

Implementation of Fourth Industrial Revolution Technologies

Subjects: Construction & Building Technology

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The fourth industrial revolution (4iR) technologies offer an opportunity for the construction industry to improve health and safety (H&S) compliance. Therefore, implementing the technologies is of top priority to improve the endless H&S incidents in construction projects, which lead to poor quality of work, late project delivery, and increased worker injury claims. Central to improving the nature of work and other industrial processes, the 4iR technologies have emerged. Concurrent with this trend is the importance of 4iR technologies in enhancing health and safety performance on construction sites.

Keywords: innovation ; 4iR ; fourth industrial revolution ; health and safety ; challenges ; opportunities ; technologies ; strategies ; awareness

1. Introduction

Health and safety (H&S) refer to the wellbeing and safety of humans from hazards. It includes programs, guidelines, and procedures that protect the safety, welfare, and health of any person engaged in work or employment, aiming to provide the ultimate safe working environment and reduce the risk of accidents and fatalities at work ^[1]. Furthermore, it aims at protecting the health of customers and the public, including anyone who might be affected by the worksite environment. This is the rule of the latest Acts, Amendment Act, No. 181 of the 1993 Labour Relations Act and Construction Regulations, 2003 [4]. This latest Act aims at ensuring the H&S of persons at work and persons who interact with construction plant and machinery at work. In addition, the Act is meant to protect persons from H&S risks arising from or in connection with the activities of persons at work and to set up an advisory council on occupational H&S ^[2].

Ensuring the safety of employees and the general public is a huge challenge for the construction industry. The construction industry constantly fails to implement H&S measures in the workplace ^[1] and continues to battle with poor H&S implementation. The problem of poor H&S is global, and South Africa is also affected ^[3]. It is therefore crucial that H&S in the construction industry should receive more attention than ever before. Choi, Ahn and Seo ^[4] proposed the use of fourth industrial revolution technologies (4iR) in the industry to manage the H&S. According to Choi, Ahn and Seo ^[4] that the 4iR technologies at the initial stage of projects are capable of being used to plan for safety management and to detect possible risks and hazards, which may occur during the construction stage. The authors ^[4] further indicated that these technologies have the capability of automating H&S management through real-time site monitoring of humans and vehicles movement while detecting hazardous zones on site which might result from ongoing activities and provide signals to humans when they are entering hazardous zones. This automated workplace monitoring uses a combination of 4iR technologies to enhance safety in work zones and of humans at the workplace ^[5].

Various studies have presented the benefits of using 4iR technologies in the construction industry. For instance, Nnaji and Karakhan ^[6] and Shamsudin, Mahmood, Rahim, Mohamad and Masrom ^[7] used the Virtual Reality (VR) tool to train staff at the worksites on H&S to avoid hazards. Likewise, Raphaelson ^[8] used drones in various construction projects to perform multiple tasks such as inspecting works, monitoring the safety of humans and movements of vehicles while detecting hazards. On the other hand, Ramage ^[9] presented real-time safety detection, alarms on possible dangers to humans and vehicles and report to centralized management systems through smart sensor technologies and management tools. Despite these benefits, the implementation of 4iR is faced with challenges. Thus, the study establish many issues faced by the construction industry in implementing 4iR technologies.

2. The 4iR in Construction

The 4iR is South Africa's hope in boosting the current declining economy ^[10]. More investment in the automation of construction industry is the one most important factor to boost the economy. Through the reviewed literature, it was observed that there are benefits that this revolution brings to the construction industry. According to Choi, Ahn and Seo ^[4], the technologies will benefit the industry by resulting in the best form of accident prevention by protecting workers in hazardous areas through the provision of real-time data collection for safety reporting and incidents prevention. Furthermore, the technologies help provide greater visibility, better reporting, accountability, better communication, and improved workflows. These technologies will improve productivity, save on project time and cost, reduce workplace hazards, and push construction into the future by enhancing safety zones and mobility ^[5]. In addition, the authors

emphasized that the technologies could shape and improve H&S in the construction industry. Other benefits of 4iR include fast transaction, reduced cost and easy usage ^[11].

Nevertheless, the construction companies are afraid of the political landscape, concerned about potential job losses and their impact on labour forces and infrastructure challenges and that smart technologies cannot be adopted in an unstable environment. According to Olojede, Agbola and Samuel ^[12], South African construction companies have long-standing resistance to change and rather focus on traditional methods, poor productivity, and tight competition in the industry. Therefore, they are afraid that digitisation might affect sustainability of the industry. Therefore, the Government should play a major role in promoting technologies through policies, standards, and procurements to make it easy for small and medium enterprises to adopt the technologies ^[13].

3. Current Opportunities to Manage H&S Using 4iR Technologies

The management of H&S entails proper training, communication, monitoring and controlling. These are made easy by 4iR technologies, which encourage safety training using virtual reality, augmented reality, inspection through automation, simulation training, and collaborative (human-robot) teams ^[6]. Furthermore, technologies such as BIM can enhance controlling and monitoring the overall project from the design phase to the closeout phase ^[14].

Choi, Ahn and Seo ^[4] corroborated that the technologies benefit from fending off accidents, generating greater visibility, easing reporting procedures and accountability, providing healthier communication, and ameliorating workflow. On the other hand, Zhang, Cao, and Zhao ^[15] asserted that technologies such as GPS and RFID help monitor workplace operations, transfer communication, detect harmful areas, and report on possible incoming dangers. Nnaji, Gambatese, Lee and Zhang ^[5] found that the use of tools such as speed reduction systems (SRS) decreases and monitor the speed of vehicles, intrusion prevention and warning system (IPWS) warns workers and vehicles drivers when entering an intrusion zone and human-machine interaction detection system (HMIDS) warns the worker and driver of equipment collision.

4. Challenges of 4iR Technologies Implementation

4.1. Construction Firms' Level of Interest and Views

Implementing 4iR technologies in the construction industry is perceived to be too expensive to adopt and maintain rather than innovate ^[16]. On the other hand, Japheth and Kiprotich ^[17] disclosed that the professionals in the industry show no interest in implementing the technologies and resist change to their traditional ways. This low interest in embracing 4iR results from a lack of specialized professionals, technical skills and the client not insisting and strategizing on implementing the technologies. Likewise, Bayode, van der Poll and Ramphal ^[18] pointed out that the construction industry is faced with insufficient electricity, unavailability of financial resources, poor accessibility to wireless broadband and lack of skills as notable barriers. Moreover, construction firms choose to stick to the proven methods of performing works and perceive adopting new technologies as risky ^[19].

4.2. The Size of Projects and Availability of Resources

Most companies are not implementing the 4iR technologies because the projects they are involved in are small-to-medium in size. These companies are undecided about adopting the technological assets due to the cost affordability of implementing and maintenance ^[20]. On the other hand, Alade and Windapo ^[21] opined that the industry lacks dynamic capabilities for adopting technologies. Studies show that lack of education and unalignment of labour supply and demand are the challenges in the industry. The narrative that digitization will cause job losses is a significant worry of many companies, while another impediment is the lack of digital skills ^[22]. Gaspar, Julião and Cruz ^[23] asserted that the fear of job losses is a challenge to adopting 4iR. Furthermore, Kariem ^[24] opined that lack of technical capacity with the absence of policy and regulation on 4iR implementation is another barrier to adopting the technologies.

4.3. Unavailability of Funds

The South African Cooperative Governance and Traditional Affairs is keen to support the civil construction industry to move to digital operations; however, it is faced with challenges in moving to e-governance ^[25]. The challenges include developing policies for affordable access to developing mobile broadband infrastructure and adequate skills to develop e-government services. Furthermore, Alade and Windapo ^[21] disclosed that the most significant challenge to implementing the technologies include the high cost of obtaining innovation and the high cost of training.

5. Implementation Strategies

The implementation of 4iR technologies is a critical factor in managing H&S in the construction industry. However, the implementation in South Africa is challenged with issues discussed in the above section. It is of great importance to mitigate these challenges. Osunsanmi, Aigbavboa and Oke ^[26] indicated a low level of awareness of these technologies and a low level of understanding of how the technologies operate to manage works in the industry. This level of

awareness results from the lack of understanding of the benefits in the construction industry. This suggests that the adoption of 4iR can be improved through training, workshops, and seminars.

On the other hand, Aghimien, Aigbavboa, Aghimien, Thwala and Ndlovu ^[27] concludes that the industry has a low awareness rate of the benefits of 3D printing. Therefore, higher education institutions should improve the training on these technologies in their syllabuses ^[28]. In addition, case studies should be conducted, a module in 4iR should be incorporated in the construction department and professionals should be educated on the technologies ^[29]. Ignoring these strategies of overcoming the implementation challenges of these technologies will result in the industry lacking the required skills ^[24] and thus will face difficulties in the future.

6. Conclusions

Implementing 4iR technologies will help reduce fatalities, injuries, and accidents, finally improving performance. Moreover, it will produce construction work that has fewer hazards. Nevertheless, the implementation of 4iR technologies is faced with severe challenges. This study established the many issues faced by the construction industry in adopting 4iR technologies. Although the study presents findings from South Africa, the issue of 4iR adoption is faced by many developing countries. Hence, the study provides information to an international audience of Built Environment practitioners and scholars to compare the applicability of similar phenomenon and/or methodologies in their countries. The issues go beyond just low level of awareness as identified by several scholars. For example, construction companies do not implement these technologies because of the nature of contracts. Most companies rely on the national government for support and the size of their firms is also a factor. The companies rely on government contracts that have a standard approach for carrying out contracts. Therefore, there is a great need for the national governments to revisit their procedures, policies, and regulations to enable technologies to be implemented. Moreover, most companies lack the financial capability and are not sure if they can maintain the 4iR process; therefore, proper planning to accumulate financial resources should be established. The government and the construction firm should develop strategies to adopt and maintain these technologies in the industry to overcome the challenges faced by the industry to implement the technologies.

The issue of 4iR adoption is faced by many developing countries. Publishing this entry will ensure that the research is easily visible for broader audience, helping other scholars to compare the applicability of similar phenomenon and/or methodologies in other countries. Moreover, the subject of 4iR in health and safety management is still not fully comprehended on a global scale. Therefore, lessons even from local settings are useful at a global level.

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