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# Assessing South African Construction Worker's Knowledge of Modern Technologies for Effective Material Management

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**Abstract** Material management is a matter of concern for construction stakeholders in South Africa. ICT is the way forward for all sectors upon which the economy thrives both in the national and international level. Incorporating modern technologies will lead to effective material management. However, the level of awareness of modern technologies among South African construction stakeholders needs to be assessed. The study adopted a quantitative approach where questionnaires were administered to professionals in the South African construction industry. Descriptive statistics tools were used to analyse the gathered data. Findings showed that construction stakeholders in South Africa are aware of modern technologies for effective management. The tools according to the level of awareness are Microsoft programs, barcoding, RFID, construction materials planning systems and materials handling equipment selection advisor. Also, the level of importance of these tools according to Stakeholders in South African Construction industry are Microsoft programmes, Barcoding, RFID, materials handling equipment selection advisor, construction materials exchange and construction materials planning system. Therefore, it is evident that there is still unyielding to recent technological move in the construction industry, which may be preventing the progressive growth. It is imperative to indulge modern technologies to counter this problem which in turn help effective material management.

**Keywords:** ICT, material management, construction workers.

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## 1. Introduction

A successful project delivery requires effective material management. Odubiyi and Oke [1] opined that construction project delay can be reduced by effective material management. Therefore, an effective material management method is necessary for improved construction delivery [2]. It will prevent some common problem like time overrun, cost overrun, delay, construction waste, wastefulness, project abandonment [3]. Hence, proper material management techniques are necessary.

Along these lines, there is a need to improve on an existing method of project execution. Errors arise from manual tracking of material in construction site [4]. These errors like double handling make manual material handling ineffective. As a result of poor material management on-site, there could be project delay. Project delay takes a negative toll on a construction project. For instance, [5, 6] states that the material administration problems is one of the key factors central to project delay, hence, there is a need for a coordinated material handling method that will be implemented from the concept period of the project to the use of materials. The use of ICT tools for materials management will solve the problems arising from manual methods [3]. Among these technologies that can be used for materials management, mobile phones and laptops are largely accessible while various other technologies like the RFID, GIS, GPS and tracking technology can be accessible as they have materials tracking technologies [3]. The usage of IT has the competence for shifting a traditional structure with an objective of barrier reduction in functionalities that are different [7]. Therefore, there exists a relationship between material management techniques and project success.

Identifying and understanding factors leading to awareness of modern technologies is crucial if material management is to be achieved in South Africa. It is based on this knowledge, that this study investigated South African Construction worker's knowledge of recent technological tools for adequate material management. Also, the importance of these tools to the South African construction industry according to stakeholders were assessed. The subsequent parts of the paper include the review of literature relating to the subject matter, the methodology used, and the results and findings. Based on the findings, conclusions were drawn, and the necessary recommendations were made thereof.

## 2. Literature Review

Tracking of materials in the construction industry is mostly done manually and this can add to the escalation for the scope of human error such as double handling. Paper report on material management is liable to errors which make them inadequate [4]. Gulghane and Khandve [2] argued that the aim of any activity that is managed on a construction site should be more focused on achieving

materials effective usage and their security. In another view, adequate materials management can affect in yielding considerable savings in general project costs [8]. There exists a correlation between financial probity of a project, material management and the techniques with which this is achieved. In the present age of globalization, information communication technology (ICT) is an effective medium of having tasks completed effectively. The construction industry being a germane sector of the economy thrives better with ICT.

The construction industry might be thriving on the effective use of ICT, yet there is some noticeable gap. The construction industry struggles to use ICT effectively for material management processes. Thus, this is preventing the construction industry from advancing at an accelerated pace. It is then suggested that as projects get bigger in scope and scale there is a need for improved technologies that would meet up with this increase and as well reduce wastage to a considerable level [9]. It is worth noting that complex tasks might pose a threat to material management. Material management in instances where advanced instruments and systems are essential can be risky because of the different components included and the significance of the venture. However, ICT can help new administration forms for complex tasks and rising advancement like remote technologies and tagging which have the future prospect of material management [10]. Another way to overcome the problems associated with materials management according to [11, 12] is to use real-time materials tracking tools such as RFID. ICT tools like these are capable of improving material tracking and construction materials management on the construction sites.

Information and Communication Technology (ICT) in the construction industry can be defined in several ways. ICT can be defined as the usage of automated technologies and drivers for the presentation of data. In this present age, communication technology is a key part of Information technology (IT) [12]. Combined IT and communication technology which are hardware and software make up the term ICT [13]. Hasan et al. [14] opined that mobile and portable devices examples of ICT gadget or tool come in various forms which keep improving in smartness, functionality, capability, application areas, feature, and usability to increase productivity in a construction project. Different parties have the chance to use information communication technology as a means of communicating during a project when it is progressing through different activities. While the work on the construction site is in process, technologies such as tracking and on-site positioning simplify the arrangement of materials arrival while paying attention to the least possible cost. Hence, materials would arrive in the right quantities and at the right time [15]. This shows the importance of modern technological invention for proper construction material handling.

Other ICT applications used in material management also function in different ways. Radio frequency-based information and communication technologies, like the

GPS and RFID tags, can locate resources and their abilities to track materials and mechanised data collection capabilities have developed. Zhang, et al., [16] states that GPS technologies are designed for tracking purposes in a multifaceted operation. Also, an RFID tool is very useful in reducing the misunderstanding levels about material delivery from point of source to point of use. Furthermore, construction enterprises are discovering the advantages of automating the processes of handling materials as this improves their productivity, saves space, improves customers satisfaction, operating expenses reduction and material flow is enhanced. The benefits that material management technologies provide are numerous. synchronizing RFID, barcoding, cell phones, PDA's and web entrances can boost date and material movement in a system [17]. Past researchers express that execution of ICT devices is fundamental in beating the construction industry's material management troubles. Additionally, it is discovered that a viable execution of ICT tools has a colossal perspective to deliver essential advancements.

Despite the benefits of ICT in material management, it looks as though there is a disinclination towards the execution of ICT in the construction industry. Also, the construction industry faces some genuine difficulties in adequately conveying projects as such these problem equally affects workers since there are poor quality work delivery method and low efficiency[18]. These can be attributed to the way that the management of materials is done on the construction site. In South Africa, according to [18] material management majorly is done using some technologies like Microsoft that other parts of the words have advanced over in technology advancement. Also, RFID and barcoding are not yet fully implemented while PDA is common for complex projects [2]. The best explanation for the limited implementation of these tools is attributed to the level of knowledge of these tools among construction workers.

### 3. Research Methodology

The study adopted a Survey design with quantitative data gathered from construction professionals in the Johannesburg metropolitan of South African. The concerned stakeholder were professionals ranging from Construction Managers; Quantity Surveyors; Project Managers; Material Managers; and Site Managers, who are either in private or public sector and who are either construction material suppliers or contractor. A well-structured Questionnaire was adopted as an instrument of data collection. The questionnaire was divided into sections. The background information of respondents was gathered in the first section. The second section has the factors that serve as challenges to the use of recent technologies for adequate construction material handling

in the South African construction industry. These factors were ranked according to a Likert scale of 1-5 point with 1 being Strongly disagreed, 2 as Disagree, 3 being Neutral, 4 as Agree, and 5 as Strongly agree. A total of 55 questionnaires were conveniently administered to these aforementioned professionals with 44 retrieved out of which 40 were deemed suitable for analysis. This accounts for 72.7% response rate from the distributed questionnaire. Data analyses were done using percentage for background information of the respondents, while the mean item score was used to rank the identified challenges and strategies. The reliability of the questionnaire was also analysed using Cronbach's alpha test. The Cronbach's alpha value of 0.629 was derived which is justified as the knowledge level of respondents were not large. This shows that the instrument used is reliable since the degree of reliability of an instrument is more perfect as the value tends towards 1 [19].

## 4. Results and Discussion

The result and discussion section are divided into three parts. The first part discusses the background data of the respondents. This is to show that they meet up with the criteria for assessment. The second section discusses variables attached to the level of awareness of material management tools. The last section discusses the significance of material management tools according to construction stakeholders

### 4.1. Respondents Background

Background Information revealed that 35.0% of the respondents are between the age of 20-25, 32.5% of the respondents were in the age group 26-30 years old; 22.5% of the respondents were in the age group 31-35 years old; 5.0% of the respondents were in the age group 36-40 years old and 5.0% of the respondents were in the age group of 41-45 years' old. In terms of educational qualification, Grade 12 certificate holders are 2.5%, 30% had post-matric diplomas or certificates, 52.5% had bachelor's degrees and only 15.0% had post-graduate degrees. 22.5% were construction managers, 20.0% were quantity surveyors, 25.0% were project managers, and 15.0% were materials manager while 17.5% were site managers, this is showing the profession of respondents. 7.5% had no projects involvement, 27.5% were involved in 1-2 projects, and 47.5% were involved in 3-5 projects, whilst 17.5% were involved in 6-8 projects as regards years of experience, 25% had 0-2 years, 42.5% had 3-5 years, 20% had 6-10 years and only 12.5% had more than 10 years' experience in the construction industry. This shows that professionals had adequate background information to give appropriate responses to the questionnaires.

Table 1. Basic Data.

Category	Classification	Percentage (%)
Age of Respondent	20-25	35.0
	26-30	32.5
	21-35	22.5
	36-40	5.00
	41-45	5.00
Education	Grade 12	2.50
	Post matric Diploma/Certificate	30.0
	Bachelor	52.5
	Post graduate	15.0
Occupation	Construction Manager	22.5
	Quantity Surveyor	20.0
	Project Manager	25.0
	Material Manager	15.0
	Site Manager	17.5
Institution/sector	Public clients	20.0
	Private clients	27.5
	Consultants	7.50
	Contractor	45.0
Projects handled	none	7.50
	1-2 projects	27.5
	3-5 projects	47.5
	6-8 projects	17.5
Years of experience	0-2 years	2.50
	3-5 years	42.5
	6-10 years	20.0
	>10 years	12.5

#### 4.2. Level of Awareness of Material Management Tools

This study focused on certain technological tools to assess the respondent's awareness of such tools based on their mean item score, z-value and significant p-value derived from the Mann-Whitney U Test. Mann-Whitney is used to ascertain if there is a significant difference in the view of construction stakeholders and their knowledge level of modern technologies for material management. Table 2 demonstrates that at a 95% confidence interval, there is no significant difference in the view of professionals and the level of awareness of these tools. Therefore the result from mean item score is liable it is statistically not different. The result also identified that the first three tools that construction stakeholders in South Africa are majorly aware of are Microsoft programmes (MIS 4.13), Bar Coding (MIS 3.20), Radio Frequency Identification (MIS 3.05). Following closely are Construction material exchange, construction planning system, and Materials handling equipment selection advisor with MIS

2.20, 2.08 and 2.05 respectively. Afolabi, et al. [3] agrees that Microsoft excel program is commonly used for material management. This shows that the Microsoft program is vital to project management tools that are commonly used by construction stakeholders for material management [20]. Barcoding is another modern material management tool [21]. Bar Coding is an effective IT-based solution for material management. It is also agreed that Barcoding is a vital material management tool [22]. This shows that barcoding is an ICT tool used for facilitating construction productivity through effective material management. Radio Frequency Identification (RFID) has been identified as a material management tool that construction stakeholders are aware of. RFID has improved traceability of construction materials [23]. Ren and Tah [17] also agrees that it has been used to facilitate construction material management. Finally, it is also agreed that synchronizing RFID, Barcoding, cell phones, and web entrances can boost date and material movement in a system [17].

Table 2. Level of Awareness.

Factors	Mean	R	Z-value	P-value
Microsoft programmes	4.13	1	-0.050	0.960
Bar coding	3.20	2	-0.202	0.840
Radio Frequency identification (RFID)	3.05	3	-0.052	0.958
Construction materials exchange	2.20	4	-1.378	0.168
Construction materials planning system	2.08	5	-1.144	0.253
Materials handling equipment selection advisor	2.05	6	-0.809	0.419

#### 4.3. Significance of Material Management Tools according to Construction Stakeholders

The level of importance of modern technology for material management from construction workers perspectives was also determined. The consistency in the opinion of the respondent was ascertained using Mann-Whitney U-test with Null Hypothesis stating that there is no significant difference in the opinion of construction stakeholders and the various importance level of modern technological tools for material management. According to table 3 below, the top-ranked tools are Microsoft suites, barcoding, RFID and Material handling equipment selection advisor. They have mean item scores which are above 3.0 that is considered the average. Construction stakeholders do not classify construction material exchange (MIS 2.20) and construction material planning system (MIS 2.08) as much as significant as others. It can also be iterated that Microsoft excel program is a vital tool used for material management [3]. This shows that the Microsoft program is significant to project management tools for material management. Barcoding is another modern material management tool. Also, the authors agree that Barcoding is a significant technology for effective

material management [22, 24]. This describes the significance of RFID as a modern technological tool for effective material management. This describes that Bar Coding is an affective-based solution for material management. However, according to [25] organizations face challenges such as acceptance of new technology by their staff which can be attributed to the level of importance attached to these tools.

Table 3. Level of Importance.

Factors	Mean	R	Z-value	P-value
Microsoft programmes	4.40	1	-1.289	0.198
Radio Frequency identification (RFID)	4.35	2	-0.705	0.481
Materials handling equipment selection advisor	3.53	3	-1.428	0.153
Bar Coding	3.50	4	-1.144	0.253
Construction material exchange	2.20	5	-1.144	-1.167
Construction materials planning system	2.08	6	-0.809	0.419

## 5. Conclusion and Recommendation

This study assessed the South African Construction worker's knowledge of modern technologies for effective material management. Literature review reveals that although there are technological tools that are available for use in the construction industry, there is not enough awareness amongst the stakeholders regarding their benefits such as cost and time saving while increasing productivity. Furthermore, barcoding and RFID technologies are adequately used for construction material tracking. Findings from the study also revealed that Microsoft programmes were the most popular tool to be used in the construction industry, whilst construction materials exchange; construction materials planning exchange and materials handling equipment selection advisor were the least popular hence confirming that their other tool but have minimal awareness of their existence in the construction industry. It can be concluded that this objective has been met and the levels of awareness were identified and analysed. The construction industry is still relying on the traditional methods, although they are now computerised systems, it is not enough to conclude that the industry is finally adapting to the use of modern technologies. Moreover, it is evident that there is still resistance to change in the construction industry which may not be advancing the industry, therefore, yielding to the use of modern technologies will help counter this problem which in turn help effective material management. However, this work is limited by the respondent's population which calls for further expansion of research scope.

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