Roles and effects of utilizing recent technologies on material management for construction work in South Africa

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Abstract. The role of technology in every facet of the economy cannot be handled with levity. The construction industry like other germane sectors of the economy thrives best with the adoption of technology in various parts of its subsets. It has been established that Material management can be handled effectively with the use of modern technologies. It is based on this that this research focuses on identifying the roles and effects of adopting modern technological tools 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 prevalent roles of adopting technological tools for effective material management in South African construction industry are majorly continuously Progress monitoring; Monitoring mechanisms with regard to stated outcomes are clearly explained from the beginning, and scope and use of materials are explained to all role players. On the other hand, the effects of technological tools are seen mainly as profit maximization; constant monitoring of materials on site and, Aids in planning and clarification of materials before projects begin. The implication of the roles and effects is that there is an opportunity of great productivity in construction industry with the use of technology as it makes things easier while improving principles of management.

Keywords: Technology, Material Management, South Africa, Construction

1. Introduction

The success of any construction project is highly dependent on the mechanisms of execution one of which is modern day technological tools. Primarily, the motive for any construction project differs, it might be to achieve value, time, quality, cost or just satisfaction for the client [1]. It is therefore important to address the mechanisms of project execution. The mechanisms play major roles and generally affect the whole existence of such a project. One of such is the role and effects of adopting modern technologies on material management in the South African construction industry. It determines output, managerial expertise and construction projects expenses and time. This all boils down to sustainable construction practices for a better-built environment.

Michalowski and Costa,[2] is of a view that material management technologies have the following roles; they enhance location of items at all times while reducing the time that it would take to search for such items. Thus, improving stock inventory, and manufacturing process control enhanced. It also help to enhance the compliance, improve the productivity of the work in process and reduces the finished goods costs. As discussed by Stukhart [3,4] planning, procurement, logistics, handling, stock and waste control are however pertinent to better understanding the effects of adopting modern technologies for materials management.
In the opinion of Wamae [5], as long as the technology to be implemented is well understood and properly utilized, its benefits can be experienced by any organization irrespective of the size. Several studies have recognized the benefits that are linked to the usage of technology [6–8]. They include time saving since vital information is made accessible at a rapid rate when required [9]. As a result of faster information exchange, productivity may also be improved [9]. Tracking and better security is enhanced through the use of coded communication channels among participants engaging in the conversation; and development of customer relations through improved interchange of information between stakeholders as information that is important is timely made available, among others. For all these technological benefits to be appreciated, proper planning and implementation need to follow as any system is guaranteed to be unsuccessful if not understood entirely regarding its business and workforce fundamentals [2]. After this background statement, this study reviewed relevant literatures on modern Information and Communication technology (ICT) tools for material management in the construction industry. The next section described the research methodology designed for the study. Then it discussed the result of the study which later informed the discussion section. Upon these, conclusion is drawn for the study.

1.1 Literature Review
The subject of material management in the construction industry has been studied across the board. Material management is simply described as the process of planning, monitoring, coordinating and controlling material flow [10]. Kasim and Ern [11] described that the material management process is divided into planning, procurement, logistics, handling, stock and waste control processes. Evidence gleaned from literature have described that there are some challenges to achieving effective material management in the construction industry [12]. For example, construction waste is an aftereffect of poor material management [13]. These wastes are prevalent when core construction materials are mishandled. As a result of faster information exchange, productivity may also be improved [9]. Tracking and better security is enhanced through the use of coded communication channels among participants engaging in the conversation; and development of customer relations through improved interchange of information between stakeholders as information that is important is timely made available, among others. For all these technological benefits to be appreciated, proper planning and implementation need to follow as any system is guaranteed to be unsuccessful if not understood entirely regarding its business and workforce fundamentals [2]. After this background statement, this study reviewed relevant literatures on modern Information and Communication technology (ICT) tools for material management in the construction industry. The next section described the research methodology designed for the study. Then it discussed the result of the study which later informed the discussion section. Upon these, conclusion is drawn for 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 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 roles and effects of the use of modern technologies for effective construction material in the South African construction industry. These factors were ranked according to a 5-point Likert scale of 5 as Strongly agree, 4 as Agree, 3 being Neutral, 2 as Disagree, and with 1 as Strongly disagreed.

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. Cronbach alpha gives a range of value of between 0 and 1, and the higher value, the higher the degree of internal consistency. Cronbach’s alpha reliability test is an estimate of the internal consistency associated with the scores that can be derived from a scale or composite score, [17,18]. From the table, it is observed that the Cronbach’s alpha coefficient values are greater than 0.70 (>0.70). To support this, Tavakol and Dennick [19] stated that the score values between 0.70-0.90 are the standard acceptable values for the reliability of a test to be proven.

| Table 1. Test of Reliability |
|-----------------------------|
| Heading | Cronbach's Alpha | N of Items |
| Roles of adopting modern technologies on material management | 0.801 | 8 |
| Effect of adopting modern technologies on material management | 0.791 | 18 |

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 reveals that professionals had adequate background information to give appropriate responses to the questionnaires.

| Table 2. Biographical data |
|---------------------------|
| Category | Classification | Frequency | Percentage (%) |
| Age of Respondent | 20-25 | 14 | 35.0 |
| | 26-30 | 13 | 32.5 |
| | 21-35 | 9 | 22.5 |
| | 36-40 | 2 | 5.00 |
| | 41-45 | 2 | 5.00 |
| Education | Grade 12 | 1 | 2.50 |
| | Post matric Diploma/Certificate | 12 | 30.0 |
| | Bachelor | 21 | 52.5 |
| | Post graduate | 6 | 15.0 |
| Occupation | Construction Manager | 9 | 22.5 |
| | Quantity Surveyor | 8 | 20.0 |
| | Project Manager | 10 | 25.0 |
| | Material Manager | 6 | 15.0 |
| | Site Manager | 7 | 17.5 |
| Institution/sector | Public clients | 8 | 20.0 |
3.1.1 Roles of Adopting Modern Technologies for Material Management

Table 3 below explains the roles of modern adopting technological tools according to respondents, paying close attention to project outcomes. Continuous project monitoring was ranked first with a Mean Item Score ($\bar{x}$) of 4.13 and a Standard Deviation ($\sigma_X$) = 0.79; monitoring mechanisms clearly explained from the beginning was ranked second with a $\bar{x}$ of 4.10 and a $\sigma_X = 0.78$; the explanation of the scope and use of materials to all role players was ranked third with a $\bar{x}$ of 4.05 and a $\sigma_X = 0.81$; making sure that the project is back on track by the project management team when there has been mismanagement of materials was ranked forth with a $\bar{x}$ of 4.03 and a $\sigma_X = 0.97$; the proper outlining of outcome of each material by the project managers from the project’s onset was ranked fifth with a $\bar{x}$ of 3.78 and a $\sigma_X = 0.89$ and ranked sixth and last was the procurement of materials from the onset of the project with a $\bar{x}$ of 3.78 and a $\sigma_X = 0.89$.

| Roles                                                      | $\bar{x}$ | $\sigma_X$ | R  |
|------------------------------------------------------------|-----------|------------|----|
| Continuous project monitoring                              | 4.13      | 0.79       | 1  |
| Monitoring mechanisms clearly explained from the beginning | 4.10      | 0.78       | 2  |
| The scope and use of materials are explained to all role players | 4.05      | 0.81       | 3  |
| Where there is mismanagement of materials, the project management team makes sure everything is back on track | 4.03      | 0.97       | 4  |
| The outcome of each material is properly outlined by the project managers from the onset | 3.78      | 0.89       | 5  |
| Materials are procured properly from the onset            | 3.78      | 0.89       | 6  |

3.1.2 Effects of Adopting Modern Technologies for Material Management

Table 4 reveals the respondent’s rankings on the effects of adopting modern technologies on material management. The major effects are maximizing of profits; constant monitoring of materials site; Aids in planning and clarification of materials before projects begin; development of customer relations; development of customer relations and, Logistics control.

| Effects                                                                 | $\bar{x}$ | $\sigma_X$ | R |
|------------------------------------------------------------------------|-----------|------------|---|
| Maximises profits                                                      | 4.53      | 0.60       | 1 |
| Constant monitoring of materials on site                              | 4.50      | 0.68       | 2 |
| Aids planning and clarification of materials before projects begin     | 4.48      | 0.78       | 3 |
| Development of customer relations                                      | 4.43      | 0.59       | 4 |
Quick provision of information regarding materials from site managers 4.40 0.63 5
Logistics control 4.40 0.71 6
Fast-tracking the delivery of materials from suppliers 4.38 0.70 7
Constant updating of materials schedules upon delivery 4.30 0.65 8
Inventory control 4.30 0.65 9
Reduces inventory costs 4.30 0.56 10
Constant integration between site managers, procurement officers and financial managers 4.28 0.60 11
Reducing labour costs 4.28 0.68 12
Advances business competitiveness 4.25 0.67 13
Aids in ongoing correspondence between project teams 4.25 0.54 14
Inventory tracking 4.25 0.74 15
Monitoring the scope of the project in relation to materials required and used 4.20 0.65 16
Automated regular updating of the material schedule 4.18 0.68 17
Faster data gathering 4.18 0.68 18

Their mean and standard deviation are $\bar{x}$ of 4.53 and $\sigma_{X}$=0.60; $\bar{x}$ of 4.50 and $\sigma_{X}$ = 0.68; $\bar{x}$ of 4.48 and $\sigma_{X}$ = 0.78; $\bar{x}$ of 4.43 and $\sigma_{X}$= 0.59; $\bar{x}$ of 4.40 and $\sigma_{X}$ = 0.63 and, $\bar{x}$ of 4.40 and $\sigma_{X}$ = 0.71 respectively. Following closely are effects such as Fast -tracking the delivery of materials from suppliers was ranked with a $\bar{x}$ of 4.38 and $\sigma_{X}$ = 0.70; Constant updating of materials schedules upon delivery with a rank $\bar{x}$ of 4.30 and $\sigma_{X}$ = 0.65; Inventory control with a $\bar{x}$ of 4.30 and $\sigma_{X}$ = 0.65; Reduces inventory costs with a $\bar{x}$ of 4.30 and $\sigma_{X}$ = 0.56; Constant integration between site managers, procurement officers and financial managers with a $\bar{x}$ of 4.28 and $\sigma_{X}$ = 0.60 and, Reducing labour costs were ranked with a $\bar{x}$ of 4.28 and $\sigma_{X}$ = 0.68. The least factors are outlined as monitoring the scope of the project in relation to materials required; Automated regular updating of material schedule and faster gathering of data with a $\bar{x}$ of 4.20 and $\sigma_{X}$ = 0.65; $\bar{x}$ of 4.18 and $\sigma_{X}$ = 0.68 and, $\bar{x}$ of 4.18 and $\sigma_{X}$ = 0.68 respectively.

Findings from the questionnaire survey reveal that the effects that most respondents were in agreement with were, maximizing of profits, constant monitoring of materials on site, aids in planning and clarification of materials before projects begin, development of customer relations and quick provision of information regarding materials from site managers. While monitoring the scope of the project in relation to materials require and used, automated regular updating of materials schedule and faster gathering of data least supported factors in terms of rankings as per the mean item score. This is in agreement with [8]that Information and Communication Technology (ICT) tools add value and efficiency to the business procedures and senior business managers have recognized this aspect. The literature reviewed reveals also that indeed ICT tools have proven to have many long- and short-term benefits to an organisation and their presence in an organisation can add efficiency and value to business procedures. Furthermore, the flexibility of technology permits it to be functional and too practical to any form of business.

4. Conclusion
This study addressed the roles and effects of adopting modern technologies for material management in South African Construction Industry using a survey approach with a questionnaire administered among Construction professionals in Johannesburg, South Africa, the study has been able to identify the highest impacts of the use of modern material technologies. It also identified the roles of these tools for the construction industry. The most significant, the key roles that modern technology tool for material management plays includes continuous project monitoring, Monitoring mechanisms clearly explained from the beginning, and the scope and use of materials is explained to all role players. ICT tools add value and efficiency to the business procedures and senior business managers have recognized this aspect. In addition, effects of modern technologies that most respondents were in agreement with were, maximizing of profits, constant monitoring of materials on site, aids in planning and clarification of
materials before projects begin, development of customer relations and quick provision of information regarding materials from site managers. Having established the roles of these modern technology tools, it implies that there exists a relationship between the roles these tools plays and the effect it has on construction activities. Based on these, modern material management tools have proven to have many long- and short-term benefits to an organisation and their presence in an organisation can add efficiency and value to business procedures. Furthermore, the flexibility of technology permits it to be functional and too practical in any form of business. It is recommended that adequate use of modern material management tools is necessary. However, it is pertinent to state that this study is however limited by the size of the sample population. It is suggested that a further research is carried out to address more issues of ICT tools for material waste management as it affects the construction productivity.

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