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Assessment of the Level of Awareness of Robotics and Construction Automation in South African

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Abstract. South African economy is dependent on infrastructural development, which plays a major role in the country's economy. The Construction Industry has shown a slow increase in the adaptation of robotics and construction automation hence it is facing construction accidents, poor quality of work, and sometime projects results in cost overrun of which accident occur as the results of low level of supervision on site. The study focused on assessing the level of awareness of robotics and construction automation in South Africa. The research was carried out using information from the literature review and findings obtained from the questionnaire to achieve the objective of the study. A sample of respondents were chosen to represent the entire population of the construction professional, questionnaires were distributed to relevant respondents including Architects, Quantity Surveyors, Project Managers, Construction Managers and Contractors as well as Civil Engineers and the analysis was based on the returned questionnaires. Data obtained were analysed and the study revealed that construction professionals are fully aware of robotics and construction automation in the South African construction industry. The study concluded by indicating that construction automation and robotics would have positive effects on the delivery of the construction project by increasing quality of the construction product, enhancing supervision, working conditions, cost effectiveness and it reduces construction accidents.

Keywords: Automation and Robotics, Building Information Modelling, Computer Aided Design, Computer Aided Manufacturing, Industrialised Building System.

1 Introduction

Construction Industry plays a major role to the national and world's economy. The construction industry is faced with challenges of poor quality of the construction products and an increase in the risks associated with the occupational health and safety. Balaguer and Abderrahim [1] mentioned construction automation as a solution to the problems faced in the construction industry and further discussed that construction industries should implement fully and adopt the use of construction robotics since the construction professionals are interested in completing projects within short period of

time to carry on with other investments. Robots are given certain characteristic to perform construction duties and automated by means of integrating robots with computer software. This advanced technology in construction are used to maintain and monitor quality of the products to ensure that minimum standards can be achieved in order to encourage long life span of the construction product, which will reduce maintenance [2].

Robotics and construction automation are deployed in the construction industry to mitigate human related errors, with advanced computer software easier to detect defaults that cannot easily be detected by human and can be done repetitively [3]. Automation can be integrated with lasers to improve inspection of the complete product with thin short period since robotics are more productive than using manual labour and feedback of the inspection can be stored in the data base for future use. Since automation minimises the demand of skilled labour and substitute workers at workplace, it will decrease construction the amount of construction accidents and insurance may be reduced to low level of risks associated with occupational health and safety. Robots and construction automation help with the development of new products such as construction equipment and tools used in the construction industry [2, 3].

Construction automation and robotics are modern type of technology used in the construction industry, this technology involves using combination of electronics, mechanical and computer software to operate robots by using special codes to perform required functions [2]. The use of construction technology is to improve working conditions, improve health and safety, scheduling and improving quality of the construction products. There is a lack of automation in the construction industry due to cost for purchase of these equipment hence there is a slow adaptation of this machinery in construction [4]. Construction automation is an integration of information technology with robots, to assist in the designing of construction, planning and estimating cost of the project [5].

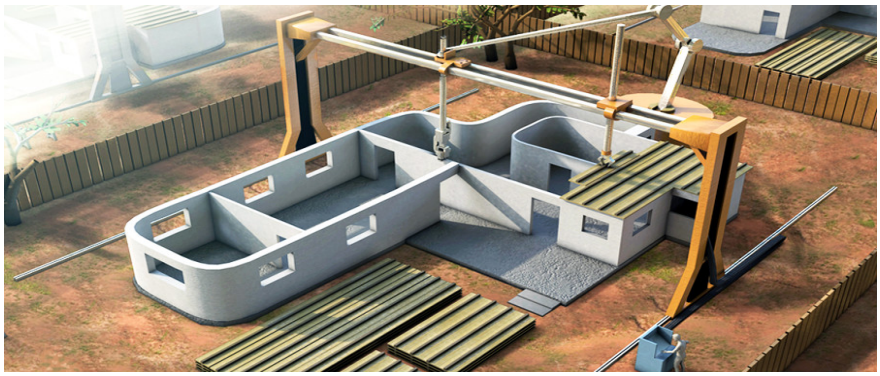

Fig. 1. 3D representation of the use of robotic for the construction of bungalow (Source: Google 2018)

As shown in fig. 1., the use of robotics for the construction of buildings is possible such that it reduces the workload on human power which will eventually result to

reduction in the accidents on site and enhance the maintenance of standards in the quality of workmanship and it also doesn't eliminate the labour workforce as operators will still be required as well as setup labour. Computer technology assist the manufacturing industry to produce construction products at constant speed, which makes this technology more advanced because machines are accurate and assist in planning to avoid wastage of materials [3]. Automated machines can estimate accurate amount of material that is required to finish the product hence can improve working environment by ensuring less wastage in the working environment that has an impact on the health and safety of the workers [1]. This research seeks to the level of awareness of Robotics and Construction Automation in the South African Construction industry to determine areas in which the technology needs to be improved on for the development of the construction industry.

2 Methodology

Leedy and Ormrod [12] defined methodology as the approach that the researcher takes in carrying out a research project. This research survey was conducted by using questionnaire to collect data from the respondent. Questionnaire was distributed to the construction professionals from different department in the Gauteng province specifically Johannesburg. Construction professionals that were involved in the collection of data were Architects, Quantity Surveyors, Project Managers, Construction Managers and Contractors as well as Civil Engineers because of their experience in the construction. The research questionnaire used Likert scale for the respondents to rank the question that are required to answer the research questions and objective in this study. The respondents were required to rank each factor using the 5- point scale (1- very low, 2- low, 3- Average, 4-high, 5-very high). Factors for each question were extracted from the literature review which were obtained from the primary source of information including journal, internet source, text books and articles. Data for this research were analysed using the descriptive statistics to help describe, summarize data and organize data in a sequence. This information was computed by using special statistic software called SPSS.

3 Results

3.1 Respondent's Demographic Information

The research result shows 64% of the respondents are males and 36% females. Findings indicated that 14% are Architect, 30% are Quantity Surveyor, 20% are Construction Engineers, 20% are Project Managers and 16% are Construction Managers. Years of experience of the respondents showed 43% have between 1-5 years, 32% are between 6-10 years, 20% are between 11-15 years, 5% are between 16-20 years and 0% have 20 years and above of working experience. The study also discovered that 0% of the respondents are with no qualification, 5% have secondary qualification, 34% have

Diploma, 18% have Degree, 32% have Honours and 11% have Masters degree. With this demographic information of the respondents, it can be concluded that the respondents possess enough experience in the construction industry and their opinion on the level of awareness of robotics and construction automation in the South African construction industry can be relied upon.

3.2 Level of Awareness of Robotics and Construction Automation

Findings for level of awareness of robotics and construction automation forms in South African construction industry as shown in table 1 indicated that Building Information Modelling (BIM) was rank first with a mean score item of 4.02 and standard deviation (SD) = 1.089, closely is Computer Aided Design (CAD) which was ranked second with a mean item score of 3.86 and standard deviation (SD) = 1.231, Computer Aided Manufacturing (CAM) was ranked third with mean score item of 3.77 and standard deviation (SD) = 1.118, while Non tactile sensor was rank lowest with a mean score item of 3.09 and standard deviation (SD) = 1.395.

Table 1. Level of Awareness of Robotics and Construction Automation

Forms of Robotics and Construction Automation	Mean Item Score	Standard Deviation	Rank
Building information modelling (BIM)	4.02	1.089	1
Computer Aided Design (CAD)	3.86	1.231	2
Computer Aided Manufacturing (CAM)	3.77	1.118	3
Construction equipment reversing camera	3.75	1.241	4
Vehicle Warning Alarm	3.61	1.125	5
Automated welding machine	3.59	1.335	6
Vision sensors	3.52	1.229	7
Site Monitoring Camera vision	3.48	1.248	8
Global Positioning system (GPS)	3.45	1.486	9
Equipment blind sport sensor	3.43	1.319	10
Automated cutting grinder	3.43	1.453	11
Inspection laser sensor	3.39	1.333	12
Proximity sensors	3.34	1.493	13
Concrete steam curing system	3.30	1.456	14
Automatized Braking Assistance	3.27	1.246	15
Concrete electric and infrared curing system	3.11	1.401	16
Non tactile sensor	3.09	1.395	17

4 Discussion

The findings from the respondents shows a high level of awareness on construction automation and robotics with an average Mean Item Score of 3.50 coming to 70%. Building Information Modelling gained most awareness among construction

professionals in Gauteng province, South Africa. This agrees with the findings of [7] that although BIM is a new technology, it has gained high percentage of awareness due to the fact that it is generic among all the construction industry professionals in United Kingdom, Canada and Finland Construction Industries. This also agrees with [8] indicating high level of awareness in BIM in the Middle east. CAD and CAM ranked second and third respectively which agrees with [9] who are with the opinion that most construction professionals are aware of these two forms of construction automation and that only about half of the respondents were taught about them from their educational institution while other half has seen CAD and CAM machines/software. From this research, it is evident that the South African Construction industry professionals are aware of robotics and construction automation forms which is an indication that the industry is ready for the adoption of these technologies in order to advance project delivery to time, cost, quality while considering the safety of workers on construction site.

5 Conclusions and Recommendations

The study showed high level of awareness of robotics and construction automation in South Africa. The study concluded by indicating that construction automation and robotics would have positive effects on the delivery of the construction project by increasing quality of the construction product, enhancing supervision, improving working conditions, cost effectiveness and it reduces construction accidents. This will therefore reduce human error which the construction professionals are prone to making in carrying out their professional services to an extent. It is therefore recommended that the government should provide subsides on automation and robotics so that South African construction industry can have full adaptation of such technology and the government should also organise training for construction workers to increase their level of awareness of robotics and construction automation. However, the major limitation of this study is that it was carried out in Gauteng province of South Africa only, therefore it can be carried out in other areas of the country to have a general overview of Construction professional awareness of Robotics and Construction Automation. Further studies can also be carried out in assessing the willingness to adopt the use of Robotics and Construction Automation in the South African Construction Industry.

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