Professional Perspective on Inventory Management Process in Building Construction Projects, Bauchi Metropolis

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ABSTRACT
This study investigated professional perspective with regards on-site materials tracking inventory management process in building construction projects with a view to making decisions for improving construction practice in Bauchi metropolis. Four objectives were put in place to pursue the aim in which the study was approached quantitatively and adopted survey strategy with the use of 79 questionnaires as the instruments for data collection. Data collected was analysed using descriptive inferential and regression analysis to arrive at the results. The findings uncovered that paper-based format of material tracking inventory management was the most used method by building professionals however electronic materials management system is also in use in the study area but not as much as the paper-based format with mean values of 4.11 and 3.59 respectively. RFID technology and GPS technology are however not put to use in the study each with mean values of 2.44 and 2.41 respectively. It was found that the professionals are of the opinion that the success level of construction projects in the study area is generally on an average with a recorded mean value of 2.91.The impact material tracking inventory management process practices has on the success of building construction projects in the study area were established to be at about 66.9% which is equally statistically significant with p-value less than 0.01. The study further recommends that Project managers are encouraged to adopt the use of RFID technology for material tracking inventory management as it has proven to be a more effective means of managing inventory of materials, with this technology shortage, waste and theft of construction materials The government equally has a role in assisting the attainment of construction project success. Enforcement of procedures and standards has to be taken more serious by the government.The Council of Registered Builders of Nigeria (CORBON) are encouraged to intensify awareness on the adoption of more efficient methods of construction practice in general through research and mandatory continuing professional development programme for her members to update them on recent developments practiced globally and in turn create the enabling environment for her members to key into the current practices.

I. INTRODUCTION

The demand for construction development is increasing from day to day parallel with increasing in the growth of population. A lot of development has been carried out which comprise of the housing development, infrastructure, industry, institutions, health care and others to fulfil the demand. In project development, materials areamong the important elements to be taken into consideration as they are the buildingblocks that make up a project meanwhile material also constitute large amount of the project costs (Lu et al., 2011). Previous research identified that material costcomprise of 50-60% from the total project costs (Nasir, 2008; El-Ghazaliet al.,2013). Therefore, inventory which is part of materials also contribute significantamount to the above percentage.

Inventory in general could be defined as the company's raw materials, workin process, supplies used in operations and finished goods which were used to ensuresmooth running of the business (Muller, 2011; Sahariet al., 2014). However, in building construction settings; inventory was referred as materials or components on hand which was kept by contractors for the smooth functioning of construction processes.Inventory is also known as the stock of materials or components kept at the storage for future use in construction process. Adequate amount of inventory is crucial toensure the smoothness of building construction processes and

to maintain a healthy cash flow for contractors (Lu et al., 2014). However, inadequate amount of inventory results injob stoppage due to materials required for conducting construction works could notbe specified at time they are needed.

The management of inventory in building construction projects is important where significant amount of money was invested in every single activity. It involves the management of materials or components as they were unloaded to the site storageupon arrival at the project site. Several processes which considered important ininventory management are materials planning, purchasing, materials delivery,materials storage, and materials issue (Waters, 2013).

As inventory management has increase in importance, materials tracking for inventory management also have received great attention. Material tracking forinventory management process has become everyone's concern as constructionmaterials usually come in bulk without proper identification and difficult to be traced (Song, 2015). Hence, material's tracking is important as it could ensure that materials areavailable at the right time, in the right place and at the right quantity at time areneeded to carry out construction work (Song, 2015). Thus, this research focuses on material tracking practices for inventory management process in building constructionprojects particularly at the storage area.

In general, inventory could be defined as the company's raw materials; work in process, supplies used in operations, and finished goods (Muller, 2013; Sahariet al.,2014). Inventory is the amount of raw materials, fuels, lubricants, spare parts and semi-processed material to be stocked for the smooth functioning of the plant (Chitale& Gupta, 2016). According to Maré (2016), inventory were use to mean several different things, such as;

i. the company's or firms raw materials;
ii. work in process;
iii. components/sub-assemblies;
iv. finished goods;
v. maintenance, repair and operational supplies; and
vi. Transportation inventory (movement inventory).

In construction projects, inventory refers to materials or components on hand;which is kept by construction firms or projects as stock for the smooth functioning of construction process. In addition, inventory in construction also could be referred toas the amount of materials or components on the storage area.

2.2.2 The Importance of Inventory

Why businesses need inventory or why inventory is so important? Why do businesses keep inventory in their organizations? As in just-in-time (JIT) manufacturing concept, keeping a stock or inventory is considered as a waste.However, according to Muller (2011) there are several reasons for holding inventory in organisations. Such reasons are:

Predictability:In order to engage in capacity planning and production scheduling, organisations need to control the inventory quantity (raw materials, parts, andsub-assemblies) they had processed at a given time. This is important asinventory will act as a buffer as what you need from what you want.

Fluctuations in demand: Inventory on hand acts as a protection against undesirable market conditions.Inventory of finished goods is important in protecting companies from anincrease in customers demand.

Unreliability of supply: Inventory will provide organizations with a protection from unreliablesuppliers and in scarce conditions where it is difficult to ensure a steadysupply of materials and items.

Price protection: Buying and keeping large quantities of inventory at appropriate time helpsavoid the impact of cost inflation.

Quantity discount: Buying large amount of items such as buying in bulk is much susceptible to quantity discounts as compared to buying in smaller quantities.

Material Tracking for Inventory Management

Material tracking in construction projects is not an easy task (Navon&Berkovich, 2016). This is due to construction projects involve large amount of materials to fulfill the demand of construction activities. Thus, it is important for the projectmanagement to be able to trace every construction materials to make sureconstruction works could be carried out in line with the availability of resources(construction materials).

The Importance of Material Tracking

The term material tracking could be defined as the process of collecting and managing information related to present or real-time location of a products or items (Shamsuzzoha&Helo, 2014). Material tracking in construction project is crucial asmaterials constitute large portion of the total project costs. According to Green (2015), material tracking in construction projects is important

because of several reasons; (i) to know exactly the location of materials, so workers do not have towaste their time searching for materials, (ii) to make sure jobs and orders are not held up because of lack of materials, (iii) to track the quality and cost of each container ofmaterial in order to make sure that the correct materials are received according topurchase orders, (iv) to make sure the manufacturers have shipped the right materialsto the customer; and (v) the need for traceability.

Materials Tracking Technology
The implementation of technology in every day's life has ability to assist human works while at the same time improving their life quality. Hence, the implementation of technology particularly for material tracking in construction projects is expected tofacilitate and improve existing material tracking practices. From previous research, there are several technologies which were used for material tracking. Explanationson each technology were made as follows.

Radio Frequency Identification (RFID)
RFID technology was successfully used in various fields of business application such as retailing, automobile, aeronautic, medicine and also construction industry. Several researches also have been conducted regarding successful RFID application in construction projects. Based on previous research, RFID were used to track

itemsand materials, tracking location of buried assets, real-time monitoring of materials and components; and many other applications. Several researchworks regarding RFID applications in construction projects are viewed below.

Dziadak et al. (2016) use RFID technology in their research to identifyaccurate location of underground assets (i.e. water and sewage pipes). This is due tomanual method used to identify the buried assets are unreliable and unable to provideaccurate and comprehensive data on the assets location. In addition, manual method of asset tracking has several shortcomings in which limit their function. The manualmethod could not locate non-metallic utilities, might not be used in all types of soils,unable to penetrate to required depths, and it use hazardous equipment that increases risks and costs of operation (Dziadaket al., 2016). Hence, advancement intechnology enable specific method for asset tracking to be developed that use RFIDto successfully identify underground assets and equipment's.

OBJECTIVES
i.   To assess professionals' opinions with regards the inventory management process employed in construction projects in Bauchi metropolis.
ii.   To assess the impact material tracking inventory management process practices has on the success of building construction projects in the study area.

II.   MATERIAL AND METHODS
4.4   Professionals Opinion about Building Construction Delivery
Table 7: ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Completion Timeline	Between Groups	3.733	4	.933	1.018	.404
	Within Groups	67.862	74	.917		
	Total	71.595	78			
Project Compliance	BudgetBetween Groups	5.458	4	1.364	1.184	.325
	Within Groups	85.302	74	1.153		
	Total	90.759	78			
Finished Quality	ProjectBetween Groups	3.478	4	.869	.713	.586
	Within Groups	90.294	74	1.220		
	Total	93.772	78			
Performance Business Case	toBetween Groups	1.039	4	.260	.149	.963
	Within Groups	128.961	74	1.743		

	Total	130.000	78			
Customers Satisfaction	Between Groups	2.499	4	.625	.699	.595
	Within Groups	66.109	74	.893		
	Total	68.608	78			

The ANOVA result presented in Table 7 reveals that the opinion of the different professionals who participated in the study with regards the completion time of project delivery in the study area do not differ between the various group of professionals in the study area since a P-value of 0.40 is recorded which is greater than 0.05 as suggested by the rule of Thumb. Similarly, Table 7 also shows that professionals opinion with regards project budget compliance, finished project quality, performance to business case and customer satisfaction has no statistical significant difference between groups of professionals in the study area as P-values of 0.33, 0.59, 0.96 and 0.60 are recorded respectively which are all higher than 0.05. By implication, the ANOVA result exposes that despite the fact that different professionals in the building industry shared their various opinions on the success rate of building construction projects in Bauchi there are no significant differences in their opinions.

Impact of Inventory Management Process Practices on Building Construction Success

This study made use of a multiple regression in analysing the impact inventory management process currently practiced in the study area has on building construction projects delivery in the study area. This was done in an attempt to establish how each inventory management process will influence construction project delivery with a view to developing a workable opinion for on-site material tracking. The independent variables for the study included the four measured material tracking inventory processes (paper-based format, electronic materials management system, RFID and GPS) while the dependent variable used in the regression model is building construction project delivery efficiency in the study area as opined by the professionals.

Table 10: Regression Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics R Square Change	F Change	df1	df2	Sig. F Change
1	.818[a]	.669	.651	.29377	.669	36.843	4	73	.000

Table 10 reports R value of 0.818 which suggest that the independent variables (inventory management processes) have 81.8% relationship with the dependent variable (building construction delivery). Also an R square value of 0.669 implies that the independent variables have 66.9% influence on building project delivery, that is to mean that the inventory management process practiced accounts for 66.9% variance of building construction projects delivery in the study area, therefore by implication 33.1% of the of building construction projects delivery efficiency is accounted for by other factors not considered in this model.

Furthermore, Table 10 reveals a p-value that is less than 0.01 which means that the influence inventory management process has on the success of building construction is significant since p-value is less than 0.05. Table 11 further explains to what extent each of the material tracking inventory management processes influences building construction project delivery in the study area holding all other factors constant.

Table 11: Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	1.051	.201		5.219	.000
	Paper-Based Format	.019	.042	.031	.446	.657
	Electronic Materials Management System	.375	.042	.671	8.920	.000
	RFID	.095	.043	.164	2.176	.033
	GPS	.081	.040	.146	2.025	.047

The unstandardized beta (β) coefficient reported in Table 11 further reveals that for a unit change in level of usage of paper-based format for material tracking there will be a 0.019 unit increase in building construction delivery, the said variation is however not significant as seen in the reported p-value (Sig.) of 0.657 which is greater than 0.05. Nevertheless, a unit increase in the usage of electronic materials management system for inventory management will result to 0.375 unit increase in building construction delivery efficiency and having recorded a p-value that is less than 0.01 implies that the variation is significant.

In addendum, the corresponding unstandardized beta coefficient for RFID technology implies that for a unit increase in usage of RFID technology for material tracking, building construction project delivery will increase by 0.095 units and a p-value of 0.033 entails also that the variation is significant. Also, GPS reveals that for a unit increase in adoption of GPS for material tracking there will be a corresponding increase of 0.081 of building construction delivery which is equally significant having recorded a p-value of 0.047 which is less than 0.05. It can be noticed the paper-based format commonly in use in the study area as revealed earlier does not have a significant positive effect on construction delivery in the study area, however electronic materials management system which is slightly put to use and RFID technology which have is not in use at all in the study area seems to pose more positive effect on construction projects delivery in the study area.

III.   DISCUSSION OF RESULTS

The professionals' opinion with regards the inventory management process practices currently in use in the study area showed that the paper based format was the most used method, even though electronic material management system were also said to be put to use. This finding is consistent with the study of Arijeloye and Akinradewo (2016) conducted in Ondo State, Nigeria which revealed that paper and electronic records were kept on purchase of construction materials, material planning and transportation. Similarly, Ikediashi and Udo (2021) also unraveled that paper and electronic records has been employed in Nigeria for material requirement planning and warehouse management in construction sites. Therefore this study goes to strengthen the fact that the paper based format and electronic material method of inventory management practice is what is been adopted in the Nigeria construction industry.

This study again revealed that inventory management process practices impacts construction project delivery, this is in accordance with the findings of Wayrahet al. (2021) and Ikediashi and Udo (2021) whom also found that inventory management techniques has a significant influence on project delivery time and cost but however not on the quality of the project.

IV.   CONCLUSION

Construction projects carried out in Bauchi have recorded an average success rate and the success level of construction projects are by and large influenced by how building materials are efficiently put to use, hence transcending to the material tracking inventory process practiced by project managers as exposed by the findings of this study. Therefore the choice of inventory management process practiced on site will affect the general success of any construction project. It is to this end that an efficient and effective material tracking inventory process is needed as one of the key players in attaining construction project delivery success.

The building construction industry in Bauchi metropolis over time has employed the paper-based format and electronic materials management system of material tracking of inventory, in spite of this, the level of success

attained in building construction project have been at an average. To this effect, it can be concluded that the paper-based format and electronic materials management system of material tracking of inventory process practiced have not improved the success level of construction projects in the study area and as such the need for adoption of better methods for inventory management of on-site materials.

It is in light that this study has equally concluded that the adoption of RFID technology in tracking materials for inventory management is the best alternative method of inventory management process having high potentials and have proven to have a positive statistical significance on the success of building construction projects despite the non practice of the process in the study area. Therefore to improve the success level of construction project delivery in the study area the use of RFID technology for material tracking will be a major contributing factor.

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