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Abating the Barriers to the Deployment of Radio Frequency Identification for Construction Project Delivery in South Africa

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***Abstract*—**The use of technological innovations has been touted to be beneficial in the delivery of construction projects. Particularly, Radio Frequency Identification (RFID) technology is widely regarded to be of immense advantage for the management of construction projects. This study focused on evaluating the barriers to the use of RFID technology for the delivery of construction projects. Using Gauteng Province in South Africa as the study area, questionnaire was used in eliciting responses from construction professionals which made up the population of the study. Retrieved data were analyzed using Mean Item Score and One-Sample t-test. Findings from the study showed that the most significant barriers to the deployment of RFID for construction project delivery are high cost and lack of awareness. Conclusively, the study made recommendations that would aid in the abatement of the barriers to the use of RFID technology for construction project delivery.

***Keywords*—**Barriers, construction, project delivery, RFID.

I. Introduction

THE construction industry is an important sector in a nation as it serves as a major driver of economic growth and its significant contribution to development process [1]. The industry is majorly characterized with the production of physical assets whose delivery mandate is hinged on a wide range of processes and activities. However, these processes have been characterized by perennial challenges which hinders the effective delivery of construction projects. The challenges include underperforming projects, health and safety issues, poor quality delivery, delays in project execution and cost overruns etc. [2]-[4]. Hence, for the effective optimization of construction project delivery, techniques and approaches in surmounting these challenges should be adopted. One of such approaches is the uptake of innovative technologies for construction project execution.

The espousal of innovative technologies for construction processes has been heralded as a viable approach in curbing some of the challenges militating against the effective delivery of construction projects [5]-[8]. According to [9], the construction industry serves as the perfect candidate for an upgrade resulting from its numerous challenges due to outdated techniques and methods. Moreover, the uptake of digital technologies by other sectors has proven to be beneficial as it has led to reduction in task schedule, service delivery enhancement, process optimization and cost saving [10]. Digital transformation in the construction industry has the potential to lead to an approximate savings of $1.7 billion annually in the global construction landscape [11]. Comparatively, the construction industry has only attained half of the efficiency improvements of other industries in the last half century [12]. This depicts the level of adoption of innovative technologies in the construction industry.

RFID technology serves as one of the innovative technologies touted to proffer solutions to some of the problems of construction project execution. RFID technology works on the premise of sending signals to a transponder which awakens and either give back or broadcast a signal to a passive or active system [13]. Reference [14] noted that RFID technology utilizes radio waves for the automated identification of objects by employing radio frequencies for the acquisition and transmission of data from a tag also known as transponder. The technology is one of the most extensive and promising wireless non-contact technologies [15]. According to [16], RFID technology is used in construction sites for efficiency improvement, asset protection, material monitoring, supply chain improvement and theft prevention. Other benefits of using RFID technology for construction projects are logistics tracking systems for materials, asset management, equipment and tool management, safety improvement, cost and time savings, waste reduction and data collection [17]-[20]. Furthermore, the use of RFID technology enables the effective management of labor on site with RFID tags by tracking their mobility and working hours [15].

With numerous benefits accruing from the utilization of RFID technology for construction project delivery, the uptake of the technology is still hindered by several factors. According to [21] and [14], the acquisition cost of RFID serves as hampering factor for its use by construction organizations. Comparatively, the prices of RFID tags might come at higher cost to barcodes, thus serving as a deterrent to prospective users. Also, RFID systems portray better delivery when incorporated with extra components such as circular process

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mechanism [22]. This comes with a higher cost of purchase and installation. Furthermore, RFID technology is prone to ethical and privacy issues. Internet-based databases linked with RFID can be targeted thereby exposing the reader to the likelihood of exposure [23]. Reference [24] stated that the lack of industry standards is an impediment to the espousal of RFID technology for construction project delivery while stakeholders' lack of awareness of the technology has impeded its adoption for construction project delivery. Reference [25] affirmed that the low level of awareness of RFID technology among construction professionals casts a shadow in the drive for inculcating innovative technologies in construction processes. Also, the lack of requisite skills for the use of the technology has been a major challenge to its espousal. The need for training prospective users of the technology is essential for the effective utilization of the technology [26].

It has been shown that innovative technologies such as RFID presents significant benefits that will help proffer solutions to some of the challenges confronting the effective delivery of construction projects. However, there are barriers to the deployment of the technology by construction stakeholders as portrayed earlier. Based on the aforementioned, this study is motivated to explore the barriers to the uptake of RFID technology for optimized construction project delivery with a view to proffering recommendations on how best to abate the identified barriers and ultimately propel the espousal of RFID technology for construction projects. The other sections of the paper are methodology, presentation of results, discussion of findings, conclusion of the study and the recommendations proffered.

II. Methodology

The study assessed the barriers of deploying RFID technology for construction project delivery. A quantitative approach was adopted for the study utilizing questionnaire as the instrument for data collection. The choice of questionnaire is based on its ability to cover a vast number of respondents within a limited time schedule [27]. The study area was Johannesburg in Gauteng province of South Africa while the target respondents for the study were construction professionals namely Architects, Quantity Surveyors, Construction Managers, Construction Project Managers and Engineers. The questionnaire was formulated in two sections: the first section elicited responses from respondents based on their demographic characteristics, while the second section dwelled on the hindrances of the deployment of RFID technology for construction project delivery in South Africa. For the second section of the questionnaire, a 5-point Likert scale was used which indicated 1 being strongly disagree, 2 being disagree, 3 being neutral, 4 being agree and 5 being strongly agree. A total of 81 questionnaires were electronically distributed and subsequently filled and returned. The methods of data analysis deployed for the study were percentage, mean item score, standard deviation and one sample *t*-test. Percentage was used in the analysis of the demographic information of the respondents, mean item score was used in ranking the identified barriers, while one sample *t*-test was used in ascertaining the significance of the identified barriers. Also, Cronbach's alpha was adopted in testing the validity and reliability of the questionnaire. The test gave an alpha value of 0.819, thus indicating a high validity and reliability of the questionnaire [28].

III. Results and Discussion

A. Demographic Information of Respondents

The demographic characteristics of the respondents shows that from the total number of 81 respondents of the study, 54.64% were male while 45.36% were female. Also, based on the highest academic qualification of the respondents, 33.33% had a bachelor's degree, 30.86% possessed an honor's degree while 13.58% had a master's degree. With respect to the professional designation of the respondents, 23.46% were quantity surveyors, 22.22% were construction managers, 18.52% were engineers, 23.46% were construction project managers and 12.34% were architects. Furthermore, based on the years of working experience of the respondents, 32.1% had a working experience of 5-10 years, 28.4% had 1-5 years, 18.52% had 10-15 years, while 11.11% had a working experience of more than 20 years.

B. Barriers of the Use of RFID for Construction Project Delivery

After a review of extant literature, the study identified a total of 11 barriers to the utilization of RFID technology for construction project delivery. The study adopted the use of one sample *t*-test in determining the significance of the identified barriers based on the respondents' rating. Consequently, a null hypothesis was set which stipulates that a barrier is not important when the mean value is less than or equal to the population mean (H_0: $U \leq U_0$) while the alternate hypothesis stipulates that a barrier is important when the mean value is greater than population mean (H_a: $U > U_0$). The study adopted a fixed population mean (U_0) of 3.50 while a 95% significant level was established which is conventional confidence level [29]. Accordingly, a barrier with a mean value greater than 3.50 is given to be important, while a barrier whose mean value less than or equal to 3.50 is given not to be important. Table I shows a two-tailed *p*-value portraying the significance of the identified barriers to the use of RFID technology for construction project delivery.

Table II shows the rating of the identified barriers to the deployment of RFID technology for construction project delivery in South Africa. All the identified barriers have a mean value above the adopted cut-off point for the study (3.50). Also, the *p*-value of the barriers at the stipulated confidence level (95%) are all significant resulting from their values being below 0.005. Therefore, all the identified barriers are portrayed to be important and statistically significant. Furthermore, the analysis shows that the most rated barriers to the utilization of RFID for construction projects in South Africa are high cost (*MIS = 4.59, sig. = 0.000*), lack of awareness (*MIS = 4.44, sig. = 0.000*), lack of industry standards (*MIS = 4.05, sig. = 0.000*), lack of government support (*MIS = 4.09, sig. = 0.000*), complexity of

use (*MIS = 4.28, sig = 0.000*).

TABLE I
ONE-SAMPLE TEST

Barriers	Test Value = 3.50					
					95% Confidence Interval of the Difference	
	T	df	Sig. (2-tailed)	MD	L	U
Complexity of use	8.734	80	.000	.396	.2179	.8287
Privacy and ethical issues	4.902	80	.000	.912	.6836	1.4821
Technical limitations	5.331	80	.000	.885	.7028	1.4983
Lack of industry standards	2.739	80	.000	.710	.6872	1.0627
High cost	1.038	80	.000	.793	.5551	1.2759
Lack of government support	9.392	80	.000	.364	.1858	.8726
Lack of awareness	5.352	80	.000	.618	.3829	1.7427
Lack of training	7.648	80	.000	.765	.7239	1.2829
Resistance to technology adoption	6.313	80	.000	.759	.2817	1.1182
Delay in decision making	5.829	80	.000	.919	.3729	1.2873
Problem of interoperability	7.396	80	.000	.837	.2347	1.6829

NB: MD = Mean Difference, L = Lower, U = Upper.

TABLE II
SUMMARY OF T-TEST SHOWING THE RATING OF THE BARRIERS TO THE USE OF RFID TECHNOLOGY

Barriers	Mean	Std. Deviation	Std. Error Mean	Rank
High cost	4.59	.685	.14819	1
Lack of awareness	4.44	.707	.11362	2
Lack of industry standards	4.28	.855	.11028	3
Lack of government support	4.09	.840	.12183	4
Complexity of use	4.05	.705	.11239	5
Lack of training	4.02	.821	.11937	6
Delay in decision making	3.95	.773	.12846	7
Resistance to technology adoption	3.89	.880	.11284	8
Privacy and ethical issues	3.86	.818	.11194	9
Technical limitations	3.81	.743	.11973	10
Problem of interoperability	3.78	.866	.12873	11

The findings of this study show that the cost of the acquisition of RFID technology is a significant hurdle to its espousal for construction project delivery. This is corroborated by [21] and [14] which stated that the cost of purchasing RFID technology remains expensive thereby serving as a hurdle for its espousal by contracting organizations. Also, the comparative cost between RFID technology and other similar technologies such as barcodes indicates that the cost of RFID appears to be higher thereby serving as a hindrance. Furthermore, the lack of awareness of RFID technology has been proven by the findings of this study to be a significant barrier in its uptake in construction processes. The lack of knowledge of most digital technologies deployed for construction delivery is a major challenge for their adoption by relevant stakeholders [22], [25]. This showcases that the drive for digitalization of construction processes and activities is hugely determinant on the efforts in trying to get construction stakeholders acquainted with the different innovative technologies and their potential benefits. Moreover, the lack of visible industry standards has impeded the drive for the utilization of innovative technologies such as RFID. Reference [24] affirmed that the construction industry needs to start thinking in the line of promulgating standards that will compel the use of innovative technologies. When high quality standards are set for construction processes and activities, stakeholders saddled with the responsibility of delivering construction projects would be compelled to adopt innovative technologies such as RFID for enhanced and effective construction project delivery.

IV. CONCLUSION

The study empirically assessed the barriers of the uptake of RFID technology for construction project delivery in South Africa. Resulting from the review of literature, 11 barriers were identified. These barriers were subjected to rating by the study's respondents through a close-ended questionnaire. The findings from the statistical analysis conducted show that all the identified barriers are important and statistically significant. The most ranked barriers from the findings of the study are high cost, lack of awareness, lack of industry standards, lack of government support and complexity of use. Due to the several benefits of utilizing RFID technology for construction processes and activities, it is pertinent that the adoption of the technology should be vigorously encouraged. In this light, there is a need for stakeholders in the South African construction industry to be consciously aware of emerging technologies that would aid in solving some of perennial challenges plaguing the construction industry. Also, the government can help in subsidizing the cost of these innovative technologies as the cost of their purchase is serving a major barrier to the uptake of technologies such as RFID for construction processes. Furthermore, relevant agencies and professional bodies in the construction industry should as a matter of importance promulgate standards that would aid the espousal of innovative technologies for construction project delivery.

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