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Dynamics of short-term operations scheduling in supply chain distribution centres

Abstract

A warehouse or distribution centre has a key role to play in the success of modern supply chains in the highly competitive business environment as a commercial building for the buffering, pre-merchandising and temporarily storing of goods. In as much as it is a virtual warehouse, cross docking for transportation costs minimization looks at the transit or shipment of inbound goods to their prescribed destination within a period of less than 24 hours with no intention of keeping any inventory. One of the motivating factors that drive warehouses and distribution centres into being more efficient is that the customer demands delivery of the requested shipments on time, in the right quantity, in the right place and at an affordable price. This study analyzes the dynamics of short-term scheduling in systematic supply chain distribution centres. This study further examines the extent of information sharing among workstations and supply chain partners within the inbound and outbound scheduling perspective. The study uses the descriptive statistics as well as factor analysis to analyze data on 104 respondents in proportion to their managerial size. The targeted respondents range from the top management to lower management and operational/genaral worker in the warehouses and distribution centres. Respondents are both male and female with a level of experience ranging from less than one year to over ten years. Three major players in the distribution industry as third party logistics were considered as participants within the frozen goods sector. The findings of this study indicate that the phenomenon of short-term scheduling in this study assists to model the efficient scheduling of trucks, to absorb challenges encountered from inbound traffic through to outbound, and to mitigate any lack of information sharing within and among supply chain partners. The main managerial implications of this study are that it provides an understanding of the bottlenecks that normally hinder the smooth flow of inbound and outbound operations. The role of short-term scheduling might offer improvements on the operations processes that are faced with the challenges of bottlenecks.

Key words: distribution centre, inbound and outbound logistics, short-term scheduling.
JEL Classification: L14, L19.

Introduction

In ancient times caves served as places to temporarily store goods. In modern times distribution centres and warehouses serve more or less the same purpose. A distribution centre may be used to re-direct goods to other destinations within the network without having to store any goods at all. Different warehouses perform specific functions, and Bolten (1997, p. 8) identified seven types of warehouses such as general merchandise warehouses, food warehouses, bonded warehouses, customs warehouses, temperature-control warehouses, hazardous-material warehouses and liquid and dry-bulk warehouses. A warehouse serves as a hub in a logistics network in which goods are kept for a short period or re-routed to their specific destination in the network. Aggregate planning and capacity requirements planning are associated with medium to short-term time horizons whereby these facilities may be viewed as simple commercial buildings for the sole purpose of buffering and storing goods. In the short-term, more emphasis is placed on operational control than on planning (Mahadevan, 2010, p. 510). Scheduling determines the timing and the amount of equipment, facilities and all human activities to be used (Kruger, De Wit and Ramsdass, 2007, p. 446). Proper consideration needs to be taken when scheduling operations as scheduling is part of the decision making process. Heizer and Render (2014, p. 602) identify the importance of effective short-term scheduling as faster movement of goods and services through the facilities.

A basic distinction can be made between supply, distribution and handling warehouses, but mixed forms also exist (Runyan, Silverman and Bragg, 2009, p. 21). In as much as the cross docking is deemed to be a warehouse, it is not designed to keep an inventory but rather for shipments to be forwarded to their predefined destinations (usually in less than a day). One of the most challenging issues that affect the performance of the cross docking system, is designing a proper schedule for inbound and outbound operations (Mohammadi, Tavakkoli and Razani, 2012, p. 46). This study seeks to address the dynamics of short-term operations scheduling in supply chain distribution centres. The study kicks off by establishing the research objective followed by the research framework supporting the study and literature review. The study further presents the results of the primary data collected through a research instruments, discusses the result and concludes on the study.

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1. Research statement and objectives

The inbound flow is likely to include all the steps required to get the necessary goods or services to the distribution centre. Due to the important role it plays on the value chain in the warehouse, the inbound area is normally utilized to temporarily store goods before they are processed further up the chain. The pressure that emanates from the need to improve customer service levels, time saving activities, minimizing warehousing cost, logistics and inventory reduction have transformed the structure of supply chains and drastically changed the role of warehouses within the supply chain. One of the challenges facing warehouses lies in striking a balance between performing their functions while maintaining the key tenets of effectiveness and efficiency.

For the product to get to the intended customer it must first go through the inbound process. As a result it is important for this process to be completed in the predetermined time and in the prescribed manner. The variability of the products arriving in the distribution centre indicates operational challenges. Scheduling appears to be an important part in the operations process, as processes often require the participation of different workstations. The proper utilization of limited resources is expected to mitigate the magnitude of bottleneck as per the schedule. Improper short-term scheduling results in poorly executed orders, poor quality, a high level of rejects, bottlenecks along the line, and a long lead time in the processing of an order. Customers need their shipments to be delivered on time, in the right quantity, in the required place and at the reasonable price.

The objectives of this study are firstly to analyse the dynamics of short-term scheduling and resource utilisation in systematic supply chain distribution centres; secondly, to examine the extent of the information-sharing among work stations and supply chain partners within the collaborative inbound and outbound scheduling perspective; and thirdly to establish the interrelationship between the inbound and outbound operational dimensions, the extent of the internal information sharing, and the influence of short-term scheduling on mitigating the harmful effects of bottlenecks.

2. Theoretical framework

2.1. Short-term scheduling. Operations management requires planning and control at various levels and within time horizons. The configuration of operations and manufacturing systems in the most suitable location and the selection of appropriate processes and product designs are issues that may be associated with the long term. Aggregate planning and capacity planning requirements are associated with the medium to short term. In the short term more emphasis is placed on operational control than on planning, as the time horizon is close to real time (Mahadevan, 2010, p. 510). Mahadevan further identifies three reasons that make short-term scheduling important, such as using real-time approaches to make schedules more real and robust; avoiding random shocks in order to achieve more accurate scheduling in the short term; and focusing on micro-resources neither possible nor warranted in medium- or long-term scheduling. Supply chain collaboration focuses on coordinating activities between the network partners for improved supply chain performance, such as increasing excellence in the service level and effectively responding to changes in the market place. Spekman, Kamauff and Myhr (1998, pp. 630-650) highlight that full collaboration includes a high level of trust and a common vision of the future. The timing by the supplier for the placement of goods in the proximity of the customer's location requires a sound knowledge of the final customer demand and access to real-time demand information to improve product availability (Chen and Chang, 2010).

Collaboration is vital in the context of the resource-based view as it involves firms mutually leveraging each other's resource base and capabilities in order to derive competitive advantage (Min, Roath, Daugherty, Gnchev, Chen and Arndt, 2005, pp. 237-256). In harnessing limited resources, short-term scheduling dovetails operations processes between the inbound and outbound, and requires the consolidation of internal and external resources to share economic information, suppress the bottlenecks and improve the efficiency of the distribution centre or cross docking systems. The resource-based theory subscribes to the premise that a sustainable competitive advantage is derived by firms' optimally harnessing their resources and capabilities (Barney, 1991, pp. 99-120), to improve information and knowledge sharing in order to synchronise the scheduling of inbound and outbound operations processes (Revilla, Cordeiro and Sarkis, 2011) and to improve the general efficiency and effectiveness of the distribution centre.

Extensions of the resource-based view have included the integration of dynamic capabilities (Helfat and Peteraf, 2003). The dynamic capability theory (DCT) elaborates on how organisations and supply chains can integrate, build or deploy and reconfigure their internal resources and external competencies in changing environments (Teece, Pisano and Shuen, 1997; Newbert, 2007). Leveraging supply chain visibility for responsiveness requires greater access to high quality information describing various factors of demand and supply between integrated partners (Barratt and Oke, 2007, p. 514). Efficient short-term scheduling in the distribution centre or warehouse

requires meticulous operations processes from the inbound to the outbound and the consolidation of resources across the logistical supply chain network. This integration of internal and external resources should ensure that pre-merchandised customer shipments are delivered on time, in the right quantity, in the required place and at a reasonable price.

3. Literature review

The receiving area for incoming shipments that is normally used to temporarily store goods before they are processed is often referred to as the information point (Tompkins and Smit, 1998, p. 45). Delivery-related activities and the dispatching of goods to the recipient desired destination allows for transport-related processes to be viewed as being primary and important activities. This flow-through distribution system allows active storage that includes the assembly of goods from various upstream suppliers, the combination of goods and the shipping of the combined orders to customers (Bowersox, Closs, Cooper and Bowersox, 2013). According to Bartholdi and Gue (2004, pp. 235-244), cross-docking promotes the timely distribution of freight and better synchronization with demand, with the distribution centre essentially acting as a high throughput sorting facility.

The supply chain distribution system across the network has a value-adding strategic role of integrated consolidation, with transportation consolidation (shipping full truckloads) and product mixing for customer orders customers (Bowersox, Closs, Cooper and Bowersox, 2013). Integrated service allows for a consolidation of products for delivery and expedites premium transport services combined with supply chain information technology. From a short-term scheduling operational perspective, Bowersox, Closs and Cooper (2010, p. 249) note that the central supply chain distribution system enables both the inbound movement from origin and the outbound movement to destination to be consolidated into a large-size shipment, which generally results in lower transportation costs per unit and most often quicker delivery. Corsten and Kumar (2005) and Dougherty, Richey, Roath, Min, Chen, Arndt and Genchev (2006) list the benefits for firms engaged in long-term collaborative relationships as improved visibility, higher service levels, increased flexibility, greater end-customer satisfaction, and a reduced cycle time to create unique value that neither partner can create independently.

The speed at which innovative products rather than functional products (Fisher, 1997, p. 109) are produced leads to uncertainty concerning demand and variability, and buyers tend to be reluctant to purchase such products in bulk. The frequency with which the product is purchased increases the amount of time during which buyers engage with the distribution centre (Simchi-Levi, Kaminsky and Simchi-Levi, 2008), and it is likely to keep the docks busy at all times (Bowersox, Closs and Cooper, 2010).

3.1. Scheduling role in distribution. Scheduling is an important planning activity which has to do with how resources should be used in the operations processes and the timing of operations processes. The business environment has become more competitive and operates on a global level (Nejad, Sugimura and Iwamura, 2011, p. 1373). Scheduling decisions begin with capacity planning, which involves ensuring the availability of the relevant facility and equipment. Capacity plans are usually drawn up annually or quarterly, as new equipment and facilities are purchased or old ones are disposed of (Pycraft, Singh and Phihlela, 2007, p. 378). Short-term scheduling translates capacity decisions, aggregate planning and master schedules into job sequences and the specific assignment of personnel, material and machinery (Heizer and Render, 2011, p. 602). Scheduling follows planning and aims to implement the operating strategies developed during the planning process (Swensen and Acuff, 2011, p. 9). Scheduling means different things to different people, but in this context the term refers to the way in which resources are allocated within an organization; the assignment of start and completion times to particular people or equipment; and the setting of timetables to allow the process to flow (Evan and Collier, 2007, p. 261). Firms seem to undertake short-term scheduling to improve efficiency, which reduces the cost of manufacturing or rendering the service. The distribution centre is just one link in a chain; being efficiently connected to the upstream segment can be as important as being connected downstream, in order to ameliorate the oscillation of the bullwhip effect customers (Bowersox, Closs, Cooper and Bowersox, 2013). These centrally positioned hubs in the supply chain network are expected to be more information-based than inventory-based (Mbhele, 2013). The expectation that the supply chain distribution centres will gather information means that they will be required to obtain a greater volume and/or quality of information from the end-user. According to Mbhele (2013, p. 155) the central supply chain distribution system makes products available in the supply chain network using integrated information sharing, thus providing visibility to the whole supply chain for the fast replenishment of goods in stores customised precisely to the needs of individual retail stores. Coyle, Bardi and Langley Jr (2003) describe the way in which the streamlined distribution system is segmented into national distribution centres, regional and zone distribution centres, and local branches.

3.2. Cross docking system. According to Stevenson (2013, p. 620) short-term scheduling is defined as drawing up schedules giving detailed times for jobs, people, materials, equipment and any other resources utilized in the process. The objectives would be to allocate and prioritize to available facilities demand generated either by forecasts or customer orders. Pinedo (2009, p. 192) identifies short-term scheduling problems in a supply chain as challenges that work against the achievement of the medium-term output. Predefining the output of medium-term planning specifies that in the short term a certain quantity of items has to be produced.

Cross docking is the logistics system that assists in minimizing transport costs in a supply chain (Agnetis, Hall and Pacciarelli, 2006; Yeng, Choi and Cheng, 2011). In as much as cross docking is deemed to be the equivalent of a warehouse, it is not designed to keep an inventory but rather for shipments to be forwarded to their predefined destinations (usually in less than a day) (Amorim, Pinto-Varela, Almada-Lob and Barbosa-Povoa, 2013; Wu, Chun, Chun and Zhou, 2008). One of the most challenging issues that affects the performance of a cross docking system is designing a proper schedule for inbound and outbound operations (Mohammadi, Tavakkoli and Razani, 2012, p. 46). One important aspect that necessitates that warehouses and distribution centres are efficient is the downstream customer demand, which can be uncertain at times. Customers need their shipments to be delivered on time, in the right quantity, in the required place and at a reasonable price (Rodrigue, Comtois and Slack, 2009). Morris's (2004, p. 86) research into freight efficiencies and security in urban areas found that shippers and carriers frequently cited inadequate off-loading facilities as the major barrier to freight efficiency. The receiving operations are in place to ensure that suppliers deliver the ordered product in the right quantity and in the desired condition, but the product does not always arrive on schedule (Agnetis, Hall and Pacciarelli, 2006; Yeng, Choi and Cheng, 2011). As scheduling comes into effect (as soon as the order is announced), it is important to take note of when and at what time the order is scheduled to arrive, and to allocate an empty bay for unloading. Material handling equipment must be provided, the documents needed for receiving should be available, and the manpower to perform the operations should be sufficient.

4. Research methodology

This study has targeted warehouses, distribution centres and logistics companies. The targeted population consists of the relevant elements within this population. These ranged from top management, to middle managers, supervisors and the entire workforce within the warehouse and distribution centre. The study uses univariate analysis, as it summarizes data by examining: the frequency of distribution and descriptive statistics. Multivariate approaches are used to establish the degree of association among the variables. In order to know whether the sample is adequate to conduct factor analysis, the Kaiser-Meyer-Olkin (KMO) test will be used in the study. Bartlett's test is another indication of the strength of the relationship among variables. This tests the null hypothesis that the correlation matrix is an identity matrix. Rotation methods based on Maximum Varian (Varimax) will be used to identify valid items for each dimension of independent variables. Through Varimax, the same items will be distributed under one factor.

4.1. Research design. The research design was an exploratory survey on an empirical research design framework that constituted the blueprint for the identification of the data sources, the data collection, the data sampling methods and measurement, and the statistical analysis of the data. The study used a cross-sectional quantitative approach (that is, measurements were taken at one point in time on numerical exploration) to analyze data, and a self-administered questionnaire survey instrument was used for the data collection. According to the literature, quantitative measures are required for the more rigorous testing of the hypothetical themes of the study (Pekrun, Goetz, Titz and Perry, 2010, p. 91). This research paradigm indicates the relationship and interrelationship between the factors in play, but does not explain why the relationship exists. The study used a quantitative research approach to establish the interrelationship of the factors of information sharing, short-term scheduling and logistical inbound and outbound operations processes in the distribution centres. Statistical inferences were used to eliminate the possibility of human preferences, biases and perception.

4.2. Sampling. The study was conducted using a non-probability sampling design. Schiffman, Kanuk and Wisenblit (2010, p. 122) recognize that the selection of respondents from a particular group in a non-probability sample takes place in the form of a non-random fashion based on the researcher's decision. This implies that the findings of the study cannot easily be generalized to the entire population under study. A nonprobability sample that conformed to this study's criteria with purposive sampling is called judgment sampling. Nonprobability sampling has some compelling practical advantages and addresses the sampling objectives of the study (Blumberg, Cooper and

Schindler, 2008, p. 235). Such sampling occurs when a researcher selects participants to conform to some criterion (Cooper and Schindler, 2008, p. 397). Convenience and judgment sampling were used in this study. Churchill, Brown and Suter (2010, p. 152) advise that convenience sampling is the process whereby people are selected for the sample based on their availability. In this study, the targeted population was to be conveniently available at all working stations within the warehouses, distribution centres and logistics companies. In judgement sampling, the elements of the sample serve to fulfill specific criteria in order to be included in the sample (Sekaran and Bourdie, 2011, p. 274). According to Sekaran and Bougie (2011, p. 195) a sample size of 132 is sufficient for a population size of 200.

4.3. Research setting. The study was conducted in warehouses, distribution centres and logistics companies located in Durban and Johannesburg. Three companies that are major players in the frozen goods trade in Durban and Johannesburg were identified. The reason for choosing those particular companies was that they are the major players in the industry of third-party logistics. The size of their contribution to the research population was in proportion to their managerial size. The estimated total population from all sources was 250 of those who hold the three levels of management positions. The size of the particular organization was taken into consideration with the aim of getting 100 from the larger companies and approximately 50 from the smaller company. A table produced by Krejcie and Morgan (1970, p. 607) was used as a guideline to determine the sample size. Roscoe (1975, p. 163) outlines a number of rules of thumbs that are in line with the table of Krejcie and Morgan (1970), which can aid in determining the appropriate sample and sample size for a behavioral study.

4.4. Data collection Data were collected from warehouses and distribution centres in Durban and Johannesburg in order to ascertain and evaluate the views of warehouse and distribution centre staff on issues around short-term scheduling within their organizations. Questionnaires were personally distributed by the researcher at the identified distribution centres where the permission had been granted for him to do so.

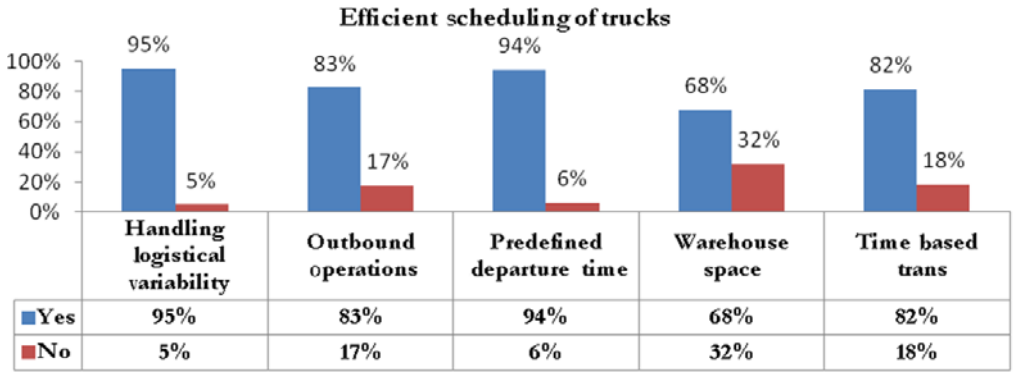
4.4.1. Data collection instrument. Sekaran and Bougie (2011, p. 197) describe a questionnaire as being an efficient data collection mechanism. The sort of questionnaire they have in mind contains a pre-formulated, written set of questions to which the participants respondent in writing, usually answering within rather closely defined parameters. Information was collected by administering a self-developed questionnaire prepared after consulting experts and reviewing relevant literature. The questions set required responses in the nature of general information and the expression of various opinions about warehouse and distribution centre management. A self-developed structured questionnaire using a five-point Likert scale was developed to assess the key challenges of short-term scheduling on the inbound and outbound logistics in the distribution centres. The five-point scale ranged from (1) strongly disagree, (2) disagree, (3) undecided, (4) agree to (5) strongly agree. The Likert scale was used as it enables certain arithmetical operations to be performed on the data collected from the respondents and it also measures the magnitude of the differences among the individuals. Dichotomous questions (Yes or No) and ranking order (4 = most important and 1 = least important) relating to information sharing among work stations and supply chain partners were also used. The questionnaires were distributed to warehouses and distribution centres in Durban and Johannesburg.

4.4.2. Reliability. An instrument is considered to be reliable if it can at the very least provide consistency in the results it produces. Consistency is the hallmark of reliability; as a result, improving reliability requires decreasing random errors. Cronbanch's Alpha coefficient was used in this study as an estimate of reliability. Cronbach's Alpha coefficient is an estimate of the internal consistency associated with the scores that can be derived from a scale or a composite score (Cooper and Schindler, 2008, p. 293). Cronbach's Alpha coefficient assists in determining whether it is justifiable to interpret scores that have been aggregated together. Reliability is of critical importance because, in the absence of reliability, it will be difficult to have any validity associated with the scores.

4.4.3. Validity. Churchill et al. (2010, p. 259) acknowledge types of validation that one needs to consider when constructing a measurement instrument. Content validity was used in this study to look at how adequately the key characteristics of the study were captured by the measure. The other type of validity that was used in the study assessed the competency of the instrument to capture the constructs and the traits it was supposed to be measuring. Establishing construct validity involves demonstrating that the measure positively correlates with other measures of the same construct, does not correlate with other measures of other related constructs, and is related to other constructs in theoretically predictable ways.

4.5. Statistical findings. Descriptive statistics summarize all the information regarding the relevant variables. The results reveal that 104 respondents responded to questions relating to on time delivery, order quantity, innovative technology and the

workforce. A total of 100 respondents responded to questions relating to information dissemination, short-term scheduling, the cycle time, performance and bottlenecks. The total number of valid observations as represented by the "N statistic" is said to be 100.

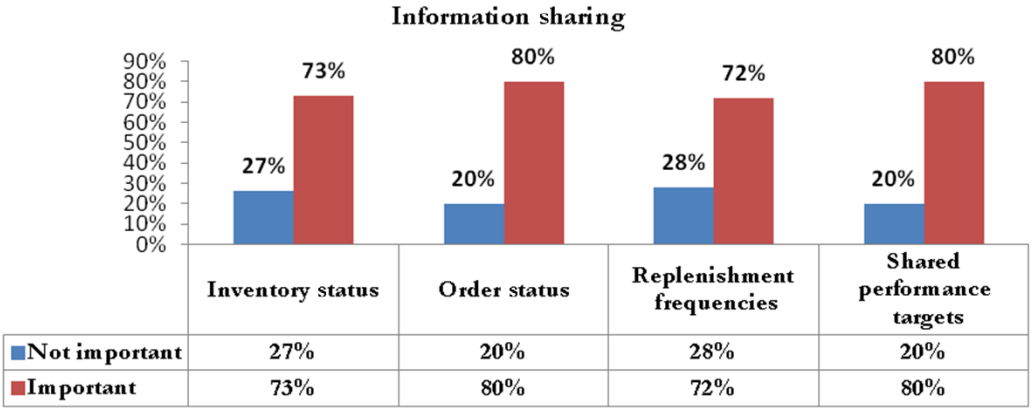


	Handling logistical variability	Outbound operations	Predefined departure time	Warehouse space	Time based trans
Yes	95%	83%	94%	68%	82%
No	5%	17%	6%	32%	18%

Fig. 1. Efficient scheduling of trucks and a view of the total operation time of the warehouse

Scheduling does not only need to be limited to facility where operations are taking place. Figure 1 indicates the efficient scheduling of trucks and a realistic view of the total operation time of the warehouse. Ninety-five per cent (95%) of the respondents agreed that managing scheduled inbound products to the warehouse is considered as a viable way of handling logistical variability. Ninety-four per cent (94%) of the respondents indicated that the scheduling of outbound trucks in advance (at a predefined departure time) does indeed contribute to the minimization of the total operation time of warehouse operations. In contradiction, six per cent (6%) disagreed with the notion that outbound trucks should be scheduled in advance at predefined departure times.

Eighty-three percent (83%) of the participants indicated that outbound operations attract more attention than inbound operations, given their proximity to the downstream customer. Eighty-two per cent (82%) of the participants indicated that there is a time-based trans-shipment relationship between uploading outbound trucks and offloading inbound trucks. Sixty-eight per cent (68%) of the respondents indicated that there was sufficient space inside the warehouse where the study was conducted, despite the demand level. Thirty-two per cent (32%) of the respondents indicated that (based on their observation and continuous encounters within a warehouse) there was insufficient space inside the warehouse, despite the demand level.



	Inventory status	Order status	Replenishment frequencies	Shared performance targets
Not important	27%	20%	28%	20%
Important	73%	80%	72%	80%

Fig. 2. Information sharing

Information technology has been proven to play an important role in the co-ordination of supply chains. The sharing of demand information (downstream) with suppliers (upstream) has drastically improved supply chain performance in practice. The most rapidly evolving and significant changes in operations take places through the supply chain. Through the use of contemporary information technology organizations are now able to share and integrate their processes, disseminate information, conduct business and be informed of an entire process as it unfolds. This tends to deliver better results (provided the process is well implemented) as it reshapes the organization from within and results in the provision of a more efficient service than previously possible.

About 73% of the sample indicated that it is important for workstations and other supply chain partners to have access to the inventory status. Most respondents also indicated that it was important to share information regarding order status, replenishment frequencies and shared performance. Eighty per cent

(80%) of the participants thought it to be important to share information relating to the order status and shared performances. Whereas seventy-two per cent (72%) said replenishment frequencies should be made available to other workstations, a notable twenty-eight per cent (28%) of the sample felt there was no need to share replenishment frequencies. They thought that information sharing among workstations and supply chain partners were solely for scheduling purposes, and occurred without any chance of risking potential exploitation. The aim was to ensure reliable replenishment frequencies and to manage capacity.

Table 1. Descriptive statistics

	N	Mean	Std. deviation	Median	Mode
On-time delivery	104	4.12	0.896	4.00	4
Information dissemination	104	4.02	0.887	4.00	4
Short-term scheduling	104	4.01	1.000	4.00	4
Cycle time	104	4.01	0.859	4.00	4
Order quantity	104	3.93	0.906	4.00	4
Performance targets	104	3.93	0.977	4.00	4
Innovative technology	104	3.86	0.970	4.00	4
Bottlenecks	104	3.73	1.053	4.00	4
Workforce	104	3.51	1.052	4.00	3
Valid N (listwise)	104				

The mean statistic for on-time delivery is 4.12, which is greater than the mode 4, and the median 4. This indicates that on average more than fifty per cent (50%) of the respondents were of the view that the on-time delivery of orders creates an agile system within the warehouse. The standard deviation for on-time delivery is 0.896, which measures the spread of a set of observations. The mean value for the short-term scheduling cycle time was 4.01, where the respondents agreed that short-term scheduling addresses challenges of bottlenecks within the warehouses. The respondents also agreed that warehouse handling and storage operations have an influence on the variability of inbound and outbound cycle time processes. "Workforce" had the lowest mean of all the variables (3.51) as the respondents were asked to indicate whether they agreed or disagreed with the notion that management of the labor workforce was related to the variability of the inbound products.

Cronbach's Alpha was used to ensure the reliability of the instrument used to generate information, and the value was 0.809 for the whole model for nine items. Reliability statistics indicate the internal consistency of the scale used by the researcher. An internal consistency of 0.809 was obtained, which indicates that the results are good, reliable and can be accepted.

4.6. Factor analysis. Factor analysis was applied to help categorize the suitable items for each dimension of independent variable. Factor analysis is used to assist in finding factors among observed variables. With factor analysis the researcher can produce a smaller number of factors from a large number of variables which are capable of explaining the observed variance in the larger number of variables (Reinmann, Filzmoser, Garrett and Dutter, 2008, p. 175).

Table 2. Factor analysis

Kaiser-Meyer-Olkin measure of sampling adequacy Bartlett's test of sphericity			Approx. Chi-square Df Sig.		0.779 214.309 28 0.000
	Component				
	1	2	% of variance	Mean	Std deviation
Factor 1:					
Order quantity	0.779			3.59	0.903
Innovative technology	0.771			3.89	0.952
On-time delivery	0.644			4.10	0.905
Information dissemination	0.562*			4.02	0.887
			42.136		
Factor 2:					
Cycle time		0.773		4.01	0.859
Performance targets		0.759		3.93	0.977
Bottleneck		0.697		3.73	1.053
			12.912		
*= rounded off to .60; total variance explained = 55.048					

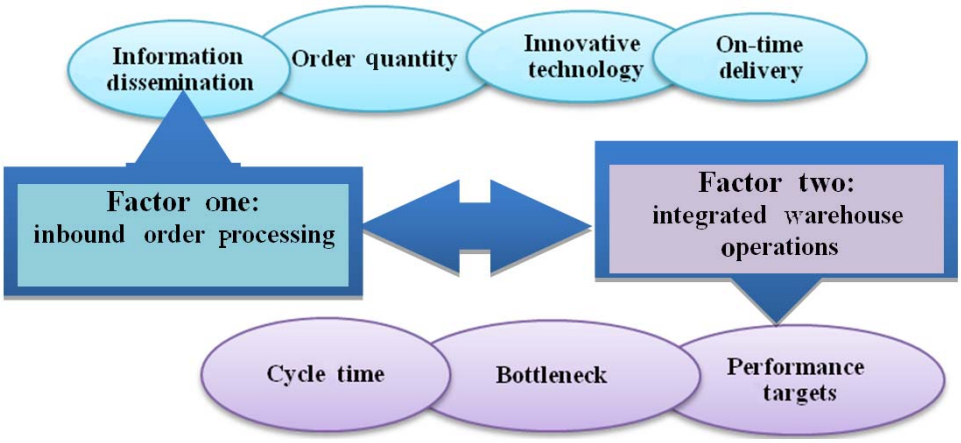
5. Kaiser-Meyer-Olkin measure of sampling adequacy

The tests of the appropriateness of factor analysis for the factor extraction include the 'Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy and the Bartlett test of sphericity for the extraction factors (Paulraj, Chen and Flynn, 2006, p. 112). The data set was foud to be suitable for factor analysis as the KMO value is 0.779. According to Pallant (2007, p. 190) a data set is considered to be suitable if it is 0.6 and above.

According to the Bartlett test of sphericity, the data set proves to be fit as well, as the Sig value is significant at p = 0.000, suggesting that the data matrix has sufficient correlation to the factor analysis. The desired value should be significant and 0.05 or below. For the sample to be sufficient and fit enough, all elements on the diagonal of the matrix need to be greater than 0.5 (Field, 2000, p. 446). The KMO statistic is said to range from 0 to 1, where a value equal to zero shows that the sum of partial correlation is large in comparison to the sum of correlation, which shows dispersion in the pattern of correlation. Contrary to values closer to zero, values closer to one imply that the sequence of correlations is moderately solid. As a result factor analysis is more likely to provide mutually exclusive and more reliable individual factors.

Despite the fact that the varimax method discourages the revealing of factors influencing all variables, the method further encourages the revealing of individual factors related to few variables. The main reason is to find rotated loadings the make the best use of the variance of the squared loadings for each, with the absolute goal of making certain loadings as great as possible and the remainder as small as possible in absolute values (Garson, 2012). The varimax solution produces outcomes that easily facilitate the potential identification of individual variables with a single factor as an orthogonal rotation of the factor axes. Eigenvalues measure the extent to which variation in the total sample can be attributed to each factor. Pallant (2007, p. 182), through the Kaiser rule, recommended retaining all factors with eigenvalues more than 1.0. Extracting from the total variance explained, the first eigenvalue is equivalent to 3.371 and it corresponds to forty-two point fourteen per cent (42.14%) as the highest loading, whereas the last eigenvalue is equal to 1.033 (being the lowest) and it corresponds to a twelve point nine one per cent (12.91%) variance in the original data. In the cumulative percentage, both factors together explain a fifty-five point zero five per cent (55.05%) variance in the original data. An eigenvalue is meant to show how much of the variance in total (for all the variables) is covered by the factors. The main goal for a factor analytic procedure is to minimize the level of complexity by making factor loading more clearly defined, understandable and interpretable. Items loading equivalent to or greater than 0.60 (the cut-off) were considered to be factor loadings. The ultimate goal of rotation is to simplify and clarify the data structure (Costello and Osborne, 2005, p. 3). The researcher used factor loadings as the basis for imputing a label to the different factors. The factor interpretations and labels are confined to the assumption of the face valid imputation of the factor label (the face validity) that is rooted in theory.

5.1. Factor one: inbound order processing. Factor one relies on the number of orders being placed in the warehouse, the type of technology being used in the warehouse, the rate and time within which goods are delivered to the warehouse, and the way in which information is shared within the warehouse and among supply chain partners. Factor one indicates the greatest variable loading of the nine factors that were extracted. The loadings of four out of the nine variables that were loaded have the highest variance figure of forty-two point fourteen per cent (42.14%).



Source: Designed by the author from empirical findings.

Fig. 3. Factor one – inbound order processing

5.2. Factor two: integrated warehouse operations. Factor two is made up of the entire start-to-finish process, the amount of time the entire process takes, the targets that are set to be met within that process time, and the time spent trying to meet the targets. Short-term scheduling plays a critical role in facilitating integration within the warehouse operation. Inbound orders processing describes the way in which orders can efficiently be processed given the availability of the right technological resources in the warehouse in order to meet the required deliveries on time. Critical information at each stage of the process

needs to be available to all relevant supply chain partners in order that inbound orders may be successfully processed. A predetermined order (from the suppliers) facilitates the creation of a short-term schedule. Advanced technology mitigates the variation in quantity coming in from the suppliers. On-time delivery of orders from the suppliers prepares the warehouse for the required capacity.

6. Discussion of the results

The importance of information sharing was noted through inventory status, order status, replenishment frequencies and shared performance targets. The abundance of information technology has had noticeable impact on supply chain coordination. Information technology is an important enabler of efficient supply chain. Raghunathan (2001, p. 606) wrote "sharing demand related information vertically among supply chain members has achieved huge impact in practice". According to Raghunathan (2001, p. 607), organizations may reduce the cycle times, fulfil orders more quickly, reduce inventory on hand and ultimately improve their customer service if they share information internally and externally. Information to be shared may range from point of sale, forecasting date, inventory levels and sales trends just to mention few. Information sharing has changed the way in which organizations interact with internal and external stakeholders customers (Bowersox, Closs, Cooper and Bowersox, 2013). The availability of sophisticated information tools has improved the value added by sharing of such information internally and externally.

In an attempt to understand the impact of information sharing, one may consider the traditional supply chain strategies. Supply chains are highly difficult systems with more than one production and storage facilities. A typical supply chain involves raw material suppliers, assembly manufacturers, distributors and retailers. It is often managed in a decentralized manner, with decentralized information (Ramanathan and Ramanathan, 2014, p. 43). Each stage is managed based on information received from its immediate suppliers and customers. Objectives at each stage are to maximize profits with very little, or no consideration, to its impact on other stages in the supply chain (Ramanathan and Ramanathan, 2014, p. 43). As a result, each stage makes optimal decisions based on the orders placed by its customers, and the replenishment lead time provided by its suppliers.

Information about shared performance targets and order status seemed to be most valuable to business, as 80% of the respondents were indifferent to the level of importance of pieces of information regarding order status and shared performance targets. When referring to the short-term scheduling of integrated warehouse operations, cycle-times have to be reduced in order to facilitate the meeting of performance targets. This can happen only if information that is shared among the supply chain members is well integrated, and all the bottlenecks have been removed. There is a link between short-term scheduling, the inbound processes and how effective the internal operations are in the warehouse. This will determine the outbound operations, as it looks at whether there is inventory or pre-merchandising available that will be delivered to the individual stores concerned. Alternatively there are systems in place within the warehouse for sorting, handling and storage. If the warehouse does not have sufficient storage, the schedule should be linked to how much is needed before the trucks are sent to the downstream retailers. Warehouses have to be linked with the lead suppliers in order to make deliveries on time before the trucks are sent to deliver to the customers. Those who deliver straight to the suppliers should be synchronized to the warehouse's system. Information sharing among work stations and supply chain partners within the scheduling perspective is significant in ensuring sufficient capacity; and outbound trucks are scheduled in advance using predefined departure times underpinned by the proximity of outbound operations being on the downstream and closer to customers.

Conclusion

An integrated system which would allow information sharing among different stakeholders would need to be in place to manage customer orders, manage supplier orders, and manage inbound transportation. All stakeholders concerned from downstream to upstream have got a role to play in the outbound cycle. These roles may be actioned sequentially or in parallel in order to maximize cycle time. In order to best drive the right behavior for inbound processes, upstream customer response metrics should also be developed on the inbound side. The alignment of operations on the inbound and the outbound ensures that the organization is working towards achieving its common goal.

This study has provided insight into the main factors that affect the operation processes of a distribution centre with a supply chain. These factors are lead times, delayed deliveries, space in the warehouse and information-sharing among workstations. The study serves to assist managers to understand the dynamics of short-term scheduling from inbound through to outbound operations processes with the warehouse and distribution system being integrated with supply chain partners. The level to which capacity supply may be adjusted in outbound logistics is rather

more flexible than inbound, owing to the need to engage with external logistics service providers. More often than not, processes relating to outbound logistics are generally outsourced, for transportation and for warehousing. Distribution centres profit from the integrated supply chain network expertise and may manage the capacity requirements more adaptably. Scheduling and reducing process time normally aims at adjusting capacity, which results in capacity management. In the field of logistics the efficient utilization of space is of foremost importance. Capacity may be optimally utilized through the scheduling of loading times and the efficient determination of transport.

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