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The construction industry transformation and the digital divide: Bridging the gap

Professor Abimbola Olukemi Windapo is the recipient of the 2019/2020 NSTF-South32 Engineering Research Capacity Development Award for her research of construction business and management that confronts the problems of poor project and organisation performance from a practice perspective.

Numerous digital technologies aim to improve both the productivity and performance of construction professionals, projects and companies. However, they have not been completely adopted, and low productivity is evident. Maintaining technological skill levels in line with industry progress also presents a challenge to women, because crucial skill development in emerging technologies tends to be achieved by aspirational labour. Previous research suggests a possible transformation of the construction industry using digital technologies. However, a digital divide exists.

Introduction

The construction industry has not achieved the best possible performance, which is largely due to low productivity on construction sites.^{1,2} This most often leads to time and budget overruns, which create a high-cost escalation for the projects.³ The issue of low productivity is a problem worldwide, not just in developing countries; even developed countries suffer from a decline in productivity.⁴ This is a major issue across the construction industry, and if the current trend continues, there will be a major negative effect on its health and viability.¹

Howell and Higgins⁵ hold a theory that organisations in the construction industry must be leaders in the identification, evaluation, and adoption of the latest technological innovations if they are to remain relevant and competitive. However, many companies do not fully adopt these innovative technologies.⁶ The numerous innovative construction technologies available on the market aim to complement job functions and improve the performance of construction companies. However, in line with the Diffusion of Innovation theory, these technologies have not been adopted in the construction sector of many developing economies, such as Nigeria, and low productivity continues to affect them.⁵

Although previous research suggests that there are opportunities for the digital environment to transform the construction industry and make it more productive, scholars such as Oke et al.⁷ note several barriers to adopting digital technologies. There is limited knowledge of how they could improve the productivity of projects and transform the construction industry. Here I examine construction's digital future and whether it can be proactively reconstructed, promoting gender equity in the construction industry, rather than creating a barrier, and how to bridge the digital divide. Recommendations are made to help professional builders, especially women in the construction industry, to take advantage of this digital environment to increase their effectiveness in technically dominated and male-dominated workplaces.

Overview of digital innovation

According to Barrett⁸, Construction 4.0 could potentially offer opportunities to resolve issues of gender equity in the industry. Barrett⁸, however, notes that Construction 4.0 itself is a gendered concept that leans towards male professionals, because there has been no strategy offered to ensure that both women and men can fill anticipated skills shortages. This exacerbates the situation in which higher rates of men are attracted to and enter a digitally transformed construction industry, and in doing so, enable the bridging of the digital divide. Digital innovative technologies which may offer new opportunities to resolve issues of poor productivity and performance in the construction industry include 3D scanning, building information modelling/management, 3D printing, augmented/virtual reality, drone technology, the Internet of Things, big data analytics, machine learning and blockchain technology. These are explained in the following paragraphs.

The process of 3D scanning analyses a real-world object to collect data on its shape, and possibly its appearance. This type of scanner is used to model and build the structure. Laser scanning is used to create quick and accurate 3D models of existing buildings, to support the subsequent process of 3D scanning.

Building information modelling relies upon various tools, technologies, and contracts involving the generation and management of digital representations of buildings, and of the infrastructure's physical and functional characteristics.

Integrated building information modelling and 3D scanning involves converting laser scans into a Building Information Model. It thus collects and documents valuable information in a consistent building database that serves as an accurate source for engineering, design and construction.

3D printing is an automated, additive manufacturing process for producing three-dimensional solid objects from a digital model.

Augmented reality is an interactive experience of a real-world environment, where the objects in the real world are enhanced by computer-generated perceptual information, sometimes across multiple sensory modalities, including the following senses: visual, auditory, haptic, somato-sensory and olfactory.

Virtual reality is the use of computer technology to create a simulated environment. Unlike traditional user interfaces, virtual reality places the user inside an experience. Instead of viewing a screen in front of them, users experience themselves as immersed in, and interacting with 3D worlds.

Drone technology provides construction teams with an overhead view of job sites, materials, machinery and people. Contractors use autonomous flying machines to record videos that help optimise everything from grading plans and operations to identifying differences between as-designed and as-built site plans.

The Internet of Things is a system of interrelated computing devices, mechanical and digital machines, objects, animals, or people provided with unique identifiers and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction. Internet devices can monitor and control the mechanical, electrical and electronic systems used in infrastructure and buildings in home automation and building automation systems.

Big Data Analytics is the process of collecting, organising and analysing large sets of data (called 'big data') obtained from text, audio, video, and images to discover patterns and other information. Analysts working with big data typically want the knowledge from analysing the data. Organisations in charge of assets analyse big data to find consumer patterns and trends, to make investment decisions.

Machine learning is an application of artificial intelligence that provides systems with the ability to learn from experience automatically, without being explicitly programmed. Machine learning focuses on developing computer programs that can access data and use it to learn for themselves. This iterative aspect is important; when models are exposed to new data, they can independently adapt, and produce reliable results.

Blockchain technology stores transactional records of the public, also known as the 'block', in several databases, known as the 'chain', in a network. This storage is referred to as a 'digital ledger'. Together with building information modelling, blockchain can create a single source of truth for all aspects of a construction project (see Figure 1). Such a model can become the trusted digital twin of an asset, supporting its design and construction and its operation and maintenance, through the life cycle.

Using innovative digital technologies

Low productivity on construction sites can lead to time overruns and excessive cost on a project.³ Karim et al.⁹ showed that the use of technology could improve both productivity and project performance. These results show that it is a priority to find effective innovative technology.

Traditional career structures are becoming less attractive and no longer the norm in the emerging digital environment.^{8,10} Furthermore, the labour-intensive nature of construction is increasingly lessened by digitisation; automation and robotics increasingly perform physical tasks previously identified as only within men's ability. The new digital environments remove the physical visibility of distinctions between women and men, which reduces the likelihood of gender discrimination.

The use of innovative technologies has also been shown to positively impact companies' performance.¹¹ Pelsler¹² found that innovation had a positive correlation with the company's performance, showing that when companies made positive use of the technologies, they could boost their competitiveness. Molenaar et al.¹³ indicated that innovative technologies provided more collaboration and cohesiveness across the project team, which positively benefited cost, schedule, and quality performance measurements.



Figure 1: Smart contracts using blockchain technology.

The digital network has supported women to connect and network more flexibly with colleagues and clients. Previously, networking in the construction industry has seemed to exclude women and impose a barrier to career progression. The construction industry's digital access will widen participation in professional learning, enabling more opportunities for women in digital learning and networking.

Overview of barriers to the adoption of digital technologies

Mtya¹⁴ found that digital technologies such as building information modelling are not widely adopted in the construction industry; although firms possess capabilities to use the technology, some barriers prevent them from using those capabilities and digitising. These barriers are outlined below:

Resistance by the consultant team

According to Oke et al.⁷, the lack of cooperation within the professional team creates the most significant barrier to innovation. The strict standards across industries, and the unwillingness of professional councils to change, are a barrier to industry change.¹⁵

Training and upskilling of employees

The lack of structured training is another critical barrier to adopting innovative technology on projects.¹⁶ Dupwa¹⁷ states that significant investment in industry professionals' education in the use of innovative technologies is imperative to their successful adoption. The construction industry is extremely competitive, and a shift towards the use of innovative technologies has meant that company executives continually need to improve their staff's proficiency to improve overall performance.¹⁸ A construction company's ability to adapt to new technology faster than its competitors is vital to a competitive advantage.¹⁹ To meet the growing industry requirements for further adoption of innovative technologies on projects, firms are required to be more proficient in their use.²⁰

Costs incurred when adopting innovative technology

The high cost of training employees⁷ combined with the high initial cost of implementing the technology²¹ discourages companies from adopting the technology²².

Current legislation

Mostafa et al.²³ identify the main barrier within developing countries as the current legislation – for example, legislation about drone technology. Many companies have not fully adopted innovative technologies on projects.^{23,24} Additionally, data security, protection, and control of information are all barriers to adoption.⁷

Clients' lack of knowledge

Clients and governments lack an understanding of the positive impact that new technology can have on performance. This is a significant barrier to the implementation of innovative technology on construction projects.^{24,25}

The way forward – bridging the digital and empowerment divides

Can construction's digital future be proactively reconstructed as an opportunity for change, promoting professional gender equity, rather than creating a barrier to it? In my appraisal of different types of innovative digital technology, the barriers to, and benefits of using it, several advantages of using innovative digital technology emerged, including high productivity, and project and company performance. These technologies have the added benefit of eliminating the necessity of women's physical visibility and allowing them to network easily. Digital technologies will empower women to overcome disadvantage and participate equally in the construction industry.⁸ Therefore, the industry can be transformed to become more productive and representative, by using innovative digital technologies.

However, there are barriers to using innovative technologies in construction, which must be addressed to enable this transformation: resistance by the consultant team, the training and skills required, costs involved when adopting innovative technologies on projects, current legislation, and clients' lack of knowledge.

To bridge the digital divide and transform the construction industry, it is recommended that the project consultant team should develop relationships promoting the use of innovative technology; also that clients should be more exposed to the benefits of digital technology, despite the cost. Legislation should be updated regularly and should not lag behind industry regulations.

To meet these goals, the government and the construction sector must provide targeted investment in education and training. This should support individuals, especially women and girls, considering or beginning digital construction careers. Barrett⁸ identifies a strategy of supporting businesses and organisations to remove the barriers that hinder women's career progression, by closing gender pay gaps and neutralising traditionally masculine cultures. The digital transformation should be paralleled by a cultural revolution, to fully embrace gender equity opportunities. Barrett⁸ posits that this cultural shift should allow women to manage their diverse and fluctuating out-of-office commitments. It should also define alternative career and reward structures to encourage professionals to deliver their best work.

The construction industry can be transformed; and the digital divide can be closed if the government makes targeted investments in training and upskilling, and regularly updates legislation in step with new construction knowledge.

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