Dama Academic Scholarly Journal of Researchers | Published by: Dama Academic Scholarly & Scientific Research Society

https://damaacademia.com/dasj August 2020 Pages: 01-28 Volume 5 | Issue 8

Analyzing the Critical Barriers to ICT Application in Materials Management Processes in Ghanaian Construction Industry

Paul Kwabla Afatsawu
Akatsi College of Education
Email: paulbless2012@gmail.com

Abstract

Effective and efficient use of construction materials is very crucial in achieving project success. Increasingly, construction companies need to develop competitive advantages based on an adequate and intensive use of information and communication technologies (ICTs) to enhance the efficiency and effectiveness of construction Material Management Processes. The aim of the dissertation was to explore the application of ICT to materials (MMP) in the construction industry in Ghana. The research design adopted was a quantitative approach using survey questionnaires to collect field data. The key findings included: Organizational Policy, Identification of materials and supervision of workers for usage of store materials, tracking of materials movement and quality materials from suppliers and Working relationship and formal training. Also, it was found that ICT tools application in MMP have positive significant impact on labour productivity (LP). Key barriers that militate against the application of ICT tools included; Technical, environmental and legal reasons, Financial Reasons and Complete Technical Reasons. Benefits identified included; More cost effective projects are achieved, expedite purchasing processes of construction material, Reduction in craft labour cost, a better standard of work and Completion of construction works on schedule. A descriptive framework for categorizing major enabling factors, critical barriers, ICT tools, (LP) and benefits derived was developed. It is recommended that, Stakeholders of construction education in Ghana should make sure that they have adequate ICT content in construction education in addition; Materials managers should have much commitment towards ICT tools application in (MMPs).

Keywords: Materials Management Processes, Ghanaian Construction Industry, Critical Barriers to ICT Application

2.0 LITERATURE REVIEW

2.1 ICT Tools/Software for Materials Management Processes (Model)

2.1.1 Model description Navon and Berkovich (2006) indicated that the model comprises of five units (Fig. 2.9and Fig. 2.10) (1) Input Unit, (2) Purchasing Unit, (3) Tracking Unit, (4) Analysis

Unit and (5) Output Unit. The Input Unit uses data stored in the Planning Database (PD). The PD includes data regarding the schedule of the project, the planned quantities and inputs associated with each activity, as well as catalogues of construction materials. It is assumed here that all these data are up-to-date, which means that this database is updated every time there is any change in the schedule, or a change order is issued, etc. The Input Unit periodically calculates the materials needed for pending activities („PD Interface"). The pending activities are all the activities whose predecessors are completed and the ones whose early start falls within a specified time duration (defined by the user).

The result of this calculation is recorded in the Required Materials file, which lists the activities in the specified time duration, the quantities of materials, the time when the material is scheduled to arrive, or be used, etc. The Purchasing Unit determines which materials are to be ordered, based on the data in the required materials file, Decision Rules and the inventory of the materials on the site. The algorithm of the Purchasing Unit is detailed in Section „Purchasing unit". The Tracking Unit records the incoming materials and the ones dispatched for use. The data relating to the arrival of materials and their use are collected with Automated Data Collection (ADC) technologies such as barcode or RFID. The Unit follows up the rolling and the dead inventories. The algorithm of the Tracking Unit is detailed in Section, „Tracking Unit'. The Analysis Unit receives data from the Purchasing and from the Tracking Unit and generates the data for the Output Unit. The Unit compares between the planned and the actual quantities of materials and, based on this, makes recommendations.

https://damaacademia.com/dasj August 2020 Pages: 01-28 Volume 5 | Issue 8

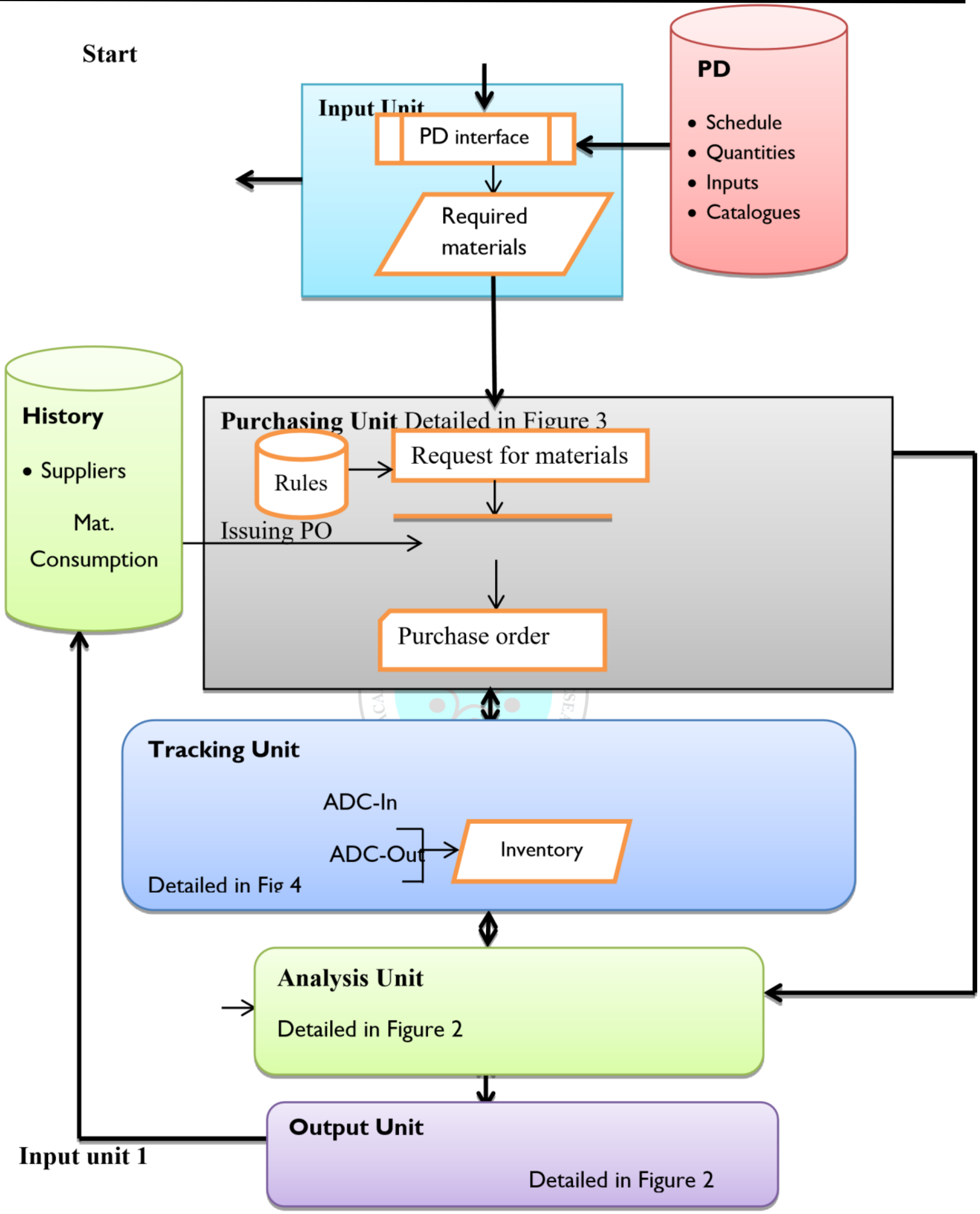


Fig.2.9: Model Architecture
Source: Navon and Berkovich (2006)

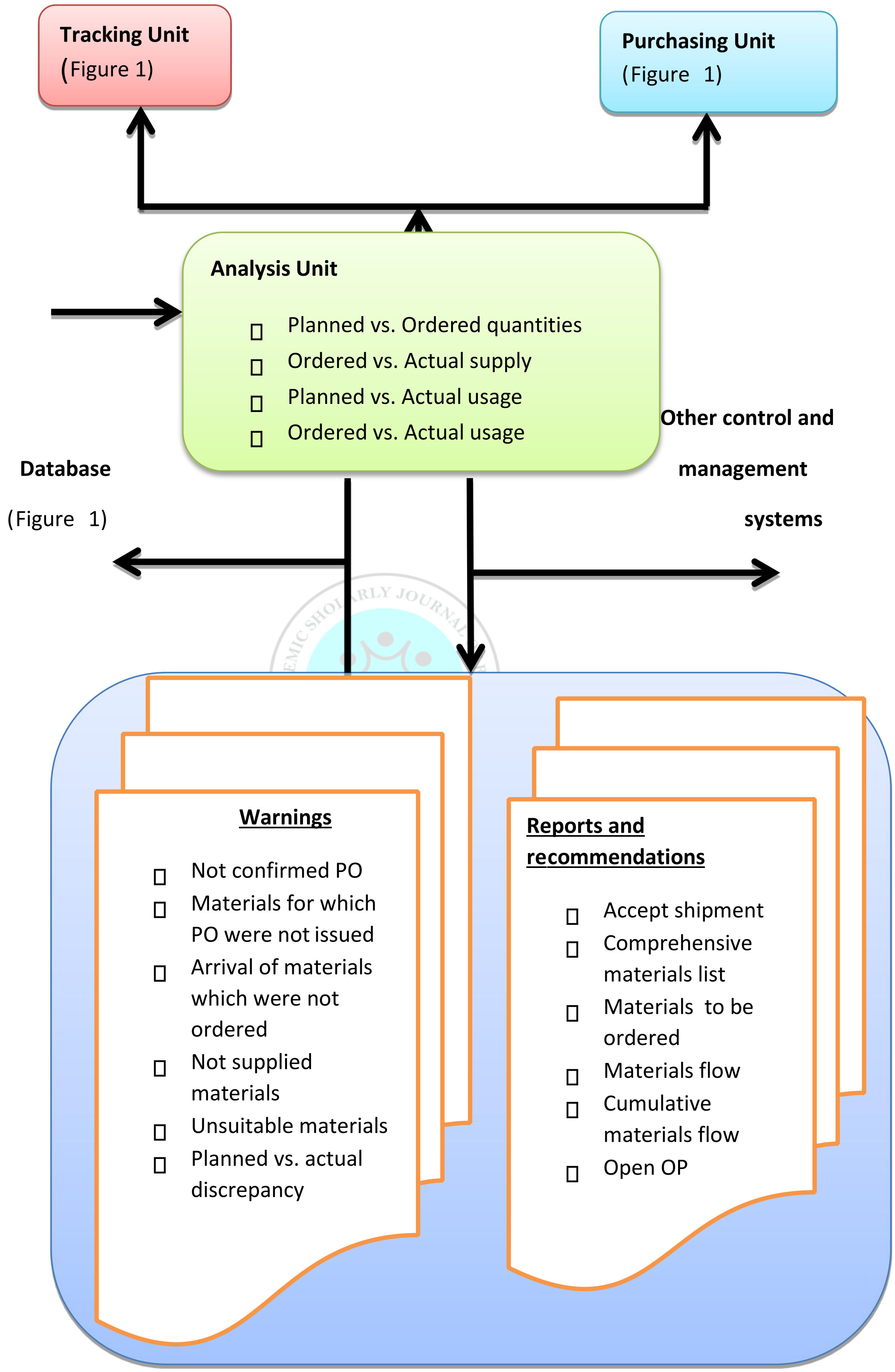
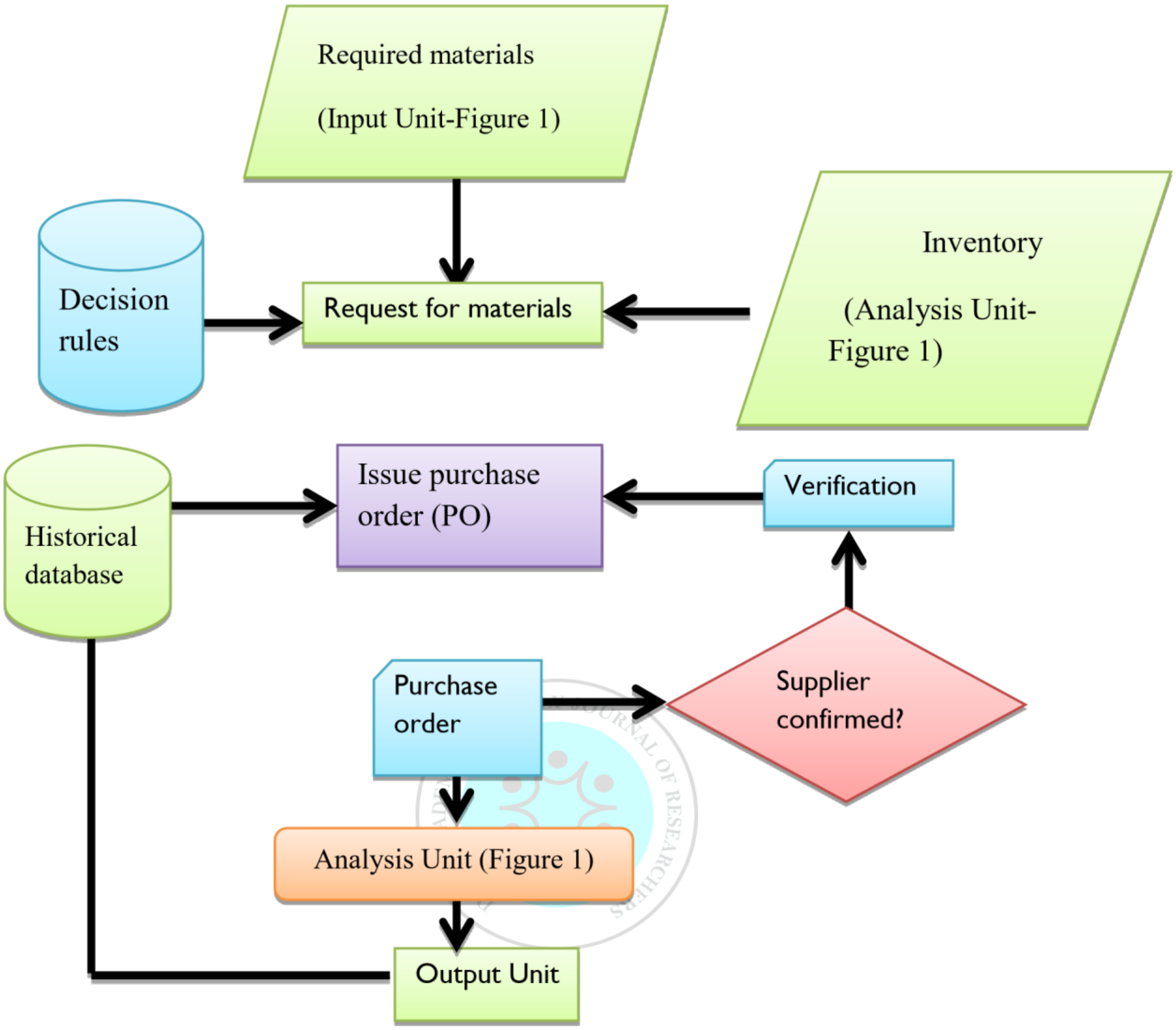


Fig. 2.10: Model architecture (continued)

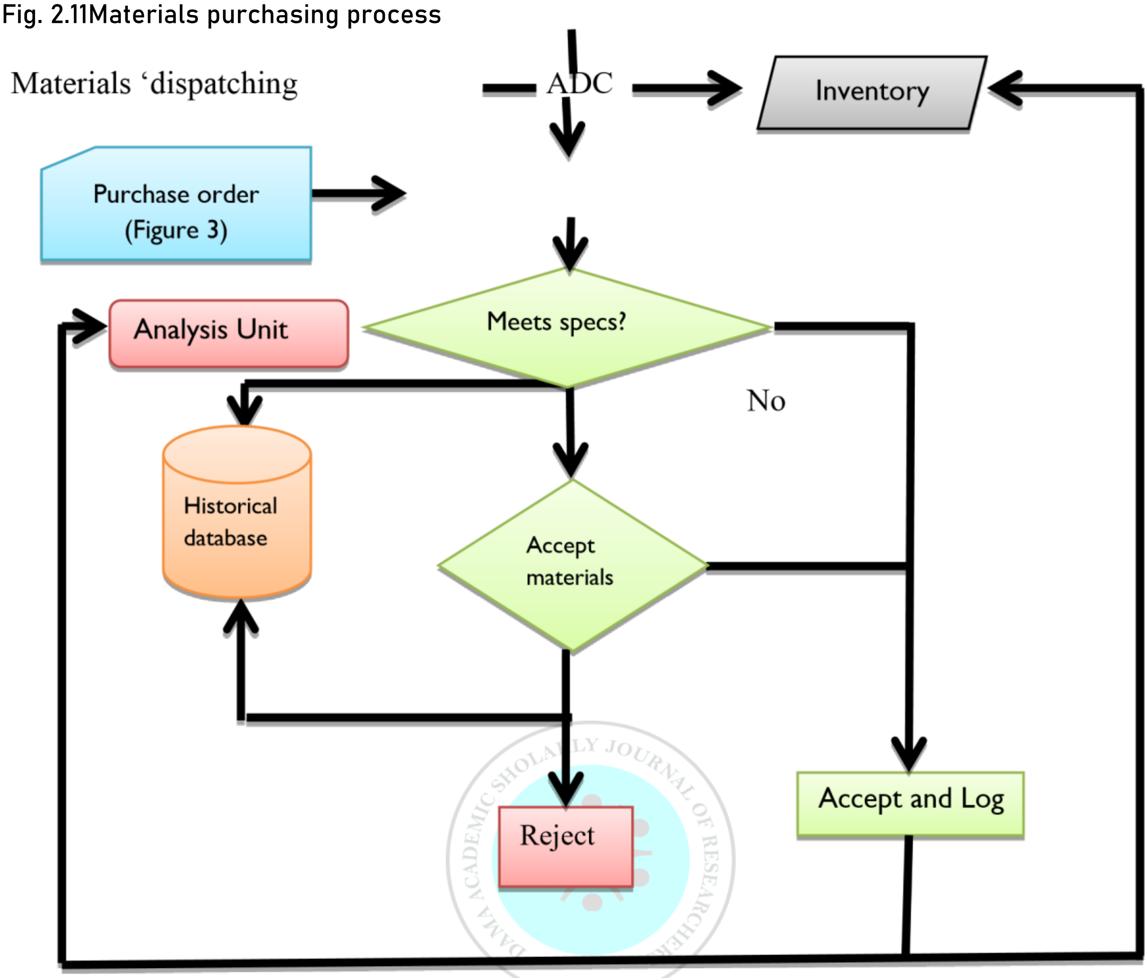
Source: Navon and Berkovich (2006)


Required materials
(Input Unit-Figure 1)
Decision rules
Request for materials
Inventory
(Analysis Unit-Figure 1)
Historical database
Issue purchase order (PO)
Verification
Purchase order
Supplier confirmed?
Analysis Unit (Figure 1)
Output Unit

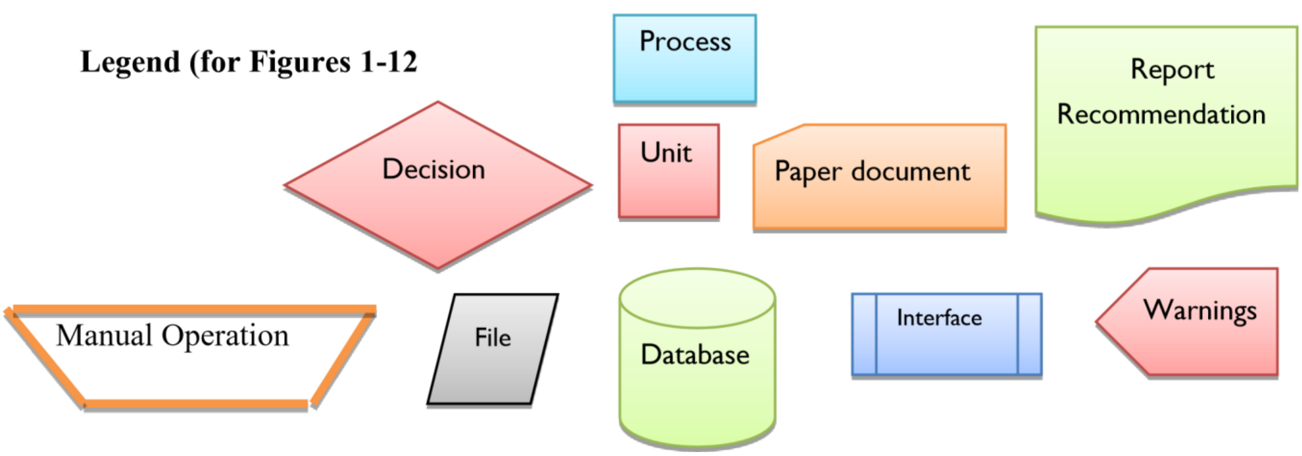
Dama Academic Scholarly Journal of Researchers | Published by: Dama Academic Scholarly & Scientific Research Society

https://damaacademia.com/dasj August 2020 Pages: 01-28 Volume 5 | Issue 8

Fig. 2.11Materials purchasing process



Source: Navon and Berkovich (2006)
Yes



It is clearly identified that these are important for effectively managing materials in the construction industry in order to provide better handling of construction materials, overall performance of construction projects in terms of time, budget (cost) and labour productivity. In the contrast, Patel and Vyas (2011) contended, in a case study on manual material management, that, there should be a centralized material management team co-ordination between the site and the organization, Proper control, tracking and monitoring of the system is required. Awareness and accountability should be created within the organization. Furthermore, there is a need of an efficient materials integration system (MIS) integrating all aspects of material management. Firms employing proper material management system are seen to have increased their overall efficiency by 35%.

2.2 Radio Frequency Identification (RFID) Technology in Materials Management

RFID technology has grown dramatically in usage by industries such as production, manufacturing, retail, distribution and etc. Nevertheless, the RFID application has a short history in the construction industry. However, the construction sector in the UK has shown interest in how a number of applications such as tags can be incorporated into boilers and doors, also which can be used by most housing associations and facilities management (FM) for asset management systems (Innovation & Research Focus) and (Kasim et al., 2013). Past experienced in the UK construction industry has been carried out into the use of RFID in quality control, logistics tracking, system or component build, waste reduction, and asset management. RFID technology is becoming cheaper and should offer construction new opportunities to improve maintenance of assets. It can provide potential savings (money and efficiency) through; labour productivity improvements; availability of „real time" data capture; job tracking; better quality control; better stock control; reduction in paperwork; reducing the incidents and associated cost of sending incorrect products to site; improvement in customer information; web-enabled customer information system; improved health and safety (Kasim et al., 2013).

Schneider (2003) stated that the RFID systems can also provide the industry with the potential to improve construction labour productivity, quality, safety, and economy, cutting labour and material costs and enhancing project schedules. According to Wood and Alvarez (2005) mentioned that the use of RFID will indeed help achieve effective results in the construction industry such as tracking and managing unique tagged materials through the supply chain and on the construction site. They also stated that examples of RFID applications in materials management are as follow:

Inventory tracking: RFID systems can enable automatic, real-time, error-free tracking and inventory of unique materials through the supply chain from fabrication, transport, receipt, site storage, and issue to installation. For example, a pipe spool can be automatically identified as they are shipped and received and reduced error-prone in current manual identification, updating and immediately downloaded electronically into materials management systems without manual data entry.

Streamlined materials tracking and expediting: RFID-enabled process can deliver material status information earlier than the current manual processes, provide field planners with reliable advance information, and be able to optimize planning on schedule critical tasks or quickly find available work for crafts that might otherwise be temporarily under-utilized.

Accurate material status and inventories: Provide accurate information about shipping, receiving, and inventory to avoid items missing, misplaces, or not received which can cause schedule disruption. This situation can easily be supported by using a hand-held reader, for example, to confirm possession of material that may have been placed or moved to an incorrect location within a yard. Many research projects have been conducted for the past few years to explore the possibility of implementing RFID technology in the construction industry. These include:

- The implementation of RFID technology to monitor planning of the materials usage in a water supply project which suffers from poor materials management due to the complex operational environment (Ren, Sha & Hassan 2007);
- The application of RFID for tool tracking on construction job sites by developing a tool tracking and inventory system capable of storing operation and maintenance data (Goodrum, McLaren, & Durfee, 2006)
- Development of an automated model for materials management and control with the application of RFID technology (Navon, and O. Berkovich (2006);
- A model to track the progress of percentage completed in construction projects by the adoption of RFID and wireless technologies (Ghanem, Razig, & Mahdi,2006);

- Automating the task of tracking the delivery and receipt of materials in projects by using RFID technology to address some problems of current methods for tracking (Song, Haas, Caldas, Ergen, & Akinci, 2005);
- The utilization of RFID for tracking precast concrete components and their historical information from fabrication to post construction (Akinci, Patton, & Ergen 2002);
- The development of a prototype system for identification and partial tracking of structural steel members at the construction site (Furlani, & Pfeffer, 2000).

Radio frequency identification (RFID) technologies use active and passive tags in the form of chips or smart labels that can store unique identifiers and relay this information to electronic readers. Tag- is a microchip that holds data using electronic product code (EPC) and antenna that transmits data to a reader. Reader uses radio waves to read the tag and sends the EPC to computers in the supply chain (Usman & Said, 2012) as cited in Kasim et al. (2013).

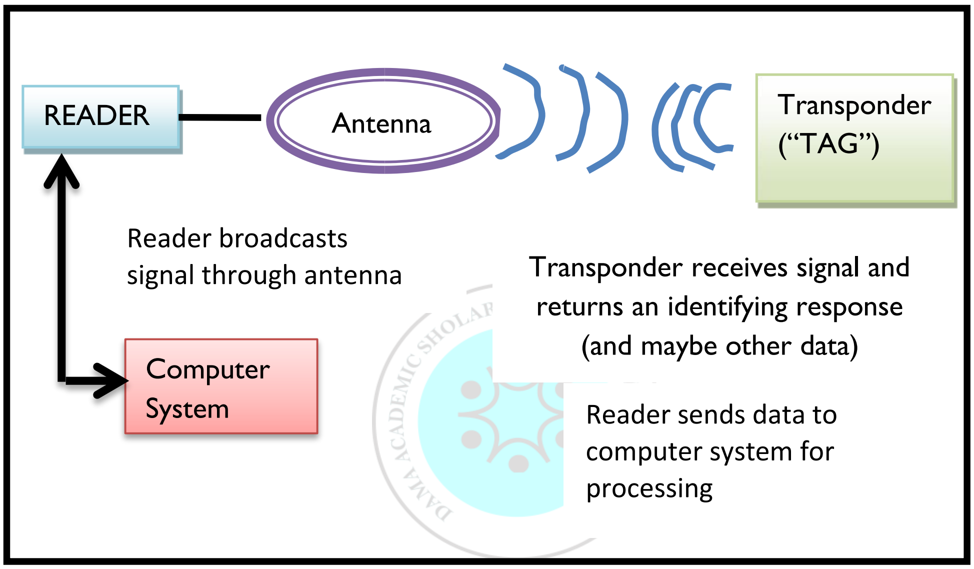


Fig . 2.13: How RFID Works
Source: Wood and Alvarez, 2005).

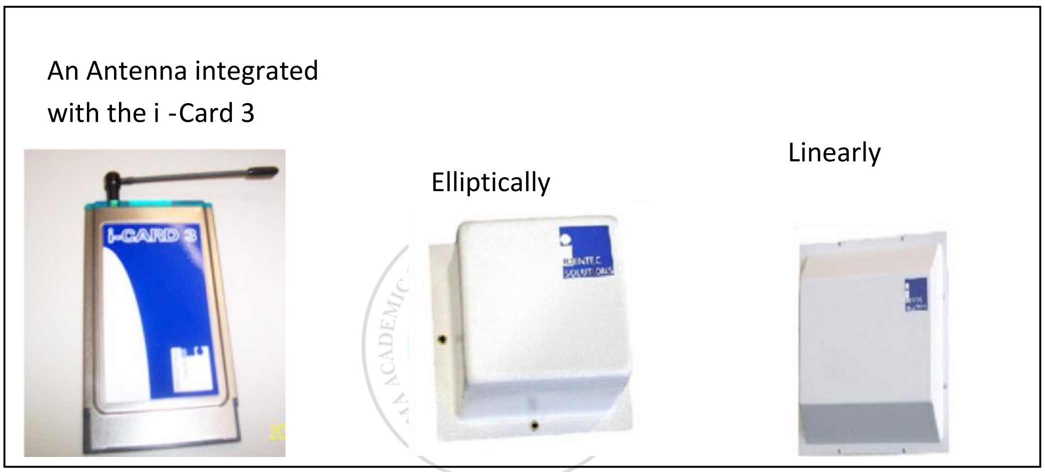
Kasim et al. (2013) assessed that there are two primary components of RFID system as shown in Fig. 2.13. The whole RFID system requires the tags and the reader including an antenna to be operated. The RFID tags or transponder are normally located on the object or people to be identified. The RFID reader or interrogator provides, read and write/read facilities through a fixed or mobile reader to communicate data to and from the tags.

2.7.2 RFID Readers

RFID readers or the interrogator typically contains a radio frequency module (transmitter and receiver), a control unit and a coupling element to the transponder (Finkenzeller, 2003). According to Wood and Alvarez (2005) the RFID readers may be fixed or mobile and capable of communicating data to and from the tags to share data with the larger information system they support. The data is exchanged between tags and readers using radio waves. The mobile RFID readers can be integrated (fitted) into personal computers (PCs), handheld computers (such as PDAs, notebook PCs, tablet PCs), or stationed and positioned at strategic points such as a facility entrance or on an assembly line (Schneider 2003). The RFID readers included an antenna for sending and receiving signals to give instructions and information to the reader through the scanner. The information provided in the scanner is converted into a digital format by the reader, which the computer can then use for data analysis, recording, and reporting.

2.3 RFID Antenna

An RFID antenna is the conductive element that enables the tag to send and receive data (RFID Journal, 2007). The antenna attached to a reader functions to transmit an electromagnetic field that activates a passive and active tag when it is within reading range. Fig. 14 shows some other examples of the RFID tags antenna such as an antenna integrated with the i-Card 3 (Fig.14 (a)) and elliptically and linearly polarized antennas (Fig. 14 (b)). The elliptically polarized antennas are desirable when a large quantity of tags needs to be read at one time, or when tags moving at great speeds need to be interrogated. The linearly polarized antennas are more suitable for selective data collection and restriction of read zones or when tags moving at great speeds need to be interrogated ("Identec Solutions", 2004).



(a) i -Card 3 with an Antenna (b) Polarized Antennas

Fig. 2. 14. Examples of RFID Antennas (source: Identec Solutions, 2004)

Sardroud (2012) advised that Identification is a powerful capability which is useful in classifying, counting and organizing objects that are vital to many aspects of modern management. Automatic Identification (Auto-ID) technologies, also referred to as automatic data capture technologies, are used to gather data on objects or users, such as items, animals or humans, and identify them using minimal or no worker input. There are five major forms of Auto-ID technologies. These technology elements are: Barcode systems, RFID systems, Smartcards, Biometric systems, and Optical Character Recognition (OCR). It is important to consider the appropriate forms of Auto-ID to be used for any identification application. Variables should be taken into account, such as affordability, ease of use, data storage capacity, read range, life expectancy, multi label reading (rather than one at a time), fast read rates, resilience to ambient noise and interference, readability, and maintenance cost. He further projected that there are some principal advantages that RFID has over barcodes. These are:

- A unique code, RFID tags are able to identify every item individually.
- RFID systems are capable of reading multiple tags simultaneously and instantaneously, and can cope with harsh and dirty environments. Theoretically, this allows a pallet of mixed products, containing individual RFID tags and equipped with an RFID reader, to read all tags within the palletized load, without having to physically move any of the materials or open any cases.
- RFID tags can hold greater amounts of data, and data on tags can be read or updated without line of sight. In interactive applications, such as work-in-process or maintenance tracking, the read and write capability of an active RFID system is also a significant advantage.
- Tagged items can be automatically tracked without worker input, eliminating human error.

https://damaacademia.com/dasj August 2020 Pages: 01-28 Volume 5 | Issue 8

- RFID tags are reusable, more durable and suitable for a construction site environment, and they are not damaged as easily as barcodes.

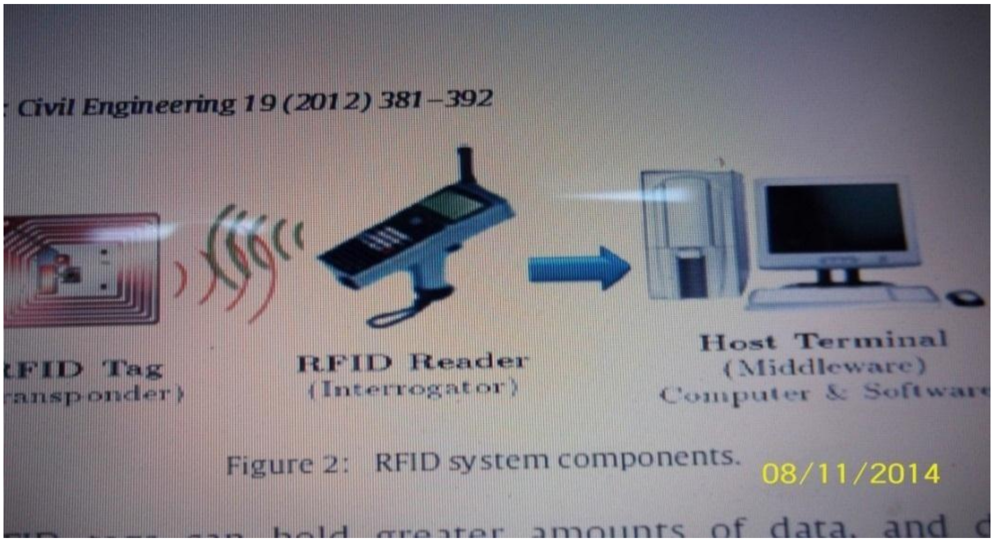


Fig. 2.15: RFID system components (Source: Sardroud (2012).

This is a schematic representation of RFID-GPS based management tool architecture. The hardware of the system mainly consists of three types of hardware component, namely:

Global Positioning System technology (GPS receiver): GPS was selected as the technology in system positioning and the material location tracking segment. In order to track the location of materials, GPS was used for positioning equipment that transports materials, or positioning the location of the system. In otherwise, Global positioning system (GPS) is a device that determines current latitude, longitude, speed, and direction movement. Automobiles have GPSs linked to maps that display in a screen on the dashboard driving directions and location of the vehicle. Some cell phone provides their phones with GPS chips that enable users to be located within a geographical location about the size of a tennis court (Usman & Said, 2012).

Global System for Mobile communications (GSM technology): The system is then synchronized over the GSM network via SIM cards, and the information (ID, date, and location) retrieved from RFID readers and the GPS is transferred to the server in the form of General Packet Radio System (GPRS). Therefore, data collection and transmission are done continuously and autonomously (Sardroud 2012). The Fig 2.16 shows a sample of the proposed integrated system, which is capable of working just with the High-Frequency (HF) RFID reader.

https://damaacademia.com/dasj August 2020 Pages: 01-28 Volume 5 | Issue 8

Fig.2.16: A sample RFID-GPS based integrated system (Source: Sardroud (2012)

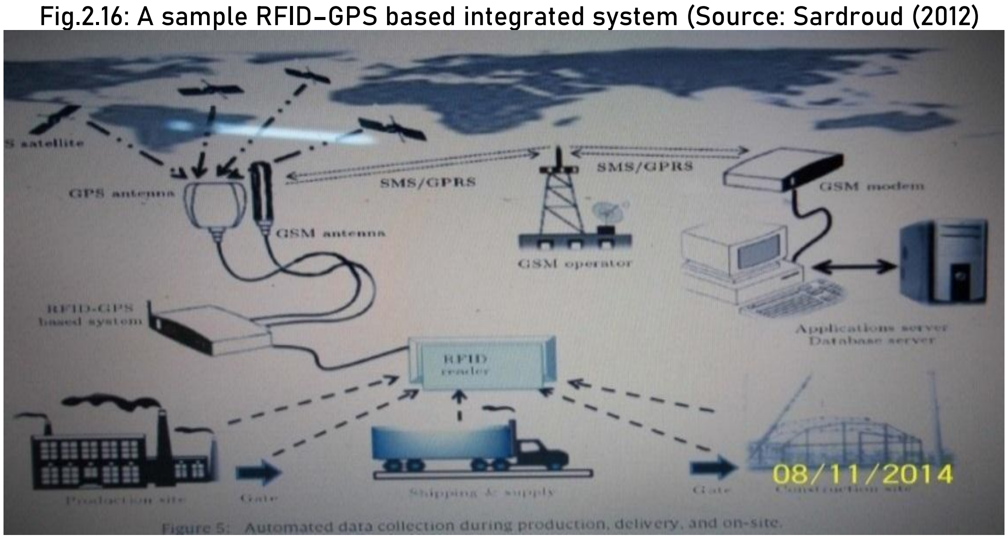


Fig. 2.17: Automated data collection during production, delivery, and on-site.
Source: Sardroud (2012)

Wireless Technology: Usman and Said (2012) explained that Wireless Technology gives users a live (internet) connection via satellite or radio transmitters. International Corporation forecasts that by 2010 nearly two-thirds of handheld devices will include integrated wireless networking. Like file transfer protocol (FTP) is used to transfer computer files over a network, integrated services digital network (ISDN) is an international communications standard for sending voice, video, and data over telephone wires. In other words, the term wireless network is generally used to describe a collection of devices (computers, telephones, PDAs etc.) that are connected using radio signals. Wireless networks tend to operate over short distances, although using specialist equipment can extend this.

Web Camera (webcam): Webcam is a video camera that is used to send periodic images or continuous frame to a web site for display. Webcam software typically captures the images as JPEG (joint photographic experts group) or MPEG (moving pictures experts group) files and transfers them to the internet (Usman & Said, 2012).

Project Extranets or Project Specific Web Sites: Project extranets or Project Specific Web Sites are web based applications for providing collaboration through ICT investment platform to perform typical project management tasks such as storing and managing project information (Becerik, 2004). It is a network that uses Internet protocols and public telecommunication system for communicating both privately and selectively with the contractor"s client and business partners. Other terms and acronyms used to describe the same collaboration platform include Web Based Project Management Systems

(WPMS) and On-Line Project Management (OPM) (Colwell, 2008). Project owners, designers, contractors and suppliers can share information and in so doing improving communication, coordination and collaboration. The technology may also allow for instance, contractors to securely share part of its company information resources with suppliers, subcontractors, project partners, clients or other companies (Bowden, 2005). Typical features include document control (including version control), task automation, file and workflow tracking, electronic design review and file viewing capabilities. Typical documents include drawings, specifications, reports and schedules. Up to date information is available to everyone on the team. Portal access by contractors, subcontractors and suppliers will reduce costs through access to information (Colwell, 2008).

Facebook: Facebook can be defined as a social networking website. It is also social utility that connects people with friends and others who work, study and live around them. According to Vander-Veer (2008) facebook is the wildly popular, free social networking site that combines the best of blogs, online forums, photo sharing, clever applications, and interaction among friends. Facebook is part of a broader transformation of the internet called web which helps people to communicate more efficiently with others, is one of the world"s most trafficked web sites (Tamara, 2008).

Electronic mail (Email): Email is one of the successful computer applications, which has contributed to the growth of distributed organizations, by allowing people at different geographical areas to communicate (Whittaker & Sidner, 1996). Email is a highly effective way of communication but sometimes time consuming and can compromise the security of an organization because sensitive information can be distributed intentionally or accidently. Likewise, some emails may carry viruses.

Intranet: Intranets are communication infrastructure that is based on communication and content standards of the internet. With intranet, access to information is restricted only to the construction company"s personnel. Construction companies can set up an intranet to allow project managers to access data from both central data banks and different projects (Hore & West, 2005).

Twitter: Twitter is a social networking and microblogging service that allows you answer question by sending short text messages, 140 characters in length, called "tweets", to your friends, or "followers." It has many uses for both personal and business use. It is a great way to keep in touch with your friends and quickly broadcast information about where you are and what you are up to (Usman & Said, 2012).

Electronic Data Interchange (EDI): Admittedly, construction projects always involve the collaboration of a multidisciplinary project team located in different parts of a country. Some may be resident on site, others located in an office. The advent of the Internet has greatly enhanced the operational scope of collaboration tools. One example is the application of Electronic Data Interchange (EDI). Electronic Data Interchange (EDI) is the exchange of structured data according to agreed message standards between computer systems (Harris & McCaffer, 2001). These data transfer is achieved by electronic means without human intervention. Indications are that, Electronic Data Interchange (EDI) has also become a preferred way of compressing and transmitting data between a buying firm and its suppliers in many sectors. Example of EDI application in the construction includes procurement of 46 materials or other project procedures that employ document type processing such as invoices (Peansupap, 2004).

Webcast: Webcast is a web broadcast in which a live event is presented to a large number of web users from a website, it allows for interactive user participation (Webfinance, 2012). Webcast use the internet to broadcast live or delayed audio and/or video transmissions.

YouTube: YouTube is a web-service that allows anybody to post their video files and share them with other people. There are many kind of information that can be found on YouTube like tutorials, marketing, video-blogs, news, lectures etc. (Usman &Said, 2012).

Video Conferencing/ Teleconferencing: Video conference is a means of conducting a conference between two or more participants at different sites by using computer networks to transmit audio and video data. It has made a significant achievement in business, education, medicine, and media. In other word, video conference is a live connection between people in separate locations for the purpose of communication, it provides transmission of static images and text between two locations and it also provides transmission of full motion video images and high-quality audio between multiple locations (Teachtarget, 1997). It can also be defined as communication technology that integrates video and audio to connect users anywhere in the world as if they were in the same room, it saves time and money

(Anissimov, 2012). Teleconferencing is a technology that allows a group of people to confer simultaneously from different location.

Communications within this technology can be in the form of texts, audio and visual formats through the use of computer systems. In the construction industry, use of teleconferencing can allow all parts of a construction project/ projects can become one community to allow for an improved and effective administration. Examples of this form of teleconferencing include Data conferencing and Video conferencing. Data conferencing allow interaction between parties to confer over text and graphic document only. For instance, designers located in different geographical regions can work on the same drawings simultaneously.

Barcoding and RFID Tracking System: Modern technologies can also play a role in material management. For example, almost two decades ago, Stukhart (1990) identified barcoding as helpful for the easy identification and retrieval of materials. Since then, barcode asset management system has been recommended in the "BSRIA Guidance Note – ACT 5/2002" to streamline the processes of procurement, delivery, installation and inspection on site, and to reduce time on site collecting, handling, monitoring, controlling and re-ordering effectively and productively (Dicks, 2003). Hawkins (2003) found that between 5 per cent and 10 per cent of tools and equipment are normally lost on construction projects that do not employ an asset management system and much time is spent on stock-taking, report generation and material
collection.

3.0 METHODOLOGY

This chapter discusses the methodology adopted for the study base on following sections; Research Design, Population, Sampling Technique, Data
Collection and Analysis of Data.

3.1 Research Design

The design is the structure of any scientific work. It gives direction and systematizes the research, the method selected will affect results and how the findings are concluded. Creswell (2009, 3rd Ed.) admits that research designs are plans and procedures for research that span the decisions from broad assumptions to detailed methods of data collection and analysis. Also, the overall decision involves which design should be used to study a topic. Therefore, in order to achieve the objectives of this study, the research design adopted is based on survey. There are types of survey designs to mention but few, Qualitative, Quantitative and Mixed Methods (Cohen, Manion & Morrison, 2011; Creswell, 2009). Creswell and Clark (2007) apparently opine that qualitative research is the means for exploring and understanding the meaning individual or group ascribe to a social or human problem and those who engage in this form of inquiry support a way of looking at research that honors an inductive style. In contrast, quantitative research is a means for testing objective theories by examining the relationship among variables. These variables in turn can be analyzed using statistical procedures. Unlike qualitative research, those who engage in this form of inquiry have assumptions about testing theories deductively, building in protections against bias, controlling for alternative explanations and being able to generalize and replicate the findings (Creswell, 2008). On the other hand, Creswell (2008) holds that mixed method research, involve the use of both qualitative and quantitative approaches and mixing of both approaches in a study. Thus it is more than simply collecting data and analyzing both kind of data; it also involves the use of both approaches in tandem so that the overall strength of study is greater than either qualitative or quantitative research.

Having carefully assessed the characteristics of the survey research designs, and the objectives of this study, quantitative research design is adopted for the study. Integral to this approach is the expectation that the researcher will set aside his experiences, perceptions and biases to ensure objectivity in the conduct of the study and conclusion that are drawn. Key features of many quantitative studies as assessed in the literature are the use of instruments such as questionnaire test or survey to collect data and reliance on probability theory to test statistical hypotheses that correspond to research questions of interest. In addition, quantitative strategies have involved complex experiments with many variables and treatments (e.g. factorial design and repeated measure design). They have also included

https://damaacademia.com/dasj August 2020 Pages: 01-28 Volume 5 | Issue 8

elaborate structure equation models that incorporate causal paths and the identification of the collective strength of multiple variables (Creawell, 2009). Pretty much, the choice of quantitative research design was based on the review of empirical work done on construction materials management by Babatunde and Olusola (2012), Jeruto and Mutwol (2012), Sadroud (2012) and Kasim et al. (2013) using face-to-face structured interview, qualitative approach and content analysis, case study using questionnaire. These previous works have actually failed (to the best of my knowledge) to consider various relationship of the factors identified using quantitative, census approach method and multiple regression to determine how the factors identified relate to each other and contribute to labour productivity in the construction industry.

3.2 Population

Kothari (2004) described a population as all the items under consideration in any field of inquiry. In order to achieve the objectives of the study, the construction companies that are registered with Association of Building and Civil Engineering Contractors of Ghana (ABCECG) are selected as the population for the study. The literature indicates that construction activities on going in the country (Ghana) are more concentrated in the two regions, Greater Accra and Ashanti Region due to the population and demands on infrastructure, these have led many experience contractors to have their company registered in the two regions. Therefore, it will be representative in nature if these two regions are used as the population for construction companies that registered with ABCECG with good standing in the regions. The target population in order to achieve the objectives of this study is the Site Engineers/Project Managers currently working with the registered construction companies with good standing in Greater Accra and Ashanti Region.

3.3 Sampling Frame

The study drew its sample frame from the Association of Building and Civil Engineering Contractors of Ghana (ABCECG) registered list of good standing contractors in the Head Office, Accra (Darkuman Junction off Kaneshie Odorkor Road). There were 1,230 registered members as at 27th Feb. 2015, at 16:25 GMT when the data was obtained.

Table 3.1: Association of Building and Civil Engineering Contractors of Ghana (ABCECG) Registered List of Good Standing Contractors

Regions	Number of Registered Members	Percentages (%)
Greater Accra	300	24.39
Ashanti Region	150	12.10
Western Region	150	12.10
Eastern Region	150	12.10
Brong Ahafo Region	80	6.50
Northern Region	70	5.69
Upper West Region	60	4.88
Upper East Region	70	5.69
Central Region	100	8.13
Volta Region	100	8.13
Total	1230	100

Statistically, from the Table 3.1, Greater Accra and Ashanti region represent 36.59% of the Total registered members in the (ABCECG) and the same 36.59% for Western Region and Greater Accra likewise Eastern Region and Greater Accra whereas the remaining eight Regions in Ghana account for 63.4% of contractors registered with (ABCECG) if any paired of these regions is to be considered as the site for the study. In appendix II, List of Ghanaian regions by population, ranked according to the latest census, which took place on 26 September 2010. Past census data (1960, 1970, 1984, and 2000) is included for comparison.

The record indicated that Ashanti and Greater Accra region have the highest population. These could be a driving factor for most experience construction companies to work in these regions since the population demands on infrastructure, such as Shops, Buildings, Factories, Road- Networks and other construction related project, will certainly be high. Therefore, the researcher conveniently selected registered contractors in Greater Accra and Ashanti region from the list of ABCECG membership of the ten (10) regions for the study. The characteristic of these construction companies (site engineer's/ project managers) could hold a representative view of other construction companies in the regions due to different kinds of job availability in the regions. Based on this, the study was limited to these two regions in Ghana.

3.4 Sampling Technique and Sample Size

The sample size of this study was determined using census approach method. This was deemed to be necessary because, the researcher consulted PWD, Ghana Highways, Urban-Road and Feeder-Roads in the two regions in other to use the contractors that registered with them. It was revealed that the contractors were very many and majority were not having offices in other to locate them easily to answer the questionnaires so it was more convenient dealing with a sizable population of contractors that have a characteristic of representing other contractors in the region (Greater Accra and Ashanti). Therefore, contractors registered with ABCECG in Greater Accra and Ashanti with total population of (450) construction companies, were used to enable the researcher to generalize the findings for the whole population of construction companies in the two regions respectively. United Nation report (2010) indicated that a survey on the census method is vital for providing information about the population in order to present a full and reliable picture of the population. It also provides essential information for policy development and planning for managing and evaluating programme activities across a broad range of sectoral application.

Baffour, et al (2013) confirmed that, the census is also the best, if not the only, source of information on small population groups in terms of area or membership. Additionally, the census is a pivotal part of the official statistics produced by a country because it, typically, provides the benchmark for the population count at national and local levels. Finally, a country"s census information is used by international organisations in projections of the world population, and relatedly, it underpins national accounts which allow the understanding of international credit risk. The census has a unique role in both the national and international statistical system.

3.5 Data Collection

The strategy and approach to employ in collecting data are very important for effective and reliable data to address the purpose of the research. Research strategy is defined as the way in which the research objectives can be questioned (Naoum, 2001). There are three types of research strategies, and this includes quantitative, qualitative and mixed method (Creswell, 2009). For this study, quantitative strategies were used in order to give a broad generalized set of findings concisely and parsimoniously by measuring reaction of large number of contractors to limited questions. These, according to Zhang, (2000) helps in comparison and statistically aggregating of data and it requires the use of standardized instrument so that the varying perspectives and experience of people can fit a limited number of predetermined response categories, to which numbers are assigned and measured statistically. The approach to be adopted for collecting data in social science research depends on the nature of the investigation and the type of data and information that are required and available. This includes experimental, archival, case problem solving and survey (Naoum, 2001). This study was based on survey because; it enabled the researchers to use smaller groups of people to make inferences about larger groups which was prohibitively expensive to study (Holten & Burnett, 1997). Otherwise, earlier researchers on construction materials management such as Wong and Norman (1997), Gopalakrishnan and Sundaresan (1977), Navon and Berkovich (2004), Kasim (2011) used surveys in their studies.

3.5.1 Questionnaire Development

https://damaacademia.com/dasj August 2020 Pages: 01-28 Volume 5 | Issue 8

The data for this research was collected through the use of questionnaires targeting Site Engineers/Project Managers working with Contractors in Association of Building and Civil Engineering of Ghana (ABCEG)

- To identify major enabling factors to the application of ICT tools in materials management processes in Ghanaian construction industry;
- To assess the impact of ICT application to material management processes on labour productivity in Ghanaian construction industry;
- To identify the critical barriers to ICT application in materials management processes in Ghanaian construction industry; and
- To recommendation on ICT application variables that lead to high labour productivity in materials management processes in Ghanaian construction industry.

3.5.2 The Questionnaire is in two Parts, A & B

Part A was developed to elicit information on demographics of respondents. Part B was also developed to address objectives one (i) to four (iv). Part A is to identify the types of companies and the kind of personnel (Demographics) from whom information was being sought and indeed this was to establish the credibility of the data. The information included in Part A was Age category, Gender, Qualification, Organizational role Number of year practicing. Project awarded in year and. Part B covers questions on four (4) key areas of materials management processes (MMP)and these included ICT tools use in materials management in the organizations, factors that enable the application of ICT tools in materials management, barriers to the application of ICT tools in materials management, Benefit derived, Labour productivity in the organization and last but not the list indicators of ICT tools application.

3.5.3 Construct and Instrument Development

Regarding the development of the instrument for the quality factors (construct) of MMP, the method adopted by Mojtahedzadeh and Arumugam (2011) was chosen for the study. This method was developed by psychologists and it has been widely accepted in the development of an instrument for measuring variables in social sciences (Conca, et al, 2004). For this research, the method was pursued in three stages namely,

- Stage 1-identification of critical success factors
- Stage 2 –measurement of construct by selecting initial quality items
- Stage 3 –performing reliability, detailed item analysis and constructs validity measurement.

Stage 1: Stage one deal with review of literature in order to identify critical success factors on MMP. The process of developing the questionnaire was based on the review of empirical works done by Wong and Norman (1997), Naik, Aditya and Naik (2011), Ademeso and Windapo (2008), Martin (2011), Phen and Chuan (2001), Lamber, et al (1998), Sardroud (2012), Kasim et al. (2013), Alvrez, (2005), Arditi and Mochtar (2000) as cited in Santosh and Apte (2014). Six constructs were developed.

Stage 2: Stage two involves ensuring that the instrument covers all the relevant aspects of MMPs and the whole proposed survey instrument is well worded and understood. Thus, content validity. An instrument has content validity if researchers agree that the instrument is made up of a group of items covering the issues to be measured (Conca, et al, 2004). Content validity is judged by the researchers subjectively.

3.5.4 Validity of Instruments

Validity of instrument is often defined as the extent to which an instrument measures what it purposed to measure (Kimberlin & Winterstein, 2008). An initial questionnaire was sent to Five (5) experts on the subject, thus pilot questionnaire, to check the comprehensiveness of the items under each construct. The feedback from these experts was used to improve the content as well as ease understanding to eliminate ambiguity and duplication of test. The questionnaire was measured within a five point using a scale of1 to 5: strongly disagree (1), disagree (2), uncertain (3), agree (4), and strongly agree (5)

3.5.4.1 Construct Validity

Construct validity is also statistical tool that measures the extent to which the items in a scale measures the same construct (Flynn, Schroeder & Sakakibara, 1994) and can be evaluated by the use of factor analysis. There are two forms of factor analysis; exploratory factor analysis and confirmatory factor analysis (Hair, Anderson, That-am and Black, 2007). According to Hairet al. (2007) factor analysis condenses or summaries the information into a smaller set of new composite dimensions (factors). However, with this study exploratory factor analysis was used. There are two methods of exploratory factor analysis; Principal Component Analysis (PCA) and Common Factor Analysis. PCA is appropriate when researcher is primarily concerned with the number of factors. Therefore, PCA was used in this study.

3.5.5 Reliability

Reliability refers to whether you get the same answer by using an instrument to measure more than once (Zhang, 2000). Reliability is a statistical tool to measure how reproducible the surveying instrument data is (Zhang, 2000). Four methods are used in measuring reliability namely; the split-halves, test-retested, alternative form and internal consistency methods (Zhang, 2000: Hair et al. 2007). For the purpose of this research internal consistency method will be used because it is the most widely used reliable estimate in empirical research (Zhang, 2000; Conca et al., 2004). It is more reliable because it requires simple administration (Suresh- Chander, Rejendran & Anantharaman, 2001). The internal consistency of each factor will be determined by examining each item inter-correlation and computing the Cronbach"s Alpha. The minimum advisable level is 0.7(Nunnally, 1978; Cronchbach, 1951) although it may be reduced to 0.6 in exploratory research (Hair et al., 2007); Conca et al., 2004) and anything less than 0.6 is usually eliminated (Malhotra and Grover, 1998). The proposed success factors whose calculated Cronbach"s α greater than the critical point of 0.70, is said to be highly reliable and internally consistent. Therefore, based on this study the computed Cronbach"s Alpha is (.933) indicating that the instrument used was highly reliable and internally consistent. See Appendix II.

3.5.6 Administration of Questionnaire

Prior to the distribution of the main questionnaires, the researcher piloted it. This stage aimed at minimizing inevitable problems of converting the design of the questionnaire into reality. A little survey was piloted on a small scale in order to ensure the questionnaire"s readability, accuracy, and comprehensiveness to the following participants, two (2) Academician well versed in material management studies, Site Engineers/Project Managers Three (3) with good standing and currently working on site. Their feedbacks including validations and improvements in terms of wording of statements, the overall content, format, layout and suggestions was adhered to before administering the main questionnaires.

The developed questionnaires were distributed to Site Engineers, working in Association of Building and Civil Engineering Contractors of Ghana (ABCECG) in Greater Accra and Ashanti Regions who have active construction sites and of good standing. In other to reach all the respondents in the regions, the researcher sorts the assistance of the various regional secretaries who met the Site Engineers at their regional meetings to distribute the questionnaires. The secretaries retrieved questionnaires in person from the Site Engineers and scheduled with the researcher to pick them. This process of distribution and retrieving of the questionnaires was guided with suggestion made by Ahadzie (2007), that it makes sure that the questionnaires get to the intended recipients and secondly, to help improve the response rate. The questionnaire took a maximum time of 30-35 minutes of respondents" time to answer.

3.6 Data Analysis

Data collected for the study was analyzed base on the research questions using Descriptive statistics including frequencies, percentages, some measures of central tendencies (mean, standard deviation) as well as some inferential statistics (Factor Analysis) were employed in the analysis of the data to make meanings to the responded questions from the respondents. Relative Importance Index (RII) together with some descriptive statistics was also used, in identifying the most important indicators and labour productivity variables. Multiple regression analysis was also used to investigate the relationship

between the dependent variable (Labour Productivity) and independent variables, Enabling Factors (ICT Application variables) and Critical Barriers, which resulted from the factor analysis in ICT application to materials management processes. The data was presented in tables and others were discussed and actual responses were italicized. Statistical package for social scientist (SPSS.20) was used as a tool for the analysis of the data retrieved from the survey as the research was more of quantitative in nature.
Measurement for reliability was done to determine the measurement scale that had been developed. This would produce consistent results if measurement is done on a repeated basis. This study utilized internal consistency method in determining the instrument reliability with the Cronbach coefficient, Alpha, as the relevant coefficient to evaluate. Construct validity was determined by conducting exploratory factor analysis (through principal component analysis) using SPSS.20.

3.6.1 Exploratory factor Analysis (Principal Component Analysis)

Before conducting principal component analysis, two tests were carried out to screen the presence of multi-colinearity or correlation among the items and then appropriateness of factor analysis. The two tests were Kaiser-Meyer-Olkin (KMO) and Bartlett"s tests. KMO quantifies the degree of inter-correlation among the variables and the appropriateness of factor analysis (Field, 2005). Bartlett test of sphericity checks for the presence of correlation among the variables and provides the probability that correlation matrix has significant correlation among at least, some of the variables (Hair et al 2007 and Field, 2005). Kim and Mueller (1978) suggested that KMOs in the range of 0.5-0.6 are considered poor, those in the range of 0.6-0.7 are average, those in the range of 0.7-0.8 are considered good, 0.8-0.9 are great and values greater than 0.9 are superb. In regards this study, the KMO"s values for Enabling factors to the application of ICT tools in materials management processes and Critical Barriers to application of ICT tools in materials management processes based on FA conducted are .870 and .894 respectively and these are considered good.

4.0 DATA ANALYSIS

4.1 Critical Barriers to application of ICT tools in materials management processes in Ghanaian construction industry

The Bartlett"s test of sphericity as shown in Table 4.14 was used to test for the adequacy of the correlation matrix. (i.e. to find out whether the correlation matrix has significant correlations among at least some of the variables). The Bartlett"s test of Sphericity, test the hypothesis that the correlation matrix is an identity matrix, or the variables are independent. From Table 4.14, the Bartlett test of Sphericity yielded a value of 2064.610 and an associated *p-value* of 0.000. Hence by rule, since the *pvalue* (0.000) is less than the default level of significance (0.05), we reject the null hypothesis and conclude that, all the variables are dependent or the variables are fairly dependent or inter-correlated among themselves, hence fulfills the major assumption of FA, therefore we can proceed with the application of FA. (See appendix II), for correlation matrix Table.

Table 4.14: The Bartlett's test of sphericity

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.	Bartlett's Test of Sphericity		
	Approx. Chi-Square	Df	P-value
.894	2924.023	210	.000

The communality section as shown in Table 4.15 presents the proportion of variance in each variable accounted for by each common factors or the communality for a variable is 1 for all variables as shown in Table 4.15. From Table 4.15, at least, approximately 50% or 0.50 of the variance accounted for by each variable in general was accounted for by each common factor.

Tables 4.15: Communalities

	Initial	Extraction

Budget constraint for ICT investment	1.000	.704
Cost of training professional in ICT	1.000	.552
Limited benefit /Low return on investment in ICT	1.000	.616
High cost of employing ICT	1.000	.534
Inadequate ICT content (program) in construction education	1.000	.501
Lack of commitment of firm's management towards ICT	1.000	.635
Inadequate knowledge about return on ICT investment	1.000	.507
Lack of staff with appropriate skill and knowledge in ICT	1.000	.531
Fear of job losses/making professionals redundant	1.000	.557
Satisfaction with existing method of work	1.000	.507
Rapid changes in ICT technologies	1.000	.664
Problem of ICT integration/compatibility in the organization	1.000	.602
Software and reliability problems	1.000	.757
Security concerns/privacy fears	1.000	.688
High rate of obsolesce (no longer in use) ICT products in the Ghanaian market	1.000	.683
Access to relatively cheap workforce	1.000	.561
Majority of client not interested in firm's with ICT base	1.000	.619
Lack of adequate construction jobs in the market	1.000	.515
Risks for liability (debt)	1.000	.561
Lack of legal support for use of ICT in construction projects	1.000	.714
Security implications (privacy fear) of ICT transaction	1.000	.547

Extraction Method: Principal Component Analysis

Table 4.16 presents the number of common factors computed, the eigenvalues associated with these factors, the percentage of total variance accounted for by each factor and the cumulative percentage of total variance accounted for by factors. In deciding on the number of factors to extract to represent the data, the associated eigenvalues with the factors were used. Using the criterion, factors with eigenvalues of 1 or greater were retained to be the extracted factors. From Table 4.16, the first four (4) factors were retained for rotation, being the extracted factors to explain the variables. Also the four (4) extracted factors accounts for almost 60% of the total variance in the data. However, the remaining seventeen factors accounts for approximately the remaining 40%. Meaning larger proportion of the variable/ contribution is being accounted by the four extracted factors hence representative. Therefore, a model with four factors will be adequate to represent the data.

Table 4.16: Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	8.501	40.483	40.483	8.501	40.483	40.483	3.393	16.157	16.157
2	1.453	6.917	47.399	1.453	6.917	47.399	3.153	15.015	31.172
3	1.449	6.898	54.297	1.449	6.898	54.297	3.119	14.851	46.024
4	1.153	5.491	59.788	1.153	5.491	59.788	2.890	13.764	59.788
5	.969	4.616	64.404						
6	.870	4.143	68.547						
7	.827	3.936	72.483						

8	.691	3.291	75.774
9	.639	3.045	78.818
10	.590	2.809	81.628
11	.533	2.540	84.167
12	.493	2.348	86.515
13	.437	2.079	88.595
14	.426	2.028	90.623
15	.387	1.842	92.465
16	.319	1.521	93.986
17	.313	1.489	95.475
18	.293	1.394	96.869
19	.243	1.155	98.024
20	.219	1.041	99.065
21	.196	.935	100.000

Extraction Method: Principal Component Analysis.

Table 4.17 shows the component matrix which represent the unrotated component analysis factor matrix and therefore presents the correlations that relate the variables to the six extracted factors. The coefficients as shown in the Table, also called the *factor loadings* indicate how closely the variables are related to each factor. Unrotated factors results in significant *loadings to factor one only* (i.e. all variables loading highly with one factors), hence making the interpretation of the factors difficult and theoretically less meaningful.

Table 4.17: Component Matrix

	Component			
	1	2	3	4
Budget constraint for ICT investment				
Cost of training professional in ICT				
Limited benefit /Low return on investment in ICT	.660			
High cost of employing ICT				
Inadequate ICT content (program) in construction education	.622			
Lack of commitment of firm's management towards ICT	.633			
Inadequate knowledge about return on ICT investment	.621			
Lack of staff with appropriate skill and knowledge in ICT	.695			
Fear of job losses/making professionals redundant	.708			
Satisfaction with existing method of work	.665			
Rapid changes in ICT technologies				
Problem of ICT integration/compatibility in the organization	.623			
Software and reliability problems	.629			
Security concerns/privacy fears	.672			
High rate of obsolescence (no longer in use) ICT products in the Ghanaian market	.636			
Access to relatively cheap workforce	.664			
Majority of client not interested in firm's with ICT base	.704			
Lack of adequate construction jobs in the market	.603			
Risks for liability (debt)	.647			
Lack of legal support for use of ICT in construction projects	.647			
Security implications (privacy fear) of ICT transaction	.614			

Extraction Method: Principal Component Analysis.

a. 4 components extracted. The component matrix in Table 4.18 was therefore subjected to VARIMAX rotation method to maximize the relationship between the factor and the variables. Hence in Table 4.18, the twenty-one variables were explained by four (4) extracted factors. Factor 1, 2 and 4 explain three variables, factor 3 explains two variables respectively. Factor 1explains the statements "Problem of ICT integration/ compatibility in the organization", "Majority of client not interested in firms with ICT base" and "Lack of legal support for use of ICT in construction projects" and therefore reflects the technical, environmental and legal reasons of barriers to ICT application in construction companies and hence labeled as *Technical, environmental and legal reasons.* Factor 2 explains the statements "budget constraint for ICT investment", "Cost of training professionals in ICT" and "High cost of employing ICT", therefore reflects the Financial Reasons and hence can be labeled as *Financial Reasons*, factor 3 explains the statements "Lack of commitment of firm‟s management toward ICT application in MMP" and "Lack of adequate construction jobs in the market, therefore reflects the Human and Environmental Reasons so will be named *Human and Environmental Reasons*, factor 4 explains the statements " Rapid change in ICT technologies", Software and reliability problems" and "High rate of obsolescence (no longer in use) ICT products in the Ghanaian market", which reflects a complete technical reasons, hence can be labeled as a *Complete Technical Reasons.* In summary, the four main factors being the critical barriers to the application of ICT tools in materials management processes in the construction industry are

- *Technical, environmental and legal reasons*=BICTA/TEALR COMBIND
- *Financial Reason*=BICTA/FR COMBIND
- *Human and Environmental Reasons*=BICTA/HAER COMBIND
- *Complete Technical Reasons*=BICTA/TR COMBIND

Table 4.18: Rotated Component Matrix[a]

	Component			
	1	2	3	4
Budget constraint for ICT investment		.806		
Cost of training professional in ICT		.695		
Limited benefit /Low return on investment in ICT				
High cost of employing ICT		.637		
Inadequate ICT content (program) in construction education				
			.724	
Lack of commitment of firm's management towards ICT				
Inadequate knowledge about return on ICT investment				
Lack of staff with appropriate skill and knowledge in ICT				
Fear of job losses/making professionals redundant				
Satisfaction with existing method of work				
Rapid changes in ICT technologies				
				.745
Problem of ICT integration/compatibility in the organization	.690			
Software and reliability problems				.817
Security concerns/privacy fears				
High rate of obsolesce (no longer in use) ICT products in the Ghanaian market				.734

https://damaacademia.com/dasj August 2020 Pages: 01-28 Volume 5 | Issue 8

Access to relatively cheap workforce		
Majority of client not interested in firm's with ICT base	.669	
Lack of adequate construction jobs in the market		.618
Risks for liability (debt)		
Lack of legal support for use of ICT in construction projects	.750	
Security implications (privacy fear) of ICT transaction	.656	

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
a. Rotation converged in 7 iterations.

4.2 Benefits Derived from ICT Application to Material Management Processes

Table 4.19 presents the summary of results of the various benefits derived in ICT application to material management. Respondents generally agreed to all the various statements based on their computed mean scores (being at least 4) for each statement.

Table 4.19: Benefits derived from ICT application to material management

ICT Application to materials management	*Rating, N(%)*					
Benefit derived	SD=1	D=2	U= 3	A=4	SA=5	Mean
More cost effective projects are achieved.	2(0.7)	0	4(1.4)	100(35.6)	175(62.3)	4.59
Expedite purchasing processes of construction material.	2(0.7)	0	0	110(39.1)	169(60.1)	4.58
Reduction in craft labour cost due to the improved available of materials as needed on site.	0	7(2.5)	8(2.8)	119(42.3)	147(52.3)	4.44
A better standard of work due to quality specification of construction materials and equipment.	0	2(0.7)	5(1.8)	106(37.7)	168(59.8)	4.57
Completion of construction works on schedule.	0	2(0.7)	7(2.5)	102(36.3)	170(60.5)	4.57

5.0 CONCLUSION

The result reveals that *Technical, environmental and legal reasons* relating to ICT tools uses in materials management processes in Ghanaian construction industry, turns to prevent the ICT tools application in managing materials. Technical: respondent indicate that there are problems of integrating ICT tools into their organization due to rapid changes in ICT technologies whereas, environmental: majority of clients are not interested in construction firms with ICT base, indicating that construction companies that employ the ICT in managing their construction activities turns to charge clients for high cost of construction works.

https://damaacademia.com/dasj August 2020 Pages: 01-28 Volume 5 | Issue 8

This perception as indicated by the respondent, made most of Ghanaian contractors not interested to invest in ICT tools for materials management processes, hence, chose to just in time approach of materials management. These situations have led the respondent to conclude that there are inadequate construction jobs in the market for them to invest in ICT tools for managing materials processes. Legal: respondent indicated that there is lack of support for use of ICT tools in construction project (thus, designing ICT technologies that is unique for construction materials management only and not to be used by any other sector) which, to some extent, led to some kind of security implication like privacy fears of ICT transaction.

In addition, the respondents indicated *Financial Reasons* as one of the barriers. This was based on the fact that most of the projects awarded to them were pre-finance with their limited budget and this has put undue pressure on their budget that, there was no room for further investment into ICT tools for materials management processes. Also, cost of training professionals in ICT tools application in managing materials will be of great stress on their budget since accessing most of the well pay construction projects in Ghana were sort of whom you know or political affiliation. Otherwise, respondents indicated that even if one should try to invest in ICT tools for materials management processes the culture of maintenance will a financial threat due to the high cost of ICT tools accessories. From the respondent"s opinion, financial reasons could be minimized if not eradicated, to some extent if contractors in region in Ghana are allow to access loans on reduced rate. This will boost their financial strength in other to invest in the use of ICT tools for materials and other related construction activities management processes.

These notwithstanding, *Human and Environmental Reasons* were also considered to be some of the barriers to ICT tools application in materials management processes. Respondents indicated lack of commitment by construction firms" management towards ICT tools application, relating to majority of client's perception on ICT base construction firms that they charged exorbitantly for projects constructed, they hardly patronize their services. These have made some firms hardly accessing construction jobs from individual clients in the regions. Security wise, respondents express their fear on issues of internet fraud if one does not take care in transacting construction business with others. Last but no means the least, is *Complete Technical Reasons* which was hinged on the following: Rapid changes in ICT technologies, the frequency at which ICT software are change, posed threat to respondents in the sense that one may buy ICT tools today and only to realize in the few days" time that the software is outdated.

This will definitely call for reinvestment. The perspective of respondent, are that though, ICT tools application in materials management processes could increase labour productivity whiles use in managing materials, but the rate at which these technologies are changed due to software designs, discourage most of them both for security assurance and investing their limited resources into it The respondent lamented that if ICT tool could be made more affordable to construction industry by customizing it and making to have a duration that will make them recouped their capital in a way, would have been a great bait to all construction firms to invest in the ICT tools for materials management processes.

The barriers for not investing in ICT tools for MMPs throws more light on the assertion made by Martin (2005, 4th Ed., p.82) that failure to recognize that supply chain may be at their most vulnerable where the probability of occurrence is small; the potential impact could be catastrophic. Furthermore, logistics activities do not just generate cost; also generate revenue through the provision of materials availability. Hence, logistics activity requires resources in the form of fixed capital and working capital so there are financial issues to be considered when supply chain strategies are devised. So, the respondents were careful and fearful in investing their limited resources in ICT tools for their MMPs.

5.1 Critical Barriers to the Application of ICT Tools in Materials Management Processes in Ghanaian Construction Industry

The result reveals that *Technical, environmental and legal reasons* relating to ICT tools uses in materials management processes in Ghanaian construction industry, turns to prevent the ICT tools application in managing materials. Technically, respondent indicate that there are problems of integrating ICT tools into their organization due to rapid changes in ICT technologies whereas, environmentally, majority of clients are not interested in construction firms with ICT base, indicating that construction companies that employ the ICT in managing their construction activities turns to charge clients for high cost of construction works. This perception as indicated by the respondent, made most of Ghanaian contractors not interested to invest in ICT tools for materials management processes, hence, chose to just in time approach of materials management. These situations have led the respondent to conclude that there are inadequate construction jobs in the market for them to invest in ICT tools for managing materials processes. Legally, respondent indicated that there is lack of support for use of ICT tools in construction project (thus, designing ICT technologies that is unique for construction materials management only and not to be used by any other sector) which, to some extent, led to some kind of security implication like privacy fears of ICT transaction.

In addition, *Financial Reasons* also contributed to the barriers of ICT tools application in materials management processes in Ghana as indicated by the respondent. In fact, respondent clearly revealed the constituents of *Financial Reasons* serving as barriers to ICT tools application in materials management processes as; Budget constraint for ICT investment, Cost of training professionals in ICT, Limited benefit/ low return on investment in ICT and High cost of employing ICT (maintenance). From the respondent"s opinion, financial reasons could be minimized if not eradicated, to some extent if contractors in Ghana are allow to access loans on reduced rate. This will boost their financial strength in other to invest in the use of ICT tools for materials and other related construction activities management processes.

These notwithstanding, *Human and Environmental Reasons* were also conceded to be one of the barriers to ICT tools application in materials management processes. Human reasons explained by respondent indicate, lack of commitment by firm's management towards ICT tools application, relating to majority of client's perception on ICT base construction firms and lack of adequate construction jobs in the market or base on political affiliations. Last but no means the least, is *Complete Technical Reasons* which was hinged on the following; Rapid changes in ICT technologies, Problem of ICT integration/compatibility in the organization, Software and reliability problems, Security concerns/privacy fears, High rate of obsolescence (no longer in use) ICT products in the Ghanaian market and Access to relatively cheap workforce. The perspective of respondent, are that though, ICT tools application in materials management processes could increase labour productivity whiles use in managing materials, but the rate at which these technologies are changed due to software designs, discourage most of them both for security assurance and investing their limited resources into it.

5.2 Findings

There were barriers revealed by the study regarding financial challenges for investing in ICT tools due to unstable nature of ICT software/ hardware in the system. *Environmental* issues as one of the barriers were hinged on political affiliations, where some contractors were marginalized because of not being a party member. *Complete Technical Reason* which explain rapid change in technologies, software and reliability problems and high rate of obsolesce (no longer in use) of ICT product in the region were also the critical barriers suggested by the study that could affect ICT application variables. Hence, could negatively influence labour productivity. Management"s commitment to ICT tools application in materials management processes through visions and strategies may offset these barriers in other to achieve high labour productivity.

References

Abdul-Rahman, H., & Alidrisyi, M. N. (1994). "A Perspective of Material Management Practices in a Fast Developing Economy: the case of Malaysia." Construction Management and Economics. 12. 412-422

Ademeso, O. S., & Windapo, A. O. (2008). Relationship between Material Management Approach and Scheduled Project Completion Time. In COBRA. "Conference The construction and building research of the Royal Institution of Chartered Surveyors." Dublin Institute of Technology,

Afriyie, G. O. (2010). Looking at the Public Private Partnerships and the Traditional way of construction of Projects.

Ahadzie, D. K. (2007). "Model for Predicting the Performance of Project Managers at the Construction Phase of Mass House Building Projects," Retrieved from

Akinci, B., Patton, M., & Ergen, E. (2002). "Utilizing Radio Frequency Identification on Precast Concrete Components - Supplier‟s Perspective," Proceedings.
ISARC‟02, IAARC, Washington, DC, pp. 381-386.
Alaghbandrad, A., Nobakht, M. B., Hosseinalipour, M., & Ehsan Asnaashari, E. (Undated). ICT Adoption in The Iranian Construction Industry.
Ammer, D. S. (1986). Top management‟s view of the purchasing function. Journal of purchasing and materials management, 25, 16-21
Ampadu-Asiamah, A. D., &Ampadu-Asiamah, O. K. (2013). Management of Government Funded Construction Projects in Ghana: Stakeholders‟ Perspective of Causes of Delays in Construction of Public Buildings. School of Engineering, Accra Polytechnic Ghana.
Anissimov, M. (2012). Approaches, Pearson Education," Inc., USA. Architecture, Engineering and Construction, Volume 2,
Armstrong, M. (1990). Handbook of human resource management. London: Kogan Page Ltd.
Arnold, J. R., & Chapman, S. N. (2004). Introduction to Materials Management, (5th ed.). New Jersey.
Asabere, N. Y., Oppong, D., & Kusi-Sarpong, S. (2012). A Review of the Roles Importance of Information and Communication Technologies (ICTs) in Supply Chain Management (SCM) of Organizations and Companies,
International Journal of Computer Science and Network (IJCSN) Volume 1, Issue 4, www.ijcsn.org ISSN 2277-5420.
Ashwini R., Patil, A., &Pataskar, S. V. (2013). Analyzing Material Management Techniques on Construction Project. (2008) Certified International Journal of Engineering and Innovative Technology (IJEIT) Volume 3. ISO 9001:
Ahire, S., Golhar, D., & Waller, M. (1996). Development and validation of TQM implementation constructs. Decision Sciences, 27(1), 23-56.
Babatunde & Olusola S. (2012). Quantitative Assessment of Construction Materials Wastage in the Nigerian Construction Sites, Journal of Emerging Trends in Economics and Management Sciences (JETEMS) 3(3): 238-241 © Scholarlink Research Institute Journals, 2012 (ISSN: 2141-7024) jetems.scholarlinkresearch.org.
Baffour, K. & Valente (2013). The Modern Census: Evolution, Examples and Evaluation Institute for Social Science Research, University of Queensland,
Brisbane, Australia. School of Education, Communication and Language Sciences, University of Newcastle, Newcastle upon Tyne, United Kingdom. 3.
Statistical Division, United Nations Economic Commission for Europe (UNECE), Palais des Nations, Geneva, Switzerland.
Becerik, (2004). A review on past, present and future of web based project management and collaboration tools and their adoption by the US AEC industry", International Journal of IT in Architecture, Engineering and Construction, Volume 2, Issue #, October 2004, P 233-248.
Bernold, L. E., & Treseler, J. F. (1991). Vender Analysis for Best Buy in Construction, Journal of Construction Engineering and management, 117, (4). 645-658.
Boussabaine, A. H., & Elhag, (1999). A Neural Network approach for forecasting Cost- Flowfor water industry projects. Journal of Engineering Construction and Architectural management, 6, (3) 213-224.
Bowden, S. (2005). Application of mobile IT in construction. Dissertation, University of Loughborough, Department of Civil and Building Engineering.
Chase, R. B., &. Aquilano, N. J. (1989). Production and Operation Management. A life cycle Approach (5th ed.). USA: R. R. Donnelly and Sons Company.
Cohen, L., Manion, L., & Keith M, K. (2011). Research Methods in Education, (7th ed) third Avenue USA by Routledge.
Colwell, D. (2008). Improving Risk Management and Productivity in Megaprojects through ICT Investment. Executive Director Construction Technology Center Atlantic.
Conca, F. J., Llopis, J., & Tari, J.J., (2004). "Development of A Measure to Assess Quality Management in Certified Firms" Journal of Operational Research, 156, 683-697.
Creswell, J. W. (2008). Educational Research Planning, Conducting and Evaluating quantitative and qualitative research. Upper Saddle River, NT: Pearson/

Merril Education.
Creswell, J. W. (2009). Research Design: Qualitative, Quantitative, and Mixed Methods Approaches, (3rd ed.). California: Sage Publications.
Creswell, J. W., & V. L. Plano Clark. (2007). Designing and conducting mixed methods research. Thousand Oaks, CA: Sage Publications.
Cronbach, L. J., (1951). "Coefficient alpha and the internal structure of tests", Psychometrika, 16, 297-334.
Datta, A. K. (1992). "Materials Management procedures, text and cases", (Rev, Ed)" New Delhi: Prentice Hall.
Development of Economic and Social Affaires United Nations (2010) statistic division htt://unstat.Un.org/unsd/ansus.htm
Dicks, M. (2003). "Innovative M & E data sheet" BSRIA, Guidance Note ACT 5/2002, BSRIA, Berkshire.
Enshassi, A., Mohammed, S., Mustafa, Z.A., & Mayer, P. E. (2007). Factors affecting labour productivity in building projects in the Gaza Strip. Journal of Civil Engineering & Management, 13(4), 245-254.
Equere, E., & Tan, L.C.M. (2010). Dearth of Automation: The Consequences in Nigeria Construction Industry Kent School of Architecture, University of Kent, Canterbury, UK2 School of Construction Management and Engineering, University of Reading, UK.
Field, A. (2005). "Discovering Statistics using SPSS for Windows". London: Sage
Finkenzeller, K. (2003, 2nd Ed.). Fundamentals and Applications in Contactless Smart Cards and Identification. England: John Wiley and Son,
Flynn, B., Schroeder, R. G. & Sakakibara, S. (1994). "A Framework For Quality Management Research And Associated Instrument", Journal of Operations Management, 11., 339366.
Formoso, C. T., ASCE, L. S. M., Cesare, D. C., & Isatto, E. L. (2002). "Materials waste in building industry: Main causes and prevention." Journal of Construction Engineering and Management.128(4).316-325.
Fujitsu, C. (1998). Information Technology in the Building and Construction Industry; Current Status and Future Direction, A Report for the National Building and Construction Committee Department of Industry Science and Resources, Australian Graduate School of management and Building Research Centre Faculty of the Built Environment, University of New South Wales, August.
Furlani, K. M., & Pfeffer, L. E. (2000). "Automated Tracking of Structural Steel Members at the Construction Site," ISARC Taipei, Taiwan.
Ghanem, A. A., Razig, Y. A., & Mahdi, S. M. (2006). "Evaluation of a Real-Time Construction Project Progress Tracking, Sustainable Development through Culture and Innovation," The Joint International Conference on Construction Culture, Innovation and Management (CCIM), 26-29 November, Dubai, pp.771-780,
Gichoya, D. (2005). "Factors Affecting the Successful Implementation of ICT Projects in Government" The Electronic Journal of e-Government, 3 (4), 175184, available online at [www.ejeg.com.](www.ejeg.com)
Goodrum, P. M., McLaren, M. A., & Durfee, A. (2006). "The Application of Active Radio Frequency Identification Technology for Tool Tracking on Construction Job Sites," Automation in Construction, 15, (3), 292-302,
Gopalakrishnan, P., & Sundaresan, M. (1977). "Materials Management: an integrated approach." New Delhi: Prentice-Hall. 189, 240.
Harrison, F. & Lock, D. (2004): Advanced Project Management, A Structural
Haddah, E. A., (2006). "Construction materials management system for gaza strip Building Construction" Dec.
Hair, J.F., Anderson, R.E., That-am, R.L., & Black, W.C. (2007). "Multivariate Data Analysis with Reading", NJ: Prentice Hall, Englewood Cliffs,
Harris, F., & MacCaffer, R. (2001). "Modern Construction Management." (5th ed.). London: Blackwell Science.
Hawkings, G. (2003). "Enabling Technologies guide; How to use barcode asset management" BSRIA Enabling Guide 2/2003 BSRIA, Berkshire

Holton, E. H., & Burnett, M. B. (1997). Qualitative research methods. In R. A. Swanson, & E. F.Holton (Eds.). Human resource development research handbook: Linking research and practice. San Francisco: Berrett-Koehler Publishers.

Hore, A.V., & West, R. P. (2005). "Attitudes towards Electronic Purchasing in the Irish Construction Industry", CIB W92/T23/W107 International Symposium on Procurement Systems, Las Vegas, USA.

Identec Solutions (2004). PC i-CARD III User"s Guide, Lustenau, Identec Solutions AG, Austria,

Idrus A. B., & Newman J. B. (2002). "Construction Related Factors Influencing Choice of Concrete Floor Systems", Construction Management and Economics, 20, 13-19.

Illingworth, J., & Thain, K. (1998). "Material Management is it Worth It?" Technical Information Service, the Chartered Institute of Building ASCOT. 93. 1-5,

Jang, W., & Skibniewski, M. J. (2009). Cost benefit analysis of embedded sensor system for construction materials tracking. Journal of Construction Engineering and Management, 135 (5), 378-386.

Jeruto, K. P., & Mutwol, L. (2012). An Investigation of the Effect of Interdepartmental Coordination between Material Related Departments on Organizational Performance: A Survey of Eldoret Water and Sanitation Company Limited (Eldowas) Kenya. International Journal of Science and Research (IJSR) ISSN (Online): 2319-7064 Impact Factor 3.358

Kasim, K. (2011). ICT Implementation for Materials Management in Construction Projects: Case Studies KICEM Journal of Construction Engineering and Project Management Online ISSN 2233-9582

Kasim, N. B. (2008). Improving Materials Management on Construction Projects. A thesis submitted in partial fulfilment of the requirements of Lough borough University for the degree of Doctor of Philosophy.

Kasim, N. B., & Ern, A. S. (2010). The Awareness of ICT Implementation For Materials Management In Construction Projects, Int. J. of Computer and Communication Technology, 2, (1).

Kasim, N., Latiffi, A. A., & Fathi, M. S. (2013). RFID Technology for Materials Management in Construction Projects – A Review. International Journal of Construction Engineering and Management, 2(4A): 7-12 DOI: 10.5923/s.ijcem.201309.02

Kasim, N. B., C. J. Anumba, & A.R.J. Dainty, (2005). "Improving Materials Management Practices On Fast-Track Construction Projects," Proceedings, ARCOM Twenty First Annual Conferences, SOAS, London.

Kim, J., & Mueller, C. (1978). "Introduction to Factor Analysis: What it is and how to do it", Beverly Hills, Sage.

Kimberlin, C. L., & Winstertein, A. G (2008).Research Fundamentals. Am J Health- syst. Pham, 65.

Knutson, J. (2001). Project Management for Business Professionals. A Comprehensive guide. John Wiley & Sons Inc, NY, USA p3-Kvale.

Kometa, S. T., Olomolaiye P. O., & Harris F C. (1994). Attributes of UK construction clients influencing project consultants performance. Construction Manage Econ; 12: 433–43.

Kothari, C. R. (2004). Research Methodology, (2nd ed). New Delhi: New Age International Limited Publishers.

Lambert, D. M., Stock., J. R., & Ellram, L. M. (1998). "Fundamentals of Logistics Management. United States: McGraw Hill. 20, 96.

Li, H. (2009). Study on Construction Cost of Construction Projects Audit Department of Tianjin Polytechnic University.

Malhotra, M.K., & Grover, V. (1998). "An Assessment of Survey Research in POM", From Constructs To Theory, Journal of Operations Management, Vol., 16, pp., 407-425 Managing Library Finances,Vol.17,No.1,pp.15-19.

Martin, C. (2005). Logistics and Supply Chain Management, (3rd Ed).

Martin, C. (2011). Logistics and Supply Chain Management, (4th Ed).

Mojtahedzadeh, R., &Arumugam, V. C. (2011). Determinants of TQM in the Iranian Automotive Industry: A Theoretical Approach, International Journal for Quality research (5), 1, 2

Moson- Jones, R., & Toweell D. R. (1998). Time Compression in the Supply Chain Information management is the vital ingredient, Logistics Information Management 11, iss 2.

Mustapa, F. D., Mustapa, M., Misnan, M. S., & Mahmud, S. H. (2012). ICT Adoption in Materials Management among Construction firms in Construction Industry.
Department of Quantity Surveying, Faculty of Built Environment UniversitiTeknologi Malaysia, Skudai, Johor faradiva@utm.my.
Naik, G. M., Aditya, M., & Naik, S. B. (2011). Integrated 4D Model Development for
Planning and Scheduling of a Construction Project using Geographical
Information System International Conference on Construction and Project Management IPEDR vol.15.
Naoum, S. G. (2001). "Dissertation Research and Writing for Construction Students",
Butterworth-Heinemann, Linacre House, Jordan Hill, Oxford OX2 8DP, 225 Wildwood Avenue, Woburn, M.A.
Navon, R., & Berkovich, O. (2006) .An automated model for materials management and control. Construction Management and Economics 24, 635–646.
Navon, R., &Berkovich, O. (2004).Development and on site evaluation of an automated material management and control model. Accepted by Journal of Construction engineering and Management, ASCE.
Nunnally, J. C., (1978). "Psychometric Theory", (2nd ed.). New York: McGraw-Hill
OECD (2000). Measuring materials flows and Resource Productivity Volume 1. The
OECD Guide.
Ofori, R., & Dampson, D. A. (2011). Research Methods and Statistics Using SPSS.
Okorocha, K. A. (Undated). Department of Project Management Technology, Federal University of Technology, Owerri. factors affecting effective materials management in building construction projects- a case study of selected building sites, in imo state, Nigeria. International Journal of Management
Sciences and Business Research, 2, (4)- ISSN (2226-8235).
Oladapo, A. A. (2005). "An Investigation into The Use Of ICT In The Nigerian
Construction Industry" Retrieved from Http://www.Itcon.Org/Data/
Works/Att/2007
Onyegiri, A. J., Nwachukwu, C. C., & Jamike, O. (2011). Information and communication technology in the construction industry. American Journal of Scientific and Industrial Research ISSN: 2153-649X doi:10.5251/ajsir.2011. 2.3.461.468. , http://www.scihub.org/AJSIR
Patel, V. K., & Vyas, C. M. (2011). Construction Materials Management on Project
Sites. National Conference on Recent Trends in Engineering & Technology.
Peansupap, V. (2004). An Exploratory Approach to the Diffusion of ICT in a Project
Environment. PhD, School of Property, Construction and Project Management. Melbourne, RMIT University
Pheng, L. S., & Chuan, C. J. (2001). "Just-in-time management in precast concrete construction: a survey of the readiness of main contractors in Singapore."
Integrated Manufacturing Systems, 12. 416-429,
Prabu, V. & Baker, M. (1986). "Material Management." UK: McGraw-Hill.
("Project management body of knowledge, Fourth Edition", n. d)
RFID (2000). Technology for Materials Management in Construction Projects – A Review. International Journal of Construction Engineering and Management. Faculty of Technology Management & Business, UniversitiTun Hussein Onn Malaysia, Johor, 86400, Malaysia 2UTM Razak School of Engineering &
Advanced Technology, Universiti Teknologi Malaysia, Kuala Lumpur, 54100, Malaysia.
Ren, Z., Sha, L., & Hassan, T. M. (2007). "RFID facilitated Construction Material
Management - A Case Study of Water Supply Project," Proceedings of the
24th CIB W78 Conference Information Technology in Construction, Maribor, Slovenia, pp. 401 – 406,.
Rethinking Construction (2000). The report of construction Task Force to the Deputy prime Minister, John Prescott on the scop for improving the quality and efficiency of UK Construction.
Robles, G., Stifi, A., José L., Ponz-Tienda, S. G. (2014). Labor Productivity in the Construction Industry-Factors Influencing the Spanish Construction Labor
Productivity. International Journal of Civil, Structural, Construction and Architectural Engineering 8, (10).
Santosh, E. V., &Apte, M. R. (2004). Productivity in Building Construction IOSR
Journals of Management and Civil Engineering (ISOR-JMCE) e-ISSN; VOL. 10, Issue 5. www.10srjournals.org.

Sardroud, J. M. (2012). Influence of RFID technology on automated management of construction materials and components. Faculty of Engineering, Central Tehran Branch, Islamic Azad University, Tehran, Iran.
Sawalhi E. S., & Kiss, M. M. A. (2012). A Construction Materials Management System for Gaza Building Contractors. The 4th International Engineering
Conference –Towards engineering of 21st century
Schneider, M. (2003). Radio Frequency (RFID).Technology and its Application in the
Commercial Industry. Master"s of Science in Civil Engineering, University of Kentucky.
Sekou, E. A. (2012). Promoting the Use of ICT in the Construction Industry:
Assessing the Factors Hindering Usage by Building Contractors in Ghana. A
Thesis Submitted To the Department of Building Technology, Kwame
Nkrumah University of Science And
Song, J., Haas, C.T., Caldas, C., Ergen, E., &Akinci, B. (2005). "Automating the task of tracking the delivery and receipt of fabricated pipe spools in industrial projects," Automation in Construction, 15, (2), 166-177.
Stukhart, G., & Bell, L.C., (1987).Costs and Benefits of Materials Management Systems. ASCE, Journal of Construction Engineering and Management, 113, (2), 222-234.
Sturheart, G. (1990). "Bar- code standardization in Industry Construction" Journal of Construction Engineering and Management, 123, (2).171.
Suresh-Chander, G. S., Rajendran, C., & Anantharaman, R.N. (2001). "A Holistic
Model for Total Quality Service", International Journal For service industry Management, 12, 338-412.
Tamara, A. S. (2008). The facebook effect? On-line campaigning in the 2008 Canada and US elections. Policy Options.
Teachtarget. (1997). Retrieved from Http://Searchmobilecomputing.Techtarget.Com/
Definition/Videoconferee
Teo, M. M. M., & Loosemore, M. (2001). "A theory of waste behaviour in the construction industry." Journal of Construction Management and Economics.19, (7).741-751.
Usman, N., & Said, I. (2012). Impact of Technological Devices on information and Communication Technology Acceptance for Construction Site Management in
Nigeria. Journal of Emerging Trends in Computing and information Science
(3), 3.
Vander – Veer, E. A. (2008). Facebook: The missing manual. ACM Digital library,
O" Reilly publishers.
Varghese, K., & O" Connor, J. T. (1995). "Routing large vehicles on industrial
construction sites." Journal of Construction Engineering and Management.121 (1).1-12.
Vrijhoef, R., & Koskela, L., (2000). The four roles of supply chain management in construction. Journal of Purchasing & Supply Management, 6, 169-178.
Webfinance. (2012). Retrieved from Http://Www.Businessdictionary.Com/
Definition/WeBcast.Html
Weele, A. J. V. (2000). Purchasing and Supply Chain Management, Analysis,
Planning and Practice, (2nd ed.). U. K, TJ International Padstow Conrn wall.
Whittaker, S., & Sidner, C. (1996). Email Overload: Exploring Personal Information Management of Email. CHI 96 Vancouver. BC Canada
Wong, E. T. T., & Norman, G. (1997). Economic evaluation of materials planning systems for construction. Construction Management and Economics. 15. 39-
47.
Wood, C. R., & Alvarez, M. W. (2005). Emerging Construction Technologies A Fiatech TM Catalogue. FIATECHTM,
Zhang, Z. (2000). "Implementation of TQM: An Empirical Study of Chinese manufacturing Firms", PhD Unpublished thesis, Faculty of Management and Organization of the University of Groningen, The Netherlan.
Zanto, B. (2008). Purchasing and Supply Management, Kaduna: Timo Books.
(https://en.wikipedia.org/wiki/List_of_Ghanaian_regions_by_population)
http://www.statsghana.gov.gh/docfiles/2010phc/National_Analytical_Report.pdf