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Assessing construction material manufacturers' warehouse processes from a customer satisfaction perspective

Authors:
Polycarp O. Alumbugu[1]
Winston W.M. Shakantu[1]
Ibrahim Saidu[2]

Affiliations:
[1]Department of Construction Management, Faculty of Engineering, The Built Environment and Information Technology, Nelson Mandela University, Port Elizabeth, South Africa

[2]Department of Quantity Surveying, Faculty of Environmental Technology, Federal University of Technology, Minna, Nigeria

Corresponding author:
Polycarp Alumbugu,
s216788099@mandela.ac.za

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Background: The objective of warehouse processes is to satisfy customer's desires and requirements whilst using house, equipment and labour effectively. However, in Nigeria studies have revealed operational problems in warehousing and a lack of customer satisfaction in the delivery of construction materials.

Objectives: The aim of this study was to evaluate the level of customer satisfaction with the delivery of construction material from the manufacturers' warehouses to customers or other terminals, with a view to improving the operations.

Method: This article adopted a case study research design method in which quantitative data were collected and analysed. The target population was the North-Central geo-political zone of Nigeria. A total of 32 construction material manufacturers were purposively selected from the zone. The observation and measurement approaches were adopted for data collection. A total of 72 customers' orders were observed and recorded to be representative of deliveries from the sampled (n = 32) manufacturers' warehouses to other terminals. A customer quintile benchmark metric was also adopted for analysis and for comparing field results with best practices.

Results: The findings revealed that the involved construction material manufacturers' warehouse processes, were suboptimal and ineffective in terms of perfect order completion and total order cycle time. These results indicated major opportunities for improvement.

Conclusion: This article concludes with providing construction material manufacturers with information about their warehouse processes that might help to ensure that the construction material arrives at its final destination in optimal quality, time and cost.

Keywords: construction materials; warehouse process; customer satisfaction; effectiveness; construction.

Introduction

Warehousing is the part of a company's logistic function that is responsible for the storage space and handling of the inventories, starting with the receipt of goods from manufacturers and ending with the consumption point, a process that accounts for a substantial part of logistic costs (Sivakumar & Ruthramathi 2019).

De Koster, Le-Duc and Roodbergen (2007) reiterated that warehouses contribute about 20% of logistic costs. Marco and Mangano (2011) advocated for an effective operation of the manufacturers' warehouses to improve quality service, delivery time and customer satisfaction and decrease the cost of logistics system. Sivakumar and Ruthramathi (2019) affirmed that the objective of warehouse processes is to satisfy customers' desires and requirements whilst using house, equipment and labour effectively (Sivakumar & Ruthramathi 2019).

For construction material manufacturers, the importance of customer satisfaction cannot be overemphasised, as it is a basic constituent in construction projects and can make an important contribution to the cost effectiveness of projects (Abhilin & Vishak 2017). Research has revealed that the cost of construction material is usually about 50% – 60% of the total cost of a project (Duiyong, Shidong & Mingshan 2014). However, projects are made difficult by material inadequacies, delays in supply, increase in cost, material wastage and damage, as well as the absence of storage space (Kasim, Latiffi & Fathi 2013).

In Nigeria, another study that was conducted on the logistics systems of chemical and paint manufacturers revealed that the customers of these materials were not satisfied with the distribution of the materials (Obiegue 2010). Customers are demanding on-time delivery (OTD) and with just-in-time ordering, the need to move stock through the warehouses and distribution centres on short timescales and puts additional pressures on the order picking systems, pickers and packers (Webster et al. 2014). Similar studies by Lange and Schilling (2015) affirmed that the regular customer satisfaction problems of construction materials delivery were as follows: missing or delayed deliveries, no direct offloading of transporters, ineffective management of storage space, installation of wrong and damaged material and no or insufficient separation of emerging waste.

Furthermore, a literature review for warehousing research by Davarzani and Norrman (2015) reveals gaps, in terms of both methodology and topic-wise, which showed that a substantial methodological imbalance is observed. The imbalance in methodology was that the majority of researchers focus on quantitative research methods and mathematical modelling without any examples from real cases (Davarzani & Norrman 2015). Whilst a majority of experts' interests identify supportive parts of warehouse processes (e.g. infrastructure design, technology and equipment and performance evaluation) rather than operational aspects (picking, storage and shipping and receiving operations), a reasonably high number of reviewed studies established operational problems. Davarzani and Norrman (2015) suggested future research areas, which include the importance of supportive aspects of the warehousing business and the use of real data in evaluation and empirical research approaches. The findings from practitioners emphasise the anticipated trends of business environment such as more volatile demand, higher need for customised services and more extension of online business (Davarzani & Norrman 2015). These findings particularly motivated the researchers of this study, in an effort to support construction materials warehouse managers in their customer service challenges regarding warehouse operations. Therefore, the *research question* was what is the level of customer satisfaction with construction material delivery? The aim of this study was to evaluate the level of customer satisfaction for delivery of construction material from the manufacturers' warehouses to distribution centres, warehouses (DC/WHs), retail stores and construction sites, with a view to improving the operations.

For the purpose of clarifying the position of the customer service area, on which this study will focus, in Figure 1 the construction logistics process is presented. The construction logistics process in the supply chain is divided into internal and external components as shown in Figure. 1 (Jang, Russell & Yi 2003). An external logistics component covers the relation between a constructor and his or her suppliers, whereas an internal logistics component deals with the relationships amongst various parties involved in the project, namely constructor, designer and owner (Vidalakis, Tookey & Sommerville 2011). This article focusses on the customer service area between the external logistics and internal logistics (material supplier [manufacturer] and contractor) as shown in Figure 1. Customer service level is determined by the manufacturing firms' (factories') capacity to provide materials to the contractor (internal agents) on a site at the right time and at the right place whilst satisfying the correct specifications.

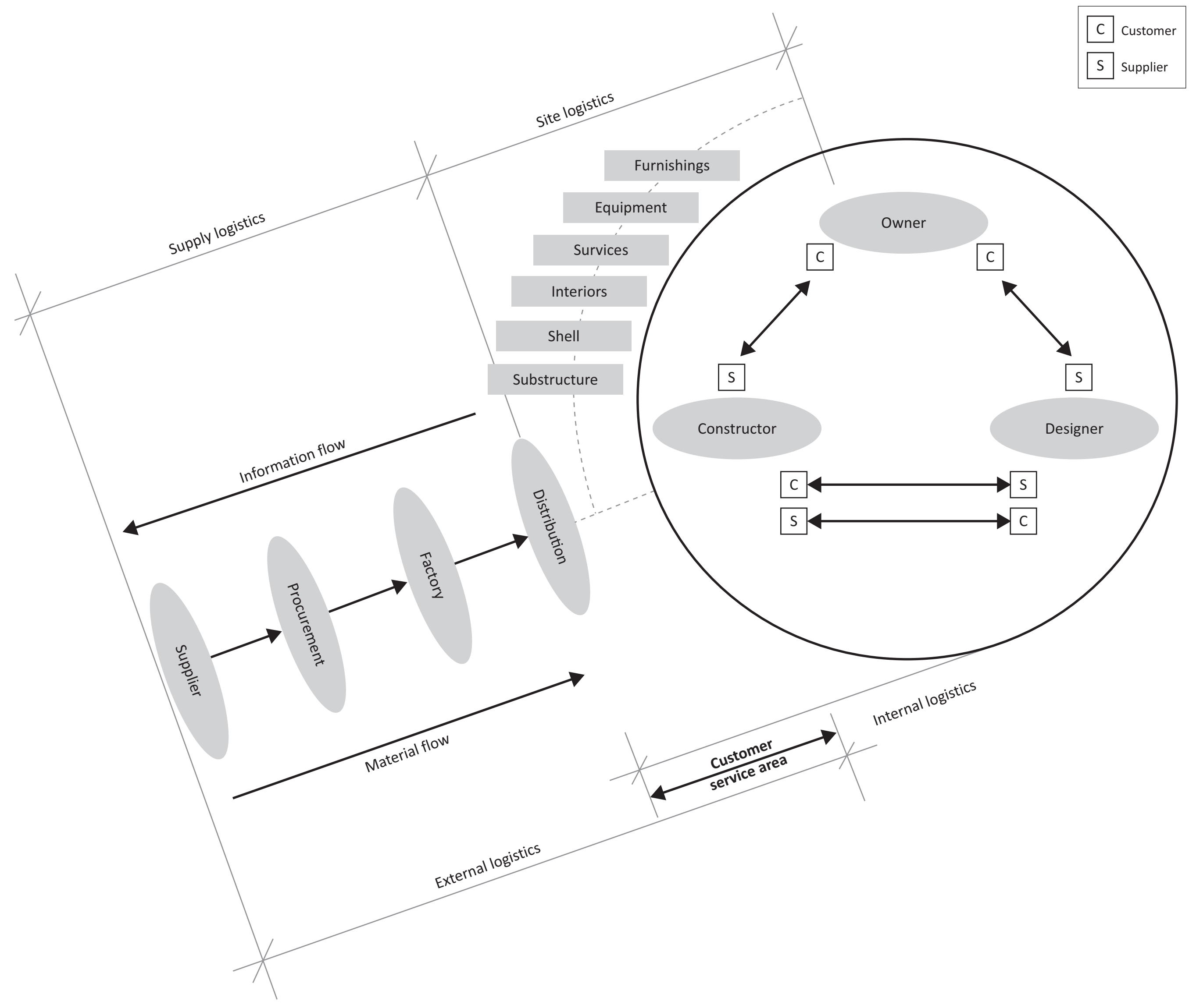
Literature review

This section covers six subsections vital to this topic, which are warehouse processes, warehouse process efficiency and effectiveness, customer service, warehouse performance evaluation, perfect order completion metrics and order cycle time (OCT).

Warehouse processes

Generally, a warehouse process comprises operational activities such as 'receiving, put away, storage, picking and shipping' (Gwynne 2014). Receiving is an operation that includes the allocating of trucks to docks and the planning and carrying out of offloading operations (Chen, Cheng & Huang 2013). Putting away is a process of placing the procured materials in the warehouse, including materials-handling processes and confirming the position and the placement of the materials (Gwynne 2014). Storage is the movement of materials from the offloading area to its selected location (Johnson & Mcginnis 2011). Order picking is the preparation of the order, which is viewed as the core and a labour-intensive operation of warehouses (Grosse, Carlo & Giersch 2013). Transport is the process that includes planning and allocating of trucks to docks for the orders, the packing of orders (after picking) and the loading of trucks (Kusrini, Novendri & Helia 2018).

According to Chen et al. (2013), 'the overall receiving, storage, picking, sorting, packaging and shipping processes in every warehouse consist of 30 steps'. Amongst these, stockpiling and request (order) picking are the most expensive. Storage requires stock holding, which is costly (one of the eight types of wastes), and order picking requires a great deal of work hours and costs of labour (which is specified as an alternate sort of waste) in the study by Rouhollahi (2011). Throughput study of diverse warehouse processes must be investigated to ascertain bottlenecks and plan for overall improvement (Davarzani & Norrman 2015). Ramaa, Subramanya and Rangaswamy (2012) and Chen et al. (2013) indicated that present warehouse processes in both Central Distribution Centres (CDC) and Local Distribution Centres (LDC) are ineffective because of bottlenecks, copious amounts of paper work and slow manual operations.



Source: Adopted from Jang, H., Russell, J.S. & Yi, J.S., 2003, 'A project manager's level of satisfaction in construction logistics', *Canadian Journal of Civil Engineering* 30(6), 1133–1143. https://doi.org/10.1139/l03-068

FIGURE 1: Juan's triple role and construction logistics process.

Warehouse process efficiency and effectiveness

'Efficiency' means realising warehouse objective of material delivery at the most minimal time, whilst 'effectiveness' is the evaluation of how well warehouse service conforms to the expectation of customers or how well the supplied goods satisfy their needs (Pienaar & Havenga 2016). As a performance measure, effectiveness may be expressed as the degree to which the desired level of service is provided to meet customer satisfaction.

'Efficiency' suggests accomplishing an objective of warehouse processes for the delivery of (construction) materials to customers at a minimal cost (Pienaar & Havenga 2016). Technology has an empowering influence on efficiency of warehouse processes (Gwynne 2014). As a soft technology, a suitably designed warehouse management system (WMS) is necessary to provide correct information on inventory and storage location, which can actually reduce discrepancies (Davarzani & Norrman 2015). Karimi and Namusonge (2014) suggested that WMS is implemented to improve the operational and tactical issues in warehouse operations. Furthermore, electronic data interchange (EDI) can be used in improving internal efficiency, saving time and resources and thus reducing organisational costs (Fallah 2011). An efficient warehouse layout ought to reduce the total amount of movement and handling points (Gwynne 2014). It needs to prevent bottlenecks, cross traffic where feasible and ensure that movement takes place in a logical sequence. The complete cube of the building should be utilised and not just the floor space. By addressing this, the efficiency of the operation can be improved, leading to an order fulfilment and customer retention (Gwynne 2014).

'Effectiveness' is the evaluation of how well warehouse service conforms to the expectation of customers (Pienaar & Havenga 2016). An effective warehouse performance will improve quality of operations, delivery time and customer satisfaction and decrease cost in logistics system (Marco & Mangano 2011). In addition, an effective warehouse operation will guarantee that the materials are delivered correctly when they are needed at the right time, at the right place, with the right quality and at the right price (Augiseau & Barles 2017). To increase the effectiveness of warehouses, Karimi and Namusonge (2014) recommended that warehouses are automated to improve processes such as picking, loading and offloading, thereby increasing the productivity. Besides, automation improves precision, quality, aptness and cost-effectiveness in controlling the operations.

Furthermore, the concept of effective inventories, which is most important for understanding the planning of optimum inventory levels, is availability (Cronje 2016). It refers to the ability of the manufacturing firms to have inventory when desired by a customer. The reason for holding inventory is to have products available. In practice, there are three approaches in which availability is usually measured. They are stock-out frequency, fill rate and order that was shipped completely (Cronje 2016). Findings have shown that there is an important relationship between good inventory management and warehouse process efficiency and effectiveness (Anichebe & Agu 2013). Finally, Davarzani and Norrman (2015) reiterated that the relation with other departments and companies should be managed to improve efficiency and effectiveness of the warehouse.

Customer service

Philosophically, customer service signifies the warehouse processes that satisfy the needs of the customer (Fallah 2011). A customer service must organise all operations needed to meet the customers' requirements better than the competitors. Customer service consists of various elements. According to Ballou (2004), these can be categorised into three groups: pre-transaction elements, transaction elements and post-transaction elements.

The pre-transaction elements are not directly connected to warehouse operations but rather are concerned with customer order preparation and pre-receipt (Gwynne 2014:202). The pre-transaction elements provide customers with a fulfilling customer-service network and possess the flexibility to react to a specific customer demand (Agboyi & Ackah 2015).

Transaction elements are directly associated with warehouse processes: receiving, putting away, storage, picking, replenishment and value-adding services (Gwynne 2014:202). This category involves dealing with customer requests and meeting them on time and with a high level of accuracy. Furnishing customers with on-time, arranged records such as the status of inventories and definite delivery dates creates a positive customer experience (Agboyi & Ackah 2015). Order cycle is a key component of the transaction process. Each phase ought to be engaged and managed in an efficient way. From the customers' perspective, order cycle time is the duration of time from when they make an order, until the delivery of the material, or service to them (Fallah 2011). Order-processing operations are exceptionally reliant on how information flows between related departments.

Post-transaction elements occur after the transaction and dispatch (delivery) of materials to the customer (Gwynne 2014). The post-transaction process includes packing after picking and the loading of trucks for delivery to customer, but excluding transport (Kusrini et al. 2018). The principal objective of post-transaction elements is to give backup actions, such as managing customer grievances and entitlements. Every seller ought to have a plan to manage returns and should define a suitable way for handling them. Providing the customers with accurate and quick feedback is essential (Fallah 2011:204).

In addition, post-warehouse operations include seeking feedback from customers. To determine whether the desired goods, services and information are consistently made available at the designated place and time, in the required condition and quantity and at the agreed price, feedback must be obtained directly and clearly from the customer (Pienaar & Havenga 2016). In doing so, the following measures are most critical:

- Percentage of loads received at the correct place.
- Percentage of materials received damage-free.
- Percentage of products received completely.
- Percentage of orders fulfilled accurately.
- Percentage of orders billed accurately.

Feedback from customers, therefore, makes performance evaluation of warehouse processes possible.

Warehouse performance evaluation

A warehouse performance measurement is a technique to measure operational performance or service, which is provided by a warehouse (Kusrini et al. 2018). A performance measurement method is a set of metrics used to evaluate both the efficiency and effectiveness of operation (Neely, Gregory & Platts 2005). Warehouse performance evaluation has been studied in different ways by many researchers (Kusrini et al. 2018), in terms of objectives, indicators, warehouse systems and measuring instruments. A reason for this variety of studies is that there is not agreement on measures used to evaluate warehouse performance (Keebler & Plank 2009).

A study on construction material warehouse processes by Kusrini et al. (2018) revealed some performance metrics such as receiving productivity (received per man-hour), put-away cycle time, storage utilisation (% location and cube occupied), order picking cycle time and shipping productivity (order prepared for shipment per man-hour). The study also suggests that improving warehouse performance could be achieved by comparing warehouse performance with the best performance amongst peer groups.

A study in the United States by Warehouse Education Research Council (WERC 2012) identified 12 metrics as the performance metrics most commonly used in warehouses. Out of the 12 metrics, there are four most popular customer-based metrics that are central to effective customer satisfaction. Warehouse Education Research Council (2012) classifies these four metrics as follows:

- On-time delivery.
- Internal OCT in hours.
- Total OCT in hours.
- Order picking accuracy.

Three of the main four categories of metrics indicated above were customer-based metrics, for order picking accuracy is categorised as a quality-based metric (WERC 2012). However, picking accuracy directly affects customer satisfaction. Not only does the perfect order require on-time and in-full delivery, but also the product must be damage-free and has an accurate invoice (Gwynne 2014). The customer metrics identified above are discussed under the two umbrella concepts of ‘perfect order completion metrics’ and ‘total order completion metrics’.

Perfect order completion metrics

Perfect order completion metrics include the following: on-time delivery, in-full delivery, damage-free delivery and accurate documentation, labelling and invoicing. These metrics are measured individually, then multiplied together and divided by 100 000 to produce the perfect order percentage index (Gwynne 2014; WERC 2010).

- On-time delivery (OTD) is usually measured by dividing orders delivered on time by the total number of orders delivered. The goal to achieve ratio of 100% is ideal.
- Damage-free measurements mean percentage of items received undamaged by the customer (Ecklund 2010).
- Fill rate is based on the number of orders that were filled completely as percentage of all orders received (Ecklund 2010).
- Order accuracy is the calculation of orders picked and dispatched accurately, divided by total orders received × 100.

On-time delivery is one of the main components that could allow firms to sustain their business and customers’ trust, which eventually assumes the significant part to increase profits (Kamali 2018). However, according to Kamali (2018), OTD is one of the principal problems that organisations still have deficiencies and most of them have failed to measure how their warehouse processes could achieve optimal delivery and how it can practically be evaluated. On-time delivery has an important impact in improving dealings with customers in the supply chain (Kamali 2018).

Frödell (2009) conducted a study in the construction industry amongst Swedish companies and found that OTD is the main constraint in supplier–contractor relations that needed to be overcome. Long delivery time and late delivery of construction materials have been recognised as the fundamental causes of delay in major construction projects (Ahmadian et al. 2014). Timely delivery of materials is essential to ensure meeting completion date of construction activities (Fallahnejad 2013).

Honeywell (2008) outlined some procedures and technologies that could improve the accuracy and perfect order performance as presented in Table 1.

Table 1 shows that improving performance in one area may involve making changes beyond the procedure itself. Karimi and Namusonge (2014) suggested that integrated WMS is implemented to improve the operational and tactical issues in warehouse operations. By using WMS, the quality of warehouse processes can be improved through receiving, inspection, addressing, storage, separation, package, shipping, documents sending, and system registers, giving real-time information to other sections or departments. This will reduce errors, costs and duplication of entry of information. Similarly, integrating warehouse operations with complementary technologies such as scanning, digital imaging, mobile printing, speech input, Enterprise Resource Planning (ERP) and Radio Frequency Identification (RFID)-enabled new processes will help companies to meet their perfect order goals (Abhilin & Vishak 2017). Customers, who get on-time deliveries, in accurate numbers, damage-free and with accurate documentation, usually pay their bills more willingly (Peter, Karl & Vitasek 2008).

Order cycle time

Order cycle time (OCT) is a critical measure to determine the efficiency of service to customers (WERC 2010). Order cycle

TABLE 1: Processes and technologies that can improve accuracy and perfect order performance.

Metric	Goals	Technology enablers
On-time delivery	Streamline receiving, put-away and picking.	Integrated warehouse management system (WMS) and wireless computing to manage receiving put-away and picking.
	Speed check-in, loading and check-out operations with automated documentation.	Advance shipping notices/electronic data interchange (EDI) and mobile computers enable quick scan of barcodes and reduce time to receive loads. Validate outbound shipments with bar-coding and RFID.
Complete orders	Identify and record items as they are received.	Area imaging technology allows scanning barcodes at any orientation, from 6 to 50 inches away providing efficiency in the warehouse.
	Improve receiving and put away.	Use mobile printers to generate barcode labels right at receiving.
	Pick items accurately.	Speech technology with mobile computing and barcode systems raises accuracy levels.
Damage-free delivery	Provide documentation that goods were shipped and delivered damage-free.	Mobile computers with integrated imager to take picture and show goods delivered damage-free, also with signature capture for proof of delivery.
Accurate invoicing and documentation	Provide documentation information to customer.	Advance shipping notices/electronic data interchange (EDI) provides documented information to destination receiving operations.
	Prevent customer invoice disputes.	On-site signature with mobile computers and on-site invoice generation with mobile printers.

Source: Honeywell, 2008, *Using technologies to increase perfect order metrics,* Intermec Technologies Corporations, Washington
RFID, Radio Frequency Identification.

time comprises internal OCT and transit (transportation) time (Ecklund 2010; WERC 2010). Warehouse Education Research Council (2012) classifies OTC metrics as internal OCT and total OCT in hours. Internal cycle order time is the measure of duration from when an order is received up to the point when the order is ready for delivery (WERC 2010), whilst the total OCT is the measure of elapsed time from receipt of order until the customer receives the product (Ecklund 2010).

The measurement process of OCT should be conducted on a daily basis as it enables us to more easily take corrective action immediately (Wegelius-Lehtonen 2001). Stock and Lambert (2001) identified six steps of the order cycle process: (1) order preparation and transmittal, (2) order receipt and order entry, (3) order processing, (4) warehouse picking and packing, (5) order transportation and (6) customer delivery and offloading. The total OCT is possibly the best assessment of flexibility as it covers all aspects of the customer request process and how the request is taken care of, regardless of whether stock is available, how fast the request is treated through the warehouse and finally how speedily the goods can be transported to the customer (Gwynne 2014).

In an investigation conducted to determine the influence of automation on OCT in warehouses, three distribution centres were included in the study, where one had a computerised WMS and the other two were run manually. It was established that with the computerised WMS, the internal order cycle duration decreased from 773 min to 236 min and the non-value-added duration reduced from 139 min to 95 min (Ramaa et al. 2012). Order-handling processes used to take as much as 70% of order cycle duration time, but this has been decreased with the assistance of leading-edge technologies such as Electronic Data Interchange (EDI) (Ramaa et al. 2012). With ERP, OCTs can be reduced, resulting in improved productivity, customer response times and delivery promptness (Cotteleer & Bendol 2006).

Research methodology

Research design

This article adopted a case study research design method in which quantitative data were collected and analysed. This article evaluates construction materials manufacturers warehouse processes from a customer satisfaction perspective in the North-Central Nigeria. The adopted case study approach is supported by Yin (2014) who confirmed that when knowledge is available only on the initial phases of the development of the theory, it is also a suitable method that leads to further knowledge. Similarly, Abawi (2008) considers a case study method as reality 'out there' and something that can be examined objectively. The unit of observation in this study was the warehouse operations of selected construction materials manufacturers and their customers.

Population and sampling methods

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

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

For this study, the observation included watching and monitoring people (warehouse managers and operatives), automation and technology used in the sampled manufacturers' warehouse processes and DC, WHs, retail stores and construction sites, whilst the measurements involved recording of OCT and deliveries in terms of perfect orders.

Data collection

Quantitative data collected include observations of warehouse processes, measurement and records of materials orders delivered damage-free, the number of on-time deliveries, order accuracy and order fill rate, the number of orders received in full, the internal OCT and transit time. An 'observation and measurement guide' comprising these warehouse performance metrics was formed. A total of 72 customers' orders were observed and recorded to be representative of deliveries from the sampled (32) manufacturers' warehouses. These orders from each site were processed and delivered to the respective state capitals and

Abuja. The observation and recording processes were repeated at the sampled DC, WHs, retail stores and construction sites. A summary of the data collected is shown in Table 2.

Method of analysis

Benchmarking studies can be helpful to identify inefficiencies and propose improvements based on the successful cases investigated (Davarzani & Norrman 2015). In addition, the evaluation tools are mainly designed to measure the output of specific operations or equipment. Benchmarking is the process of improving performance by continually identifying, understanding and adapting outstanding practices and processes found inside and outside the organisation (Tillman, Mandrodt & Williams 2016). Besides, benchmarking also seeks to improve any given warehouse process by exploiting 'best practices', rather than merely measuring the best performance. Therefore, the 'warehouse customer satisfaction performance metrics' developed by WERC (2010) were adopted in this study. The benchmarking data are presented in a 'quintile' format that presents the data on a five-point maturity scale that reflects where the manufacturers' warehouses are situated with respect to the drive towards 'best practices'. Manrodt, Vitasek and Tillman (2014) indicated that the WERC 2010 benchmark survey was based on hundreds of responses from experts from a variety of industries including manufacturing, retail, third-party warehouse, food distribution and transportation service providers. This represents the most wide set of performance measurement data known and provides an exclusive opportunity to obtain understanding into measurement of warehouse practices in the industry. The observation and measurement data were entered into Microsoft Excel (Bowen, Edwards & Cattel 2012), to calculate and report OCT and the perfect order completion index by using descriptive analytical tools (Loeb et al. 2017).

Analysis and results

The data were collected from manufacturers' warehouses processes that lead customer satisfaction for construction materials' delivery. The data include the number of orders delivered on time and in full, quantities of material delivered damage free, orders filled accurately, internal OCT, transit time and total OCT.

For the purpose of this analysis, customer quintile benchmark metric was adopted for comparing field result with best practices (WERC 2012). As in the benchmarking, data are reported by using a 'quintile' format that presents the data on a five-point maturity scale that reflects where the manufacturers' warehouses are situated with respect to the drive towards 'best practice'. Therefore, the five quintile benchmark customer metric developed by WERC (2010) was adopted to analyse the data, and results are summarised in the form of perfect order completion index and OCT.

Table 3 reflects the five customer service metrics used for this study.

Table 3 shows a summary of the perfect order metrics presented in a 7-column 'quintile' format that is intended to shed light on how companies are performing. A quintile is the one-fifth (20%) portion of the whole. In statistics, it is a population or sample divided into five equal groups, according to the values of a particular variable. From 80% to 100% is the fifth quintile (also called the top quintile (WERC 2010).

The seven columns split the data responses into five equally divided groups. Each quintile ranking indicates 20% of the responses, with the five groups divided into categories representing:

- Column 1. Metrics: this represents the dimensions of the perfect order metric that is being examined.

TABLE 2: Summary of data recorded.

Materials	No. of manufacturing companies	Transportation†	Location‡							Construction sites
			Abuja	Minna	Lafia	Lokoja	Jos	Makurdi	Distribution centres/warehouses	
Cement	2	12	2	2	2	2	2	2	12	-
Reinforcement bars	2	12	2	2	2	2	2	2	12	-
Ceramic tiles	2	12	2	2	2	2	2	2	12	-
Crushed stone	2	12	2	2	2	2	2	2	6	6
Hollow sandcrete blocks	12	12	2	2	2	2	2	2	-	12
Sand	12	12	2	2	2	2	2	2	-	12
Total	**32**	**72**	**12**	**12**	**12**	**12**	**12**	**12**	**42**	**30**

†, n = 72 deliveries.
‡, n = 42 distribution centres, warehouses and retail shops.

TABLE 3: Customer quintile benchmark metrics.

Customer metrics	Major opportunity	Disadvantage	Typical	Advantage	Best in class	Median
On-time shipments	Less than 96%	≥ 96% and < 98.3%	≥ 98.3% and < 99.5%	≥ 99.5% and < 99.8%	≥ 99.8%	99%
Damage-free delivery	Less than 95%	≥ 95% and < 98%	≥ 98% and < 99%	≥ 99% and < 99.5%	≥ 99.5%	98.9%
Perfect order completion index	Less than 85%	≥ 85% and < 91.1%	≥ 91.1% and < 98%	≥ 98% and < 99.3%	≥ 99.3%	96%
Internal order cycle time	Greater than 27.4 h	≥ 21.2 h and < 27.4 h	≥ 8 h and < 21.2 h	≥ 3.4 h and < 8 h	< 3.4 h	12 h
Total order cycle time	Greater than 72 h	≥ 28.9 h and < 72 h	≥ 24 h and < 28.9 h	≥ 8 h and < 24 h	< 8 h	24 h

Source: Warehouse Education and Research Council (WERC), 2010, *Warehouse manager's guide to benchmarking*, 2nd edn, Warehousing Education and Research Council, Boston
>, greater than; ≥, greater than or equal to; <, less than; h, hours.

- Column 2. Major Opportunity: this represents the lowest 20% of responses (lowest performance).
- Column 3. Disadvantage: this represents responses ranging in the 20th – 40th percentile.
- Column 4. Typical Advantage: this represents responses ranging in the 40th – 60th percentile.
- Column 5. Advantage: this represents responses ranging in the 60th – 80th percentile (second best performance).
- Column 6. Best in Class: this represents top 20% of all responses (the best performance).
- Column 7. Median: this indicates the actual median performance of all respondents.

In addition, Emerson (2018) explained the customer quintile benchmarking results as a five-point maturity scale that reflects where the respondents are situated with respect to the journey towards 'best practice'. It gives readers an improved tool for judging their own performance and what constitutes best practice. To be considered best practice, the level of performance would have to fall within the top 20% of all respondents. This was used to compare field results with best practices.

According to Manrodt and Vitasek (2010), it is possible to adopt the WERC (2010) performance metrics by other industries when it comes to warehouse performance. Moreover, there are no statistically significant differences amongst firms based on demographics such as large size, small size, solely third party, mixed and types of customers. This explanation justifies the adoption of WERC (2010) and provides a unique opportunity to obtain much knowledge into warehouse measurement practices in the industry.

The analysis of the perfect order completion metrics, internal OCT and total OCT of this study follows below.

Analysis of perfect order completion indicators

Table 4 shows the data of this study, whilst Table 5 presents the calculation of the perfect order fulfilment indicators. It was confirmed that 66.67% of the orders were delivered on time and 100% of the orders were shipped in full. Order fill rate was 100%, and order accuracy was 100%. Some 91.67% of orders were delivered free of any damage. The major findings were that two-thirds (67%) of the customers received their orders on time, and a majority (93%) of materials were received free of any damage.

A summary of perfect order percentage was computed. The four indicators were measured individually (computed in Table 5) and then multiplied separately to obtain the perfect order percentage:

Perfect Order Percentage = On time × in full × Order fill rate × Order accuracy × Orders received damage free ÷ 100 000.
= 66.67 × 100 × 100 × 100 × 91.67 ÷ 100 000
= 61.12% [Eqn 1]

The summary of the computation of the perfect order percentage index was 61%. Compared with the customer quintile benchmark metrics, it was less than 85%. This indicates a m*ajor opportunity for improvement*.

TABLE 4: Perfect order completion indicators.

Indicator	No. of orders	Total orders
On-time delivery	48	72
Order fill rate	72	72
In-full delivery	72	72
Order accuracy	72	72
Damage-free delivery	66	72

Order cycle time

Order cycle time is the time from when an order is placed until the product or service is delivered. The OCT data were recorded for a total of 70 orders received by the manufacturing companies (Ecklund 2010). This section presents the analysis and results of OCT, under the subthemes internal OCT and total OCT.

Internal order cycle time

Table 6 presents the analysis of the internal OCT by using the customer quintile benchmark metrics as indicated in Table 3. The internal cycle order time is the measure of the time elapsed from the receipt of the order until the order is ready for shipment. It shows that internal OCTs were 87.5% (major opportunity), 6.94% (disadvantage), 2.78% (typical), 2.78% (advantage) and 0% (best in class). The results reveal that the performance falls within the lowest 20%; however, what constitutes best practice is that the level of performance would have to fall within the top 20% of all respondents. The verbal descriptors here would be *major opportunity*, *disadvantage*, *typical* and *advantage*. They indicate that most internal OCT records were within (> 27.4 h) the *major*

TABLE 5: Analysis of perfect order completion indicators.

Indicators	Calculation	Value
On-time delivery	Orders on-time/total orders shipped ×100	66.67% on-time deliveries
In-full delivery	Orders shipped completely/total order shipped ×100	100% in full deliveries
Order fill rate	Orders filled completely/total orders shipped ×100	100% complete deliveries
Order accuracy	Error-free orders/total orders shipped ×100	100% deliveries are error-free
Orders received damage free	Percentage of items received undamaged by customer/total items shipped to the customer	91.67%

TABLE 6: Internal order cycle times.

Quintile performance metrics for determining internal order cycle time by WERC	No. of orders processed	Percentage of 72 deliveries
Major opportunity >27.4 h	63	87.5
Disadvantage ≥21.2 h and 27 h	5	6.94
Typical ≥8 h and <21.2 h	2	2.78
Advantage ≥3.4 h and 8 h	2	2.78
Best in class <3.4 h	0	0
Total	**72**	**100**

Mean = 84.20 hours; median = 77.53 hours.
WERC, Warehouse Education Research Council.

TABLE 7: Total order cycle times.

Quintile performance metrics	No. of orders processed	Percentage of 72 deliveries
Major opportunity >72 h	49	68.06
Disadvantage ≥28.9 h and 72 h	15	20.83
Typical ≥24 h and <28.9 h	3	4.17
Advantage ≥8 h and 24 h	4	5.50
Best in class <8 h	1	1.38
Total	**72**	**100**

Mean = 103.34 hours; median = 95.14 hours.

opportunity for improvement descriptor and by implication, performing far below *best in Class* < 3.4 h.

In addition, it is established that the mean of the internal OCT was 84.20 h, and the median was 77.53 h. This indicates that the internal OCT median was greater than 12 h. As per the WERC benchmark, this implies a *major opportunity for improvement* of the process.

Total order cycle time

Total OCT is the measure of elapsed time from order receipt until the customer receives the products (this includes transportation or transit time) (Ecklund 2010).

Table 7 shows the analysis of total OCT by using the customer quintile benchmark metrics shown in Table 3. It shows that total OCTs were 68.06% (major opportunity), 20.83% (disadvantage), 4.17% (typical), 5.50% (advantage) and 1.38% (best in class). The significant finding was that most total OCTs were within (> 72 h), which indicates a *major opportunity for improvement* and by implication, performing far below *best in class* (< 8 h).

The mean of the total OCT was 103.34 h, and the median was 95.14 h. This indicates that the total OCT median was greater than the WERC benchmark of 24 h, suggesting a *major opportunity for improvement* of the process.

Ethical considerations

This article followed all ethical standards for research without direct contact with human or animal subjects.

Discussion of results

This study sought to determine the level of customer satisfaction by using perfect order measures. This study revealed that 67% of the customers received their orders on time. The findings in terms of the level of customer satisfaction are much weaker with regard to the on-time delivery study by Manrodt et al. (2014). They found that 85% of customers received their orders on time.

However, if the result is compared with the WERC's (2010) customer quintile benchmark metrics (Refer Table 3), the best-in-class for on-time deliveries is 99.8%, whilst any value less than 96% is a *major opportunity for improvement*. Because the research value of on-time deliveries is 67%, which is far less than the 96% quintile benchmark, it can be deduced that OTD of materials by the manufacturing companies was suboptimal and not effective. These findings confirmed that technology enablers (Honeywell 2008) shown in Table 1 were not utilised in the warehouse processes of the companies that were subjected to this study. However, the findings support Frödell's (2009) results that OTD is the major problem in supplier–contractor relations that needed to be overcome. It can be concluded that if a company fails to meet the delivery on time, it will decrease the efficiency (Kamali 2018).

The other major findings were that the majority (92%) of materials were received free of any damage; orders were shipped in full; and order fill rate and order accuracy were all rated at 100% each. However, if the result (92%) of materials received damaged free is compared with the customer quintile benchmark metrics (Table 3), the best-in-class performance is 99.5%, whilst any value less than 95% is a *major opportunity for improvement*. Therefore, it can also be inferred that damage free and on-time deliveries are suboptimal and ineffective. Therefore, the level of customer satisfaction for construction material delivery was suboptimal.

It was found in this study that the perfect order completion index, which is a summary of on-time delivery, damage-free delivery, orders shipped in full, order fill rate and order accuracy, was 61.12%. When the result is compared with the WERC (2010) customer quintile benchmark metrics (Table 3), the best-in-class performance is 99.3%. Any value less than 85% is a *major opportunity for improvement*. With a perfect order completion index value of 61.12%, which is far less than 85%, it can thus be deduced that the perfect order completion processes for delivery of materials by the manufacturing companies were suboptimal and ineffective. In fact, this indicates a *major opportunity for improvement.*

This study also sought to find out how long it takes for the manufacturing companies to process an order internally. The analysis revealed that the majority (87.5%) of companies' internal OCT was more than 27.4 h. The decisive rule, as indicated in the customer quintile benchmark metrics (Table 3), is that any value of internal OCT more *than 27.4 h means a major opportunity for improvement.* Most of the company's internal OCTs were more than 27.4 h. It can thus be inferred that the internal OCT for processing construction material by the manufacturing companies was suboptimal and ineffective.

With regard to total OCT, it was found that most of the companies (68.06%) had a total OCT that was more than 72.4 h. The mean was 102 h. The decisive rule as presented in the customer quintile benchmark metrics (Refer Table 3) is that *any value of total OCT more than 72.4 h means a major opportunity for improvement.* Therefore, it can be concluded that the total OCT was suboptimal and ineffective. The findings support the study by Manrodt et al. (2014) that a gap exists for improvement in bottom-line result. It was established from other studies that with the implementation of WMS, ERP and EDI, the internal OCT and the non-value-added time reduced and customer response times and shipment speeds improved (Cotteleer & Bendol 2006; Ramaa et al. 2012). It can be concluded that the total OCT was suboptimal. Therefore, the level of customer satisfaction for construction material delivery was low.

Conclusion

The objective of warehouse processes is to satisfy customers' desires and requirements whilst using house, equipment and labour effectively. But the outcome of this study established that the warehouse performance metrics, on-time delivery, damage-free delivery and perfect order completion index, were all below best practices and in some areas totally ineffective. This means that manufacturing companies could not fulfil the delivery commitment based on the agreed time (which is known as the delivery date) and zero tolerance for damage-free delivery. This study established that the level of customer satisfaction for construction material delivery was low. In addition, the manufacturing companies' OCT (internal OCT and total OCT) fell within the *major opportunity for improvement*, which is far below best practice. Thus, this study also established that the customers were dissatisfied in terms of time taken for processing and delivery of construction material. Poor delivery reliability to customers has a long-term negative influence on them. These implications include causing project delays and increasing construction costs.

This study identified the gaps in the performance of the warehouse processes, which is the first step for the management of warehouses to plan for remedial action. This study also noted that the low OCT and perfect order completion index were mainly caused by a lack of the utilisation of software such as ERP and WMS in warehouse operation. In fact, most of the operations are still paper based and manually made.

Perfect order is a significant metric for warehouse performance. As the need to optimise perfect orders increases, so does the need to improve the warehouse processes. Therefore, this study recommends the adoption of information technology to enhance the operational and tactical processes and actions in warehouse operations. Information Technology software may empower manufacturing firms to attain the objectives of customer satisfaction. With the use of WMS, the quality of warehouse processes is optimised (receive, inspection, address, storage, separation, package, shipping and documents sending). The system captures information and sends accurate information to other information system, thereby decreasing errors and costs. Therefore, the system can lead to a higher customer service level, because the productivity can increase. Secondly, combining warehouse processes with complementary technologies such as improved scanning, digital imaging, mobile printing, bar code systems, speech input and RFID enables new processes that will assist manufacturing firms to achieve their perfect order objectives.

A recommendation is made for further study to explore why technology is not adopted, despite its purported advantage in improving the effectiveness of perfect order metrics and OCT for customer satisfaction. This study was conducted using observations, which is one of the limitations of this study. The sample size of 72 orders processed can also be increased in further study. Another limitation of this study is geographical in nature; because this study covered only one out of the six geopolitical zones of the country, it is further suggested that other zones are studied and the results are compared.

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The authors declare that they have no competing interests that may have inappropriately influenced them in writing this article.

Authors' contributions

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Data availability

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