducing the risk of losing important documents, and being certain that everyone in the project group is using the correct documents and drawings reduces the likelihood of rework and errors. It also helps by giving members a platform for online data communication via the web, enhancing group collaboration by enabling colleagues to pose and respond to questions in an orderly fashion. Using ICT also makes it easier to maintain records of all communications, giving clients and other stakeholders a clear picture of the project as certain ICT solutions incorporate augmented models that show the current status of a project.

### 5. CHALLENGES FACED WITH THE USE OF ICT IN CONSTRUCTION MANAGEMENT

Bai (2022) grouped ICT management challenges into three problems which are lack of focus as will be discussed.

#### 5.1. Lack of focus

The construction of electronic information for management requires a significant amount of investment in all walks of life, leading to a delay in advancing technology, resulting in many companies seeing investment as a waste of their human and material funds as well as the organization's finances, leading to non-participation of small (Muthalif et al., 2022). Although some organizations have started concentrating on IT administration, employee management, and financial management, there is still some successful information.

#### 5.2. Poor foundation

The market distribution has a wide range of management information systems, together with effective promotion; this will affect the enterprise's choice in terms of software and hardware. The chosen software and its customization will be brought about by the enterprise's own management's electronic positioning and development of fuzzy information. Some problems arise because of the insufficient amount of change in the industry. Kushwaha (2014) comments that Companies want to welcome the use of managing electronic information structure, but there are

several concerns decreasing progress such as weak stability, single function, and terrible operation. As a result, controlling the development of electronic information requires enhancing the enterprise's risk prevention and control capabilities as well as developing its infrastructure.

### 5.3. Lack of education advancements

Talent has emerged as the key component of core competitiveness in all spheres of life as well as the essential basis for business innovation. Construction industries need to set better standards for those working in the field so they can adjust to the needs of change and improvement. Internet technology has rapidly developed, resulting in many enterprises not having time to eliminate invisible transformation and upgrading. Nuria (2005) noted that employees' low level of information literacy is one of the challenges faced in the industry. Many electronic construction projects rely on traditional information gathering and office software operations. Generally, companies do not have adequate skills in managing their information construction, as well as a lack of knowledge of professional software, professional software, and master's degrees, as well as a lack of knowledge of networks, database concepts, and professional software. Likewise, some organizations need to enhance the professional attributes of their human resource managers, such as their moral character and spirit of innovation (Zachiang, 2017).

Users must immediately accept and utilize ICT to move away from a paper-based environment and toward one that is completely automated. While many industries in the construction sector strive to benefit from ICT job opportunities, they may be constrained if fewer people accept and use ICT. Some employers still believe that it is difficult to explain what they want other team members to do; instead, they want to be physically communicated to their co-workers (Tanga et al., 2020). Working with both hardcopy and automated data means that the sector might lose out on potential productivity gains. However, workers recognized that further ICT practice development will raise the company's competitiveness

## 6. CONCLUSIONS AND RECOMMENDATIONS

The emergence of technology in construction has transformed the construction industry. In the past years, the industry has neglected technology management which has caused the industry progression to be backward. With Technology constantly evolving, great attention is now being given to the sector. ITC will enable technical solutions that will be crucial in achieving significant improvements in construction management. Below are some ways that ICT can be improved in construction management.

### 6.1. Augmented reality in construction management

Subsoil utilities are significant assets that must be taken into consideration while carrying out any building work. For the efficient administration of building projects, positioning and visualizing the underground utilities before a construction activity begins to have major advantages. A possible technique for seeing underground utilities is augmented reality (AR). It is feasible to get a better visualization using spatially aware AR, enabling the virtual content to interact with the actual world. Consequently, including real-world topology might perhaps enhance the AR visualization of subsurface utilities. Also, it might be challenging for many individuals, especially owners, to see the 2D images coming to life because they aren't continuously staring at drawings. AR may be a fantastic communication tool for displaying construction-related problems or progress as well as outlining how tasks will be completed.

It is indisputable that there are certain instances of human mistake inefficiency, even if I believe there will always need to be a human component to a building job. Having robots should reduce errors caused by human perceptions and emotions, and perhaps they can lift and move better than a person, increasing productivity. This reduces the number of mistakes making the project be completed at the estimated cost and also on time. The appeal of having a more productive workforce cannot be denied, but I believe we are still a few decades away from having fully functional robots.

### 6.2. Knowledge management

The willingness to change must be included in every building project. Construction businesses have been providing capital for the use of IT to assist business operations and project management to tackle the increasing customer demand to deliver on time and under budget. The capacity of an organization to create knowledge and produce new ideas is sometimes hampered by the loss of specialized expertise from one project to the other. IT can help project team members to share information and expertise, facilitating the creation of fresh knowledge for innovation to learn. Companies must also encourage their employees to learn the current software application by giving them educational breaks and also paying tuition fees so that they knew skills to improve the inefficient in construction.

## CONFLICT OF INTEREST STATEMENT

The authors declare that there is no conflict of interest.

## REFERENCES

- [1] Adwan, E., & Al-Soufi, A. (2018). A Review of ICT Technology in Construction. *International Journal of Managing Information Technology*. 8(4), 1-21. [10.5121/ijmit.2016.8401](https://doi.org/10.5121/ijmit.2016.8401)
- [2] Ahuja, V., Yang, J., & Shankar, R. (2009). Study of ICT adoption for building project management in the Indian construction industry. *Automation in Construction*. 18(4), 415-423. <https://doi.org/10.1016/j.autcon.2008.10.009>
- [3] Alshabat, A. O. (2020). Information technology (IT) in construction project management. *Global Scientific Journals*. 8(5), 1511-1528. [https://www.globalscientificjournal.com/researchpaper/Information technology IT in the construction project management.pdf](https://www.globalscientificjournal.com/researchpaper/Information%20technology%20IT%20in%20the%20construction%20project%20management.pdf)
- [4] Bai, C. (2022). Research on Electronic Information Construction of Management Based on Internet Technology (pp. 292–294) [Review of Research on Electronic Information Construction of Management Based on Internet Technology]. IEEE. <https://doi.org/10.1109/ISAIEE55071.2021.00077>
- [5] Bernstein, L. (2020). What is Computer-Aided Design (CAD) and Why is it Important? <https://www.procore.com/jobsite/what-is-computer-aided-design-cad-and-why-its-important/>
- [6] Brewer, G., Gajendran, T. and Chen, S. E. (2005). *The use of ICT in the construction industry: critical success factors and strategic relationship in temporary project organizations*. Information Communication Technology in Construction conference paper. Available at: [https://www.researchgate.net/publication/235906821\\_The\\_use\\_of\\_ICT\\_in\\_the\\_construction\\_industry\\_critical\\_success\\_factors\\_and\\_strategic\\_relationship\\_in\\_temporary\\_project\\_organizations](https://www.researchgate.net/publication/235906821_The_use_of_ICT_in_the_construction_industry_critical_success_factors_and_strategic_relationship_in_temporary_project_organizations) [28 October 2022].
- [7] Ding, L., Zhou, Y., & Akinci, B. (2014). Building Information Modeling (BIM) application framework: The process of expanding from 3D to computable nD. *Automation in Construction*. 46, 82-93. <https://doi.org/10.1016/j.autcon.2014.04.009>
- [8] Hoseini, A., Zhang, T., Nwadiogo, O., Hoseinib, A. G., Naismith, N., & Raahemifar, K. (2017). Application of nD BIM Integrated Knowledge-based Building Management System (BIM-IKBMS) for inspecting post-construction energy efficiency. *Renewable and Sustainable Energy Reviews*. 27, 935-949. <https://doi.org/10.1016/j.rser.2016.12.061>
- [9] Kushwaha, V. (2014). 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 (IRJET)*. 3(1), 100-105 <https://www.irjet.net/archives/V3/i1/IRJET-V3I117.pdf>
- [10] Mayer, J., Meng, D., Mo, S., & Rojas, S. (2018). Information and Communication Technology (ICT) In Construction: Implementing Safety Coordination with Efficient Strategies for Residential Construction Management [Project, School of Construction at SAIT].
- [11] Moshood, T. D., Nawanir, G., Sorooshian, S., Mahmud, F., & Adeleke, A. Q. (2020). Barriers and Benefits of ICT Adoption in the Nigerian Construction Industry. A Comprehensive Literature Review. *Applied System Innovation*. 46(3), 1-19. <https://doi.org/10.3390/asi3040046>
- [12] Muthalif, M. Z. A., Shojaei, D., & Khoshelham, K. (2022). A review of augmented reality visualization methods for subsurface utilities. *Advanced Engineering Informatics*, 51. <https://doi.org/10.1016/j.aei.2021.101498>
- [13] Nouban, F. & Abazid, M. (2017). An overview of Total Quality Management in Construction Management. *Academic Research International*. 8(4), 68-74.
- [14] Nouban, F., Aliji, N. & Tawalbeh, M. (2020). Integrated earned value analysis and its impact on project success. *International Journal of Advanced Engineering, Sciences, and Applications*. 1(1), 34-39. <https://doi.org/10.47346/ijaesa.v1i1.18>
- [15] Núria, F. M. (2005). Life cycle document management system for construction [Doctoral Thesis, Universitat Politècnica de Catalunya]. <http://hdl.handle.net/2117/93472>
- [16] Onungwa, I. O., Olugu, N. U., & Igwe, J. M. (2020). WIT Transactions on The Built Environment. *In building information modeling as a construction management tool in Nigeria* (Vol. 169, pp. 25–33). Lisbon. <https://doi.org/10.2495/BIM170031>
- [17] Onyengiri, A. I, Nwachukwu, C. C. and Jamike, O. (2011). Information and communication technology in the construction industry. *American Journal of Scientific and Industrial Research*. 2(3), 461-468. <https://doi.org/10.5251/ajsir.2011.2.3.461.468>
- [18] Taher, G. (2021). Industrial Revolution 4.0 in the Construction Industry: Challenges and Opportunities. *Management Studies and Economic Systems*. 6(3/4), 109-127. Available at: [http://www.msae.org/article\\_140504\\_1d5f182cf5bc70a06e4a181e884359e0.pdf](http://www.msae.org/article_140504_1d5f182cf5bc70a06e4a181e884359e0.pdf) [28 October 2022].
- [19] Tanga, O. T., Aibavoboa, C. O., Akinradewo, O. I, Thwala, D. W. and Onyia, M. (2020). Construction digitalization tools in South African construction industry: An added advantage. *International Conference on Engineering for Sustainable World*. <https://doi.org/10.1088/1757-899X/1107/1/012230>
- [20] Vasista, T. G. and Abone, A. (2018). Benefits, barriers, and application of Information Communication

Technology in the construction industry: A contemporary study. *International Journal of Engineering and Technology*. 7(3), 492-499. <https://doi:10.14419/ijet.v7i3.27.18004> [27 October 2022].

- [21] Zachiang, J. B. (2017). The impact of ICT in the construction industry. Available at: [https://www.academia.edu/29363044/the\\_impact\\_of\\_ict\\_in\\_construction\\_industry](https://www.academia.edu/29363044/the_impact_of_ict_in_construction_industry) [28 October 2022].