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LITERATURE REVIEW ON EFFICACY OF ICT IN REALM OF CONSTRUCTION INDUSTRY

[1]Sanjay Pandey, [2]Dr. G.T. Thampi

[1]Research Scholar, [2]Professor
[1,2] Department of Information Technology
Thadomal Shahani Engineering College, Bandra (w), Mumbai of University
Mumbai, Maharashtra, India.

Abstract: Many industries have embraced digitally-enabled technologies and artifacts to maximize their productivity and efficiencies, but construction is one of the least digitized sectors, and underperformance is an industry-wide issue. To address this issue, we researched ICTs penetration in construction enterprises and had gone through a critical review of the existing body of knowledge, and identified some fundamental ICT used in the construction industry. We highlighted various ways and means to integrate ICT into the construction industry and depicted different ICTs used in several construction tasks. Also, we discussed the impact and benefits of ICTs integration in the construction domain. Some notable hindering factors coming in the way of ICT integration in the construction industry are worth noting.

Index Terms **- Construction Industry, Information & Communication Technology (ICT), Investigating, Efficacy, Productivity, Multidisciplinary challenges.**

I. INTRODUCTION

The construction industry is highly fragmented and plagued with lots of multidisciplinary challenges for many decades like low productivity, poor efficiency, the chronic shortage of skilled labor, performance & sustainability. Apart from these challenges, there are many more deficiencies the constructions industry is trying to get rid of viz. idle time, delayed/insufficient supply shipments, breaking down of construction equipment, frequent weather inclement, complications related to design arising midway during construction, friction between the various stakeholders, etc. The construction industry continues to face the challenge of modifying and refining the present modus operandi to become more productive, efficient, client-centric, and competitive through the use of ICTs-enabled construction processes. The need of the hour is to make a concerted effort to improve construction productivity and efficiency by using ICTs. The use of ICTs in the domain of construction enterprises is an area worth focusing on because it can improve the schedule, reduce the budget, and optimize resources to complete the project within schedule and budget.

II. LITERATURE REVIEW

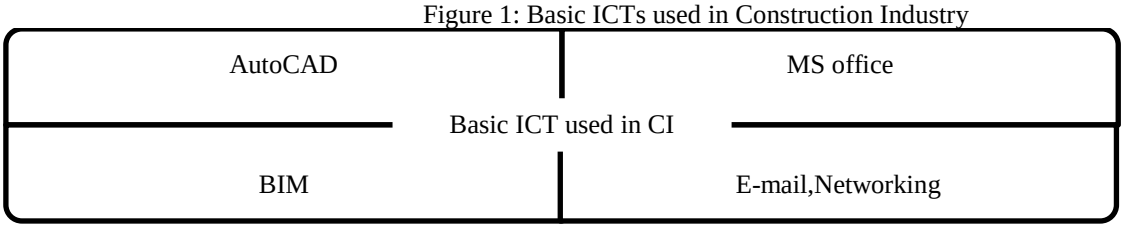
We carried out, an extensive study of existing body of knowledge about use of ICTs in construction sector and classified outcome of literature survey under following sub-categories:

A. Basic ICT Infrastructure used in Construction Industry

After analyzing a substantial quantity of existing literature about the usability of information & communication technology in the construction sector, we discovered that the construction sector had embraced some basic ICTs such as AutoCAD, MS Office, BIM, spreadsheets, e-mails & networking as shown in figure 1, to increase productivity in bits and pieces. Although it has been noticed that the construction sector is digitally fragmented, many authors have concluded that the usage of ICTs may help to improve the current scenario of the construction enterprises [1], [2]. The transfer of data/information among stakeholders, and different phases of the project is unstructured, inefficient, and lurking in their silos, and this transfer of information is often very slow and done manually. The advancement of information & communication technology may provide chances to improve communication among construction project participants. It can facilitate more effective and efficient communication and coordination among many stakeholders. ICT use is an area worth focusing on since it can reduce the time required for data processing and efficiently disseminate information [3], [4].

The use of computer networks, whether guided or unguided, has also been proven to eliminate the requirement for coworkers to be physically present at the same time. Comprehension and adopting cutting-edge ICTs in the construction area requires a basic understanding of modern computer and web technology [5].

Figure 1: Basic ICTs used in Construction Industry



B. Ways and means of Integrating ICT into the Construction Industry

This section discussed different ways and means to incorporate ICT in the construction industry. Incorporating ICTs into various phases and procedures of the construction project life cycle can be done in several ways. Some institutions and organizations are attempting to hasten the adoption of state of art information and communication technologies in the various build phase. Many studies also suggest that information & communication technology can help to overcome few of the existing challenges that plague building projects and also state that ICT adoption is in its early stages and needs quicker ICT embracement. The sizable amount of the literature available supports the idea that the main constraints impeding the construction industry's migration to greater use of ICT are cultural.
The points cited below, have explained various ways of incorporating ICTs into construction industry

- Virtual Design and Construction (VDC): Core concept of VDC is to virtually build the construct before starting the actual process of construction and even before commencing the acquisition of materials. It facilitates the validation of a project's constructability. This particular methodology enables remarkable savings for the contractors & design solutions which can be validated [6].
- nD Modeling: It is an extension of building information modeling and define as a computer database of building design information. It encompasses all the relevant design information needed for every stage of the project development life cycle. Any information related to design can be extracted from this database automatically and any formal change in the build model gets reflected automatically [7],[8].
- Creation of GEN (Global Engineering Networks): Giant construction enterprises are spreading their operations across the globe at a very fast speed to access the global resources also they have to manage changes, global competition, and fast-changing technologies. To address the above-said issue, the research community had proposed a framework named global engineering networks (GENs) [9]. Global Engineering Networks can help construction enterprises to search for the best processes and products across different companies or industries, also it can facilitate other organizations a better and more holistic viewpoint when sharing the best practice. All enterprises have to adopt this process & improvise their engineering networks regularly. This continuous improvement and continuous deployment lead engineering networks toward greater perfection.
- Formation of CVT (Collaborative Virtual Team): Form a collaborative virtual team to enhance the conversation & transfer of data/information between enterprises, different stakeholders, and different teams, and even within a team member of the organization. Many researchers have recommended the formation of virtual teams in the construction industry [10]. The collaborative virtual team relies on information and communication technologies to foster their daily operations & construction sector is always some distance away from adopting it.

C. Various ICTs used in different Construction tasks

This section revealed the present scenario of information and communication technologies used in different construction enterprises tasks. We have studied several prominent journals and papers taken from various portals, concentrating on past and current trends in the use of various types of ICTs for different construction tasks. After the systematic review of numerous papers, we have arrived at the conclusion that CAD, BIM, Video Conferencing, Mobile-based technologies, web-based technologies, information systems, etc. are used in most of today's construction tasks. Table cited below depicts matrix of ICTs vs. Construction tasks [11],[12].

Table: Matrix of ICTs and Construction Task

ICTs Vs. Construction Tasks	Project mgmt.	HR Management	Communication	Collaboration	Budget	Design	Virtual Collaboration	Project Planning
Web- Based Technology	x	x	x	x	x	x	x	x
BIM			x	x	x			x
Video Conferencing	x	x	x		x		x	
CAD Technology	x	x				x		x
Mobile Technology			x		x		x	
Information System	x	x	x					

Few bloggers and white paper writers working in the domain are pinpointing the notion of adopting cutting-edge technologies like IoT, AI/ML, Blockchain, Big data analytics, etc. in different construction tasks. Integration of these ICTs for different construction tasks are in the nascent phase and needs good attention from the researcher community to uplift the present condition of the industry [13],[14]. However, increasing assistance for the development sector from global firms is expected to stimulate researchers in the future to bring state of art technologies in the realm of the construction sector.

D. ICT's impact on CI Performance

A critical review of ICT infrastructure in construction projects pointed out that the industry has embraced few basic ICT for its various tasks. Few articles published in the domain have highlighted impact of ICT on construction sector performance in their research tasks. The majority of construction enterprises have not adopted ICTs in their different tasks on other hand few construction companies are practicing information & communication technology actively, and achieved good performance & productivity than construction companies that does not utilize it [15],[16]. Particularly, the ERP system & use of the BIM had shown a noticeable effect on performance parameter of construction sector. A group of researchers highlighted about ICTs positive and notable impact on the performance of construction companies. For future researchers, it's quite important to have more insight on use of information & communication technology & how it impacts performance of construction enterprises [17].

E. Benefits of embracing ICT in the Construction Industry

Seamless ICT integration into construction sector can enhance productivity and build efficiencies. Research scholars are advocating that engineering project design requires that stakeholders should effectively communicate, coordinate, and collaborate, which may be attained via the strategic adaptation & harnessing of ICT in the construction domain [18],[19]. Various construction enterprises (microscale or large scale) agreed that utilization of ICT may be future game changer & worth concentrating, and can proliferate productivity, efficiencies, and reliability.

There are several advantages of harnessing ICT into construction sector like high productivity, lowering budget, saving of time, effective information sharing, wastage control, and many more [20]. Construction site workers are not proficient in handling computing devices, less competent in technical aspects, and are afraid of virus attacks, which has confined the proper utilization of ICT approach in construction enterprises [21],[22]. Also, site personnel believes that ICT penetration is a welcoming step for the construction industry to maximize the productivity and efficiency.

F. Hindering factors in Integration of ICT into Construction Industry

Construction enterprises are very slow in adopting ICT-driven solutions, poor in collaboration among the stakeholders resulting very miserable success rate. To enhance the success rate of the industry we had gone through a rigorous literature review of the existing body of knowledge and have highlighted various limiting factors about the embracement of communication technologies in realm of construction enterprises [23],[24]. Complex nature, lower productivity, less skilled workforce, slippage of schedule, and budget overrun push the construction enterprises to adopt information & communication technologies in the various phases of construction. To gauge the penetration & utilization of ICT in construction projects, many researchers distributed questionnaires and conducted expert interviews to identify various factors that are derailing the construction projects. The leading hindering factors [25],[26] identified are cited in table no. 2.

Table 2: List of hindering factors in integration of ICT in the construction sector

Sr.No.	Hindering Factors
1	The cost of ICT integration is higher
2	Lack of strategic planning
3	Requirement of Proper training to use ICT
4	Complex Regulatory Norms
5	Lacking of enough Govt. support
6	Fear of job security and virus attack

Thus, to uplift the productivity and efficiency of construction enterprises all stakeholders must promote and adopt ICTs in all phases of construction wherever feasible.

III. Conclusion and Recommendations

Today's construction industry is suffering from many issues e.g., low productivity, poor efficiency, shortage of trained staff, performance, and personnel safety. To understand and overcome these challenges, we have done an exhaustive study of the existing body of knowledge about the penetration of ICT-enabled solutions in the construction industry. The present study comprises basic ICTs used in construction industries and some methods of ICT integration in the domain. We have also studied various ICTs used in different construction tasks and highlighted their impact on the performance of the industry. While studying the literature we recorded some advantages of embracing ICT in the construction sector and on other hand there are various hindering factors coming in the way of ICT integration in the construction industry.

The use of ICT would minimize the cost incurred, curtails the schedule of the project, improvise productivity, and creates new jobs and value proposition in the sector.

With the advent of 5G technologies, industry stakeholders should be poised to embrace cutting-edge technologies like IoT, AI/ML, Blockchain, Big data analytics, etc. in different construction phases to improvise productivity, efficiencies, and delivery on a predefined schedule and budget. Integration of these ICTs for different construction tasks needs good attention of the researcher community to uplift the present condition of the industry. However, increasing assistance for the infrastructure sector from global firms is expected to stimulate researchers in the future to harness state of art ICTs in the realm of the construction sector.

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