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An Evaluation on the Implement of Artificial Intelligence Technology on South African Construction Projects

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Abstract
Artificial Intelligence(AI) technology has the power to unlock the industry's greatest challenges faced such as poor efficiency issues, design errors, low productivity, and accidents on site. Therefore, the study is a literature review on the assessment of the implementation of AI technology on construction projects in South Africa. The study was carried out with reference to existing theoretical literature, published research, and internet sources. The study has adopted a quantitative research approach. The study has revealed the positive impact of implementing AI technology on construction projects and how it can transform the construction sector. This includes timeous delivery of the construction project(s), enhanced profitability, increased productivity, enhanced efficiency, and reduction of construction accidents. However, the adoption of AI technology in South Africa is still at an early development stage. The study would contribute to the existing body of knowledge of AI technology, particularly to developing countries where literature is lacking. Again, it will assist and enlighten the construction inclusive of consultant company owners to advance their firms and construction projects.

Keywords
Automation, Artificial Intelligence Technology, Fourth Industrial Revolution, Construction Sector, Robotics.

1. Introduction

Over the past years, the construction sector was considered to be a less digitalized sector with poor productivity issues when compared to others (Barbosa *et al.,* 2017). Currently, most construction firms are forced to shift from the old traditional ways of carrying out tasks on-site to a more advance digital shift. This transition is moving at an exponential rate where the construction sector is struggling to keep up (Harty *et al.,* 2015). However, the usage of digital technologies such as Artificial Intelligence(AI) on construction projects means they would be an increase in efficiency (Gotthardt *et al.,* 2019). Again, construction projects would be successfully delivered timeously. Past studies have indicated that developing African countries especially South Africa are still lacking behind with the usage of AI technology. Therefore, the purpose of this study is to investigate the implementation of Artificial Intelligence on construction projects in South Africa as a technological tool for Increasing productivity.

To achieve this purpose, the study aims to assess how the adoption of AI technology can transform construction projects. This study will enlighten the construction firms about the importance of adopting AI on construction projects. Again, will provide light to the author's main dissertation research. The paper is structured as follows; section Two will present a literature review, section Three will present the research methodology, whilst section Four presents research findings and discussions. Lastly, section Five will state the conclusion and recommendation(s) of areas for further future studies.

2. Theoretical Overview of Artificial Intelligence

2.1 Artificial Intelligence and its Role in the Construction Sector

Artificial Intelligence(AI) can be defined as "an interdisciplinary branch of computer science which deals with the development of machines, software and algorithms that mimic the cognitive functions of humans to solve complex information processing problems" (Salehi & Burgueno, 2018). Past studies have been conducted on Artificial Intelligence technology regarding the benefits and challenges on both construction projects and organizations on how they can be improved or affected through the usage. Researchers such as (Salehi & Burgueno, 2018; Jesuthasan, 2018; Blanco *et al.,* 2018; Gotthardt *et al.,* 2019; Jariwala, 2015; Bolton *et al.,* 2018; Nickerson, 2019) have all done studies on AI technology. Again, Thirgood & Johal (2017); Boyd & Holton (2017) researched the impact of adopting AI on

the construction sector where it will affect human laborers negatively. Since it is claimed that AI machines will cause human beings to lose their employment. Previous studies have again indicated that if AI is properly exposed and exploited would see timeous delivery of the construction projects.

On the other hand, AI technology can be used in most of the sectors such as on Controlling difficult systems (Kiela *et al.,* 2016), transportation (Tango & Bott, 2013), fixing hardware and software issues (Gordon *et al.,* 1993), for controlling safety concerns on construction projects (Ticket *et al.,* 2016). Advantages of using AI technology on construction projects include; managing the building effectively (Klashanov, 2016), prevention of injuries that occurs on construction site (Sarka *et al.,* 2019), enhancement of efficiency on a construction project(s), and can make an effective decision (Klashanov, 2016), can monitor the health conditions of a human beings (Zitnik *et al.,* 2019), can improve productivity growth on construction projects (Jesuthasan, 2018), improves profitability, eliminates design errors made by a human, and reduces construction waste. AI technology can reach a lucid conclusion with the capabilities of surpassing human intelligence. Because the tasks which were normally requiring human intelligence will now be completed by intelligent machines. However, the usage of AI technology on South African construction projects is not fully exposed and exploited. Hasegawa (2006) claims that it is still at an early development stage. According to Blanco *et al.* (2018), further said the implementation of Artificial Intelligence in the construction sector would eliminate the industry's greatest problems faced such as safety issues, time, and cost overruns. Below is a summary of how AI can be adopted on construction projects.

Some of the benefits of implementing Artificial Intelligence(AI) technology on construction projects include the following;

2.1.1 Reduction of Construction Risks

Normally, when the construction site is busy with certain activities the chances of risks occurring would likely be higher. In contrast, the implementation of technological software such as AI systems is capable of monitoring construction site risks so that they can be prevented from occurring again. This is because the implemented intelligent machines on-site can perform the tasks used to be done by human beings (Boyd and Holton, 2017).

2.1.2 Improvement of Quality on Work Done

The AI technology can also be used after the completion of constructing a building structure or anything for identification and checking of errors. According to Roubini (2014), postulated that intelligent machines are capable of detecting any problems on the completed structure that can lead to a collapse of the building. The majority of the project team are still using Building Information Modelling (BIM) which is capable of storing important information of the constructed structure and does not provide solutions to the discovered problem during the construction stage (Frey and Osborne, 2013).

2.1.3 Enhanced Health and Safety of the Construction Projects

Some of the projects have been closed due to accidents and incidents constantly occurring as a result of the mismanagement of the funds, improper construction methods adopted by contractors (Lamb, 2016). However, the adoption of AI technology on projects is capable of assessing safety hazards, especially for the workers who enter the construction site(s) without pre-requirements of the protective clothing and equipment (Lawson, 2016). Most importantly, AI offers prevention of accidents through the analysis of Artificial intelligent machines. Safety officers can use those intelligent systems to monitor construction site safety as this will ensure a good health and safety standard on the construction projects.

2.1.4 Time and Cost-Saving

The adoption of Artificial Intelligence (AI) technology on construction projects would save time such as on reducing plaster wastages and eliminating design errors. However, if less time was taken to construct the designed structure more costs would be saved. The adoption of intelligent machines would save the contractors funds which would result in more profit made from the contract awarded (Adriaanse and Voordijk, 2005).

2.2 Artificial Intelligence and Human Collaboration

The introduction of digital transformation in the construction sector forces humans and technology to be used simultaneously. According to Carpenter *et al.* (2018), opines that human and AI technology are two things that are different in terms of capabilities. Abbass (2019), further said that the usage of AI on construction projects is more effective than a human being. Moreover, AI can analyze more data accurately within seconds,

whilst human intelligence cannot match with the intelligence of smart technology (Carpenter *et al.,* 2018). Human beings are capable of making good decisions during project life-span with limited intelligence (Abbass, 2019), AI can reach a lucid conclusion which leads to increased productivity and efficiency. Construction projects were or are still delivered longer than expected as a result of the limited decision-making of human beings. On the other hand, AI technology has been playing an active role in other parts of the world such as countries like Japan, China, and Malaysia. However, in developing countries majority of the human being is still ambiguous about the positive impact AI has on construction projects. Hence, the implementation of AI technology in developing countries particularly in African nations is relatively low (Chui *et al.,* 2018). Abbass (2019), further said that teaching human being about how AI technology works can bring trust to AI technology. Fox *et al.* (2017), noted the human capacity and understanding of analyzing data would be improved. For the successful implementation of government institutions together with the professional regulatory bodies must work together in encouraging the organizations to start adopting the AI technology on construction projects to advance the sector and their firms to be more competitive with the other industries who are already using this Fourth Industrial Revolution feature on their daily activities.

3. Research Methodology

The study has adopted a quantitative research approach. Studies of Cresswell (2014); Fellows & Liu (2015) further justified that the usage of quantitative research approach is suitable where the research study topic is still new in the field of study. The study will collect data from the targeted participants through a structured interview to gain an understanding and knowledge of adopting AI technology on construction projects. The targeted participants for the study include; Architects, Construction Project managers, Quantity Surveyors, and Engineers who are registered with the various professional statutory regulatory bodies such as ECSA, SACPCMP, SACAP, and SACQSP. The participants for the study will be contacted and selected from the database list provided by the professional statutory regulatory bodies. Due to Covid-19 pandemic restrictions, online questionnaire surveys were disseminated to the above-mentioned targeted participants to ease the coronavirus infection on construction projects.

The study has adopted a non-probability purposive sampling technique to select the participants. On the other hand, Cresswell & Plano Clark (2011), further added that purposive sampling is used to select individuals or groups of people who have sound knowledge and extensive experience. 260 online questionnaire surveys were distributed and 223 were returned back with an 86% response rate. A 5-point Likert scale was used to determine the benefits of implementing Artificial Intelligence on construction projects. The scale adopted was as follows; 1= Strongly Disagree, 2= Disagree, 3= Neutral, 4= Agree, 5= Strongly Agree. A 5-point Likert scale was further transformed to Mean Item Score(MIS) and Standard Deviation(SD). In addition, wereranked from highest to lowest based on the highest MIS values. The Cronbach alpha value for the benefits of implementing AI was 0.702 which is assumed to be acceptable.

4. Research Findings and Discussions

4.1 Respondent's rating on the Usefulness of Artificial Intelligence on stages of Project Life Cycles

Figure 1 below represents the use of Artificial Intelligence (AI) technology on stages of the project life cycle. The findings reveal that 21% of the respondents think the usage of AI would be useful, 72% of the respondents think AI

technology would be most useful on stage three, 44% of the respondents think AI technology would be most useful on stage four. Whilst, 90% think would be useful on stage five, whereas 84% think would be useful on stage six.

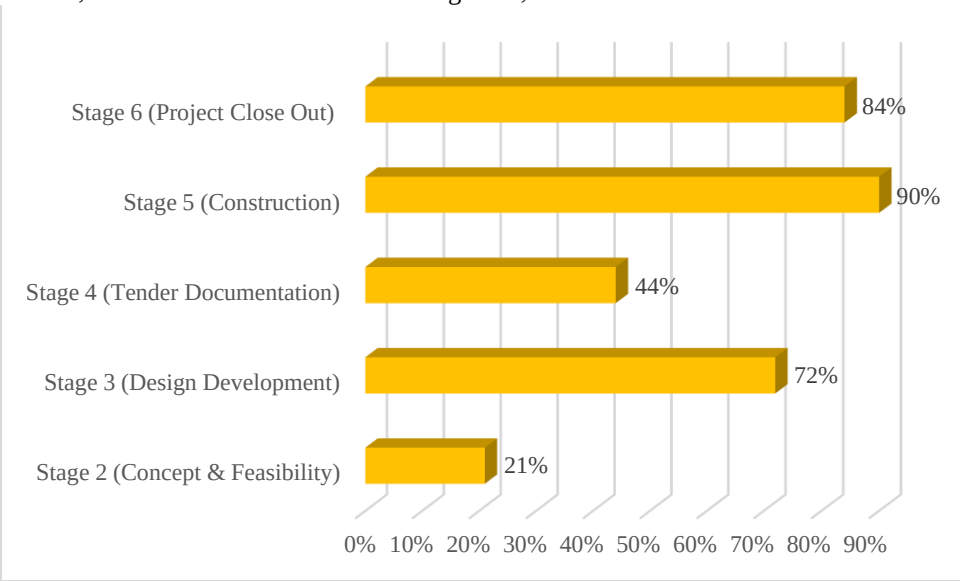

Figure 1. Respondent's rating on the usefulness of Artificial Intelligence technology

4.2 Respondents on Benefits of Implementing Artificial Intelligence

Table 1 below represents respondent response on the benefits of implementing Artificial Intelligence (AI) on construction projects. The top Five results for the benefits of implementing of AI are: 'improves quality of work post-construction' with (MIS= 4.19, SD= 0.510, R= 1), 'reduces budget overruns' with (MIS= 4.08, SD= 0.545, R=2), 'saves time' with (MIS= 4.01, 0.724, R=3), 'overcome shortage of experienced labors' with (MIS= 3.95, SD= 0.701, R=4), 'improves performance on construction work' with (MIS=3.93, SD= 0.666, R= 5), 'improves the health and safety of the construction projects' with (MIS= 3.950, SD= 0.697, R=5).

Table 1. Benefits of implementing Artificial Intelligence on construction projects

Factors	MIS	SD	Rank
Improves quality of work post-construction	4.17	0.510	1
Reduces budget overruns	4.08	0.545	2
Saves time	4.01	0.724	3
Overcomes shortages of experienced labors	3.95	0.701	4
Improves performance on construction work	3.93	0.666	5
Improves the health and safety of the construction projects	3.93	0.699	5
Elicits faster information exchange	3.91	0.697	6
Improves productivity	3.84	0.377	7
Reduces construction risks such as accidents on-site	3.83	0.643	8
Reduces construction errors	3.81	0.655	9
Improves customer relations	3.78	0.615	10
Improves profitability	3.76	0.477	11
Saves cost	3.75	0.456	12
Improves communication amongst the project team	3.73	0.531	13
Improves tracking and security	3.71	0.571	14
Facilitates improved decision making	3.58	0.556	15

The top five least results which were ranked by respondents are: 'improves profitability' with (MIS= 3.67, SD= 0.477, R=11), 'saves cost' with (MIS=3.75, SD= 0.456, R=12), 'improves communication amongst the project team' with (MIS= 3.73, SD= 0.531, R=13), 'improves tracking and security' with (MIS= 3.71, SD= 0.571, R=14), 'facilitates improved decision making' with (MIS= 3.58, SD= 0.556, R=15). The findings of the study are in agreement with Thirgood and Johal (2017) and Decker *et al.* (2017) that the benefits of implementing Artificial Intelligence (AI) on construction projects add a significant value such as reduction of budget overruns, reduced construction errors, and improvement of productivity. However, Qureshi and Syed (2014), agreed that productivity and performance on construction will be improved through the usage of AI technology. Further benefits include cost and time saving (Adriaanse and Voordijk, 2005). The issue of health and safety on construction projects has been part of the reasons why the projects were delivered late. Lawson (2016), argued that the usage of AI technology would massively improve construction projects.

5. Conclusion and Recommendations

The study has successfully revealed the benefits of implementing Artificial Intelligence(AI) technology on construction projects. Moreover, the study has further pointed out that the adoption of AI technology on construction projects has the capability of making adequate effective decisions than human labor. Also, the benefits of implementing AI technology were highlighted. Further research has to be conducted to encourage South African construction firms on the importance of using AI technology to advance their works on a construction project(s). Again, further research has to be conducted on where specifically during project phases should AI technology be mostly used for improving productivity and efficiency. The study recommends that the South African government institutions must invest more in infrastructural development and also, to financially support the construction firm owners to start using AI technology on construction projects.

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