**174. Utilisation of technology in construction material logistics processes for efficiency**

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**Abstract**

The adoption of technology for logistics operations is critical for improving the total effectiveness and efficiency of a logistics system. However, the current technology used for construction materials logistics processes in the Nigerian construction industry are relatively unknown and inadequately investigated. The aim of this study was to determine the level of technology used in logistics processes by construction material manufacturers in North-Central Nigeria, with a view to improve operational efficiency thereby reducing cost. This article adopted a case study research design method in which quantitative data were collected and analysed. The target population was the North-Central geo-political zone of Nigeria. A total of 32 construction material manufacturers were purposively selected from the zone. The observation and measurement approaches were adopted for data collection for logistics processes. A total of 72 customers’ orders were observed and recorded to be representative of deliveries from the sampled (n = 32) manufacturers’ warehouses to other terminals. The descriptive method of data analysis was employed using percentages and results presented in a form of bar charts. The study established low level of utilisation of technology such as, AutoID, order picking, communication, information technology, e-business, and technology in vehicles in logistics processes by the manufactures. This leads to inefficiencies in terms of speed, accuracy and reliability. It concludes by providing the construction material manufacturers with areas that requires technology to optimise material logistics operations. A recommendation is made for further study to explore why technology is not adopted by these companies, despite its advantage. **Keywords:** Construction material, Technology, Logistics processes, Efficiency and Projects

**1.0 Introduction**

Construction material is a basic constituent in construction projects and can make an important contribution to the cost effectiveness of projects ( Abhilin & Vishak, 2017). Research has revealed that the cost of construction material is usually about 50%-60% of the total cost of a project (Duiyong, Shidong & Mingshan, 2014). For the management of construction material logistics system, the purpose of better logistics customer service is to guarantee that materials are adequate and accessible for construction processes. However, projects are made difficult by material inadequacies, delays in supply, increase in cost, material wastage and damage, and the absence of storage space (Kasim, Latiffi & Fathi, 2013).

Efficiency is an evaluation of the manner that the utilisation of assets maximise output, given the effort and technology. It largely suggests accomplishing an objective at minimal cost (Pienaar & Havenga, 2016). Technology is an empowering influence in this regard (Gwynne, 2014). Effectiveness can be measure as to how much the required level of service is given to meet expressed goals and objectives (Pienaar & Havenga, 2016). The concept of technology adoption for the improvement will result in the following advantages; shortening of the working time, lowering of the costs referring to the internal transport, increase in the productivity, facilitation of stocktaking in the warehouse, control over the proper level of supplies, and accessibility of the goods (Drozd & Kisielewski, 2017). However, this technology is not sufficiently applied to overcome human error and are not well coordinated with project management systems to make tracking and management of materials easier and faster (Kasim, 2015). The utilisation of technology can reduce time required for data processing and information sharing. It likewise improves total project operations through communicating the relevant information which results in an effective organisation and decision-making (Al Maatouk, Qusay & Othman, 2017).

In addition, utilisation of new technology into existing logistics operations can help a lot in increasing customer service, reduce costs, and streamline supply chain (Wilson, Iravo, Tirimba & Ombui, 2015). Jang & Skibniewski (2009) opined that the advancement in technology and innovation in the construction industry should make it, in fact, reasonable to execute an automated monitoring and tracing of material in a system. Even though the construction industry in Nigeria has advanced to the point of executing big and complex projects, they still largely operate manually (Jang & Skibniewski, 2009). Time and effort cannot be wasted through the labor-intensive processes of reporting and documentation, and communication from site through the present manual handling systems, especially as the construction projects increase in size and scope (Equere & Tang, 2010). It becomes imperative, therefore, that utilisation of technology in logistics processes to efficiently manage further anticipated growth. Besides, a study by Isah, Shakantu & Ibrahim, (2020) established that the technological part of construction logistics, particularly the forecasting, is overlooked and hardly understood in the Nigerian construction industry.

However, manufacturers of construction materials are external to the organisation of the construction project and are thus observed to be of lesser significance in the project approach. Consequently, the construction material manufacturers logistics process even though critical, has been largely ignored. Therefore, Vidalakis, Tookey & Sommerville (2011) suggested the need to expand the scope of logistics management outside the environment of the project. Similarly, an effective logistics system would not be achieved if the manufacturers operated wastefully, dangerously and expensively (Shakantu, 2005). The problem to be resolved is how to minimise resources and costs in the construction logistics system, whilst retaining the same level of construction output. According to Choy, Gunesekaran & Lam ( 2013) the efficiency of Technology adoption in managing information flow, facilitating operational processes and systems and supporting decision making can be measured by examining how IT influences logistics performance. Nevertheless, there is limited understanding of the technology adoption in logistics processes utilised for construction material in the Nigerian manufacturing industries. Therefore, the research question was, what is the level of utility of technology in logistics processes by the Nigerian construction material manufacturers? The aim of this study was to determine the type and level of technology used in logistics processes by the Nigerian construction material manufacturers in North Central Nigeria.

**2.0 Literature Review**

In the field of logistics, diverse new technologies are utilised in developed nations, while this adoption is extremely slow in developing countries. The level of technology present differs vastly, and the range can go from remarkably vital installations with high manual effort and minimum computerisation, to completely mechanised and robotic installations (Bhandari, 2013). Thus, selecting the right technology for different logistics operations or sub-processes is critical for any business to increase competitive gain in current markets (Bhandari, 2013). Therefore, the latest advanced technology software’s being adopted in logistics were reviewed under the sub themes, Automatic Identification (AutoID), communication and information (Bhandari, 2013), and e‐business application ( Matopoulos, Vlachopoulou & Manthou, 2009).

**2.1 Automatic Identification Technology**

Automatic Identification (Auto ID) technology is the term used to describe the direct inputting of data or information into the computer system, where programmable reasoning controllers or any microprocessor-controlled device is used without operating a keyboard (Bhandari, 2013). The data capturing tools are optical scanning, electronic-pen notepads, voice recognition and robotics. Electronic Data Interchange (EDI), Electronic Fund transfer (EFT), intranet, internet and extranet enable such technology (Asadi, 2011). Additionally, the tools include Bar Coding, Radio Frequency Identification (RFID) and voice recognition (Bhandari, 2013).

The main strategy of the order picking system, is how much automation is utilised and whether pickers move between pick spaces or whether items are automatically delivered to them (Webster, Dalby, Fox & Pinder, 2014). Order picking typically account for 50-75% of the total operational expenses for a warehouse (De Koster, Le-Duc & Roodbergen, 2007). Any inefficiency in order picking can lead to unsatisfactory service and high operational expenses for the warehouse, and the entire supply chain (De Koster *et al.,* 2007). The picking techniques that are as of now being used in warehouses incorporate paper pick list, pick by the label, pick by voice, barcode scanner, radio frequency identifciation, pick light/pick to light, put to light and automated picking (Gwynne, 2014).

A study by Biju & Faisalu (2013) established that most organisations use bar coding now. They opined that most AutoID software are essential and should be implemented. These bar codes increase efficiency in three ways: speed, accuracy and reliability (Sople, 2010). In a similar study by Gwynne (2014) it was shown that various producers have presented a joined voice and automated guided vehicle (AGV) or laser guided forklift truck system. By implementing both systems simultaneously, productivity improved by up to 70%. A related investigation by Tambovcevs (2012) establishes that Enterprise Resource Planning (ERP) system merchants need to work with manufacturing and construction industry professionals to improve more customised results for manufacturing and construction companies. In addition, the recommended that the application of ERP can give considerable benefits.

In addition, problems concerning the monitoring and locating of materials on-site have become an incredible concern in construction industry as materials always come in bulk without proper identification (Kasim, Liwan, Shamsuddin, Zainal & Kamaruddin, 2012). Most importantly, Aberdeen Group (2009) observed that 70% of best-in-class organisations are more probable than other organisations to accept products without utilising paper documents. All have moved to the utilisation of barcodes, RFID or voice technology. Thus, the inventory levels are updated automatically (Asadi, 2011).

**2.2 Communication Technology**

All communication, whether oral or written, plays an extremely critical part in business accomplishment. Bhandari (2013) noted that communication technology facilitates better customer service, leading to competitiveness through the speed and accuracy in the communication. He identified the developing communication technologies as follows: Electronic Data Interchange (EDI), Very Small Aperture Terminal (VSAT), Geographical Positioning System (GPS), Geographical Information System (GIS), Automated Guided Vehicle System (AGVS), Information Directed System (IDS) and web-based tracking.

Furthermore, other basic communication software used in logistics and supply chain management are: Material Requirement Planning (MRP), Manufacturing Resources Planning (MRPII) and Enterprise Resource Planning (ERP). Another kind of communication device is the World Wide Web (WWW), a uniform interface that permits worldwide exchange of information using browsers (Asadi, 2011). The use of communication technology software is a tactical plan that enhances a firm’s effectiveness, permitting cost reduction and improving efficiency ( Ramaa, Subramanya & Rangaswamy, 2012). The majority of the tracking and monitoring platforms are just web based real-time systems that operators can access from any location that has internet access and a web browser (Ruamsook & Thomchick, 2012; Kasim, 2015). Based on the Control Theory of Automation, the entire process is automatically controlled and recorded. Inventory activities are computerised to make it easy to locate stock in a warehouse and update record in real time (Ndonye, 2014).

**2.3 Information Technology (IT)**

Nowadays, the effectiveness and accuracy of distribution systems depend on the transfer of information. Information can be viewed as the life blood of a logistics system and it acts as a glue in logistics roles, holding the network together and managing all components of logistics (Asadi, 2011). The IT tools adopted in logistics and supply chain management are Enterprise Resource Planning (ERP), Distribution Requirement Planning (DRP), Automated Inventory Tracking System (AITS), Collaborative Planning, Forecasting and Replenishment (CPFR) and Web-based collaboration (Bhandari, 2013). In earlier times, logistics was more manually rigorous and there was zero ability to monitor and track the delivery of goods. Nevertheless, with the dawn of IT and technologies such as RFID and GPS, complete visibility in movement of goods is assured, thus resulting in efficient logistics and warehouse management (Bhandari, 2013). The impact on management of construction material logistics system is transformative and justifies the need for this study.

A system completely computerised will lead to constant monitoring at three stages, specifically at manufactures sites (off-site), en-route (shipping) and construction sites (on-site) (Sardroud, 2012). DRP enhances stock visibility in the network, leading to reduction in stock level and warehouse space requirements (Bhandari, 2013). ERP data networks reinforce manufacturing procedure and construction project related information (Tambovcevs, 2012). This enables a more rapid response to customer requirements, a reduction in inventory costs, an improvement in service at internal and external levels, an improvement in stock turnover rate and a decrease in logistics costs (Bhandari, 2013).

For logistics to be effective, there should be appropriate information sharing, trust and teamwork among the partners. These can be achieved by the appropriate adoption of new information technology software in the management of logistics systems (Biju & Faisalu, 2013). An investigation by Wilson *et al.* (2015) revealed that the full adoption of ERP, JIT, RFID, VMI, and having a separate Logistics Department, are not frequent among manufacturers. However, the higher the level of Information Technology use in companies, the more effective and efficient the logistics system will clearly be. The successful integration of information within an organisation is a powerful enabler for: reduced costs; increased productivity; and improved customer service (Aleksandar, Aleksandar & Dejan, 2011).

**2.4 E-Business Adoption in the Logistics Process**

Matopoulos, Vlachopoulou & Manthou (2009) classified e‐business application complexity as inclusive of Internet access, E‐mail, Website Intranet, Selling‐buying online, Extranet, E‐banking, E‐marketplace and Collaborative Platforms. Advancement in e‐business adoption and impact result in enhanced operational reliability and improved levels of partnership. With respect to e‐business impact, this for the most part is about process duration reductions and quality enhancements, rather than direct cost reductions as reported by other researchers (Matopoulos *et al.,* 2009).

E-business application has turned out to be common because of real time exchange information and funding at the same time (Sharma & Sahu, 2014). A study by (Matopoulos *et al.,* 2009) found that the adoption of e‐business in the logistics process was not entirely a matter of resources. Despite what might be expected, operational compatibility and the level of teamwork are two factors that assume a determining role in improved e‐business adoption and impact. Johnson, Klassen, Leenders & Awayshehet (2007) stated that knowledge of how and where companies utilise e‐business, and the immediate benefits that they offer, is still limited

In summary, Honeywell (2008) outlined procedures and technologies that could improve accuracy and perfect-order performance as presented in Table 1. It demonstrated that improving performance in one area may include making changes beyond the procedure itself. Critically, each of these softwares contribute to the analysis of construction material logistics processes.

**Table 1: Processes and Technologies that can Improve Accuracy and Perfect Order Performance**

|  |  |  |
| --- | --- | --- |
| Metric | Goals | Technology Enablers |
| On-time Delivery | Streamline receiving, put-away and picking. | Integrated WMS, wireless computing to manage receiving put away and picking. |
| Speed check-in, loading and check-out operations with automated documentation. | Advance shipping notices/ Electronic Data Interchange (EDI) and mobile computers enable quick scan of barcodes and reduce time to receive loads. Validate outbound shipments with barcoding and RFID. |
| Reduce drive time and track shipments en-route. | GPS and/or wide area wireless communications to redirect and track deliveries. |
| Complete Orders | Identify and record items as they are received. | Area imaging technology allows scanning barcodes at any orientation, from 6 to 50 inches away providing efficiency in the warehouse. |
| Improve receiving and put away. | Use mobile printers to generate barcode labels right at receiving. |
| Pick items accurately. | Speech technology with mobile computing and barcode systems raises accuracy levels. |
| Damage-free Delivery | Provide documentation that goods were shipped and delivered damage free. | Mobile computers with integrated imager to take picture and show goods delivered damage free, also with signature capture for proof of delivery. |
| Accurate Invoicing and Documentation | Provide documentation information to customer. | Advance shipping notices/ Electronic Data Interchange (EDI) provide documented information to destination receiving operations. |
| Prevent customer invoice disputes. | On-site signature with mobile computers & on-site invoice generation with mobile printers. |

Source: Honeywell (2008)

**3. 0 Research Methodology**

**3.1 Research design**

This article adopted a case study research design method in which quantitative data were collected and analysed. This research was designed to evaluate the types and level of utilisation of Technology in construction material logistics for operational efficiency by the manufacturing firms in North-Central Nigeria. The adopted case study approach is supported by Yin (2014) who confirmed that when knowledge is available only on the initial phases of the development of the theory, it is also a suitable method that leads to further knowledge. Similarly, Karim (2008) considers a case study method as reality ‘out there’ and something that can be examined objectively. The node versus links method is by far the most suitable way to observe the logistics system in a construction context (Shakantu & Emuze, 2012). Thus, the unit of analysis was the utilisation of technology in construction material logistics operations at the manufacturers’ warehouse (node) and the Distribution centres/Warehouses (DC/WHs), retailers store and sites.

**3.2 Population and sampling methods**

The target of this study was the North-Central geo-political zone of Nigeria, which comprises six states and the Federal Capital Territory (FCT), Abuja. The choice of North Central was because it is one of the fastest developing regions, and it has a high concentration of construction activity. Because of the wideness of this zone, 32 construction materials manufacturers were purposively selected from the zone. This is supported by Leedy & Ormrod (2013) stress that purposive sampling ensures that the scholar selects persons or other components, as the name suggests, for a particular reason. From these 32 manufacturer firms, customers in the supply chain were randomly selected, including 42 DC, WHs, retail stores and 30 construction sites, with at least two customers for one particular material. The selected construction materials manufacturers produce materials such as cement, reinforcement bars (steel), ceramic tiles, crushed stones, masonry hollow sandcrete blocks and sand (fine and coarse). Their products were distributed to their customers in the five state capitals and Abuja. Chosen sites were carefully and logistically selected, instead of those that are statistically significant in the population (Shakantu & Emuze, 2012).

The decision of multiple case studies over a sole case study was to allow contrasts between the surveyed practices by subjects studied to obtain broad knowledge of these practices (Yin, 2012). The research methods used in this study were observation and the analysis of delivery records, because they helped to understand how the on-time delivery performance is implemented by the firms (Kamali, 2018). In the observational study technique, the researcher observed aspects of human behaviour and types of technology utilised , processed this with as much as objectivity as possible and then recorded the phenomena in its current state (Williams, 2007). The case study gives observers a chance to reflect on conditions in retrospect. Scott and Garner (2013) added that observation offers chances to obtain the truth of a larger condition and to draw conclusions that the individual subjects might have difficulty in noticing.

**3.3 Data collection**

Quantitative data was collected using primary records and through non-participant observations of material handling operations. A modified list of the types of technology software’s utilised in logistics processes in the studies of Bhandari (2013); Gwynne (2014) and Matopoulos *et al.* (2009) were adopted in this study. The observation includes watching and recording the types of technology software’s used in: AutoID, communication, Information technology and e-business, whilst the measurements involved recording of the time for loading and offloading material in vehicles. An observation and Measurement Guide comprising the afore-mentioned parameters was formed. A total of seventy-two (72) observations were recorded to be representative of vehicle deliveries from the manufacturer’s plant to DC/WHs, retailer stores and construction Sites. These orders from each site were processed and delivered to the respective state capitals and Abuja. This is summarised in Table 1

**Table 1: Summary of Data Recorded**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Materials | No. of Manufacturing Companies | Transportation  (No. of Deliveries) | Location  No. of DC/WHs and Retailer Shops | | | | | | | Construction Sites |
|  |  |  | Abuja | Minna | Lafia | Lokoja | Jos | Makurdi | Distribution Centres/ Warehouses | Sites |
| Cement | 2 | 12 | 2 | 2 | 2 | 2 | 2 | 2 | 12 |  |
| Reinforcement bars | 2 | 12 | 2 | 2 | 2 | 2 | 2 | 2 | 12 |  |
| Ceramic tiles | 2 | 12 | 2 | 2 | 2 | 2 | 2 | 2 | 12 |  |
| Crushed stone | 2 | 12 | 2 | 2 | 2 | 2 | 2 | 2 | 6 | 6 |
| Hollow Sandcrete blocks | 12 | 12 | 2 | 2 | 2 | 2 | 2 | 2 | - | 12 |
| Sand | 12 | 12 | 2 | 2 | 2 | 2 | 2 | 2 | - | 12 |
| Total | 32 | 72 | 12 | 12 | 12 | 12 | 12 | 12 | 42 | 30 |

Source: Researchers’ Field Survey (2019)

**3.4 Method of analysis**

The descriptive method of data analysis was employed using percentage and results presented in a form of bar charts and interpreted directly. This kind of descriptive study can be informative when there is little knowledge and understanding of a phenomenon (Loeb *et al.,* 2017). The observations and measurements data were entered into Microsoft Excel (Bowen, Edwards & Cattel, 2012), to calculate and report in bar chart and pie chart formats.

**4.0 Analysis and Results**

**4.1 Adoption of Automatic Identification Technology (Auto ID)**

This analysis is aimed at understanding the type and level of new automatic identification technology software’s used in inputting data or information into the computer system by the construction material manufacturers. Figure 1 illustrates the identification of current type of technology utilised for AutoID and order picking processes in the manufacturer warehouses. This established that 88% of the companies used the paper picking method, while 12% use an automated method (using automatic loader for picking process). The major finding was that most of the companies used the paper picking method, which suggests low adoption of AutoID technology. This is contrary to the fact that the adoption of AutoID software’s has changed the picking activity and improved precision and efficiency meaningfully. This finding implies that most of the processes of data capturing and order picking method are manually done, suggesting low productivity.

**Figure 1: AutoID Software’s utilised in the Manufacturer Warehouses**

**4.2 Utilisation of Communication Technology Software’s**

Figure 2: indicates the level of utilisation of communication tools in logistics operations by construction materials manufacturers. It confirmed that 8% of the companies use GPS and GIS, while 6% were Web-based. Some 78% of the companies did not adopt any of the identified communication tools in logistics operations. This is a very low level of utilisation of communication software’s. However, it was observed that the few companies that used GPS, GIS and Web-based for tracking and monitoring their vehicles did so to achieve vertical communication between Headquarters, plant, drivers and distribution centres. The technology was also not aimed at horizontal communication with other logistics partners.

**Figure 2: Utilisation of Communication Technology software’s** **in Logistics Operations**

**4.3 Utilisation of Information Technology Software’s**

The analysis of the utilisation of type and level of information technology software’s used in logistics processes is presented in Figure 3. The finding shows that 6% of the companies (Cement) utilised ERP in logistics operations, while 94% do not use any of the information technology software’s. This indicates a low level of utilisation of information technology software’s in logistics operations by the construction material manufacturing industries. The findings suggest that the benefit of using technology to improve efficiency and effectiveness in logistics is not being achieved.

**Figure 3: Utilisation of Information Technology software’s in Logistics Operations**

**4.4 Utilisation of E-Business Tools**

Figure 4 presents the type and level of adoption of e-business tools by the companies. The analysis revealed that 25% of companies used both internet and e-banking in logistics operations. The Web-based tools were adopted by 9% of the companies, while 75% did not use any of the e-business tools. The findings indicate a very low utilisation of e-business software’s in logistics processes by the construction materials manufacturers. However, they used both internet and e-banking for payment and receiving credit alerts by the companies. This does not provide for information sharing, or for partnership/collaborations with other stakeholders in the logistics system.

**Figure 4: Utilisation of E-Business in Logistics Operations**

**4.5 Discussion of Results**

The utilisation of the right technology for different logistics operations or sub-processes is critical for improving the total effectiveness and efficiency of a logistics system. The researcher sought to find out the type and level of utilisation of the AutoID software’s in construction material logistics processes. The study established that most of the manufacturers used the paper-based picking method. This finding contradicts a study by Biju and Faisalu (2013), which established that the majority of companies currently used bar coding. They opined that most of the AutoID software’s are highly necessary and should be implemented. Bar codes increase productivity in three ways: speed, accuracy and reliability (Sople, 2010; Bhandari, 2013). Moreover, the Aberdeen Group (2009) reported that 70% of Best-in-Class companies are more likely than all other companies to receive goods without using paper documents. All have migrated to the use of barcodes, RFID or voice technology.

This finding also concurred to Webster *et al.*, ( 2014) that manual order picking methods are slower as the picker must handle and read the paper. A reduction in paper work and operation time will lead to a reduction in human mistakes, and an increase in the efficiency of the logistics system through speed, accuracy and reliability (Eckhardt & Rantala, 2012). In addition; it produces difficulties in monitoring and locating of materials on construction site since materials continuously come in bulk without proper identification (Kasim *et al.,* 2012). In the light of this knowledge, it can be deduced that there was low level of AutoID technology utilisation of logistics process. Hence the logistics process of identification and recording of data and order picking were sub-optimal and inefficient.

The study also found that most of the construction material manufacturers did not utilise many of the communication technology software’s in their logistics operations. A few companies used GPS, GIS and Web-based tools for tracking and monitoring their vehicles. The findings contradict the call for utlilisation of communication technology software as a tactical plan to improves a firm’s effectiveness and improving efficiency of logistics operations ( Ramaa *et al.,* 2012). The finding also negate the need to form a web based main platform real-time systems for the tracking and monitoring of material from any location (Kasim, 2015). Furthermore, it is contrary to Ndonye (2014) claim that inventory activities are required to be computerised to make it easy to locate stock in a warehouse and update record in real time. For instance, the efficiency of a Warehouse Management System (WMS) technique is higher than when the operations are done by hand ( Ramaa *et al.,* 2012). It can be inferred that the current method of communication utilised in the logistics processes by the construction material manufacturer was sub-optimal, thus ineffective and inefficient.

The study further sought to find out which information technology software’s used in the logistics operations. The finding established that most of the companies did not use any information technology software’s, except for the cement companies that utilised ERP in their logistics operations. This finding was supported by Wilson *et al.* *(*2015) that the level of application of ERP, JIT, RFID and VMI are very low among suppliers. However, this contradicts the assertion that the higher the level of information technology used in a firm, the more effective and efficient that firm is (Biju & Faisalu, 2013). In addition, information technology supposed to acts as the glue in logistics roles, holding the network together and managing all components of logistics (Asadi, 2011). It can be deduced that the level of information technology utilised for logistics operations was sub-optimal and inefficient.

In terms of e‐business utilisation, this study established that most of the manufacturers had not used e-business software’s in their logistics operations. In addition, the study revealed that only a few of the manufacturers use the internet, web-based tools and e-banking in logistics operations. However, this does not provide for information sharing or collaboration and integration with the other stakeholders in the logistics system. The finding is contrary to claim by Sharma & Sahu, (2014) that e-business utilisation has become the most commonly used technology because of real time exchange of information and funding at the same time. In addition, it requires a business practice that combines intelligence of multiple trading partners in the planning of how to fulfil customer demand (Sari, 2008). Therefore, with the low utlilisation of e-business software’s by the manufacturers, it can be inferred that the level of e-business usage in logistics operations was minimal which in turn has negative impact on logistics operation efficiency.

**5.0 Conclusions**

The crux of this study was to evaluate the types and level of technology utilisation in construction material logistics processes efficiency by manufacturers in North Central Nigeria. Based on empirical findings, it concludes that there is a low level of adoption of technologies namely; AutoID, order picking, communication, information technology and e-business. The low-level adoption of technology leads to inefficiency in the construction material logistics operations especially in terms of speed, accuracy and reliability. The implications of inefficiency in construction material logistics process is increase in construction material price and delay of delivery to customers. These have the impact on increasing construction cost and cause delay in project execution.

It also follows, that there was no information sharing or collaboration and integration with the other stakeholders in the logistics system for operational efficiency. However, to improve on efficiency of logistics processes of manufacturers need to integrate both their internal functions and external data sharing and communication with logistics partners in an effective way. In summary, it concludes by providing the construction material manufacturers with areas that requires technology to optimise material logistics operations. A recommendation is made for further study to explore why technology is not adopted by these companies, despite its advantage This research was conducted using some selected materials and observations method which are the limitations of this study. Another limitation of this study is geographical in nature; since this study covered only one out of the six geopolitical zones of the country, other zones should be study and compare the results.

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