Assessment of Radio Frequency Identification (RFID) Technology in Transport Logistics in Nigeria

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The logistic technologies for effective and efficient 'transport operations' in the areas of stock tracking, machine tracking, workers tracking, time tracking, stock sizes and shape, location identification, and stock routing and schedule shipment are deficient in the Nigerian construction industry, when compared to manufacturing and retailing sectors which are known to have fully adopted the RFID technology in these operations for effective performance. This article assessed the benefits of RFID technology for transport logistic operations in the construction industry. Lagos State and the F.C.T. Abuja, Nigeria were the selected geographical study areas, from which 5 manufacturing companies, 5 retailing companies and 5 construction projects were purposively selected. Mixed methods research strategy was used. The research instruments included an observation guide (quantitative) and interviews (qualitative). The collected quantitative data were analysed, using descriptive analytical tools: frequencies and percentiles. The qualitative data was analysed, using the thematic method. The study found that 80% and 60% of the manufacturing and retailing sectors respectively, observed, adopted RFID technology for transportation processing operations. The study revealed further that, RFID technology was not utilised in construction for transportation purposes. It was found that the key benefits of utilising the RFID technology are: improved degree of material traceability; improves safety of resources; improvement in control of material; easy to tracking of materials on site; check on the availability of materials; and allows for contactless identification in construction. It can be concluded that implementation of RFID technology in construction would translate into improvement in material control, checking, tracking, safety and traceability onsite.

Keywords: Construction, RFID, transport, logistics, technology

INTRODUCTION

The current application of logistics technologies in the construction industry is relatively inefficient when compared with the retailing and manufacturing industries (Ibrahim & Moselhi**,** 2016**).** The logistics technology used in transportation process operations in the Nigerian construction industry is outdated, ineffectual, and often overlooked, due to its weak contributions to project performance (Yahaya *et al*., 2020). Janné (2018) opined that the performance of these systems is still not robust enough for most industry processes. Hence, choosing appropriate technologies for various industry processes is very crucial to any construction activity, in order compete with other industries (Bhandari, 2014). Ibrahim *et al*. (2020) added that traditional methods are still in used for the transportation management, although they neither adequately meet site needs nor suits the overall management process. This is because manufacturing and retailing industries are not investigated to access new technologies that can improved working practice and logistics in the construction industry (Sullivan *et al*., 2010). Gadde and Dubois (2010) noted that huge efforts must be made in the area of transportation logistics technology.

Radio Frequency Identification (RFID) technology using readers and RFID tags, whether passive, semi-passive or active in nature, has been deemed to be a promising candidate (Goh & Aslam, 2020). Hence, choosing an appropriate transportation technology like RFID for various logistics processes is crucial to any construction activity, in order to gain advantage in competitive markets (Bhandari, 2014). Therefore, identifying the appropriate tasks and their relevant technologies in the construction industry would help integrate and facilitate the processes of logistics management practices (Yahaya *et al*., 2021). In essence, construction in urban areas faces two problems; the urban transport problem and the problem of coordinating multiple construction stakeholders, this can be solved through the use of construction logistics technology solutions like RFID technology (Janné, 2018). According to Braun *et al*. (2015) RFID technology has been widely applied in various areas such as retail, and railway transportation and brought great benefits in these areas through improving real-time information visibility and traceability.

Research evidence has shown that previous studies on construction logistics from different part of Nigeria have focused on order processing and forecasting logistics

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(Fatnani & Malik, 2015); Braun *et al*. (2015) focused on effectiveness and efficiency in logistics supply chain. However, very little is focused on logistics technology, especially the use of RFID technology for transportation process to improve construction logistic processes. The technological aspect of construction logistics, most especially the transportation process is over looked, and little is understood in the Nigerian construction industry. It is, consequently, important to examine transportation process related tasks in the manufacturing, retailing and construction industries; the percentage level of usage of RFID logistics technologies in the execution of these tasks, and the accruable benefits to construction from the utilisation of the transportation logistics process using RFID technology in the industries. The article assesses the level of utilisation of transportation process technology using RFID technology in the manufacturing and retailing industries, in order to improve the transportation process of the Nigerian construction logistics.

LITERATURE REVIEW

Logistics

The effective economic development of a country, as well as industrial and commercial business success is not possible without logistics services that create added value for businesses, ensuring the expediency of products' time, place and meeting the client's needs (Guerlain *et al*., 2019). Yahaya (2020) added that logistics is a business planning frame work for the management of material, service, information and capital flow required in today's business management. Therefore, lack of proper logistics management is made problematic in the area of materials shortages and delays in supply that can lead to materials damage and wastages (Xiang, 2019).

Construction Logistics Technology

The goal for any construction project is to deliver the project on time and on cost (Janné, 2018). Therefore efficient management of construction project from inception to completion in a timely manner, and given due consideration to its numerous constrains requires skillful integration of construction logistics (Usman & Ibrahim, 2015). The transformation to automated production and handling in other industries over the past years has resulted in the development of effective practices that could enhance consideration of logistics, technologies in the construction industry (Yahaya, 2020). As property development and information technologies are growing rapid in these few decades, logistics technology in construction becomes necessarily as a management tool (Wang *et al*., 2020) Lack of understanding and slow technology development currently affected the adoption of new technologies in the construction industry (Fatnani & Malik, 2015). Technologies have to be adopted for improvement of the logistics processes of construction in order to manage inefficiencies especially in the area of transportation (Mohammed & Ali, 2016: 21).

Radio Frequency Identification (RFID)

A number of technologies have been reported to date for identification of objects, humans, and animals, some of the most well-known technologies entail barcodes, RFI and Near Field Communication (NFC) (Xiang, 2019). The introduction of logistics technology like RFID can help improve data accuracy by tracking products and identifying products and object at specific points (Yahaya, 2020).

The 1970's witnessed potential growth of RFID tags in transportation that is, automobile vehicle identification, automated toll system, electronic license plate, electronic manifestation and vehicular routing (Goh & Aslam, 2020). The technology depends on the use of electromagnetic or electrostatic coupling to identify objects by a unique code identification so that the system can recognize and read information and details about items that can be read from a specified rang via wireless connection (Ibrahim *et al*., 2020). According to Ibrahim *et al*. (2020) the system is divided into three main components; the tag, reader and computer on which the program and database are installed, in addition to the antenna that helps increase the network communication for providing wide-range waves for readers on construction sites.

Radio Frequency Identification (RFID) Technology as Transportation Logistics Tool in tConstruction Industry

RFID technology is a promising technology for the construction industry that can be integrated into systems to track materials, identify vehicles, and assist with cost controls (Fatnani & Malik, 2015). Yahaya *et al*. (2020) opined that, the technology is widely used for different tasks such as Stock tracking, machine tracking, workers tracking, time tracking, stock sizes and shape, location identification, and stock routing, schedule shipment, 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. Ibrahim *et al*. (2020) 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 in the transport system.

Manufacturing and Retailing Industries' Experiences of RFID Logistics Technology

RFID technology has been used for more than 60 years. In its early states, it was used in World War II by the allies and Germany to identify whether an aircraft was

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enemy or friend (Goh & Aslam, 2020). Today, RFIDs are applied in numerous areas such as healthcare for tagging medicines, reduce medical errors and make fast payment transactions. In library management, books were self-checked out/in, and automatically record the borrowing information eliminating manual labour. At store entrances/exits, RFIDs was used to detect thefts (Xiang, 2019). According to Wang *et al*. (2020) RFID technology has been widely applied in various areas such as retail, electronic transaction, logistic, security and many others, but few applications have been developed that are related to the construction and facilities operations environment

Benefits of RFID technology in manufacturing, retailing and construction logistic operations

Benefits	Manufacturing Firm	Retailing Firm	Construction Firm
Help in speed of the work	Jafari and Sadeghi-Niaraki (2013)	Jafari and Sadeghi-Niaraki (2013)	Mohammed & Ali (2016)
Better financial control		Xiang (2019).	Jimoh *et al*. (2015)
Better communications	Wang *et al*. (2020)		
Simpler access to data		Ibrahim *et al*. (2020)	
Increase in the quality of documents			Jimoh *et al*. (2015)
Decrease in documentation errors	Bryde *et al.* (2014)		
Better tracking and monitoring	Jimoh *et al*. (2015)		Bottani *et al.* (2010)

RESEARCH METHODOLOGY

This study uses a mixed methods approach where both quantitative and qualitative data are collected in parallel, analysed. In this study, the task performed by RFID technology from the manufacturing, retailing and construction sectors was observed and recorded on the observation checklist which generated quantitative data. Furthermore, interviews were conducted with a representative/attendant of the RFID technology in order to explore the likely benefits of implementing RFID technologies in the construction sector. This is because, the manufacturing and retailing sectors have some features that are similar to construction sector. Since RFID has not been implemented in construction, some of the important benefits that may accrue to construction or any other sector, may be asked from those that have implemented it.

The geographical study areas for this study 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 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. 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 RFID. 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.

An observation guide and semi-structured interviews were used to observe only the RFID technology utilized, including four RFID technology from manufacturing companies; three RFID technology from retailing companies, and none from construction projects. The observation guide included seven main transportation tasks for the manufacturing and retailing companies, namely: goods tracking, vehicle tracking, workers monitoring, transport time determination, good identification, mode selection, and routing and scheduling shipments , as well as seven main tasks for construction companies, namely: stock tracking, machine tracking, workers tracking, time tracking, stock sizes and shape, location identification, and stock routing and schedule shipment.

The observations were carried out with the aid of the workers in the sectors (manufacturing, retailing, and construction) who were stationed to work on the technologies. The observations were done by taking the researcher around the RFID technology 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 RFID as transportation logistics technologies available (See Table 1).

The respondents of the semi-structured interviews were one worker each from the different sectors visited who

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was stationed to work on the technology. This included four from manufacturing companies, three respondents from retailing companies and non-respondent from a construction sector, making a total of seven respondents from the companies. The semi-structured interview guide contains only one major question: How can the benefits of utilising this RFID logistics technology be accruable to the logistics transportation process of the construction industry? (See the last column of Tables 1).

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 the manufacturing and retailing industries, and 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 a total of ten companies. The identification in each of these companies represented 20% of the 100% for the five manufacturing and the five retailing companies, respectively. In addition, the tasks in the five manufacturing and retailing companies were identified, with each occupying 20% of the 100%. For example, goods tracking in Table 1 was used by 4 manufacturing companies out the five (5) manufacturing companies, each company occupying 20%. This means 20% multiply by 4 industries, equals to 80% of the 100% of the five manufacturing companies. The same process applies to the five (5) retailing companies. Moreover, for identification of the technologies in the 5-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 (5) projects in the construction industry. The tasks under the construction project were sub-divided in to sub-tasks, for which 20% occupied by each project was further sub-divided into the sub-tasks under the projects in the construction projects. This means, machine tracking only occupied 20% which will be divided among the number of sub-tasks that appear under machine tracking. For example, considering the corresponding task to vehicle tracking in construction is machine tracking in Table 1 line 2. Therefore, machine tracking as a main task, each occupying 20% to make 100%, the 20% under 'machine tracking'' was further divided into 2 different sub-tasks in machine tracking (plant and equipment) that is, 20% divided by 2 equals to 10% for each sub-task. Furthermore, the total of this percentages from the manufacturing, retailing and construction sectors were utilised to produce the percentage level of usage of the task and sub-task in the three industries. 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 (3) industries were used to develop the Figure 1 for RFID technology. 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.

RESULTS AND DISCUSSION

Level of Usage of RFID Technology

A total of 80% and 60% of manufacturing and retailing respectively utilised RFID technology for transportation purposes. These results corroborate the findings of Chen *et al*. (2010) on the use of RFID for transportation purposes.

Furthermore, 80% and 40% of manufacturing and retailing respectively used the RFID technology for goods tracking. Moreover, 60% and 20% of the manufacturing and retailing industries respectively used the RFID technology for workers monitoring. These results support the findings of Visich *et al*. (2009) that the technology is used for tracking and control of the movement of materials. These are also in line with the findings of Lima and Ferreira (2009) and Chen *et al.* (2010) on goods tracking.

Moreover, 80% and 40% of manufacturing and retailing respectively used the RFID technology for goods identification. Similarly, 60% of both manufacturing and retailing used the RFID technology for routing and scheduling shipments. These results support the findings of Chen *et al*. (2010) and Lima and Ferreira (2009) in Section 2.5.9.1 on goods identification and shipment.

Lastly, the RFID technology in manufacturing and retailing occupied a proportion of 63.6% and 36.4%, respectively, meaning that RFID was not utilised in construction for transportation.

It was therefore revealed that though, the RFID technology was not utilised by the respondents, but could be utilised to improve the following area of construction logistics tasks

i. Stock tracking: Management of material
ii. Machine tracking: Plant and equipment
iii. Worker's tracking: Driver tracking and labourer's tracking
iv. Time tracking: Loading, conveyance and offloading
v. Stock sizes and shape: Material sizes, material specification and material type
vi. Location identification: Vehicle tracking and plant tracking
vii. Stock routing and schedule shipment: Material, plant, equipment and manpower

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Accruable Benefits of RFID Technology to Construction

All the 10 respondents of both manufacturing and retailing sectors visited responded to the interview questions. It is clear from table 1 that the interviewed respondents deemed that the following benefits could be accrued to construction industry if the RFID technology is utilised in the construction industry for transportation processes of logistics management, these include: improved degree of material traceability; improves safety of resources; improvement in control of material; make it easy to track materials on site; check on the availability of materials; and allows for contactless identification in construction.

These results confirm the findings of Visich *et al*. (2009), Kim *et al*. (2011) and Jimoh *et al*. (2015), who stated that RFID technology allowed real-time monitoring and documentation of activities. Moreover, the results are also in line with the findings of Sarac et al. (2010), Bottani *et al*. (2010) and Lu *et al*. (2011) on the increase of efficiency, tracking and reading of multiple tags.The results support the findings of Jafari and Sadeghi-Niaraki (2013) that the RFID technology is more advantageous over barcodes in terms of non-optical proximity communication, information density, speed and two-way communication ability.

Table 1: Radio Frequency Identification (RFID) technology (transportation)

Manufacturing and retailing						Construction				
		Manufacturing		Retailing		Construction				
Percentage Identification		80%		60%		0%				Benefits that could accrue
Tasks in Manufacturing and Retailing		100%	% Level of usage	100%	% Level of usage	100%	% Level of usage	Tasks in Construction: Sub tasks	Tasks in Construction: Main tasks	
1	Goods tracking	80	18.2	40	9.1			Management of material	Stock tracking	Improved degree of material traceability on site and allows for contactless identification
2	Vehicle tracking							Plant	Machine tracking	
								Equipment		
3	Workers monitoring	60	13.6	20	4.5			Driver tracking	Workers tracking	Improved safety of resources in construction and improved control of materials
								Labourer's tracking		
4	Transport time determination							Loading	Time tracking	
								Conveyance		
								Offloading		
5	Good identification	80	18.2	40	9.1			Material sizes	Stock sizes and shape	Improved safety of resources and improved check on the availability of materials
								Material specification		
								Material type		
6	Mode selection							Vehicle tracking	Location identification	
								Plant tracking		
7	Routing and scheduling shipments	60	13.6	60	13.6			Material	Stock routing and schedule shipment	Increased speed of work
								Plant		
								Equipment		
								Manpower		
Total		280	63.6	160	36.4					

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CONCLUSION AND RECOMMENDATION

The technological aspect of construction logistics, most especially the transportation process is over looked, and little is understood in the Nigerian construction industry. This research assessed the benefits of RFID technology for transport logistic operations in the construction industry.

The research found that 80% and 60% of the manufacturing and retailing industries respectively, observed, adopted RFID technology for transportation processing purposes (for goods tracking, vehicle tracking, workers monitoring, transport time determination, good identification, mode selection and, routing and scheduling shipments). That RFID technology was not utilised in construction for transportation. Based on these findings, it can be concluded that RFID technology was not utilise in the construction projects

Conclusively, the RFID technology, could be utilised to improve the following tasks in the construction industry: stock tracking: management of material; machine tracking: plant and equipment; workers tracking: driver tracking and labourer's tracking; time tracking: loading, conveyance and offloading; stock sizes and shape: material sizes, material specification and material type; location identification: vehicle tracking and plant tracking; stock routing and schedule shipment: material, plant, equipment and manpower. Since the construction sector has similar and related transportation tasks with manufacturing and retailing sector, it can be concluded that implementation of RFID technology for transport owing to its benefits would translate to efficiency gains in the construction sector by improvement in material control, checking, tracking, safety and traceability onsite.

References

Alomari, S. A. L. I., Salaimeh, S. A. L., Jarrah, E. A. L., & Alzboon, M. S. (2020). Enhanced Logistics Information Service Systems Performance : Using Theoretical Model and Cybernetics Principles. *WSEAS TRANSACTIONS on BUSINESS and ECONOMICS*, *17*, 278–287. https://doi.org/10.37394/23207.2020.17.29

Bhandari, R. (2016). Impact of Technology on Logistics and Supply Chain Management. *IOSR Journal of Business and Management*, 19–24. Retrieved from www.iosrjournals.org

Bottani, E., Montanari, R., & Volpi, A. (2010). The impact of RFID and EPC network on the bullwhip effect in the Italian FMCG supply chain. *International Journal of Production Economics*, 124, 426–432. https://doi.org/10.1016/j.ijpe.2009.12.005

Braun, A., Tuttas, S., Borrmann, A., & Stilla, U. (2015). Automated progress monitoring based on photogrammetric point clouds and precedence relationship graphs. *Pages 1-7 (2015 Proceedings of the 32st ISARC, Oulu, Finland*, 1–7.

Bryde, D., Broquetas, M., & Volm, J. M. (2014). ScienceDirect The project bene fi ts of Building Information Modelling (BIM). *International Journal of Project Management*, *31*, 971–980.

Chen, J.-H., Chang, H.-B., Shen, C.-Y., Wang, T.-W., & Chang, W.-C. (2010). Immersive Learning Environment with Integrated Interactive Video and Ubiquitous Technologies. *Journal of Convergence Information Technology*, *5*(9), 189–199. https://doi.org/10.4156/jcit.vol5.

Fatnani, K., & Malik, L. G. (2015). A Review of Various Industrial Applications of Barcode Technology. *International Journal of Innovative Research in Computer and Communication Engineering*, *3*(4), 3252–3255.

Gadde, L. E., & Dubois, A. (2010). Partnering in the construction industry-Problems and opportunities. *Journal of Purchasing and Supply Management*, *16*(4), 254–263. https://doi.org/10.1016/j.pursup.2010.09.002

Goh, M., & Aslam, M. Z. (2020). A Comparative Survey on Silicon Based and Surface Acoustic Wave (SAW) -Based RFID Tags : Potentials, Challenges, and Future Directions. *IEEE Access*, *8*, 91624–91647. https://doi.org/10.1109/ACCESS.2020.2976533

Guerlain, C., Renault, S., & Ferrero, F. (2019). Understanding Construction Logistics in Urban Areas and Lowering Its Environmental Impact : A Focus on Construction Consolidation Centres. *Journal of Sustainablity*, *11*, 1–11. https://doi.org/doi:10.3390/su11216118

Ibrahim, M., & Moselhi, O. (2016). Automation in Construction Inertial measurement unit based indoor localization for construction applications. *Automation in Construction*, *71*, 13–20. https://doi.org/10.1016/j.autcon.2016.05.006

Ibrahim, O. A., Mohammed, I. A., & Varouqa, I. F. (2020). Materials Management on Construction Sites Using RFID Technique. *International Journal of Scientific & Technology Research*, *9*(4), 1575–1581. Retrieved from ISSN22778616

Jafari, P., & Sadeghi-Niaraki, A. (2013). Use of ubiquitous technologies in military logistic system in Iran. *SMPR Conference 2013*, *40*(1W3), 215–220. Retrieved from http://www.scopus.com/inward/record.url?eid=2-s2.084924290133&partnerID=40&md5=7c1c2bd6c390a70cefc2e3543fdcf873

Janné, M. (2018). *Construction Logistics Solutions in Urban Areas*. Unpublished PhD thesis, Submitted to the Department of Science and Technology, Linköping University, Norrköping, Sweden.

https://dx.doi.org/10.4314/etsj.v13i2.4

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. *The Nigerian Institute of Quantity Surveyors: 2nd Research Conference – ReCon2 1st to 3rd September*, 1–912.

Kim, C., Kim, H., Ryu, J., & Kim, C. (2011). Ubiquitous Sensor Network for Construction Material Monitoring. *Journal of Construction Engineering & Management*, *137*(2), 158–165. https://doi.org/10.1061/(ASCE)CO.1943-7862.0000257

Lima, F., & Ferreira, M. (2009). Mining spatial data from GPS traces for automatica road network extraction. *6th International Symposium on Mobile Mapping Technology,Presidente Prudente, São Paulo*, 21–24. Brazil.

Lu, W., Huang, G. Q., & Li, H. (2011). Scenarios for applying RFID technology in construction project management. *Automation in Construction*, *20*(2), 101–106. https://doi.org/10.1016/j.autcon.2010.09.007

Moh'd, Z., & Ali, S. (2016). The Operational Benefits of Enterprise Resource Planning (ERP): A Case Study on Food Processing and Manufacturing Companies in Jordan 1 Department of Business Administration. *International Journal of Business and Social Science*, *7*(2), 21–38.

Montaser, A., & Moselhi, O. (2012). RFID+ for Tracking Earthmoving Operations. *In Construction Research Congress 2012: Construction Challenges in a Flat World*, 1011–1020. https://doi.org/10.1061/9780784412329.102

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), 77–95. https://doi.org/http://dx.doi.org/10.1016/j.ijpe.2010.07.039

Sardroud, J. M., Limbachiya, M. C., Saremi, A. A., & *. (2010). Ubiquitous Tracking and Locating of Construction Resource Using GIS and RFID. *Conference Paper BIM-Based Applications of Metaheuristic Algorithms to Support the Decision-Making*, 1–10.

Sullivan, G., Barthorpe, S., & Robbins, S. (2010). *Managing construction logistics*.

Usman, N., & Ibrahim, A. M. (2015). Efficient Management of Construction Logistics : A Challenge to both Conventional and Technological Systems in the Developing Nations. *Jeddah Saudi Arabia*, *13*(01), 1883–1898.

Visich, J. K., Powers, J. T., & Roethlein, C. J. (2009). Empirical applications of RFID in the manufacturing environment. *International Journal of Radio Frequency Identification Technology and Applications*, *2*(3/4), 115–132. https://doi.org/10.1504/IJRFITA.2009.025148

Wang, D., Jing, K. T., & Kan, Z. (2020). Exploring the Application of Digital Data Management Approach for Facility Management in Shanghai's High-rise Buildings. *Journal of Progress in Energy and Environment*, *13*, 1–15. Retrieved from http://www.akademiabaru.com/progee.html

Xiang, J. (2019). *Radio Frequency Identification (RFID) on Textiles*. Unpublished PhD thesis, Submitted to the Department of Electrical and Computer Engineering of The Ohio State University, Nigeria.

Yahaya, I, Shakantu, M., & Saidu, I. (2021). Utilisation of order processing technology for logistics process improvement in the Nigerian construction industry,. *Acta Structilia Journal, South Africa.*, *28*(1), 32–67.

Yahaya, I. (2020). *Utilisation of technology to improve construction logistics in Nigeria*. Unpublished PhD thesis, Submitted to the Department of Construction Managemen, Nelson Mandela University, Port Elizabeth, South Africa.

Yahaya, I, Shakantu, W., & Saidu, I. (2020). Utilisation of forecasting technology for improving construction logistics in Nigeria. *Journal Acta Structilia*, *27*(1), 1–28. Retrieved from http://journals.ufs.ac.za/index.php/as

https://dx.doi.org/10.4314/etsj.v13i2.4