Journal of Engineering, Project, and Production Management
2020, 10(1), 19-26

Analysis of Outbound Logistics Channels for Construction Material

Polycarp Olaku Alumbugu[1], Winston W. M. Shakantu[2], and Abel John Tsado[3]

[1]Ph.D. Student, Department of Construction Management, School of the Built Environment, Faculty of Engineering, the Built Environment and Information Technology, Nelson Mandela University, Port Elizabeth, South Africa. Email: s216788099@madela.ac.za (corresponding author).

[2]Professor, Department of Construction Management, School of the Built Environment, Faculty of Engineering, the Built Environment and Information Technology, Nelson Mandela University, Port Elizabeth, South Africa. Email: Winston.shakantu@mandela.ac.za

[3]Ph.D. student, Department of Construction Management, School of the Built Environment, Faculty of Engineering, the Built Environment and Information Technology, Nelson Mandela University, Port Elizabeth, South Africa. Email: s217072933@madela.ac.za

Project Management
Received May 15, 2019; revised August 8, 2019; accepted September 24, 2019
Available online October 13, 2019

Abstract: Outbound logistics channels are of crucial importance for an efficient construction materials logistics management and impacts on customer satisfaction. However, there is limited knowledge of the outbound logistics channels for construction material in Nigeria. This study aims to identify and examine the current outbound logistics channels used by the Nigerian construction material manufacturing industries. A quantitative research method using a case study approach was adopted in this research. The purposive sampling technique was chosen, where six construction material manufactured and distributed within five states capital and Abuja in the North-central region of Nigeria were selected for this study. A research instrument was developed and used in conjunction with an observation protocol in the form of a template. The data were collected through observations, direct measurement onsite and archival records of transactions. A descriptive method of data analysis was employed to analyse the data. Our findings indicate that there exist six alternative outbound logistics channels that can be used separately or in combination with each other to deliver materials to end users. The study concludes that the research finding provides a potential knowledge and understanding of the manufacturers' outbound logistics channels that can be used at the start of a project to accomplish effective planning and delivery of the whole project. The study also established the average transportation cost per average ton and average transportation cost per average distance driven for construction material delivery. This information can be used for construction material transportation management.

Keywords: Logistics channels, distribution center, construction materials, transportation and warehousing.

DOI 10.2478/jeppm-2020-0003

---

1. Introduction

There exist different outbound logistics channels can be utilised independently or in combination with each other to bring goods or material to the end user (Hoff et al., 2010; Hannan, 2011). Outbound logistics channels are important for efficient construction materials logistics management and influence customer satisfaction (Robert and Skender, 2017). The outbound logistics operations form the last step of the three main order processes: order receiving from the distribution centers (DC), warehouses (WH) and retailers stores by the manufacturers of construction materials, and shipping finished products to the DC, WH, and retailers (Nazmul, 2012). Outbound logistics of construction materials from the company's plant to DC, WH, and retailers have an influence on the effectiveness of the overall logistics system by representing the lead time to the customer which is interested when materials will be delivered. The proportion between manufacture lead-time and transport lead-time means little; customers just need to know when the materials will arrive (Miemczyk and Holweg, 2004).

2. Literature Review

2.1. Logistics Channels

Logistics channels are connections of middle parties or indirect marketing channels engaged with delivery, storage, handling, communication and supplementary roles that add to the efficient flow of material (Palvic et al., 2016).

Outbound logistics channel is a link connecting the production area with the consumption area and its task is to bridge the gap between these two stages. The gaps refer to time, space, quantity, range of products and information (Szymonik, 2010). Additionally, the key economic benefits of logistics channels are 'reducing lead times, delays and entire transportation costs, as well as improving efficiency, reliability and quality' in the administration of all systems (Hoff et al., 2010).

Fig. 1 indicates the primary alternative logistics channels compiled by Rushton et al. (2006) and Boone et al. (2010). The physical shipment of materials between channel members is outlined by the hand-shaped symbols in the figure. Although these channels are mainly for consumer products, industrial marketing channels are quite the same (Hannan, 2011). The number of these middlemen can be reduced by adding an intermediary (an agent or broker, a wholesaler, or a retailer) between manufacturers and end users. Consequently, the existence of intermediaries can remove the duplication of efforts of both the manufacturers and customers and increase the effectiveness of the outbound logistics system (McKinnon, 1989).

Besides, there is a drive to 'omni-channel' retailing, which is a more all-in-one approach to consumer knowledge through all shopping channels, including the internet, stores, direct mail and so forth (United States Postal Service, 2013), and Harris (2013) recommends that moving to online business could enhance performance and decrease transaction costs. Consumers will then have the capacity to order materials for delivery to sites, check prices, specifications and stock level online, while then being also able to visit nearby offices or stores to collect materials at short notice.

From a micro-scale perspective, the effectiveness of logistics depends on the time and distance between the nodes of the system, for example, the proximity of builder merchants (BM) and material suppliers (MS) are to construction sites (Vidalakis et al., 2011). Thus, the cost of construction material may increase as a result of the presence of the middle people in the material shipping process, but from an overall perspective, when compared with producers, such intermediaries do profit users by reducing the transportation unit cost (Khooban, 2011). Clearly, these developments speak directly to the management of the construction material logistics system (Management-CMLS).

The significance of logistics channels has been widely debated in the literature (Andrejić and Kilibarda, 2016). In spite of the fact that intermediaries add a markup to the products cost, they give some benefits to the two, manufacturer and customers, three of which are specialised outbound functions, better product variety, and increased transactional efficiency (McKinnon, 1989).

2.2. Construction Material Logistics Cost

The total acquisition cost (TAC) of material is the sum of all the reliable and potential costs associated with the purchasing process (Department of Trade and Industry, 1995). It combines all direct and indirect costs related to the buying of a product or service through the entire supply chain, including the purchase price. Therefore, poor cost performance by manufacturers and suppliers can significantly increase the TAC of construction material which, through rising material purchase prices, results in higher construction costs (Vidalakis and Sommerville, 2013).

An investigation by Wegelius-Lehtonen (1995) revealed that a material merchant's logistics cost can vary between 2% and 18% of the material purchase price, confirming that construction costs can be significantly affected by the indirect costs related to wholesaler logistics efficiency. In addition, Scandinavian-based research by Soderman (1985), revealed that up to 40% of the material cost can be attributed to expenses related to logistics operations. Thus, if the contractors don't watch out, their logistics too will be determined by the manufacturers and the dealers, who will minimize the cost of delivery to the construction site without considering the handling costs (Sven and Jorgen, 1997)

2.3. Efficiency and Effectiveness of Logistics Channels

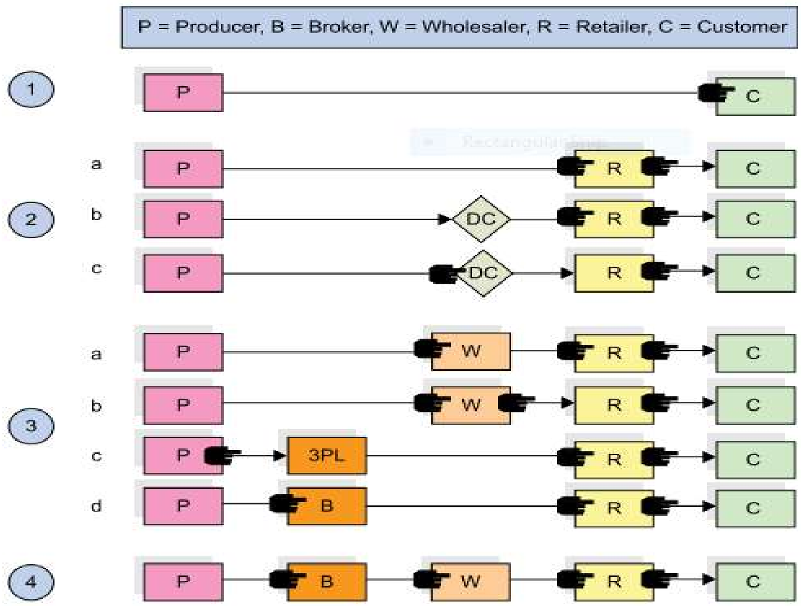

Fig. 1. Alternative outbound logistics channels (Source: Rushton et al., 2006; Boone et al., 2010)

Michel (2007) defines channel performance by results gained from various dimensions, which he used to evaluate the effectiveness of outbound logistics channels. The dimensions are:

i. Effectiveness: How well did a channel respond to the customers' requirements and expectations?

ii. Efficiency: How well did a company minimize costs related to this channel's operations?

iii. Productivity: What was the rate of return of the channel?

iv. Profitability: What was the economic performance of this channel?

Many logistics procedures are conducted through logistics channels. The delivery of products is conditioned by the efficiency of logistics procedures. For an efficient and effective logistics system, the objective of the delivery network is to select the optimum numbers, locations and capacities of plants and warehouses such that all customer demand is satisfied at an minimal overall cost to the outbound network (Turkensteen and Klose, 2012; Andrejić and Kilibarda, 2016). Minimisation of delivery distance-related costs can be achieved by the proximate location of warehouses and distribution centres (Turkensteen and Klose, 2012). However, it is worth noting that the cost of material may rise due to the presence of intermediaries in the material delivery process. From a broader perspective, compared to manufacturers, intermediaries do profit users by reducing the transportation unit cost (Khooban, 2011).

A study by Khalfan et al. (2008) concluded that there was potential to use the know-how and understanding of a manufacturer's logistics channel at the start of a project to accomplish effective planning and delivery of the whole project. This would enable greater supply chain collaboration. Chopra (2003) summarised that intermediaries like wholesalers and distributors add value to a logistics system, especially between the supply and customer stage. If there are numerous small players at the customer stage, with each demanding a small quantity of the material at a time, then the movement is faster improvement in logistics system performance occurs.

2.4. Problem Statement

There is limited knowledge of the outbound logistics channels for industries manufacturing construction material in Nigeria. We know a little and therefore, we have a little understanding of outbound logistics channels utilised for construction materials in the Nigerian manufacturing industries. Thus, the aim of this paper is to identify and examine the current outbound logistics channels used by industries manufacturing construction material in Nigeria.

3. Research Methodology

A quantitative research method rooted in the positivist paradigm was adopted for this study. While a case study research approach was employed, where six construction material (cement, reinforcement bar, ceramic tiles, gravels, hollow sandcrete block, and sand) manufactured and distributed within five states capital and Abuja in the North-central region of Nigeria were selected for this study. Purposive sampling techniques was adopted because it allows a researcher to choose sample or units for specific reasons. Consequently, the selected sites were logistically, rather than statistically significant in the population (Shakantu and Emuze, 2012).

Thus, the sample size was composed of 10 manufacturer's warehouses, 42 distribution centers/ warehouses and retailers store, 30 construction sites and 72 deliveries by transport providers. A research instrument was developed and used in conjunction with an observation protocol in the form of a template. Multiple methods of data collection techniques were adopted, and the data collected includes locations and number of DC/WH and retailer stores, size of DC/WH and retailers stores, road distances between manufacturers plants and DC/WH, retailer stores and construction sites, quantities driven per vehicle, cost of transport per delivery, vehicle capacity, and price of materials per ton at the manufacturer warehouse.

The descriptive method of data analysis was employed to analyse the data. The descriptive study can be informative when there is a little knowledge and understanding of a phenomenon (Loeb et al., 2017)

4. Analysis and Results

This section presents the combined research results for manufacturing companies' site (MFC sites 1-10), DC/WH, retailer stores, construction sites and transport delivery. The analysis starts with identifying current logistics channels used by MFC sites 1-10 and examining; network structures used in DC/WH and retailer store, size of DC/WH and retailers store, and the economies of a distance of the logistics channels.

4.1. Outbound Logistics Channels Utilised by MFC Sites 1-10

Fig. 2 presents the results of the analysis of companies using each of the identified alternative logistics channels in the delivery of materials. It was established that 100% of companies used the direct-end-user channel, which bypassed all other intermediaries in the supply chain. It was also established that 60% of the companies used the agent/ marketer - distributors/ wholesalers - retailer - end user channel. Furthermore, 40% of the companies used BM/ MS - end user channels, and 30% used DC/WHS - retailer - end user channels. In summary, analyses revealed that 70 % of companies used two alternative channels, while the remaining 30% used three alternative channels in the delivery of their products to customers.

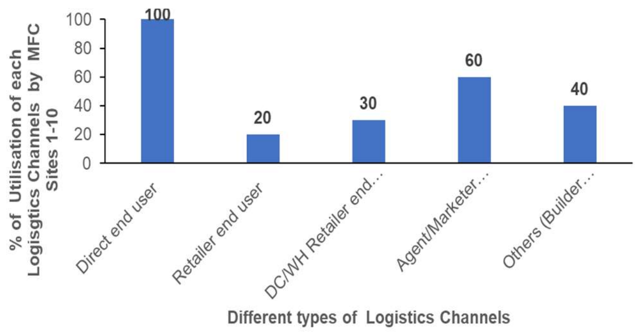

Fig. 2. Outbound logistics channels utilised by MFC sites 1-10

4.2. Network Structure of Manufacturer Warehouses for MFC Sites 1-10

This research study at this stage sought to understand the type of network structures used at the manufacturer warehouses. The finding revealed that 100% of the manufacturer warehouses adopted a break-bulk strategy, as shown in Fig. 3. This means that bulk shipment was transported in full truck load (FTL) from the manufacturing plant to the DC/WH, retailer stores. Here, the materials are broken into smaller quantities (lots) and transported in less truck load (LTL) to smaller retail outlets or customers. This signifies consolidation in transportation at the manufacturing company warehouses.

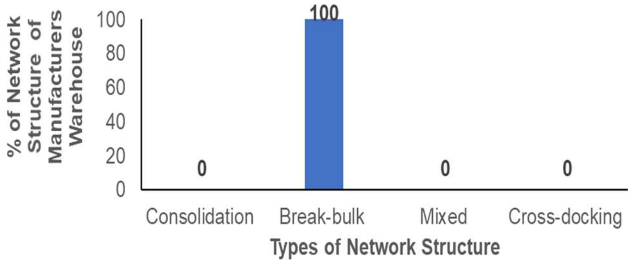

Fig. 3. Type of network structures of manufacturer warehouses

4.3. Network Structures Used in DC/WH and Retailer Stores for MFC Site 1-10

The finding revealed that 93% of DC/WHs and retailer stores were mixed warehouse structures, while 7% were consolidated warehouses as presented in Fig. 4. In a mixed warehouse, deliveries from several manufacturing plants arrive as FTL consignments to the DC/WH and retailer stores. The deliveries are broken up and then consolidated once more to create several multi-product FTL shipments. Each of these multi-product FTL shipments goes as direct delivery to one of the several retailers/customers. Smaller lots are sent as LTL shipments to smaller retail outlets or to customers located nearby.

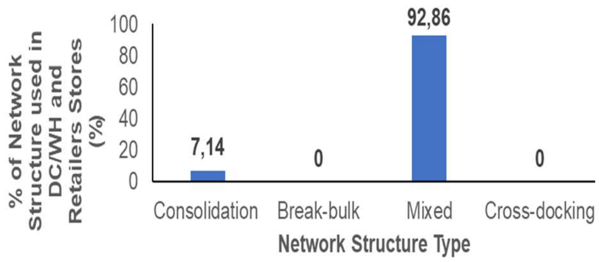

Fig. 4. Network structures used in DC/WHs and retailer stores

4.4. Location and Number of DC/WH and Retailers Stores Used by MFC Sites 1-10

The Fig. 5 presents the number of DC/WH and retailer stores that are in the various state capitals. The findings show that 49% of all DC/WH and, retailer stores are in Abuja. It also established that Minna had 12%, and Jos had 16%. This confirms that almost half of the DC/WHs and retailer stores are concentrated in Abuja. The fact that a great deal of difference exists between the geographical market and other factors, such as travel minimisation and total cost, plays a key role in determining location and number to be established.

4.5. Size of DC/WH and Retailer Stores Used by MFC Site 1-10

The result of the analysis of sizes of the DC/WHs and retailer stores is presented in Fig.6. It shows that 80% of the DC/WH and retailer stores size were less than 500 m^2 and 17% were between 5001-3000 m². The significance of the finding is that the majority of the DC/WH were small sizes (less than 500 m²), and therefore have limited capacity for large stockholding. Most of the buildings were just 3.0 m high, limiting their capacity for cube method storage, which is more cost-effective. However, a significant finding was that granite was being stored in an open space in three towns, Minna, Lafia and Makurdi.

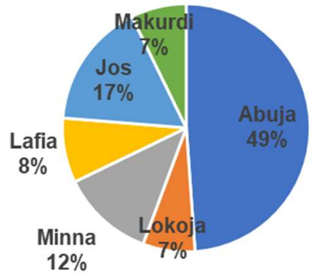

Fig. 5. Location and number of DC/WHs and retailer stores

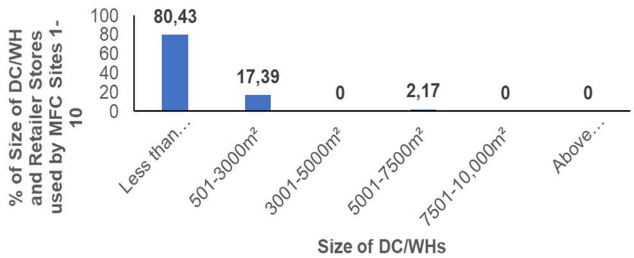

Fig.6. Size of DC/WHs and retailer stores

4.6. Distance and Cost for Material Delivery Utilised by MFC Sites 1-10

Based on the need to determine the transport related costs for this study, information was captured in such a way that it accommodated relationships between distances travelled, material quantities delivered and transportation costs. The four points are identified for discussion as follow:

4.6.1. Distance between individual manufacturer plants and DC/WH, retailer stores and sites

Fig. 7 presents an analysis of distance between individual manufacturer plants to the DC/WH, retailer stores and construction sites. It shows that manufacturer plant distances between 151 and 350 km to DC/WHs, retailer stores and sites were as follows for each material: cement (25%), reinforcement bars (42%), ceramic tiles (50%) and granite (83%). In addition, 50% of cement manufacturing plant distances to DC/WH and retailer stores were between 351-500 km; while block (100%) and sand (92%) plant distances to construction sites were between 0-50 km.

The major findings were that the majority of DC/WH and retailer stores for ceramic tiles and granite were between 151 and 350 km away from the manufacturer plants, while half of cement DC/WH and retailer stores were between 351-500 km away from cement plants.

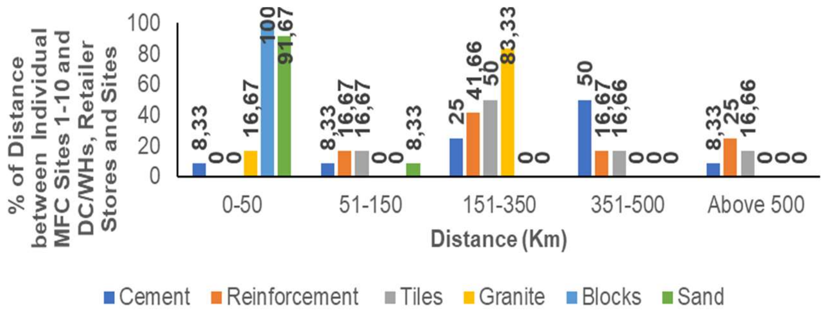

Fig7. Distance between individual manufacturer plants and DC/WHs, retailer stores and sites

4.6.2. Summary of distances between manufacturer plants and DC/WH, retailer stores and sites

Fig. 8 indicates the summary of distances between manufacturer plants and DC/WHs, retailer stores and construction sites. 36% of DC/WH were between 0 and 50 kilometres away from the manufacturer plants. 35% of DC/WHs were located between 151-350 kilometres away from the manufacturer plants. The major finding indicates that the majority (79%) of the DC/WHs and retailers are located between 0-350 kilometres of the manufacturer plants. This is new in the Nigerian research profile.

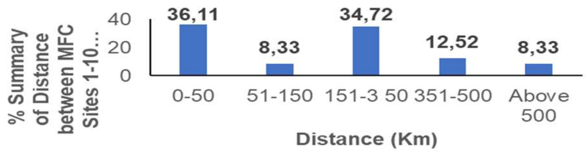

Fig. 8. Summary of distance between manufacturer plants and DCS/WHs, retailer stores and sites

4.6.3. Transportation costs per distance travelled for individual materials

Fig. 9 presents the analysis of average transportation costs of individual material per average distance travelled and average transportation cost per average tons of material shipment. It established the average transportation cost per average distance for sand (₦776.89/km), granite (₦701.86/km) and reinforcement bars (₦572.10/km) as the three highest. Blocks have ₦128.71/km as the least average transportation cost per average distance of a shipment.

In addition, the findings revealed that the average transportation cost per average ton of shipments for reinforcement (₦5,446.51/ton), tiles (₦5,167.60/ton) and cement (₦3,638.55/ton). The major findings were that the highest cost of the material transport per distance was ₦776.89/km and the least ₦128.71/km. The highest average transportation cost per average tons was ₦5,466.51/ton, and the least was ₦1,037.23/ton. The significant findings are average transport cost per average distance and average transport cost per average ton of a shipment.

4.6.4. Summary of average Transportation Cost of material per average distance travelled

The summary of correlation between average transportation costs per average distance for delivery of material is shown in Fig. 10 The highest average transportation cost per average distance of ₦996.95/km was recorded between 51-150 km. The trend that was noted that the average transportation cost per average distance decreased as the distance increased in kilometres as follows: ₦610.05/km for 151-350 and ₦328.18/km for above 500km. In the case of 0-50km, where the average transportation cost per average distance was ₦662.27/km (lower), the explanation may be the fact that some block moulding industries normally give a discount on transportation for certain ranges of distance. Others have a fixed charge per block in respect of distance of a shipment.

Further information generated was that the average transportation cost per average ton shipped increased as the distance increased in kilometres: ₦823.99/ton for 0-50km, ₦4447.67/ton for 151-350 km and ₦5200.00/ton for above 500km. The major findings were that the average transportation cost per average distance decreased as the distance increased, while the average transportation cost per average ton shipped increased with increases in distance per kilometre.

5. Discussion of Results

The aim of this research was to identify and examine the current logistics channels utilised by the industries manufacturing construction materials in Nigeria.

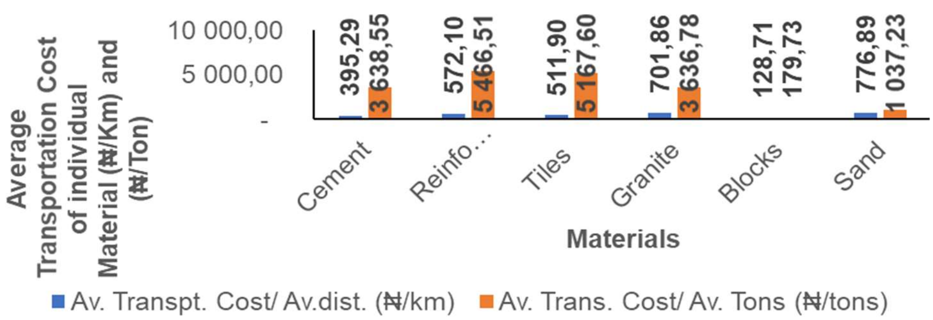

Fig. 9. Transport cost per distance travelled and transport cost per tons delivered

5.1. Logistics Channels

The review of the related literature revealed that there are currently six logistics channels that can be used, independently or in combination with each other, by manufacturing companies to deliver materials to customers (end users). These identified logistics channels are as follows: manufacturer (producer) - consumer (end user), manufacturer - retailer - end user, manufacturer - distribution centre/ warehouse - retailer - end user, manufacturer - broker/ agent - distribution centre/ warehouse - retailer - end user, manufacturer - building merchants (BM), and material suppliers (MS) - end user, and Omni-channel.

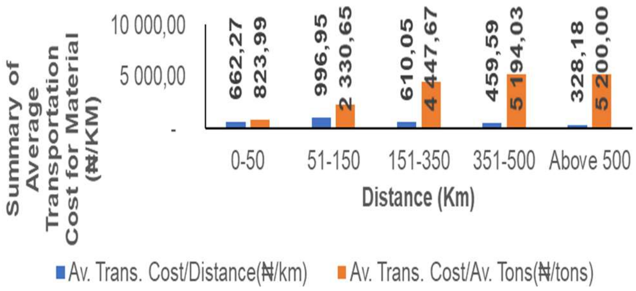

Fig.10. Summary of average transportation cost of material per average distance travelled

Having identified the current logistics channels, the study sought to find out which of these channels were used by the Nigerian construction material manufacturing industries. The study established that all construction materials manufacturing companies used multiple alternative logistics channels for the delivery of materials to customers. The minimum of two and maximum of three channels were used. Therefore, it can be deduced that all the manufacturing companies used multiple alternatives or combined logistics channels for their logistics operations. These findings corroborate Gwynne's (2014) conclusion that companies are increasingly delivering via multiple channels to reach customers more effectively. Each channel has its own benefits.

In addition, the direct-sales strategy channel is gaining popularity (Dangote Cement PLC, 2014). It has a high response time (Chopra, 2003) and also reduces cost and lead time. The condition of this channel is the minimum order quantity (for instance, cement is 30 tonnes or 600 bags), as this limits the affordability by individuals. However, it provides an opportunity for handlers of bigger construction projects to purchase, thereby cutting off the mark-up to the cost of materials by the intermediaries and reducing the lead time.

5.2. Location and Number of DC/WHs, Retailer Stores and Sites

The results established that half the number of DC/WH, retailer stores and sites are in Abuja. It can therefore be inferred that the market here is larger because there is more construction work in the area. This confirms the assertion by Ecklund (2010) that, in addition to transportation costs, the location of DC/WHs is based on the availability of major markets and customers. When the warehouse is located close to several demand points or retailers, then the scale of economies and stability of demand are easier to achieve (Apte and Viswanathan, 2000).

There is no doubt that multichannel retailing is influencing the number and size of locations in operation (Gwynne, 2014). The effectiveness of logistics depends on the time and distance relationship between the nodes of the system, such as BM and MS proximity to construction sites (Vidalakis et al., 2011).

5.3. Size of DC/WHs and Retailer Stores

The study sought to find out the sizes of the DC/WHs and retailer stores to know their capacity for large stockholding to meet customer demand. The finding was that the size of the majority of the DC/WHs and retailer stores was less than 500 m^2. The implication is that an arrangement must be made for frequent deliveries to the DC/WHs and retailer stores to ensure the availability of material. Therefore, it can be deduced that the sizes of DC/WHs and retailer stores were too small and hence had limited capacity for large stockholding. For instance, most of the cement DC/WHs and Retailer stores could take only 600 bags of cement (30 tonnes).

In contrast, Milan (2013) suggested that it does not matter whether a warehouse or distribution centre size is 1000m^2 or 500,000 m^2. It is essential to cut costs and to improve operating efficiency. However, there is an ongoing debate as to whether companies are going to increase the size or decrease the number of warehouses operating within the supply chain (Gwynne, 2014). A study by Motorola (2013) showed that while some planned to increase the number of warehouses, others preferred to increase the size of their existing facilities. However, there is a need for a trade-off between number and size of the DC/WHs and retailer stores per location.

5.4. Network Structures used in DC/WHs and Retailer Stores

The study investigated the type of network structure used in the DC/WHs and retailer stores. The findings revealed that the majority of the DC/WHs and retailer stores were of mixed network structure. This result was supported by Bowersox et al. (2013) that a mixed warehouse combines the methods of both consolidation and break-bulk warehouses. while consolidation of transportation benefits was further supported by Hoff et al. (2010) and Pienaar (2016a). This is important because transportation economies and product variety can be obtained by using the mixed structure warehouse.

5.5. Distance between Manufacturer Plants and DC/WHs and Retailer Stores

The analysis for each individual company (cement, reinforcement bars, ceramic tiles, and granite) established that most distances from manufacturer plants to DC/WHs, retailer stores and sites were between 0-350 kilometres. This agreed with Khooban's (2011) recommendation of a road transport range of 350 km as ideal for achieving economies of transport for long distance haulage. However, if road distance is beyond the 350 km, railroad intermodal transport becomes more economical than road transport. This correlation becomes progressively more expensive if the distance increases above 500 km (Pienaar, 2016b). Moreover, the distance between the manufacturer and the end customer determined the amount of stock to be held in the warehouse and distribution centres. The trade-off here was between more expensive local suppliers and producers, and increased costs in transport and inventory holding costs (Gwynne, 2014).

The results revealed that the majority of block and sand industries were between 0-50 km distances away from the construction sites. This finding was similar to the results of a study by Saka and Mudi (2007), that most suppliers of selected materials were located between 5 and 10 km from the construction sites. The distances from manufacturing industries would be critical to Management-CMLS in view of the chaotic transport system in the cities. Traffic congestion, bad roads and man-hour loss on roads during shipping add up to financial loss as well (Saka and Mudi, 2007).

5.6. Distance and Cost

The study established that four out of six of the averaged transport costs (calculated for materials) per average distance were above ₦500/km. Half of the material average transportation cost per average ton was above ₦5000/ ton. This supported the claim that high transport and freight costs had been identified as the factors responsible for price increases in construction material in African countries such as Nigeria, Uganda and Kenya (Mathews, 2009; Mwijagye, 2010). However, the conclusion, as noted by Sinclair et al. (2002), was that the cost of materials increased primarily because of increased transport charges.

The data analysis revealed that the average transportation cost per average distance decreased as the distance increased per kilometre. This is in agreement with Pienaar's (2016b) assertion that the economies of distance would be attained when total transport cost per kilometre decreased as the trip distance increased. This would invariably reduce the price of material, thereby reducing the cost of any construction project. Economies of distance can be achieved by the fact that with an increase in the travelling distance, there would be fewer fixed costs such as load/offload cost, and admission tax in cross docking (Motraghi and Marinov, 2012; Pienaar, 2016b). Andrejić and Kilibarda (2016) nonetheless advised that though distance driven, and the quantity of goods delivered in tons form important information for transport management, these major drivers have not been sufficiently studied for more conclusive, researched evidence.

6. Conclusion

The study of outbound logistics channels for construction material in North Central Nigeria is relatively new, more so in the construction sector which is dismally under researched in this part of the world. The study concludes, there exist six alternative outbound logistics channels that can be used separately or in combination with each other to deliver materials to end users. Majority of the Nigeria construction material manufacturing companies used multiple alternatives or combined channels for quick response and more effective delivery of materials to customers. The implication is that there is potential in the use of knowledge and understanding of the manufacturers outbound logistics channels at the start of a project to accomplish effective planning and delivery of the whole project. This would allow for greater supply chain collaboration.

Most distances from manufacturer plants to DC/WH, retailer stores and sites was between 0-350 kilometres, which is within the recommended road transport range ideal for achieving economies of transport for long distance haulage. This implies that if logistics channels are properly managed could lead to the realisation of economic benefits of; reducing lead time, delays and entire transportation cost of construction material.

The study also established the material average transportation cost per average ton and average transportation cost per average distance driven. This information can be used in the construction material transportation management.

The findings of this study would provide guidelines for decision making and planning towards effective and efficient construction materials logistics management. This study was conducted using observations which is one of the limitations of this study. Another limitation of this study is geographical in nature; since this study covered only one out of the six geopolitical zones of the country, other zones should be study and compare the results.

References

Amiri, A. (2006). Designing a distribution network in a supply chain system: Formulation and efficient solution procedure. *European Journal of Operational Research*, 171(2), 567–576. https://doi.org/10.1016/j.ejor.2004.09.018

Andrejić, M. and Kilibarda, M. (2016). A Framework for Measuring and Improving Efficiency in Distribution Channels. *International Journal for Traffic and Transport Engineering*, 6(2), 137–148. https://doi.org/10.7708/ijtte.2016.6(2).02

Apte, U. and Viswanathan, S. (2000). Effective Cross Docking for Improving Distribution Efficiencies. *International Journal of Logistics Research and Applications*, 3(3), 291–302. https://doi.org/10.1080/713682769

Boone, L. E., Kurtz, D. E., MacKenzie, H. F., and Snow, K. (2010). *Contemporary Marketing,* (Second Canadian Edition). Toronto, Canada: Nelson Education Ltd,.

Bowersox, D. J., Closs, D. J., Cooper, M. B., and Bowersox, J. C. (2013). *Supply Chain Logistics Management* (Internatio). Singapore: MCGraw- Hill Education.

Chopra, S. (2003). Designing the distribution network in a supply chain. *Transportation Research Part E: Logistics and Transportation Review*, 39(2), 123–140. https://doi.org/10.1016/S1366-5545(02)00044-3

Dangote Cement PLC. (2014). *Dangote Cement : An emerging cement major building shareholder value and prosperity in Africa*. Retrieved from http://www.dangotecement.com.

Department of Trade and Industry (DTI). (1995). *Efficiency and Value in Purchasing and Supply*, HMSO, London. Retrieved from www.tandfonline.com

Ecklund, D. K. (2010). Warehousing Efficiency and Effectiveness in the Supply Chain Process. *Supply Chain Management Review Magazine*, 1–8.

Ghiani, G., Laporte, G., and Musmanno, R. (2004). *Introduction to Logistics Systems Planning and Control*. New Jersy: John Wiley & Sons.

Gwynne, R. (2014). *Warehouse Management: A Complete Guide to Improving Efficiency and Minimising Costs in Modern Warehouse,* (Second). London, U.K.: Kogan Page limited.

Hannan, S. (2011). Physical flow K. Rezar Farahani, Shabnam Rezapour, Laleh (Ed.). *Logistics Operations and Management, Concepts and Models* (First, pp. 13–34). New York: Elsevier.

Harris, E. C. (2013). Construction Industry: Supply chain analysis. Retrieved from www.gov.uk.

Hoff, A., Andersson, H., Christiansen, M., Hasle, G., and Løkketangen, A. (2010). Industrial aspects and literature survey: fleet composition and routing. *Computer Operation Research*, 37, 2041–2061.

Kennneth, M. M., (2010). *Supply Chain Constraints in the South Africa Coal Mining Industry*, the award of Degree: Doctoris Technologiae (Business) in the Faculty of Management Sciences, Vaal University of Technology, (3rd ed.). London: Kogan Page.

Khalfan, M., McDermott, P., Oyegoke, A., Dickinson, M., Li, X., and Neilson, D. (2008). Application of kanban in the UK construction industry by public sector clients. *Proceedings of the 2008 Annual Conference of the International Group for Lean Construction*, Manchester, England, 347-359.

Khooban, Z. (2011). Transportation. In Logistics and Operations Management, Concepts and Models (First, pp. 109–124). *Elservier.* , London

Loeb, S., Dynarski, S., McFarland, D., Morris, P., Reardon, S., and Reber, S. (2017). Descriptive Analysis in Education: A Guide for Researchers. *(NCEE 2017-4023). U.S Department of Education, Institute of Education Sciences. National Center for Education Evaluation and Regional Assistance*, 1–40.

Mathews, S. (2009). Building material price increases expected in 2010. Retrieved from http://www.constructionweekcom.

McKinnon, A. C. (1989). *Physical Distribution Systems (First)*. Routledge, London: New Springer.

Michel, J. (2007). Dictionary of marketing and advertising. New York: Palgrave Macmillan UK.

Miemczyk, J. and Holweg, M. (2004). Building cars to customer order what does it mean for inbound logistics operations?. *Journal of Business Logistics, Oak Brook*, 25(2), 1-21.

Milan, M. A. (2013). Measuring Efficiency in Logistics. *VojnoTechnicki Glasnik/ Military Technical Courier,* LXVI(2), 84–104. https://doi.org/10.5937/vojtehg61-1756

Motorola (2013). From Cost Centre to Growth Center: Warehousing 2018. Retrieved from https://secure eloqua.com

Motraghi, A. and Marinov, M. (2012). Analysis of urban freight by rail using event based simulation. *Simulation Modelling Practice and Theory* (p.25,73-89). doi:10.1016/j.simpat.2012.02.009

Mwijagye, P. (2010). Building Materials in Uganda Prices up. Allafrica.com. Retrieved from http://ww.allafrica.com on 03 July 2011.

Nazmul, H. (2012). *A collaborative framework in outbound logistics for the US automakers,* Dissertations, Wayne State University.

Palvic Skender, H., Host, A., and Nuhanovic, M. (2016). The Role of Logistics service Providers in International Trade. *16th international scientific conference Business Logistics in Modern Management,* Osijek, Croatia.

Pienaar, W. J. (2016a). *Transport Management.* In Business Logistics Management (Fifth, pp. 408–426). Cape Town South Africa: Oxford University Press.

Pienaar, W. J. (2016b). *Transport Modal Cost Structures, Competition and Pricing Pricinples.* Business Logistics Management. (Fifth, pp. 376–407). Cape Town South Africa: Oxford University Press.

Robert, B. and Skender, H. P. (2017). Delivery reliability in outbound vehicle distribution - A factor of successful Automotive supply chain. *17th International Scientific conference Business Logistics in Modern Management, Osijeka, Croatia,* 265–280.

Rushton, A., Croucher, P., Baker, P. (2006). *The Handbook of Logistics and Distribution Management*. Kogan Page.

Saka, N. and Mudi, A. (2007). Practices and challenges of supply chain management by building contracting firms in the Lagos Metropolitan Area, *Proceedings 23rd Annual ARCOM Conference, Belfast, UK, Association of Researchers in Construction Management,* UK (Vol. 2, pp. 777–786).

Shakantu, W. M. and Emuze, F. A. (2012). Assessing Reverse Logistics in South African Construction. *Proceedings for the 20th Conference of the International Group for Lean Construction,* San Diego, California, 661–672.

Sinclair, N., Artin, P., and Mulford, S. (2002). Construction Cost Data Workbook. *Proceedings of Conference on the International Comparison Program,* World Bank, Washington, D. C. USA.

Soderman, S. (1985). *Om Byggmaterialdistribution : (On the Distribution of Building Materials).* Project No. 791344-9, Byggfiorskninsradet, Sweden.

Sven, B. and Jorgen, N. (1997). Just-In-Time Logistics in the Supply of Building Materials. Singapore. *1st International Conference on Construction Industry Development: Building the future Together*. Singapore.

Szymonik, A. (2010). Logistics and Supply Chain Management. *Pearson Education Limited*.

Turkensteen, M. and Klose, A. (2012). Demand dispersion and logistics costs in one-to-many distribution systems. *European Journal of Operational Research*, 223, 499–507.

United States Postal Service. (2013). *The Global Logistics Revolution : A Pivotal Moment for the Postal Service,* Report Number*:* RARC-WP-13-010.

Vidalakis, C. and Sommerville, J. (2013). Transportation responsiveness and efficiency within the building supply chain. *Building Research and Information*, 41(4), 469–481.

Vidalakis, C., Tookey, J. E., and Sommerville, J. (2011). The Logistics of Construction Supply Chains: the Builders Merchant Perspective. *Engineering, Construction and Architectural Management*, 18(1), 66–81.

Wegelius-Lehtonen, T. (1995). Measuring and re-engineering logistics chain in the construction industry. *In Browne, J. and O'Sullivan, D. (Eds), Re-engineering the Enterprise* (p. 209–219.). London.: Chapman & Hall.

Alumbugu, Polycarp Olaku is a PhD student at the Department of Construction Management, School of the Built Environment, Faculty of Engineering, the Built Environment and Information Technology, Nelson Mandela University, Port Elizabeth, South Africa, With research interest in construction Logistics.

Professor Winston W. M. Shakantu research interest is in the broad area of Construction Management. Specific areas of interest have been eclectic; ranging from Construction Cost Control through Risk Management to Supply Chain Logistics Management at BSc, MSc and PhD respectively. Current research interest and work is in SMMEs, Contractor Development, Construction IT and Technology.

Tsado Abel John is a PhD student at the Department of Construction Management, School of the Built Environment, Faculty of Engineering, the Built Environment and Information Technology, Nelson Mandela University, Port Elizabeth, South Africa, With research interest in construction innovation, construction cost accounting and construction SME's.