Evaluation of the use of modern technologies for effective material management in South African construction industry

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Abstract. A vital building block for construction project globally is construction materials which are huge, costly and are often delivered in great quantities to the construction sites. One of the key roles in the successful completion and delivery of a project is effective construction materials management. However, it has been established that material wastage is a prevalent problem in developing countries which can be tackled with modern technologies for effective material management. It is based on this assertion that this paper focuses on the challenges to use of modern technologies for effective material management in the South African construction industry. 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 the common challenges to using modern technologies for effective material management in the construction in South African are; Scale of construction projects, Cultural barriers, environment challenges, financial challenges, and Behaviours of people in key positions. The way forward are; change in business approaches and procedure, and implementation of skill set is necessary

Keywords: Construction Materials; Material Management; Project Delivery; Technology; South African Construction Industry

1. Introduction
The construction industry is a renowned industry globally for its labour and intensive-information exchange. In most developing countries, the construction industry has been faced with the challenge of the use of modern technologies for effective material management. Stukhart [1] describes that the traditional forms of managing materials have problems such as theft of building materials on site, delays and cost overruns or extra expenses due to the unavailability of expected materials on site. Bowden, Dorr, Thorpe and Anumba [2] also mentioned that the exchange of data and information between those who participate in a project daily is a basic component of major construction processes. This implies that manpower has a major contribution to the method of project management through means of project execution. Hence, emphasised that technology is an alternative form of managing materials effectively. [1,3]
There is an exceptional need for a system that handles materials on construction projects since construction activities aims at achieving value for money. Solanke and Fapounda [4] stated sustained economic prosperity is necessary when considering material use for construction activities in recent times. Lately, it is observed that modern technology transfer is in favour of the change or improvement that the construction industry requires (for instance, material management) [5]. In context of this literature, construction industry in South Africa like other developing countries faces skills shortages challenges, environmental issues and energy shortages, making the technology used in the construction industry to age and not keep up with advances in other sectors of the economy [6] which hampers important issues in the construction industry like material handling. Notably, traditional means of material handling is no longer adequate, calling for a more modern means involving use of technology.

In addition, according to [5], challenges to the effective use of technologies for material management are identified as Lack of clear policy, language, ethnic and cultural differences, organisational culture barriers, lack of time, lack of funding provisions, limited capabilities of individuals and attitude of individuals. More challenges faced by the construction sector is that technological tools are still considered costlier to young and emerging contractors. Wamaae [7] mentioned that there is enough proof to display that the construction industry does not have enough absorptive capability to benefit from international technological transfers. In addition, the construction industry production competency needs to be advanced and it can only be through the use of technology [8–10]. It is therefore pertinent that technology has an important part to play in refining efficiency in the construction industry but there is a need for additional effects why its implementation has been slow in this specific industry, [11] Moreover, data inadequacies and the absence of coordination among construction players required in the construction strategy add to the frameworks of data innovation being considered as not living up to their desires and this is portrayed on the literature as a portion of the issues these organisations confront [11]

Technology has an important role to play when it comes to the exchange of information through the use of cell phones, computers and computerised devices [9]. Thus, a key reason behind the utilisation of ICT in effective materials management is that there can be the delivery of value for money than when using the methods that are traditionally paper-based. It is based on this background knowledge that and the need to achieve effective material management within the South African construction industry that this study investigated the challenges to the use of modern technologies for effective material management. Subsequently, the paper discussed the research method, the result from the study, the discussion and the conclusion from the study.

2. 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 modern technologies for effective construction material in 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 and frequency 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 0.7 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, stated by Moser and Kalton [12].

3. Results

3.1. Background Information
The finding 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. Background Information |
|---------------------------------|
| **Category** | **Classification** | **Percentage (%)** |
| Age of Respondent | 20-25 | 35.0 |
| | 26-30 | 32.5 |
| | 21-35 | 22.5 |
| | 36-40 | 5.0 |
| | 41-45 | 5.0 |
| Education | Grade 12 | 2.5 |
| | 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 | 7.5 |
| | Contractor | 45.0 |
| Projects handled | none | 7.5 |
| | 1-2projects | 27.5 |
| | 3-5projects | 47.5 |
| | 6-8projects | 17.5 |
| Years of experience | 0-2 years | 2.5 |
| | 3-5 years | 42.5 |
| | 6-10 years | 20.0 |
| | >10 years | 12.5 |
3.2. Challenges to the use of modern technologies for effective material management

The result from table 2 below reveals the respondent’s agreement on the challenges affecting the usage of modern technologies for effective material management in the South African construction industry. It revealed that all the assessed factors have a mean score of an above average of 3.0 which to some extent implies that they all have the tendency to contribute to the challenges affecting usage of modern technologies for material management in South African construction industry. The most important factors include Scale of construction projects, Cultural barriers, Work environment challenges, Behaviours of people in key positions, Lack of attention by procurement officers, Shortage of skills towards operating complex technologies, Late payments from clients, Lack of time to implement new technologies and Incomplete information about materials needed on construction sites from site managers. Their Mean Item Scores (\(\bar{x}\)) are 4.38, 4.35, 4.35, 4.33, 4.25, 4.23, 4.23, 4.20 and 4.18 respectively, following closely are Lack of information security, Organisational cultures, Delays in materials that have been ordered, Attitude of superiors towards technological tools, Industrial cultures, Misunderstanding of responsibilities, Lack of investment from the construction stakeholders, Misunderstanding of responsibilities, Lack of investment from the construction stakeholders, Lack of investment from the construction stakeholders, Information overload at the suppliers, Cultural beliefs, and Unshared ideas, Views, Values and opinions. Also, their Standard deviation (\(\sigma_X\)) are: 0.78, 0.71, 0.70, 0.86, 0.72, 0.75, 0.62, 0.75, 0.80 and 0.60 respectively. The least factors are Disparities in ideas with mean value of 0.89 and Personal backgrounds with mean value of 1.06. These findings are in line with the opinion of [5], following challenges to the effective use of technologies are identified as follows; Lack of clear policy, language, ethnic and cultural differences, organisational culture barriers, lack of time, lack of funding provisions, limited capabilities of individuals and attitude of individuals. Also, this also tallies with the view of this can also be encouraged by the governments with the aim of creating jobs as this stimulates the economy and the use of technological tools can greatly impact on this as stated by [6]. Also, to overcome the challenges of posed to effective material management, studies have identified that modern ICT tools can reduce work environment challenges, procurement problems, handling of material problem among other problems identifies. Such new technologies include web-based ICT tools for material management [13], Radio Frequency Identification (RFID) for tracking material which in the long run reduce delay in procurement and use of material [14,15], computer aided material management tools (like email, e-commerce platform, Microsoft excel suite) [13,16], Barcoding [15,17], BIM [18,19] and other real time ICT tools [3].

Table 2. Challenges to the use of technological tools for material management

| Factors                                                        | \(\bar{x}\) | \(\sigma_X\) | R  |
|---------------------------------------------------------------|-------------|--------------|----|
| The scale of construction projects                            | 4.38        | 0.63         | 1  |
| Cultural barriers                                             | 4.35        | 0.58         | 2  |
| Work environment challenges                                   | 4.35        | 0.77         | 3  |
| Financial challenges                                          | 4.35        | 0.70         | 4  |
| Behaviours of people in key positions                         | 4.33        | 0.73         | 5  |
| Lack of attention by procurement officers                     | 4.25        | 0.67         | 6  |
| Shortage of skills towards operating complex technologies      | 4.23        | 0.70         | 7  |
| Late payments from clients                                    | 4.23        | 0.70         | 8  |
| Lack of time to implement new technologies                    | 4.20        | 0.82         | 9  |
| Incomplete information about materials needed on construction sites from site managers | 4.18        | 0.78         | 10 |
| Lack of information security                                  | 4.18        | 0.78         | 11 |
| Organizational cultures                                       | 4.18        | 0.71         | 12 |
| Delays in materials that have been ordered                    | 4.15        | 0.70         | 13 |
The attitude of superiors towards technological tools 4.15 0.86 14
Industrial cultures 4.13 0.72 15
Misunderstanding of responsibilities 4.05 0.75 16
Lack of investment from the construction stakeholders 4.03 0.62 17
Information overload at the suppliers 4.00 0.75 18
Cultural beliefs 3.98 0.80 19
Unshared ideas, views, values, and opinions 3.95 0.60 20
Disparities in ideas 3.85 0.89 21
Personal backgrounds 3.75 1.06 22

4. Conclusion
This study set out to assess the factors serving as challenges to the use of modern technologies for effective material management using a survey approach with questionnaires administered among Construction professionals in Johannesburg, South Africa, the study has been able to ascertain the most significant factors responsible for, challenges to the use of modern technologies for effective material management. Previous researchers’ outline that technology has a part to play in refining efficiency in the South African construction sector, but there is a need for additional discourse on why its implementation has been slow in this specific industry. Based on the findings from the questionnaire, scale of construction projects, cultural barriers, work environment challenges, and financial challenges were the top factors affecting the usage of technological tools in the construction industry. While information overload at the suppliers, cultural beliefs, and unshared ideas views, values and opinions, disparities in ideas and personal backgrounds were found to have the least effects. After identifying the challenges to the problem, it can be said that this objective was met and the challenges were established.

It is therefore recommended that since the major factors that are challenges to the use of modern technologies for effective material management are the scale of construction projects, cultural barriers, work environment challenges, and financial challenges were the top factors affecting the use of technological tools in the construction industry. The way forward are a change in business approaches and the procedure, and implementation of skill. Also, the construction industry should be open to a better work environment, well defined scale of construction, unification of cultural disparities, and conducive work environment. The study contributes to the body of knowledge as it brings to light the major factors contributing to material management in South African construction. However, it should be iterated that this study is limited by sample size. It is suggested that further studies be done to address the subject based on a wider scope.

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