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Drivers of Information Communication Technologies Adoption in the South African Construction Organisations

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Abstract

The building sector relies entirely on good communication among teams, individuals, and organisations. But communication in a project-based environment involves different stakeholders and individuals that come together for a certain period to share the project's goals as well as organisational goals. The adoption of information and communication technologies (ICTs) has developed a productive and active method of information exchange among experts. This study set out to evaluate the drivers of ICTs in South African construction organisations to encourage more adoption. An e-questionnaire was employed as part of a quantitative research technique to gather information from construction industry professionals. They consist of mechanical, industrial, and electrical engineers, construction managers, and project managers, as well as quantity surveyors. Standard deviation (SD), mean item score (MIS), and Kruskal-walli's were utilised to examine the collected data. The results showed that the most prominent drivers of ICTs in construction organisations involve the elimination of time-consuming processes, communication and collaboration, and maximized project profitability. It is recommended that construction professionals should adopt the various ICTs because of the advantages they bring to construction projects from inception to completion. Additionally, training should be given to all the project members to encourage its adoption.

Keywords

ICT, Communication, Construction Industry, South Africa

1. Introduction

Projects in the construction industry are large, and complex involving many stakeholders, and requiring continuous communication of a large amount of data during the construction phase of project execution (Zhang and Yuan, 2016). According to Cheng et al. (2001), communication is defined as the transferring of data from one individual to another or among a group of people which can be done in writing or verbally. These data usually incorporate operation dates, skills, technology, and knowledge. Adan et al., (2012) asserted that communication is a construction key factor that should be done honestly, openly, and efficiently to promote the execution of a construction project's success. In general, communications represent the foundation on which stakeholders build their relationships with clients and other project stakeholders (Cheung, 2013). The building sector relies entirely on good communication among teams, individuals, and organisations. Putnam & Nicotera (2009) stated that ICT tools enable effective communication among organisations and stakeholders in the construction industry. In addition, the assembly and accumulation of works on a vast scale are necessary for the building project's execution, for it to be realized. Therefore, effective planning which is made possible by ICT is necessary for a project to succeed in any construction company. According to Dawood (2010), stakeholders have historically communicated project data mostly through paper documents such as architectural drawings, specifications, engineering, bills of quantities, and schedules of materials. Sheglabo (2016) backed up this claim by stating that this paperwork often requires recurrence and constant information changes when transferring and recording data from one media to another, which could result in data mistakes and in some cases, data loss. The development of information communication technology (ICT) has therefore enabled digital communication

between different members of the industry to be possible, and enhanced an active and proficient way of exchanging and storing data with negligible or no mistakes (Ahuja, 2010). Weber and Kauffman (2011) stressed that the worldwide, global adoption of information and communication technologies (ICT) presents information systems (IS) and electronic commerce academics with unique opportunities to conduct research that will have a positive impact. The adoption of and expenditure on ICTs are mainly driven by sectors such as insurance, information, finance, manufacturing, scientific, professional, health care, and technical services (Weber and Kauffman, 2011). ICT is also employed in several building industries, as explained by Hu & Kapucu (2016), to foster strong working relationships and cooperation between individuals and organizations. ICTs is also employed in the business for worker learning platforms, training sessions, and experience sharing. However, despite their potential contributions, and technical advancements in the construction industry; the construction industry has lagged in the adoption, compared to other industries. This shows that the construction sector is missing on a lot of business advantages including fast communication, and cost effectiveness (Tanga et al., 2021a). Therefore, this research aims to investigate the drivers of ICT in the South African construction industry.

2. Reviewed literature on construction ICTs

Adriaanse et al., (2010) stressed that ICT usage is influenced by the advantages and disadvantages of ICT applications as well as the skills and knowledge required for ICT use. The disadvantage is that the use of ICT can affect the conventional forms of the organizational procedures within the building industry and result in a modification in organizational procedures and activity, working strategies, and culture according to Ibironke, et al. (2011). Hu and Kapucu (2016) highlighted a few benefits of ICT basics to project execution in the construction sector which include decreasing the time for information handling, communicating data and upgrading the exchange for viable and successful decision-making and masterminding among building members, and enhancing building efficiency. The professionals and other parties involved in projects have benefited greatly from the introduction of ICT to the building sector (Tanga et al., 2021a). Mohandes and Omrany (2015) opined that ICTs such as building information modelling (BIM) which is a collaborative tool that allows the planning, building, and design of a structure within a single 3Dmodel is beneficial. Besides BIM, Augmented and virtual reality (AR and VR) are also part of ICTs. These are tools utilized for project data exchange, labourer's education and visualization, time management, and programme safety (Ahmed, 2018). Sensors which are small sized devices equipped with sub-systems communication, and resource processing cannot be excluded from relevant ICT tools in recent times (Ammari, 2018). Additionally, the internet of things (IoT), representing a system of interrelated devices connected to the internet according to established protocols via information sensing equipment are also included in ICT tools (Patel et al., 2016). Also included is enterprise resource planning (ERP), one of the significant ICT tools which consists of interconnected groups of comprehensive software that can be used to oversee and integrate all of the business procedures such as project management, accounting, risk management and compliance, and procurement within a company (Shehab et al., 2004). The main benefits of using ICTs include the expansion of the work done, financial control, better information interchange, less complicated and quicker access to information, and a reduction in errors while identifying unrecognized problems in numerous tasks. Additionally, ICTs benefits for the building sector also include providing the best possibility for information processing and shortening the time for data transmission (Tanga et al., 2021a). As indicated by Ibironke et al., (2011), it is one of the two main considerations that have affected the building sector over the the past couple of years when there was an expansion in computer possession by building experts, which was related to the accessibility of the software packages. IT turned out to be progressively important in dealing with a vast volume of data and in overseeing complex projects (Ahuja et al., 2009). It is a field that offers numerous potential advantages and chances to the building sector in general, and to the professionals specifically. It is also important to note that the adoption of ICT is a business strategic decision/direction and true front end strategic planning (FEP) drives the adoption (Govender, 2013). Burger et al., (2018) summed up the effect of ICT in building as the expanded speed of conveyance and work execution, upgraded quality, and arrangement of the large scope of administration services. The drivers of ICTs adoption involve:

2. 1 Increased Profit and Maximized Project Profitability

In the 21st century, ICT's usefulness to many fields of human endeavour including construction activities cannot be undermined because it has contributed immensely to the success of day-to-day businesses (Govender & Pretoruis, 2015). Apulu & Latham (2011) and Tanga et al. (2021a) explained that the use of ICTs has allowed organisational expansion through improved performance which is made possible through fluent and rapid information transfer amongst project parties. Furthermore, ICTs will also help to strategies data that is required to obtain sales targets

leading to increased profit (Apulu & Latham, 2011; Tanga et al., 2021a). Therefore, the more profitable ICT is; the more companies are motivated to employ it in their operations. According to Tanga et al. (2022) and Tanga et al. (2021b), ICTs allows data management for easy organisational work and data flows, sound business decisions based on the available data, leading to the organizations having a competitive advantage over rival companies, as well as a maximised project profitability.

2. 2 Speed and Customer Satisfaction Results

Kannabiran & Dharmalingam (2012) stated that ICTs are everyday modern tools that help to move from manual to an electronic data processing to promote productivity. The productivity of construction works and projects is recognised as one of the reasons explaining ICT usage in organisations (Tanga et al., 2021a). Apulu & Latham (2011) opined that most industries chose to embrace ICT to become increasingly effective in their different business operations in terms of speed and manual document stress handling which can be cumbersome. Furthermore, ICTs allow strong error detection which in turn eliminates the need for reworks and the extra cost related to it, when executing a project. This leads to better customer satisfaction (Krishnamoorthy, 2017). The speed of accurate information transmission, reflects the pace of the project delivery, leading to customer satisfaction (Tanga et al., 2021).

2. 3 Communication and Collaboration

Construction projects require varied groups of people, operations, and organizations to accomplish an ideal objective. Thus, collaboration, coordination, and data communication between different parties are important for successful project execution (Tanga et al., 2021a, b). Moreover, Sekou (2012) affirmed that ICTs can be utilised as the empowering tool of knowledge and collaboration management via knowledge warehouses, management systems, enterprise planning, decision support systems, groupware applications, use and establishment of database knowledge discovery.

2. 4 Elimination of Time-Consuming Processes

Information Communication Technologies help in construction project scheduling, which aims to coordinate the resources including equipment, materials, and labor with project work tasks, over time. A project can be completed as quickly as possible with the help of effective scheduling, which can also help with the timely acquisition of necessary supplies and the elimination of problems caused by production constraints (Tanga et al., 2021a; Nayak and Mohanty, 2012). In contrast, bad scheduling can result in enormous waste as employees and equipment wait for the availability of essential resources or the execution of preceding activities. The lack of a proper scheduling can also cause delays in a project's completion, which can be disastrous for owners who are eager to begin using the newly built facilities (Tanga et al., 2021a; Nayak and Mohanty, 2012).

2. 5 Reduced Cost and Information Storage

Information and communication technologies can help organisations succeed in their operations by reducing costs and saving time through better cooperation. This is because ICTs improve client interactions through improved consumer feedback and communication systems, quicker access to important information, improved data storage, monitoring, and safety (Ballan, 2011; Savvides, 2015). Moreover, Tanga et al. (2021b) explained that for instance cloud storage offers superior functionality and performance requirements, portable needs, cost demand, and other benefits over the prior type of storage, which required significant maintenance costs, additional infrastructure investment, and the addition of servers to meet the rising demand. This can therefore boost the embracing of ICTs in the construction sector.

2. 6 Improved Project Administration

Burger et al., (2018) stressed that ICTs in the building sector are used for the expanded speed of conveyance and work execution, efficacy exchange, upgraded quality, and arrangement of the large scope of administrative services through their automation ability. Its utilisation and the mix of computer applications inside the professional's services build the dimension of efficiency in the building sector and grow the scope of data accessibility and the services offered while accelerating building work and lessening costs (Ahuja, 2009). However, Nguyen (2015) noticed the deficiency of comprehensive ICTs by the administration and supervision team. This affects the adoption of ICTs on construction projects.

2. 7 Business Data Integration and Nature of Business

The construction business is very vast and receives data or information from various sources and stakeholders. This information needs to be organised and integrated into a single and trusted storage which is possible with the adoption

of ICTs (Tanga et al., 2021b). However, the nature of the construction business is to be considered as big projects require more stakeholders, more information, and administrative work involving the need for ICTs compared to small businesses (Tanga et al., 2021a, b). This applies to a certain category of ICTs only because for instance, emails are used in both small and big businesses (Tanga et al., 2021a).

2. 8 Process Improvement and Site Management

Peansupap (2004) & Sekou, (2012) opined that ICT dispersion in the building industry is a significant driver for improving the productivity and efficiency of the industry. In line with this, Samuelson (2002) & Sweis (2010) have submitted that ICT use was generally high in the facility management, and its utilization by workers and site labourers in the production procedure was shockingly low. They furthermore put forward that, some part of the poor efficiency figures in the building sector could be clarified by the way data is needed and the communication practices in building sites which are not satisfactorily met. Until now, the industry has experienced lots of exertions to improve efficiency. With the assistance of ICT tools and different its applications, have demonstrated that there is noteworthy potential for productivity and efficiency improvement in the building industry and that ICT is playing a great role in it. (Samuelson, 2002). During site management and process improvement, ICTs will help in the data collection, safety precautions (hazards alarm), daily report production, and delivery of needed data and information (Sekou,2012).

2. 9 Electronic Commerce and Electronic Procurement

Parida & Örtqvist (2015) asserted that information communication technology (ICT) is a tool that can be used to improve electronic procurement in the building industry. Electronic procurement also known as e-procurement can be categorised into electronic purchasing (e-purchasing) and electronic tendering (e-tendering) in the construction industry. Electronic tendering is utilized for different purposes such as selecting the best contractors and suppliers and resolving tender problems. Nawi (2016) put forward that e-procurement has been created for the selection of a reasonable number of suppliers, the best price and quality relation, and the best contract plan. Sekou (2012) opined that e-tendering helps to access the organization's publications and notices of tenders inside and outside the country for bidding internationally. E-procurement thus influences the establishment of a market for building amenities and construction materials. This is thus a driver since it allows smooth and improved construction business processes.

3. Research Methodology

Regarding this study, a quantitative research methodology was selected to assess the main ICT adoption drivers in the construction sector. An electronic questionnaire was created as the data collection method to rate the participants' knowledge. The information gathered from researched literature was used to create the questionnaire. The South African province of Gauteng was chosen as the study's field of investigation. This area was chosen because it is close to the researchers and because it has the research issue that this study is trying to tackle. The Gauteng province in South Africa served as the study's target market, which comprised civil engineers, construction managers, quantity surveyors, architects, and industrial, electrical, and mechanical engineers. In Gauteng province, there are 1054 participants in total. The sample size of 289 was attained using the Yamane sample size formula and a degree of precision of 5%. To contact the population through their professional bodies, a convenient and random sampling method was adopted since it offers each person a chance to be chosen or included in the sample while working with the available set of participants. Eighty-five properly completed surveys served as the basis for this analysis. This indicates a 30% response rate. Previous research has demonstrated that a response rate of 20–30% is statistically appropriate for online social science research (Knaub, 2013). To rank the advantages of ICT tools, the data were analysed using the mean item score (MIS) and standard deviation (SD), and Kruskal-Wallis. Kruskal-Wallis was used to compare the participants' opinions based on their years of experience. Additionally, the data sets' dependability was assessed using Cronbach's alpha reliability test, which produced a result of 0.9000, which indicates a high level of consistency.

4. Findings and discussion

Based on the examination of the collected data, all of the respondents are members of a professional organisation, hold academic degrees, and have an average of six years' experience working in the construction sector. The participants' backgrounds also revealed that they have a sufficient level of professional training and years of experience in the construction sector. This implies that they are qualified to answer the research question. Table 1 showed the participants' ranking of the drivers of ICTs in the South African construction industry. It discovered that Elimination of Time-consuming Processes and Communication and Collaboration were the leading drivers of ICT use with a mean

score of 4.25 and a standard deviation of 0.84 respectively; followed by maximized project profitability as the third most eminent driver of ICT use with a mean score of 4.20 and standard deviation of 0.86. At the bottom of the ranking, Electronic Commerce and Electronic Procurement and Reduced cost were ranked eleventh with a mean score of 4.04 and standard deviation of 089 and 0.98 respectively while Nature of Business ranked the least with a mean score of 3.89 and a standard deviation of 0.86.

Table 1. Drivers of ICT tools in the construction industry

Drivers of ICT use	$\bar{x}$	Σ	R
Elimination of time-consuming processes	4.25	0.84	1
Communication and Collaboration	4.25	0.84	1
Maximized Project Profitability	4.20	0.86	3
Information Storage	4.18	0.82	4
Customer Satisfaction	4.17	0.83	5
Business data integration	4.16	0.75	6
Improved Project Administration	4.16	0.75	6
Process Improvement and Site Management	4.14	0.82	8
Speed	4.13	0.94	9
Increased profit	4.05	0.90	10
Electronic Commerce and Electronic Procurement	4.04	0.89	11
Reduced Cost	4.04	0.98	11
Nature of Business	3.89	0.86	13

σ = Standard Deviation; $\bar{x}$ = Mean; R= Rank

Table 2. Kruskal-walli's test result

Variable	P–Value
Increased profit	0,288
Speed	0,253
Communication and Collaboration	0,313
Business data integration	0,122
Process Improvement and Site Management	0,107
Electronic Commerce and Electronic Procurement	0.088
Information Storage	0,382
Reduced Cost	0,293
Customer Satisfaction	0,164
Nature of Business	0,525
Maximised Project Profitability	0,207
Improved Project Administration	0,605
Elimination of Unnecessary Processes	0,057

A Kruskal-test Walli's was used to compare the participants' perspectives based on their years of experience, as can be seen in table 2. All of the specified "drivers" were found to have no significant difference in mean values as all p-values are greater than 0.05. Although "Elimination of Unnecessary Processes" p-value recorded of 0,057 is close to 0.05, it is still exceeding 0.05.

From the analysis result, it is evident that all the variables are actual drivers of Information and Communication Technologies adoption with each of them having a mean item score above 3.00 known to be the 5-point Likert scale average. As indicated from the survey result elimination of time-consuming process is the highly-rated driver of ICTs. The implementation of ICTs helps to eliminate processes that are manually handled which is time-consuming. This is supported by the study of Krishnamoorthy, (2017); Tanga et al. (2021a, b) who stated that allowing the sharing of bulky documents while ensuring information and data security at the same time which is the case of cloud storage. The study also reveals that communication and collaboration is a driver of ICTs. This is because for projects to be successful, there is a need for constant exchange and communication of information among project parties because the construction business involves several groups of people coming together to fulfil project objectives (Zhang and Yuan, 2016 and Cheung, 2013). Sekou (2012) explained that this exchange of information is achieved through the use of tools and data storage systems such as decision support systems, knowledge warehouses, management systems, as well as databases. The study shows that maximised project profitability is one of the drivers of ICTs. The adoption of ICTs in the construction industry leads to organisational growth through improved performance that is made possible via fluent and rapid information transfer amongst project parties. Furthermore, ICTs make it possible to handle data, facilitating simple organizational tasks and data flows as well as wise business decisions based on the information at hand, maximizing project profitability and giving a company a competitive edge over its competitors (Tanga et al. 2021b). In line with the submission of Ballan (2011) and Savvides (2015) information storage is a driver of ICTs adoption, the author affirmed that ICTs enhance customer engagement by enhancing systems for receiving customer feedback and communicating with them, providing faster access to crucial information, and improving data preservation, surveillance, and safeguarding. This will enable customer satisfaction and therefore promote company success. Moreover, Tanga et al. (2021a) pointed out that the implementation of ICTs does only provide customer or client satisfaction but also quickens the pace of project completion due to the fact that time consuming processes are eliminated from the shifts from manual documents handling to electronic data processing and handling. Thus, fast project delivery made possible through quick information exchange will allow good company reputation and permit the organisation remain in business for a very long period of time.

5. Conclusions and Recommendation

The research was designed to evaluate the drivers of ICTs adoption in construction organisations. According to the literature, the use of ICT tools has increased construction work production and effectiveness in the building industry sectors throughout time by managing tasks including engineering design, architectural drawing, and bill of quantities preparation. These benefits positively influence many construction organisations to adopt ICTs. The collected data revealed that the most common drivers of ICTs adoption encompass the elimination of time-consuming processes, communication and collaboration, and maximised project profitability. In light of this research, it is recommended that construction companies offer their employees education on how to use various ICT tools. This will keep professionals abreast of cutting-edge ICT innovations as well as encourage continuous ICTs adoption. Additionally, the construction sector will be able to more effectively manage its information which is one of the factors that promotes construction projects' success. Furthermore, this work recommends that project members need to accept the cultural change that comes with ICTs adoption to facilitate its adoption. Besides that, financial support from NGOs and the government is needed to help organisations that are struggling financially. This study's concentration on the Gauteng province of South Africa constitutes a limitation. Further research can analyse other provinces to get a broader picture of ICT usage in the South African construction sector.

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