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Analyzing the Enabling Factors and Constraints on Application of ICT to Materials Management Processes

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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 & Labour Productivity

1.0 INTRODUCTION

Computing and communication technology, also commonly known as Information Technology (IT) has been radically transforming the way we live, learn, work and play. Many companies in the construction industry do not appear to have appreciated the positive changes and advantages that the new technology was providing to companies in other sectors of economy. (Kasim, 2011) stated that, during the 1980s ITs were only used in few construction companies. Though, most building firms were using computers in the 1980s, their core function was such as accounting, wages and salary, very few of the companies used the ITs for planning and managing the construction activities. Today, a large number of software packages are available to all the disciplines of the construction team at every stage of the construction processes. They provide support for a broad range of activities such as computer aided design and drafting, cost estimation, structural analysis, on-site management, facilities management and others. The use of Information and Communication Technologies (ICTs) in the construction industry is generating new opportunities for collaboration, coordination and information exchange among organizations that work on a construction project. Project management as a discipline has for some decades been spreading in construction and engineering industries and getting enlarged and becoming acceptable as a way of planning and managing work in organizations (Knutson 2001, p.3).

In these days, as individuals and nations have been receiving knowledge of managing projects, there is dramatic growth in the membership of professional bodies including Project Management Institute (Harrison and Lock, 2004 p.1). Ghana, a developing nation in the sub-Saharan Africa with a total population of (24,658,823) as at 2010 census, face numerous challenges in the construction industry in undertaking and managing construction projects effectively (Harrison and Lock, 2004). Some of these challenges identified are; project delays, shoddy-works, costoverrun inefficient management of materials and inability on the part of the government to pay the contractors to finish project on schedule Kasim et al., 2013). Nevertheless, in the construction industry various projects are undertaken with a specific goal

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and objectives. These are achieved by the efficient use of materials through processes. A project is a temporary endeavor undertaken to create a unique product, service or result. The temporary nature of projects indicates a definite beginning and end. Project can also have social, economic and environmental impacts that far outlast the projects themselves ("Project management body of knowledge, Fourth Edition", n. d).

The key factor adversely affecting projects performance is the improper handling and management of materials on site (Kasim et al., 2005). It is a significant subject for the extensive engineering managers to have effective engineering cost management in construction project management and to reasonably determine and control construction cost on the condition of ensuring quality and time limit (Li, 2009). Clearly, Kasim and Ern (2010) defined materials management as a coordinating function, responsible for planning and controlling materials flow. In detailed, it is explained that is a planned procedure that comprises the purchasing, delivery, handling and minimization of waste with the aim of ensuring that requirements are met. Successful completion of project requires all resources to be effectively managed.

2.0 THE CONSTRUCTION SECTOR IN GHANA

The construction industry has made significant contribution to both industrial output and overall Gross Domestic Product (GDP) in Ghana over the years. With reference to available countrywide statistics, the impact of the built environment sector as a whole is much greater; including segments of the manufacturing, mining, quarrying, electricity and water sectors. From observations and reference to legal and regulatory documents such as the Building Regulations (ROG 1996), it suggests that the Ghanaian built environment sector is modelled on the UK regulatory system. The Ghanaian construction sector is akin to the UK construction sector about 20 years ago. Nevertheless, there are serious shortfalls in materials handling, safe working practices, quality and timeliness of construction project.

The modern world is currently exploiting every available technology to ensure the best results at every opportunity. Effective construction materials management process is one of the success factors of a construction project. Successful management of construction materials has to be based on updated information and processed utilizing a well-designed construction materials management system. Navon and Berkovich (2004) indicated that even though construction materials and components may constitute more than fifty percent (50%) of total project costs, existing methods for managing them still depend on human skills. Kasim et al. (2013) conceded that paper-based reports are mostly used to record and exchange information related to the materials component within a supply chain, which is problematic, error-prone, and inefficient. This traditional data collection is time and labuor-intensive, error-prone, and unreliable, due to the reluctance of workforces to monitor and record the presence of large numbers of materials.

2.1 Construction Materials Management Processes

The literature speculates that Materials Management is simply the process by which an organization is supplied with the goods and services that it needs to achieve its objectives of buying, storage and movement of materials (Navon & Berkovich, 2004). Materials Management is related to planning, procuring, storing and providing the appropriate material of right quality, right quantity at right place in right time so as to co-ordinate and schedule the production activity in an integrative way (Kasim, 2012). Abdul-Rahman and Alidrisyi (1994) maintains that, materials management is an essential function that improves labour productivity in construction projects. In a detailed view, Illingworth and Thain (1998) admitted that materials management is a planned procedure that comprises the purchasing, delivery, handling and minimization of waste with the aim of ensuring that requirements are met. Arnold and Chapman (2004) also granted that Materials management is defined as a coordinating function responsible for planning and controlling materials flow. Hence, the efficient use and management of material have an important influence on company"s profit and can avoid delay in construction. Naik, Aditya and Naik (2011) assessed that, the current day demand of construction industry requires a highly accurate planning, scheduling and management of the process of the project which can enable the overall optimization of the cost, time and resources.

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Canter (1993) as cited in Kasim (2008, p.1) contended that there are major issues which affect materials management activities such as constraints on storage areas, site logistics with regards to materials handling and distribution, ordering and delivery of materials to the construction site. Previous research has also highlighted materials management issues such as; improper storage, requirement for large storage capacity, transportation difficulties and inappropriate materials delivery, other issues include; manual processes, and non-compliance with specifications and late delivery. Base on the literature, materials management is categorized into six (6) processes, namely planning, procurement, Purchasing, logistics, handling, stock and waste
control processes.

Planning*:* Wong and Norman (1997) assessed that materials planning include quantifying, ordering and scheduling. It is stressed that planning is especially significant in terms of increasing labour productivity, profit, and facilitating the timely completion of construction projects. Hence, labour productivity will suffer if the material planning process is not executed properly.

Procurement: All the organizations need an efficient and economic purchasing and procurement of materials from the suppliers. The materials management department has to perform this function of purchasing and procurement of materials very efficiently. Lamber, Stock and Ellran (1998) indicated that 50% to 60% of project cost is spent on the purchase of various materials, the amount of profit earned on these projects very much depends how economically the materials are purchased and utilized in the organization. The profitability depends on the efficiency by which this particular function of purchasing and procuring the requisite materials at appropriate time will be done and its availability is assured. Lamber, Stock and Ellran (1998) described Procurement as the purchase of materials and services from outside organizations to support the firm"s operations from production to marketing, sales and logistics. As such, Ademeso and Windapo (2008) defended that a detailed materials schedule and co-ordination of the procurement and order of material are important in assuring materials availability.

Materials Purchasing Performance: Measuring purchasing performance is important as the purchasing department plays an ever increasingly important role in the supply chain in an economic downturn (Zanto, 2008). A reduction in the cost of raw material and services can allow companies to competitively market the price of their finished projects in order to win contracts. According to Martin (2011, 4th Ed.) an obvious performance measure of the success of any purchasing department is the amount of money saved by the company. However, there are a number of performance measurements that companies can use when they measure purchasing performance.

Purchasing Efficiency: Administrative costs are the basis for measuring purchasing efficiency. This performance measurement does not relate to the amount of purchased items that the department has procured. The measurement relates to how well the purchasing department is performing in the activities they are expected to perform against the budget that is in place for the department. If the purchasing costs are within the budget, then the efficiency of the purchasing department will exceed expectations. If the department is using funds over and above the budget then the purchasing function is not efficient (Martin (2011, 4th Ed.).

Purchasing Effectiveness: The price that the purchasing department paid for an item is not necessarily a good measurement for purchasing performance. The price of an item may fluctuate due to market conditions, its availability, and other demand pressures; therefore, the purchasing department may not be able to control the price. A popular method of assessing purchasing effectiveness is to review the inventory turnover ratios. The ratio measures the number of times, on average; the inventory is used, or turned, during the period. However, this is not always a great measure of purchasing effectiveness as seasonal requirements for having items in stock can make this measurement inaccurate (Vrijhoef & Koskela, 2000)

Purchasing Functionality: Purchasing performance can be measured against the functional requirements of the purchasing function. The primary function of the department is to provide the correct item at the required time at the lowest possible cost. The performance measurement can take into account these elements, but it does not take into account factors that may relate to the supplier stability, material quality issues and supplier discounts (Vrijhoef & Koskela, 2000).

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Performance Measurements: The performance of the purchasing function can be measured using a variety of measurements. A company can decide which of these measurements of effectiveness are relevant to the performance of their purchasing department. The measurements can include:

- Cost Savings: If the purchasing department procure an item at a lower price than they did previously, then it is a cost saving. This can occur when a new supplier is found, a less costly substitute item is used, a new contract has been signed with the vendor, a cheaper transportation method has been found or the purchasing department has negotiated a lower price with the existing supplier (Vrijhoef&Koskela, 2000).
- Increased Quality: When an item has improved quality either by using a different supplier or by negotiating with the existing supplier, the improvement will be reflected in a reduction of waste or production resources (Vrijhoef & Koskela, 2000). Chase and Aquilano (1989 5th Ed. P.164) state that the philosophical orientation and role of manufacturing and production quality control (QC) function has begun to change radically in the past few years. Traditionally manufacturing and production QC was operated as a gatekeeping activity; the objective was to control product quality (PQ) of the output stage through inspection. This means working much more closely with vendors, providing engineering support to ensure that the materials or products they deliver are of high quality aspects of their jobs, particularly the materials and procedures needed for quality checks and improvement, the organization must involve in standard quality performance as shown in fig 2.1(juran and Gryna (1979, p.96).

- Purchasing Improvements: Efficiencies in the method used in the purchasing department will increase effectiveness. These can include the introduction of e-procurement systems, vendor managed inventory and pay on receipt processes. When a purchasing department negotiates with a carrier or number of carriers to reduce the cost of transporting materials from the vendor to the production facilities or site, the unit cost of the materials will be reduced. This cost saving can be used as a measurement of effectiveness (Vrijhoef & Koskela, 2000).

A number of studies have been carried out on purchasing performance and the results have noted that there is no one method that will cover every purchasing department. However, there are a number of key measures that are found to be common in evaluating performance, namely; cost saving, vendor quality, delivery metrics, price effectiveness and inventory flow. Although, the weight placed on these measures will vary between industry to industry and business to business. As cited in Chase and Aquilano (1989, 5th Ed. P. 708). Ammer (1986) enumerated four major activities to be identified by the purchasing department; Selecting the suppliers, negotiating the most advantageous terms of purchasing with him and issuing necessary purchase orders. Expediting delivery from suppliers when necessary to assure delivery in time to meet schedules, and negotiating any change in purchase schedules dictated by circumstances. Acting as liaison between suppliers and other company department including engineering, quality control, manufacturing, production control and finance, on all problem involving purchased materials. Looking for new products materials and suppliers that can contribute to company"s eye and ears to the outside world reporting on changes in market. It is therefore, indicates that, the merit of adopting multiple sourcing system including reducing the risk of interruption with supply due to quality problems, getting a healthy competition in which each vendor will devote themselves to improving methods and reducing cost in order to get a greater share of business. Also, the unit prices of the materials are lower with two or more sources than it would be if all requirements were concentrated on a single source Chase and Aquilano (1989 5th Ed., p 709).

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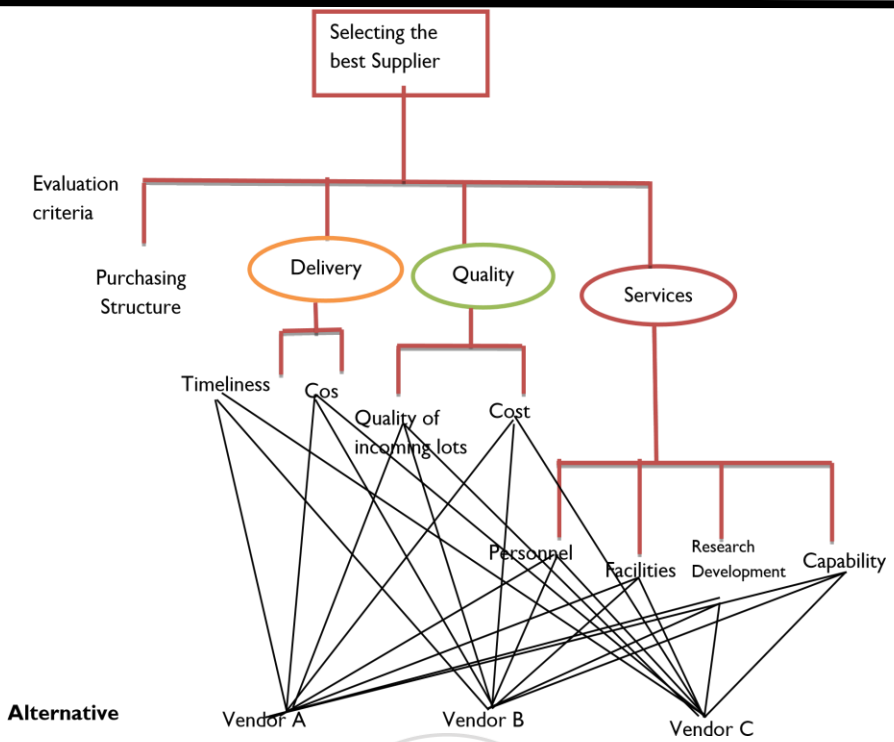

Fig. 2.2: An Illustrative Decision Hierarchy for Supplier Selection (Source: Adopted from Ram Narasimham "Analytical Approach to Supplier Selection". Cited in Chase and Aquilano (1989 5th Ed., p 709)

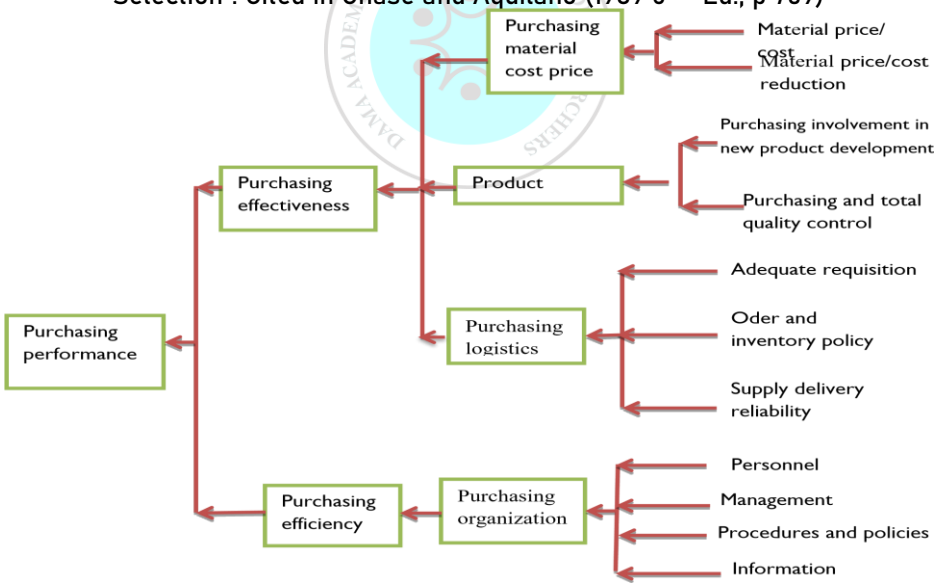

Fig. 2.3: An outline of Purchase Performance Measurement Source: Adopted from Weele (2000, 2nd Ed. P. 245).

2.2 Logistics

Generally, logistics is a concept base on an organizational policy that emphasizes materials movement and it may include planning implementing, and controlling the flow and storage of all goods from raw materials to the finished product to meet client requirements (Pheng & Chuan, 2001). Varghese and Connor (1995) grants that, there is evidence that the routing of materials is one of the main points which affect cost and time during construction projects. However, Martin (2005, 3rd Ed., p.82) analyzed that logistics activities does not just generate cost; also generate revenue through the provision of materials

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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. 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. Supply chain risk = probability of disruption x Impact (Martin, 2011, 4th Ed., p.194). Furthermore, Martin (2011, 4th Ed.) stated that, to help identify the risk profile of companies, it is helpful to undertake an audit of the main sources of risk across the network. The audit should examine potential risk to logistics disruption arising from five sources:

Supply risk: How vulnerable is the logistics to disruption in supply? Risk may be higher due to global source, reliance on key suppliers, poor supply management, etc
Demand risk: How volatile is demand? Does the „bullwhip" effect cause demand
amplification? Are there parallel interactions where the demand for another product affects the demands for ours?

Process risk: How resilient are our processes? Do we understand the sources of variability in those process e. g manufacturing? Where are the bottlenecks? How much
additional capacity is available if required?

Control risk: How likely are disturbances and distortions to be caused by our own internal control systems? For example, order quantities, batch sizes and safety stock policies can distort real demand. Our own decision, rules and policies can cause
„chaos" type effect.

Environmental risk: Where across the supply chain as a whole are we vulnerable to external forces? Whilst the type and timing of extreme external events may not be forecastable, their impact needs to be assessed.

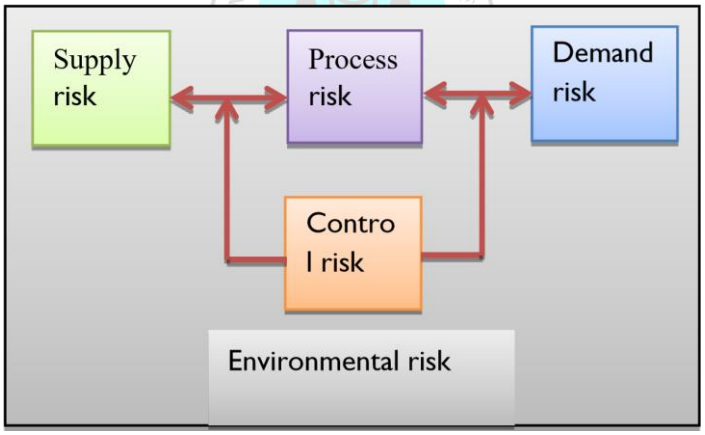

Fig.2.4: Source of Risk in the Supply Chain management
Source: Adopted from Mason-Jones and Towell (1998, p.17-22).

Handling: Gopalakrishnan and Sundaresan (1977) disputed that, poor material handling may result in delays leading to the idling of equipment and labours on site. Materials handling is described as a broad area that encompasses virtually all aspects of all movements of raw materials, work in process, or finished goods within a plant or warehouse (Lamber, Stock and Ellran1998)). In addition, 50 % of the production cycle time in many industries is spent on handling materials.

Stock and Waste Control: Stock control is classified as a technique devised to cover and ensure all items are available when required. Stock control can include raw materials, processed materials, and components for assembly, consumable stores, general stores, maintenance materials and spares, work in process and finished products (Prabu & Baker, 1986). It is of great importance that the bulk of construction materials delivery requires proper management of stock control. The reason is that, construction activities can generate an enormous amount of waste (Teo & Loosemore, 2001) and materials

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waste has been recognized as a major problem in the construction industry (Formoso, ASCE, Cesare & Isatto, 2002).

However, tighter materials planning can reduce waste and can directly contribute to profit-improvement and productivity (Datta, 1992). Each processes stated above plays an important role for an effective materials management. Contrary to these, there are materials management issues that have not yet been tackled effectively. Kasim et al. (2013) insist that generally, emerging technologies such as wireless system, bar-coding and Radio Frequency Identification (RFID) are not being adequately used to overcome human error and are not well integrated with materials management systems to make the tracking and management of materials easier and faster. Sardroud (2012) speculates that automating the task of identifying and tracking construction materials can provide timely and accurate information on materials availability to the manager.

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 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.

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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 27thFeb. 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

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

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- 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

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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

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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 Information Communication Technology (ICT) Tools Used in Construction Materials Management Processes

The study involved the use of ICT tools in construction materials management processes. In order to find out the most ICT tools use in materials management processes in the construction companies in Greater Accra and Ashanti region in Ghana, Relative importance Index (RII) together with some descriptive statistics, were used in identifying the most important ICT tools used in the construction companies understudy. Ranking was used to determine the level at which the ICT tools were used in the construction companies. The responses to the use of each tool by the respondents in their construction companies are indicated in the Table 4.2,

The number 1 in the table represents Yes, indicating that the company uses ICT tools in managing materials processes, 2 represents No, indicating that the company does not use ICT tools but have knowledge about its existence, 3 represents I don't know, indicating that the respondent is not sure whether the company uses ICT or not.

Calculation of RII for the Uses of ICT Tools in the construction companies

RII = 1.77 / 3 = 0.59

The mean value was used to represent the weight of each of the statement. For the first statement the W = 1.77, N=the total number of respondents who agreed to the statement, A=the highest rating. Multiply the formula by 100.

i.e RII = $\frac{W}{A \times N} \times 100$

Zero (0) *RII* means not inclusive

Higher value of RII indicates more important variable.

Table 4.2: The most important ICT tools used in the construction companies understudy

ICT Tools	Rating, N (%)						
	Yes = 1	No = 2	I don't know = 3	Mean	Std. Deviat.	RII	Ranking
E-mail and short message service(SMS)	99 (35.2)	149 (53.0)	33 (11.7)	1.77	.645	.6	1

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Mobile internet	119 (42.3)	89 (31.7)	73 (26.0)	1.84	.812	.52	2
CCT Camera	124 (44.1)	103 (36.7)	54 (19.2)	1.75	.751	.50	3
Twiter	122 (43.4)	106 (37.7)	53 (18.9)	1.75	.751	.48	4
File Transfer Protocol	124 (44.1)	104 (37.0)	53 (18.9)	1.75	.754	.47	5
Electronic Purchasing	1126 (44.8)	111 (39.5)	44 (15.7)	1.71	.722	.45	6
Radio Frequency Identification(RFID) and barcoding	138 (49.1)	77 (27.4)	66 (23.5)	1.74	.812	.42	7
Intranet	144 (51.2)	83 (29.5)	54 (19.2)	1.68	.777	.39	8
YouTub	146 (52.o)	101 (35.9)	34 (12.1)	1.60	.695	.37	9
Electronic Data Iterchange (EDI)	156 (55.5)	82 (29.2)	43 (15)	1.60	.741	.34	10
Webcas	156 (55.5)	80 28.5)	45 (16.0)	1.60	.749	.34	11
Barcoding and RFID tracking system	165 (58.7)	87 (3.0)	29 910.3)	1.52	.677	.31	12
Teleconferencing	160 (55.9)	107 (38.10	14 (5.0)	1.48	.592	.31	13
Global Position System(GPS)	198 (70.5)	51 (18.1)	32 (11.4)	1.41	.666	.24	14
Geographic Information Service(GIS	212 (75.5)	43 (15.3)	26 (9.3)	1.9	.942	.23	15
Videoconferencing	259 (92.2)	19 (6.8)	3 (1.1)	1.09	.321	.14	16
Integrated Service Digital Network(ISDN)	266 (94.7)	9 (3.2)	6 2.1)	1.07	.335	.13	17

4.2 Ranking the Use of ICT Tools

It has clearly emerged that E-mail and short message service (SMS) was the most popular ICT tools that was used in materials management processes among the registered contractor association in Greater Accra and Ashanti region in Ghana. This confirmed the assertion made by Whittaker and Sidner (1996) that 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. This was followed by Mobile internet and File Transfer Protocol. The least ICT tool used among the contractors (ABCECG) in Greater Accra and Ashanti region in Ghana was Video conferencing representing

4.3 Important Indicators and Labour Productivity Variables

This section presents the results of assessing the important indicators and labour productivity variables in Ghanaian construction industry. Relative importance Index (RII) together with some descriptive statistics, were used in identifying the most important indicators and labour productivity variables. From The table 4.5, the various indicators of ICT application to material management processes in Ghanaian construction industry were categorized into supplier management, Material handling, stock and waste control, organizational policy. Evidence from the mean scores of the statements indicates generally that the respondents generally agreed to each and every indicator of ICT application to material management processes and the variables of labour productivity. Kometa et al (1994) used the Relative Importance Index (RII) method to determine the relative Importance of the various causes and effects of delays. However, the RII can be mathematically expressed as:

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Calculation of RII for the first statement in Table 4.11a

RII □□□ ——— 4.16 □□□100 □ 0.69

□5□120□

The mean value was used to represent the weight of each of the statement. For the first statement the□*W* □ 4.16, *N=the total number of respondents who agreed to the statement, A=the highest rating. Multiply the formula by 100.*

i.e RII □□□ □*W* □□□100 □□

A□*N* □□

Zero (0) *RII* means not inclusive

Higher value of RII indicates more important variable. The important indicators and labour productivity variables in Greater Accra and Ashanti region in Ghanaian construction industry are summarized in Tables 4.3 and Table 4.3a. From Table 4.3, the most important indicators when using ICT tools in MMP, is conceded by the respondent to be I evaluate the materials supplier using computer software and I use ICT tracking devices to monitor workers and movement of materials on site (CCT Cameras or FRID). and subsequently followed by I use computer application to keep proper records of materials usage per time and on particular site, I use ICT to cross check quality and number of materials delivered on site, I send working drawings and other relevant documents to project management team using computer applications, I update materials records using ICT tools/software, I train worker using ICT tools to acquire materials management skills to control materials waste, I take good stock of materials arrived on site using computer applications, I communicate to materials supplier using." Facebook, Twitter and other communication software, I use Customer Relationship Management CRM) software to establish good relationship with the supplier.

Also, the most important labour productivity variables of ICT application to material management processes in Greater Accra and Ashanti region were based on the fact that; Timely delivery of material on project site has had a positive impact on project completion and subsequently followed by; Workers in my company being highly motivated leading to increased output, In-service training for labours on ICT from time to time, leads to high labour productivity, Effective supervision of labour during working avoids construction reworks, hence, leads to high labour output, Workers compliance with Organization of Health and Safety (OHS) regulation when using ICT tools and equipment has increased their output, The enthusiasm of teamwork by labours on site, has led high labour productivity, The readiness of labour to adopt new ICT tools in working procedures has led high to labour output, The positive attitude of labour towards work has certainly brought about an increase in labour productivity, ICT tools and equipment given to labours to work with, increase their output and The output per labour hours is high.

Table 4.3: Important Indicators of ICT Application in construction materials management processes

Indicators of ICT Application	*Ratings, f (%)*								
	SD=1	D=2	U=3	A=4	SA=5	Mean	SD	RII	RK
Supplier Management									
I evaluate the materials supplier using computer software	4(1.4)	11(3.9)	21(7.5)	109(38.8)	136(48.4)	4.29	.87	0.78	1

I communicate to materials supplier using Facebook, Twitter and other communication software.	0	4(1.4)	12(4.3)	127(45.2)	138(49.1)	4.42	.65	0.70	5
I send tenders to supplier through Email.	0	4(1.4)	3(1.1)	136(48.4)	138(49.1)	4.45	.59	0.65	8
I send clear materials specifications to supplier using.	1(0.4)	10(3.6)	22(7.8)	134(47.7)	114(40.6	4.25	.78	0.63	10
Electronic Document Management (EDM) software.									
I pay materials cost to supplier using e-Invoice	0	10(3.6)	28(10)	129(45.9)	114(40.6)	4.23	.77	0.66	7
I use Customer Relationship Management(CRM) software to establish good relationship with the supplier	7(2.5)	39(13.9)	20(7.1)	113(40.2)	102(36.3)	3.94	1.10	0.69	6
I use ICT to cross check quality and number of materials delivered on site.	0	7(2.5)	16(5.7)	117(41.6)	141(50.2)	4.40	.71	0.75	3
Material Handling I use ICT tracking devices to monitor workers and movement of materials on site (CCT Cameras or FRID).	10(3.6)	28(10)	26(9.3)	103(36.7)	114(40.6)	4.01	1.10	0.78	1
I use ICT tools/ software to speed up materials delivery on site.	1(0.4)	8(2.8)	8(2.8)	144(51.2)	120(42.7)	4.33	.70	0.60	12
I update materials records using ICT tools/software	0	3(1.1)	8(2.8)	125(44.5)	145(51.6)	4.47	.61	0.72	4
I use ICT tools/software to identify materials and issuing it to workers on site.	0	3(1.1)	11(3.9)	137(48.8)	130(46.3)	4.40	.62	0.64	9

Indicators of ICT Application	*Ratings, f (%)*								
	SD=1	D=2	U=3	A=4	SA=5	Mean	SD	RII	RK

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I take good stock of materials arrived on site using computer applications.	1(1.4)	3(1.1)	9(3.2)	126(44.8)	142(50.5)	4.44	.65	0.70	5
I take clear records of works that receive materials from store using computer application.	0	4(1.4)	7(2.5)	136(48.4)	134(47.7)	4.42	.62	0.65	8
I use computer application to keep proper records of materials usage per time and on particular site.	1(0.4)	1(0.4)	9(3.2)	117(41.6)	153(54.4	4.49	.62	0.77	2
Stock and Waste Control I reduced materials waste using computer application to plan for materials effectively.	0	7(2.5	21(7.5)	141(50.2)	112(39.9)	4.27	.71	0.61	11
I train worker using ICT tools to acquire materials management skills to control materials waste.	8(2.8)	24(8.5)	27(9.6)	112(39.9)	110(39.1)	4.04	1.04	0.72	4
Organizational Policy I keep organizational policy documents for future analysis and decision making using computer application.	0	7(2.5	21(7.5)	141(50.2)	112(39.9)	4.27	.71	0.61	11
I update working documents for lesson learnt base on the construction activities using computer applications.	8(2.8)	24(8.5)	27(9.6)	112(39.9)	110(39.1)	4.04	1.04	0.72	4
I send working drawings and other relevant documents to project management team using computer applications.	0	3(1.1)	3(1.1)	120(42.7)	155(55.2)	4.50	.59	0.75	3

RII=Relative Importance Index, RK=Rank Table 4.3a Important Labour Productivity variables for ICT Application in construction materials management processes

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Labour Productivity	Rating, N(%)					Mean	SD	RII	RK
	SD=1	D=2	U= 3	A=4	SA=5				
The output per labour hours is high in my company.	6(2.1)	21(7.5)	14(5)	120(42.7)	120(42.7)	4.16	0.97	0.69	10
Effective supervision of labour during working avoids construction reworks, hence, leads to high labour output in my company.	0	5(1.8)	6(2.1)	109(38.8)	161(57.3)	4.52	0.63	0.83	4
The readiness of labour to adopt new ICT tools in working procedures has led high to labour output.	1(0.4)	13(4.6)	19(6.8)	112(39.9)	136(48.4)	4.31	0.82	0.76	7
The enthusiasm of teamwork by labours on site, has led high labour productivity in my company.	1(0.4)	1(0.4)	1(0.4)	118(42.0)	160(56.9)	4.55	0.57	0.77	6
The positive attitude of labour towards work has certainly brought about an increase in productivity in my company.	0	1(0.4)	7(2.5)	122(43.4)	151(53.7)	4.51	0.56	0.74	8
In my company, timely delivery of material on project site has had a positive impact on project completion.	0	3(1.1)	2(0.7)	104(37)	172(61.2)	4.58	0.57	0.88	1
Workers in my company are highly motivated leading to increased output.	0	5(1.8)	5(1.8)	105(37.4)	166(59.1)	4.54	0.63	0.86	2
ICT tools and equipment given to labours to work with, increase their output in my company	1(0.4)	4(1.4)	16(5.7)	121(43.1)	139(49.5)	4.40	0.69	0.72	9
Workers compliance with Organization of Health and Safety (OHS) regulation when using ICT tools and equipment has increased their output in my company.	0	1(0.4)	8(2.8)	108(38.4)	164(58.4)	4.26	0.83	0.79	5

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In-service training for labours on ICT from time to time, leads to high labour productivity.	0	1(0.4)	8(2.8)	108(38.4)	164(58.4)	4.55	0.57	0.84	3

RII=Relative Importance Index, RK=Ran

5.0 CONCLUSION

From the result, it shows that most of the contractors do use E-mail and short massages, indicated with the highest RII value of 0.6, for communication purposes with construction team members in the diverse site. Construction activities or projects are time bound and its activities need to be clearly communicated to each team member clearly in order to complete projects on schedule. This confirmed Whittaker and Sinner (1996) assertion that E-mail and short are one of the successful computer applications, which contributed to the growth of distributed organizations, by allowing people at different geographical areas to communicate. This was followed by Mobile internet which is used for accessing information on strategies and approaches of managing materials. Thirdly, C.C.T Camera was also confirmed by the respondents as one of the ICT tools which were used for security purposes in monitoring the materials movement both on site and on the divers" site in the firms. The least ICT tool used by the respondents was Integrated Service Digital Network (ISDN).

5.1 Important Indicators of ICT tools Uses in ICT Application Variables and Labour Productivity Variables

This section presents the results of assessing the important indicators and labour productivity variables relating to materials management processes in Greater Accra and Ashanti region in Ghanaian construction industry. The indicators imply which of the materials management processes do the respondent use some of the ICT tools identified in this study most. The result turns to reveal that, respondents, in level of importance apply ICT tools to the following ICT Application Variables to *evaluate* the materials supplier using computer software to know the potentials of the materials supplier in terms of quality materials delivery and delivery on schedule.

Also the respondents indicated clearly that human involvement in materials management processes some time leads to materials theft, hence. They use the ICT tools for as tracking devices to monitor workers and movement of materials on site (CCT Cameras or FRID. Documenting construction activities for lesson learnt is crucial in construction materials management, therefore, care needs to be taken to keep record properly, so the respondents indicated that the ICT tools help or is important for keep proper records of materials usage per time and on particular site. Other important reasons for ICT tools application is indicated by the respondents were based on communicating to materials supplier and cross check quality and number of materials delivered on site.

Delivering projects on schedule is a paramount objective, therefore the few respondents that apply ICT tools to their materials management processes revealed that timely delivery of material on project site has had a positive impact on their project completion which has also highly contributed to workers in companies being highly motivated leading to increased output. Further high productivity assessed by respondents on the use of ICT tools in materials management processes shows that effective supervision of labour during working avoids construction reworks, hence, leads to high labour output and enthusiasm of teamwork by labours on site. The positive attitude of labour towards work has certainly brought changes due to the ICT tools uses. These confirmed the assertion made by Equere and Tang (2010) that Automation of materials handling and tracting processes provide a more accurate and timely working system. Also, confirmed Asabre et al (2012) declaration that worldwide, the use of ICT tools in materials management processes plays a role in the process of providing effectively, efficient services, product and packages to better satisfy their client.

These have led to underpin the fact that the use of ICT tools in materials management will improve labour productivity. Also, Successful management of construction materials has to be based on updated information and processed utilizing a well-designed construction materials management system. It also confirmed AbdulRahman (1994) assertions that, materials management is an essential function that

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improves labour productivity in construction projects. The result also confirmed Sardroud (2012) that, automating the task of identifying and tracking construction materials can provide timely and accurate information on materials availability to the manager, an indication that labours will not be idle during productive hours.

5.3 Application Variables to ICT Tools Application in materials management processes in Ghanaian construction industry

The major application variables to ICT tools application in materials management processes in Ghanaian construction industry was identify using Factor analysis. The result was based on the responses of the sampled Site Engineers and Project managers working in the various construction companies registered with the ABCECG and of good standing. In every organization there are goals and specific objectives that are to be achieved and as such there are rules, regulations and the standard at which these objectives are to be achieved. Therefore, the organization adopts or makes a policy to enable a smooth running of the organization. The study noted that *Organizational Policy;* is one of the enabling factors to which ICT tools could be applied to in materials management processes. *Organizational Policy* talks about laydown working procedures and the structure of the role play by the respondents in the construction companies based on materials movement (materials handling) and this confirmed Pheng and Chuan (2001) that *Organizational Policy* is a concept that emphasizes materials movement and it may include materials planning implementation, and controlling the flow and storage of all goods from raw materials to the finished product to meet client's requirements. In achieving a good result of managing materials, there is that needs for a comprehensive system to be followed, therefore allows the use of ICT tools to structure the policy of the company comprehensively.

Otherwise, organizational policy dealt with handling a volume of document that serve as the brain behind the organization or the engine on which the organizational activities would be run. In other to avoid confusion in the routing of materials management processes in the organization, organizational policy documents need to be clearly and well kept, such that it can be duly followed, hence the need to employ ICT tools to expedite the structuring of the organizational policy and also keep the policy for future references. These also confirmed Patel and Vyas (2011) assertion that to fulfill all organizational objectives, it is necessary to establish harmony and good co-ordination between all the employees of material management department and this department should have good co-ordination with the other departments of the organization to serve all production centers.

Identification of materials and supervision of workers for usage of store materials; also met the decision of respondents as one of the enabling factors to ICT application in materials management processes. The construction site is such an environment that has a lot of activities that are ongoing at the same time which involve the use of materials by workers to achieved projects deliverables. It is really of great importance to identify materials that are brought on to site and kept in the store. This is to ensure a systematic issuing of materials to workers on site and also ensure that materials are put to efficient use by supervising workers during working processes. The least wastage of materials due to lack of proper identification and supervision lead to poor productivity and high cost of entire project undertaken. This relate to Gopalakrishnan and Sundaresan (1977) that poor material handling may result in delays leading to the idling of equipment and labours on site. Otherwise, it is also confirmed by Varghese and Connor (1995) that, there is evidence that the routing of materials is one of the main points which affect cost and time during construction projects. Hence it is actually plausible to employ ICT tools to effectively handle materials through proper identification and also supervise the works to put materials to the good use in other to achieve the objective of the project undertaken. Which is also in line with, Sardroud (2012) that automating the task of identifying and tracking construction materials can provide timely and accurate information on materials availability to the managers.

Records taking and specifications of materials; Effective construction materials management process is one of the success factors of a construction project. Successful management of construction materials has to be based on record keeping, updating information and processed utilizing a well-designed construction materials management system. *Records taking and specifications of materials*, is an indication of major reduction in materials waste. Record taking in materials management turns to explain the process of keeping document in regards to the quantity of materials, types of material, cost of

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materials that are purchased and the movement of materials either on site or outside the site. This is to ensure that materials purchase is of good standard and are properly issued to workers on site to achieved projects deliverables. In otherwise, if not to eradicate, then to minimizes materials losses or theft during the processes of ordering materials from the supplier and it uses on site. In the study, respondents describe *Specifications of materials* in terms of its quality, quantity, sizes, uses and place of use on site. The major aim is to reduce waste and can directly contribute to profit-improvement and productivity (Datta, 1992). It is also an indication that *Specifications of materials,* helps to reduce the problem associate with: Materials that do not match the purchase order. If unsuitable materials are discovered on time, they can be changed and the damage is minimal. If, on the other hand, upon arrival they are stored without checking and retrieved just when needed, the work can be delayed until the correct materials arrived. Wrong quantity of materials arriving to the site, if the quantity of the materials arriving to the site is smaller than the needed quantity, the effect is similar to late arrival of materials. If, on the other hand, the quantity is higher, either the excess has to be sent back or stored for later usage. This leads to time and cost to keep the excess materials or return it to the supplier (Navon & Berkovich, 2006).

Timely and accurate information on materials availability to the manager on site can be trace to the tracking of materials movement from the supplier and this will also give the assurance as to whether the materials supply by the supplier is of the specified quality by the construction firm. With regards to these, the respondents in this study pointed out that *Tracking of materials movement and quality materials from suppliers* is one of the good enabling factors to ICT tools application in construction materials management processes. Materials movement (handling) is described as a broad area that encompasses virtually all aspects of all movements of raw materials, work in process, or finished goods within a plant or warehouse (Lambert et al., 1998). It is therefore, an indication that materials movement and its specified quality start right at the commencement of the project to the finished end, as such, every activity in the project cycle involve the use of materials from the supplier, specified base on quality, quantity and sizes. These need to be closely monitored to avoid inferior materials and do away with theft, losses on site and also reduced materials wastage. This is an indication that confirmed Kasim (2011), Equere and Tang (2010) and Asabre et al., (2012) in the literature that automation of materials handling and tracking process provide a more accurate and timely working system in various services providing companies and organizations worldwide in the process of providing effectively, efficient services, products and packages to better satisfy their client.

Teamwork is very critical in construction materials management processes. In materials management, there are different sections within the process that needs good co-ordinations to harness the skills of management in other to avoid materials waste. Otherwise co-ordination is needed to manage the supplier, track materials movement both from the supplier and its uses on site. These is the steps toward a positive direction of making sure that materials of good quality are timely available on site to increase labour productivity and other related productivities in the construction sector. It is also worthy to note that, acquiring requisite knowledge in managing materials in the construction industry is of its great importance. Therefore, personnel in charge of managing materials need to be well trained or educated in other to keep materials records or supervise workers using the materials. Nevertheless, it will be of great challenge to materials managers to work as a team or relate to each other especially when they work on diverse site, in other to share ideas or exchange experiences in regards to materials management objectives, the respondents indicated that *Working relationship and formal training* will actually be an enabling factor to ICT application in materials management processes since this will have harmonized skills and ideas of materials managers on diverse site.

The efficient and economic purchasing and procurement of materials from the suppliers, is a very important decision undertaken by any organization. It is actually no news that profit earned on projects very much depends on how economically the materials are purchased and utilized in the organization. Co-ordination of the procurement and order of material are important in assuring materials availability. Though, the general perception in the Ghanaian context of business shows that the more your suppliers the more chances you have in getting your materials on time and being able to compare prices of materials in the market before ordering, now, there is a new paradigm shift as indicated by the respondents of this study that *Management of usage of few suppliers* is of great important and will serve as one of the best enabling factors to ICT application in materials management processes in Ghanaian construction industry.

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They are of the view that dealing with the few supplier encourages trust in terms of timely delivery of materials since the routine of work is known to the supplier and also there is that opportunity of building a system using a software with your supplier in other to enhance specification of materials, information regarding the status of materials availability in store in teams of quality and sizes to ease the cost of transportation and avoidance of materials waste. These will actually reduce the cost of materials management teams in the respective construction companies. This agrees with Martin (2011, 4th Ed.) assertion that Administrative costs are the basis for measuring purchasing efficiency. This performance measurement does not relate to the amount of purchased items that the department has procured. The measurement relates to how well the purchasing department is performing in the activities they are expected to perform against the budget that is in place for the department. Therefore, *Management of usage of few suppliers* will lead to efficiency of materials purchasing and ordering in the construction industry in Ghana.

5.4 Findings

The major finding of this study was that enabling factors (ICT Application Variables) has positive relationships with the labour productivity when compared. This implies that if there is any improvement in ICT tools application, say one – step, there will be an increase in labour productivity by that one – step. Otherwise, investment made in ICT tools application in materials management processes make a significant contribution to high labour productivity achievement. The study suggests that *organizational policy base on the uses of ICT tools* was the most contributing variable towards achieving labour productivity.

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