Dynamics of Short-Term Operations Scheduling in Systematic Supply Chain Distribution Centres

by

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Abstract

A warehouse or distribution centre has a key and vital role to play in the success of modern supply chains within business in recent times – where the term ‘warehouse’ is referred to as the commercial buildings for buffering and storing of goods. Cross docking on the other hand is more concerned with the minimisation of transportation costs within the supply chain. In as much as it is a warehouse, cross docking looks at the transit of shipment of inbound goods to their prescribed destination within a period of less than 24 hours with no intention of keeping an inventory. One of the motivating facts that drive warehouses and distribution centres into being more efficient are the customer demands to deliver the requested shipments on time, in the right quantity, in the right place with affordable price.

In this study, the researcher analyses the dynamics of short-term scheduling in systematic supply chain distribution centres. The aim is to understand inbound and outbound operations, internal information sharing and to understand the role of short-term scheduling on resolving bottleneck. The phenomena of short-term scheduling is modeled by efficient scheduling of trucks, challenges encountered from inbound right through to outbound and the magnitude of information sharing within and among supply chain partners.

Keywords: Scheduling, Cross dock, Inbound-outbound, Warehouse, Distribution Centre, Short-term

TABLE OF CONTENT PAGES

CHAPTER ONE: INTRODUCTION

CHAPTER TWO: LITERATURE REVIEW

List of tables

List of Figures

Abbreviations

OQ : Order Quantity

OTD : On Time Delivery

WF : Workforce

IT : Innovative Technology

ID : Information Dissemination

B : Bottleneck

CT : Cycle Time

PT : Performance Targets

STS : Short-Term Scheduling

PT : Performance Targets

DBR : Drum-Buffer-Rope

SPSS : Statistical Package for Social Sciences

POS : Point of Sale

CPFR : Collaboration Planning Forecasting and Replenishment

VMI : Vendor Managed Inventory

QR : Quick Response

MTO : Make to Order

KMO : Kaiser-Meyer-Olkin

ANOVA: Analysis of Variance

VIF : Variance Inflation Factor

BWE : Bullwhip Effect

CHAPTER ONE
INTRODUCTION

1.1 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 destination within the network without having to store any goods at all. Different warehouses perform specific functions. Bolten (1997: 8) identified seven types of warehouses. These are general merchandise warehouses, food warehouses, bonded warehouses, customs warehouses, temperature-control warehouses, hazardous-material warehouses and liquid and dry-bulk warehouses. A warehouse serve 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. Warehouses also play a key role in the modern supply chains and are important in determining the success or the failure of the business. They may be viewed as simple as commercial buildings for the sole purpose of buffering and storing goods. A basic distinction can be made between supply, distribution and handling warehouses, however, mixed forms may be used (Runyan, Silverman and Bragg, 2009:21).

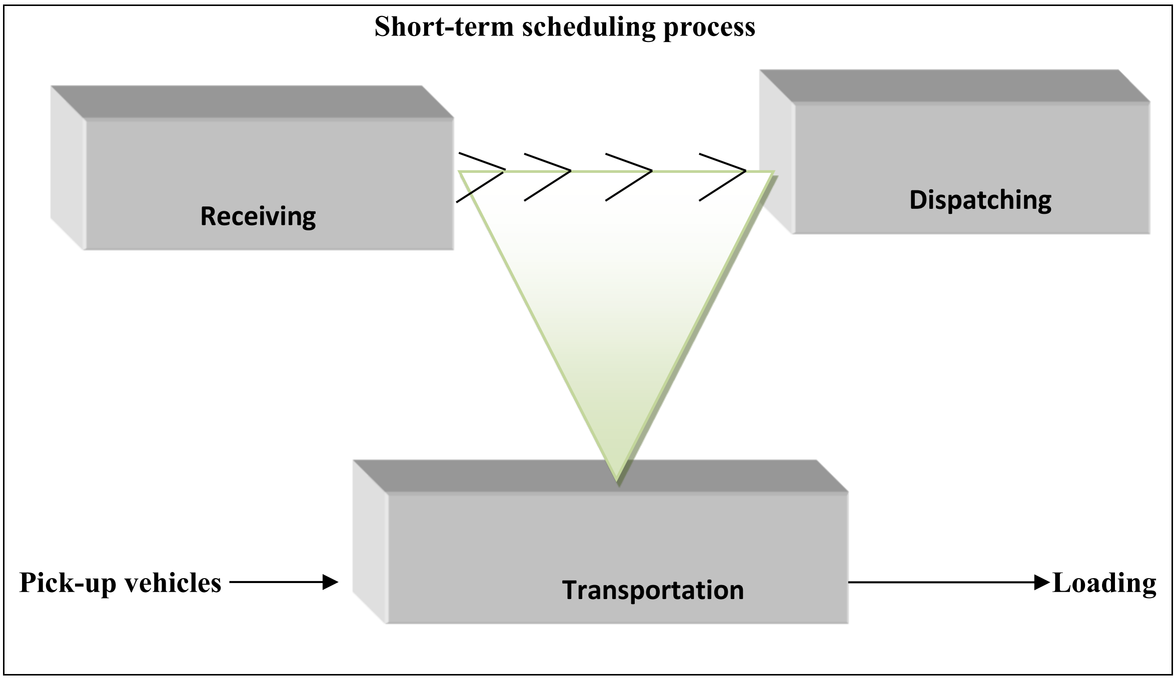
In a typical distribution system the way inbound traffic and material is handled has an important indirect influence on the customer experience. The inbound flow is likely to include all the steps required to get the necessary goods or services to the distribution centre. For the products to get to the intended customer, it must first go through the inbound process as a result it then becomes important for this process to be completed on the predetermined time and in the manner in which it was expected. The variability of products arriving in the distribution centre due to some distribution centres operating within a network makes the process even more complicated and challenging. A trade-off may present itself during inbound process. The facility and its' resources may be caught between fastening the pace at which they convert product into inventory and finding variability in handling that comes along with fulfilling orders.

One of the principle factors that lead to distribution centres and warehouses to try and be more efficient is the demand that is customer driven. Customers require their delivery to be made in the prescribed time, in the right quantity and the right place at the least price. Transportation cost has proven itself to be an important factor in determining the cost of a product. Cross docking system is popular for its advantages of achieving goals surrounding delivery on time at the least transportation cost. In improving operations within the warehouse and throughout the process, this research attempt to determine the dynamics challenges that are encountered within the warehouse. It further attempt to ascertain as to what extent scheduling in a short-term period may be used to overcome these challenges. Research objectives are outlined and some research questions are raise that will serve as guideline and provide a road map throughout the research.

1.2 Background of the study

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 Smith 1998:45). Shipment includes both the delivery related activities and the dispatching of goods to the recipient. Shipments start immediately once the goods are receipted from the packing station. A provision to keep goods temporarily that goes back to pick-up needs to be made as well as the loading and pick up vehicles. Shipping considers transport-related processes as being primary and important activities. Only under exceptional cases that goods would stay for an additional time in the transition period.

Figure 1.1: Short-term scheduling process



Source: Designed by the author from ideal conceptual study

The pressure that emanate from the need to improve customer service levels, time saving activities, minimising 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.

The supply chain strategies employed in the respective operational processes are highly likely to be directly and indirectly affected by the product type. Fisher (1997:109) categorises products into two categories, namely innovative and functional products. Innovative products are produced quickly – using high levels of technology, with a shorter product life cycle and exhibit high levels of product variety. Functional products are produced more slowly – using lower levels of technology, with lower levels of product variety and typically have lower profit margins. The speed at which innovative products 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. This is likely to keep the docks busy at all times. In contrast, functional products can be purchased in bulk, less frequently.

1.3 Problem statement

Scheduling appears to be an important part in operations process as, processes require the participation from different work stations. In order to avoid bottleneck within operations, the utilisation of limited resources need to take place as per the schedule. The capacity constraints are not always due to the unavailability of resources, but rather about when and how resourceful those resources are utilised. Improper short-term scheduling results in poorly executed orders, poor quality, high levels of rejects, bottleneck along the process and long lead time in the processing of an order.

1.4 Aims of this study

This research project aims to contribute in the body of knowledge by exploring the dynamics of short-term operations scheduling in systematic supply chain distribution centres. The effects of bottleneck resources utilized in the best possible manner at the best possible time.

1.5 The research questions

- ❖ What dynamic challenges of short-term scheduling are encountered from the inbound processes right through to the outbound operations processes?
- ❖ What is the magnitude of information sharing among work stations and supply chain partners within the scheduling perspective?
- ❖ What is the extent of the performance target on the relationship between the scheduling systems and the actual execution of operations processes?

1.6 Research objectives

The principal objective of this study is to explore the dynamics of short-term operations scheduling on systematic supply chain distribution centres. The purposes of this study aim:

- To understand the dynamics of short-term scheduling from the inbound through to the outbound operations processes with the warehouse and distribution centres' system integration with suppliers
- To establish the magnitude of information sharing among work stations and supply chain partners within the scheduling perspective
- To understand the role of short-term scheduling on the challenge of bottlenecks in operations, work processes and cycle times performance targets

1.7 The research hypothesis

The research hypothesis is developed from the research questions to ensure that the research questions are answered. The elements of the study, research strategy and techniques, theoretical framework, comparison and outcome variables are summarized in a form that establishes the basis for running statistical tests. In this study the hypothesis are constructed to assist in providing guidance to the study objectives. Looking at some of the key areas in the study, the following hypothesis were constructed:

$H_0$1: There is no relationship between capacity management strategies and the warehouse space

H_a1: There is a relationship between capacity management strategies and the warehouse space

$H_0$2: There is no relationship between handling logistical variables and the workstation

H_a2: There is a relationship between handling logistical variables and the workstation

$H_0$3: There is no relationship between outbound operations and predefined departure times

H_a3: There is a relationship between outbound operations and predefined departure times

1.8 Theoretical framework

The real-time strategy, theory of constraints and Six Sigma form part of the principal theoretical framework of this study. As the application of real-time systems become more popular, scheduling system mechanisms come across different requests and experiments as a result of the co-existence of various types of non-real time and real time activities. The open real-time system has been the focus of attention because of its ability to provide solution to this problem and its ability to bring new idea to the scheduling theory and approaches (Jensen, Locke and Tokuda, 1985; Abbott and Garcia-Molina, 1992).

The theory of constraints' main focus is systems improvements; which refers to improvement in the execution of a series of interdependent processes. The performance of the entire chain depends on the strength of the weakest link. Various authors (Rand, 2000, Dettmer, 1997 and Rahman, 1998) agree on five common steps that constitute the theory of constraints, namely: exploiting the constraint; identifying the constraint; elevating the constraint, subordinating other processes to the constraint and starting the cycle all over again.

Six Sigma claims that by reducing variation, process problems can be solved (Breyfogle, 2003:31). Through the use of different statistical tools one can predict the expected result of a particular process. If the outcomes are not satisfactory, associated tools can be used to further investigate the elements influencing that process.

1.9 Ethical consideration

The researcher will give all participants a letter requesting permission to carry out a study on the premises. The letter of approval will authorise the researcher to proceed with the study. All the data collected will be securely stored at the University of KwaZulu-Natal, and will be disposed in accordance with the instructions of the Ethical Clearance Committee.

1.10 Limitations

In carrying out this study, the researcher foresees a number of areas of concern that may prove to be limiting. These include the availability of respondents. Some of the information that the researcher may require may be deemed classified and confidential by the participants. Access to the sector in which the study is carried out may as a result be limited. The rate at which the respondents will respond to the study instrument is a further concern, as the study relies heavily on the availability of the participants. In an attempt to minimise the effect of the limitations, the researcher will obtain permission along with a supporting letter authorising the study, in good time. The study instrument will be issued to the participants in advance. The use of the non-probability sampling technique in this study restricts the result from being able to be generalized to the entire populations.

1.11 Validity and reliability

Cronbanch's Alpha coefficient was used to measure reliability. This 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, 2008:293). Cronbach's Alpha assists in determining whether it is justifiable to interpret scores that have been aggregated together. Reliability is important because without it, the scores of the scale may not be valid.

1.12 Dissertation structure

Chapter 1: Introduction

A brief introduction of the study, as well as a brief background is provided in this chapter. Most of the information discussed in this chapter is mainly intended to identify need for the study, how the study will be conducted through data collection and how the results found should be analysed. This chapter closes off by identifying the limitations, delimitations and future possible study.

Chapter 2: Literature review

The theoretical framework of the study is provided. The concept of scheduling at large is discussed, along with factors affecting scheduling. This chapter aims at generating information intended to address the objectives of the study.

Chapter 3: Research methodology

In this chapter, the research methodology used will be outlined along with the data collection techniques put into place to generate information. Further to the research methodology and research techniques being outlined, the examiner's choices of data analysis will be justified and discussed.

Chapter 4: Data analysis and presentation of results

This chapter features the analysing computer program (SPSS) that will be used to analyse all the data collected through the data collection instrument (questionnaires). Graphs and tables are used to further illustrate the reduced form of the data output.

Chapter 5: Findings, conclusion and recommendations

Making use of the information generated by the study, finding are summarised and the conclusion is drawn in this chapter. Further to that, recommendations are offered in areas which are deemed necessary after completion of the study.

1.13 Conclusion

To summarise, study on the benefits of short-term scheduling in systematic supply chain distribution centres is still early at this stage. A noticeable achievement has been made, while some issues are still an area that need further understanding. Among issues that requires further understanding are the impact of information , different strategies that may be applied within the warehouse to manage capacity. The study intends to provide insights on ways in which various customers, both downstream and upstream, may make use of shared information most effectively to make less riskier and less cost decisions. The study will further indicate that through short-term scheduling, an improved accuracy in forecasting through the use of demean d information is likely to be achieved.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

Incoming traffic is one of the functions within a distribution centre that needs to be handled with care. What happens in the receiving bay may in more ways than one have a direct effect on customer service, merchandising and even returns. Scheduling carrier shipments plays an important role in gaining control of this traffic. The receiving and dispatch bays are significant areas in any warehouse and distribution centre. Everything that comes into the distribution centre and leaves distribution centre moves across the dock. The size of shipping and receiving areas is often reduced when other functions or operations increase in size. The size of the receiving area is dependent on various factors, including its different functions, the volume of goods handled and the frequency of shipment receipts and the number of items.

2.2 Short-term scheduling

Operations management requires planning and control at various levels and time horizons. Configuration of operations and manufacturing systems in the most suitable location and on selection of appropriate process and product design are issue that may be associated with long term. Aggregate planning and capacity requirements planning are associated with medium to short-term. In the short-term, more emphasis is placed on operational control than on planning (Mahadevan, 2010:510). Short-term scheduling denotes a time horizon close to a real time. Mahadevan (2010:512) identifies three reasons that make short-term scheduling becomes important. Firstly, as real time approaches; organisation becomes more exposed to more information than they were at the initial stage. Incorporating such information makes schedules more real and robust. Secondly, it’s not always the case that an organisation can avoid random shocks. It is not possible to include all the details of potential random short while scheduling for the medium term, but may be included more accurately when scheduling in the short-term. Thirdly, in the short-term scheduling, focus is on micro-resources. Such a focus is neither possible nor warranted in the medium or long-term scheduling.

Undertaking scheduling in the organisation functions to establish the better ways in which certain resources within an organisation are utilised in specific time frames. Scheduling determines the timing and the amount of equipment, facilities and all human activities to be used (Kruger, De Wit and Ramsdass, 2007:446). Proper consideration needs to be taken when scheduling operations as scheduling is part of the decision making process. Heizer and

Render (2008:602) identifies the importance of effective short-term scheduling as faster movement of goods and services through the facilities. This may be translated to greater use of assets and hence capacity per Rand invested. Faster deliver may be as achieved through added capacity, faster throughput and related flexibility.

2.3 Cross docking system

Cross docking is the logistics system that assists in minimising the transport costs in the supply chains. 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, 2012:46). 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 the reasonable price. The total cost of a product includes the transportation costs as well (Rodrigue, Comtois and Slack, 2009).

Extensive research has been conducted on the different aspects of scheduling. Amorim, Pinto-Varela, Almada-Lob and Barbosa-Povoa, (2013), Wu, Chu, Chu and Zhou, (2008), Agnetis, Hall and pacciarelli (2006) and Yeng, Choi and Cheng (2011). Morris's (2004:86) research of 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. 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.

There are various strategies that can be used to distinguish between different intermediate inventory storage points. One of the most fundamental strategies involves the length of time that an inventory is kept in the distribution centres and warehouse. In traditional warehousing strategies, distribution centres and warehouses hold stock inventory and provide their downstream customers with inventory as required. In cross docking strategies distribution centres and warehouses serve as transfer points for inventory, however no inventory is held at these transfer points (Simchi-Levi, Kaminsky and Simchi-levi, 2008:231). Items delivered to the warehouse by inbound trucks are immediately sorted, re-organised (based on customer requirements), routed and loaded to the outbound trucks for delivery to customers without the items being actually held in inventory at the distribution centre or warehouse. Because of its ability to deliver items to the intended customers within a period of 24 hours, it provides numerous favourable outcomes for the stakeholders concerned.

Lee, Jung and Lee (2006:247) have endorsed cross docking's ability to reduce inventory and improve responsiveness to various customer demands. The turnaround times for customer orders, inventory management costs and distribution centres or warehouse space requirements are reduced. One of the objectives of the cross docking system as outlined by Boysen, Fliedner and Scholl (2010:135) in the paper titled "scheduling inbound and outbound trucks at cross docking terminals", show how well trucks can be scheduled at the dock and how the items in inbound trucks can be allocated to the outbound trucks to optimise the measure of system performance. The main objective of this study is to research the dynamics of short-term operations scheduling in systematic supply chain distribution centres. This entails the scheduling sequences for both inbound and outbound operations to minimise the time that a temporary storage buffer is located at the shipping dock.

Before the study proceeds to unpack issues considered in scheduling, a need arises to elaborate on low material handling costs. The main objective of a warehouse is to find the optimum trade-off between handling costs and costs associated with warehouse space. Consequently, management's task is to maximise the usage of the total area of the warehouse while maintaining it. Heizer and Render (2008:353) define material handling costs as all the costs associated with the transaction. These consist of the inbound transportation, storage and outbound transportation of goods to and from the warehouse. Among other things, the cost may, although it is not be limited to include human capital, machinery and material. Proper scheduling minimises the amount of resources spent on the finding and transportation of material as well as the quick wear and tear, and damages of the material to be transported or kept in the warehouse. The variety of items kept and the number of items picked in the warehouse have a direct impact on the optimum layout. A warehouse that stores a few unique items lends itself to higher density than a warehouse storing a variety of items.

2.4 Scheduling role in distribution

Scheduling plays an important role and acts as the back-bone of the performance of the manufacturing or service organisation. Scheduling is therefore prevalent in nearly every organisation. Scheduling follows planning and aims to implement the operating strategies developed during the planning process (Swensen and Acuff, 2011:9). In today's competitive world; orders and processes need to be fulfilled on or before the stipulated time. Operations scheduling has a very sensitive and important role to play in the completion of such orders to avoid delays. Operations managers need reliable information on various elements of capacity at their disposal, including the existing and projected workload, as well as the efficiencies of the people and processes concerned. Scheduling means different things to different people, but in this regard the concept is used to refer to the way in which resources are allocated within an organisation; the assignment of start and completion times to particular people or equipment; as well as the setting of timetables to allow the process to flow (Evan and Collier, 2007:261). Firms and organisations undertake short-term scheduling to improve efficiency; which in turn reduces the cost of manufacturing or rendering the service.

Aside from the ability of scheduling to fast track the movement of goods and services; scheduling improves capacity and output and increase flexibility; improved customer service is achieved through faster deliveries. Good scheduling therefore enables the making of realistic commitment and ensures dependable delivery (Kister and Hawkins, 2006:30). Scheduling deals with the timing of operations. Scheduling decisions include capacity planning, which involves total facility and equipment resource availability. Short-term scheduling requires decision relating to capacity, aggregate planning and master scheduling into the job sequence, as well as specific assignment of personnel, material and machinery. More narrowly defines issues relating to scheduling in the warehouse and distribution centres (with regard to short-term incoming and outgoing orders) include matching daily or hourly requirements to specific personnel and equipment (Kister and Hawkins, 2006:34). Scheduling techniques are determined by the volume of orders, the nature of operations and the overall complexity of the job, as well as the importance placed on minimising completion time, resource usage, works-in-progress and customer waiting times. Scheduling conforms to the plan that is in place. The idea behind scheduling is to put all the pieces of activities together, such that the desired output or outcome is achieved. The volume of stock that the warehouse plans to receive or distribute,

2.5 Scheduling issues

Scheduling is an important planning activity which deals 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, 2011:1373). Among the issues that scheduling deals with is the timing of operations. Scheduling decisions begin with capacity planning which involves total facility and equipment resources availability. Capacity plans are usually annual or quarterly as new equipment and facilities are purchased or disposed of. Aggregate planning concerns the determination of the quality and timing of production for the intermediate future, often three to 18 months ahead (Pycraft, Singh and Phihlela, 2007:378). Resources are allocated in terms of aggregate measures such as total units or shop hours. A master schedule breaks down the aggregate plan and develops a schedule for the specific product line for a short future period, for example for each week. Short-term scheduling translates capacity decisions, aggregate planning and master schedules into job sequence and specific assignment of personnel, material and machinery (Heizer and Render, 2008:602).

2.5.1 Capacity Management

A certain level of balance needs to be maintained between the capacity of an organisation to satisfy customers, suppliers, related stakeholders needs and future demands. Such a balance can be beneficial to the organisation in terms of profits. Planning, controlling and capacity may be the major responsibility of the operations manager, however these responsibilities involve other functional managers as well. Pycraft, *et al*., (2007:376) put forward three reasons why other functional managers need to be involved. Firstly, capacity decisions have a companywide impact. Secondly, all other functions provide important input to the planning process. Thirdly, each business function usually has to plan and control the capacity of its own micro-operations to match those of the main operations functions. Capacity planning is also concerned with the operations ability to respond to the demand placed upon it and includes how the operations should react to fluctuations in demand.

Cost, revenue, working capital, quality, speed, dependability and flexibility are some of the important objectives behind capacity planning. Capacity levels could determine the level of resource usage, which could then give a clear direction in terms of how cost-effective the operations processes are with regard to resource usage. Under-usage of capacity could potentially lead to high unit costs. However, full usage of resources and facilities within the operations processes results to incurring the necessary costs and having effective manufacturing processes. Capacity levels equal to or higher than demand will ensure that all demands are met and no revenue is lost. The response to customer demands could be improved, either by the build-up of inventories or by the deliberate provision of surplus capacity to avoid queuing (Pycraft, *et al.*, 2007:380).

Heizer and Render (2008:295) break capacity planning into two phases. In the first phase, future demand is forecast with traditional models, whereas in the second phase the forecast is used to determine capacity requirements and the incremental size of each additional capacity. The difficult part about forecasting is that demand is neither constant nor certain. For an organisation to satisfy demand, it has to have an adequate capacity to fulfill consumer needs. Pycraft *et al.,*(2007:380) outline three steps that must be taken into consideration by operations managers when they deal with forecast of demand which is unlikely to be either certain or remain the same from period to period. Operations managers must have an idea of their ability to meet the demand, but before making any decisions, they need to be informed of the quantitative data of both capacity and control. The first step is to measure the aggregate demand and capacity. The second step is to identify the alternative capacity plan. The third and final step is to choose the most appropriate plan.

Matching capacity and demand in the short-term (three to eighteen months) is the central focus of aggregate planning. Aggregate planning is usually concerned with meeting forecast demand while minimising cost over the planning period. For a service organisation, the aggregate schedule ties strategic goals to workforce schedules. The main purpose of the aggregate plan is to specify the optimal combination of production rate, workforce level and inventory on hand. Chase and Jacobs (2011:570) point out three production planning strategies which involve trade-offs between the workforce size, work hours and backlogs. Chase and Jacob's (2011:570) strategy seeks to match capacity to demand. The planned output for the period is set at the expected demand for that period. The strategy is most appropriate for periods when demand is certain. Demand in this case could be matched through the variation of workforce. There are different options which an organisation may use it in an attempt to vary workforce. It can be varied through hiring and laying off, the use of overtime or through the employment of part-time labour and subcontracting work to other organisations.

The second production planning strategy that an organisation may use is the level capacity strategy. Variations in demand are met by using some combinations of inventories, overtime, part-time workers, subcontracting and back orders while maintaining a steady rate of output that absorbs any shortages and surplus that may occur. Employees benefit from stable work hours, however this takes place at the cost of potentially decreased customer service levels and increased inventory costs (Stevenson, 2013:608). It requires a level rate of output throughout the planning period. Inventory is used to balance the difference between demand and output. A stable demand is a requirement for level strategy to be used.

The third strategy is the stable workforce in relation to the variable of work hours. The output can be varied by varying the number of hours worked through flexible work schedules or overtime. By varying the number of work hours, the organisation can match production quantities to orders. This strategy provides workforce continuity and avoids many of the emotional and stable costs of hiring and laying-off people, which are associated with the Chase strategy (Chase and Jacobs, 2011:570).

2.5.2 Information sharing

The abundance of information technology has had noticeable impact on supply chain coordination. Information technology is an important enabler of efficient supply chain. Raghunathan (2001:606) wrote "sharing demand related information vertically among supply chain members has achieved huge impact in practice". According to Raghunathan (2001:607), organisations 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 organisations interact with internal and external stakeholders. 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 usual supply chain involves raw material suppliers, assembly manufacturers, distributors and retailers. It is often managed in a decentralised manner, with decentralised information (Ramanathan and Ramanathan, 2014:43). Each stage is managed based on information received from its immediate suppliers and customers. Objectives at each stage are to maximise profits with very little, or no consideration, to its impact on other stages in the supply chain (Ramanathan and Ramanathan, 2014:43). 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.

Such a decentralized information and control system is likely to face major challenges, such as Bullwhip effect. Ordering information flow may be distorted in the sense that the variation of orders tends to increase as one moves up the supply chain. The Bullwhip effect was later quantified by Lee, Padmanabhan and Whang (1997), and Chen, Drezner, Ryan and Simchi-Levi (2000). Lee *et al*., (1997:548) identified the sources of Bullwhip effect to be: promotional activities, inflated orders, order batching and price variation. Chen *et al*., (2000:438) show that traditional forecasting methods such as moving average and exponential smoothing also contribute to the increase in variability, they also play an important role in the bullwhip effect. They also show that transferring demand information across supply chain partners can significantly reduce the Bullwhip Effect (BWE) but it will never eliminate it.

The increase in order variability implies that the organisation needs to increase safety stock levels if the organisation does not want to be rated as having poor customer service.

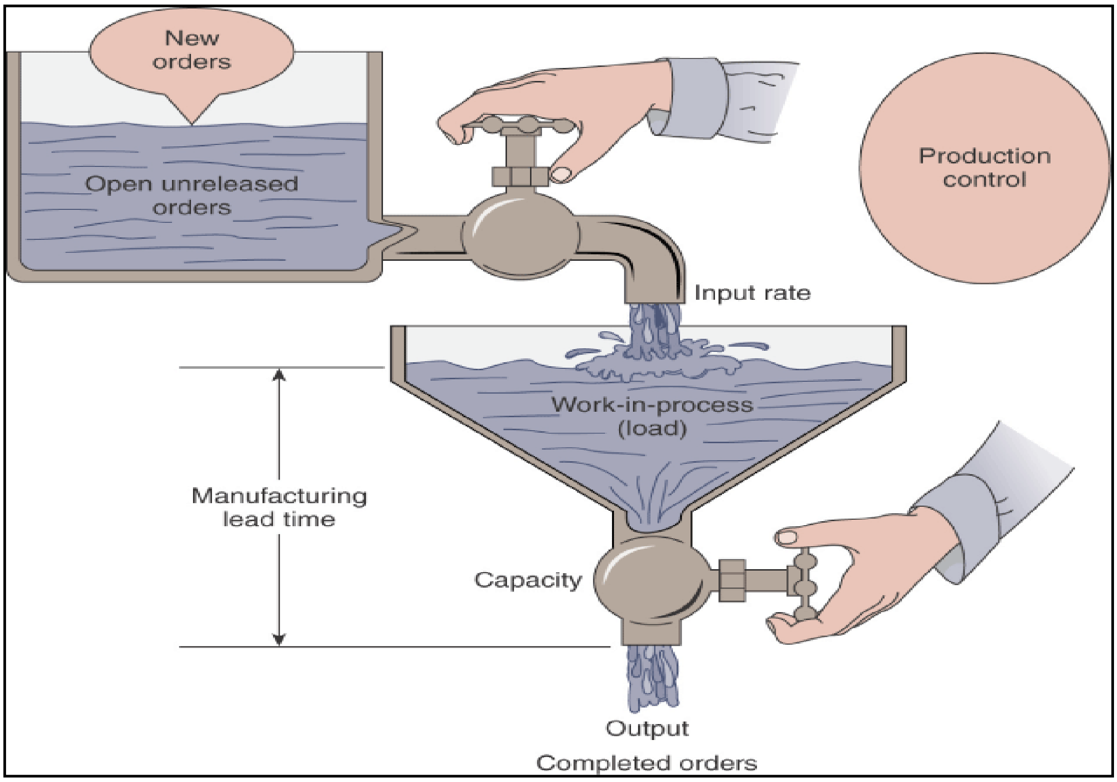
Information distortion otherwise make it difficult for an organisation to manage labour, transportation and other resources efficiently. The response rate to the market changes are likely to be observed as a result of distorted information. Literature provides various benefits that may be reaped as a result of employing various strategies of sharing information. In the Quick Response strategy, endorsed by Fahrenwaid, Wise and Glynn (2001), organisations share Point-Of Sale (POS), inventory levels and forecast data and information relating to promotional events. With the visibility to current demand and inventory levels, suppliers can improve forecasting and schedule production-inventory accordingly, and provide better service to upstream customers. Information sharing can reduce the demand uncertainty to such an extent that suppliers can build inventory well in advance of receiving promotional order.

Fahrenwaid, Wise and Glynn (2001) also regard Collaboration Planning, Forecasting and Replenishment as an alternative strategy to sharing information. In this strategy organisations not only share information with their supply chain partners, but also make decisions jointly in order to improve performance. In the Collaboration Planning, Forecasting and Replenishment (CPFR) strategy, organisations share information and collaborate on forecast, promotional activities and production strategies. The third strategy that is covered extensively by Simchi-Levi, Kamansky and Simchi-Levi (1999:240) is the Vendor Managed Inventory (VMI). A strategy most employed by frozen goods suppliers. Suppliers not only determine their production schedule, but the consignment and inventory policies at the retail facilities. The ultimate objective is to optimise decisions for the entire supply chain. It is worth noting the common denominator is all the trends, that is, Quick Response; Collaboration Planning, Forecasting and Replenishment and Vendor Managed Inventory; they all require transfer of demand information among downstream and upstream customers. Lee and Whang (1998) identified some challenges that organisations need to be aware of during the information sharing or that may result from sharing information. Challenges include the breach of confidentiality of the information shared, anti-trust regulations, costs associated with information technology, timeline and the level of accuracy of the information shared, and lastly the development of capabilities that allows the utilisation of the shared information in the most effective manner and in the way intended.

2.5.3 Input-Output control

The manufacturing of planning and control systems requires a greater consideration for the control of input versus the expected output. According to Chase and Jacobs (2011:677), the underlying belief with regard to input versus output control is the idea that the planned inputs to a work centre should under no circumstances exceed the planned work outputs. Backlogs are likely to occur in the required inputs in fulfilling an order exceed output. This also has the potential to result in an increase in the lead time for jobs upstream. Over and above that, when orders to be fulfilled mount at one particular work station, bottlenecks occur, inefficiencies in operations are observed, and the entire flow of manufacturing processes becomes distorted as a result.

Figure 2.1: Capacity control analogue



***Source: Chase, R.B. and Jacobs, F.R. (2011) Operations and Supply Chain Management: Global Edition with Global Cases and Alternate Problems*. 13th ed, New York: McGraw-Hill.**

The water flow analogue to manufacturing capacity control clearly illustrates the idea behind the input-output control. Figure 2.1 depicts the process from receiving orders through to processing them and the final output. Water in the jug at the top left side of figure 2.1: Capacity control analogue represents new orders that are received by each work centre. Given the limited resources in each work centre, all the orders cannot be processed simultaneously. Control mechanisms need to be in place to control the production process. Considering the associated lead time, the rate at which inputs are loaded into the process needs to be in exact relation to the operating Gantt chart in place. Inputs need not be continuously loaded into the system just for the sake of having inputs or to keep the process going. Each process requires time to complete the stage in that particular work station and then feed the processed product into the proceeding work station. The limited capacity of each work centre in terms of resources, human resources or automated resorces is the major reason behind scheduling each process (Chase and Jacobs, 2011:677). The ability to produce output in a particular work centre depends on capacity. Output that is far below the expectation of the manufacturer (after investing so much input) may be the result of serious capacity problems that exist in a certain work station. Capacity problems need not necessarily lie in the existing work centre, but might result from prior work centre feeding the current work centre.

2.5.4 Master schedules

The master schedule breaks down the aggregate plan and develops a schedule for a specific products or product lines within the predetermined period. Master scheduling involves different functions of business and crosses most departmental lines. It determines the quantities needed to meet demands from all sources that governs the key decisions and activities throughout the organisation (Stevenson, 2013:620). It is an anticipated built schedule of items assigned to the master scheduler. This schedule is maintained and in turn becomes a set of planning numbers that drives material requirements. It represents what the company plans to produce, expressed in a specific configuration, quantities and dates. This is not a sales forecast that represents a statement of demand. The master production schedule must consider the forecast, production plan and other important considerations such as backlogs, availability of material and availability of capacity (Proud, 1999:30).

2.5.5 Short-term schedules

According to Stevenson (2013:620) short-term scheduling is defined as schedules giving detailed times for jobs, people, materials, equipment and any other resources utilised in the process. Short-terms schedules show what any part of the process is doing at any time. In this regard schedules translate the capacity decisions, aggregate (intermediate) planning, and master schedule into job sequences and specific assignment of personnel, materials, and machinery (Heizer and Render, 2008:603). The objectives would be to allocate and prioritise demand generated either by forecasts or customer orders to available facilities. Factors that allow the achievement of allocation and prioritising involve the type of scheduling to be used (forward scheduling or backward scheduling) and the criteria for prioritising. The short term schedules are aimed at solving the short-term problems. Pinedo (2009:192) identifies short-term scheduling problems in a supply chain as challenges that work against the achievement of the medium term output. Predefine output of the medium term planning problem specifies that over the short-term period items of the certain amount has to be produced. Scheduling problem can either be modeled as a flexible flow shop that takes all the production steps into consideration. Alternatively, scheduling can opt for the simpler single machine scheduling problem that focuses only on the bottleneck operations (Pinedo 2009:192). In the event that the operations within a facility are well balanced and the location of the bottleneck depends on the type of orders that are in the system, Pinedo (2009:194) suggests that the entire facility may be modelled as a job shop (flexible flow shop). In the event that the bottleneck in the facility is a permanent bottleneck, the focus according to Pinedo (2009:194) may be justified.

2.5.6 Forward scheduling and backward scheduling

Forward scheduling starts the schedule as soon as the job requirements are known. This kind of scheduling is common in facilities where jobs are performed to customer orders and delivery is often requested as soon as possible. The due date is not of high priority and in most cases a build-up of work-in-process in inventory is usually an option. A number of situations favour the route of forward scheduling. It is beneficial in terms of its high labour usage as workers always start work to keep busy and build-up inventories. The schedule is also flexible; the time slack in the system allows unexpected work to be loaded (Pycraft *et al.,* 2007:363). The build-up of inventory can also be viewed as mass production. Mass production is possible for a production process that uses standardised components. Economies of scale come as an added advantage whenever mass production takes place. Backward scheduling involves starting jobs at the last possible moment to prevent them from being late. Steps in the job are then scheduled, one at a time in reverse orders. The start time is obtained by subtracting the lead time for each item, however, the necessary resources to accomplish the schedule may not exist. Backward scheduling presents a number of benefits such as: low material costs (materials are not used until necessary) which leads to a delay of added value until the last moment; fewer risks (schedule changes by customers tend to focus the operations on customer due dates).

The correct scheduling techniques depend on the volume of orders, the nature of operations and the overall complexity of jobs, as well as the importance attached to each of the four criteria. Kruger, *et al.,* (2007:455) determine some of the common criteria as minimising completion time which is evaluated by determining the average completion time per job; maximising usage time (evaluated by determining the amount of the time the facility is used). Minimising work-in-process inventory is evaluated by determining the average number of jobs in the system being processed. The relationship between the number of activities already being processed and the work-in-process inventory will be high. Finally, minimising customer waiting time is evaluated by determining the average number of late days (Heizer and Render, 2008:605).When using either forward scheduling or backward scheduling, managers can make use of a schedule chart to keep track of all the tasks or activities that have been scheduled. This schedule chart is a type of Gantt chart that shows the jobs or orders in progress and whether or not those jobs or orders are not scheduled (Kruger, *et al.,* 2007:456).

2.6 Theory of constraints

It is important to remember that resource profiles are based on representative products for an entire family product range. Incoming orders however may not exactly fit the predicted mix, causing discrepancies between aggregate and detailed planning. Also the manner in which setup time is handled may affect load predictions in various ways. Other concepts and systems have been developed which also recognise the importance of planning to known capacity constraints, rather than overloading part of the production system and failing to meet the plan. The Theory of constraints places more focus and attention on the capacity constraints and bottleneck parts of the operations. By identifying the locations of constrains, working to remove them, and then looking for the next constraint, an operation is always focusing on the part that critically determines the pace of output (Proud, 1999:428).

Manufacturing goals may be the generation of a schedule for new, existing and potential orders. Orders may specify vague values for certain manufacturing and production fields, such as "very fast" for speed. These can be viewed as soft constraints which can be relaxed to a certain extent to obtain a feasible schedule. In manufacturing, constraints can be any restrictions on the type of solutions to be generated. Constraints can be external or internal, physical or non-physical. External constraints can be found in the order form, such as speed, whereas internal constraints are introduced by the manufacturing company. There are predetermined internal constraints such as a company philosophy and internal constraints which are derived by a pre-processor from the order and the current state of the manufacturing plant. An internal model of manufacturing for a company and its current status create the problem environment. The operations managers need to identify what the constraints on any processes area, and the things that will impact negatively on the throughput rate of the processes. The physical constraints could be anything which might include the availability of employees, the availability of raw material and suppliers. Non-physical constraints may include: procedure, employee morale and employee empowerment (Kruger *et al.*, 2007:466).

Chase and Jacobs (2011:719) identify a five-step process that manages manufacturing limitations within the scheduled operation processes. Firstly, the operation process constraints have to be identified. No improvement can be initiated and executed successfully unless the constraint is found. Secondly, decide how to exploit the system constraints. Once the limitations have been identified, a plan must be developed detailing how the limitations will be met with and overcome. Thirdly, in ensuring the success of developing a plan to overcome the identified constraint, the necessary resources must be made available to achieve that. Align every other part of the system to support the constraints even if that would reduce the efficiency of constraints resources. Fourthly, reduce the effects of a particular constraint by loading work to subcontractors or by expanding the capabilities of the processes (capacity) recognised by all those who can impact on them. If the output is still inadequate, acquire more of the resources so that it is no longer a constraint. The fifth and final step is when the current set of constraints has been overcome, return to the first step and identify a new set of constraints that needs to be solved, a continuous process of improvement.

2.6.1 Constrained work centres

Bottlenecks in the operation process are constraints that will impact on the effective and efficient operations of any processes. A bottleneck can be any work station or operation process where an insufficient capacity is available to complete a jobs scheduled for work at that operation's process or work centre (Lopez and Roubellat, 2008:37). The reason bottlenecks occur could be because the work stations at which the bottlenecks form have less capacity. Regardless of how well the process has been designed, the process does not remain balanced for long. By changing volumes and products, bottlenecks can be created and often occur in more than one place over a period of time.

Bottlenecks at work stations occur in nearly all processed focused facilities (Stevenson, 2013:741). Some operation managers deal with bottlenecks by ensuring that the bottlenecks at work stations stay busy, increasing the bottleneck capacity, rerouting work, changing the lot size, changing the work sequence, or accepting the idleness at other work stations (Stevenson, 2013:741). This can be achieved by using employees creatively; cross training employees to assist when bottlenecks occur; and maintaining the process well. There are available common techniques in place to manage bottlenecks effectively. Among them are to release capital for other purposes by keeping the inventory levels low; shortening the lead time of products through a high throughput rate; improving product quality and thereby also improving component quality; reducing the floor-space requirements for each work centre; and finally and most relevant to scheduling not overload any work station.

The throughput rate should match the available capacity at any work centre. In many instances this will mean that less work will be scheduled at a particular work station. The main emphasis in the manufacturing environment is the scheduling of material (Kruger *et al.*, 2007:467). The belief behind the theory of constraints is that output of the system is limited by the output of the bottlenecked operation processes, therefore, it is essential to schedule the bottleneck operations processes in a way that will minimise the idle time of the bottleneck operation processes. Thus, the idle time of non-bottleneck operations is not a factor in the overall productivity of the operations process, as long as the bottleneck operations are used effectively. Scheduling intermittent production systems that are simpler and are less time consuming could therefore resolve the bottleneck problems. In resolving these bottleneck problems, scheduling within a manufacturing work stations can be carried out using the Drum-Buffer-Rope system.

Wherever the Drum-Buffer-Rope system is implemented in manufacturing plants; the detailed design rule or application must be customised based on the special characteristics and requirements of different manufacturing environments (Wu, Chen, Tsai and Yang, 2010:8127). Drum-Buffer-Rope is an idea that emanated from the theory of constraints. The drum is the beat of the system; it provides the schedule and pace of the production. The goal is to schedule the maximum use of a bottlenecked resource. While the buffer is the resource, inventory is usually necessary to keep the constraint operating at full capacity. The role of the buffer is to keep a small amount of inventory ahead of the bottleneck operations to minimise the risk of having it standing idle. The rope provides the synchronisation necessary to pull the units through the system. The rope can be thought of as a kanban signal (Schragenhem and Rozen, 1990:18). The goal is to avoid costly and time consuming multiple setups, particularly with capacity constrained resources, so they do not become bottlenecked too.

The Drum-Buffer-Rope approach provides a basis for developing a scheduling that achieves maximum output and shorter lead times, while avoiding carrying excess inventory (Caspari and Caspari, 2004:174). Using the Drum-Buffer-Rope approach generally results in operations capable of consistent on-time delivery, reduced inventory, and shorter lead times, as well as a reduction in disruption that requires expediting. Alternatively, a system of varying batch sizes to achieve the greatest output of a bottlenecked operation could be used. A batch could be split into two or more parts. Splitting a large batch at one or more operations preceding the bottlenecked operations will reduce the waiting time of the bottlenecked operations. The theory of constraints aims to maximise flow through the entire production process (Levinson, 2007:20). It does this by emphasising the balance of flow through the various operation processes. As mentioned earlier, it begins with identifying the bottleneck operations.

2.7 Synchronisation

Companies manufacture a variety of parts and products; not all of which are made with sufficient regularity to warrant the full levelled scheduling treatment. Synchronisation looks at the pace of output at each stage in the production process to ensure the same flow characteristics from each part or product as they progress through each stage (Erlach, 2013:157). Parts need to be classified according to the frequency with which they are demanded. One method of doing that is through termed Runners, Repeaters and Strangers.

Runners are products or parts which are produced frequently. Repeaters are products or parts which are produced regularly, but at long intervals, while and Strangers are products or parts that are produced at irregular and possibly unpredictable time intervals (Stamatis, 1997:91). There are advantages in trying to reduce the variability of timing intervals for producing Runners and Repeaters. The aim is to synchronise processes concerned with parts and sub-assemblies for such products so that they appear to take place on a drum beat pulse which governs material movement (that is according to the schedule). It might even be better to slow down faster operational processes than to have them produce more than can be handled in the same time by the next process. In this way, output is made regular and predictable (Pycraft *et al.*, 2007:548).

2.8 Job shop

The use of numerical controlled machining centres in manufacturing has brought about the need to develop new and tailored production systems for automated manufacturing. The characteristics of low intermediate volume systems are considerably different from those of high and intermediate volume systems. Products are made-to-order, and orders usually differ considerably in terms of processing requirements, material needed, processing times, processing sequence and set ups. Because of these circumstances, job-shop scheduling is usually fairly complex (Stevenson, 2013:724). A make-to-order (MTO) manufacturing strategy involves the making of components and parts along with assembly (Gunasekaran and Ngai, 2005). The make-to-order supply chain can accommodate as many product differentiations as required, as long as they are made from the same materials available in the facilities (Goldratt, Cox and Schleier, 2010:211). A close relationship exists between the parties (customers and manufacturers) in the supply chain network. The customer order decoupling point is located where the production of a customised product begins (Simchi-Levi, *et al.,* 2008:344). According to Stevenson (2013:677) customisation enters the production process at the earliest stage of production. Manufacturers provide customisation opportunities in the product design in anticipation of expected product delivery strategies.

The make-to-order strategy is exposed to inventory risk management (Berry, Naim and Naylor, 2005:108). This is compounded by the unlikelihood of establishing firm schedules prior to receiving the actual job orders. Job-shop processing gives rise to two basic issues for scheduling: How to distribute the workload among work centres, and what job processing sequence to use? A job-shop problem can be experienced when shops manufacture parts with different characteristics, but which require processes of which the sequence is known in advance. Each job must visit machines in a given sequence, but the difference with the flow shop is that this sequence may be different for each job (Lopez and Roubellat, 2008:26).

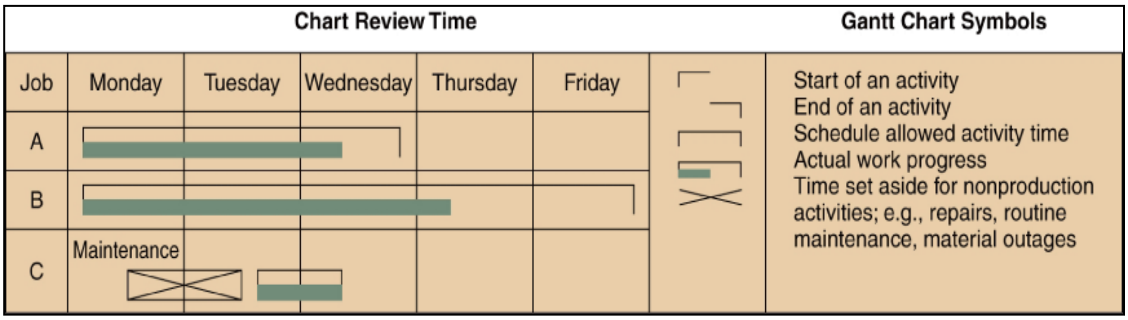
2.9 Loading

Loading decisions involve assignment of a specific job to work centres and to various machines in the work centres. In cases where a job can be processed only by a specific centre, loading presents little difficulty. However, problems arise when two or more jobs need to be processed, and there are a number of work centres capable of performing the required work. In such cases, operations managers need some methods by which to assign jobs to the centres (Proud, 1999:112). The plant or work centre manager's goal may be to run the manufacturing facility at a steady pace and at a level load. A level load is very close to peak operating capacity, yet provides enough slack for periodic repairs and maintenance. In an ideal world, overtime and expediting costs are eliminated, and workers are spared the punishment of periodic plant shutdown and layoffs (Pycraft, *et al.,* 2007:356).

2.10 Gantt charts

Schedule may be presented in a variety of way. According to McDaniel and Bahnmaier (2001:19) regardless of how the schedule are displayed, the fundamentally convey information concerning activities or responsibilities to be achieved over a certain stipulated amount of time. Schedules also display milestones that occur at a particular point in time. McDaniel and Bahnmaier (2001:19) goes further into identifying four type of schedules that are in common use and convey the categories of information. These types are, Gantt charts, schedule chart, network schedule and production schedule. This study will only make reference to Gantt chart and Schedule chart as they are normally combined to show a program's schedule. Visual aids called Gantt charts are used for a variety of warehousing and distribution purposes related to loading and scheduling. The purpose of the Gantt chart is to organise and visually display the actual or intended use of resources in a time frame. In most cases, a time scale is represented horizontally, and resources to be scheduled are listed vertically. The use and idle times of resources are reflected in the chart (Chase and Jacobs, 2011:674). The chart shows both the amount of time involved and the sequence in which activities can be performed.

Figure 2.2: Gantt Chart Analysis



Source: Davis, M.M. Aquilano, N. J. and Chase, RB. (1999) Fundamentals of Operations Management, 3rd Ed, North America, McGraw-Hill

Managers in warehousing and distribution industries may use these charts for trial and error schedules to develop an idea of what different arrangements could be involved. Thus, a tentative distribution schedule might reveal insufficient allowances for operations processes that take longer than expected and can be revised. There are two types of Gantt Charts, namely the load chart and the sequence chart.

Loading charts depict the loading and idle times for a group of machines or a list of departments. Two different approaches are used to load work centres: infinite loading and finite loading. Infinite loading assigns jobs to work centres without regard for the capacity of the work centres. This can lead to order overloads during certain time periods and under loads in others. One possible result of infinite loading is the formation of queues in some work centres. Finite loading projects include actual job starting and stopping times at each work centre, taking into account the capacity of each work centre and the processing times of jobs, so that capacity is not exceeded. One output of finite loading is the detailed projection of hours during which each work centre will operate. Schedules based on finite loading may often have to be updated, perhaps daily, due to processing delays at work centres and the addition of new jobs or cancellation of current jobs (Stevenson, 2007:726).

Taking finite loading into account, managers may need to prepare some response to overloaded work centres. Some possible responses are shifting work to other periods or other work centres, working overtime, or contracting out a portion of the work (Poonia, 2010:23). This may allow the work centre to increase capacity and to actually meet the work load. Finite loading may reflect a fixed upper limit on capacity (Landvaster, 1997:195). A manufacturer may have one specialised machine that it operates around the clock. Thus, it is operated at the upper limit of its capacity, so finite loading would be called for.

2.11 Schedule chart

Among the two types of scheduling regime which may be considered before the schedule attempt to overcome constraints, forward and backward scheduling. Forward scheduling is mostly used if the issue at hand is the length of time it will take to complete the job. According to (Dechter, 2010:461) forward scheduling is performed in the increasing direction of time while the backward scheduling is done is the decreasing direction of time. Backward scheduling is used if the issues concern the latest time and date that a particular job can be started to still be completed by the due date (Uyttewaal, 2003:276). Schedule charts are often used to monitor the progress of a job. The chart indicates which jobs in the operation process are on schedules, and which jobs within the process are behind or ahead of schedule.

The Schedule chart is not without limitations, the common one being the need to repeatedly update a chart to keep it current. A chart does not directly reveal costs associated with alternative loading. The processing time of a particular job may vary depending on the work centre, while certain work centres may be capable of processing some jobs faster than other work centres. Such a situation would increase the complexity of evaluating alternate schedules. Managers often rely on input or output reports to manage the work load (Davis and Heineke, 2005:622). Problems that are normally encountered when scheduling low-volume production call for certain techniques to deal with the problems.

2.12 Priority rules

Priority rules are used when only one machine or one work station is considered. Any rule may be applied to determine the processing sequence, although the best-known rules include the first-in-first-out, last-in-first-out, shortest processing time, largest processing time, earliest due date first and according to the critical ratio. Critical ratio is the ratio that examines the relationship between the time remaining up to and includes the due date for the order and the processing time. The job with the smallest critical ratio is processed first. If the critical ratio is smaller than one, the job is already late; if it is equal to one, just enough time is left for the processing; and if it is greater than one, more than enough time is available than is required for processing.

2.13 Johnson’s rule

In various operations, short-term scheduling is still more of an art than a science. Although mathematically optimising approaches have been developed in certain specialist applications, the optimising model can usually only be used for the simplest of applications. One such optimising rule is Johnson’s rule. This applies to the scheduling of a certain number of jobs through the work centres (Davis and Heineke, 2005:617). The algorithm ensures that the optimal sequence is found and that the sequence will minimise the total processing time. Johnson’s algorithm has as its point of departure the existence of a fixed sequence according to which the job moves through the work centre or machine.

It is possible that some jobs may be processed by only one of the work centres or machines. Chase and Jacobs (2011:671) identify a four step process that makes up the Johnson’s rule. The first step involves the listing of operation processing times for each job on both or all machines. Second is the selection of the shortest operation processing times. The third step is: If the shortest time is for the first machine, the job must be done first. If the job is for the second machine, the job must be done last. In the case of a tie, the job on the first machine must be done first. Both second and the third steps must be repeated for each of the remaining jobs until the sequence is complete.

2.14 Job sequence

The processing of a complete product may require various machines and various additions at different work stations. An individual type or part in a designated work station needs to be processed for a specified length of time at each machine in a prescribed sequence of machines. Machines may need set-ups when changing between part types and parts may incur a variable transportation delay when moving between machines and work stations. The objective behind job sequencing is to dynamically schedule all the machines in a way that all the part types are produced at the designated rates while maintaining buffer sizes at all machines (Kumar and Seidman, 1990:289).

Job sequence looks at the process of determining the job order on some machine or in some work centres. It is usually used hand-in-hand with priority rules. Priority rules can be very simple, requiring only that jobs be sequenced according to one piece of data such as processing time, due date, or order of intervals. Johnson's rule applies to job scheduling on a sequence of machines and requires a computational procedure to specify the order of performance. Whether the approach to loading is finite or infinite, when work arrives, a decisions must be taken on the work order of the job. The priorities given to work in operations are often set by some predetermined set of rules.

Operations will, at times, allow an important or aggrieved customer order to be processed prior to others, irrespective of the order arrival of that particular customer. This approach is typically used by operations whose customer base is skewed, containing a mass of small customers and a few large, very important customers. However, sequencing work by customer priority may mean that large volume customer service receives a very high-level service, but service too many other customers is eroded. This may lower the average performance of the operations if existing work flows are disrupted for important customers. It can also erode the quality and productivity of the operations, making it less efficient overall.

Prioritising by due date allows the work to be sequenced according to when it is due for delivery, irrespective of the size of each job or the important customer. Due date sequencing usually improves the reliable delivery of an operations processes and improves the average delivery speed. However, due date sequencing may not provide optimal productivity, as a more efficient sequencing of work may reduce total costs. It can be flexible when new, urgent work arrives at the work centre. Some operations fulfil orders in the exactly the same sequence in which they arrive. In high-contact operations, arrival times may be viewed by customers in the system as a fair way of sequencing, thereby minimising customer complaints and enhancing service performance. Customers could be other work centres who await the products being produced in the prior work centres. Because there is no consideration of urgency or due date, some customers' needs may not be served as well as others. Delivery speed and delivery reliability, therefore, may not be of the highest priority. Constraints may be encountered when trying to achieve delivery speed along with reliability. Some departments may require more frequent and rapid delivery of components compared to others.

However, this race against time leads to reduced reliability. On the cost against benefit analysis, to create delivery schedules that are almost perfect in terms of their relevance and reliability can lead to undue effort. The result could be that the attained benefit is outweighed by the enormous cost to the entity. It is also difficult to be flexible in a system where this prioritisation is visible to customers. If the sequence is not physically visible, just like in manufacturing, it may be more likely to exercise some flexibility, allowing some work to jump the queue without other customers being aware of it.

2.15 Communicating the schedule

There is no one correct approach of communicating the schedule across the plant. The key to making the best choice is keeping the ultimate purpose of the finishing of final assembly schedule in mind, the simple and clear communication of work authorisation, specifications and priority. While no iron-clad rules are possible, some approaches to finishing and final assembly schedules are used more often in certain environments. In a business with a job shop organisation, low volumes, a high potential product mix, long lead times and a high need for proper sequencing, it is normal to see individual work orders and bills of materials travelling with the work to communicate work authorisation and specifications. Conversely, in environments with a flow-line organisation, high volumes, little product variations, and short lead times, manual or electronic-generated line schedules such as schedule boards communicate end-product priorities exist. Kanbans may be used to trigger work authorisation and signal priorities for all feeder lines and departments that supply the production lines (Proud, 1999:368).

Most distribution environments are somewhere between these two ends of the spectrum. The influence of continuous improvement programmes is pushing more job type environments towards the flow line scenario. It also pushes high-volume flow lines towards shorter and quicker runs that can be better supported by the vigorous use of kanbans in all upstream-process steps. Thus, there is something of a convergence of the two extreme models of processing. Kanban is a method of communicating to operations processes. Kanban control is one method of operationalising a pull-based planning and control system as it controls the transfer of material between the stages of operations. An order creates requirements for products which in turn pull material through the entire system of suppliers and production. In an ideal kanban system, nothing moves until an order is taken, but when the order does appear, every level of the operating system becomes the customer of the next lower level of processing. As the processing depletes material from the kanban container, the empty container becomes an order to refill, a source of demand pulling more of the same materials through the operations process. When the container is full, that sector of the processing system stops. The kanban system was designed as a simple but elegant way to tightly link processing with demand, thereby eliminating the need for costly inventory and finished goods for which there may be no demand (Sheldon, 2005:179).

Production Kanban is one type of kanban. It gives a signal to the production processes to start producing a part or item to be placed in an inventory. The information contained in this type of kanban usually includes the particular part's name and number, a description of the process, the materials required for the production of the parts, and the destination to which the parts need to be sent when they are produced. Vendor Kanban in turn is used to signal to supplier(s) to send material or parts onto a stage. Whichever kind of kanban is used, the principle remains the same which is that the receipt of a kanban triggers the conveyance, production, or supply of one unit or a standard container of units. If two kanbans are received, it triggers the conveyance, production or supply of two units or standard containers of units. Kanbans are the only means by which conveyance, production, or supply can be authorised. There are two procedures which can govern the use of a kanban. These are known as the single-card system and the dual-card system. The single card system is by far the simplest system to operate. It uses only Conveyance kanban or Vendor kanbans when receiving the supplies of materials from an outside source. The dual-card system uses both Conveyance and Production kanban (Davis and Heineke, 2005:357).

Large companies generally support production through a number of production plants. Final assembly and finishing are supported by separate production facilities. Good communication among plants and work centres is an important element in successful manufacturing. A problem of multi-plant communication which may stand out above others is that, lower level plant or work centres may have trouble controlling their own schedules, and are often harassed by the changing demand of the upper-level plants or work centres they serve. Unlike the independent company, which has a right of refusal with respect to customer demand, the lower-level plant as part of the large corporate machine typically cannot just say no to a demand from a finishing plant or a corporate office. Nor does it have much latitude in shifting or splitting orders or in sourcing the work. Overloading of schedules at lower-level plants is a typical result. When one work centre passes down an order to another work centre, its knowledge of the scheduling and manufacturing situation is often imperfect.

Lack of communication and general lack of insight into production problems at the lower-level plant provokes a number of management concerns.

Managers of lower-level plants would generally prefer a multi-plant system in which they have greater autonomy in meeting the requirements of high-level plants. That greater autonomy would give them control of their own schedule, the ability to negotiate movement and splitting of orders; the right to refuse an order, the same autonomy enjoyed by independent companies that must adhere to the sharp discipline of the marketplace if they hope to survive and prosper (Maritan, Brush and Karnani, 2004: 501). Multi-plant scheduling problems affect just about everyone, solving them is in the operation process's best interest.

2.16 Flow shop

Scheduling in the world of intermittent manufacturing is primarily concerned with getting material purchased, plant equipment and people ready to build up and order when the request come in. Scheduling is a fully-fledged planning process. From that point forward, everything else is executed through plant and supplier scheduling. With a few exceptions, the flow environment shifts much of the schedulers' work from preparing to building a product to the actual execution. The reason for this shift is that most intermittent manufacturing operations involve dozens of components, all with different lead times.

The flow environment is dominated by the optimisation of the manufacturing process. The goal of scheduling in the flow environment is less about matching up materials and resources against customer orders than about ensuring the efficiency of a manufacturing process that will produce a high quality output at the lowest possible cost (Proud, 1999:183). In high volume scheduling, decisions have to be made regarding the correct workloads for machines and workers, as well as the sequence in which the jobs are done. In high-volume systems, there is a high degree of standardisation of the equipment and the jobs undertaken. This may also apply to the warehousing and distribution industry, where a certain degree of standardisation exists. Chase and Jacobs (2011:200) suggests that such products are best product in an assembly line. Scheduling in this regard ensures the smooth flow of products through the process. This will ensure the highest possible usage of machines, people and material.

Line balancing plays a major role in the design phase of the system. Tasks are assigned to work stations so that all work stations have approximately the same amount of work. Line balancing is achieved by the allocation of required tasks to the correct work stations to ensure adherence to technical constraints that will further ensure the equal division of work among work stations. A balanced line will also ensure the maximum usage of machines, people, and raw materials to produce the highest possible rate of output (Kruger *et al.*, 2007:450).

A major concern when scheduling takes place is possible disruptions to the system. These disruptions will have to be considered when scheduling is done. The result will be that the desired output of the system cannot be reached. Disruptions can be caused by anything such as a machine breakdown, non-availability of materials, absenteeism, or industrial accidents. It then becomes difficult to increase output to compensate for the disruptions. The simple reason for this is that flow systems are designed to produce at a steady rate. In overcoming such problems, overtime could be offered or subcontracting to other organisations.

2.17 Conclusion

This chapter began by defining scheduling and discussing the importance of short-term scheduling. Scheduling involves the timing of operations to achieve the efficient movement of units through a system. In this chapter several aspects and approaches to scheduling, loading and sequencing of jobs were introduced. These approaches range from the Gantt Charts and the assignment method of scheduling to a series of priority rules, Johnson's rule for sequencing and finite capacity scheduling.

CHAPTER THREE
RESEARCH METHODOLOGY

3.1 Introduction

This chapter aims to outline the research methods that will be used in carrying out the study. It focuses on: research objectives and hypothesis; research approach and design; research settings, research population and sampling; data collection; reliability and validity; and just before concluding it looks at ethical considerations.

3.2 Research objectives and hypothesis

Objective One: To understand the dynamics of short-term scheduling from the inbound operations through to the outbound operations within the warehouses and distribution centres' system integration with suppliers

$H_0$1: There is no relationship between capacity management strategies and the warehouse space

H_a1: There is a relationship between capacity management strategies and the warehouse space

$H_0$2: There is no relationship between handling logistical variables and the workstation

H_a2: There is a relationship between handling logistical variables and the workstation

$H_0$3: There is no relationship between outbound operations and predefined departure times

H_a3: There is a relationship between outbound operations and predefined departure times

Objectives Two: To establish the magnitude of information sharing among work stations and supply chain partners within the scheduling perspective.

Objective Three: To understand on-performance targets, the role of short-term scheduling on the challenge of bottleneck operations, work processes and cycle times.

3.3 Research strategy

This study combines a theoretical framework with field investigations. In order to assess the research objectives and questions with regard to theoretical framework, the principal sources are journals, articles, relevant books and the Internet. Two common types of research methodologies have been identified: qualitative research and quantitative research. Qualitative research is scientific research approach that seeks to answer the questions the researcher requires responses to, which systematically uses a predefined set of procedures to answer the questions through the collection of evidence (Churchill, Brown and Suter, 2010:150). This has the added advantage of producing results that are not predefined and are applicable beyond the immediate boundaries of the study (Berg, 2004:70). Qualitative research seeks to provide an understanding of a given research problem or topic from the perspective of the local population. It asks where, when, how and under what circumstances certain behaviour comes into being. In contrast, quantitative research aims to define the relationships that may otherwise exist between the dependent and the independent variable. Quantitative measures are required for more rigorous tests of hypotheses (Pekrun, Goetz, Titz and Perry, 2010:91). This research methodology indicates the relationship, but does not explain why the relationship exists. Its main concern is to quantify relationships between variables. This study 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, supervisory level and the entire workforce within the warehouse and distribution centre who were available to participate in the study.

The study uses univariate analysis, as it summarises data by examining: the frequency of distribution; descriptive statistics in the form of measures dispersion (kurtosis); measures of central tendency; the behaviour of a random variable in terms of the degree of peakedness (Wegner, 2007:98). The bivariate and multivariate approaches are used to establish the degree of the association among the variables. In order to describe the basic features of the large amount of data collected for this study, the study uses descriptive statistics. Such statistics reduce a great deal of data on a variable into a simpler summary that enables comparison across the sample elements (Wegner, 2007:5). Inferential statistics will only be used to reach conclusions that extend beyond the immediate data.

In summarising the cross-sectional data under univariate analysis, the study uses distribution (frequency distribution, frequency histograms, symmetry and skewedness). Distribution can be positively or negatively skewed and be measured according to a central tendency (mean, median and mode) and dispersion (variance and standard deviation). The mean is the arithmetic average value of the responses on a variable (Churchill, *et al.,* 2010:430). The median is the score found at the exact middle of the set of values. It informs the study that fifty per cent (50%) of the values lies below a particular range (Wegner, 2007:61). The mode is the most common value in the sample.

The study will be conducted using a non-probability sampling design. Schiffman, Kanuk and Wisenblit (2010:122) recognise that the selection of respondents from a particular group in a non-probability sample, take place in a form of non-random fashion based on the researcher's decision. The sample under examination is determined in advanced. This implies that the findings of the study cannot easily be generalised to the entire population under study. Convenience and judgment sampling will be used in this study. Churchill *et al.,* (2010:152) defines convenience sampling as the process whereby people are selected for the sample based on their availability. This may be as a result of the participants being conveniently available at the right place, at the right time where the study will be conducted. In this study, the targeted population will be conveniently available at all working stations within the warehouses, distribution centres and logistics companies.

In judgement sampling, elements are handpicked by the researcher because it is expected that they are able to serve the study purpose. The elements of the sample need to fulfill specific criteria in order to be included in the sample (Sekaran and Bourdie, 2010:274). The study will make use of quantitative methods to conduct study. Statistical inferences will be used to eliminate the possibility of human preferences, biases and perceptions which may influence the data captured. The study will analyse views on short-term scheduling in warehouses and distribution centres. Questionnaires will be sent to warehouses and distribution centres in Durban and Johannesburg respectively. The SPSS programme will be used to analyse the findings. The targeted sample size is 200. The sample will comprise all those who are conveniently available and are fit to participate in the study within the warehousing and distribution centres.

3.4 Research approach and design

The study will be conducted using a quantitative research approach. Quantitative research aims to determine the relationship between an independent variable and a dependent variable. Pekrun, *et al.,* (2010:94) view quantitative measures as measures that are needed for more labour intensive tests of hypotheses. Quantitative research has the ability to indicate the relationship that exists between two or more variables, but it does very little to explain why the relationship exists (Sale, Lohfeld and Brazil, 2002:44). This research method is mainly concerned with quantifying the relationship with variables.

3.5 Research setting

The study will be conducted in warehouses, distribution centres and logistics companies located in Durban and Johannesburg respectively.

3.6 Study population and sample

The study will be conducted using a non-probability sampling design. Schiffman, *et al.,* (2010:63) refers to a non-probability sample in which the population under study is predetermined in a non-random fashion on the basis of the researcher's judgement or decision to select a given number of respondents from a particular group. This sampling technique will use both convenience and judgement sampling.

3.6.1 Sampling criteria

Participants included in the sample will be selected in order to meet the specific criteria. For participants to form part of the sample, participants will have to be currently employed or working for a warehouse, distribution centre or a logistic company. Participants must have reasonable work experience (at least one year) and work in one of the workstations within the organisation. Participants can be male or female and must be willing to participate. The study will be conducted using a non-probability sampling design. Schiffman, *et al.,* (2010:124) notes that in a non-probability sample, the population under study is predetermined in a non-random fashion on the basis of the researcher's judgement or decision to select a given number of respondents from a particular group. This implies that the findings of the study cannot be easily generalised to the entire population under study.

Three companies that are major player in the frozen goods in Durban and Johannesburg were identified. The reason for choosing these three companies is based on the fact that they are the major players in the industry as third party logistics. Population was in proportion to their managerial size. The estimated population was 250 of those who hold the three levels of management positions. The researcher was looking at the size of the organization. They have a proportionate size which was aimed at getting 100 for the larger companies and approximately 50 from the smaller company.

In as much as there is a table produced by Krejcie and Morgan (1970:607) that may be used as guidelines in determining the sample size for study activities, Roscoe (1975:163) outlines a number of rules of thumbs that are in line with the table endorsed by Krejcie and Morgan (1970) that can be taken into consideration in determining the appropriate sample and sample size for behavioural study.

1. The use of statistical analyses with samples less than 10 is not recommended.
2. In simple experimental research with tight controls (for example matched –pairs design) successful study may be conducted with samples as small as 10 to 20.
3. In most experimental study, sample of 30 or more are recommended.
4. There is seldom justification in behavioural study for sample sizes of less than 30 or larger than 500.
5. Within these limits (30 to 500), the use of a sample about 10% size of the parent population is recommended.

3.7 Data collection

The study will make use of quantitative methods to conduct the study. Statistical inferences will be used to eliminate the possibility of human preferences, biases and perceptions which may influence the data captured. The study analyses views on short-term scheduling in warehouses and distributions centres. Data will be collected from warehouses and distribution centres in Durban and Johannesburg respectively in order to evaluate the view of warehouse and distribution centre staff on issues around short-term scheduling within the organisation. Questionnaires will be personally distributed by the researcher at the identified distribution centres where the permission has been granted. The researcher will if possible on site during the completion of questionnaire by respondents. Respondent may also complete the questionnaire during their own time. The researcher will collect questionnaire during a stipulated time. According to Sekaran and Bougie (2010:195) a sample size of 132 is sufficient for a population size of 200.

3.7.1 Data collection instrument

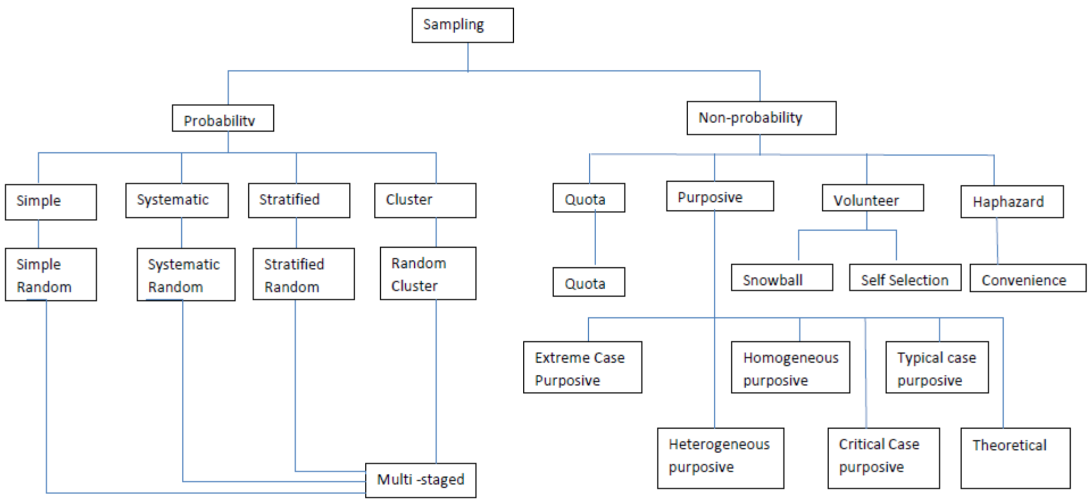
The use of a questionnaire is viewed as the most suitable means of gathering data, given that it ensures a high response rate. Information will be collected by administering a self-developed questionnaire prepared after consulting experts and reviews of literature which comprise of general information and various statements about warehouse and distribution centre management. Questionnaires will be distributed to respondents to complete and will be personally collected by the researcher on site. The purpose of using the questionnaire will be to ask information from employees of warehouses and distribution centres regarding short-term scheduling. The information and rating provided by the respondents will assist the researcher in identifying the dynamics of short-term operation scheduling in systematic supply chain distribution centres. The questionnaire is designed to take each respondent on average 10 to 15 minutes to complete. The questionnaire request respondents to indicate what is true for them as there is no right or wrong answer. The cover page in the questionnaire allows respondents to remain anonymous. The disclosure by the respondent is optional. An annexure was attached to the questionnaire and it left the digression to the respondent to provide their identity or not. Non-disclosure does not invalidate the questionnaire, so long it is signed. Questions designed in the instrument will be closed-ended, which will make it possible to compare the respondents' responses. The questionnaire will be written in English, however the researcher will be on site to assist where further explanation and interpretation is required.

The questionnaire will be split into three sections. The first section will contain biographic data of the respondents where respondents will be required to mark with a tick or encircle responses that define them. The second section contains dichotomous questions regarding efficient scheduling of trucks and a more realistic view about the total operations of the warehouse. The third and final section is based on a Likert scale and relates to dynamic challenges of short-term scheduling that are encountered across the inbound operations right through to the outbound operations.

3.8 Sample technique

The process of going through a sample technique is done when the researcher aims to draw conclusions for the entire population after conducting a study on a sample taken from a sample population (Som, 1996:8). This can be accomplished by using randomised statistical sampling techniques or probability sampling. Saunders, Lewis and Thornhill (2012:261) categorises sampling technique s into probability or representative sampling and non-probability sampling

Figure 3.1: Sampling techniques



Source: Saunders, M. Lewis, P. and Thornhill, A. (2012) *Research methods for business students.* 6th ed. New York: Pearson

In probability samples the chance, or the probability, of each being selected from the population is known and is usually equal for all cases. For non-probability sample, the probability of each case being selected from the total population is not known (Saunders, *et al.,* 2012:262). Having chosen a suitable sampling frame and established the actual sample size required, the study would need to select the most appropriate sampling techniques to obtain a representative sample. Saunders *et al.,* (2012:270) identified five main techniques that may be used to select a probability sample. These techniques are simple random, systematic random, stratified random, cluster and multi-stage. Sampling techniques that may be used in selecting a non-probability sample include quota, purposive, volunteer and haphazard.

Convenience and judgement sampling will be used in this study. Churchill *et al.,* (2010:152) defines convenience sampling as the process whereby people are selected for the sample because they happen to be in the right place at the right time. In the study, the targeted sample will be conveniently available at all working stations within the distribution centres and logistics companies. In judgement sampling elements are handpicked by the researcher because it is expected that they can serve the study purpose. The elements of the sample need to fulfil specific criteria in order to be included in the sample (Sekaran and Bourdie, 2010).

3.9 Reliability and validity

3.9.1 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. Evaluating the reliability of any measuring instrument consists of determining the amount of the variation in scores is due to inconsistencies in measurement. A more reliable measurement instrument is more desirable, because this means it will not be heavily influenced by transitory factors that cause random errors. However a measure could be reliable, but not necessarily valid due to systematic error. The instrument may not be measuring the right thing but may provide consistent results. Therefore reliability is necessary, but not sufficient, for establishing the validity of the measure.

In measuring reliability, Cronbanch's Alpha coefficient will be used in this study as an estimate of measuring 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, 2008:293). 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 of the scale.

3.9.2 Validity

Churchill *et al.,* (2010:259) acknowledge three types of validation that one needs to consider when constructing a measurement instrument. Predictive validity will be used to look at the useful the measuring instrument can be as a predictor of some other characteristics or behaviour of the individual of which, at times, Churchill *et al.,* (2010:259) refer to as predictive validity or criterion-related validity. Content validity will be used in this study to looks at adequately the key important features of the study characteristics are captured by the measure. The third type of validity that will be used in the study will be applied to assess the competency of the instrument capturing the constructs and the traits it is supposed to be measuring. Establishing construct validity involves demonstrating that the measure highly positively correlates with other measures of the same construct, not correlated highly with other measures of other related constructs, and finally that it is related to other constructs in theoretically predictable ways.

3.10 Ethical consideration

Conducting study does not only require diligence and expertise, but integrity and honesty. This is done to respect, protect and recognise human rights in subject. To ensure that the study is within the ethical parameters, the study will be conducted with the approval of an UKZN ethical approval committee to ensure anonymity, confidence and determination. However, an option for those respondents wishing to reveal their identity, will be provided as well. The researcher will give all participating warehouses, distribution centres and logistics companies a letter requesting permission to carry out a research on the premises. The letter of approval will authorise the researcher to proceed with the study. All the data collected will be securely stored at the University of KwaZulu-Natal, and will be disposed in accordance with the instructions of the Ethical Clearance Committee.

3.11 Data analysis

After data collection, data will be organised and analysed. The data collection instrument comprised of only the closed ended questions. In analysing the closed-ended questions, a computer program called the Statistical Package for Social Sciences (SPSS) will be used. The following method will be used to analysed the data, ranging from Univariate, Bivariate and subsequent Multivariate.

3.11.1 Univariate data analysis

The study will make use of univariate analysis, as this summarises data by examining the frequency distribution; descriptive statistics in the form of measures of central tendency; and measures of dispersion (kurtosis) that describes the behaviour of a random variable in terms of the degree of peakedness (Wegner, 2007:98). Univariate analysis studies the contribution of each variable in a data set independently of the set of variables. It looks at the range of values, as well as the central tendency of the values. A pattern of responses to the variables is described. Each variable is described independently. As univariate analysis involves a single variable, it does not deal with causes and relationships. The major purpose of univariate analysis is to describe through the use of a central tendency (mean, mode, meadian), dispertion (range, variance, minimum, maximum, quantiles and standard deviation), frequency distribution and graphical presentation. (Nordyke, 2010:2).

In summarising, the cross-sectional data under univariate analysis, the study will use distribution (frequency distribution, frequency histograms, symmetry and skewedness) which can be positively or negatively skewed, measures of central tendency (mean, median and mode) and dispersion (variance and standard deviation).

The mean is the arithmetic average value of the responses on a variable (Churchill, *et al.,* 2010:430). The median is the score found at the exact middle of the set of values after the data has been arranged in an orderly manner. If there is no one value in the middle, the average of the two values in the middle is taken. The median is not affected by the extreme values. A median as a statistical form which is normally denoted as $\tilde{y}$ (y-tidle). It informs the study that 50 per cent (50%) of the values lies below a particular range (Wegner, 2007:61). The mode is the value that occurs most frequently in the sample. Not every sample has a distinct mode though. Sometimes the sample has two modes which representation is referred to as bimodal (Jackson, 2012:44). The mode is the only measure of central tendency that can be used for nominal data.

Standard deviation (σ^2) measures the variation of values around the mean. As the standard deviation is a square root of variances, it is always positive. A standard deviation of the sample will always be in the same units as the observations in the sample. However, the disadvantage of a standard deviation is that extreme values or outliers for that matter can have a substantial effect on the value of the standard deviation (Nordyke, 2010:25). A negative relationship exists between the sample size and the size of the standard deviation. An increase in the size of the sample, is associated with a decrease in the value of the standard deviation (Gravetter and Wallnau, 2013:207).

Table 3.1: Difference between univariate and bivariate

Univariate data	**Bivariate data**
• Involves a **single variable**	• Involves **two variables**
• Does not deal with causes or relationships	• Deals with causes or relationships
• The main purpose of univariate analysis is to describe	• The main purpose of bivariate analysis is to explain
• Central tendency - mean, mode, median • Dispersion - range, variance, max, min, quartiles, standard deviation • Frequency distributions • Bar graph, histogram, pie chart, line graph, box-and-whisker plot	• Analysis of two variables simultaneously • Correlations • Comparisons, relationships, causes, explanations • Tables where one variable is contingent on the values of the other variable • Independent and dependent variables

Lehman, A. O'Rourke, N. Hatcher, L and Stepanski, E. J. (2013) *JMP for basic univariate and multivariate statistics: methods for researchers and social scientist. 2nd ed.* North Carolina: SAS Institute Inc.

3.11.2 Bivariate data analysis

Both bivariate and multivariate approaches will be used to establish the degree of relationship between the variables. Johnson, Kemp and Kotz (2005:152) define bivariate data analysis as a statistical measure involving two variables in dealing with a causal relationship. Tables are used where one variable is contingent upon the values of the other. The Pearson correlation coefficient will be used to determine the relation between: the dependent variable; short-term scheduling and independent variables; order quantity; on-time delivery; information technology information dissemination; bottlenecks; cycle time and performance. The correlation will determine whether the variable should be included in the multiple regression. Burns and Grove (2001:256) agree that correlation determines the relationship between variables. In order to describe the basic features of the large amount of data collected for this study, the study will make use of descriptive statistics. Such statistics reduce a great deal of data on a variable into a simpler summary that enables comparison across sample elements (Wegner, 2007:5). Inferential statistics will only be used to reach conclusions that extend beyond the immediate data.

This section provides a picture of how two variables interrelate. The researcher in this section aims to determine whether there is a correlation between the variables in question. Following the examination of the distribution of individual variables, the next step is to look for a relationship among variables. As hypothesis testing tests the existence of variations between two sample distributions, it tries to define variation can be explained through random chance or not. In determining whether two distributions vary in a meaningful way, care needs to be taken in determining that differences do not just occur through random chance as this provides the opportunity for type one or type two error.

Cunningham and Aldrich (216:2012) refer to a type one error, also referred to as a "false positive", as the error of rejecting a null hypothesis when it is actually true. This may also mean that there is a difference when in actual truth there is none. A Type two error, also referred to as "false negative" is the error of failing to reject a null hypothesis when in actual fact it is false. This error implies that results in the study fail to observe a difference when in actual fact there is a difference.

H_0: $\mu = 0$

H_a: $\mu \neq 0$

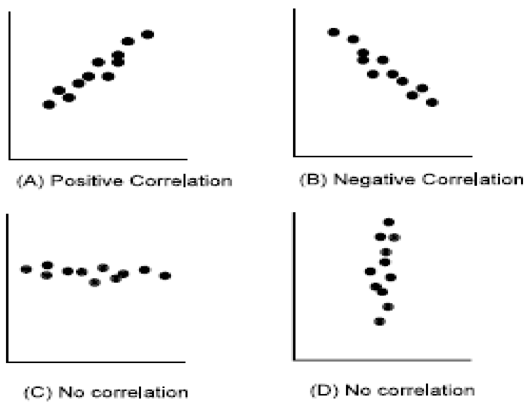
3.11.3 Factor Analysis

Factor Analysis will be applied the collected data to help categories the suitable items for each dimension of independent variable. Factor Analysis will assist to find factors among observed variables. Factor Analysis group variables with similar characteristics together.

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, 2008:175). 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.

3.11.4 Pearson correlation

The Pearson correlation coefficient quantifies the extent to which two quantitative variables go together. When an increase in one value is associated with an increase in the other variable, a positive association exist. However, when an increase in one variable leads to a decrease in the other variable, a negative correlation exists (Taylor, 1990:36).

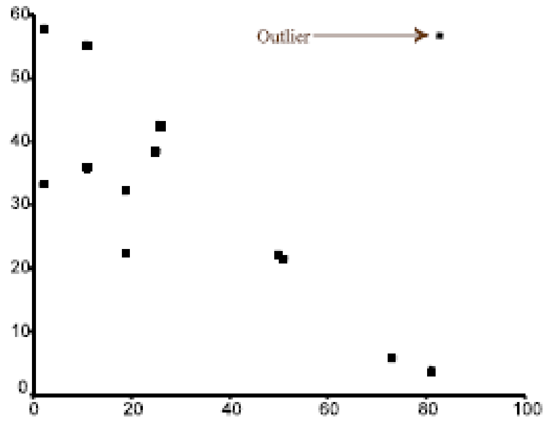


Source: Tukey, JW (1997). Exploratory Data Analysis. 3rd ed. United State of America: Addison Wesley, 43

Scatter plots may reveal:

- A positive correlation where a high value of an independent variability is associated with a high value of a dependency
- A negative correlation where a high value of an independent variability is associated with a low value of a dependent variability
- No correlation, where a value of an independent variability is not by any chance a predictive value of a dependent variable

In so much as the Pearson correlation provides the direction and the strength of the relationship, it does not provide the causal relationship (Tukey, 1997:43).



Source : Stan, M. H. Austin, A. V and Ku. H. H (1969) Precision measurement and calibration: Statistical concept and procedures. *International journal of commerce* **1**(300) 1-331

It is important to take note of the outliers in the observation. What can be said in terms of the observations depends on what can be learned and what is generally known. There is a great possibility that a lesson learned from the outlier is more important than the main objective of the study.

|r| = 0 Non relationship
0 < |r| < .3 Weak correlation
.3 < |r| < .7 Moderate correlation
|r| > 0.7 Strong correlation
|r| = 1 Perfect relationship

The Pearson correlation value determines whether the correlation is positive or negative. The magnitude of the Pearson correlation value determines the strength of the correlation. Valid values of the Pearson correlation are between minus one and positive one. Taylor (1990: 37) and Cooper and Schindler (2008) define larger correlation values closer to one as those indicating stronger relationships, whereas correlation values closer to zero indicate weaker relationships. A correlation value equal to zero indicates that there is no relationship, while a correlation value of one indicates a perfect relationship. The Pearson correlation coefficient works by providing a single summary number that indicates how an average amount that a person scores on a variable is related to another variable.

Statisticians including Higgins (2005:22) point out five assumptions for using the Pearson correlation coefficient:

1. Data on both variables is measured on either an interval scale or a ratio scale. An interval scale consist of data having equal intervals between points on the scales but

which do not have a true zero point, while ration scale data have both equal intervals between points on their scale and have a true zero point.

2. Traits being measured are normally distributed among the population. Even though data in the sample may not be normally distributed, there will be some level of certainty that if the data is collected from the entire population, the results would be distributed normally.
3. A linear relationship exists.
4. Scores on dependent variables are normally distributed across each value of the independent variable (Homoscedasticity).

3.12 Conclusion

The study will be conducted using a quantitative study approach. A questionnaire will be designed and administered by the researcher in order to collect the data from a convenient sample comprising 200 respondents. Due to time limitations in the specific industry the researcher had targeted, and to maximise responses, the questionnaire has only closed-ended questions. This will allow the researcher to receive targeted responses to the posed questions. However, it is noted that this may limit respondents and deny them the ability to contribute more to the research. The sampling characteristics include only those people who are employed by the warehouses, distribution centres and logistics, both males and females, who will voluntarily be willing to participate without expecting any form of remuneration.

Permission will be obtained from the organisations concerned. Consent will also be obtained from the subjects themselves. Confidentiality and anonymity will be ensured during the administration of the questionnaires. Questionnaires will be distributed to subjects to ensure validity. This chapter described the research methodology, including the population, sample, data collection instrument, as well as strategies to ensure ethical standards are met. Reliability of the research is also of concern and relevant tools are used to ensure reliability of the research.

CHAPTER FOUR
DATA PRESENTATION

4.1 Introduction

This chapter begins by describing the analysis of data through the discussion of study findings. The study is guided by the research questions that are directly related to the research findings. The data analysis is carried out with the objective of understanding, establishing and identifying the dynamics of short-term scheduling in systematic supply chain distribution centres. A self-administered questionnaire was used to collect data from the respondents.

The main idea in writing up this chapter is to present data obtained through an instrument used, a questionnaire in this case, into usable and useful information. The presentation, irrespective of whether the data is qualitative or quantitative, may describe and summarise data. This presentation may also indicate existence or non-existence of relationship between variables. Variables are compared, identify differences between variable.

4.2 Descriptive statistics

In transforming the data collected and giving it meaningful information, descriptive statistics were used. This involved describing the sample characteristics and the description of the study variables range, mean as well as standard deviation. Frequency distribution, mean, standard deviations were all included in the descriptive statistics. In ascertaining the existence of a relationship between short-term scheduling and bottlenecks in the manufacturing operations processes, the Pearson correlation coefficient was applied.

Descriptive statistics were used as they provide an accurate reflection of study characteristics such as beliefs, knowledge and opinions of subjects. This design was deemed suitable for the study as it required the knowledge and opinions of warehouse staff. Descriptive statistics is used in order to measure central tendencies and measures of dispersion (kurtosis) describes the behaviour of a random variable in terms of the degree of peakedness. If the mean is less than the mode, the distribution will be negatively skewed, (mean is less than the mode). A great amount of data in the distribution will lie towards the upper limit. If the mean is greater than the mode, the distribution is positively skewed, (Mean is greater than the mode). An extensive amount of data or respondents in the distribution lie towards the lower limit. The two cases represent an asymmetric case of distribution. If the mean is equal to the mode which is then equal to the median (mean is equal to the mode which is equal to the median), the distribution is normal and is often referred to as being symmetrical. The variables are centred around the mean.

Table 4.1: Descriptive statistics

	N	Mean	Std. Deviation	Skewed-ness	Median	Mode	Kurtosis
On-time delivery	104	4.12	.896	-.810	4.00	4	-.074
Information dissemination	104	4.02	.887	-.747	4.00	4	.401
Short-term scheduling	104	4.01	1.000	-1.010	4.00	4	.587
Cycle time	104	4.01	.859	-.899	4.00	4	.997
Order quantity	104	3.93	.906	-.904	4.00	4	1.379
Performance targets	104	3.93	.977	-1.051	4.00	4	1.071
Innovative tech	104	3.86	.970	-.682	4.00	4	.155
Bottleneck	104	3.73	1.053	-.708	4.00	4	.314
Workforce	104	3.51	1.052	-.434	4.00	3	-.162
Valid N (listwise)	104						

The number of non-missing values in the data output is depicted by the valid n (listwise). N represents the number of valid observations for the variables. The total number of observations is the sum of variable values (n values) and the number of missing values. Mean represents the arithmetic mean across observations. It measures the central tendency. It is however sensitive to extremely large and small values. Standard deviation is the square root of variance. Standard deviation represents the amount of deviation from the mean. The smaller the standard deviation, the more accurate future predictions are likely to be. It measures the spread of a set of observations. The larger the standard deviation, the more spread out the observations are likely to be. Skewedness measures the degree and direction of asymmetry. A symmetric distribution such as normal distribution has a skewedness of 0, and distribution that is skewed to the left when the mean is less than the median is negatively skewed. Kurtosis measures the heaviness of the tails of distribution. Extremely non-normal distribution may have high positive or negative kurtosis values, while nearly-normal distributions will have Kurtosis values close to zero.

Table 4.1, descriptive statistics; summarises all the information regarding the variable run to perform descriptive statistics. The table reveals that 104 respondents tackled questions relating to: on time delivery; order quantity; innovative technology and workforce. A total of 100 respondents took part in responding to questions relating to: Information dissemination; Short-term scheduling; Cycle time; Performance and Bottlenecks. The total number of valid observations as represented by the "N statistic" in Table 4.1, descriptive statistics said to be 100.

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 On-time delivery of orders creates an agile system within the warehouse. The standard deviation for On-time delivery is .896 which measures the spread of a set of observations. As the standard deviation for On-time delivery is .896, it is closer to one showing that the distribution of responses was spread out. The skewedness value provides an indication of symmetry of the distribution. The value being positive or being negative shows the direction where the data is clustered. A positive skewedness value indicates a positive skewness, values are clustered on the lower end with a long tail to the right. A negative skewedness value indicates a negative skewness where values are clustered on the upper end with a long tail to the left. The negative skewedness value for on-time delivery of -.810 indicates a negative skewedness with values clustered towards the upper end with a long tail to the left. Kurtosis provides information about the peakedness of distribution. A kurtosis value equals to zero indicates a perfectly normal distribution.

Positive kurtosis values indicate that the distribution is peaked, clustered in the centre, with a long thin tail. Kurtosis values below zero indicate a distribution that is relatively flatter, too many cases on the extremes. A negative kurtosis value of -.074 for on-time delivery indicated that the distribution was relatively flat, with too many cases on the extreme.

In the variable concerning information dissemination, participants were asked to rate the extent to which they regarded information sharing among supply chain partners as a way of enhancing integrated short-term scheduling of operations. One hundred participants responded to this question. The mean value for information sharing is 4.02 which is greater than the mode, 4, which is greater than the median, 4. On average, more than fifty per cent (50%) of the respondents agreed that information sharing among supply chain partners enhanced the integrated short-term scheduling operations.

Information dissemination with a negative skewedness statistic of -0.747 indicates that scores are clustered at the upper limit. The positive kurtosis value of 0.401 reflected that more values are clustered around the centre and have a long thin tail. The standard deviation statistic of .887 (which is closer to one) shows that the respondents' responses are spread across and not centred on a certain point. Information dissemination contributes significantly to the model.

One hundred (100) participants responded to the variable concerning short-term scheduling and cycle time. On average for both variables more than fifty per cent (50%) of the sample agreed with the significant contribution of these variables. The mean value for the short-term scheduling cycle time was 4.01 which were greater than the mode and the median. The distribution of responses was positively skewed. Respondents agreed that short-term scheduling addresses challenges of bottlenecks within the warehouses. Respondents also agreed that warehouse handling and storage operations have an influenced on the variability of inbound and outbound cycle time processes.

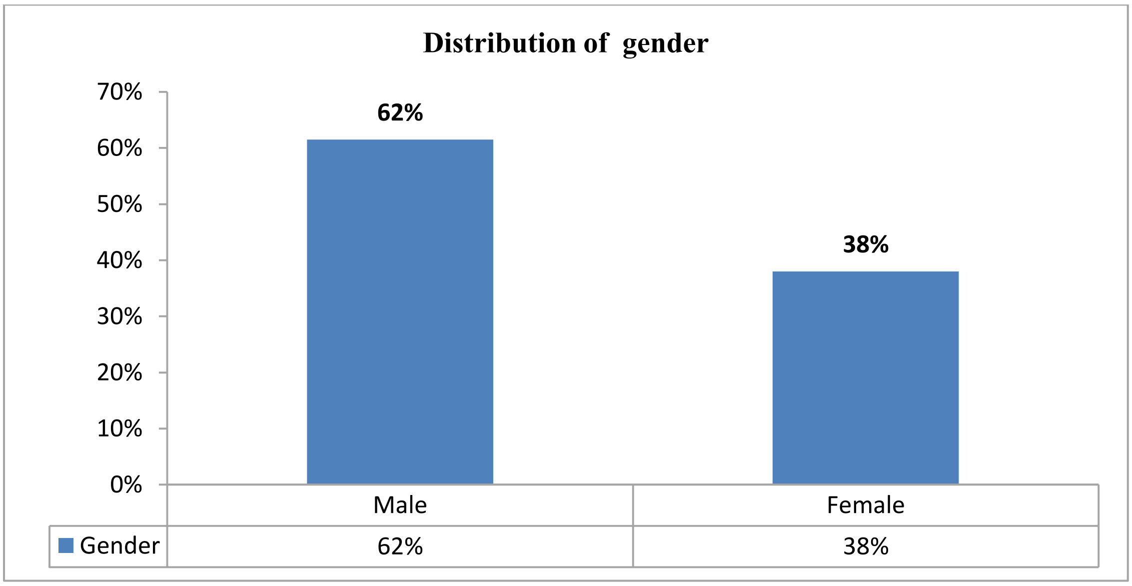
Workforce had the lowest mean of all the variables – seating at 3.51. This can be attributed to the highest number of respondents who participated in responding to the question surrounding the workforce in viewing the dynamics and challenges of short-term scheduling encountered across the inbound right through to the outbound operations processes.

Respondents were asked to indicate whether they agreed or disagreed with the notion that management of the labour workforce is related to the variability of the inbound products. Standard deviation represents the amount of deviation from the mean. The mean value for the workforce was the lowest of them all and was less than the mode (which is less than the median). Less than fifty per cent (50%) of the respondents agreed with the management of the labour workforce being related to variability in the inbound product. The smaller the standard deviation, the more accurate future predictions are likely to be. The workforce standard deviation statistic was 1.052, which was relatively higher than the other standard deviation values, with the exception of bottlenecks which had the highest standard deviation value of 1.053. This indicates that more inaccurate future predictions are likely to be observed as there is possible variation. The variable contributes importantly to the model, however the large amount the data may get, is likely to affect the variation for the workforce variable.

4.2.1 Frequency distribution

This part of the study does not entirely affect the purpose of the study; however it was intended to describe the biographic details and job characteristics of the sample to assess any potential influence on the research findings.

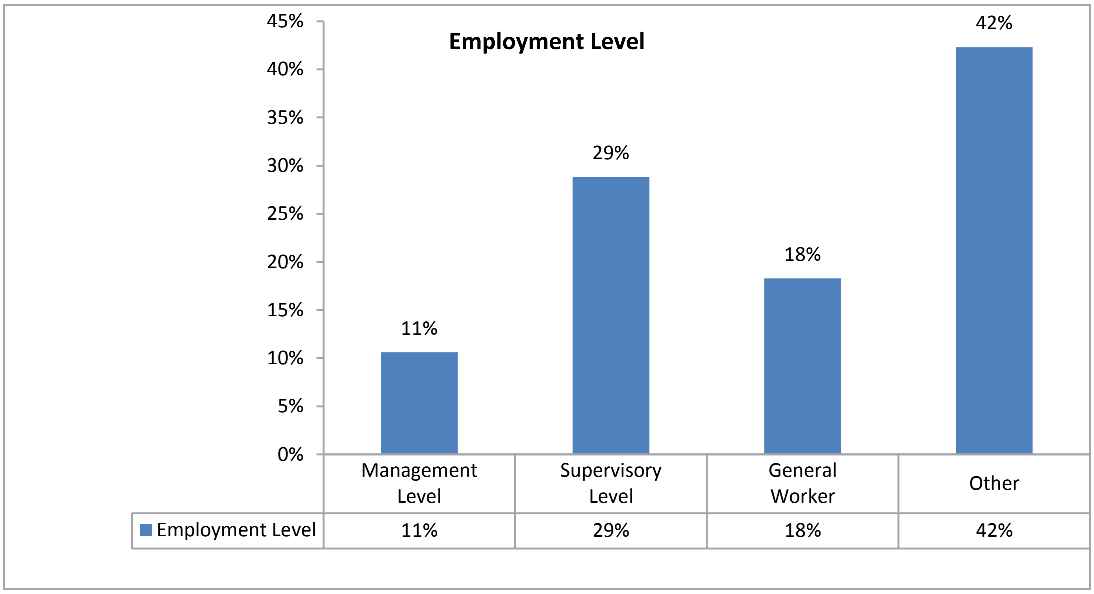
Figure 4.1: Distribution of gender



Sixty-two percent of the sample as shown by figure 4.1: Distribution of gender were males, while 38 percent of the respondents were females. The distribution of gender representation was sampled across participants. The study tried by all means possible to balance the distribution of gender representation in the sample, however due to the industry being male dominated, the sample ended up with more males than females. It is worth noting that it was not the intention of the researcher to structure the sample in this way.

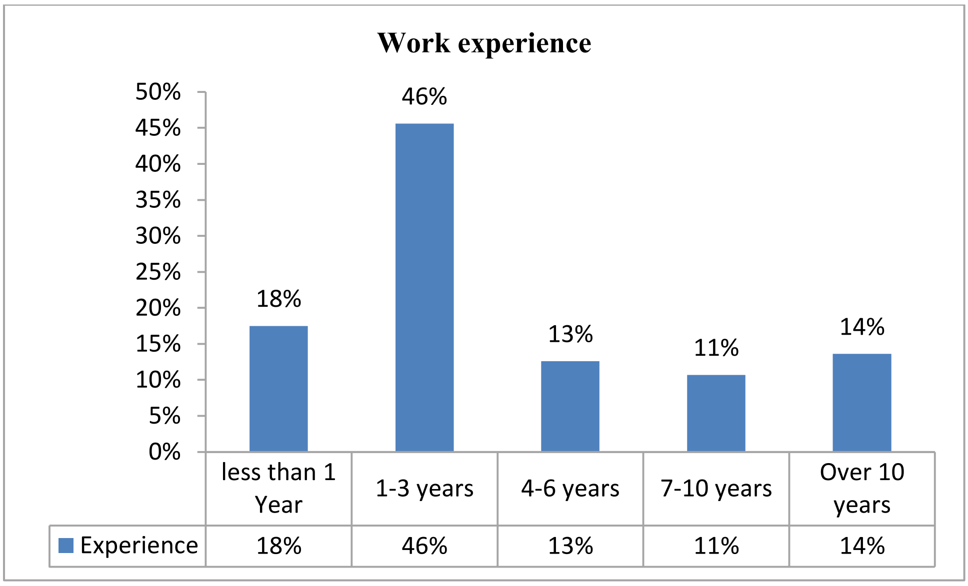
While the study does not place much emphasis on distribution of gender, the inclusion of gender in the study is merely to integrate gender and socio-cultural differences in all phases of the study. The use of Distribution of gender in the context of this study refers to not just socio-cultural differences, but extends to biological differences between males and females.

Figure 4.2: Employment level



Different levels of employment are exposed to different activities within the organisation. The environment in which individuals works and the exposure they have allow them to view things in a different way. The response from employees working on the operational side was anticipated to be in line with those on the strategic side. Figure 4.2: Employment level depicts the level of employment of those participating in the study. A significant number of respondents (forty two per cent (42%)) chose ‘Other’ when asked to indicate their employment level in the organisation. Although this aspect was not part of the study, the researcher was privileged to discover that most employees did not know their ranking in the organisation, while some were uncomfortable being ranked as ‘General workers’. As a result, a substantial amount of respondents decided to indicate themselves as ‘Other’ when prompted to indicate their employment level in the organisation. The instrument presented to collect data made a provision for those who pick other to specify their level of employment should it not be one of the options. Some of the respondents that ticked other indicated that they are at the lower management level responsible be operations that range from fork lifts shift operators, administration for the department, truck operations, outbound operation , transport clerks and drivers. The information presented in figure 4.2: Employment level, indicated that twenty 29% of participants were at Supervisory level, followed by eighteen per cent (18%) who were General Workers, with the lowest number of participating 11% at Management level.

Figure 4.3: Work experience



Work experience plays a role in the way participants responded to the questionnaire. This may be as a result of various factors, among which may be the rotation among workstations, involvement in different workshops and insights and knowledge generated during the period of employment. For the purpose of this study, the researcher only focused on the participants' years of work experience in the current warehouse or distribution centre they worked and therefore not the cumulative work experience from previous employers. This data does include the current year (2013) in which the study is being conducted. Forty six per cent (46%) of participants indicated that they have been with the current warehouse or distribution centre for longer than a year, but less than three years. Eighteen per cent (18%) of respondents have been with the warehouse or the distribution centre for less than a year.

Figure 4.4: Workstations

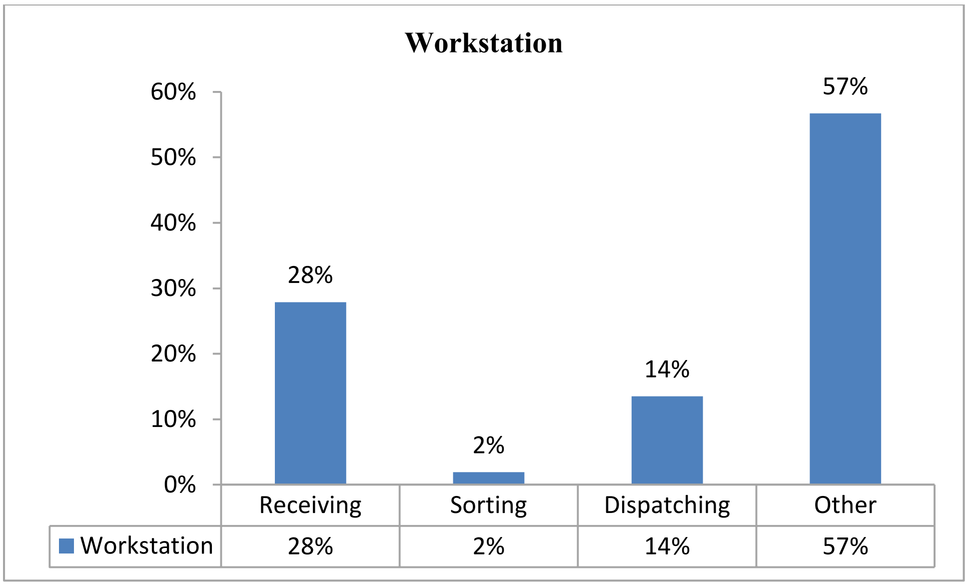
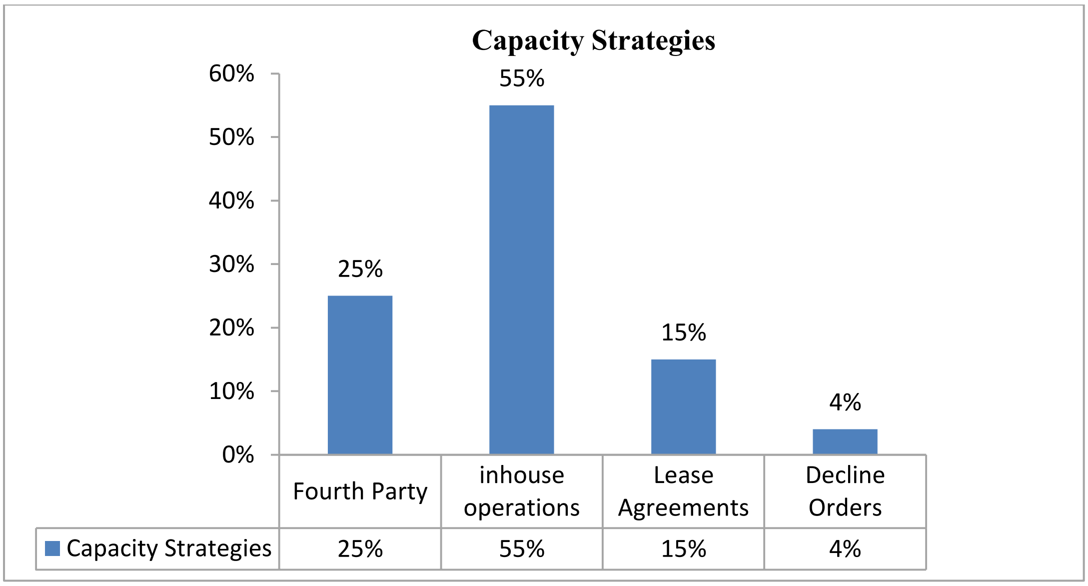


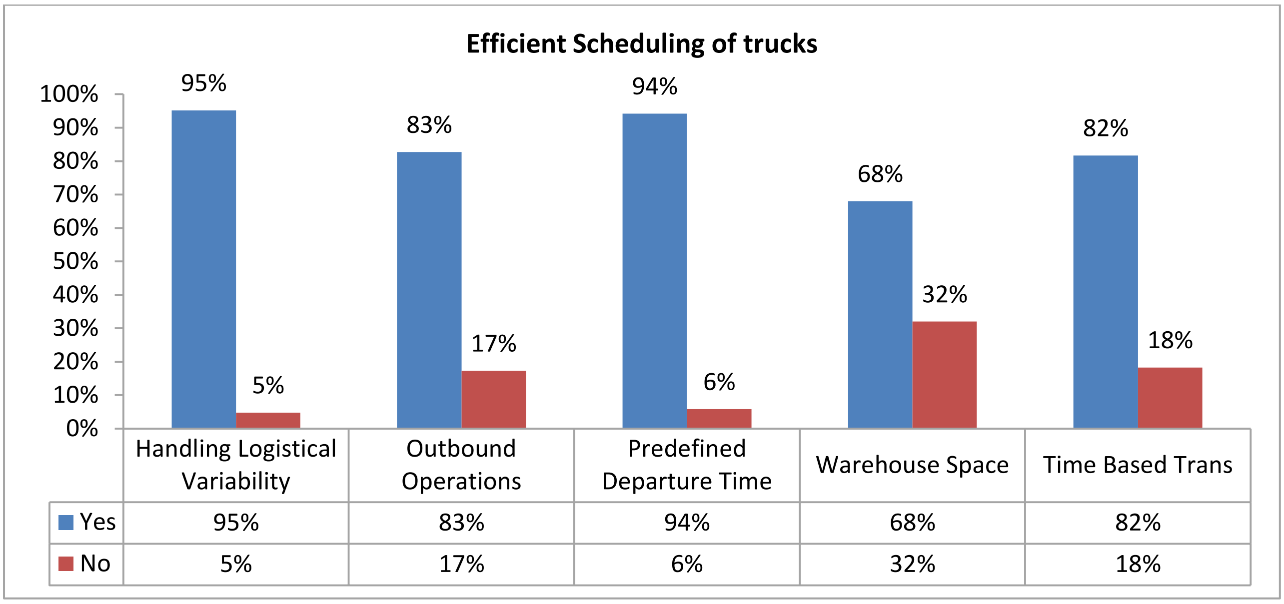
Figure 4.4: Workstation depicts the number of employees in each section within the warehouse or distribution centre. Two points that the study primarily targeted were the inbound and outbound sections. The inclusion of data on workstations is to view the flow of communication across the organisation. Further to that, a view of consistency across the organisation is oath to be provided by collecting of data from different work stations. Twenty eight per cent (28%) of the respondents who participated were stationed in the Receiving area, while fourteen per cent (14%) of participants are responsible for Dispatching. A very small percentage, two per cent (2%) of participants work in the Sorting division, while fifty seven per cent (57%) of respondents indicated that their area of employment was not provided in the research instrument, and as a result indicated 'other' and wrote their specific employment areas. The work stations ranged from sales, orders, admin, (strategic) supply chain, reverse logistics, call centre, Finance, truck tracking, controller, distribution , transportation some ticked other without specifying their workstation but this did not invalidate their responses. A combination of workstation was not provided as an option in the instrument. Some of the top management respondents were responsible for a combination of workstation and they indicated the combination of the workstations they are responsible for under other, such as sorting and distribution. The consideration of other work station played a considerable role as it provided an overview of the entire distribution centre.

Figure 4.5: Capacity strategies



Capacity management is viewed as a vehicle to achieve current and future capacity and performance aspects of the business requirements in the most cost effective manner. Figure 4.5: Capacity strategies looked at the strategies that an organisation may use in order to manage capacity in the warehouse. Four strategies were presented as options that participants could choose from. The participants were not given the option to choose ‘None’ unless they chose to omit answering the question. Of the four strategies provided as options, ‘In-house operations’ received responses as the one strategy most used for capacity management. Fifty five per cent (55%) of respondents indicated that their organisations rely on in-house operations in managing capacity. The second highest response was the use of integrated service providers, which was indicated by 25% of the respondents to be a strategy considered in managing capacity. A very small percentage opted ‘Decline Orders’ as an attempt to manage capacity. In an engagement with the respondents, most did not favour this method, feeling that it could reflect negatively on future potential business.

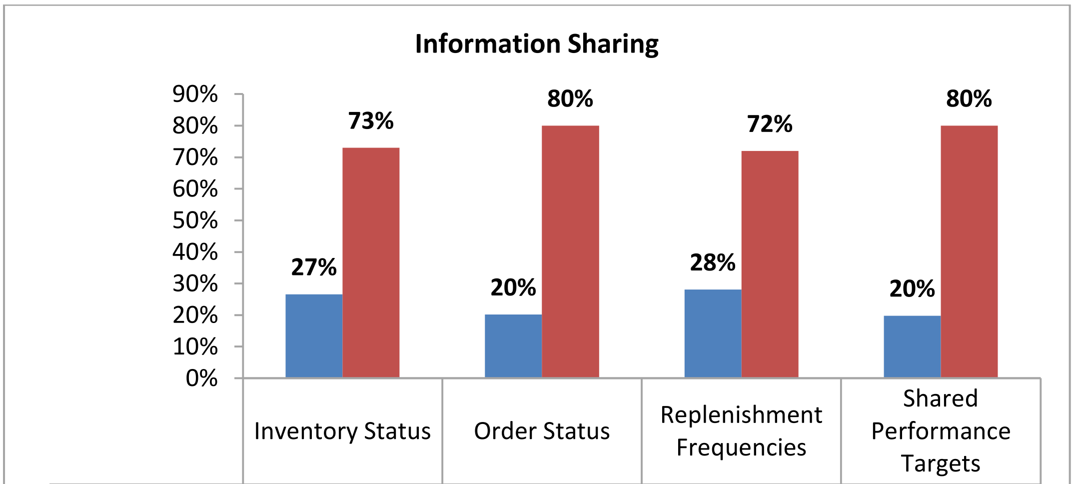
Figure 4.6: Efficient scheduling of trucks and a more realistic view of the total operation time of the warehouse



Scheduling does not only need to take place within the facility of operations. Figure 4.6: Efficient scheduling of trucks and a more realistic view of the total operation time of the warehouse; looks at the views of respondents regarding efficient scheduling of trucks, taking into consideration the total operation time. Ninety five percent (95%) of the respondents agreed that managing scheduled inbound products to the warehouse is considered as a viable way of handling logistical variability. Five per cent (5%) disagreed with the view of handling logistical variability through managing inbound scheduled products. Ninety four per cent (94%) of the respondents indicated that the scheduling of outbound trucks in advance (on a predefined departure time) does in deed contribute to the total operation time of warehouse operations. Contrary to that, six per cent (6%) disagreed with the outbound trucks being scheduled in advance on a predefined departure time.

Eighty three percent (83%) of the participants indicated that outbound operations attract more attention as compared to inbound, considering the proximity to the downstream customer. About seventeen percent (17%) disagreed with the view of outbound operations attracting more attention versus inbound, despite the proximity to the downstream customers. 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. Eighteen per cent (18%) of respondents indicated that there is no 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, 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 no sufficient space inside the warehouse, despite the demand level.

Figure 4.7: Information sharing

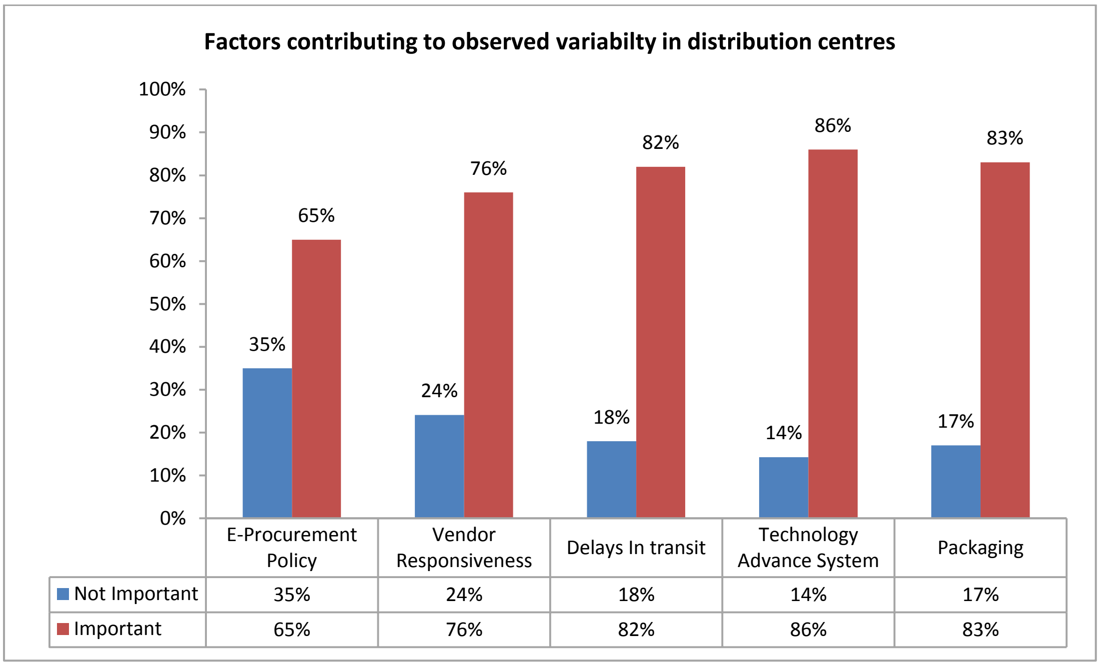


	Inventory Status	Order Status	Replenishment Frequencies	Shared Performance Targets
Not Important	27%	20%	28%	20%
Important	73%	80%	72%	80%

The availability of information technology has been proven to play an important role in the co-ordination of the supply chains. Sharing of demand information (downstream) with suppliers (upstream) has drastically improved supply chain performance in practice. The most evolving and significant changes in operations take places through the supply chain. Information dissemination vehicles have facilitated the process making it smooth and flowing. Through information technology, organisations are now able to share and integrate their processes, disseminate information, conduct business and be informed of the entire process. This tends to deliver better results (provided the process is well implemented) as it reshapes the organisation from within and results in much better and efficient channels.

About 73% of the sample indicated that it is important for workstations and other supply chain partners to have access to the inventory status. Respondents also indicated that it was important to share information regarding the order status, replenishment frequencies and shared performance. Eighty percent (80%) of the participants proved it to be important to share information relating to the order status and shared performances. Whereas seventy two percent (72%) said replenishment frequencies should be made available among other workstations, a notable twenty eight per cent (28%) of the sample felt there was no need to share replenishment frequencies. The information sharing among workstations and supply chain partners is solely for scheduling purposes, and occurs without any chance of risking any potential exploitation. The aim is to ensure reliable replenishment frequencies and to manage capacity.

Figure 4.8: Electronic systems



	E-Procurement Policy	Vendor Responsiveness	Delays In transit	Technology Advance System	Packaging
Not Important	35%	24%	18%	14%	17%
Important	65%	76%	82%	86%	83%

The supply chain refers to the planning and co-ordination of organisational activities from the primary stages, right through to the execution. The availability of electronic systems has significantly lifted a huge weight off the shoulders of some businesses. Participants in the study were asked to rank factors that they felt played a role in the variability of orders in the warehouse. Participants were given E-procurement policies; vendor responsiveness in determining order lead time and variability; delays in transit as a determining factor for delivery in the warehouse; and advance technology systems and vendor specifications in packaging.

Innovative technological systems were an important factor in determining fluctuation in orders within the warehouses, this factor was chosen by the most participants. A total of eighty six per cent (86%) of respondents felt in as much as advance technology systems are important for warehouse operations, they are the main reason there is variability in orders in the warehouse. Second to the advanced technology advance systems was packaging. Vendor specifications in packaging have resulted in eighty three per cent (83%) of participants agreeing that this causes variability in orders within the warehouse. Eighty two per cent (82%) of respondents indicated that delays in transit determine the warehouse delivery and this is important to curb the order variation being observed within the warehouse. Twenty four per cent (24%) of the participants in the study felt vendor responsiveness has nothing to do with the variability in the warehouse. Thirty five per cent (35%) of respondents all agreed that E-procurement policies do not contribute to order variability in the warehouse. A significant sixty five per cent (65%) though felt E-procurement has a part to play in the order variability being observed in the warehouse.

4.3 Inferential Statistics

4.3.1 Cross-tabulation

Objective one: To understand the dynamics of short-term scheduling from the inbound operations through to the outbound operations processes with the warehouse and distribution centres' system integration with suppliers.

$H_0 1$: There is a no relationship between capacity management strategies and warehouse space

$H_a 1$: There is a relationship between capacity management strategies and warehouse space

Fourth Party and warehouse space

Table 4.2, capacity management and warehouse space cross-tabulation shows that out of the Twenty four (24) who selected Fourth party; twenty two (22) respondents which is equivalent to ninety one point seven per cent (91.7%) agreed on the organisation's use of integrated service providers as a strategy to manage and provide enough capacity. These respondents also agreed that there was sufficient space inside the warehouse despite the demand level. They further indicated that the use of integrated service providers would always ensure that there was sufficient space within the warehouse, regardless of the demand level. Two respondents which is equivalent to eight point three per cent (8.3%) did not believe that the use of integrated service providers would in any way provide sufficient spacing within the warehouse.

Table 4.2: Capacity management and warehouse space

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Per cent	N	Per cent	N	Per cent
Capacity Management Strategies * Warehouse Space	99	95.2%	5	4.8%	104	100.0%

Capacity Management Strategies * Warehouse Space Cross-tabulation

			Warehouse Space		Total
			Yes	No	
Capacity Management Strategies	Fourth Party	Count	22	2	24
		% within Capacity Management Strategies	91.7%	8.3%	100.%
	In-house operations	Count	31	24	55
		% within Capacity Management Strategies	56.4%	43.6%	100.%
	Lease Agreements	Count	10	5	15
		% within Capacity Management Strategies	66.7%	33.3%	100.%
	Decline Orders	Count	3	1	4
		% within Capacity Management Strategies	75.0%	25.0%	100.%
Total		Count	67	32	99
		% within Capacity Management Strategies	67.7%	32.3%	100.%

Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	10.115[a]	4	.039
Likelihood Ratio	11.883	4	.018
Linear-by-Linear Association	1.341	1	.247
N of Valid Cases	99		
a. 5 cells (50.0%) have expected count less than 5. The minimum expected count is .32.			

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Phi	.320	.039
	Cramer's V	.320	.039
N of Valid Cases		99	

Table 4.2, capacity management and warehouse space cross-tabulation that make use of combination of percentages and absolute values in summarising results, shows that a total number of respondents who indicated that there was sufficient space within the warehouse , 22 respondents out of 67 (32.8%) believed that this was as a result of making use of integrated service providers to manage and provide capacity within the distribution centre. When looking at potential strategies that a warehouse may use to manage capacity, 22 respondents out of the 99 which represent twenty two point two per cent (22.2%) of the sample indicated that making use of integrated service providers does provide sufficient space inside the warehouse, despite the demand level.

In-house operations and warehouse space

Fifty six point four per cent (56.4%) of the respondents, as shown in table 4.2, capacity management and warehouse space cross tabulation, responding to the option of in-house strategy believed that making use of in-house operations had a relationship to the availability of space within the warehouse. Of those who selected in-house, forty three point six percent (43.6%) indicated that the warehouse did make use of in-house strategies in managing capacity; however this did not provide the warehouse with sufficient space within the warehouse given the level of demand. Forty six point three percent , 31 divided by 67, (46.3%) of respondents who indicated that capacity management strategies did provide the warehouse with sufficient space indicated that in-house operations could provide that space. Thirty one point three per cent, 31 divided by 99, (31.3%) of the sample believed that the use of in-house operations to manage capacity in the warehouse was related to the sufficient space inside the warehouse, despite the demand level.

Lease agreement and warehouse space

As per the table 4.2, capacity management and warehouse space cross tabulation, a lease agreement is one of the options a warehouse may have in place in order to manage capacity. Sixty six point seven percent (66.7%) of the respondents who indicated a lease agreement as a capacity management strategy, believed that this had a relationship with the sufficient space they had observed in the warehouse. Across all four strategies that were presented in the study as options for capacity management strategies (Fourth party; In-house operations; Managing capacity through additional lease; Decline orders once fully capacitated), fourteen point nine percent (14.9%) of all respondents (who indicated that these strategies have a relationship with the sufficient space in the warehouse) were in favour of a lease agreements. Ten point one per cent (10.1%) of the sample indicated that an additional lease an agreements have a place in the warehouse.

Decline orders and warehouse space

Table 4.2, capacity management and warehouse space cross tabulation, shows that out of those that selected decline orders (4), seventy five point one per cent (75.1%) of respondents (who indicated declining additional orders once fully capacitated as a capacity management strategy) believed that this have a relationship with the sufficient space being observed in the warehouse despite the demand level. Across all four options that were presented as strategies for capacity management strategies, four point five per cent (4.5%) of respondents indicated that declining additional orders (once fully capacitated) have a relationship with the sufficient space in the warehouse despite the demand level. Three per cent (3%) of the entire sample indicated that there is a relationship between declining additional orders once fully capacitated and the availability of sufficient space inside the warehouse despite the demand level.

When considering the warehouse space, 67.7% of the respondents said yes for enough warehouse space. Because the chi-square p-value < 0.05, reject the Null hypothesis (there is no relationship between capacity management strategies and response to warehouse space), and conclude that some relationship exist. This relationship can be seen from the fact that those selected in-house operations (and lease agreements to lesser extent, have a larger no vote for warehouse space than the other groups.

Table 4.3: Handling logistics variability and workstation

Case Processing Summary						
	Cases					
	Valid		Missing		Total	
	N	Per cent	N	Per Cent	N	Per cent
Handling Logistical Variability * Workstation	104	100.0%	0	0.0%	104	100%

Handling Logistical Variability * Workstation Cross tabulation							
			Workstation				
			Receiving	Sorting	Dispatching	Other	Total
Handling Logistical Variability	Yes	Count	29	2	14	54	99
		% within Handling Logistical Variability	29.3%	2.0%	14.1%	54.5%	100%
	No	Count	0	0	0	5	5
		% within Handling Logistical Variability	0.0%	0.0%	0.0%	100%	100%
Total		Count	29	2	14	59	104
		% within Handling Logistical Variability	27.9%	1.9%	13.5%	56.7%	100%

In this section the researcher was trying to determine whether each workstation considered managing scheduled inbound products to the warehouse as a viable way of handling logistical variability. Areas of employment that the researcher primarily provided on the research instrument were receiving, sorting, packing dispatching while anything that fell outside this, was considered as ‘other’. In responding to the research instrument, the researcher noted that some respondents were based in more than one workstation. Some respondents decided to opt for the option ‘other’ and indicated both.

Cross departmental, when considering all the respondents who said ‘yes’ to the statement that managing scheduled inbound products to the warehouse considered it as a viable way of handling logistical variability, table 4.3, handling logistics variability and workstation cross tabulation, shows that out of a total of 99, twenty nine point three per cent (29.3%) of those respondents were from receiving. One hundred per cent (100%) of respondents within the receiving area indicated that managing scheduled inbound products to the warehouse is considered a viable way of handling logistical variability. Twenty seven point nine per cent

(27.9%) of the sample who participated in the study were from Receiving and they all indicated that handling scheduled inbound products to the warehouse is considered a viable way of handling logistical variability. Respondents from various other workstations within the warehouse also agreed to the management of scheduled inbound products to the warehouse as a viable way of handling logistical variability. Fifty four point five per cent (54.5%) of the respondents (representing all departments) have answered 'yes' to this statement. The majority of the respondents, ninety five point five per cent (95.2%), indicated that managing scheduled inbound products to the warehouse is considered a viable way of handling logistical variability.

Table 4.4: Outbound Operation and Predefined departure time cross tabulation

Case Processing Summary						
	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Outbound Operations * Predefined Departure Time	104	100.0%	0	0.0%	104	100.0%

Outbound Operations * Predefined Departure Time Cross tabulation					
			Predefined Departure Time		Total
			Yes	No	
Outbound Operations	Yes	Count	81	5	86
		% within Outbound Operations	94.2%	5.8%	100%
	No	Count	17	1	18
		% within Outbound Operations	94.4%	5.6%	100%
Total		Count	98	6	104
		% within Outbound Operations	94.2%	5.8%	100%

The discussion in this section is centred around outbound operations. The researcher tried to determine which operations required more attention and resources as a result of them being busy. In the event that a certain operation was considered to be busy, a schedule of departure times of outbound trucks could play a role in resolving such a challenge.

Table 4.4, outbound operation and predefined departure time cross tabulation shows that out of a total of 86 of those who selected outbound operations ninety four point two per cent (94.2%) of the respondents agreed to outbound attracting more attention when compared to inbound (considering the proximity to the downstream customers have indicated that outbound trucks are scheduled in advance on predefined departure times). Out of all respondents who agreed on outbound trucks being scheduled in advance on predefined departure times, eighty two point seven per cent (82.7%) indicated that outbound attracts more attention compared to inbound (considering the proximity to the downstream customers). When looking only at the respondents who said 'no' to outbound trucks being scheduled in advance on predefined departure times, eighty three point three per cent (83.3%) disagreed that outbound attracts more attention compared to inbound (considering the proximity to the downstream customers). Out of those who responded to outbound operations, table 4.4, outbound operation and predefined departure time cross tabulation shows that seventy seven point eight per cent (77.9%) of the sample indicated the existence of a relationship between outbound operations and predefined departure times. Four point eight per cent (4.8%) of the sample disagreed that there is a relationship between predetermined departure times and outbound operations.

Ninety four point four per cent (94.4%) respondents as shown in table 4.4, outbound operation and predefined departure time cross tabulation who responded ‘no’ to outbound attracting more attention compared to inbound (considering the proximity to the downstream customers) indicated that outbound trucks are scheduled in advance on predefined departure times. Seventeen point three per cent (17.3%) of all the respondents who said ‘yes’ to outbound trucks being scheduled in advance on predefined departure times disagreed with the idea that outbound attracts more attention compared to inbound considering the proximity to the downstream customers. Sixteen point three per cent (16.3%) of the sample who responded ‘no’ to outbound attracting more attention (compared to inbound considering the proximity to the downstream) indicated that outbound trucks are scheduled in advance on predefined departure times. In total ninety four per cent (94%) of respondents indicated that there is a relationship between outbound operations and predefined departure times.

Objectives Two: To establish the magnitude of information sharing among work stations and supply chain partners within the scheduling perspective.

Table 4.5: Capacity management strategies and order status

Case Processing Summary					
	Cases				
	Valid		Missing		
	N	Percent	N	Percent	Percent
Capacity Management Strategies * Order Status	86	82.7%	18	17.3%	100%

Capacity Management Strategies * Order Status Cross-tabulation

			Order Status		
			Not Important	Important	Total
Capacity Management Strategies	Fourth Party	Count	4	17	21
		% within Capacity Management Strategies	19.0%	80.9%	100%
	In-house operations	Count	11	37	48
		% within Capacity Management Strategies	23.0%	77.1%	100%
	Lease Agreements	Count	1	11	12
		% within Capacity Management Strategies	8.3%	91.7%	100%
	Decline Orders	Count	1	3	4
		% within Capacity Management Strategies	25.0%	75.0%	100%

This section attempts to establish the magnitude of information sharing among workstations within the scheduling perspective. Four workstations were presented as an option for respondents to select from: Receiving; Sorting; Packing and Dispatching. Any other workstation that fell outside this scope was classified as ‘Other’.

Capacity management strategies and order status

Table 4.5, capacity management strategies and order status shows that out of those who selected capacity management strategies, eighty point nine per cent (80.9%) of the respondents indicated the use of fourth parties as a way to manage capacity, they also indicated that sharing of order status information is important. Twenty four point six per cent (24.6%) of respondents who indicated that sharing of order status information is important, indicated that making use of integrated service providers is a strategy that the organisation uses in order to manage capacity. Dissemination of information to forth parties enables the warehouse to manage capacity. Nineteen point seven per cent (19.7%) of the sample agreed that it is important to share order status information with forth parties to enable the warehouse to manage capacity.

Table 4.5, capacity management strategies and order status indicated that out of those who capacity management strategies, seventy seven point one per cent (77.1%) of respondents indicated that it is important to make use of an in-house operations strategy to manage capacity also indicated that it is important for supply chain partners to share order status information. Surprisingly sixty four point seven per cent (64.7%) of respondents who said it is not important to share order status among supply chain partners, indicated that it is not important to make use of in-house operations in their organisation to manage capacity. Forty three per cent (43%) of the sample indicated that it is important to share order status information and to make use of in-house strategies.

Out of those who selected lease agreement, ninety one point seven per cent (91.7%) of as shown in table 4.5, capacity management strategies and order status shows that respondents indicated that it is important for their organisations to manage capacity through additional lease. They also indicated that it is important for supply chain partners to share order status information. Only one point two per cent (1.2%) of the sample indicated that it is not important to share order status information to manage capacity through additional lease.

Of the respondents who indicated declining additional orders (once fully capacitated) as a capacity management strategy, table 4.5, capacity management strategies and order status shows, seventy five per cent (75%) indicated that it is important for the supply chain partners to share order status information among themselves. Five point nine per cent (5.9%) of respondents who indicated that it is not important for supply chain partners to share order status information status, indicated that declining order is not important to manage capacity. Eighty point two per cent (80.2%) of the sample indicated that it is important for the organisation to make use of capacity management strategies and to share information regarding order among supply chain partners.

Table 4.6: Workstations and Order status

Case Processing Summary						
	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Workstation * Order Status	89	85.6%	15	14.4%	104	100.0%

Workstation * Order Status Cross tabulation					
			Order Status		
			Not Important	Important	Total
Workstation	Receiving	Count	6	19	25
		% within Workstation	24.0%	76.0%	100.0%
	Sorting	Count	0	1	1
		% within Workstation	0.0%	100.0%	100.0%
	Dispatching	Count	0	9	9
		% within Workstation	0.0%	100.0%	100.0%
	Other	Count	12	42	54
		% within Workstation	22.2%	77.8%	100.0%

Warehouses and distribution centres comprise different workstations. An order placed moves from receiving right through to dispatching. This section is concerned with determining the magnitude of information sharing among workstations. An attempt in this case is to try and generate views of participants with regard to the importance of sharing of information among workstations. An assumption is made in this regard by the researcher that the kind of information shared will not pose any risk to any parties. This kind of information under discussion is to facilitate operations.

Table 4.6, workstations and Order status, shows that out of those who selected receiving seventy six per cent (76%) of participants agreed that it is important to share information relating to order status among workstations. However, the second to most of respondents who indicated that it is not important to share order status were from the receiving area. Thirty seven point five per cent (37.5%) out of those who selected receiving said it is not important to share order status were from the receiving area. Twenty one point three per cent (21.3%) of the sample indicated that it is important to share order status among work stations. This portion was from the receiving area.

As it can be seen in table 4.6, workstations and order status, all those who selected sorting agreed in full that it is important to share order status information among workstations. A very large percentage of respondents from various other departments also indicated the importance of sharing order status information. Seventy seven point eight per cent (77.8%) of respondents from various departments combined indicated the importance of sharing order status information among workstations. However a significant percentage, sixty six point seven per cent (66.7%) of respondents who said it is not important to share order status information were from said other departments. The researcher rejected the null hypothesis which states that there is no relationship between workstations and order status. Seventy nine point eight per cent (79.8%) of the sample deemed it important to share order status information.

Table 4.7: Warehouse space and inventory status

Case Processing Summary						
	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Warehouse Space * Inventory Status	79	76.0%	25	24.0%	104	100.0%

Warehouse Space * Inventory Status Cross tabulation

			Inventory Status		
			Not Important	Important	Ttotal
Warehouse Space	Yes	Count	13	41	54
		% within Warehouse Space	24.1%	75.9%	100.0%
	No	Count	8	17	25
		% within Warehouse Space	32.0%	68.0%	100.0%
Total		Count	21	58	79
		% within Warehouse Space	26.5%	73.4%	100.0%

The objective of this section is to establish if a relationship exists between the availability of sufficient space inside the warehouse given the demand level and sharing order status information. Should a relationship be established, this would provide response to questions about the efficiency of scheduling trucks and information dissemination among workstations.

Table 4.7, warehouse space and inventory status indicates that out of those who selected yes to warehouse space, seventy five point nine per cent (75.9%) indicated that there is sufficient space inside the warehouse believed that it was important for workstations to share order status information among themselves. Seventy point seven per cent (70.7%) of respondents who said it was important for workstations to share order status, also believed that there was sufficient space in the warehouse. Fairly close to that, sixty one point five per cent (61.5%) of the respondents who believed it was not important to share order status information, also believed there was sufficient space inside the warehouse.

Table 4.7, warehouse space and inventory status indicates out of a total of 25 of those who selected no to warehouse space, sixty eight per cent (68%) of respondents who believed there was no sufficient space inside the warehouse indicated that it was important to share order status information among workstations. However, thirty two per cent (32%) of participants who believed sharing order status was not important indicated that there was not sufficient space inside the warehouse. Seventy three per cent (73%) of the sample indicated that it was important to share order status information among workstations. Also, fifty one point nine per cent (51.9%) of the sample indicated that there was sufficient space inside the warehouse.

Table 4.8: Shared performance target and workstation

Case Processing Summary						
	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Per cent
Shared Performance Targets * Workstation	81	77.9%	23	22.1%	104	100 %

Shared Performance Targets * Workstation Cross tabulation							
			Workstation				Total
			Receiving	Sorting	Dispatching	Other	
Shared Performance Targets	Not Important	Count	3	0	3	10	16
		% within Shared Performance Targets	18.8%	0.0%	18.8%	62.4%	100%
	Important	Count	19	1	8	37	65
		% within Shared Performance Targets	29.2%	1.5%	12.3%	56.9%	100%
	Total	Count	22	1	11	47	81
		% within Shared Performance Targets	27.2%	1.2%	13.6%	58.0%	100%

Objective three: To understand on performance targets, the role of short-term scheduling on the challenge of bottleneck operations, work processes and cycle times.

This section of the study attempts to generate insights from the participants on whether workstations feel it is important or not to share performance targets and capacity for overall operations performance. Table 4.8, shared performance target and workstation shows that out of those who selected shared performance targets eighteen per cent (18%) of participants who indicated that it is not important to share performance targets and capacity for overall operations performance, were form receiving. About twenty nine per cent (29%) of respondents who indicated it was important to share performance targets were from receiving.

Table 4.8, shared performance target and workstation shows that out of those who selected dispatching, twenty seven point three per cent (27.3%) did not see the importance of sharing performance targets and capacity for overall operations performance. A look at all participants who feel it was not important to share performance and capacity for overall operations performance across all workstations, sixty two point four per cent (62.4%) represented various other departments combined. Participants from dispatching felt it was important to share performance and capacity for overall operations performance. This was indicated by the seventy two point seven per cent (72.7%) of respondents form dispatching.

4.3.2 Pearson Correlation

Table 4.9: Short-term scheduling correlations

Correlations									
		OQ	OTD	WF	IT.	ID	B	CT	PT
Short-Term Scheduling	Pearson correlation	.269**	.323**	.081	.203*	.478**	.338**	.541**	.342**
	Sig. (2-tailed)	.007	.001	.422	.043	.000	.001	.000	.000
	N	100	100	100	100	100	100	100	100

**. Correlation is significant at the 0.01 level (2-tailed). *. Correlation is significant at the 0.05 level (2-tailed).

OQ = Order Quantity; OTD = On Time Delivery; WF = Workforce; IT = Innovative Technology; ID = Information Dissemination; B = Bottleneck; CT = Cycle Time; PT = Performance Targets;

STS = Short-Term Scheduling; PT = Performance Targets

Burns and Grove (2001:256) defined correlation as the relation between two or more variables. The use of correlation in the study was to examine the relationship between the dependent variable namely short-term scheduling and independent variables comprised of order quantity, on-time delivery, workforce, innovative technology, information dissemination, bottleneck, cycle time and performance targets. The level of significance determines the statistical significance or insignificance of the variables. If the P-value is greater than the level of significant (P-value > 0.05), the researcher will fail reject the null hypothesis (H_0: which states that there is no relationship between variables (P value > 0.05 therefore reject H_0). In the event that the P-value is less than the significance (P value < 0.05), the study will reject the null hypothesis which states that there is no relationship between two variables (P value is less than 0.05 therefore reject H_0).

There is a statistically significant positive relationship between short-term scheduling and order quantity as can be seen in table 4.9, short-term scheduling correlations. The Pearson correlation (r) value is positive .269 and this indicates a very weak relationship. In addressing the challenges of short-term scheduling while influencing the inbound and outbound operations processes in the warehouse, it is likely that this would lead to having the ability to determine the quantity of orders required from the suppliers. This would create flexible capacity. The study fails to reject rejects the nulls hypothesis (H_0) as the significance level between short-term scheduling and order quantity is lower than as the P-Value (.007 > .001).

There is a weak positive relationship between short-term scheduling and on-time delivery. The Pearson correlation value is .323 and is positive. At a one per cent level of significance, table 4.9, short-term scheduling correlations indicates that there is a statistical significant relationship between the P-value for short-term scheduling and on-time delivery .001. The study in this case rejects the null hypothesis (H_0) which states that there is no relationship between short-term scheduling and on-time delivery. Addressing the challenges of short-term scheduling in influencing the inbound and outbound operations in the warehouse has little impact on having orders delivered on time to the warehouse when creating agile systems.

The relationship between short-term scheduling and the workforce has proven to be very weak. Very little can be done by short-term scheduling in order to manage the influence by workforce. The Pearson correlation between short-term scheduling and the workforce is .081, which is very weak. These correlates have also proven to be statistically insignificant as the P value is 0.422. These results are rejected by the study as the null hypothesis (which states that there is not relationship between short-term scheduling and workforce) refers to a very weak positive relationship – making it statistically insignificant.

There is a weak positive statistical relationship between short-term scheduling and innovative technology. The Pearson correlation value between these two variables is 0.203 and the P value is .043 which is statistically significant at a ninety five per cent (95%) level of significance. The study rejects the null hypothesis which states that there is no relationship between scheduling and innovative technology as the significant value of 0.05 is greater than 0.005.

There is a strong positive statistical relationship between short-term scheduling information dissemination. The Pearson correlation value is 0.478 and it is statistical significant with a P value of .000. The study fails to rejects the null hypothesis which states that there is no relationship between short-term scheduling and information dissemination. The significant value of .001 is greater than the P value of .000.

There is a strong positive relationship short-term scheduling, bottleneck, cycle time and performance targets. All three variables are statistically significant as their significant values are .001, 000 and 000 respectively. However, the researcher rejects the null hypothesis which states that there is no relationship between short-term scheduling bottleneck as the significant level of .001 is equal to the P value of .001. The researcher also rejects the null hypothesis which states that there is no relationship between short-term scheduling and cycle time, as well as short-term scheduling and performance targets.

4.3.3 Factor Analysis

Table 4.10: Factor analysis

Kaiser-Meyer-Olkin Measure of Sampling Adequacy					.779
Bartlett's Test of Sphericity			Approx. Chi-square		214.309
			Df		28
			Sig.		.000
	Component				
	1	2	% of Variance	Mean	Std Deviation
Factor 1:					
Order Quantity	.779			3.59	.903
Innovative Technology	.771			3.89	.952
On time Delivery	.644			4.10	.905
Information Dissemination	.562*			4.02	.887
			42.136		
Factor 2:					
Cycle Time		.773		4.01	.859
Performance Targets		.759		3.93	.977
Bottleneck		.697		3.73	1.053
			12.912		
*= Rounded off to .60; Total Variance Explained = 55.048					

4.3.3.1 Kaiser-Meyer-Olkin Measure of sampling Adequacy

The tests of 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, 2006:112). The data set is suitable for factor analysis as the KMO value is 0.779. According to Pallant (2007:190) the 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, 2000:446). The KMO statistic is said to range from 0 to 1. 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 are moderately solid as a result factor analysis and is more likely to provide mutual exclusive and more reliable individual factors.

In order to extract factors, the component analysis was used, and beyond that, for simplicity purposes varimax rotation was used. The idea behind the use of this model is supported by the fact that the method looks for loading values that bring the predictive of communality as close as possible to the total observed variances. 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 best us of the variance of the squared loadings for each, with the absolute goal of making certain loadings as greater where possible, and the remainder as small as possible in absolute values (Garson, 2012). The varimax solution produces outcomes that easily facilitate 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 (2007:182) 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 one four 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, the both factors together explain a fifty five point zero five per cent (55.05%) variance in the original data. An eigenvalue is met to show how much of the variance in total (for all the variables) is covered by the factors.

4.3.3.2 Rotated Component Matrix

The main goal for a factor analytic procedure is to minimise 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. Loadings of likert scales with 0.6 may just be required to be regarded “high”. Loadings greater than 0.6 (the upper limit) and those below the lowest limit 0.4, although one rule of thumb suggest loadings suggest 0.7 or higher to be confirmed that independent variables identified *a priori* are represented by a certain factor.

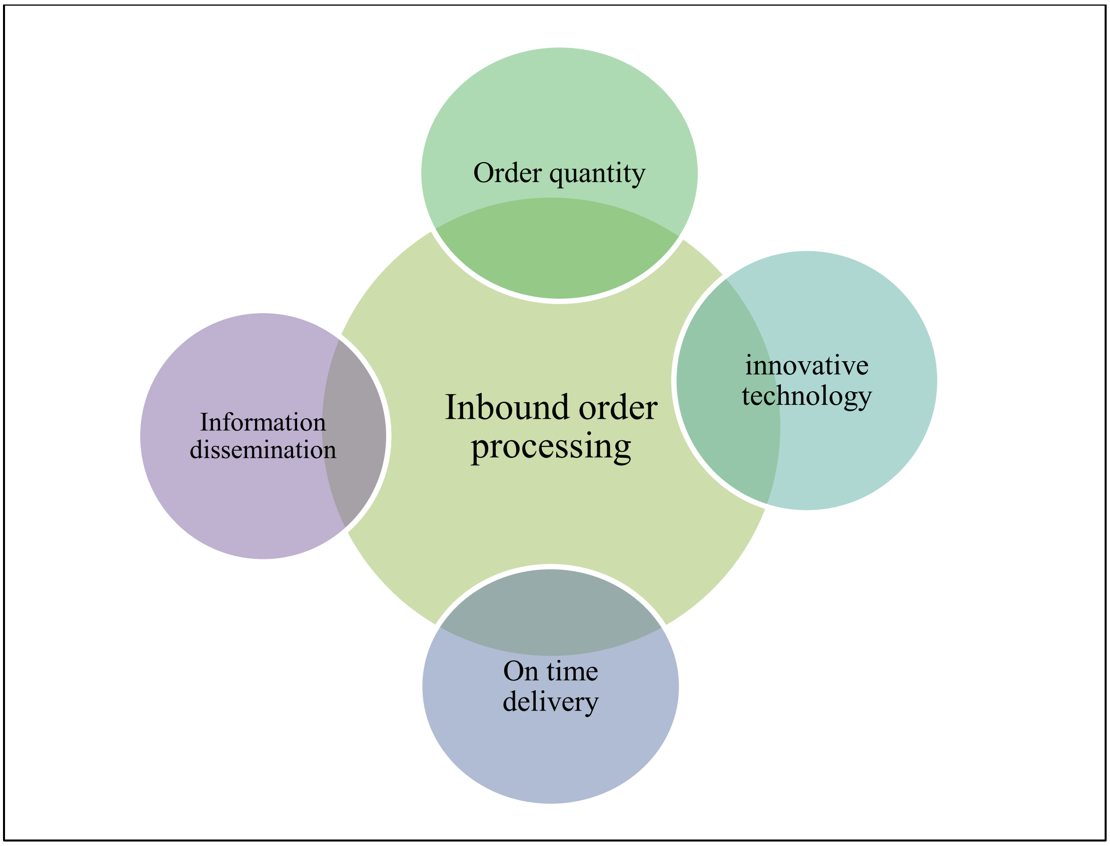
4.3.3.3 Interpretation and labelling of factors

The ultimate goal of rotation is to simplify and clarify the data structure (Costello and Osborne, 2005:3). The researcher used factor loadings as the basis for imputing a label to the different factors. The researcher examined the most highly or heavily loaded indicators in each column and assigned a factor label. The factor interpretations and labels are confined to the assumption of face valid imputation of factor label (face validity) that is rooted in theory.

Factor 1: 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 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 the four out of the nine variables that were loaded have the highest variance figure of forty two point one four per cent (42.14%).

Figure 4.9: Factor1- Inbound order processing

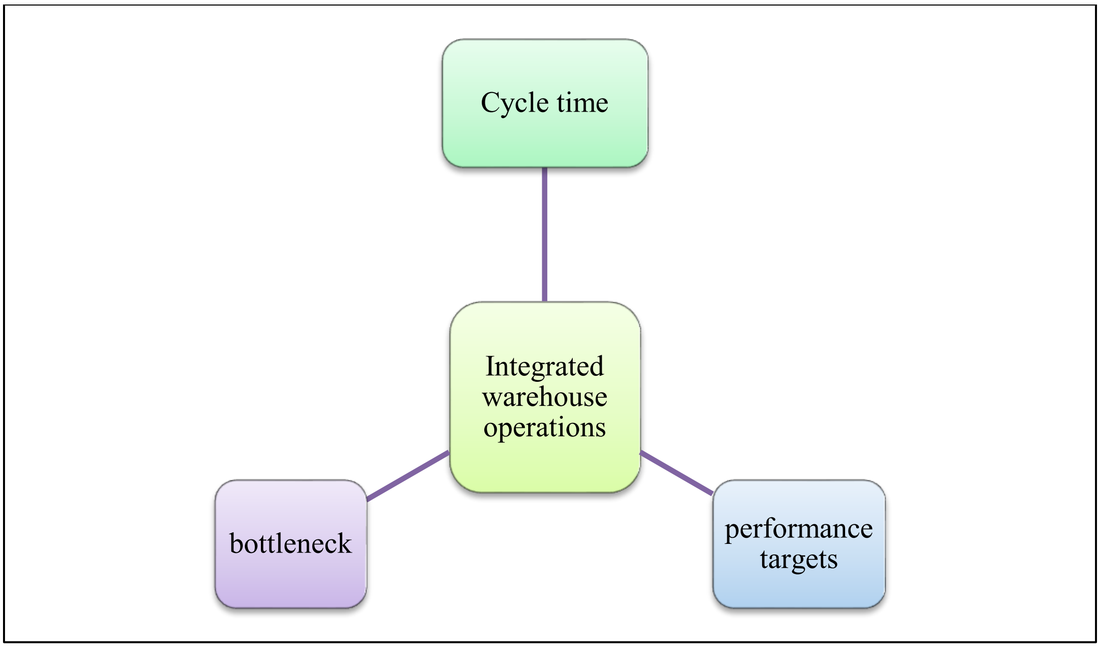


Source: Designed by the author from empirical findings

Factor 2: 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 as well as time spent trying to meet the targets. Short-term scheduling plays a critical role in facilitating the integration within the warehouse operation.

Figure 4.10: Factor- Integrated warehouse operations



Source: Designed by the author from empirical findings

Table 4.11 Pearson correlations

Correlations										
		STS	OQ	OTD	WF	IT	ID	B	CT	PT
Pearson correlation	STS	1.000	.269	.323	.081	.203	.478	.338	.541	.342
	OQ	.269	1.000	.452	.210	.387	.367	.294	.235	.133
	OTD	.323	.452	1.000	.256	.332	.476	.294	.493	.339
	WF	.081	.210	.256	1.000	.282	.194	.220	.283	.239
	IT	.203	.387	.332	.282	1.000	.421	.141	.335	.296
	ID	.478	.367	.476	.194	.421	1.000	.222	.623	.363
	B	.338	.294	.294	.220	.141	.222	1.000	.439	.345
	CT	.541	.235	.493	.283	.335	.623	.439	1.000	.458
	PT	.342	.133	.339	.239	.296	.363	.345	.458	1.000
p-value	STS		.003	.001	.211	.022	.000	.000	.000	.000
	OQ	.003		.000	.016	.000	.000	.002	.009	.093
	OTD	.001	.000		.004	.000	.000	.002	.000	.000
	WF	.211	.016	.004		.002	.027	.014	.002	.008
	IT	.022	.000	.000	.002		.000	.080	.000	.001
	ID	.000	.000	.000	.027	.000		.013	.000	.000
	B	.000	.002	.002	.014	.080	.013		.000	.000
	CT	.000	.009	.000	.002	.000	.000	.000		.000
	PT	.000	.093	.000	.008	.001	.000	.000	.000	

OQ = Order Quantity; OTD = On Time Delivery; WF = Workforce; IT = Innovative Technology; ID = Information Dissemination; B = Bottleneck; CT = Cycle Time; PT = Performance Targets; STS = Short-Term Scheduling; PT = Performance Targets

A correlation analysis was conducted to determine whether a relationship exists between short-term scheduling and several other potential predictors. An overview of the output showed that, each of the predictors' scores were favourable and significantly correlate. In describing the degrees of linear association between variables, the study made use of the Pearson correlation. This study presented a correlation matrix to estimate the relationship between all possible pairs of variables using a significance level of alpha = 0.05. The significance level indicates the likelihood that the reported correlation may be a probability in the form of the random sampling error. Since the independent variable has a value ranging between +0.7 and -0.7, the researcher established that there was no problem regarding multi-collinearity. The Pearson correlation reveals a significant relationship between variables which in turn is critical in examining the extent to which there is a variation in dependent variables (Short-term scheduling) as explained by independent variables.

Table 4.12 Statistics on Mode, ANOVA, Coefficients, Diagnostics and Residuals

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics: R Square Change	F Change	df1	df2	Sig. F Change	Durbin-Watson
1	.541	.293	.286	.845	.293	40.562	1	98	.000	
2	.570	.325	.311	.830	.032	4.662	1	97	.033	1.589

a. Predictors: (Constant), Cycle Time; b. Predictors: (Constant), Cycle Time, Information Dissemination; c. Dependent Variable: Short-Term Scheduling

ANOVA[a]

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	28.978	1	28.978	40.562	.000[b]
	Residual	70.012	98	.714		
	Total	98.990	99			
2	Regression	32.189	2	16.094	23.370	.000[c]
	Residual	66.801	97	.689		
	Total	98.990	99			

a. Predictors: (Constant), Cycle Time; b. Predictors: (Constant), Cycle Time, Information Dissemination c. Dependent Variable: Short-Term Scheduling

Coefficients[a]

Model		Unstandardised Coefficients: B	Std. Error	Standardised Coefficients: Beta	T	Sig	95.0% Confidence Interval for B: Lower Bound	Upper Bound	Correlations: Zero-order	Partial	Part	Collinearity Statistics: Tolerance	VIF
1	(Constant)	1.483	.406		3.66	.00	.678	2.288					
	CT	.630	.099	.541	6.37	.00	.434	.826	.541	.541	.541	1.00	1.00
2	(Constant)	1.110	.434		2.56	.012	.248	1.972					
	CT	.463	.124	.398	3.73	.00	.217	.710	.541	.354	.311	.612	1.634
	ID	.259	.120	.230	2.16	.033	.021	.498	.478	.214	.180	.612	1.634

a. Dependent Variable: Short-Term Scheduling

Collinearity Diagnostics[a]

Model		Eigenvalue	Condition Index	Variance Proportions: (Constant)	Cycle Time	Information Dissemination
1	1	1.978	1.000	.01	.01	
	2	.022	9.493	.99	.99	
2	1	2.959	1.000	.00	.00	.00
	2	.025	10.966	.98	.12	.26
	3	.017	13.269	.01	.88	.74

a. Dependent Variable: Short-Term Scheduling

Residuals Statistics[a]

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	1.83	4.72	4.01	.570	100
Std. Predicted Value	-3.819	1.250	.000	1.000	100
Standard Error of Predicted Value	.083	.344	.135	.050	100
Adjusted Predicted Value	1.99	4.77	4.01	.568	100
Residual	-2.796	1.259	0.000	.821	100
Std. Residual	-3.370	1.517	.000	.990	100
Stud. Residual	-3.513	1.542	.000	1.012	100
Deleted Residual	-3.038	1.308	-.001	.859	100
Stud. Deleted Residual	-3.740	1.553	-.007	1.033	100
Mahal. Distance	.001	15.977	1.980	2.604	100
Cook's Distance	.000	.356	.016	.044	100
Centered Leverage Value	.000	.161	.020	.026	100

a. Dependent Variable: Short-Term Scheduling

Table 4.11.3, statistics on mode, ANOVA, Coefficients, Diagnostics and Residuals Model Summary discloses the model that has included only cycle time and accounted for 29% of the variance (adjusted $R^2 = 0.286$) while the second model added information dissemination with addition of about 4% of the variance being explained and accounted for by 33% of the variance (adjusted $R^2 = 0.325$).
Regarding the equations: $R^2 = 1\text{-SS (Error)/SS (Total)}$; and $R^2_{adj} = 1\text{-MSE/MST}$ or $R^2_{adj} = R^2\text{-}(1\text{-}R^2)p/(n\text{-}p\text{-}1)$.

In this study, R squared is 0.325, adjusted $R^2 = 0.311$, $F = 23.370$ with degree of freedom (2; 99) at significance level, $p < 0.05$. All t-statistics for the coefficients are significant at $p < 0.05$. The final model emerged from the stepwise analysis with only two predictor variables showing significance in this model. The relationship between criterion and predictor variables is explained by only 32.5% of the variance in short-term scheduling and the two dimensions, cycle time ($\beta = 0.398$, $p < 0.05$) and information dissemination ($\beta = 0.230$, $p < 0.05$) were found to be considerably and statistically related with short-term scheduling. In testing for autocorrelation with the value of Durbin-Watson, "ranges from 0 to 4, values close to 0 indicate extreme positive autocorrelation" (standard errors of the B coefficients are too small); close to 4 indicate extreme negative autocorrelation (standard errors are too large); and close to 2 indicate no serial autocorrelation (Garson, 2012).

There is no autocorrelation problem in this study as the variance inflation factors (VIF) are equal to 1 (or VIF $\leq$ 10), and tolerance scores are more than 0.20 or 0.10 (O'Brien, 2007). Nevertheless a tolerance value of 0.50 or higher is generally accepted. The higher the tolerance value, the more useful the predictor is to the analysis as defined by $1 - R^2$ (Tabachnick and Fidell, 2007). The Durbin-Watson value is used to examine the degree of autocorrelation, and 'the values should be between 1.5 and 2.5 deemed acceptable to indicate independence of observations' (Schroeder*,* Anderson and Cleverland, 1986). It statistic tests the presence of serial correlation among the residuals and the value of Durbin-Watson statistic ranges from 0 to 4. Model 2 indicates the value (1.589) between 1.5 and 2.5, consistent with the ideal range of values with no problems relating to autocorrelation. In terms of diagnostics, the condition index is a measure of tightness or dependency of one variable on the others, and Tabachnick and Fidell (2007) suggest values less than 30 and variance proportions to be less than 0.50 for each item.

4.3.3.4 Residuals Statistics

Residual analysis is used for three reasons: 1) to spot heteroscadasticity (increasing error as the observed Y value increases); 2) to spot outliers (influential cases); and 3) to identify other patterns of error (error associated with certain ranges of X variables) Garson (2012).

The studentised residual is similar to the standardised residual in measuring outliers and influential observations. This study has standardised residual (minimum = -3.370 and a maximum 1.517) within an expected interval (±3) and studentised residual (minimum = -3.513 and a maximum 1.542) within 0 and ±3. The normal distribution of this model has a mean of 0 (0.000) and a standard deviation closer to 1 (0.990) from standardised residuals (Tabachnick and Fidell, 2007). Cook's Distance measures how much an observation influences the overall model or predicted values as a summarised measure of leverage and high residuals (D > 1 indicates a big outlier problem, that is, D > 4/N → sample size) (Baum, 2006; Stock and Watson, 2008). This study presents Cook's Distance for observations without outliers (min = 0.000 and max = 0.356) with a value of D less than 1, 'it does not have a large effect on the regression analysis'. Cook's distance, $CD_i = (p\sigma^2)^{-2}(\hat{Y}_{(i)} - \hat{Y})^T (\hat{Y}_{(i)} - \hat{Y})$. Fox (1991:34) further suggests as "a cut-off for deleting influential cases, values of D greater than 4 / (N-k-1)", when N = sample size and k = number of independents.

Leverage measures how much an observation influences regression coefficients. According to Hamilton (2006:175) leverage ranges from 0 to 1, while a value closer to 1 or 0.5 may indicate problems. Alternatively, a leverage (hat element/value) greater than 3p/n should be carefully examined as a useful rule of thumb for quickly identifying subjects which are very different from the rest of the sample on the set of predictors (Stevens, 2002). This study reveals accepted hat elements that lie between 0 (no influence on the model) and 1 (completely determines the model) (minimum = 0.000 and maximum = 0.161).

The Mahalanobis Distance is the rescaled measure of leverage [m = leverage x (N-1)], where the greater levels indicate greater distance from the average values (Baum, 2006; Hamilton, 2006). The Mahalanobis Distance is the distance measured by PC. Mahalanobis as an underlying correlation among variables by which different patterns can be identified and analysed (Mahalanobis, 1936: 49-55). It looks at how far the case is from the centroid of all cases for the predictor variables. It is further associated with those points whose Cook distances are > 1 (Tabachnick and Fidell, 2007) to determine which outliers are influential data points (Cook values have minimum = 0.000 and maximum = 0.161 less than 1 and no effect on the regression analysis). The higher the Mahalanobis Distance, the more the values on independent variables diverge from the average values.

4.4 Reliability

Table 4.13: Reliability statistic

	N	Cronbach Alpha
On-time delivery	104	.780
Information dissemination	104	.777
Short-term scheduling	104	.792
Cycle time	104	.770
Order quantity	104	.795
Performance targets	104	.792
Innovative tech	104	.792
Bottleneck	104	.799
Workforce	104	.813
Valid N (listwise)	104	
Reliability Statistics		
Cronbach's Alpha	N of Items	
.809	9	

In measuring reliability as shown in table 4.13, reliability statistic, Cronbanch Alpha coefficient was used. Cronbach Alpha estimates the proportion of variance that is systematic within the set of scores in a test. Cronbach Alpha (α) value can range from zero (if there is no consistent variance) to one if all variance is consistent. Cronbach 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, 2008:293). Cronbach Alpha coefficient assists in determining whether it is justifiable to interpret scores that have been aggregated together. Reliability is important because in the absence of reliability, it will be difficult to have any validity associated with the scores of the scale.

Table 4.13, reliability statistics indicates the internal consistency reliability of the scale used by the researcher. The measurement instrument is able to obtain consistent scores. Out of the 28 items of the study, nine were selected to run the test of reliability on SPSS. The Cronbach Alpha value corresponding to On-time delivery is 0.78, and the overall Cronbach Alpha value is 0.809. If the research was to delete the on-time delivery question from the group of questions, the overall Cronbach Alpha value will decrease from .809 to .780. The question is therefore retained in the group. The Cronbach Alpha value corresponding to Information Dissemination is 0.777, should Information Dissemination be deleted form the group, the overall Cronbach Alpha value will decrease from 0.809 to 0.777. The last question "workforce" might be deleted from the group- if it is deleted, the Cronbach's Alpha value will increase from .809 to .813. The internal consistency of .809 was obtained which indicates that the results are good, reliable and that can be accepted.

4.5 Conclusion

In this chapter, data analysis methods, study results and a discussion of the findings have been presented, including the exploring of the impact of various demographic data on Short-term scheduling. Data findings were described as correlations to the study variables and presented as tabulations.

Descriptive statistics summarised information relating to all questions and variables participants responded to. This showed a breakdown of responses towards each variable within the used instrument, which was a self-administered questionnaire. Through the mean and kurtosis, the distribution of responses was studied. Frequency distribution was used to study the nominal data presentation. The information studied ranged from distribution of gender, employment level, work experience, workstations and capacity management. The results studied cannot be generalised as the study is a non-probability study, based on the gender participated in the study a greater participation was from males. All level of employment took part in the study. Top management were the least to have participated in the study as a result of their busy schedules and therefore lack of availability.

Efficiencies in scheduling trucks and lead times were studied. Various strategies proved to be employed in various departments and were employed as per the need in a particular department. Strategies minimising logistical variability were the ones that were highly utilised, with a 95% of the respondents having said handling logistics variability is necessary. The importance of information sharing was viewed through inventory status, order status, replenishment frequencies and shared performance targets. Shared performance targets and order status seemed to be conveying the most valuable information to business as 80% of respondents were indifferent between the level of importance to pieces of information regarding order status and shared performance targets. In testing the relationship among different variables, cross tabulation was run. This was to test the relationship and not the cause of the existence of the relationship. To ensure the reliability of the instrument used to generate information, cronbach alpha was used and the value was 0.809 for the whole model for nine items.

CHAPTER FIVE
DISCUSSION OF RESULTS

5.1 Introduction

The motive behind conducting this study was to understand the dynamics of short-term operation scheduling in systematic supply chain distribution centres. A quantitative approach was used to conduct the study. This chapter follows the data analysis chapter. The aim in this chapter is to present the results established through the instrument used to conduct this study, a questionnaire in order to discuss results in terms of theory and observations made by the study. The previous chapter documented that the sample population has the representation from all three level of management, being top level management, middle level management and lower level management.

5.2 Discussion relating to research objectives and research hypothesis

5.2.1 Objective one: To understand the dynamics of short-term scheduling from the inbound operations through to the outbound operations processes within warehouses' and distribution centres' systems integration with suppliers.

In ensuring that the objective was achieved, a number of variables that might have a positive or a negative impact were considered. The first step in the attempt to understand the dynamics of short-term scheduling, was to identify and understand the environment (workstations) within which the target audience/subject matter worked. To determine strategies that in the eyes of the participants through what they do in a certain workstation, the organisation is using to ensure capacity management.

This study is mostly concerned by two points within the warehouse when looking at capacity, which are the inbound and outbound process. Therefore, managing the schedule of inbound products to the warehouse is considered as a viable way of handling logistical variables. This also in turn tests which part between the inbound and the outbound was the most likely to observe a bottleneck. In passing, a look at the space within a warehouse was conducted. A *ceteris peribas* principle was applied on demand when looking at warehouse spacing.

To ensure that constructive results that speak to the objective are generated, a relationship among affected variables was considered. The study learnt that warehouses are concerned about spacing within the warehouse, as a result various strategies are utilised in order to ensure that capacity exists. In as much as the study has shown that in-house operations is the most preferred capacity management strategy, followed by the use of fourth parties, an overall feeling is that warehouses are concerned about the capacity they have. Jackson (2005:32) views capacity management as a vehicle to improve customer service. In his model, Jackson raises flexible labour and work scheduling as the key aspects. Cycle time may be kept at its minimum for all inbound products and items can be scheduled through inbound process so that expected downstream customer shipments are fulfilled. According to Jackson (2005:32) there is a direct strong positive relationship between throughput capacity and existing labour force. This is the case as the inbound processes are highly labour intensive. The flexibility in bringing additional labour as required; is likely to result in low cycle times and as a result provide capacity. Keeping cycle times at minimum eliminate missed customer shipment dates due to excessive inbound processing time and allowing the warehouse to welcome following orders.

Cycle time may be kept low as a result of various factors. In the study of aircraft, Wright (1936) quantitatively discovered and outlined some of the reasons for improvements in cycle time. Among his observation, Wright (1936:123) picked up that the total number of labour hours required to assemble an aircraft diminishes as the quantity output of assembled aircrafts increased, and according to him, this was caused by an increase in work experience which he then referred to as learning effects. Learning effects are not only observed in human activity environment, but in automated environments as well where human support for machines is needed during the activities. Activities can range from set-up, operational, controlling, maintenance just to mention few. Rudek (2012:493) does not deny that learning effect can cease with time, however he points out alternative options in which this can be aroused such as bringing in new inexperienced employees, extension of assortments, new machines, more refined machines.

Instead of processing all orders at the inbound stage, and trying to maintain a short cycle time, work needs to be systematically released with a priority rule attached. If this is being aligned with downstream customer expectations of their shipments, it can allow the warehouse to utilise at flexible labour capacity.

The construction of hypothesis one which checked the existence of a relationship between capacity strategies and warehouse spacing has proven the existence of the relationship. This does not come as a shock to the researcher, as space within the warehouse is likely to be created should different strategies be put into use. It is worth noting that, a variety of strategies may be employed in order to benefit the most, however the researcher tried to figure out the importance of individual strategies. The use of the hypothesis confirmed that the relationship exists, Pearson correlation proved the strength and the direction of the relationship.

There are different workstations within a warehouse environment. The researcher illustrated the potential impact communication (or lack thereof) among the various sections have on potentially answering the research question. A starting point was to understand which subjects in the workstations are likely to observe bottlenecks in operations. By understanding these potential bottlenecks, sufficient resources can be put in place in an attempt to resolve the bottleneck(s).

A view of workstations was analysed, in order to determine their exposure to handling logistical variability. The researcher discovered that managing scheduled inbound products to the warehouse is considered a variable way of handling logistical variability. Research participants across all work stations supported the view that handling logistical variability is indeed a point of concern as shown and supported by hypothesis two. Hypothesis two tested the existence of a relationship between workstations and handling logistical variability. At 95% level of confidence the study rejected the null hypothesis which stated that there is no relationship between handling logistical variability and workstations.

This demonstrated in several ways that different workstations handle logistical variability. The researcher did not, however, go to the extent of trying to understand the different ways in which these workstations handle logistical variability. The main concern is to create a flow in operations for inbound products. This has also revealed that different work stations have a role to play in facilitating the flow in inbound processes. This was pointed out with a certain level of comfort, as all workstations responded to the question addressing whether the management of scheduled inbound products to the warehouse was considered a viable way of handling logistical variability.

Workstations have proven that collaboration and communication throughout the operations process play a significant role within the warehouse. If each workstation is aware of what is happening in other workstations, give an idea for each workstation of what to expect and to prepare capacity for the preceding process.

The final relationship that speaks to objective one of the study was between outbound operations and predefined departure times. Results produced by hypothesis three, show that there is a link between outbound operations and predefined departure time. Up to 83% of participants showed that they viewed outbound operations as attracting more attention than inbound, and their beliefs were supported by the proximity of outbound operations being on the downstream and closer to customers. Also 94% of the respondents indicated that outbound trucks are scheduled in advance using predefined departure times.

More resources are required for the outbound operations, as this phase applies the finishing touches before the products are delivered to customers. For the customer, this stage is what, in their eyes determines whether the order is as intended or not. Different trucks from various destinations come and go in the warehouse. Failure to determine the exact time a truck will be arriving in the warehouse, the amount of time it is supposed to spend in the loading bay and time what it is supposed to leave the warehouse premises, is likely to cause an unnecessary traffic within the warehouse. The availability of a predefined schedule in place provides a means by which to with the aim to know how many trucks are expected to come in and to load or off load.

In responding to the major question for objective one which asks, "what dynamic challenges of short-term scheduling are encountered across the inbound right through to the outbound operations processes?", the variable that speaks in providing responses are workstations, capacity strategies, handling logistical variability, outbound operations, predefined departure times and warehouse spacing. Workstations have shown that collaboration amongst workstations is likely to present a snapshot of what the next process may require. As a result, information dissemination across work stations is essential. Despite the strategy employed within a workstations or the entire warehouse, capacity strategies are of high importance. In so much as there are two points considered in the study, outbound operations require more attention due to their proximity to the downstream customer. A schedule needs to be designed beforehand so as to outline the order of operation with regards to outbound operations. The capacity strategies employed are likely to create sufficient space within the warehouse as all goods that are supposed to be delivered at a certain time will be delivered as per the schedule.

In the event that workstations are not aware of what is happening in other workstations that affect their operations, bottlenecks in operations are likely to be observed. However it is worth noting that, everyone is not required to be aware, rather those creating the schedule need only disseminate what is relevant for the operational flow. Capacity management is a determining factor for the availability of spaces within the warehouse.

5.2.2 Objectives two: To establish the magnitude of information sharing among work stations and supply chain partners within the scheduling perspective.

Apart from studying the generation of information between different workstations within the warehouse, the extent to which communication was taking place within and across workstations were also examined. The study furthermore explored the significance of the sharing of information among workstations. Communication (explain) was put in place ahead of the study to equip the study subjects at each workstation of what to expect and to ensure sufficient capacity. To ensure that the study question which asks: "what is the magnitude of information sharing among work stations and supply chain partners within the scheduling perspective?" receives a response, a number of variable were looked at. In carrying out this study, the inclusion of these variables had the potential to either affect the outcomes positively, negatively or have no impact on the outcome at all. The variables included: Workstation; Capacity strategies; Warehouse spacing; Inventory and Order status.

Workstations were included to determine the extent to which workstations view the need to disseminate information. Capacity strategies were gathered across the organisation. Sharing of information among workstations helped to determine the capacity required. Access to inventories and order status determined the capacity required and what to expect as inflows and outflows.

The value provided by both downstream and upstream customers to the warehouse stems from the improvement of order fulfilment forecast accuracy (Cui, Bassamboo, Van Mieghem, 2013:6). Sharing downstream information with upstream suppliers has the potential to improve supply chain performance. An improvement of this kind has the potential to provide better service. The researcher has learned that the use of electronic systems to disseminate different kinds of information is in place in the warehouses. Information dissemination also has the potential to facilitate procurement policy compliance and vendor responsiveness, reduce delays in transit, and account for vendor specifications in packaging.

A hypothesis was formulated to determine whether a relationship exists between capacity management strategies and the order status. The study results in chapter four discovered that said relationship exists. The number of orders placed within the warehouse determined how much capacity is required. Respondents in the study indicate that access to inventory information and order status is important in determining the magnitude of information sharing among workstation and supply chain partners within the scheduling perspective without risk of any potential exploitation.

Communication within the warehouses proved to be important in determining what needed to be kept within the warehouse. Space might not be available as a result of having to keep inventory that has not been distributed. This would imply hidden costs for the warehouse. Kaplan (2008:2) identified five factors that may result in hidden costs due to breakage in communication. Organisations have learned to live with these warehouse sunk costs and now deem them as cost of doing business. Kaplan (2008:2) put a cost implication to the warehouse's failure to communicate internally. Lack of communication can affect the warehouse's bottom-line reporting when:

1. Wrong inventory delivery are repeatedly given back and consequence lead to freight bills being duplicated
2. Inventory is delivered it gets replenished. The inventory given back turn out to be surplus inventory that might not be sold for some time, leading to an opportunity cost as money will be collecting dust on the shelves.
3. Customer who received incorrect deliveries regularly argues the invoices and not pay them on time
4. Inventory given back generate further workload both in operations and accounting
5. Returned additional workload on the accounting side has often results in missing out on potential savings through discounts

The use of automated systems has the potential to disseminate reliable information to intended stakeholders and facilitate the understanding of where items are located in the warehouse. Little time will need to be spent on trying to find items as the automation inform the picker where to pick and where to pack. In defining the capacity requirements for the warehouse, it is of vital importance to determine the co-ordination of operational programmes within the warehouse. Functions of the warehouse include picking and packing of units according to given orders. As a consequence the capacity of a warehouse is not only related to the storage space, but to other entities that require space for handling and consignment, output of stock devises and ramps (Grobe-Brockhoff, Klump and Krome, 2011:26).Study can conclude with comfort that information sharing among work stations and supply chain partners within the scheduling perspective is significant in ensuring sufficient capacity.

5.2.3 Objective three: To understand performance targets; the role of short-term scheduling on the challenge of bottlenecks; operations work processes and cycle times.

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 within the process needs to be available to all relevant supply chain partners in order to successfully process the inbound orders. 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. The warehouse in this regard would schedule accordingly.

When referring to the short-term scheduling of integrated warehouse operations, cycle-times has to be reduced in order to facilitate the meeting of performance targets. This can only happen 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 concerned individual stores. 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 with the suppliers should be synchronised to the warehouse's system.

5.3 Conclusion

In this section, the study reported on the extensive work done to developing insights about the benefits of short-term scheduling is systematic supply chain in distribution centres. The study was three fold, to understand the dynamics of short-term scheduling from the inbound operations through to the outbound operation process, to establish the magnitude of information sharing among downstream and upstream customers and finally to understand on performance targets. The study focused on environment within which the operations take place, strategies that the organisation may employ to ensure capacity; looking at the inbound and the outbound processes. This section of the study further looked at how cycle time may be taken into consideration to ensure sufficient spacing within the distribution centres. Hypotheses were constructed to test the existence of the relationship. The value of information sharing and the resulting benefits was discussed. This section of the study integrated literature and the findings of the study.

CHAPTER SIX

CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions on the major findings

6.1.1 Conclusion based on literature review

A greater deal of focus on the distribution centres and other logistics companies has been placed on the outbound logistics. It is clear that outbound is important as it has the most direct influence on the upstream customer experience. The more the distribution centre run efficiently and more towards a cross dock operations, inbound processes are likely to have more impact on upstream customer influence.

It is of vital importance for the inbound operations to start measuring its operation against the same customer metrics as that of outbound operations. In the event that order cycles are largely separated, this can make it challenging to measure inbound against outbound. 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 up to upstream have got the role to place in the outbound cycle. These role may be actioned sequential or parallel in order to maximise cycle time. In order to best drive the right behaviour 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 organisation is working towards achieving the common goal.

6.1.2 Conclusions based on empirical study

The study provided an insight regarding the main factors that affect operation processes of distribution centre with supply chain. The main factors that affect distribution centre operations are lead times, delayed deliveries, space within the warehouse and Information sharing among workstations. The objective of this study was to understand the dynamics of short-terms scheduling from inbound through to outbound operations processes with the warehouse and distribution system integration with supply chain partners. In the recent times where markets fluctuate globally, customer demands remain unpredictable along with what is requested in order to reduce high flexibility and lead-times. This is most likely to result in difficulties for distribution centres and warehouses in providing necessary and adequate capacity for keeping goods, redirecting goods and to provide the required transportation for the sufficient quantities at the time needed.

Customer's demand planning is usually the basis for capacity management, idependently of outbound logistics. To make sure capacity is utilised efficiently, planning of what is expected regarding capacity requirements and supply is necessary. Over and above that capacity supply needs to be put in place in order to synchronise it with what is required. Depending on how complex the operations processes are, capacity can at times be supported by outsourcing. In the event of highly automated operations, outsourcing may have a very limited role to play. The level to which capacity supply may be adjusted in outbound logistics, is rather more flexible owing to engaging 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. Following determining what is required by capacity, supply has to be adjusted accordingly to allow the utilisation of capacity as efficiently as possible. Scheduling and reducing process time normally aims at adjusting capacity which results in capacity management, in the field of logistics the efficient utilisation of space is of foremost importance. Admittedly handling capacity is also a critical important restriction on capacity that needs to be considered while management capacity for outbound logistics. Capacity may be optimally utilised through scheduling of loading times and efficient termination of transport.

6.2 Recommendations

6.2.1 Recommendations on the study conducted

- Synchronise processes that could be combined and have them performed together
- Avail Spare capacity in the case of delayed deliveries
- Time reduction mechanisms are required for unloading and re-loading operations through handling operations in the existing bays in order to cater for large intake.
- Provisions for priority handling of queuing operations adhering to the strategy.

6.3 Contribution of the study to knowledge

The study was conducted to provide insight in the role scheduling plays in capacity planning of distribution centres and logistics companies. Results may be valuable for role players. The study is principle designed to benefit distribution centres. Scheduling in the study has been viewed as the tool that may be employed and can resolve short term bottlenecks. The study outlines role players as distribution centres doing the scheduling, external third parties and the staff compliment within the distribution centre. Anyone who plays part and who is affected by the schedule becomes a role player.

6.4 Limitation of study

In carrying out the study, the researcher came across various factors that were considered as limiting in achieving the ultimate goal. Scheduled meeting to carry out the study were continuously postponed even though were confirmed. The sample targeted at time came across some difficulty in understanding the term used in the field of this study. Availability of participants turned out to be an issue in some of the distribution centres. Initially, potential participants would believe that they are not the suitable respondents, and only to find out that when they explain their daily responsibilities, they are the perfect match. Due to the study being conducted in a non-probability nature, conclusions were made from a survey from convenient sampling. Results may not be generalisable to the entire population, but only viewpoints of the group surveyed.

6.5 Direction for future study

Future studies may explore further the level and the intensity of information to be shared among the work stations. Further to that, risk associated with the information to be shared. The information shared in the scheduling considered in the study was suitable to execute and achieve short term goals. Time frame may be of interest to some researcher and pursue a study on the impact of time frames in scheduling.

6.6 Summary

The principal objectives of carrying out this study was to understand the dynamics of short-term operations scheduling in systematic supply chain distribution centres, to examine the magnitude of information sharing among work stations and supply chain partners within the scheduling perspective. Bottleneck normally disturbs the smooth flow of operations, therefore the study wanted to explore the role of short-term scheduling when the operations processes are faced with the challenges of bottleneck. Finally, the study wanted to understand on performance targets the balance between the scheduling systems and the actual execution of operational processes. There is no all-round approach that can be used to schedule the operations across different distribution centres. The culture with each distribution centre plays an important role in operations process.

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Appendix A: Questionnaire

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School of Management, IT & Governance

M Com Research Project
Researcher: Fani Nicholas Jojozi (073-1691 005)
Supervisor: Mr T. P. Mbhele (031-2607 524)
Research Office: Ms P Ximba 031-2603 587

<u>Title</u>: Dynamics of short-term operations scheduling in systematic supply chain distribution centres

The purpose of this survey is to solicit information from employees of warehouses and distribution centres regarding short-term scheduling. The information and ratings you provide us will go a long way in helping us identify dynamics of short-term operations scheduling in systematic supply chain distribution centres. The questionnaire should only take 10-20 minutes to complete. In this questionnaire, you are asked to indicate what is true for you, so there are no “right” or “wrong” answers to any question. Work as rapidly as you can. If you wish to make a comment please write it directly on the booklet itself. Make sure not to skip any questions. Thank you for participating!

I ***(Optional)***____(full names of participant) hereby confirm that I understand the contents of this document and the nature of the research project, and I consent to participating in the research project. I understand that I am at liberty to withdraw from the project at any time, should I so desire.

____________________ ____________________
Signature of Participant Date

Section A

Biographical details of respondent: Please tick or encircle on the appropriate box

1. Gender

Male		Female	

2. What is your position among the following options?

Management level	Supervisory level	General workers	Other (Specify)

3. Years of experience in the company

Less than 1	1-3 years	4-6 years	7-10 years	Over 10

4. Which of the following options best describes your area of employment?

Receiving	Sorting	Packing	Dispatching	Other (Specify)

5. Which one of the following strategies relates to your organisation uses in order to manage capacity in the warehouse?

Make use of integrated service providers (forth party).	In house operations	Managing the capacity through additional lease.	Decline additional order once fully capacitated.

<u>**Section B:**</u> **This section contains dichotomous questions regarding the efficient scheduling of trucks and a more realistic view about total operation times of the warehouse operations.**

Please tick (√) or encircle the appropriate response (Yes or No)

6. Managing scheduled inbound products to the warehouse is considered as a viable way of handling logistical variability.	YES	NO
7. The outbound attracts more attention as compared to inbound considering the proximity to the downstream customers.	YES	NO
8. The outbound trucks are scheduled in advance on predefined departure time.	YES	NO
9. There is sufficient space inside the warehouse, despite the demand level.	YES	NO
10. There is a time-based transhipment relationship between uploading outbound truck and offloading inbound truck.	YES	NO

<u>**Section C**</u>

The following questions are based on a Likert scale and relate to dynamic challenges of short-term scheduling that are encountered across the inbound right through to the outbound operations processes. Please tick (√) the appropriate box, 1= strongly disagree, 2=disagree, 3=neutral, 4=agree and 5=strongly agree.

11. Predefined quantity of orders from the suppliers creates flexible capacity within the warehouse.	5	4	3	2	1
12. On time delivery of orders create agile system within the warehouse.	5	4	3	2	1

13. The management of labour workforce relate to the variability in inbound product.	5	4	3	2	1
14. The advancement in technology mitigates the variability in the inbound product quantity.	5	4	3	2	1
15. The challenges of short-term scheduling influence the inbound and outbound operations processes in the warehouse.	5	4	3	2	1
16. Information sharing among the supply chain partners enhances the integrated short-term scheduling operation.	5	4	3	2	1
17. Short-term scheduling address challenges of bottleneck within the warehouse	5	4	3	2	1
18. Warehouse handling and storage operations have the influence on the variability of inbound and outbound cycle time processes	5	4	3	2	1
19. Performance targets in the warehouse are aligned to scheduling systems	5	4	3	2	1

What is the magnitude of information sharing among work stations and supply chain partners within the scheduling perspective without risking any potential exploitation? Select THREE and rank them from 1 = "Least important" to 4 = "Most important" in terms of importance to your work station.

Items	Critical (importance)	Rank
20. Access to inventory status		
21. Sharing of order status information		
22. The short-term scheduling ensures a reliable replenishment frequencies		
23. Sharing of performance targets and capacity for overall operations performance		
Please rank three (3) important factors that you deem are attributed to the observed variability of orders in the warehouse		
24. E-procurement policy		
25. Vendor responsiveness determines order lead time and variability		
26. Delays in transit determines the warehouse delivery		
27. Technology advance system		
28. Vendor specifications in packaging		

Thank You!!!

Appendix B: Turn-it-in-report

Turn-it-in Originality Report

Dynamic of Short-Term Scheduling in Systematic Supply Chain Distribution Centres

Draft by F N Jojozi

From Paper (Masters FR Thesis)

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Appendix C1: Certificate from English Specialist

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To whom it may concern

EDITING OF RESEARCH DISSERTATION: FANI NICHOLAS JOJOZI

I have an MA in English from University of Natal (now UKZN) and have been editing using my own company for seven years now. I regularly edit the research dissertations, papers and theses of the School of Nursing and Management, Information Technology and Governance among others at the University of KwaZulu-Natal as well as editing for publishing firms on contract.

I hereby confirm that I edited the dissertation of **Fani Nicholas Jojozi** for language, punctuation, grammar and spelling and commented on errors or anomalies I was unable to rectify in the MS Word tracking changes and review method by insertion of comments balloons. Following attention to these by the student, the document should be correct.

I trust that the document will prove acceptable in terms of editing criteria.

Yours faithfully

Catherine P. Eberle

Appendix C2: Certificate from English Specialist

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13 May 2014

To whom it may concern

CONFIRMATION OF EDITING AND PROOFREADING SERVICES RENDERED TO FANI NICHOLAS JOJOZI

This letter serves to confirm that I, Ella Janson, edited and proofread Fani Nicholas Jojozi's dissertation submitted in fulfilment of the requirements for the degree of Master of Commerce, Supply Chain Management as student (207518715) of the School of Management, Information Technology and Governance College of Law and Management Studies of the University of KwaZulu-Natal.

I am a qualified copywriter and editor (BA.Communications Hons – North West University) with over 22 years' experience. I am currently employed by Rand Merchant Bank as Copywriter and Content Editor in the Corporate Marketing department of the bank.

Regards

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Appendix D: Ethical Clearance

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INYUVESI YAKWAZULU-NATALI

20 August 2013

Mr Fani Nicholas Jojozi 207518715
School of Management, IT and Governance
Westville Campus

Protocol reference number: HSS/0814/013M
Project title: Dynamics of short-term operations scheduling in systematic supply chain distribution centres

Dear Mr Jojozi

Expedited Approval

I wish to inform you that your application has been granted Full Approval.

Any alteration/s to the approved research protocol i.e. Questionnaire/Interview Schedule, Informed Consent Form, Title of the Project, Location of the Study, Research Approach and Methods must be reviewed and approved through the amendment/modification prior to its implementation. In case you have further queries, please quote the above reference number. Please note: Research data should be securely stored in the discipline/department for a period of 5 years.

I take this opportunity of wishing you everything of the best with your study.

Yours faithfully

....
Dr Shenuka Singh (Acting Chair)

/px

cc Supervisor: Mr TP Mbhele
cc Academic Leader Research: Professor B McArthur
cc School Administrator: Ms Hazvinei Muteswa

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