IT Management of Building Materials' Planning and Control Processes Using Web-Based Technologies

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Abstract. Mismanagement of building materials has constantly plagued the construction industry resulting in issues of cost overrun, delay, high levels of construction waste, wastefulness, project abandonment, climate change etc. The purpose of the research is to examine an IT management of building materials' planning and control processes using web-based technologies. The study made use of a desktop review of literature and a case diagram to illustrate the various interactions involved in the use of an IT system. A framework of drivers and barriers that affect the use of web-based technologies in planning and control of building materials in order to be able to achieve IT management by Construction Managers and construction firm's head office was developed. In conclusion, the study developed a framework of a web-based material planning and control system for construction project delivery that engenders openness, transparency and accountability in the management of building materials on construction sites.

Keywords: Building materials · e-Corporate governance · ICT · Planning and control systems · Web-based technologies

1 Introduction

The introduction of the internet and the World Wide Web (WWW) have moved the world to a new phase of advancement due to the extreme demands of the business world and the social enthusiasm of the public. For the last three decades, these two entities have become indispensable, changing the way activities are conducted. The internet and the World Wide Web (WWW) are rapidly changing environments driven by technological advancements and the perceived needs of organizations who are poised to gain competitive advantage and unprecedented opportunities by engendering a web presence. As at 2001, Joshim Aref, Ghaffor and Spafford projected that web based applications in the e-commerce market would exceed one trillion dollars ($1 trillion) over the next several years due to the large number of web applications being developed. This is not far-fetched, individuals and organizations such as Facebook (social media), Amazon (e-commerce), Google (search engine), Alibaba (e-commerce), Netflix (web portal), Microsoft and Apple (software and hardware) to mention a few, gross billions of dollars in income annually as a result of their

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activities via the internet and the World Wide Web (WWW). The unmatched prospects and benefits of the internet and the web translating to web based applications means they are here to stay and therefore, should be explored to solve every day issues such as planning, which is an important aspect of life.

According to [1], information and communication technology (ICT) tools are masterpiece in increasing organizational output. The introduction of information and communication technology (ICT) in the construction industry over 40 years ago has drastically transformed the traditional landscape of the industry to one with faster and more sophisticated processes. The rational for the use of ICT in the construction industry can be understood from the unique nature of the industry. The industry is perceived as one the largest employer of labour, thereby making the industry information intensive in terms of paper works, processes and communication [2]. These requires close coordination which ICT offers. [3] added that the internet is a major driver increasing the use of ICT due to its ability to connect various project participants in diverse locations in order to readily exchange information. The close coordination is required due to the heavy exchange of data and information that takes place among the project participants on a daily basis [4]. However, [5] stated that the adoption of ICT by construction firms have been very slow. [6] noted that majority of construction process information is still heavily based on the traditional means of communication such as huge paper works and face to face meetings. As a result, [7] in [3] argued that the industry has suffered from difficult to access, out-of-date and incomplete information. Whereas, [8] stated that the construction industry needs to increase its efficiency of information management by ensuring massive volumes of accurate information are exchanged at high speed and at relatively low cost. The poor oversight on the information generated and used in the construction industry has resulted in some cost, time and quality deprived issues been encountered in the industry.

Specific to construction projects and construction firms, the subject of mismanagement of resources cannot be overemphasized. A major resource which is largely mismanaged on construction sites and affects the project, client, contractor, the firm, the environment and the nation's economy is building materials. Building materials make up as much as 60–65% of the total working capital of any construction project [9]. The critical nature of mismanaging this entity affects project cost, time and quality [10]. Matters of unavailability of materials, over-ordering, under-ordering, lack of storage spaces, bad stock control, inappropriate material delivery, material [10, 11] which are attributes of an ineffective planning and control of building materials have been traced to problems of time overrun, cost overrun, dissatisfaction of client, high levels of waste, high reports of theft, low quality, abandonment of projects, construction delay, lack of construction data [12, 13]. Moreover, some construction firms have tried to solve these issues by stockpiling of building materials, this has led to tying down limited capital, increased waste and construction material theft [11].

According to [3, 6, 10], the traditional construction methods apply more paper-based work in its data and document management during the construction process, whereas, the emergence of ICT systems could transform conventional to modern methods in managing construction activities. With over 60% of construction professionals connected to the internet, most construction professionals' use of the internet is mainly

for sending e-mails which is a far cry from the capacity and benefits which the internet and web based technologies can contribute to the construction industry [3]. The study aims to examine an IT management of building materials planning and control processes using web-based technologies. With this understanding, the study intends to proffer answers to the following research questions;

- What are the drivers and barriers to the effective use of web-based technologies in planning and control of building materials?
- How can IT systems be used in managing building materials' planning and control processes using web-based technologies?

1.1 IT Management

The Nigerian construction industry is a large employer of labour bringing people together to work. The large number of specialized but independent organizations and individuals require close coordination in order to achieve the cost, time and quality objectives of a construction project. The close coordination is required due to the heavy exchange of data and information that takes place among the project participants on a daily basis [4]. [6] noted that majority of construction process information is heavily based on the traditional means of communication. Traditional communication based, such as huge paper works and face to face meetings. As a result, [7] argued that the industry has suffered from difficult to access, out-of-date and incomplete information. This called for the use of information and communication technology (ICT). [3] opined that ICT is a potent tool for accelerating socio-economic development and narrowing the gap between developing and developed countries. According to [14] information technologies can assist project and construction managers to standardize routine tasks so that available organizational resources are utilized both effectively and efficiently.

According to [15], computers opened the door to an inventory system in material management helping to keep up-to-date records on the status of every inventory in stock. This brought a better understanding of production operation and new ways of managing production. Common use of computer based or IT based material management techniques have been developed over the years. Of such computer based or IT based are material requirements planning (MRP I & II); a computer based information system designed to control manufacturing activities [15–17], electronic mail (e-mail) and electronic commerce including electronic invoicing, payments and receipt of materials process [18], Construction Materials Planning System (CMPS) [19], Material Handling Equipment Selection Advisor (MHESA) [20], Construction Materials Exchange (COME) [21], Bar-code system - for material storage application [22], and most commonly used Microsoft Excel and Lotus 1-2-3 [23]. Most of these computer based applications were made for the manufacturing sector and are not real time or internet-based.

2 Methodology

The study made use of a desktop review of literature, case diagram to illustrate the various interactions involved in the use of an IT system for planning and control of

building materials on a construction site through we-based technologies. The IT system setup is such that, it can only be accessed via an online platform through web browsers on desktop systems. Adopting the framework of [30], where the database system is designed using MySQL connected to the HTML web-interface through a PHP script processing the data back and forth. From literature, a framework of the driver and barriers to the implementation of web-based technologies for planning and control of building materials was developed. The study showed the architectural design of the web application.

3 Drivers of Web-Based Technologies

[3] asserted that the internet (worldwide web) is a major driver increasing the use of ICT due to its ability to connect various project participants in diverse locations in order to readily exchange information.

In the study by [3], factors influencing the adoption of ICT include level of competition, changing trends in technology, client/customer demand and construction industry demands. In the manufacturing sector, [24] asserted that today's global business competition is imposing special requirements to manufacturing enterprises, such as rapid response to changing requirements, reduction in both time and cost of the product realization process.

In the Unified Theory of Acceptance and Use of Technology (UTAUT) model, [25] stated that four drivers play significant role in the acceptance and usage of ICT namely performance expectancy, effort expectancy, social influence and facilitating conditions.

In addition, successful technology adoption by expected users in construction firms requires implementation support and encouragement from senior managers if individuals are to adopt and utilize the technology [26]. Figure 1 showed the drivers to the use of web-based technologies in the construction industry. The figure showed the various drivers and barriers that would lead to the usability and acceptability of web-based technologies in the construction industry in order to meet the construction project delivery of time, cost, quality and customer satisfaction.

Similarly, [27] found that effective upper management support was one of the strongest enablers on innovation implementation in construction firms. [28] added that to reinforce this commitment, all old and informal systems must be eliminated. [29] identified other drivers which include age, gender, education and computer experience.

4 Barriers to Using Web-Based Technologies

It is continually acknowledged that the construction industry has great potential for the uptake of ICT and e-business [30], but, it appears that some fundamental problems still exist. Some of these issues include: organizational factors (people and process); the enabling environment and supportive infrastructure, and the actual technology itself [31].

In the organizational factor, [26] opined that poor user acceptance can occur when transitioning from an existing system such as a paper based system to a new system such as a fully electronic environment. [32] explained that when organizations implement a new

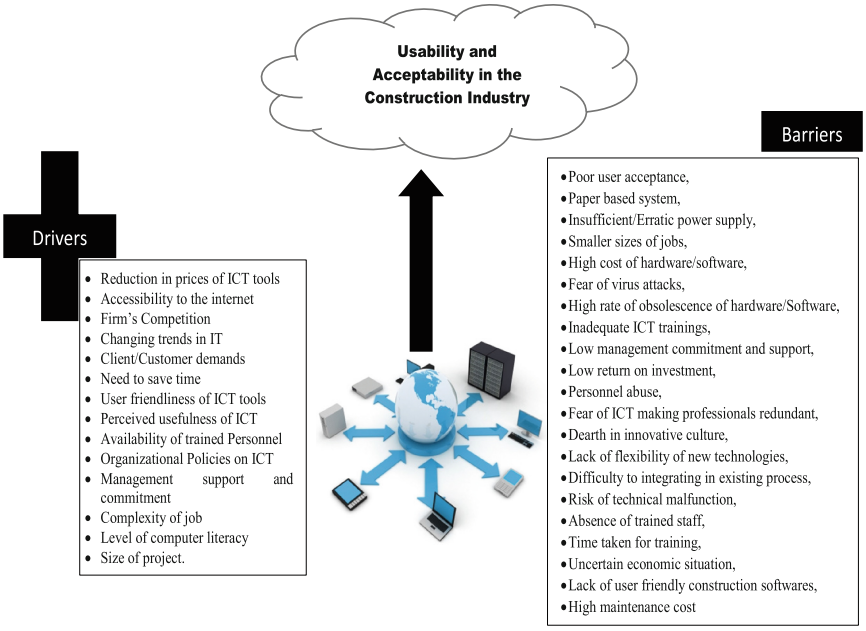

Fig. 1. Drivers and barriers to web-based technologies in the construction industry **Source:** Author's design

technology, commonly employees are not ready to adopt that technology and resist its introduction.

According to [3], the factors impeding the use of ICT in the construction industry include insufficient/erratic power supply, job sizes and fees not enough for ICT, high cost of hardware/software, fear of virus attacks, high rate of obsolescence of hardware/software, inadequate ICT content in construction education, scarcity of professional software, high cost of engaging computer staff, lack of management desire and appreciation of ICT, security, low return on investment, personnel abuse and fear of ICT making professionals redundant. Similarly, [33] identified the main barriers to ICT transformation in materials management as: when the industry believes hard copy is substantial, limited technical life cycle, dearth in innovative culture, lack of flexibility of new technologies, lack of reliability, difficulty to integrate in existing process, risk of technical malfunction, absence of trained staff, resistance from employees, time taken for training, lack of market information, uncertain economic situation, uncertain returns on investment, cost for training staff, high cost of specialist software and maintenance cost.

[13, 17] also believed that lack of user-friendly construction software packages is considered a major barrier to the development of ICT in the construction industry. Figure 1 showed the barriers to the use of web-based technologies in the construction industry.

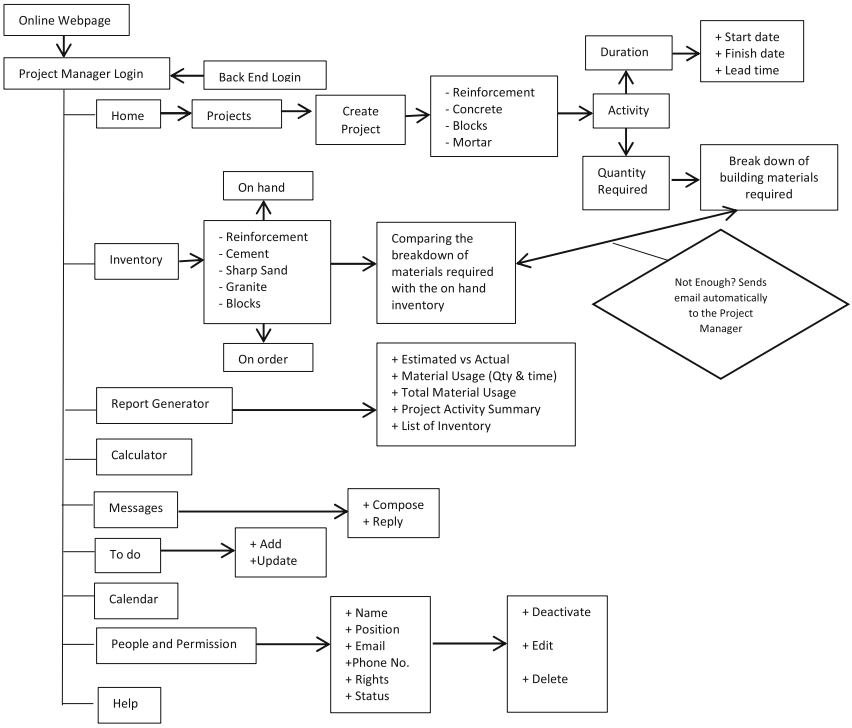

Fig. 2. Architectural design of the WB-MPC **Source:** Author's design

5 System Design and Implementation

According to [34], the development of a successful web application (website) involves many different kinds of design, including functional design, software architecture, business process or workflow design, user interface design, and database design. The purpose of the web-based material planning and control (WB-MPC) model is to have an interactive web-based interface which allows construction professionals to be able to estimate and store building material quantities, while planning and controlling the usage of building materials per time. The system is designed in a way that a shortfall in quantities of selected building materials can be brought to the notice of the construction professional by periodic short messaging systems (SMS) or email format. Figure 2 shows the architectural system design of the web-based material planning and control (WB-MPC) system; an IT system that can be used for managing these processes. The administrator or project manager for the construction site and the back end users can access the platform through a login page. The Director, Head office or any other official permitted through the people and permission can access critical information on the state of building materials to be used and onsite leading to transparency, openness and accountability. In addition, there is a messaging platform where back end users can use to make and send clarifications to the project manager on what was noticed about the ongoing project. The

messaging platform also stores the previous messages that have been sent to the project manager about shortfalls in the building materials on site.

6 Conclusion and Recommendation

The study developed a driver and barrier framework for the effective use of web-based technologies in planning and control of building materials. The study showed the architectural design of an IT system for managing building materials' planning and control processes using web-based technologies. The study recommended the use of web-based technologies in the construction industry in order to engender administrative efficiency, transparency, openness and accountability. In addition, there is need to increase the investment in ICT and ICT training of construction professionals in the construction industry.

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