

Application of Information Communication Technology (Ict) To Construction Materials Management Processes and Its Impact on Labour Productivity in Two Regions in Ghana

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I. 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).

Nevertheless, in the construction industry various projects are undertaken with a specific goal 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.

Materials management is considered as a means to achieve better productivity, which could be translated into cost reduction. Though, materials management plays a significant role in the success and productivity of construction project, it has its relative problems or challenges, such as shortages, delays in supply, prices fluctuations, damage, waste and lack of storage space. Kasim (2011) speculated that construction activities can generate an enormous amount of waste and Materials waste has been recognized as a major problem in the construction industry. However, tighter materials planning can reduce waste and can directly contribute to profit improvement and productivity. Haddah (2006) contended that materials management functions are often performed on fragmented basis with minimal communication and no clear established responsibilities assigned to owner, engineer or contractor.

Timely availability of materials and systems for management are vital to successful construction. Hence, it is important for the project manager to consider that there may be significance difference in the date

that the materials were requested or date when the purchase order was made, and the time, of which the material will be delivered, thus materials management is a key of project management. Ashwini, Patil and Pataskar (2013) concurred that materials constitutes a major cost component in any construction project and the total cost of installed materials may be 50% or more of the total cost of the project. Therefore, materials management should be a matter of concern to material managers in the construction field.

However, Kasim (2011) contended it is possible that information and communication technology ICT implementation may be the answer to overcome the challenge of materials management in the construction industry. Equare and Tang (2010) supported that Automation of materials handling and tracking process provide a more accurate and timely working system. Furthermore, Asabre, Oppong and KusiSarpong (2012) granted that in various services providing companies and organizations worldwide, information and communication technology (ICT) play a role in the process of providing effectively, efficient services, products and packages to better satisfy their clients.

The government in Ghana undertakes various construction projects for infrastructure development to meet the higher demands of the population growth. These projects are mostly characterized with challenges using traditional or manual method. Waste has a cost. This simple relationship has historically been overlooked. The critical point at which contractors and sub-contractors can influence waste is when buying materials for project, as this activity determines the materials that are supplied to site.

II. METHODOLOGY

2.1 Research Design

Quantitative research design is adopted for the study. 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 2.1: 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

2.2 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.

2.3 Data Collection

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.

3.7 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.

III. PRESENTATION AND ANALYSIS OF RESULTS

3.1 Response Rate

The study targeted a total sample size of 450 (both Greater Accra and Ashanti Region) Site Engineers/Project Managers within the registered construction companies in the Association of Building and Civil Engineering Contractors of Ghana (ABCECG), to respond to the questionnaires. Three hundred copies (300) of questionnaires were distributed in Greater Accra and one hundred and seventy-one (171) representing 57% were retrieved. In Ashanti region, one hundred and fifty copies (150) of questionnaires were distributed and one hundred and ten (110) representing 73% were retrieved. The remaining questionnaires that were not retrieved from both Greater Accra and Ashanti regions representing 38%. Therefore, the total questionnaires retrieved stood at, two hundred and eighty-one (281) representing 62% which was used in the analysis of this study. A Study conducted by Boussbaine (1999), Idrusand Newman (2002), Oladapo (2005) assessed that response rate of 30% is good enough in conducting studies in construction; hence it is plausible to use the 62% which is significantly higher than 30% in this study.

Table 3.1: The most important ICT tools used in the construction companies under study

ICT Tools	Rating, N (%)						
	Yes = 1	No = 2	I don't know = Mean 3	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
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 (52.0)	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
Barcode 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

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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

3.2 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

3.3 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 4.2: Benefits derived from ICT application to material management

ICT Application to materials management	Rating, N(%)					
	SD=1	D=2	U= 3	A=4	SA=5	Mean
Benefit derived						
	2(0.7)	0	4(1.4)	100(35.6)	175(62.3)	4.59
More cost effective projects are achieved.						
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

IV. DISCUSION

4.1 Correlation between Information and communication Technology (ICT) Application Variables and Labour Productivity in Ghanaian construction industry

The results reveal that the p-values for the test using Spearman correlation between the depended variables (labour productivity) and the independent variables (ICT Application variables) is less than the critical p-value (0.05), therefore the null hypothesis was rejected, indicating that there is significant correlation between labour productivity and ICT application variables. It is therefore, explains that the construction companies that registered with ABCECG in good standing in both Greater Accra and Ashanti region use ICT application to assess high labour productivity.

In order to investigate the relationship between the dependent variable (**LP** and the six independent variables (ICT Application variables) which resulted from the factor analysis, the Multiple regression analysis reveals that the regression line predicted by the independent variables explains a significant amount of the variance in the dependent variables $F (6, 274) = 32.933; P<0.05$. Therefore, the regression is statistically significant. The results show that the independent variable

,，“Organizational policy” has the greatest influence towards achieving labour productivity (dependent variable) with a beta coefficient of 0.975 which explains

42.5 percent of the variance of the dependent variable ($p=0.000$).

With a beta coefficient of 1.066, the variable „*Identification of materials and supervision of workers for usage*“ has the second largest influence on the dependent variable ($p=0.000$). The third and fourth variables influencing the labour productivity were, *Tracking of material movement and quality materials from suppliers* with a beta coefficient of 0.938 ($p=0.00$) and the fourth being *Working relationship and formal training* with a beta coefficient of 0.843 ($p=0.00$). The results reveal that „*Records taking and specifications of materials*“ (beta coefficient=0.462) and „*Management and usage of few suppliers*“ (beta coefficient=0.411) have less explanatory power of the dependent variable. Also, these regression coefficients are not significant. Though, *Records taking and specifications of materials* relations and *Management and usage of few suppliers* are positively related to Labour productivity but the relationships are not significant.

4.2 Benefits Derived from ICT Application to Material Management

The respondent indicated that ICT tools application in materials management processes actually lead to benefits like, *More cost effective projects are achieved*, this is an indication that the budget prepared for the specific projects as at the time of the project has duly been followed and the expenses involving administration cost of materials management processes, with regards to Planning, procurement, Purchasing, Logistics, Handling, Stock and Waste Control, have been met without any project cost overrun.

In addition, *Expedite purchasing processes of construction material*, also emerged as a driven benefit of ICT tools application in materials management processes. The respondent indicated that ordering and payment of materials processes are tremendously speed up when ICT tools are used for communication or coordination for materials arrival on schedule and on site to avoid keeping the labours idling. This are really achieved using E-mailing, Transfer Protocol and others to speed up communications or co-ordinations

Furthermore, *Reduction in craft labour cost due to the improved available of materials as needed on site*, also met the approval of the respondent as one of the benefit driven from ICT tools application in materials management processes. It is an indication that implementation of ICT tools in managing materials has actually led to reduction of people that are to work, otherwise works that are to be done by five people, due to ICT tools implementation one person will be able to handle the works and this will lead to reduction of labour cost.

A better standard of work due to quality specification of construction materials and equipment, as approved by the respondent as one of the benefit, is an indication that materials quality and quantities are well defined or described when ordering for materials to avoid wastage. Also working procedures that involve the uses of the materials are closely monitored using the ICT tools to ensure that quantity of materials issued to workers are properly used in other to achieve good standard of work.

Last but not the least, *Completion of construction works on schedule*, is one of the greatest objectives for construction companies to achieve as benefits. The respondent indicated that using the ICT tools in managing materials processes, contribute greatly to the working procedures or project schedule due to timely availability of materials on site to speed up working processes, by assigning materials to each individual task and the personnel to undertake the task (work breakdown structure, WBS). These benefits go to confirmed the assertion made by “Rethinking Construction” (2000) in the literature review that investment in such systems like ICT tools in materials management processes can be quite beneficial. This will inevitably result in a firm or project experiencing previously unknown increased levels of professionalism and benefits.

V. CONCLUSIONS

This research investigated the ICT tools uses and relationship between the labour productivity (depended variables), ICT enabling factors (ICT Application

Variables) independent variables, in construction materials management processes. The most ICT tools used by the construction firms in the regions were found to be E-mail and short message (SMS) which the respondents indicated that it helps in communicating with construction team to achieve project objectives on schedules.

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.

The study also revealed that when construction materials are well specified and workers, also, well supervised. These will lead to high labour productivity. In the same vein, *tracking of material movement and quality materials from suppliers will and Working relationship and formal training lead to high labour productivity*. Also, the result reveals that, „*Records taking and specifications of materials*“ and

,*Management and usage of few suppliers* have less explanatory power of the dependent variable indicating that though, they contribute to labour productivity, not to that great extent or significant. This may be due to some couples of extraneous variables that could not be accounted for.

Otherwise, 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.

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