

Health and Safety Management in the Digital Age: Exploring Baneful Elements of Digitalisation

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Abstract

While digital tools have been widely adopted in the construction industry to enhance quality and efficiency, adopting digitalisation for safety and health management has been relatively slow due to uncertainties regarding its potential impact. This paper examines the risks of implementing digital technologies in construction health and safety management. Despite the perceived benefits, digitalisation poses risks such as user error, increasing complexity, reduced interactive relations, information overload, and computer crashes. These risks can compromise the effectiveness and efficiency of construction health and safety management and put personnel working on sites in danger. The study suggests that understanding the different digitalisation risks is crucial for improving health and safety management in construction. Previous studies have focused on the benefits rather than the critical risks of employing digital technologies in construction, resulting in a knowledge gap. Therefore, the study provides empirical evidence on the risks associated with digitalisation to enable construction industry decision-makers to make informed decisions. The study recommends developing measures to reduce uncertainties related to employing digitalisation in construction health and safety. These measures will help overcome the risks associated with digitalisation. The strategies will further enhance construction health and safety practices and ensure that digitalisation yields positive outcomes. The findings of this study will assist construction industry decision-makers in making informed decisions regarding adopting digitalisation for health and safety management. This will help to reduce the uncertainties in return on investment and ensure that digitalisation enhances construction health and safety practices.

Keywords

Digitalisation, Health and Safety, Digitalisation Risks, Digital Tools, Construction Industry.

1. Introduction

Akinshipe, et al. (2022) noted that the world in the past couple of decades has been taken over by digitalisation, and digital technologies and the construction industry are not left out. The implementation of digital technologies has caught much attention in the construction industry to mitigate hazards and unforeseen circumstances to improve health and safety (Nnaji and Karakhan, 2020). Meno (2020) emphatically noted that there had been some progress in using digital tools in the construction industry, especially in developing countries. In the onset, digital technology was largely accepted for raising project quality and increasing overall construction efficiency, which reduced costs and increased profits. However, in recent years several construction safety publications showing a strong trend toward using digital technology to manage safety and health in the construction industry, according to Aghimien et al. (2021) and Nnaji and Karakhan (2020). Even though there is a strong trend toward using digital technologies to manage, there has been some reluctance to adopt new health and safety management methods. This reluctance is a big issue since the traditional methods do not seem effective enough, as evident by the numerous reported construction site accidents (Nnaji and Karakhan, 2020).

The implementation of digital technologies has been said to bring in a lot of benefits. However, Vass and Gustavsson (2017) noted that adopting new methods for site safety management, such as digitalisation, which poses

a threat to processes that have worked for years, is frequently regarded as risky within the industry. Previous studies focused more on the benefits rather than the critical risks of employing digital technologies. According to Aghimien et al. (2021), few studies have examined risks related to specific digital technologies. Furthermore, the reluctance to employ digital technologies is because most construction industry decision-makers are unsure of the expected consequences of digitalising health and safety in their companies (Lavikka, 2018). This is where the knowledge gap exists, and this study explored this gap. Understanding the different digitalisation risks and how they can compromise effective and efficient health and safety management in construction will help create room for improvement.

2. Digitalisation Risks in Construction Health and Safety

Previous research has given significant consideration to construction digitisation, and the studies examining the risks associated with digital technologies have yielded clear findings, as noted by Aghimien et al. (2019). These studies indicate that using digital technologies in construction has been associated with negative consequences. According to Nazareno and Schiff (2021), the impact of technology on the workplace is influenced by two interrelated aspects: the content and context of the job. The content of a job includes elements such as the characteristics of major work activities, necessary skills, and the level of autonomy and judgment expected of employees. The context of a job takes into account factors such as the working environment, the social structure of the workplace, the role of an employee within the company, and the type and level of supervision.

In a study on supply chain risks related to the 4IR, Zimmermann et al. (2019) identified several risk factors, including technology inflexibility, an aged production system, increasing complexity, lack of integration with existing IT systems, and insufficient knowledge and skills of key personnel. However, when considering the benefits and drawbacks of different technologies in the workplace, there is also a risk of loss of productivity. Gaille (2016) notes that an overreliance on computers may cause employees or supervisors to neglect their tasks, compromising health and safety in construction. The availability of the internet and access to computers may also lead to distractions such as browsing social media sites, reducing the time spent on actual work tasks and compromising health and safety. In addition, overreliance on computers can lead to work stoppages in the event of a power outage or a sudden system crash, which can jeopardise or compromise operations that depend on the information stored on those computers. Therefore, it is essential to have IT assistants on standby in case of a computer crash.

According to Nazareno and Schiff (2021), implementing new technology in the workplace can significantly impact employee well-being by altering their duties, procedures, and workplace structures. These transitions can lead to psychological stress, which may result in anxiety and mental exhaustion. Such conditions are of particular concern for safety professionals, as they can lead to accidents in industrial operations. Introducing digital tools for managing health and safety may overwhelm managers and workers, compromising their ability to perform their tasks effectively and efficiently. This can also affect productivity levels. Scholars have observed that workers often experience elevated levels of occupational stress and a sense of loss of control or autonomy during technological transition periods (Nazareno and Schiff, 2021). Research on socio-technical systems and the history of technology adoption in the workplace suggests that automation and AI may have complex and mixed effects on well-being, including worker stress, job satisfaction, and overall health.

According to Shahid and Woloszynski (2018), artificial intelligence systems like machine learning rely on appropriate sets of training data to learn and produce correct results. However, when using machine learning for compliance purposes, evaluating whether specific data subject to privacy protection can be used to train AI algorithms and whether AI can use the data to assess compliance is crucial. If the machine learning system learns from biased data, health and safety management may be at high risk of being compromised. Shahid and Woloszynski (2018) warn that adopting machine learning in compliance may take time due to its risks. Similarly, Joshi (2017) stresses the importance of avoiding biases in machine learning systems that may negatively influence decisions. Machine learning in construction can bring benefits, but its implementation could disrupt business operations, jeopardising the management of the health and safety of workers.

Meno (2020) researched technology advancements and found that it results in information overload. As technology becomes more advanced, it generates more information because these technologies collect and make data available faster than the human mind can process. This may disrupt the effectiveness and efficiency of managing health and safety, as keeping up with these digital tools can be challenging due to information overload. Aghimien et

al. (2021) also highlighted a danger that construction organisations face when adopting digital solutions: these solutions may not live up to expectations. For example, despite the adoption of BIM, there is still little direct connection between project consultants and subcontractors, leading to organisational silos and poor communication. This can compromise effective health and safety management if there are disruptions in communications between managers.

According to Jónsdóttir and Zahrandik (2017), the increased use of technology due to digitalisation hurts social interactions due to decreased physical contact. This is particularly relevant in the context of health and safety management in construction, where digital tools are used to monitor worksites and train workers, reducing physical interaction between them. As a result, health and safety managers may struggle to balance their roles effectively, compromising the overall effectiveness of health and safety management. Salento (2017) also highlights that digitalisation can affect workers, on-site supervisors and management staff, as it may encourage virtual interactions over physical ones.

According to Bruckmann et al. (2016), safety concerns are a top priority in the construction industry, and potential safety hazards cannot be ignored when humans and robots interact. They explained that digital technologies and automated equipment only run as programmed, so if a safety risk does not meet established standards, the robot will not detect it. This can compromise the health and safety of workers if they rely too heavily on these digital tools and let their guard down. In contrast, humans can naturally adapt to new situations based on their instincts, whereas digital tools are limited by their programming. Hamdi and Leite (2014) also pointed out that there is a lack of trained staff or managers who can effectively handle these digital tools, which can lead to human errors. It is clear that while using digital tools has its benefits, it can also compromise the effectiveness and efficiency of managing health and safety in construction.

Table 1. Risks of digitalising construction health and safety management.

S/N	Digitalisation Risks	Reference
1	Technology inflexibility	Zimmermann, Rosca, Antons, and Bendul (2019)
2	Loss of workforce productivity	Gaille (2016), Aghimien, Aigbavboa, Meno, and Ikuabe (2021)
3	Increasing complexity	Zimmermann, Rosca, Antons, and Bendul (2019)
4	Computer crash	Aghimien, Aigbavboa, and Oke, (2019), Gaille (2016)
5	Impact on well-being	Nazareno, and Schiff (2021)
6	Inconvenient data	Shahid, and Woloszynski (2018)
7	System biases	Joshi (2017)
8	Information overload	Meno (2020)
9	Reduced interactive relations	Zahrandik and Jónsdóttir (2017), Salento (2017)
10	Programming error	Bruckmann, et al. (2016)
11	User error	Hamdi and Leite (2014)

3. Research Methods

This research is descriptive by design as it examines various digitalisation risks and how they may compromise health and safety management in construction. The survey respondents were all working professionals in the construction industry in South Africa. The study relied on usable survey responses from industry experts retrieved for analysis. In order to quantify the significance of each rating, the five-point scale questionnaire was analysed and transformed into Mean Scores. The validity of the collected data was examined with the help of Cronbach's alpha. With a result of 0.899, it is concluded that the dataset collected was suitable for this study.

All respondents are working professionals from the building sector, with the majority being Quantity Surveyors, Construction managers and Project Managers. Participants also included other built environment professionals who have experience managing construction projects. All study participants possess at least a Bachelor's Degree, with some possessing advanced degrees. Only a small fraction of the group has more than ten years of experience in the

field, but the vast majority have between two and ten years. Furthermore, it is essential to note that the engagement sector is fairly evenly split between the public and private sectors and that many participants work in both. The relatively even distribution of respondents enhances the reliability of this study..

4. Results and Discussions

The results of the study present the risks associated with digitalisation that can compromise effective and efficient construction health and safety management. The results indicate that user error is perceived to be the highest risk associated with digitalisation, with an average rating of 4.05 out of 5. The risks perceived as the next most severe are increasing complexity, reduced interactive relations, and information overload, with average ratings of 3.95, 3.94, and 3.90, respectively. The risks perceived as the least severe are loss of workforce productivity and impact on well-being, with average ratings of 3.39 and 3.56, respectively. The standard deviation values suggest some variation in how respondents rated each risk, with computer crashes, programming errors, and system biases having relatively high standard deviations compared to the other risks. Overall, this result provides insights into the perceived risks of digitalisation for construction health and safety management, which can be useful for informing risk management strategies and decision-making in the context of digital transformation.

Table 2. Risks of digitalising construction health and safety management.

Digitalisation Risks	Mean Score	Std Deviation	Rank
User error	4.05	0.858	1
Increasing complexity	3.95	0.931	2
Reduced interactive relations	3.94	0.921	3
Information overload	3.90	0.824	4
Computer crash	3.85	0.956	5
Programming error	3.84	0.909	6
Inconvenient data	3.79	0.926	7
Technology inflexibility	3.73	0.944	8
System biases	3.71	0.876	9
Impact on well-being	3.56	1.050	10
Loss of workforce productivity	3.39	1.030	11

The study's findings support those of Hamdi and Leite (2014), who noted that there is a lack of trained personnel who can handle digital tools. This significantly reveals that human errors can come into play because the staff is not well-trained to manage these digital tools properly. Also, these findings relate to those of Zimmermann et al. (2019), who concluded that the risk factors associated with employing digital technologies include but are not limited to technology inflexibility and increasing complexity. Also, these findings align with those of Jónsdóttir and Zahrandik (2017) as they noted that employing digital tools reduces interactive relations. This is because digital tools encourage them to interact virtually more often, for instance, in the cases of communication and training. The findings on 'information overload' support those of Meno (2020), who noted that technological advancement promotes information overload. Furthermore, these findings support those of Aghimien et al. (2019), who concluded that computers could crash, and a sudden computer crash may jeopardise or compromise many operations that depend on all the information stored on that computer. Also, overreliance on computers can lead to work stoppages in the event of a power outage or computer crash.

Digitalisation is a process of change that aims to improve how things are done. However, changes in operations may not always bring only positive outcomes but can also have negative consequences. There is no doubt that digitalising construction health and safety practices is advantageous. However, according to this study, digitalisation carries risks that may undermine the effectiveness and efficiency of managing construction health and safety. The study identified several risks associated with digitalising health and safety practices. Respondents rated user error, increasing complexity, reduced interactive relations, information overload, and computer crash as the most significant

risks. These findings indicate that digitalisation can have a negative impact on managing construction health and safety. For example, if users are not adequately trained to use digital tools, mistakes can be made, compromising health and safety. The study also suggests that digitalisation may complicate things and compromise the efficiency and effectiveness of managing health and safety. Additionally, digital tools are prone to crashing, which can disrupt operations.

5. Conclusion

This study assessed how digitalisation risks could compromise the effectiveness and efficiency of managing construction health and safety. The literature review revealed that while employing digital tools has its benefits, there are also risks involved that may compromise the effectiveness and efficiency of managing construction health and safety. Empirical results revealed that the following risks are most likely to compromise the effectiveness and efficiency of construction health and safety management: user error, increasing complexity, reduced interactive relations, information overload, and computer crash. Digitalising construction health and safety practices is intended to improve practices and operations; however, it also poses risks that can undermine the effectiveness and efficiency of construction health and safety. In addition, digital tools are more likely to complicate things and make managing health and safety more complex, putting personnel working on sites in danger and compromising the successful completion of the project. This clearly indicates that the impacts of digitalising construction health and safety practices can yield positive or negative outcomes. The study recommends developing measures to overcome uncertainties related to employing digitalisation in construction health and safety to reduce uncertainties in return on investment. The study also suggests developing strategies to address digitalisation. These strategies will ensure that digitalisation effectively improves construction health and safety practices.

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