Original Article

TECHNOLOGICAL INNOVATIONS IN ORDER PROCESSING AND THEIR IMPACT ON LOGISTICS IN THE NIGERIAN CONSTRUCTION INDUSTRY

Bello Aminu Olatunde

Department of Quantity Surveying,
Federal University of Technology,
Niger, Nigeria
DOI: https://doi.org/10.5281/zenodo.16810980

ABSTRACT: The logistic technologies for effective and efficient 'order processing operations' in the areas of tracking, shipping, replenishment, dispatching and holding of inventory are deficient in the Nigerian construction industry, when compared to manufacturing and retailing sectors. This is confirmed to have a significant effect on the performance of the construction sector. This article assessed how order processing technology utilised by manufacturing and retail industries could improve the order processing logistics operations of the construction industry. Lagos State and the F.C.T. Abuja, Nigeria, were the selected geographical study areas, from which five manufacturing companies, five retailing companies and five construction projects were purposively selected. Processing technology in the logistics system could lead to full efficiency gains in the order processing aspect of the construction industry. It is recommended that the Federal Government of Nigeria should mandate all major construction project stakeholders to attend workshops on the use of recent technologies in the management of construction operations.
Keywords: Barcoding, construction industry, logistics, order processing, technology

1. INTRODUCTION

The need to develop and utilise new technology globally has made the construction industry undergo fundamental transformations, in order to raise the levels of firms' performance and to compete globally (Mohammed & Ali, 2016: 21; Preidel & Borrmann, 2015: 257). The logistics technology used in order processing operations in the Nigerian construction industry is outdated, ineffectual, and often overlooked, due to its weak contributions to project performance (Yahaya, Shakantu & Saidu, and 2020: 3). According to Bengtsson (2019: 299), these technologies are required at every stage of the logistic process, in order to increase the efficiency and effectiveness of the process, so that projects will be completed within budget, schedule and the anticipated quality. Dim, Ezeabasili and Okoro (2015: 1) believe that some design teams, contractors and suppliers have little knowledge of recent technologies and logistics tasks in construction. Therefore, identifying the appropriate tasks and their relevant technologies in the construction industry would help integrate and facilitate the processes of logistics management practices (Polacco, 2016: 12). Irizarry, Karan & Jalaei (2013: 241) highlighted that, in the past decade, researchers such as Ordoobadi and Ordoobadi (2009: 371), Janat (2009: 43) and Xie (2009: 16) have emphasised the benefits of construction logistics management philosophy in performance improvement and reduction of waste as a result of inefficient material management. The current on-site construction process is hampered by inefficiencies and limited in terms of opportunities for technological innovation (Barkokebas, Bu, Al-hussein & Manrique, and 2015: 307). Sullivan, Barthorpe and Robbins (2010: 19) argue that there are many opportunities for change in developing countries such as Nigeria and that the construction industry has been slower than other industries to realise the benefits that the application of good logistics can provide in terms of order processing. Previous studies by authors such as Fadiya (2012: 2) and Bhandari (2014: 19) on construction logistics have focused on transportation, forecasting, effectiveness or efficiency in logistics supply chain and so forth in Nigeria. There is, however, hardly any focus on logistics technology, especially in the use of order processing technology for improving construction logistic processes. A wide gap has, therefore, been identified in the Nigerian construction logistics processes (Dim et al. 2015: 2041; Fatnani & Malik, 2015: 3253; 264; Polacco, 2016: 12). The technological aspect of construction logistics, especially the order processing, is over-looked, and little is understood in the Nigerian construction industry. Therefore, this article examines order processingrelated tasks in the manufacturing, retailing and construction industries; the percentage level of usage of order processing logistics technologies in the execution of these tasks, and the accruable benefits to construction from the utilisation of the order processing technology in the industries, in order to improve the order processing procedure of the Nigerian construction logistics.

2 LITERATURE REVIEW

In order to understand how to utilise order processing technology in construction logistics, it is important to introduce the present theory on order processing and logistics included in this article. The current theory focuses on construction logistics, construction order processing logistics technology, and order processing logistics tools used in construction.

1.1 Construction logistics

Logistics is a very critical component of every construction organisation that requires serious managerial considerations, since it ties up a great deal of industry capital (Samuel & Ondiek, 2014: 23). Accordingly, logistics management should be considered at all phases of the construction process and throughout the construction and production periods, because poor logistics management can often affect the overall construction time, quality and budget (Liwan, Kasim & Zainal, 2013: 5). Lack of proper logistics management is a problem in the area of materials shortages, delays in supply, materials damage, wastages, and lack of storage space (Kasim, 2015: 1). According to Kasim (2008: 1), these problems could be attributable to inadequate utilisation of modem technologies to overcome human errors and improper integration into project management systems to make the tracking and management of materials easier and faster. Thus, there is a growing trend in the construction industry to use technology in monitoring jobsites, as the majority of onsite construction works are mostly done manually, which is cumbersome and labour-intensive (Azar, 2016: 123). Three major resources, including people, processes and technology, are required in any construction logistics setting, in order to manage and achieve efficiency and overall success of a project. People drive change and they need to be trained and well managed so that they can contribute their best to the success of the project; processes create the environment in which people work and also

Original Article

form the basis of opportunity for improvement, and technology gives people the tools to carry out and improve processes (Fadiya, 2012: 7). The major problems of construction logistics, according to Jafari and Sadeghi-Niaraki (2013: 215) include the following challenges: technology, standard, patent, cost, infrastructure, and Return on Investment (RoI). These challenges can adversely affect the performance of construction projects (Bogataj & Grubbström, 2012: 755). Therefore, managing the flow of materials, assuring their quality, checking the quantity, allocating the storage areas, coordinating the overall process, triggering the orders, and updating the participants are major obstacles in construction logistics management (Almohsen & Ruwanpura, 2011: 27).

1.2 Construction order processing logistics technology

Recently, various approaches have attempted to automate the construction process with the help of digital methods such as barcoding, RFID and EPC, in order to reduce the amount of work and simultaneously increase the quality of the planning (Preidel & Borrmann, 2015: 256). The movement and interaction of people, goods and energy without technology, especially during order processing processes, make the management of construction processes extremely slow, difficult and hampered by inefficiencies (Zhang, Cao & Zhao, 2017: 1; Barkokebas et al., 2015: 302). This means that absence of technology in the accomplishment of processing tasks could affect the efficiency and effectiveness of any construction process (Zhang et al., 2017: 1). The reason is that many construction firms lack a clear strategy for the implementation of technology in their process (Azhar, Jackson & Sattineni, and 2015: 77). Therefore, completing a construction project within budget and timely, with their numerous constraints, requires skilful integration of logistics technology (Yahaya et al., 2020: 3). The various logistic technologies for overcoming human errors in the areas of tracking and better management of materials are lacking in the construction industry (Fatnani & Malik, 2015: 3253). Moreover, locating the movement of resources on construction sites has been a challenging task to construction practitioners. Tracking technologies are suggested, in order to overcome this challenge (Nasr, Shehab & Vlad, 2013: 1). Hence, Nasr et al. (2013: 1) noted that technology utilisation in the construction industry could significantly improve daily performance and project management activities. Therefore, the effective economic development of a country, as well as industrial and commercial business success, are not possible without logistics services that create added value for businesses, ensure the expediency of products' time, as well as place and meet the client's needs (Yahaya, 2020: 322). This is similar to the statement of Jang and Skibniewski (2009: 378) that advancement in technology and innovation in the construction industry should make it technically viable to implement an automated tracking system for material. Even though the construction industry in Nigeria has advanced to the point of executing large and complex projects, they still largely operate manually. Furthermore, the logistics technology developed to support the management of the Nigerian construction industry in the area of, among others, forecasting, order entry, order processing, requirement planning, invoicing, warehouse operations, transportation is outdated, ineffectual, and often overlooked, due to its weak contributions to project performance (Langeley, Coyle, Gibson, Novack & Bardi, 2009: 32).

1.3 Order processing logistics tools

2.3.1 Barcoding technology as order processing logistics tool in the construction industry

The barcode is a machine-readable representation of identification data that can be handled by a computer using an optical reader with shorter processing time than manual identification could ever achieve (Vlahovic, Knezevic & Sabolic, and 2015: 34). This barcode is an optical representation of the data. It is composed of parallel lines with various widths and spacings, which can further be scanned by a remote device to read the represented information (Xiang, 2019). The technology is part of every purchase and has become the ubiquitous standard for identifying and tracking products, since it is a line-of-sight technology, of which a scanner has to ‘see’ the barcode in order to read it (Ramanathan, Ramanathan & Ko, 2014: 232). According to Zebra Technologies Coporation (ZTC) (2017: 2), the barcodes are fast and accurate in performing tasks such as receiving process, putaway process, shipping process, dispatching process, replenishment process, tracking inventory and holding inventory during data entry and data processing. The barcode automates the business process and procedures and, therefore, increases the productivity and reduces human errors completely. The technology is used where a huge amount of data is to be entered into the data base instead of the manual entering. The data entry operator may simply scan the unique identification number into the database with the barcode technology, which would definitely increase the automation and reduce human error (Fatnani & Malik, 2015: 3252). Vlahovic et al. (2015: 34) revealed that many industries benefit from using barcodes in terms of efficiency and accuracy during order entry and order processing. As such, barcoding became standardised internationally. Therefore, ZTC (2017: 2) pointed out that the entry and read error rates when using barcode technology is approximately one error in one million characters, against one error per every 300 characters using manual key entry. Barcode data entry is at least 100 times faster and more accurate than traditional manual keyboard entry (American Barcode & RFID, 2014: 2). The barcoding technology is used for identification, handling, retrieval and storage of goods in warehouses and stores. It is the most popular technology which is assigned to a particular inventory item to show its identity during storage, retrieval and dispatch at process of placing an order (Samuel & Ondiek, 2014: 12). Sullivan et al. (2010: 196) concluded that the trial of barcode technology in construction industry makes the processing of materials fast from the supplier to delivery on site and increases picking accuracy to almost 99.6%; it also increases the speed and certainty when validating the location of delivered goods in construction. This technology, according to Huang, Tsai, Wu, and Chung (2010: 474), provides the benefits of reduced communication and transaction time, which can lead to lower order processing cost for both the vendor and the buyer, as well as greater information accuracy, due to a reduction in paperwork.

2.3.2 Radio Frequency Identification (RFID) technology as order processing logistics tool in the construction industry

The order processing technology that monitors movement of goods and services in some industries is the RFID system. This system better tracks the status of items such as their location, temperature, and movements within the shortest time, with few numbers of or non-man power (Lee & Lee, 2015: 432). The RFID technology is an advancement over barcode for manufacturing and retailing industries and uses radio frequency waves (Ramanathan et al., 2014: 230). Valero and Adán (2016: 215) stated that the advantage of RFID over barcoding is that RFID do not need to see the tag in order to identify the object and store the information. Kim, Kim, Ryu & Kim (2011: 159) also added that RFID has the following advantages over barcording:

- RFID allows for countless identification as the reader does not need to touch the tag before receiving information;
- Multiple identification of objects at the same time, and
- Easy update of information to reflect the situation

This RFID technology is widely used for different tasks such as receiving process, put-away process, shipping process, dispatching process, and replenishment process, because the technology is connected to an enterprise application system for data-processing in support of business activities (Ramanathan et al., 2014: 231). Zhu

Original Article

Mukhopadhyay and Kurata (2012: 153) opined that RFID technology plays an important role in supporting logistics and supply-chain processes (receiving process, put-away process, shipping process, dispatching process, replenishment process, tracking inventory, and holding inventory), because of their ability to identify, trace and track information throughout the supply chain. The technology provides suppliers, manufacturers, distributors and retailers precise real-time information about the products. This makes the RFIDs more attractive in the textile industry (Xiang, 2019: 10) The RFID system can read several tags immediately and jointly without having to sort out the materials or set them apart (Ibrahim, Mohammed & Varouqa, 2020: 1578). That is why all of these organisations are working on the standards for RFID technology, particularly on applications such as supply-chain management and asset management for inventory tracking and control (Goh & Aslam, 2020: 91626). Moreover, RFID technologies improve the potential benefits of supplychain management through the reduction of inventory losses, increase in the efficiency and speed of processes, and improvement of information accuracy (Sarac Absi & Dauzère-Pérès, 2010: 77). RFID makes it possible to read data from multiple tags in one time, thus increasing the efficiency of data-processing (Lu, Huang & Li, 2011: 102). Jafari and Sadeghi-Niaraki (2013: 215) believed that RFID technology in construction will control the processes of production, supply, stock tracking, stock management, repair management, processing, and disposal. Yahaya (2020: 290) added that employing RFID technology in construction for order processing tasks could result in increased speed of work in construction, improvement in the quality of documents, decrease in documentation errors in construction, speed up shipping process on construction sites, allow for contactless identification with hardly any or no manpower, identify objects and store information without seeing the tag, reduce inventory losses, increase efficiency and speed of data-processing in construction, and improve information accuracy. Ibrahim et al. (2020: 1576) concluded that it is mandatory to use an RFID system in equipment and material management, in order to reduce time and cost and simultaneously improve quality and safety.

2.3.3 Electronic Product Code (EPC) technology as order processing logistics tool in the construction industry

Adoption of the EPC technology forces supply-chain members to change the way they handle their respective business activities, by integrating activities, cancelling, automating, or automatically triggering intra- and inter-organisational business processes (Wamba, Lefebvre, Bendavid & Lefebvre, 2008: 626). Bottani and Rizzi (2008: 549) believed that the adoption of EPC standards for products identification is experiencing an increasing diffusion in the logistics pipeline, and is expected to have a major impact in construction on labour efficiency, processes automation and accuracy. Products with an EPC tag have the ability to communicate with their environment and make or trigger basic decisions relevant to their management (Wamba et al., 2008: 616). According to Yahaya (2020: 322), construction could benefit from using EPC as follows: Improve shipping, improve business prospects, foster higher level of informationsharing, provide synchronisation between supply-chain members, provide information to the construction team, trigger basic decisions, improve the quality of documents, and decrease documentation errors in construction. The RFID-EPC network in interrelated firms of a supply chain can improve the shipping, receiving, and put-away processes. It can cancel, automate, or automatically trigger business processes, and foster a higher level of information sharing/synchronisation between supply chain members (Zhu et al., 2012: 161). The EPC technology can perform the tasks of receiving process, shipping process, replenishment process, and holding inventory (Bottani, Montanari & Volpi, 2010: 427)

2.3.4 Point of Sale (PoS) technology as order processing logistics tool in the construction industry

Original Article

The introduction of PoS makes industries now see product movement from the beginning of transaction to consumer satisfaction at point-of-use (Holloman, 2015: 6). Janat (2009: 43) added that, with PoS technology, companies settle bills through the use of electronic printouts and smart sense coupons, respond to on-line alerts and information, and take a more customer-focused approach. The implementations allow service and sales industries to conduct financial transactions in place, improving customers' experience, and freeing up valuable real estate that would otherwise be dedicated to a PoS countertop (Lin, Ha & Lin, 2015). PoS systems consist of solutions that enable connections with external organisations, which facilitates the processing, storing, and monitoring the movement of goods and management functionality (Plomp, Van Rijn & Batenburg, 2012: 265; Holloman, 2015: 6). Furthermore, the PoS system provides an instant record of transactions at the point of sale. It thus makes the replenishment of products more coordinated on time to ensure that stock-outs in the retail store are avoided (Xie, 2009: 16; Samuel & Ondiek, 2014: 12). The PoS system provides timely data, more efficient inventory control, reduced restocking times, and clearer sales data (Ahn, Andrews, Deckard, Iruku, Lee, Lue & Schulz, 2011: 15). The PoS system provides an instant record of transactions at the point of sale (Samuel, 2012: 14). Xie (2009: 16) concluded that an integrated PoS system in construction allows quick, precise information capture, so that the logistics system can act more efficiently and effectively in getting the right product to the preferred location when it is needed.

2.3.5 Manufacturing and retailing industries' experiences of order processing logistics technology

The manufacturing and retailing industries have recorded tremendous achievement in terms of the shelf-replenishment process, inventory process, picking and collecting order, returning processing, ticketing and price markdowns, restocking, receipt inspection, stock auditing, as well as inbound and outbound logistics activities (Hübner & Kuhn, 2012: 207; Reiner, Teller & Kotzab, 2013: 932; Thiesse & Buckel, 2015: 128). Technology for ordering processing provides the following benefits: reduced communication and transaction time, which can lead to lower order processing cost for both the vendor and the buyer, as well as greater information accuracy, due to a reduction in paperwork (Huang et al., 2010: 474)**.** Yahaya et al. (2020: 8) added that some important features of order processing technology systems in manufacturing and retailing industries are their ability to include productivity enhancement; reduce errors through sharing of data and practice; increase performance control and data visibility, and improve automation of business processes in organisations.

2. RESEARCH METHODOLOGY

2.1 Research design

This study uses a mixed methods approach, where both quantitative and qualitative data are collected in parallel, analysed separately, and then merged (Creswell & Plano-Clark, 2018: 8; Grbich, 2013: 27). In this study, the quantitative semi-structured questionnaire survey was investigated by observing the task performance of order processingrelated technology (Barcoding, RFID, EPC, PoS) from the manufacturing, retailing and construction sectors. The qualitative interviews explored the benefits of implementing order processing technologies in the construction sector. The qualitative method allows in-depth understanding, discovery, and clarification of the situation. It provides the researcher with a unique avenue to probe responses or observations (Guest, Namey & Mitchell, and 2013: 21). The reason for collecting both quantitative and qualitative data is to elaborate on specific findings from the breakdown of the interview transcripts, and to cross-check the data against the questionnaire data set such as similarities in the use of order processing-related technology.

2.2 Population, sampling and response rate methods

The geographical study areas for this research included the manufacturing, retailing and construction sectors in Lagos State and Abuja, the Federal Capital Territory (FCT) of Nigeria. These geographical study areas were selected, because they both have many manufacturing and retailing companies and many construction projects. Moreover, these two cities are among the metropolitan cities in Nigeria with the highest population of professionals within the built environment and with many ongoing construction projects. For the quantitative semi-structured questionnaire survey, purposive sampling was used to select a sample of 15 companies (including five manufacturing, five retailing and five construction companies) with projects of 2.8 billion Naira and above, as at 28 August 2017. Purposive sampling allows for the selection of individuals or organisations, based on their experiences, to yield adequate information about the topic under investigation (Leedy & Ormrod, 2014: 154). For this study, companies with projects to the capital base/value of 2.8 billion Naira and above are deemed mature enough and presumed to have advanced technologies such as Barcoding, RFID, EPC, PoS (Soliman & Karia, 2015: 265). According to Leedy and Ormrod (2014: 67), the typical qualitative research sample size for observations ranges between five and 25 participants. For qualitative data collection, purposive sampling was used to sample 15 participants (workers each from the different sectors visited who were stationed to work on the technology), who simultaneously participated in the interviews. Purposive sampling allows the researcher to choose participants based on their characteristics, pre-knowledge and capability of providing adequate knowledge deemed necessary for a study (Bless, Higson-Smith & Sithole, and 2013: 172).

2.3 Data collection

An observation guide and semi-structured interviews were used to observe only the order processing technologies utilised in these companies/projects. These included four barcoding technology from manufacturing companies; five from retailing companies, and two from construction projects, making a total of 11; five RFID technology from manufacturing companies; four from retailing companies, and 1 from construction projects, making a total of 10, and 2 EPC technology from manufacturing companies and 3 from retailing companies, and 4 PoS technology from manufacturing companies, and 5 from retailing companies. The observation guide included seven main order processing tasks for the manufacturing and retailing companies, namely receiving process, put-away process, stock control, dispatching process, replenishment process, stock tracking and stock holding, as well as seven main tasks for construction companies, namely receiving process, put-away process, stock control, dispatching process, and replenishment process. The observations were carried out with the aid of workers in the manufacturing, retailing, and construction sectors, who were stationed to work on the technologies. The observations were done by taking the researcher around the order processing technologies available. Questions were asked on the task performed by the technology in the industry and the related tasks and subtasks that the same technology could perform in the construction industry. The observations were only based on the order processing logistics technologies available (see Tables 2 to 5). The respondents of the semi-structured interviews were one worker each from the different sectors visited, who was stationed to work on the technology. This included: for barcoding, four respondents from manufacturing companies, five respondents from retailing companies and two respondents from a construction project, making a total of 11 respondents from the companies/projects; for RFID, five respondents from manufacturing companies, four respondents from retailing companies and one respondent from a construction project, making a total of 10 respondents from the companies/projects; for EPC, two respondents from manufacturing companies and three respondents from retailing companies, making a total of five respondents from the companies, and for PoS, four respondents from manufacturing companies and five respondents from retailing companies, making a total of nine respondents from the companies. The semi-structured interview guide contains only one major question: How can the benefits of utilising these order processing logistics technologies be accruable to the logistics order processing of the construction industry? (See the last column of Tables 2 to 5.)

2.4 Data analysis and interpretation

The collected quantitative data (observations) for this study were analysed, using descriptive analytical tools that included frequencies and percentiles. The tabulated results from the instruments were divided into two parts. The first part consisted of the related tasks in manufacturing and retailing industries, while the second part consisted of tasks and subtasks in the construction industry. In the first part, the technologies were identified in five manufacturing and five retailing companies, thus making a total of ten companies. The identification in each of these companies represent 20% of the 100% for the five manufacturing and five retailing companies, respectively. The tasks in the five manufacturing companies and retailing companies were identified, with each occupying 20% of the 100%. For example, dispatching process in Table 1 was used by four manufacturing companies out the five manufacturing companies, each company occupying 20%. This means 20% multiplied by four industries equals 80% of the 100% of the five manufacturing companies. The same process applies to the five retailing companies. Moreover, for identification of the technologies in the five construction projects, each occupied 20% of 100%. The tasks that correspond to the manufacturing and retailing companies were also identified, each occupying 20% of 100% for the five projects in the construction industry. The tasks under the construction project were subdivided into subtasks, for which 20% occupied by each project was further subdivided into the subtasks under the projects in the construction projects. This means that the receiving process only occupied 20%, which will be divided among the number of subtasks that appear under the receiving process. For example, the corresponding task to the receiving process in construction is the receiving process in Table 1. Therefore, the receiving process as a main task, each occupying 20% to make 100%, the 20% under the 'receiving process' was further divided into three different subtasks in the receiving process (processing receipt of material, processing receipt of plant, and processing receipt of equipment); that is, 20% divided by 3 equals 6.7% for each subtask. The total of these percentages from the manufacturing, retailing and construction industries were utilised to produce the percentage level of usage of the task and subtask in the three industries. This was done by dividing each percentage unit of the task by the overall percentage total of the industries (manufacturing + retailing + construction) and multiplied by 100%. For example, using this formula: L=U/T x 100%, where U = Unit percentage of one task of the three industries; T = Total percentage of manufacturing, retailing and construction industries, and L = Percentage level of usage of each unit percentage task. Moreover, the total percentage and percentage proportion of tasks in the three industries were used to develop Figures 1 to 4. Using thematic data analysis, a nuanced account of the data could be presented by transcribing, coding and setting themes from the responses of the focus-group interviews (Clarke & Braun, 2013: 120). For this study, all shared experiences during the interviews with workers/operators were recorded and used as the interview data. Using Microsoft Excel (Bowen, Edwards & Cattel, 2012: 887), the raw data on the relevant benefits of the technology that could accrue to the tasks and subtasks in the construction logistics processes in Nigeria was analysed and categorised into conceptual themes, including 'benefits accruing for receiving', 'put-away', 'stock', 'dispatching' and 'replenishment process'.

Original Article

2.5 Limitations

In the course of the data collection, access to some organisations, particularly the manufacturing and retailing sectors, was denied, as some information was considered strictly confidential and, therefore, not to be disclosed to researchers. Moreover, some organisations, particularly in the construction sectors, do not have the related technology under consideration. The researcher had to consider only those that have the technology.

3. RESULTS AND DISCUSSION

3.1 Respondents' profile

Table 1 shows the demographic information of the interview respondents on their highest educational qualifications and years of working experience. In Lagos, the majority of the respondents in the manufacturing sector (80%), retail sector (40%) and construction sector (60%) had Bachelor degrees. This is not much different from the situation in Abuja, where the majority of the respondents in the manufacturing sector (80%), retail sector (40%) and construction sector (80%) had Bachelor degrees. Most of the respondents across the three sectors (60% to 80%) had between six to ten years' working experience in both Lagos and Abuja, respectively, with very few having less than five years' working experience. This shows that a reasonable percentage of the respondents are experienced across the three sectors and within the geographical scope of Lagos and Abuja.

Table 1: **Demographic information of respondents**

Area	Characteristic	Category	Manufacturing %	Retail %	Construction %
Lagos	Highest educational qualifications	Bachelor/B.Tech	80	40	60
		Higher National Diploma	0	20	20
		National Diploma	0	20	20
		Master's degrees	20	20	0
	Years of working experience	Less than 5 years	0	0	10
		6-10 years	60	80	60
		11-15 years	20	20	20
		Above 15 years	20	0	20
Area	Characteristic	Category	Manufacturing %	Retail %	Construction %
Abuja	Highest educational qualifications	Bachelor/B.Tech	80	40	80
		Higher National Diploma	0	20	0
		National Diploma	20	0	0
		Master's degrees	0	20	20
	Years of working experience	Less than 5 years	0	0	20
		6-10 years	80	60	80

		11-15 years	20	20	0
		Above 15 years	0	20	0

3.2 Barcoding technology

Table 2 shows that 80% of the manufacturing and 100% of the retailing industries adopted barcoding technology for order processing purposes when compared to the construction industry that only used 40% of the technology for order processing. These results support the findings of Fatnani and Malik (2015: 3252) and Vlahovic et al. (2015: 34) that the barcoding technology is a machine-readable representation of identification for order processing. A total of 80% of the observed manufacturing industry used barcoding technology for the receiving process, with the receiving process occupying a percentage proportion of 7.1% among other order processing technologyrelated tasks. Moreover, the entire retailing industry (100%) used barcoding technology for the receiving process, with the receiving process occupying a proportion of 8.9%. Only 2.4% of the construction industry used barcoding technology for the receiving process, with 13.4% for processing receipt of the material and 6.7% for processing receipt of plant and processing receipt of equipment in relation to other barcoding tasks in the construction industry. These results corroborate the findings of Hübner and Kuhn (2012: 207), as stated on the receiving process. Moreover, 60% of the manufacturing and retailing industries used barcoding technology for the put-away process, occupying percentage proportions of 5.4% each, in relation to other barcoding technology-related tasks. However, the construction industries used barcoding for the putaway process, occupying a proportion of 0.9% for returns of material to the manufacturer with 10%, among others. In terms of the shipping process, 60% and 80% of the manufacturing and retailing industries, respectively, used barcoding technology for the shipping process, occupying proportions of 5.4% and 7.1% each, in relation to other barcoding technology-related tasks. However, 10% of the construction industry used barcoding for the shipping process (stock control), occupying a proportion of 0.9%. These results confirm the findings of Plomp et al. (2012: 265), Holloman (2015: 6) and ZTC (2017: 2) regarding the collection of data during shipping processes using barcoding technology. Regarding the dispatching process, 80% of the manufacturing and 100% of the retailing industries used barcoding technology for the dispatching process, each occupying percentage proportions of 7.1% and 8.9%, respectively, while the construction industry occupied 1.2% for the dispatching process, with 13.4% for equipment issued. These results are also in line with Holloman (2015: 6) and ZTC (2017: 2) that the barcoding technology is for recording during the dispatching process. Furthermore, 60% of the manufacturing and 100% of the retailing industries used the replenishment process, each occupying percentage proportions of 5.4% and 8.9%, respectively. The construction industry occupied a total of 0.6% for the replenishment process, with 6.7% for material replenishment. This confirms the statement of Sullivan et al. (2010: 196) and Samuel and Ondiek (2014: 13) that barcoding reduced the time of replenishment and stocktaking. In addition, 80% of the manufacturing and 100% of the retailing industries used barcoding technology for tracking inventory, occupying proportions of 7.1% and 8.9%, respectively. Only 13.4% of the construction industry used barcoding technology for tracking inventory (stock tracking), occupying a proportion of 1.2%; 40% of the manufacturing and retailing industries used barcoding technology to hold inventory, occupying percentage proportions of 3.6% each, considering other barcoding technology-related tasks. The results are in line with the findings of Huang et al. (2009: 577) and Ramanathan et al. (2014: 232) in identifying and tracking the product.

The respondents in the construction projects studied thus revealed that, although they did not fully utilise the barcoding technology, it could be utilized to improve the following area of construction logistics tasks:

Original Article

- Receiving process: Processing receipt of material, plant and equipment.
- Put-away process: Inter-site material transfer and returns of material to the manufacturer.
- Stock control: Inter-site material transfer and returns of material to the manufacturer.
- Dispatching process: Plant, materia, and equipment issued.
- Replenishment process: Material, plant and equipment replenishment.
- Stock tracking: Material, equipment and plant tracking.
- Stock holding: Material on site.

3.3 Accruable benefits of barcoding technology to construction

It is apparent from Table 2 that the interviewed respondents deemed that the following benefits could be accrued to construction industry if the barcoding technology is utilised in the construction industry for order processing processes of logistics management. These include provision of managerial control in the construction industry; shorter processing time than manual identification could ever achieve in the construction industry; provision of an easy way of tracking materials on site; barcodes make the processing of work in the construction industry fast and accurate; provision of realtime data-capturing and exchange in the construction industry; reduction in errors in the construction industry; increased labour satisfaction, and increased financial control on the construction site. These results corroborate the findings of Ramanathan et al. (2014: 232), Fatnani and Malik (2015: 3252), Vlahovic et al. (2015: 34) and ZTC (2017: 2) that barcoding technology was used for tracking, fast processing and data-capturing. This also supports the findings of Ordoobadi & Ordoobadi (2009: 371) and Fatnani & Malik (2015: 3252) that barcoding reduces human error and increases financial control. Figure 1 shows that the total usage of tasks using barcoding technology was 460%, 580% and 80.3% for the manufacturing, retailing and construction industries, respectively, each occupying a proportion of 411%, 51.7% and 7.2% across the three industries, respectively. This means that the use of barcoding technology in the construction industry for order processing is Very low when compared to the manufacturing and retailing industries.

Figure 1: Barcoding technology

3.4 Radio Frequency Identification (RFID) technology

A total of 100%, 80% and 20% of the manufacturing, retailing and construction industries, respectively, adopted RFID technology for order processing purposes, from which the manufacturing and retailing industries used 100% and 80%, respectively, for the receiving process, each occupying percentage proportions of 9.3% and 7.5%, respectively. The construction industry occupied a total proportion of 0.6% for the receiving process, with 6.7% for processing receipt of plants considering another related RFID task. These results support the findings of Jimoh, Abdullahi and Abdullahi (2015: 545), who opine that RFID is mostly used in the manufacturing industry when compared to other industries. Moreover, 60% of the manufacturing and retailing industries used RFID technology for the put-away process, both occupying proportions of 5.6%. Only 10% of the construction industries used RFID technology for returning goods to the manufacturer, occupying a proportion of 0.9%. Similarly, 100% and 60%

were used for the shipping process in the manufacturing and retailing industries, respectively, occupying a proportion of 9.3% and 5.6% each. These results confirm the findings of Ferrer, Dew and Apte (2010: 424) and Jafari and Sadeghi-Niaraki (2013: 215) that RFID allowed for very fast and easy shipping of materials. Moreover, 80% and 40% of the dispatching process was used by the manufacturing and retailing industries, respectively, each occupying a proportion of 7.5% and 3.7%, even though 6.7% was used in the construction industry, occupying a proportion of 0.6% for material issued considering other related RFID tasks. In terms of the replenishment process, 60% and 80% of the manufacturing and retailing industries, respectively, used RFID technology, occupying proportions of 5.6% and 7.5%, respectively. However, 100% and 80% of the manufacturing and retailing industries, respectively, used RFID technology to track the inventory process, occupying proportions of 9.3% and 7.5% each. However, 6.7% of the construction industry used barcoding to track inventory under material tracking. This occupied a proportion of 0.6% considering other related RFID technology tasks. These results are in line with the conclusions of McFarlane and Sheffi (2003: 7), Kim et al. (2011: 159,) Lee and Lee (2015: 432) and Bottani et al. (2010: 427), who stated that RFID allowed for replenishment with hardly or no manpower. The respondents in the construction projects studied, therefore, revealed that. Although they did not fully utilise the RFID technology, it could be utilised to improve the following areas of construction logistics tasks:

- Receiving process: Processing receipt of material, plant and equipment.
- Put-away process: Inter-site material transfer and returns of material to the manufacturer.
- Stock control: Inter-site material transfer and returns of material to the manufacturer.
- Dispatching process: Plant, material and equipment issued.
- Replenishment process: Material, plant and equipment replenishment.
- Stock tracking: Material, equipment and plant tracking.
- Stock holding: Material on site.

3.5 Accruable benefits of RFID technology to construction

Table 3 shows that the interviewed respondents deemed that the following benefits could be accrued to the construction industry if the RFID technology is utilised for order processing processes of logistics management. These include increased speed of work in the construction industries; provision of improvement in the quality of documents in the construction industries; provision of a decrease in documentation errors in the construction industries; make the shipping process fast and easy on the construction site; RFID allows for contactless identification with hardly any or no manpower in the construction industries; unlike barcoding, RFID can identify an object and store information without seeing the tag; reduction in inventory losses in the construction industries; provision of an increase of efficiency and speed of data processing in the construction industries; increased improvement of information accuracy, and make it possible to read data from multiple tags at one time. These results confirm the findings of Ramaa, Subramanya and Rangaswamy (2012: 18) on the benefits of RFID. These corroborate the findings of Jimoh et al. (2015: 545), who stated that the integration of the RFID would aid the construction companies' performance by allowing realtime monitoring and documenting of construction activities. These are also in line with Valero and Adán (2016: 215), who stated that RFID has an advantage over barcoding. The results validate the finding of Sarac et al. (2010: 77), Bottani et al. (2010: 427) and Lu et al. (2011: 102) on the increase of efficiency, flow of information, speed of processes and reading of multiple tags. This also supports the findings of Kim et al. (2011: 159) that RFID identifies objects and stores information.

Original Article

Figure 2 shows that the usage of the tasks using RFID technology were 560%, 480% and 30.1% for the manufacturing, retailing and construction industries, respectively, each occupying proportions of 52.3%, 44.9% and 2.7% across the three industries, respectively. This means that the utilisation of RFID technology in the construction industry for order processing is very low when compared to the manufacturing and retailing industries.

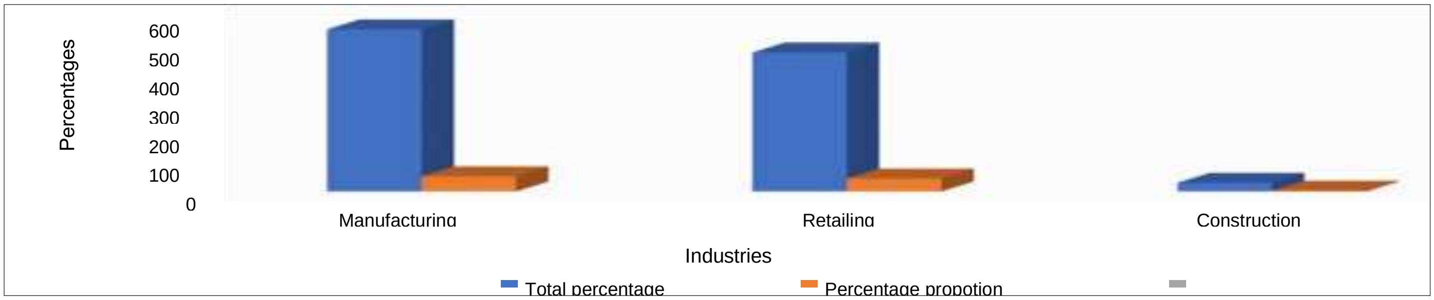

Figure 2: Radio Frequency Identification (RFID) technology

3.6 Electronic Product Code (EPC) technology

Table 4 shows that 40% and 60% of the manufacturing and retailing industries, respectively, adopted EPC technology for order processing. Moreover, 40% of the manufacturing and retailing industries, respectively, used EPC technology for the receiving process, occupying a proportion of 7.7% each. However, only 20% of the manufacturing industry used EPC for put-away processes, occupying a proportion of 3.8%, in relation to EPC technology-related tasks. These results are in line with Bottani et al. (2010: 427) on the use of EPC for supply-chain management in the manufacturing and retailing industries. A total of 20% and 40% of the manufacturing industry used EPC technology for the dispatching and replenishment processes, respectively, occupying proportions of 3.8% and 7.7%. Moreover, 60% of the retailing industry used EPC for the shipping and dispatching processes, respectively, each occupying a proportion of 11.5%. These results support the findins of Zhu, Mukhopadhyay and Kurata (2012: 161), who opine that the shipping process and dispatching are tasks under EPC. Moreover, 40% of the manufacturing and retailing industries used EPC technology for the shipping process and tracking inventory, respectively, each occupying a proportion of 7.7%. However, 20% and 40% of the manufacturing and retailing industries, respectively, used EPC for holding inventory, occupying proportions of 3.8% and 7.7%. These results confirm the findings of Zhu et al. (2012: 161) that, with EPC technology, shipping and tracking are made easy.

The respondents in the construction projects studied, therefore, revealed that, although they did not fully utilise the EPC technology, it could be utilised to improve the following areas of construction logistics tasks:

- Receiving process: Processing receipt of material, plant and equipment.
- Put-away process: Inter-site material transfer and returns of material to the manufacturer.
- Stock control: Inter-site material transfer and returns of material to the manufacturer.
- Dispatching process: Plant, material and equipment issued.
- Replenishment process: Material, plant and equipment replenishment.
- Stock tracking: Material, equipment and plant tracking.
- Stock holding: Material on site.

Original Article

3.7 Accruable benefits of EPC technology to construction

The EPC technology was not used in the construction industry, but the respondents noted that the construction industry could consider using an EPC system, in order to enjoy the promised benefits of this technology. The

The construction industry for order processing-related tasks.

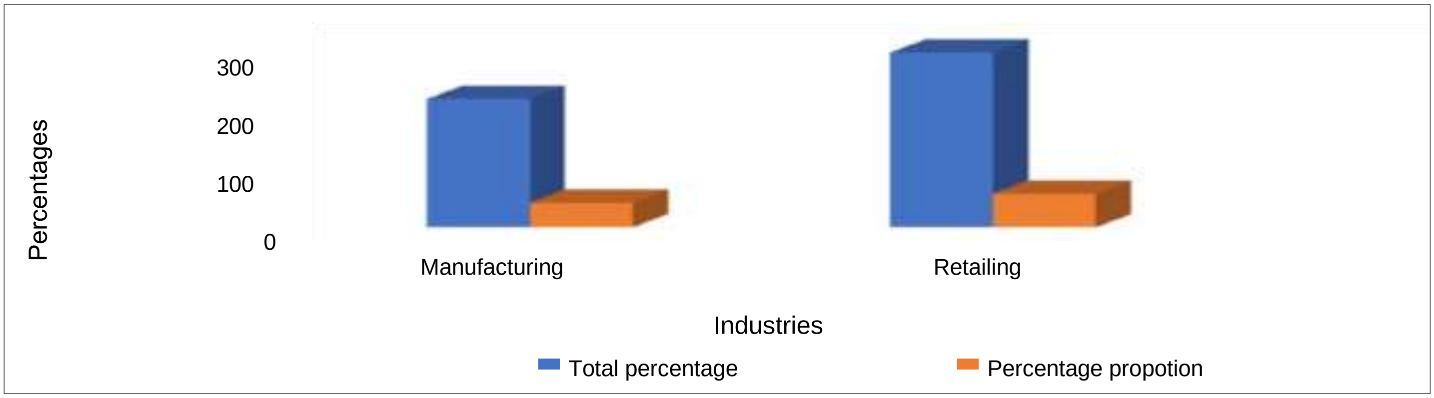

Figure 3: Electronic product code (EPC) technology

following benefits could be accrued to the construction industry if the EPC technology is utilised in the construction industry for order processing processes of logistics management: improved shipping and receiving of construction materials; the technology prompts more construction businesses; the technology fosters a higher level of information-sharing; provide synchronisation between supply-chain members in construction; provision of information to the construction team, such as the product category, size, date when the product was made, the expiry date and the final destination; products with an EPC tag have the ability to communicate with their environment and make or trigger basic decisions relevant to construction industries; the EPC network is exploited for real-time information-sharing throughout the supply; provision of improvement in the quality of documents, and a decrease in documentation errors on the construction site. These corroborate the findings of Wamba et al. (2008: 616), Zhu et al. (2012: 161) and Bottani et al. (2010: 427) that EPC triggers basic decisions and provides real-time decision between supply-chain members in construction. Similarly, these results confirm the findings of Ramaa et al. (2012: 18) on the benefits of order processing-related benefits. This is also in line with the findings of Jimoh et al. (2015: 540) on order processing. The results in Figure 3 show that the total use of the tasks using EPC technology were 220% and 300% in the manufacturing and retailing industries, respectively, occupying proportions of 42.2% and 57.7% in the industries, respectively. This meant that EPC technology was not found.

3.8 Point of Sale (PoS) technology

Table 5 shows that 80% and 100% of the manufacturing and retailing industries, respectively, adopted PoS technology for order processing. Moreover, 80% and 100% of the manufacturing and retailing industries, respectively, used PoS technology for the receiving processes, occupying proportions of 10.8% and 13.5%, respectively. These results support the findings of Ahn et al. (2011: 16) and Holloman (2015: 6) that the introduction of PoS in the industries makes it easy to monitor and track products. Moreover, 60% and 100% of the manufacturing and retailing industries used PoS technology for the put-away process, respectively, each occupying proportions of 8.1% and 13.5% However, 40% and 60% were used by the manufacturing and retailing industries, respectively, for the shipping process, occupying proportions of 5.4% and 8.1%, respectively. These results corroborate the findings of Samuel and Ondiek (2014: 12) on fast record during the shipping process. A total of 60% of the manufacturing industries used PoS technology for the dispatching and replenishment processes, occupying proportions of 8.1%, 80% and 100% of the retailing industry, which used PoS for dispatching and replenishment processes, respectively, used by the retailing industry occupying proportions of 10.8% and 13.5% in relation to other PoS technology-related tasks. These results are in line with the findings of Xie (2009: 16) and Pepe & Pepe (2012: 69) on fast delivery and the replenishment process. PoS technology was not found in the construction industry. The respondents in the construction projects studied, therefore, revealed that, although they did not fully utilise the PoS technology, it could be utilised to improve the following areas of construction logistics tasks:

- Receiving process: Processing receipt of material, plant and equipment.
- Put-away process: Inter-site material transfer and returns of material to the manufacturer.
- Stock control: Inter-site material transfer and returns of material to the manufacturer.
- Dispatching process: Plant, material and equipment issued.
- Replenishment process: Material, plant and equipment replenishment.
- Stock tracking: Material, equipment and plant tracking.
- Stock holding: Material on site.

3.9 Accruable benefits of PoS technology to construction

The construction industry could consider the use of PoS system, in order to enjoy the promised benefits of this technology. The following benefits could be accrued to the construction industry if the PoS technology is utilised in the construction industry for order processing processes of logistics management: provision of fast delivery and security to construction workers; allowance of easy service in construction industries to conduct financial transactions; provision of the update of the inventory in the construction industries; provision of easy access for the processing, storage and monitoring the movement of goods and management functionality in construction; provision of the visibility of product movement through to point-of-purchase to workers' satisfaction at point-of-use; provision of real-time construction data; provision of efficient inventory control in the construction industry; reduction in restocking times and clearer data; provision of an instant transaction record in construction; provision of easy access to track workers' purchases; and the technology creates employee schedules, purchase orders, process credit cards, view. Most of these results support the findings of Janat (2009: 43), Xie (2009: 16), Ahn et al. (2011: 15), Pepe and Pepe (2012: 69), Samuel (2012: 14), Plomp et al. (2012: 265), Samuel and Ondiek (2014: 12)**,** and Holloman (2015: 6), who highlighted the benefits of PoS techologies to enhance order processing. Figure 4 shows that, the total use of tasks using PoS technology were 300% and 440% in the manufacturing and retailing industries, respectively, occupying proportions of 40.5% and 59.4% across the three industries, respectively. This means that PoS technology was not found in the

Original Article

Construction industry for order processing.

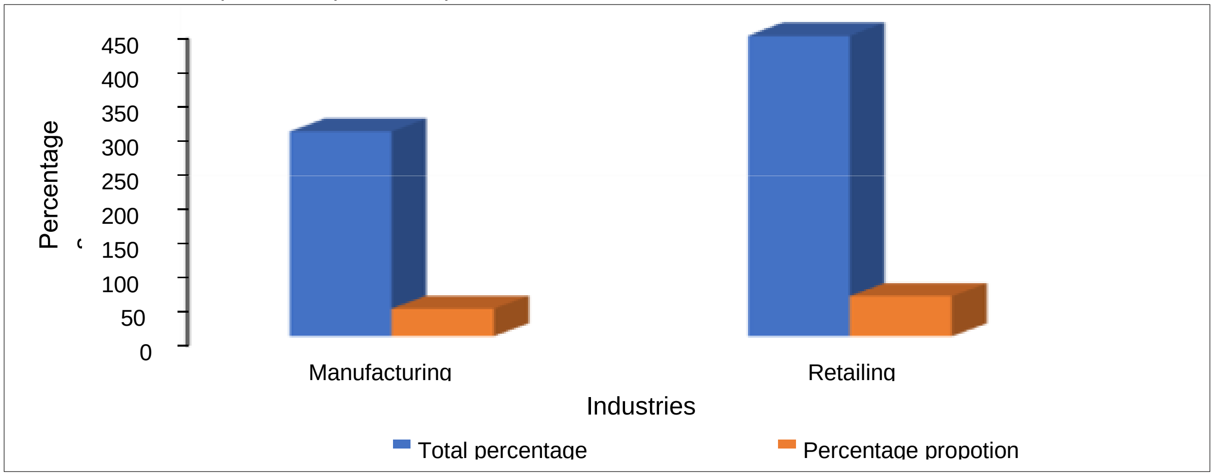

Figure 4: Point of Sale (PoS) technology

4. CONCLUSION

The technological aspect of construction logistics, especially the order processing, is overlooked, and little is understood in the Nigerian construction industry. This article assessed how Barcoding, RFID, EPC and PoS technology utilised by the manufacturing and retailing industries could be used to improve the order processing procedures of construction logistics. Findings showed that 80% and 100% of the observed manufacturing and retailing industries, respectively, adopted barcoding technology for order processing purposes. Only 40% of the observed construction projects adopted barcoding technology for order processing in the following: 2.4% for the receiving process, 0.9% for the put-away process, 0.9% for the shipping process (stock control), 1.2% for the dispatching process, 0.6% for the replenishment process, and 1.2% for tracking inventory (stock tracking). In addition, 100% and 80% of the observed manufacturing and retailing industries, respectively, adopted RFID technology for order processing purposes. Only 42% of the observed construction projects adopted RFID technology for order processing as follows: 0.6% for the receiving process, 0.9% for the put-away process, 0.6% for the dispatching process, 0.6% for the replenishment process, and 0.6% for tracking inventory (stock tracking). Moreover, 40% and 60% of the observed manufacturing and retailing industries, respectively, adopted EPC technology for order processing purposes. Similarly, 80% and 100% of the observed manufacturing and retailing industries, respectively, adopted PoS technology for order processing purposes. Based on these findings, it can be concluded that EPC and PoS technologies were not used for order processing purposes in the construction industries, while the Barcoding and RFID technologies were not fully utilised in the construction projects when compared to the manufacturing and retailing industries. Conclusively, due to the ultimate benefit that could accrue to the construction industry for the utilisation of the order processing technology for order processing purposes (namely achievement of full forecasting-efficiency gains in construction), the Barcoding, RFID, EPC and PoS technology could be utilised to improve the following tasks in the construction industry: demand control: material, labour and equipment and plant demand on site; stock control: material on site, order management, and material to be used; production output control: labour output and plant output; procurement process: bidding process, invitation to tender, submission of tender, tender evaluation and report; receiving process: processing receipt of material, plant and equipment; put-away process: inter-site material transfer and returns of material to the manufacturer; stock control: inter-site material transfer and returns of material to the manufacturer; dispatching

Original Article

process: plant, material and equipment issued; replenishment process: material, plant and equipment replenishment; stock tracking: material, equipment and plant tracking; stock holding: material on site. The Federal Government of Nigeria should, therefore, draft regulations, mandating all construction project stakeholders to attend a compulsory workshop on how technology would improve logistics management in the Nigerian construction industry. The Nigerian construction industry should also leverage this, in order to create the best ways of handling the Barcoding, RFID, EPC and PoS technology to improve the order processing logistics systems of the construction process. The study has contributed to the body of knowledge in the following areas: extrapolated the tasks to which retail and manufacturing technologies could be used in construction industries in Nigeria; increased the understanding of the benefits of utilising order processing technologies in the construction process, and highlighted the ultimate benefit for an improved and increased uptake of order processing technology under the tasks and subtasks in construction.

Reference

Jimoh, A.A., Abdullahi, M.E. & Abdullahi, H. 2015. An appraisal of the absolute adoption of electronic technology in the execution of construction projects in Nigeria. In: Ogunsemi, D.R. (Ed.). The Nigerian Institute of Quantity Surveyors: 2nd Research Conference – ReCon2, 1-3 September, Abuja, Nigeria: Nigerian Institute of Quantity Surveyors, pp. 545-556.

Kasim, N. 2015. Intelligent materials tracking system for construction projects management. Journal of Engineering and Technological Sciences, 47(2), pp. 218-230. doi: 10.5614/j.eng.technol.sci.2015.47.2.11

Kasim, N.B. 2008. Improving materials management on construction projects. Unpublished PhD thesis, submitted to the Department of Civil and Building Engineering, Loughborough University, London.

Kim, C., Kim, H., Ryu, J. & Kim, C. 2011. Ubiquitous sensor network for construction material monitoring. Journal of Construction Engineering and Management, 137(2), pp. 158-165.

Langeley, C.J., Coyle, J.J., Gibson, B.J., Novack, R.A. & Bardi, E.J. 2009. Managing supply chains: A logistics approach. 8th edition. Canada: LEAP Publishing Services.

Lee, I. & Lee, K. 2015. The Internet of Things (IoT): Applications, investments, and challenges for enterprises. Business Horizons, 58(4), pp. 431-440.

Leedy, P. & Ormrod, J. 2014. Practical research: Planning and design. 10th edition. London: Pearson Education Limited.

Lin, Y., Ha, N.-H. & Lin, K.-S. 2015. The role of mPOS system in process change and strategy change: A situated change perspective. Technologies, 3(4), pp. 198-218.

Liwan, S.R., Kasim, N. & Zainal, R. 2013. Materials tracking practices for inventory management in construction projects. In: Proceedings of the 1st Faculty of Technology Management and Business (1st FPTP) Colloquium, 12-14 December, Universitiy Tun Hussein Onn, Malaysia, pp. 1-6.

Lu, W., Huang, G.Q. & Li, H. 2011. Scenarios for applying RFID technology in construction project management. Automation in Construction, 20(2), pp. 101-106.

McFarlane, D. & Sheffi, Y. 2003. The impact of automatic identification on supply chain operations. The International Journal of Logistics Management, 14(1), pp. 1-17.

Mohammed, Z. & Ali, S. 2016. The operational benefits of Enterprise Resource Planning (ERP): A case study on food processing and manufacturing companies in Jordan. International Journal of Business and Social Science, 7(2), pp. 21-38.

Nasr, E., Shehab, T. & Vlad, A. 2013. Tracking systems in construction: Applications and comparisons. In: Sulbaran, T. (Ed.). Proceedings of the 49th ASC Annual International Conference, 10-13 April, San Luis Obispo, California: Associated Schools of Construction, pp. 1-9.

Ordoobadi, S. & Ordoobadi, S. 2009. Evaluation of advanced manufacturing technologies using Taguchi's loss functions. Journal of Manufacturing Technology Management, 20(3), pp. 367-384.

Pepe, M.R. & Pepe, M.S. 2012. Using Point of Sale (POS) data to deliver customer value in the supermarket industry through category management practices. Journal of Marketing Development and Competitiveness, 6(1), pp. 69-73.

Plomp, M.G., Van Rijn, G. & Batenburg, R.S. 2012. Chain digitisation support by point-of-sale systems: An analysis of the Dutch product software market. International Journal of Information Technology & Management, 11(4), pp. 257-272.

Polacco, A. 2016. Supply chain management and the sharing economy. In: Liang, T.P. (Ed.). Proceedings of the 20th Pacific Asia Conference on Information Systems (PACIS 2016), 27 June-1 July, Chiayi, Taiwan, article 102, pp. 111.

Preidel, C. & Borrmann, A. 2015. Automated code compliance checking based on a visual language and Building Information Modeling. In: 32nd International Symposium on Automation and Robotics in Construction and Mining (ISARC 2015), 15-18 June, Oulu, Finland: IAARC, pp. 256- 263.

Ramaa, A., Subramanya, K.N. & Rangaswamy, T.M. 2012. Impact of warehouse management system in a supply chain. International Journal of Computer Applications, 54(1), pp. 14-20.

Ramanathan, R., Ramanathan, U. & Ko, L.W.L. 2014. Adoption of RFID technologies in UK logistics: Moderating roles of size, barcode experience and government support. Journal of Expert Systems with Applications, 41(1), pp. 230-236.

Reiner, G., Teller, C. & Kotzab, H. 2013. Analyzing the efficient execution of in-store logistics processes in grocery retailing: The case of dairy products. Production and Operations Management, 22(4), pp. 924-939.

Samuel, K.S. 2012. Inventory management automation and performance of supermarket in Western Kenya. Unpublished MBA project, School of Business, University of Nairobi, Kenya.

Samuel, K.S. & Ondiek, O.G. 2014. Inventory management automation and the performance of supermarkets in Western Kenya. International Journal of Research in Management and Business Studies, 1(4), pp. 9-18.

Sarac, A., Absi, N. & Dauzère-Pérès, S. 2010. A literature review on the impact of RFID technologies on supply chain management. International Journal of Production Economics, 128(1), pp. 77-95.

Soliman, M. & Karia, N. 2015. Enterprise Resource Planning (ERP) system as an innovative technology in higher education context in Egypt. International Journal of Computing Academic Research, 4(5), pp. 265-269.

Sullivan, G., Barthorpe, S. & Robbins, S. 2010. Managing construction logistics. Oxford, UK: Wiley-Blackwell.

Thiesse, F. & Buckel, T. 2015. A comparison of RFID-based shelf replenishment policies in retail stores under suboptimal read rates. International Journal of Production Economics. Elsevier, 159, pp. 126-136. Valero, E. & Adán, A. 2016. Integration of RFID with other technologies in construction. Journal of the International Measurement Confederation, 94, pp. 614-620. doi: 10.1016/j.measurement.2016.08.037

Vlahovic, N., Knezevic, B. & Sabolic, M. 2015. Overview of recent IT technologies in retail supply chains. In: Strouhal, I. (Ed.). Proceedings of the 7th International Conference on Applied Economics, Business and Development (AEBD '15), Recent Advances on Business, Economics and Development, 12-14 December, Budapest, Hungary: WSEAS Press, pp. 31-38.

Wamba, S.F., Lefebvre, L.A., Bendavid, Y. & Lefebvre, É. 2008. Exploring the impact of RFID technology and the EPC network on mobile B2B eCommerce: A case study in the retail industry. International Journal of Production Economics, 112(2), pp. 614-629.

Xiang, J. 2019. Radio Frequency Identification (RFID) on textiles.

Unpublished PhD thesis, Department of Electrical and Computer Engineering, Ohio State University, Nigeria.

Xie, Y. 2009. Use of information technologies in retail supply chain: Opportunities and challenges. In: Hanna, M.D. (Ed.). POMS 20th Annual Conference, 1-4 May, Orlando, Florida, USA, pp. 11-26.

Yahaya, I. 2020. Utilisation of technology to improve construction logistics in Nigeria. Unpublished PhD thesis, Department of Construction Management, Nelson Mandela University, Port Elizabeth, South Africa.

Yahaya, I., Shakantu, W. & Saidu, I. 2020. Utilisation of forecasting technology for improving construction logistics in Nigeria. Acta Structilia, 27(1), pp. 1-28.

Zhang, M., Cao, T. & Zhao, X. 2017. Applying sensor-based technology to improve construction safety management. Sensors (Switzerland), 17(8), pp. 1-24.

Original Article

Zhu, X., Mukhopadhyay, S.K. & Kurata, H. 2012. A review of RFID technology and its managerial applications in different industries. Journal of Engineering and Technology Management, 29(1), pp. 152-167.

ZTC (Zebra Technologies Corporation). 2017. White paper: Barcoding 101: What you need to know.