

An investigation into the digitalisation of quantity surveying services during covid-19

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Abstract:

The coronavirus disease (COVID-19) presented the construction sector with challenges that the world had never seen before. Productivity is down, costs have increased, regulations and guidelines are becoming more incompatible, conflicts and claims have increased, accidents are increasing in number and profit margins have been reduced. This requires changes to construction management practises and strategies. In response, construction companies are digitalizing the construction delivery processes and procedures to be productive and competitive. Through a survey questionnaire, the extent of the adoption of construction technologies by quantity surveying organisations is investigated. The weightage mean was used to determine the application's priority. The other statistical tests computed are the one-way test, Cronbach's alpha reliability tests, validity tests, and mode. Building information modeling, Internet of Things, Automated Workflow Tools, Big Data, 5G and Wi-Fi 6, Mobile and Cloud Technologies, and Document Imaging and Digitisation are the most applied technologies during the pandemic to digitalise the construction delivery process. This study adds to the body of knowledge about reimagining the roles of quantity surveying organisations in the aftermath of the pandemic with the goal of resuming service development. From an ontological standpoint, the main findings of this study are generalizable to quantity surveying practise in and outside of Nigeria and to other professionals in the construction sector. The pandemic is transforming a sector that was not keen on digital uptake for a long time.

Keywords:

Uncertainty, disruption, productivity, post pandemic, digital transformation

1 Introduction

A novel Coronavirus disease (COVID-19) is a contagious disease that is spread by a newly found coronavirus. COVID-19 poses a critical health and economic risk to global economies, regardless of whether the countries are underdeveloped, developing, or developed (Olanrewaju, et al., 2021). In longer terms, the pandemic will leave lifelong marks on the economy due to poor investment, poor human capital development, and disruptions of trade and supply. Economic growth was reduced by 5.2 percent as a result of the pandemic (World Bank, 2020). The virus is typically spread through droplets and

fomites, and the particles can continue for up to 24 hours. This makes its transmission high on the construction sites. Multiple control measures, like isolation, contact tracing, and social distance, have been implemented to flatten the curve, but the size of the spread on the construction sites remains high (Sanmargaraja, et al, 2020). Most construction projects were suspended, and the construction personnel were mandated to work from home. Globally, the construction sector is facing numerous difficulties, which include a shortage of operatives, inefficiency, materials and component shortages, inability to handover completed projects, problems of access to sites and inability to obtain permits for foreign workers (Olanrewaju, et al., 2021).

While there is no specific data on COVID-19's economic impact on construction projects, data shows that it has a significant impact on the construction sector. To illustrate, data from 70 medium-sized projects revealed that the pandemic led to a 15% loss in productivity in the UK (Construction Manager, 2020). Similarly, 68% of Associated General Contractors' clients asked the contractors to suspend projects (AGC, 2020). Research revealed that the pandemic delayed projects by up to 23% (AGC, 2020). Primarily, the delay and cost overrun were due to a shortage of resources (Olanrewaju, et al., 2021). However, construction companies have to reopen and function alongside a virus that has continued to pose a threat to the economy. The threat is complicated because there is a low chance of working from home in the sector and the sector is largely labour-intensive. While the pandemic poses some threats to the construction sector, it also provides great opportunities for the sector to improve service delivery (Sanmargaraja, et al, 2020). As the uncertainty and complexities associated with the construction sector increase unabated, construction companies are switching to digital construction to increase productivity, collaboration, and competitiveness. This paper reports a study that investigated the construction technologies that quantity surveyors envisaged would see their demand increase post pandemic, based on the lessons learned at the height of the pandemic. This is because these technologies enable projects to progress, allow project meetings to be conducted, enable payment to be made, allow reports to be prepared, and allow sites to be monitored remotely.

2 Background and Conceptual Framework

The construction sector is an economic investment, and its connection with economic development is distinct without question. The construction sector is one of the most severely impacted sectors by the COVID-19 crisis. For example, many clients have not been able to take ownership of their completed projects because of restrictions on movement (Sanmargaraja, et al, 2020). In particular, construction companies with high debt profiles may be unable to pay what they owe to clients and meet other commercial obligations. In some instances, foreign components and materials were delivered late or never even arrived in some instances, as many countries, including India, Italy, the UK, and China, slowed or shut down production of major construction resources (EIC, 2020). The meeting cannot be conducted, payment cannot be honoured, and sites are shut down. As a result, the construction sector falls back on technologies to be competitive, increase profit margin, productivity, and enhance project delivery. For example, during a pandemic, there is an increase in the use of drones to monitor site activities, meetings that would normally be held on-site are held online, information is shared digitally, and satellite images are used for site inspections (Olanrewaju, et al.,

2021). The demand for precast components, like IBS, has seen an increase in demand. In fact, the pandemic opens up a sector that is receptive to innovation. The rate of trust in the sector is also increasing. Numerous renegotiations of contract provisions and terms were proposed and implemented (Olanrewaju, et al., 2021). Special conditions for contracts would be needed over and above the general conditions, largely because most of the contract provisions in the new policies and codes are not the same as those that were used when the contracts were endorsed prior to the virus.

2.1 Overview: Digitisation and digitalisation and construction technologies

Construction technology refers to the types of technology that have a specific application within the construction sector. The rate of digitisation among construction companies has increased significantly with the advancement of computers and other technologies. The movement restrictions, working from home, and [partial] closure of construction sites during the pandemic have heightened digitisation in the construction sector. This is especially critical because the conventional data is limited to basic information on time, cost, quality, number of operatives, productivity, material supply, and other information. This data is usually structured. However, during the pandemic, a lot of the data that was generated using advanced technologies to make decisions was complex and involved semi-structured and unstructured data. Examples of the data include free text, pictures, and sensors. Digitisation makes it easy and more convenient for members of the design team to work together irrespective of their locations. Graphics, videos, orals, and writing are frequently used to supplement data. By converting information into a digital format, construction companies are digitising the construction process to increase productivity and profit margin. Digitisation involves the process of creating a digital image of real-life objects. To simplify, it means converting a non-digital object into a digital representation (Gavrilov et al., 2020). A company converting a hardcopy document into a pdf document is an example of digitisation. By converting information into a digital format, construction companies are digitising the construction process to increase productivity and profit margin.

Construction companies are embracing digitisation and digitalising technologies to provide value-added services. Digitalisation uses digital technologies and digitised data to facilitate improvement processes in an organisation. Human-driven processes became software-driven as a result of digitalisation, which allows the transfer of information and existing resources, such as files, documents, and processes, into digital platforms that are accessible and readable on computers and other digital technologies. There is a lot of construction-focused software and built-in power tools that make it possible to reduce or eliminate process-related problems to improve project delivery, performance, and profit margins. Digital construction moves work from manual tasks to digital platforms and processes. Although technologies are transforming the sectors that are close to innovation and digitisation, the pandemic has pressurised the sector to embrace technologies. Adopting the digital transformation during the pandemic is indeed complex and time-consuming for construction companies that are hesitant to do so. However, as the sector's need to collaborate and increase trust grows, so will the demand for digital construction. Construction companies are under intense pressure to increase productivity, profit margins, client satisfaction, and reduce risk through better collaboration and communication, which is only possible through digital construction.

Digitalisation, or the application and adoption of construction technologies, is a productive means during the pandemic to enhance collaboration and communication in real time. Through digitalisation, companies eliminate inefficient processes and activities and poor productivity that result from a lack of collaboration, poor communication, repetitive tasks, and lack of trust.

2.2 Functions of quantity surveyors

Quantity surveyors are professional experts on cost, contract, and procurement of construction projects. Quantity surveyors provide expertise in various economic endeavours, including petrochemicals, manufacturing, automobiles, mining, telecommunications, shipping, transport, and agriculture. Quantity surveyors deliver advice on the strategic planning of a project. For construction work, this advice affects clients' decisions on whether to construct or not, and if the client decides to construct, it examines the impact of cost on other criteria within the client's or users' value systems (Olanrewaju and Anavhe, 2015). Quantity surveying involves managing the costs and value of construction projects. It is sometimes called by several names, such as cost management, cost engineering, and construction management. Modern clients are sophisticated and demanding. The clients want the project to be completed on schedule, within budget, with high performance, sustainability, pleasant safety, lower maintenance costs, and satisfying. Despite these huge responsibilities, quantity surveyors are receptive to the adoption and application of construction, especially in developing countries.

3 Research Methodology

The research involves a literature review and a survey questionnaire. Though studies on the adoption and application of technologies in construction are increasing, research on the adoption of technologies due to the pandemic is nascent, especially that relating to quantity surveying and especially in developing countries like Nigeria. The purpose of this research is to examine the construction technologies employed by quantity surveyors during the pandemic to conduct business. Therefore, there is a lack of established theories on this scope. Explicitly, the questions that this research seeks to answer are: what are the construction technologies that quantity surveyors expect to see increase in demand due to restrictions imposed by the COVID-19 crisis? The answer to this question would help to reimagine the extent of digitalisation post-pandemic and, in a way, provide implicit information on the new roles of quantity surveying organisations. A convenient sampling technique was used to collect primary data. Convenience sampling is a method of gathering data in which a survey is administered to respondents who are accessible, reachable, and prepared to respond. The method is appropriate where sufficient information on population size and sample frame is not available. However, its findings suffer from a lack of external validity. However, if the respondents are large enough, the findings can be representative. Consequently, its main principle is that if adequate data is gathered and objectivity is maintained, the results will be indicative of the population (Olanrewaju and Idrus, 2020). The questionnaires were administered to the respondents online. The survey was conducted from 4/12/2021 through 15/12/2021. The respondents were requested, based on evidence, to tick the extent to which each of the technologies would be in demand by the quantity surveying

organisation after the pandemic. The extent of demand was measured on a 5-point continuum scale of 1 to 5, where 1 denotes the least extent, 3 less extent, 4 moderate extent, 5 denotes strong extent, and 5 denotes extremely extensive. The extent of application of the technologies was positively worded, and higher scores indicated a higher extent of application of the technologies after the pandemic. The weightage mean was used to determine the application's priority. The other statistical tests computed are the one-way test, Cronbach's alpha reliability tests, validity tests, and mode. One sample t-test was conducted in order to test the hypothesis of whether each of the technologies would be applied or not after the pandemic. Missing data may be addressed by either replacing the missing data with the mode or mean of the construct. However, the missing data was not treated in this manuscript. This is in order not to influence the data.

4 Findings and Discussion

The online survey form was administered to more than 300 quantity surveyors in the construction sector in Nigeria. The responding quantity surveyors were asked to forward the form to their colleagues or friends that were competent to provide a valid response. However, by the cut-off date, 84 responses were received after several reminders spanning over six weeks.

4.1 Demographics of respondents

The results of the survey are contained in table 1 and figure 1. About 60% of the respondents are consultant quantity surveyors and have worked for about 24% of the respondents worked for contracting organisations (Figure 1). The rest worked for manufacturers, suppliers, and government agencies. More than 95% of the responding quantity surveyors have worked for more than 5 years, about 80% have worked for more than 10 years, and 50% have worked for more than 20 years. Table 1 reveals that all the respondents obtained good academic qualifications and held strategic or senior management positions in the organisations where they worked.

Table 1: Respondents' academic qualification

	Category	Percentage
Qualification	Higher National Diploma	22.5
	BSc	20.0
	MSc	42.5
	PhD	7.5
	Other	7.5
Position	Principal Partner	33.8
	Partner	15.0
	Senior Quantity Surveyor	18.8
	Managing Director	11.3
	Project Manager	10.0
	Other	11.3

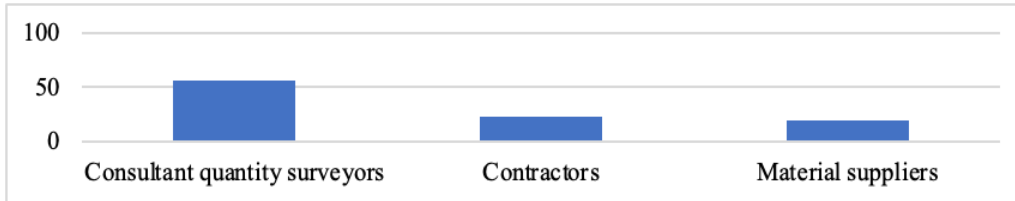


Figure 1: Respondents' organisation

4.2 Nature of disputes, claim and cost

The data revealed that compliance with the COVID-19 regulation would increase project costs by between 20% and 40% (Figure 2). In fact, 60% of the respondents measured that the compliance cost is about 30% and about 10% measured that the compliance cost is more than 50%.

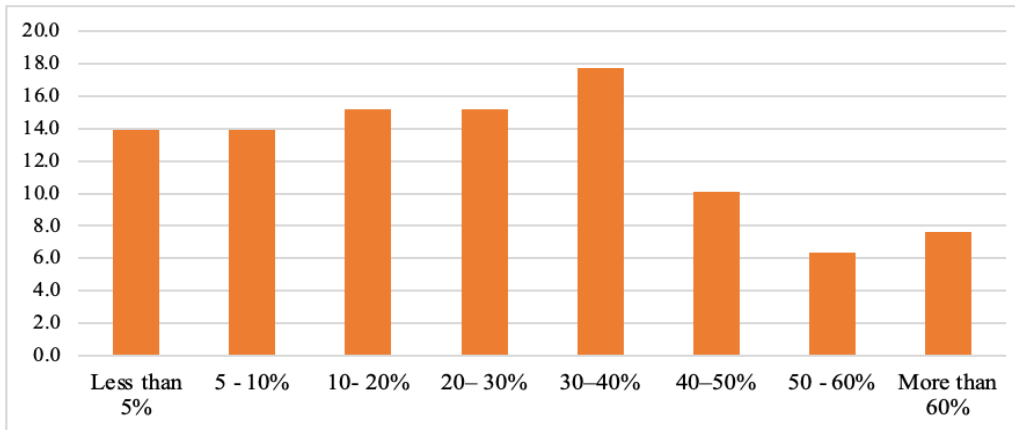


Figure 2: Extent of increase in project cost with compliance with standard operating procedures (SOPs) due to the COVID-19

Because the pandemic caused significant disruptions to the construction supply chain, which led to multiple and multi-layered disputes and claims among the various parties to the construction contract, the extent of claims and disputes during the pandemic were addressed to the respondents. In fact, the technology's adoption was necessitated by anticipated claims and disputes. About 80% of the respondents have seen the pandemic increase disputes and claims on their projects (Table 2).

Table 2: Differences in the frequency of disputes and claims

	Not at all	Yes, to a small extent	Yes, to a large extent
Dispute	21.0	64.2	14.8
Claim	20.7	48.8	30.5

4.2 Extent of digitalisation

It is interesting to find that more than 90% of the respondents agreed that construction technologies are able to reduce or avoid disputes during the pandemic (Table 3). The reliability and validity of the data are very high (Table 4). The results of the one-sample t-test confirmed the ($H_0: U \leq U_0$) hypothesis that the demand for each of the technologies will be highly required by the Nigerian construction sector post pandemic, largely because there is a surge in their need during the pandemic as compared to prior to the pandemic. Furthermore, the results of the small standard errors are lower at an average of 1%. The practical implication of these results is that the technologies are highly needed during the pandemic as the need for better collaboration increases. These results are confirmed by the results of the confidence interval (at a 95% Confidence Interval). The results of the KMO (0.879) and Bartlett's test ($\chi^2 (210) = 776.954, p < 0.050$) implied that the respondents were drawn from the same population and that the adoption and application of the technologies would increase productivity, efficiency, client satisfaction, and profit margin through better collaboration and communication. The survey found that more than 35% of the respondents measured that the technologies would be in demand moderately, but 34% measured that the demand for the technologies would be in high demand. However, the remaining 30% deviates from the estimate. The cumulative ARI score for all the technologies was 60.8%, while the cumulative standard deviation (SD) was 22.5%. To interpret, the adoption and application rates of the technologies are low in the Nigerian construction sector, and those that have used some of the technologies are not sizeable.

Table 3: Does technology have a role in reducing disputes during pandemic?

	Not at all	Yes, to a small extent	Yes, to a large extent
Percentage	8.6	49.4	42.0

In fact, about 20% of the respondents did not evaluate the application and adoption of the technologies post pandemic. In other words, many of the quantity surveyors have not used any of the technologies before and during the pandemic and, as such, have no reason to see the demand increasing post pandemic. The data revealed that the demand for BIM is expected to be the highest among the technologies in the construction sector. This finding is interesting because BIM is one of the digital tools that are used to enhance collaboration and communication in real time, irrespective of the location of the parties. This is especially true during the pandemic because of restrictions on movement, accessibility problems, and the need to adhere to SOP on site. In most countries, during a pandemic, only 50% of the sites are allowed to operate, and even then, only 50% of the operatives or people can enter the sites. The IoT is a significant driver of big-data analytics projects, enabling companies to create and analyse vast data sets. Construction data is increasingly getting intense and huge. To improve efficiency, high-speed bands and radio frequency bands are becoming more critical. For this reason, technologies like Wi-Fi 6 and 5G would be required.

Table 4: Descriptive statistics on adoption of technology post pandemic

Technology	Least extent	Less extent	Moderate extent	Strongly extent	Extremely extent	Corrected Item-Total Correlation	Cronbach's Alpha if	Validity	SD	WM
BIM	4	7	26	21	13	0.78	0.97	0.71	22	69
Internet of Things	4	9	24	13	14	0.90	0.96	0.86	23	67
Automated Workflow Tools	5	10	25	12	14	0.80	0.97	0.72	24	66
5G and Wi-Fi 6	5	11	19	20	9	0.70	0.97	0.62	23	65
Big data	5	10	20	14	10	0.86	0.96	0.78	24	65
Mobile and Cloud Technologies	3	9	32	15	8	0.81	0.97	0.77	20	65
Document Imaging	5	9	29	17	9	0.79	0.97	0.81	21	65
Internet of Everything	4	15	19	17	8	0.83	0.96	0.73	23	63
ERP Software	6	11	18	14	8	0.80	0.97	0.76	24	62
Site Sensors	6	16	15	19	8	0.75	0.97	0.72	24	62
3D Printing	5	12	26	14	7	0.62	0.97	0.66	22	62
Satellite image	7	15	26	7	12	0.64	0.97	0.82	24	61
Blockchain Technology	10	8	18	15	6	0.74	0.97	0.81	25	60
Digital stamping	6	18	17	17	5	0.83	0.96	0.75	23	59
Customised cloud applications	6	14	23	13	5	0.67	0.97	0.72	22	59
Virtual Reality and Wearables	6	11	28	11	2	0.65	0.97	0.59	19	57
Pro Crew Schedule	8	13	19	12	4	0.83	0.96	0.80	23	57
Augmented Reality	5	17	18	12	2	0.81	0.97	0.77	20	56
Artificial Intelligence	9	16	16	12	5	0.79	0.97	0.75	24	56
Drone	14	14	26	11	5	0.55	0.97	0.72	23	54
Robotics	16	14	21	8	1	0.67	0.97	0.66	22	48

Although Wi-Fi 6 and 5G technologies can be used separately, they are also complementary technologies. Wi-Fi is used to connect multiple devices like PCs, tablets, smartphones, smart speakers, and cameras. The construction sector can leverage this technology to work remotely and involve many stakeholders. Both 5G and Wi-Fi 6 can be used along with the Internet of Things (IoT).

The data is used at different phases of the project and by different stakeholders and is used to evaluate and monitor project progress and performance from inception through demolition. Technologies like the internet of things, the internet of everything, and smart technologies provide means for collecting, cleaning, storing, processing, analysing, and distributing huge quantities of data (Olanrewaju, et al., 2022). IOT facilitates communication between devices and the cloud, as well as between the devices themselves. The huge amount of data, or "Big Data," is dominant in the construction sector. Construction management is at a critical point in the construction

delivery process, especially during the pandemic. As construction companies embrace digitisation and digitalise their construction delivery processes to provide value-added services, the role of big data is becoming increasingly important. The nature of the data that is involved in construction projects is not only very large, but it is also very unstructured, semi-structured, instantaneous, and evolving. Telephones, Facebook, emails, WhatsApp, BIMs, handwritten letters, and other computer applications are all used to transmit data. The data varies and is generated by a wide range of stakeholders with varying interests and experience. A lot of estimations and assumptions are made during the process. The conventional data technology (i.e., for the collection, storage, and transmission of the data) is very unreliable, especially when it comes to future estimations that are usually imprecise. Before the advancement of big data technology, whole life appraisal (or life cycle costing) was a very delicate area where predictions were usually made with a lot of uncertainties.

Construction at the task level is very repetitive and continuous. Automated workflow tools like Nintex, Zapier, and ProcessMaker can be easily used to streamline repetitive and time-consuming work and identify inefficiencies. Workflow automation makes complicated business processes easier to manage. Automated Workflow can also be used by the supervisor/gang lead/construction manager to meet the due date of a task. This would help to monitor the progress of work remotely. Mobile and cloud technologies allow users to access and store applications and their associated data at anytime on the Internet once they have subscribed to the cloud services. Among other things, it provides enhanced broadband coverage and huge storage. Dropbox is an example of a cloud-based Android application that is used for data storage and sharing with parties.

The offices of construction companies are littered with voluminous documents (e.g., invoices, quotations, submittals, change orders, plans, drawings, and other printed documents). The documents are often difficult to find or misplaced. The data revealed that converting paper documents into an electronic format would be in high demand, as the data revealed that document imaging would be in high demand. However, beyond these, document imaging includes simultaneous access to the same document by various parties to the contract. The Internet of Everything brings resources (people, processes, procedures, and data) together through networked connections to make informed decisions in real time. The Internet of Everything is more than the Internet of Things, because the main component of the Internet of Things is things (physical objects). The Internet of Everything, on the other hand, is made up of things, people, processes, and data, allowing us to make more informed, data-driven decisions. Construction companies can implement the Internet of Everything for predictive repair in projects for maintenance and operation. Construction companies can insert sensors and smart devices on machinery to enhance distribution conditions and routing activities. The nature of the construction process demands a reference to previous projects for an estimate. ERP software has the capability to store a massive amount of data from previous construction projects for reference purposes. For example, cost analysis from data can be used for cost planning of a proposed project. The stored data can also be shared among multiple users, irrespective of their locations.

5 Conclusion and Recommendations to the Construction Sector

The economic, social, and health impacts of COVID-19 on the construction sector will remain for years to come, which will continue to change the already tense working culture in the sector. Construction companies are now increasingly adopting and using various software solutions to streamline their processes and activities and improve productivity and profit. There is a need for trust management among parties to improve the needed communication and collaboration. Looking at the findings of this research from a practical point of view, the rate of adoption of the digital tools is not impressive. A lot of education is required from the sector parties, including clients, on the need to adopt the digital tools that are appropriate to the size of the projects or their companies.

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