Redesign of the Supply Chain in a Small Retail Environment

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Submitted in partial fulfilment of the requirements for the degree
of

BACCALAUREUS IN INDUSTRIAL ENGINEERING
in the

FACULTY OF ENGINEERING, BUILT ENVIRONMENT
AND
INFORMATION TECHNOLOGY

UNIVERSITY OF PRETORIA
October 2009

ABSTRACT

This project studies the supply chain strategy of a group of small retailers. The supply chain of the retailer is not reliable and causes shortages and excessive product availability. Each store functions as a silo and this adds higher costs to the operation such as deliveries of products in the supply chain. These costs reflect on the selling price to the customer which makes the small retailer less competitive in the market. This project identifies three methodologies that can improve the operations of the supply chain, Lean, Just in Time (JIT) and Vendor Managed Inventory (VMI). These methodologies along with the allocation of a distribution centre attempts to improve the current supply chain operations. A simulation model is identified as a useful tool to analyse and compare viable options without the risk of high cost developments. The aim of the project is to improve the reliability of the current supply chain.

ACKNOWLEDGEMENTS

During the duration of this project several people where consulted and the author would like to acknowledge these individuals for without them this project would not be successful.

Christo Cronjé for his guidance and motivation.

Andre Visagie and Lee-Ann Stocks for your invaluable inputs and inspiration.

Beyers van der Merwe for your the motivation and comradeship.

Cecile Snyman and Seline van der Wat for training and guidance with Arena.

Pieter Venter for providing data and giving insight into the retail industry.

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ABBREVIATIONS

EDI	Electronic Data Interchange
JIT	Just in Time
VMI	Vendor Managed Inventory

CHAPTER 1
INTRODUCTION

1.1 BACKGROUND OF THE COMPANY

The PNA franchise was established in 1992. The main business of PNA is retail of stationery, books, and art products. All PNA stores are owner managed which adds an individual flavour to the brand. In the past three years exceptional growth took place with twelve new retailers that opened. There are currently 48 retailers throughout South Africa. PNA boast with a variety of 15000 line items and a supply network of 300 suppliers.

1.2 PROBLEM STATEMENT

The retailers function as silos, each one has a unique management structure and there is no interaction between the various stores. There is no standard operating system and procurement is the responsibility of the shop manager and the owner. Therefore a collective problem of managing inventory is experienced by the retailers.

PNA is considered to be a small buying power and suppliers do not necessarily considered the retailer as a priority customer. This leads to delays on agreed delivery schedules and higher costs incurred by transportation of small orders. Products can be out of stock at the supplier and this stretches the lead time on product replenishment.

The majority of suppliers require that a minimum order quantity should apply on all deliveries. This results in a small retailer not able to place an order due to lack of cash available or either ordering an excessive amount of stock.

PNA competes against other big retailers for its market share and it does not have the same negotiating capacity like that of the big retailer that can buy in bulk quantities.

The PNA retailers have noted that procurement and inventory control in each shop is an overwhelming task that has little reliability. The consequence of this is that a retailer that does not have a product for sale in the right quantity, at the right time may face a lost sale and can lose future customers by getting a damaged reputation.

At a high level perspective the retailer problems are caused by the unreliability of the supply chain and that the core competency as a retailer of selling products is disrupted by inventory control problems.

1.3 PROJECT AIM

The aim of the project is to ensure reliable, availability of products through the improvement of the supply chain of the small retailer.

1.4 OBJECTIVES

The objective for this project is to satisfy customer demand. This entails availability of products in the right quantity, in the right location and at the right time. This objective will be accomplished by analysing and improving the functions of PNA's supply chain. In this project a collaborative improvement strategy is established between the retailers in order for them to benefit from the supply chain.

1.5 PROJECT SCOPE

In order to direct the project and to achieve the objectives as stated above it is important to scope the project and state the assumptions.

The supply chain evaluation is done through comparison of current state and future state scenarios. This implies that the project only evaluates the direct impact on the small retailer and not that of the supplier upstream in the supply chain. In this project the focus is on seven PNA's situated around Pretoria.

The analysis of the project is limited to a few common products and seven retailers within the group. The project acts as a feasibility study for future expansion to incorporate all the retailers within the franchise.

The assumption is made that a customers' demand is satisfied when a predefined minimum amount of a product is available in the store.

A classification is made between seasonal and non-seasonal products as well as products that are only supplied in volume. It should be noted that a customer may only need one item for example, but the supply of this product may only occur in volume.

CHAPTER 2
LITERATURE REVIEW

2.1 OVERVIEW

In the economy of our time companies are struggling and some even close because of the economic recession. All companies have to cut on operational expenses and keep a tight control on their cash expenditure. It is the small companies and businesses that get hit the hardest. PNA is no exception and the retailer has to improve the current strategies in order to remain competitive in the market.

This literature review discusses the subsections that influence the supply chain of a small retailer. These sections are inventory control, logistics and information flow. To be able to improve the supply chain a global perspective is investigated of these key areas.

Considering inventory control three methodologies are investigated; Lean, Just–in-Time (JIT) and Vendor Managed Inventory (VMI). Each methodology is discussed in the appropriate manner covering the problem at hand. With regards to the logistics, a distribution centre is studied as well as the appropriate functions to establish them within a supply chain. The literature review concludes with simulation modelling and the SCOR metrics that can be used to evaluate performance of the supply chain.

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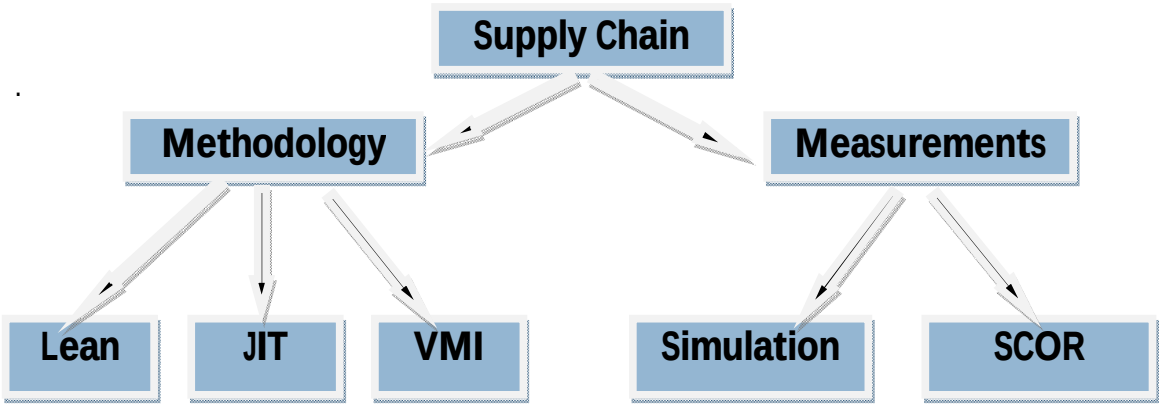

Figure 1: Overview of literature review

2.2 SUPPLY CHAIN

There are numerous studies and definitions for supply chains and Disney (2003) defines a supply chain as: “A system consisting of material suppliers, production facilities, distribution services and customers who are all linked together via a downstream feed-forward flow of materials and the upstream feedback flow of information”. (Disney2003).

The standard operating procedure of entities in a supply chain suggests that each entity is responsible for all of its own activities. These activities are procurement, inventory control, production and distribution. This mindset isolates entities which has a negative impact on the transparency of a supply chain. In this regard isolation causes uncertainty that leads entities to produce and order too many items. This tendency is amplified and creates a “bullwhip effect” as it moves up the supply chain.

To solve this predicament numerous mathematical methods and theories have been developed as illustrated in Figure2.

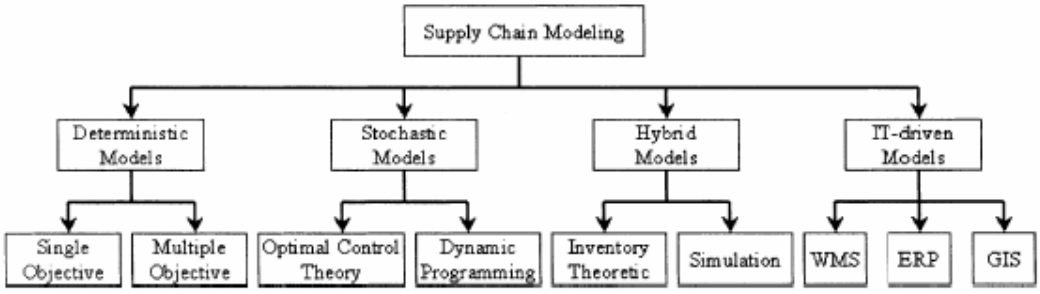

Figure 2: Models to analyse supply chains

These methods are available and can be used to calculate the replenishment quantities according to the desired replenishment rule that is convenient to the industry. The accuracy of the demand forecast does however not guarantee a responsive delivery. As Disney (2003) states: “In the real world the ordering process is frequently biased according to how is perceived as the most important customer or simply in favour of those found to be most troublesome.” In other words the spending capacity determines the nature of service one receives.

Another factor that influences a supply chain is the products that move through it. In a non perishable environment products can be classified in two categories, Functional and Innovative products. Functional products are products that satisfy basic needs and do not change much over time. Because these products do not change much over time, they tend to have a stable and predictable demand. This stability invites competition, which often leads to low profit margins. Innovative products are products that typically have a short life cycle of only a few months and require a greater variety. A greater variety creates demand fluctuation. (Chase et al, 2006)

2.3 SUPPLY CHAIN MANAGEMENT

In a supply chain it is critical to control and manage goods according to the right methodology. Christopher (2004) defined SCM as a management of relationship between suppliers and customers and through it adding value at a lower cost to the supply chain. This definition entails that there is a link between all the involved entities and that all activities form part of one system.

A company that has distinguished itself in SCM is Wal–Mart. According to professor Chopra, Wal-Mart distinguished itself by ensuring that the area where it wanted to expand to could support a distribution centre that in turn could distribute stock to the retailers in the region. The significance of this approach was that Wal-Mart would not invest in expanding to a new region if it was not able to support the outlets with a responsive supply chain. The responsiveness was guaranteed with a distribution centre reacting to sales and shortages. The initial start up cost for this development was more expensive than competitors, but the certainty of responding to all of the customers' needs made them the preferred retailer. Wal-Marts' competition did not have the same support from the supply chain and could not match the performance in getting the products to market. (Hugos & Thomas, 2006)

The success of a supply chain is depended on two fundamental principles. These principles are defined through the work of Chang-Seop (2004) as collaboration of all entities and the ability to react to changes immediately.

2.4 BULLWHIP EFFECT

The “Bullwhip Effect” is a term coined by Lee et al (1997). It refers to the fluctuation of demand experienced upstream in a supply chain. This implies that a supplier has less certainty of the level of stock that is required to be on hand to sell to customers. This uncertainty contributes to over compensation by the suppliers and too many products are introduced in the supply chain. According to Lee et al (1997) there are five primary causes of bullwhip: demand signalling, non-zero lead times, price variation, rationing and order batching. The diagram below illustrates how variability magnification occurs in a supply chain from the customer to the original supplier. The effects indicate a lack of synchronisation among supply chain members and this uncertainty causes each member to over compensate on demand. (Chase et al, 2006)

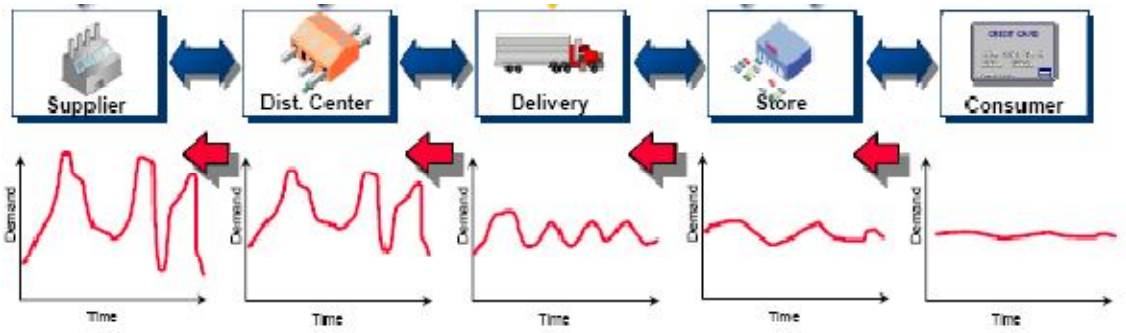

Figure 3: Bullwhip effect, Wince 2003

2.5 METHODOLOGY OF INVENTORY CONTROL

A big drive in the production environment is the push for continuous improvement in order to ensure quality of product and to minimise cost associated with production. Some of the methodologies and tools that were developed for production improvements have been established in the retail sector and have proven to be successful. The characteristics of these methods are studied in this review.

2.5.1 JUST-IN-TIME

The Just-in-Time (JIT) principle was developed for the manufacturing industry. The pioneer was the Toyota Company that used it to minimise inventory handling costs. The

principle entails that only when a product or part is required, will it be produced or delivered. The process is governed by the drum-buffer-rope principle. The process concentrates on a constraint in a process that determines the tempo of manufacturing. This is referred to as the drum. The buffer is placed in front of the constraint to ensure that it always has work to complete and the rope is the signal that is sent to the upstream supplier to send more work. All production that is more than the minimum requirement is considered a waste and unproductive. In the production environment the benefit gained from this methodology is that it makes problems of quality visible on the floor. There is very little to no inventory pilling up in front of work stations. When inventory levels are low quality problems can be identified and not be hidden away. (Chase et al, 2006)

4.4.2 JIT IN RETAIL

A JIT retailer replenishes the products in small sized orders, on a more frequent and continuous basis. It is essential that the suppliers and the retailer coordinate their interest in order to satisfy customer demand.

The benefit of JIT implementation mentioned by Andel (1996) is that orders are time based which means that the products are only acquired when there is a demand. This alternative allows suppliers and retailers to save cost associated with producing and procuring inventory that is not required at the current time. The major difference between JIT retail strategy and conventional way is that all inventories are carried on the shop floor and not in a storeroom. Continuous replenishment requires that a JIT retailer has a good relationship and communication with its suppliers. This will ensure that the response from the supplier is quick and accurate.

A risk that a retailer faces in this strategy is that products might be out of stock at the supplier and once a signal is sent no product can be delivered. The fact that there is no safety stock could cause a loss of sale. A study done by Myers et al (2000) revealed that, without proper information infrastructure serious harm could be done to the business. Myers emphasises that the principles of JIT cannot be implemented independently in retail, because of every day fluctuations in demand. Therefore an accurate demand has to be established.

2.5.2 LEAN MANUFACTURING

Lean manufacturing is developed to eliminate actions that are not valuable for a customer. An action that is valuable for a customer is an action that a customer is willing to pay for. If this is not the case the action is considered to be removed of the process or to be improved. The Lean principles were derived from the Toyota Production Systems the leader in continuous improvement. (Chase et al, 2006)

2.5.3 LEAN IN RETAIL

Ron Wince (2008) defines Lean in Retail as: "Exactly what the customers wants, where the customer wants it, when the customer wants it, in the quantity the customer wants it. While utilizing minimum resource and minimising customer effort."
Lean is used to add value to the process and to eliminate waste. Figure 4 illustrates how non value adding activities take up time in a supply chain.

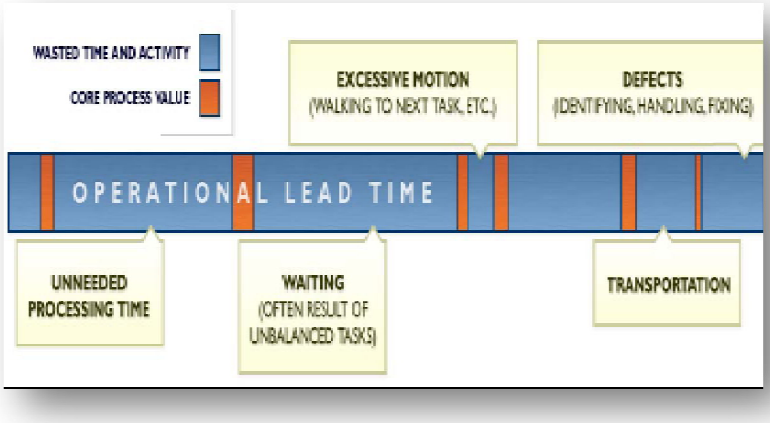

Figure 4: Waste in Lean Wince(2008)

Lean tools identify seven wastes that should be eliminated: Over production, over process, excess motion, transportation, excessive inventory, waiting and defects. These same principles also apply to the retail sector in the form of repacking, backroom storage, left over seasonal stock, changing reorder quantities, category optimisation and inspection. These activities prolong the supply chain response. (Wince, 2008). Lean in retail adds a new pespective on cost saving and adding value for the customer. The expectations are that Lean principle will transform the traditonal retail industry.

2.5.4 VENDOR MANAGED INVENTORY

Vendor Managed Inventory (VMI) is an alternative to the traditional order based replenishment practice. It is a supply chain strategy that gives the supplier or vendor the responsibility to manage the stock of the customer based on the demand required. (Disney & Towill, 2003)

Instead of putting more pressure on the supplier to deliver more accurately VMI changes the traditional approach and hands the responsibility to the supplier to deliver the correct amounts regularly. The system differs from the traditional supply chain in the way that inventory and demand information is handed to the supplier and it decides on the timing and quantity of the deliveries. This form of operation changes the measurement of a supplier performance from delivery time preciseness to availability and inventory turnover (Kaiipa Holmstrom Tanskanen, 2002). Research done by Yan et al (2003) indicated that in the short term VMI always leads to a higher profit for the buyer and that the supplier only sees the benefits in the long run. (Yan Dong et al, 2002)

The basic procedure for this method is that a stock list is send to the supplier that indicates the levels of stock at the retailer. The supplier can analyse and determine what the format and timing of the delivery should be.
The following steps stated by Kaipia et al (2002) are required for analysis of the VMI:

- To describe the existing mode of replenishment process
- Collect demand data for the alternatives to be examined
- Calculate for each product the product range, and for both the base and the alternative solution the following:
    - Mean absolute deviation of demand
    - Reorder point
    - Response time
- Calculate for each item in the product range the following:
    - Time benefit
    - Reorder amplification
    - Graph each product item in the product range and reordering amplification of demand.

2.6 LOGISTICS

2.6.1 LOCATION

In the process of getting products to the customer the logistics of the supply chain has to be effective. The reason being transportation costs add to a big percentage of the overall cost of a product. The logistic network consists of warehouses, cross docking and distribution centres that are strategically placed to support the market.

2.6.2 DISTRIBUTION CENTRE

The distribution centre performs a specific duty in connecting suppliers to customers. A distribution centre is commonly known as the middleman between supply and demand in the logistics network. It forms the backbone of all logistical movement and reliability to customers. According to Liang et al (2008) a distribution centre that is not situated in the correct location does not have the necessary capability to provide an efficient service to the network. This directly affects the reliability of the supply chain.

2.7 SUPPLY CHAIN MODELLING METHODS

There are various modelling methods available to analyse a supply chain. Beamon (1998) made a classification of four types of modelling approaches that can be used in the analysis of supply chains. These classifications are:

- Deterministic analytical models
- Stochastic analytical models
- Economic models
- Simulation models

In deterministic modelling the assumption is made that there are no uncertainties while in stochastic models there is at least one variable that is unknown and a certain probability of its occurrence is determined. Economic models are optimisation models that determine the economic order quantity of a product. Simulation modelling imitates reality without any physical disruption or high cost developments.

The problems with the analytical models are that various assumptions and simplifications have to be made regarding certain constraints that distort the real

picture. Thus in a supply chain environment a realistic approach result in two options either multi product EOQ models or simulation modelling. Beamon (1998)

2.7.1 MULTI PRODUCT EOQ MODELS

Multi product EOQ models are used to determine the optimal order frequency while minimising the cost of procuring and holding inventory. Chopra and Meidi (2001) have devised a method to find a near optimal solution given that a number of products are ordered from a supplier but not all of the products are available which leads to shortages. It is possible for these EOQ models to determine the optimal ordering quantity. The most effective way to solve this kind of model is with a spreadsheet. (Winston, 2004)

2.7.2 SIMULATION MODELLING

Raffo et al (1999) defines a simulation model as a computerised model which represents some dynamic system or phenomenon. A simulation model gives insight into the future state scenario. The advantage of using a simulation model is that it is inexpensive compared to physical implementation. One can avoid taking risks in the real world while creating a realistic picture of future state possibilities. And there is always the possibility of discovering attractive alternatives. The use of simulations models are very effective when the requirement is to represent complex models that over wise cannot be done by complex statistical techniques. Tompkins et al (2003) states that simulation does not provide an optimum solution, but by asking enough "*what-if* "questions the configuration of the system that best satisfies the criteria can be chosen. Once a process is simulated, visibility of the situation is created and if the problem is of such a nature, immediate recommendations and adjustments can be made. Software programs used for simulations modelling are Arena, Quest and Simul8.

The framework of Law (2006) is used in the preparation of simulation modelling. This framework identifies the hierarchical steps of the design process of a simulation model.

The steps of developing a simulation model are illustrated below in Figure 5.

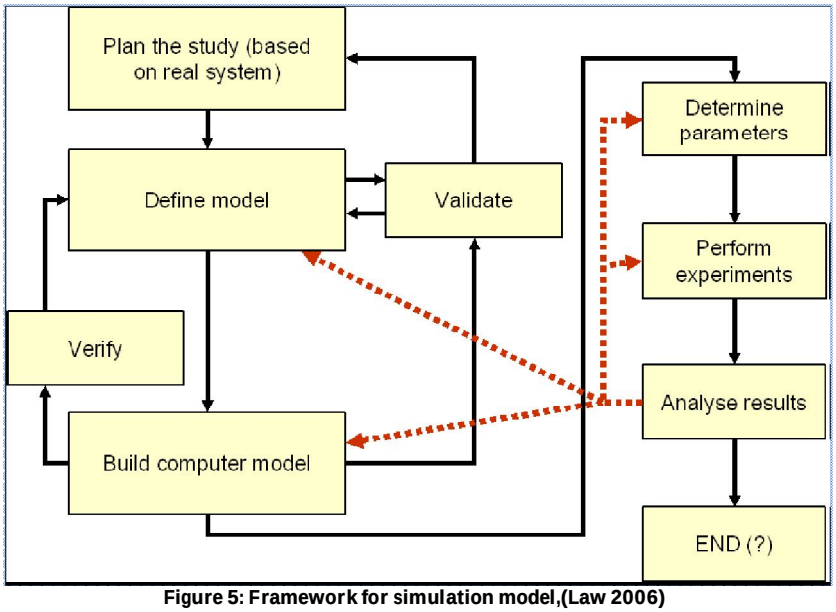

Figure 5: Framework for simulation model,(Law 2006)

Simulation starts by planning and defining the model, thereafter to validate it according to the assumed reality and lastly to build the model. Once the model is completed it can be verified to what the model was supposed to deliver. A completed model can perform experiments with different situations and results can be analysed. (Law, 2006)

2.8 SCOR METRICS

A tool that is well studied in literature in the supply chain environment is the Supply Chain Operation Reference Model (SCOR). These metrics are used by companies to compare supply chain activities and performance. The models were developed by Supply Chain Council (SCC) which was founded in 1996. The SCOR model consists of various categories that describe the business activities associated with satisfying customer demand. Bolstorff (2003) mentions that it is required of a company to use the SCOR model to define and merit supply chain activities. This ensures that the results are non-biased and comparable to other supply chains.

The model is organized into the five business processes, plan, source, make, deliver and return. Within each process different formulas are available to analyse the supply chain.

For illustrative purposes an example that is discussed by Supply Chain Council, (2008) is shown. The purpose of this formula is to evaluate the performance of the customer delivering on its commitment date.The order is considered delivered once the order is received on time as defined by the customer at the correct location.

The formula that is used to evaluate what the value of this finding is stated below.

$$\frac{[Total\ number\ of\ orders\ delivered\ on\ the\ original\ commitment\ date\ ]}{[Total\ number\ of\ order\ delivered]} * 100$$

This score of this equation gives a clear indication of the performance of the supply chain. Supply Chain Council, (2008)

2.9 CONCLUSION OF LITERATURE REVIEW

The benefits gained from the collaborative implementation of JIT, VMI in a distribution centre can be studied by simulation modelling to analyse the effect on the supply chain. A comparison can then be evaluated form the current state using SCOR metrics.

CHAPTER 3
CONCEPTUAL DESIGN

For the critical success of the project it is essential that the customers' needs are understood. Extensive consultation with the stakeholders determined that PNA does not want to reduce any product range neither lose the individual characteristics that the retailers have. With this in mind VMI and JIT methodologies are implemented to improve the supply chain.

This project uses the tools and methods discussed in the literature review with the attempt to improve the supply chain of the PNA. The current state of the supply chain is evaluated with the use of the SCOR metrics and other analysed inventory data. The future state is then simulated with the Arena simulation tool to investigate the outcome and illustrate how VMI and JIT collaborate to improve the supply chain performance.

The reason for using simulation modelling is that various studies have been conducted by Waller Johnson (1999) on the supply chain simulation. These studies proved that when replacing purchase orders with inventory replenishment it enables the supplier to improve its service while cost associated with supply chain are significantly reduced. A distribution centre will act as the VMI supplier to all the PNA retailers. The retailers are then interconnected and do not act as silos in the supply chain. The current and future state conceptual design are illustrated in Figure 6 and Figure 7 respectively.

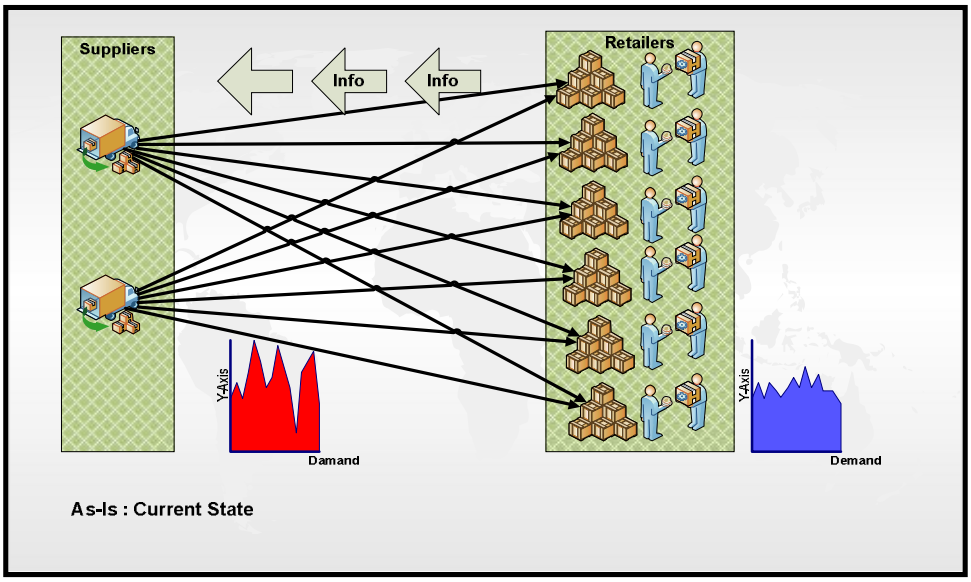

Figure 6: Current state of supply chain

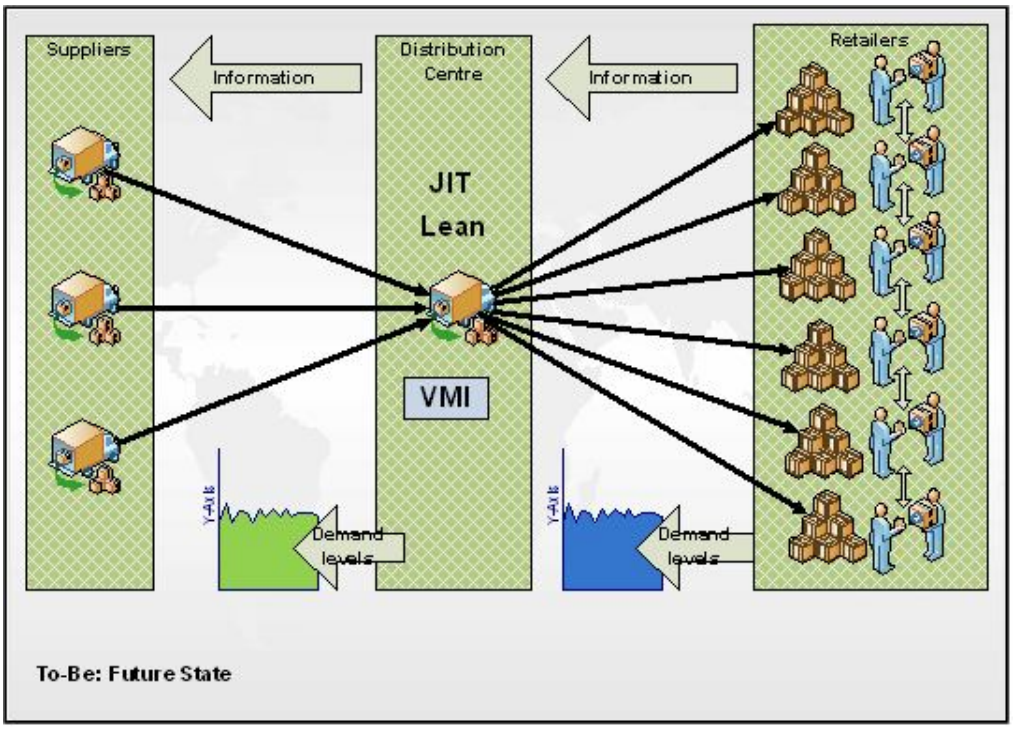

Figure 7: Future state of supply chain

3.1 CONCLUSION

To conclude the project aims to improve the supply chain of the small retailer. This will be achieved by making use of the methodologies of JIT and VMI. The VMI principle along with simulation modelling will be used to simulate the future state. In the future state a distribution centre is allocated to handle the procurement and distribution operations of the retailers. Evaluation of the improvements of the supply chain will be done by the measurements of the SCOR metrics. Concluding the project the new supply chain is considered feasible once the analysis is completed and products reach the retailer on a more reliable and available manner.

CHAPTER 4

CURRENT STATE ANALYSIS

The current state investigates problems that the individual retailers experience. This ensures that the student has a comprehensive understanding of the problems and environment of PNA. Even though the project has an overall aim to improving the supply chain, it is vital that the customer needs are stipulated unambiguously so that the project can be successful.

4.1 CUSTOMER REQUIREMENTS

Numerous discussions with the stakeholders in this project lead to the agreement of the retailers' requirements. The requirements are to ensure that the supply chain is

- More responsive and;
- Ensure on time deliveries with;
- The right quantity of products while;
- Keeping stock levels at the desired minimum level.

4.2 APPROACH

In the project seven retailers are consulted for data and analyses of the supply chain. The Deming cycle is used throughout the project to ensure that all the data and concepts that are developed are relevant to the project. This cycle is very effective as it follows a repetitive and retrospective procedure of planning, doing, validating and reacting to changes. The project has many stakeholders and this process ensures that the objectives are achieved.

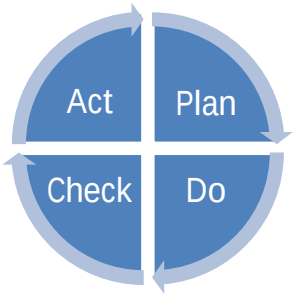

Figure 8: Deming cycle

4.3 INVENTORY ANALYSIS

A sample of products taken from the Wierdapark PNA is illustrated in Figure 9. The sample indicates that several of the products are either over stocked or short in demand. The quantity on hand is provided by the stock control system and verified with a physical stock count. The availability is determined by analysis of six months sales history and the current quantity on hand. The forecast is made in terms of how many weeks supply there is of the specific products.

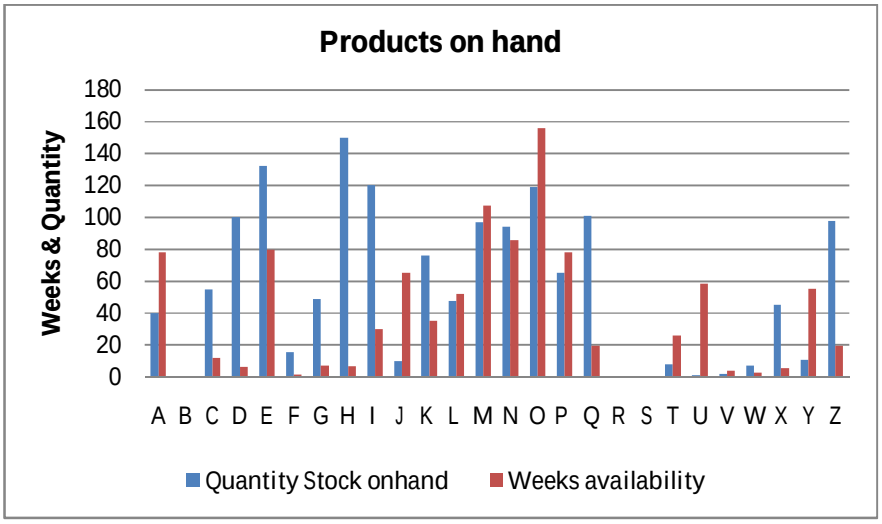

Figure 9: Inventory weeks available

The reason for the excessive amounts of products kept in the store is due to the minimum order quantities that the retailer has to order from a supplier. Thus to avoid order delivery charges on smaller orders the retailer orders products up to a quantity where the charges do not apply even though it is not required. These excessive quantities are stored in the storeroom because there is limited retail space available.

Figure 10: Storeroom at PNA

4.4 Cash to Cash Cycle

The desired cash-to-cash cycle is eight weeks and all suppliers are paid within this 60 day period. Therefore the products that are in excess are also paid for in this period even though no income is received from sales of these products.

4.5 Replenishment Accuracy

The SCOR reference model is a reference model used to evaluate the supply chain of an organisation this makes it possible to compare one supply chain performance to another. The model that is specifically designed to merit the core functionality of a supply chain is used.

In the case of this project the reference model is used in an ongoing evaluation of the suppliers' performance. The order fulfilment calculation is based on achieving all the criteria associated with an order. Therefore one point is assigned when the criterion is achieved and a zero otherwise. The criteria for the metrics are: right quantity of orders, correct committed date of delivery, documentation accuracy and good condition of products. If all the criteria are met four points are awarded for perfect order fulfilment. The result is then calculated through use of the equation and illustrated in Figure 11.

$$\frac{[Total\ Perfect\ Orders]}{[Total\ Number\ of\ Orders]} \times 100\%$$

Equation 1: Perfect order fulfilment

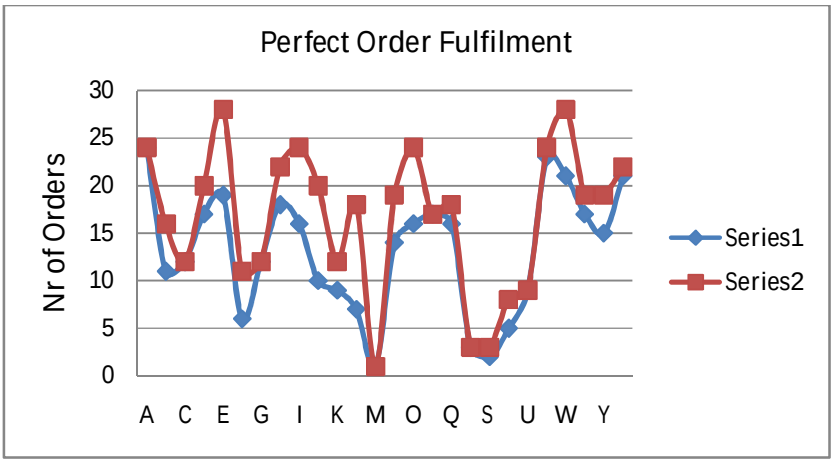

Figure 11: Perfect Order Fulfilment at Wierdapark

The total perfect orders received at PNA Wierdapark amounted to 78%. For the retailer this is a low score. It implies that 22% of orders received are incorrect and unnecessary time is spent to solve the problem. This is a cause of shortages of products and backorders are required. The perfect order fulfilment merit for the combined retailers is 86%. This indicates that the suppliers have an 86% reliability of delivering the correct order. Data analysis is provided in Appendix A.

4.6 Replenishment Lead Time

The order replenishment cycle starts at the retailer placing an order thereafter the supplier invoices the order and delivers it to the retailer. The standard delivery lead time is three to five days. The PNA retailer experiences a longer replenishment cycle as illustrated in Figure 12. This phenomenon leads to shortages in supply as the customer demand is not filled in a timely manner.

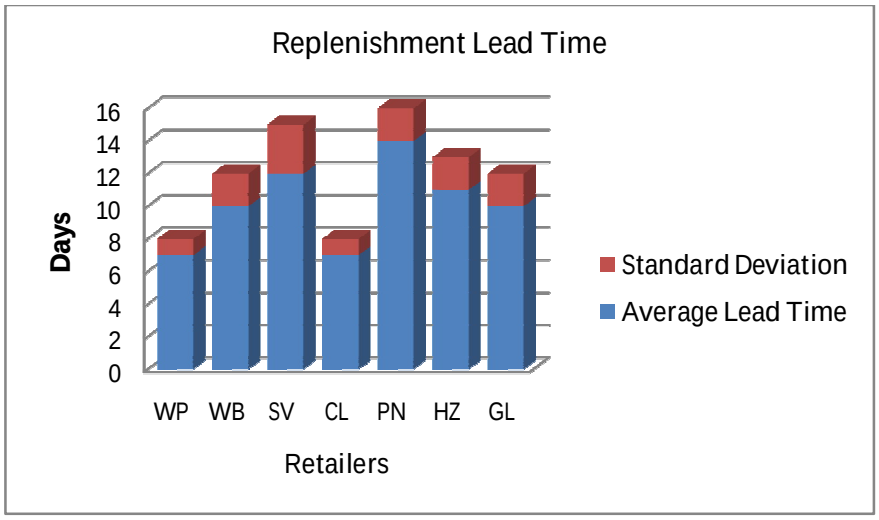

Figure 12: Lead time on replenishment

4.7 Storeroom Utilisation

The ordering and delivery process of the retailers are done from the storeroom in each shop. These processes are illustrated in Appendix A. The combined floor space lost at the retailers for storerooms is 350m².

CHAPTER 5
FUTURE STATE

As part of the development of the new supply chain strategy, tools and methods are combined to create the desired outcome. The future state is described and then evaluated with simulation modelling. It is imported to note that the supply chain is configured on the methodology and tools mentioned in the literature review, there are however other tools and terminology that are not discussed as part of the research but form part of common principles.

5.1 FUTURE STATE IMPLEMENTATION

The new supply chain uses VMI and JIT principles with the incorporation of a distribution centre. These principles require that certain adjustments are made in the current state. The changes have an impact on the role and responsibility of the retailers and suppliers.

5.1.1 RETAILERS

The retailer continues with front office activities of selling products to customers. The back office activities are limited to receiving stock and replenishing the shelves. All the actions mentioned below are completed in advance by the distribution centre and this allows the retailer to develop the core competency of selling products.

- Order new products from suppliers
- Process claims for wrong deliveries
- Enter products in operating system for stock control.

When a retailer receives the deliveries from the distribution centre it is in the required quantities that go directly to the shop floor. The staff uses the trolley in Figure 13 to assist in replenishing the products on the floor. These trolleys are ergonomically approved for safe working conditions and are a necessity because replenishment is done on a regular basis.

Figure 13: Trolley for replenishment

5.1.2 DISTRIBUTION CENTRE

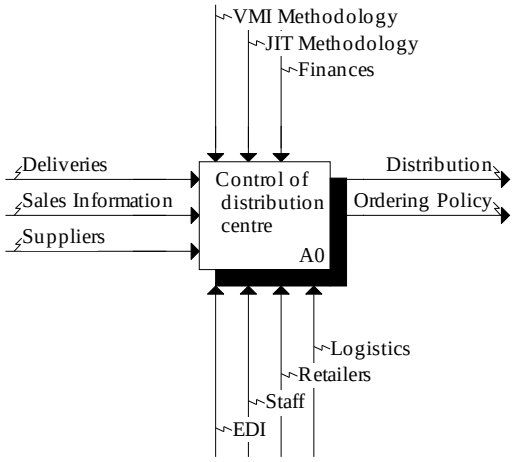

Figure 14: Functional diagram of distribution centre

5.2 THE FUNCTION OF THE DISTRIBUTION CENTRE

The distribution centre is in control of procurement, receiving of orders, management of stock and distribution to the various retailers. The function diagram in Figure 14 and Appendix B illustrates the relationship of these functions. High level descriptions of these functions are discussed.

5.2.1 PROCUREMENT

Procurement is one of the main functions of the distribution centre. The distribution centre orders in bulk from suppliers, according to the demand of the retailers. Minimum quantities of products are held in the storeroom and monthly or bimonthly orders are made at suppliers.

The combination of bulk purchases and a central delivery destination minimises delivery charges. The bulk purchases also make the procurement price lower per unit and this makes the retailer competitive in the market.

The “bull whip” phenomenon as experienced in the current state is not as vivid. This benefits the retailers and suppliers, because the variance in demand is less due to combined orders and visibility of the inventory levels.

5.2.2 RECEIVING

The distribution centre receives all the deliveries from the suppliers. These deliveries are verified and approved and the products are entered into the inventory control system. Thereafter the products are priced and stored away. This is an extensive administration process caused by incorrect deliveries and damaged products. The distribution centre has the capacity to administrate these activities. The individual retailers do not have the capacity due to lack of personnel and administrative skills.

5.2.3 MANAGEMENT OF INVENTORY

The information system receives daily sales and inventory level data from the retailers. A request for replenishment is automatically generated and a list is provided of all the products that need to be replenished. These products are picked from the distribution centre and prepared for distribution. Once all the products are prepared a delivery is made to the required retailers.

An advantage of picking products is that a break bulk delivery can be made to the retailers. An example is that one retailer receives one product while another receives three products depending on the demand; this ensures the right quantities of products are purchased. The management of inventory is a significant role as it reduces the build up of unnecessary stock.

5.2.4 DISTRIBUTION

Distributions to the retailers are done from the distribution centre. The distribution is done on a predetermined route and schedule that provides the retailer with visibility of delivery pattern.

Transfers of products between retailers are possible and can be redistributed from where there is excess available. This ensures better customer service due to a quick response that is provided.

5.2.5 INFORMATION

Information is sent between the retailers and the distribution centre by means of electronic data interchange system.

Electronic Data Interchange (EDI)

The EDI program that is used at the various retailers is a customised program developed for one of the PNA's. The program has a reliable service provider and has been developed specifically for the retailer. The program has been developed and improved over the past 12 years and incorporates the functions of automatic data transfers and forecasting.

The distribution centre receives all the sales information and has a bird's eye view of all the products in the store as well as at the retailer. The system verifies the minimum requirements for each product and then notifies the distribution centre what products are requested. The minimum quantities of products are dependent on the sales history of the products.

5.2.6 LOCATION

The optimal location of the distribution centre is not within the scope of this project. The assumption is made that the distribution centre is best situated near the retailer with the highest stock turns therefore the location is near the Wierdapark PNA.

CHAPTER 6
FUTURE STATE SIMULATION

6.1 COMPUTER MODEL

The methodologies and theoretical concepts are translated into a simulation model that can be analysed by a computer. The simulation model is developed in the Arena 10 simulation software package. Reports are generated at the end of the simulation run. These reports include statistics on the performance of entities, the length of queues and other user defined attributes.

6.2 COMPUTER SIMULATION LOGIC

6.2.1 ENTITIES

Entities in Arena represent the various characters that are simulated in the model. In this project three types of entities are defined. Type one is products that travels from the suppliers through the distribution centre to the retailer. Type two is the vehicle used to transport the grouped products from the distribution centre to the retailer and type three represents the sales occurring at the retailers.

6.2.2 VMI AND JIT SIMULATION DEFINED

As discussed in the literature review VMI and JIT are methods that require thorough knowledge of customer demand. The simulation model is developed around the theoretical knowledge of these methods. The implementation of these methods creates a pull system, with a process that starts at the customer and works upstream in the supply chain.

6.2.3 DISTRIBUTION CENTRE

The distribution centre allows entities to enter into the store depending on the inventory level of the retailers and current availability at the store.

6.2.4 *Process Description*

The process logic ensures that every time that a sale occurs at a retailer a signal is sent from the retailer to the distribution centre. This signal informs the distribution centre that the retailer has lost the product and requests to be replenished. This process is illustrated in Figure 15.

Figure 15: Product sold Logic

The process continues as the distribution centre releases the product from the stores and prepares it at the order assembly point. The product waits there while other products are also released. When the desired quantities are batched the products are transported to the various retailers that made the original requests.

Figure 16: Preparation of product

Another entity, the truck, is created and continues on a circular route to pick up assembled orders and distributes the orders to the various retailers. The truck circulates daily on a predetermined route.

Figure 17: Distribution of product

Once the truck has delivered all the products it returns to the distribution centre and waits for the next signal. The distribution centre scans for changing conditions of inventory levels and then acquires more products from the upstream suppliers. This process is then repeated to simulate various products.

6.3 MODEL DESIGN

The simulation model is grouped into three sections as illustrated is Appendix C. The three sections represent the distribution centre, decision logic and the retailer demand.

6.3.1 RUN LOGIC

The simulation is run over a period of 365 days which produces a realistic result on the sale period of one year and accounts for fluctuations in seasonal demand.

6.3.2 DATA INPUTS AND LIMITATIONS

To ensure that the simulation model is realistic, real data and the actual limitations of the system is built into the model. In order to accommodate the variety of products and suppliers that influence the distribution centre, the simulation is built with three product types that are simulated simultaneously. Historic sales data is used to establish what the probabilities of demand are for these categorised products.

6.3.3 INPUT ANALYSER

The sales data is analysed in the Input Analyser, one of the sub programs that is available in Arena. The analyser provides an expression that best describes the probability of sales occurring. These probabilities are used to trigger the demand of the various products. An example of this expression is illustrated in Figure 18. Other related distributions are also available in Appendix C.

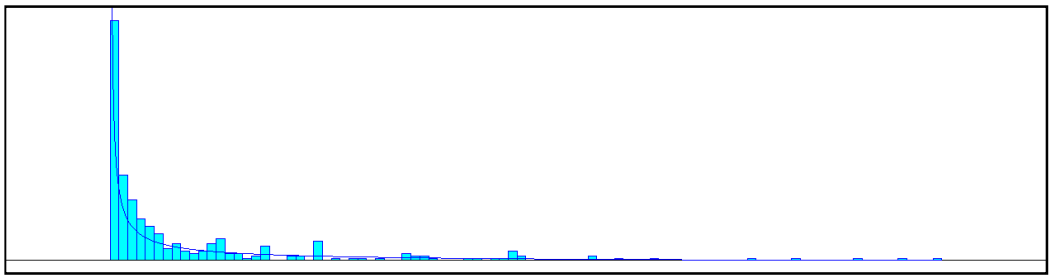

Figure 18: Distribution of demand for product 1

The distribution is expressed as: -0.5+94*BETA (0.218, 2.02). Square Error:0.006590

6.4 ANALYSES AND RESULTS

The analyses are done on the category of products that contribute to 80% of purchases made by the seven retailers as illustrated in Figure 19. These categories are Stationery, Books and Arts and Crafts. Three products types are selected from these categories and evaluated by the simulation model.

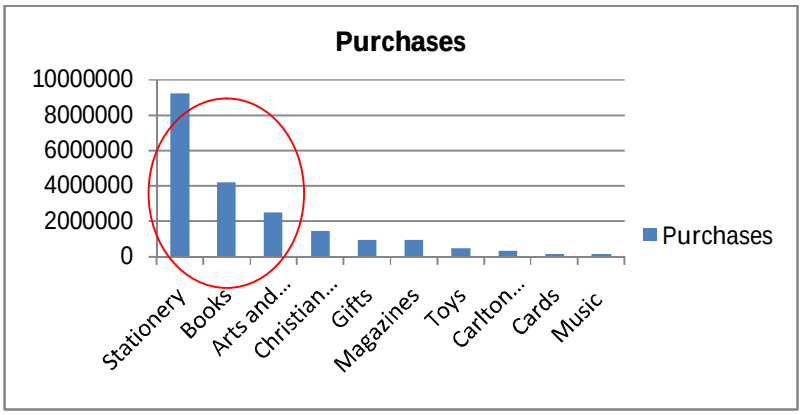

Figure 19: Category of purchase made

Evaluation

The results of inventory distributed by the distribution centre are compared to the combined current state inventory levels of the retailers' excess stock.

In the analysis of Product 1 it is evident that the distribution centre that functions on the VMI principles has a significant effect in the reduction of inventory carried at the retailers. As illustrated in Figure 20 there are 376 fewer quantities required. The distribution centre restricts unnecessary items to be sent to the retailer and this ensures that no unnecessary products are purchased.

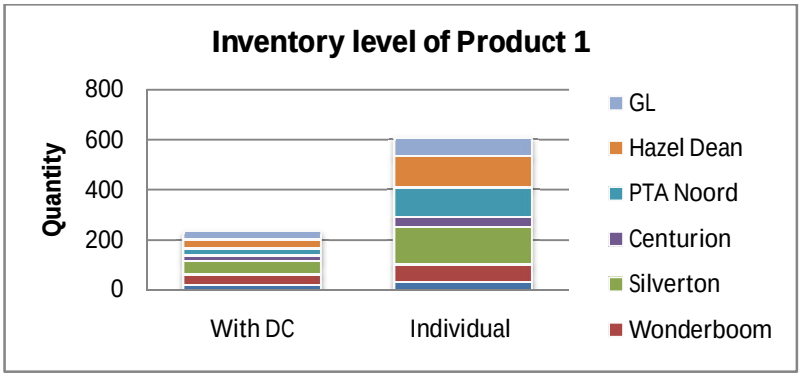

Figure 20: Inventory level of product 1

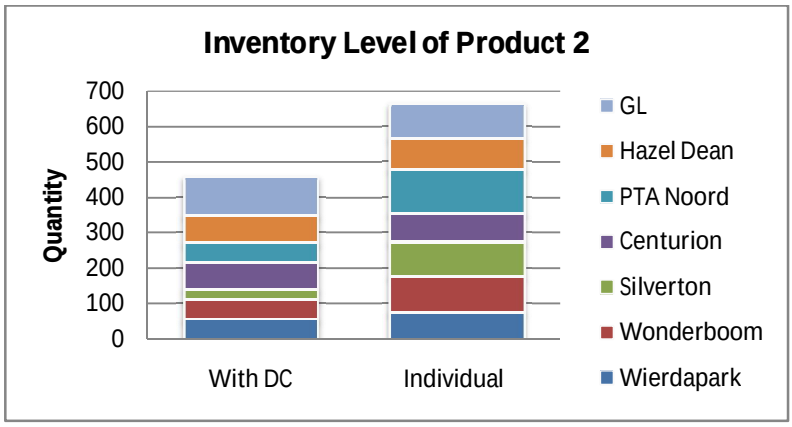

Figure 21: Inventory level of product 2

The same result is evident in the analysis of Product 2 and Product 3 (Figure 21, 22) with a reduction of 207 and 329 respectively. The conclusion of this simulation run is that given the realistic sales data the distribution centre contributes to significant reductions. There are no shortages in product delivery as replenishment takes place within one day.

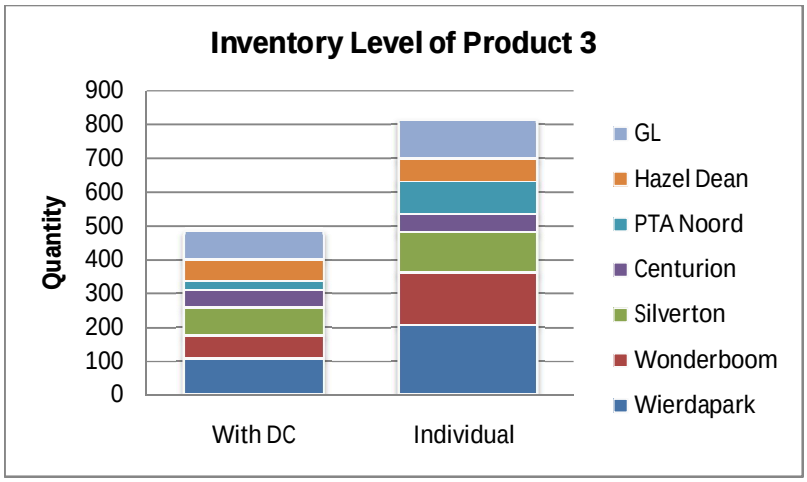

Figure 22: Inventory level of product 3

Alternative Analysis

The analysis was completed on other products and the same tendency was found with the result as indicated in Appendix D. These comparisons are sufficient for the analysis for the result represent data from the most profitable product of the retailer.

6.5 EXPECTED BENEFITS

The benefits gained from the proposed future state are:

1. Other all inventory levels are reduced.

   This is proved by the simulation model as the excess stock is reduced significantly at each retailer.

2. Lead time on replenishment is reduced

   The incorporation of JIT principles ensures that the replenishment time is only one day.

3. Space utilization.

   With the implementation of the distribution centre the retailers do not require the big storerooms.

   a. These areas can be incorporated into the shop floor areas and be used as merchandising space. This creates opportunities to expand product ranges.
   b. The retailer requires less space and therefore can occupy a smaller retail area and pay less rent.

4. Centralised administration

   All administrative activities are centralised and done from the distribution centre. This allows the retailers to focus on the core competency of the business which is selling of products.

5. Visibility of inventory

   The distribution centre is aware of all the inventory levels at each retailer. This visibility creates opportunities to purchase in bulk from suppliers. The distribution centre is also regarded as a priority customer with big buying power.

6. Reduced cost

   The centralisation of the distribution centre creates only one delivery destination for the suppliers, thus delivery charges are less and at most of suppliers the delivery charge do not apply.

6.6 CONCLUSION

The conclusions drawn is that a distribution centre with the implementation of VMI and JIT principles significantly reduces unnecessary inventory handling and ensure availability of products to each retailer. This outcome satisfies the requirements of the retailers and improves the supply chains performance.

A final comparison with current supply chain reveals that the lead time on deliveries can be reduced to one day. This is a significant reduction in delivery time. It is also noted that the elimination of excess inventory carried at the retailer creates a more profitable supply chain that is responsive and reliable while inventory levels are not in excess.

7. FUTURE WORK

Future studies on this project will include optimisation of delivery routes and the expansion of the distribution area to accommodate more PNA.

EOQ models will be developed for the distribution centre to minimise the cost of holding inventory.

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APPENDIX A

A.1 Perfect Order Fulfilment

(19 September 2009)

	Wierdapark		Wonderboom		Silverton		Centurion		PTA N	
Suppliers	Perfect	Total	Perfect	Total	Perfect	Total	Perfect	Total	Perfect	Total
A	24	24	12	12	24	24	12	12	11	11
B	11	16	11	11	24	24	12	12	5	5
C	12	12	6	7	22	24	12	12	12	19
D	17	20	17	19	21	24	10	16	12	13
E	19	28	12	14	19	24	15	17	9	9
F	6	11	12	12	24	24	12	16	8	8
G	12	12	20	23	24	24	20	24	17	17
H	18	22	16	22	22	24	17	24	19	19
I	16	24	15	17	20	22	20	24	20	24
J	10	20	9	9	11	12	10	12	19	24
K	9	12	8	8	5	5	13	18	24	24
L	7	18	9	9	19	19	12	19	20	22
M	1	1	9	9	13	14	21	21	19	21
N	14	19	9	9	9	12	21	21	17	19
O	16	24	7	7	8	12	24	24	22	24
P	17	17	6	8	17	24	24	24	24	24
Q	16	18	6	9	19	24	24	24	17	22
R	3	3	10	14	24	24	19	24	17	20
S	2	3	10	15	12	12	19	19	12	12
T	5	8	9	9	7	12	22	22	19	24
U	9	9	8	8	8	12	20	24	17	20
V	23	24	7	8	12	12	8	19	20	24
W	21	28	17	20	24	24	18	20	20	24
X	17	19	22	24	20	24	20	20	11	12
Y	15	19	24	24	24	24	17	20	6	7
Z	21	22	22	22	24	24	17	20	7	8
	341	433	313	349	456	504	439	508	404	456
	0.788		**0.897**		**0.905**		**0.864173**		**0.885965**	

Table 1: Data of perfect order fulfilment

A.2 Order Process of Retailer

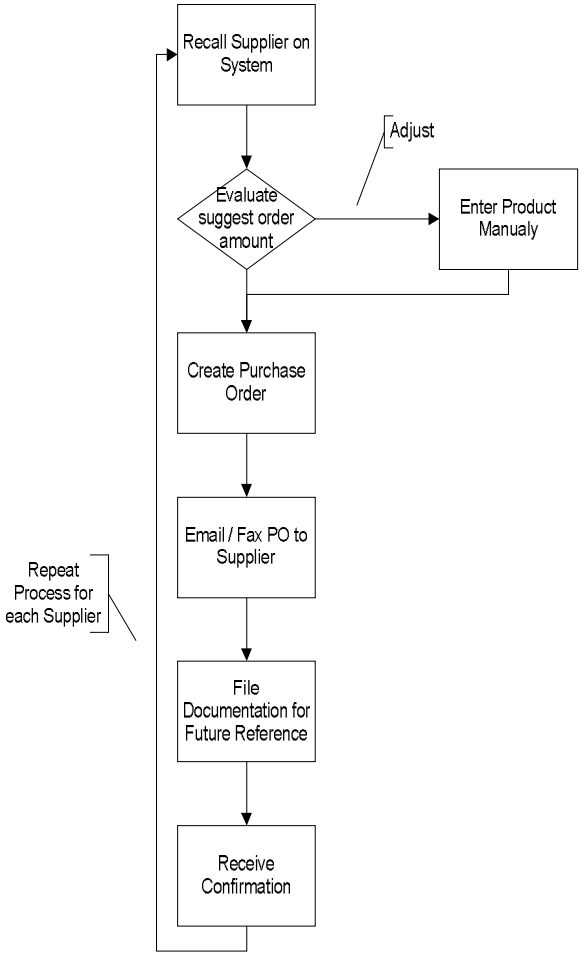


Figure 23: Ordering Stock

A.3 Receiving Process of Retailer

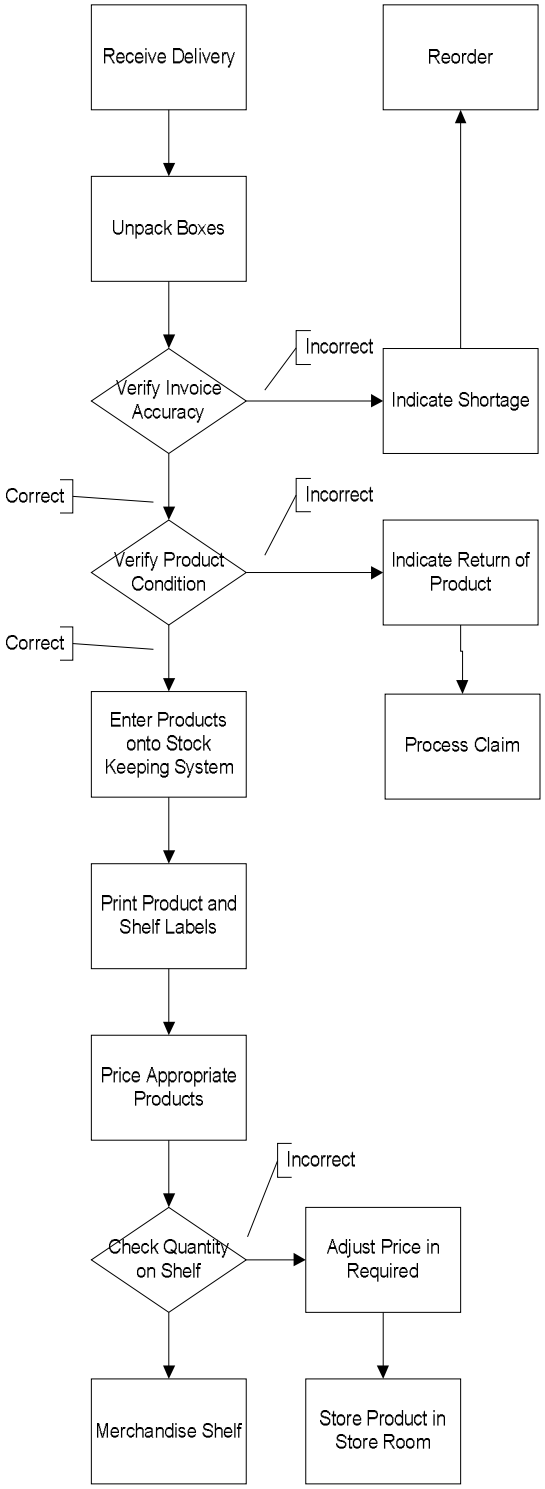


Figure 24: Receiving stock

Appendix B
B.1 Functional Diagram of Distribution Centre

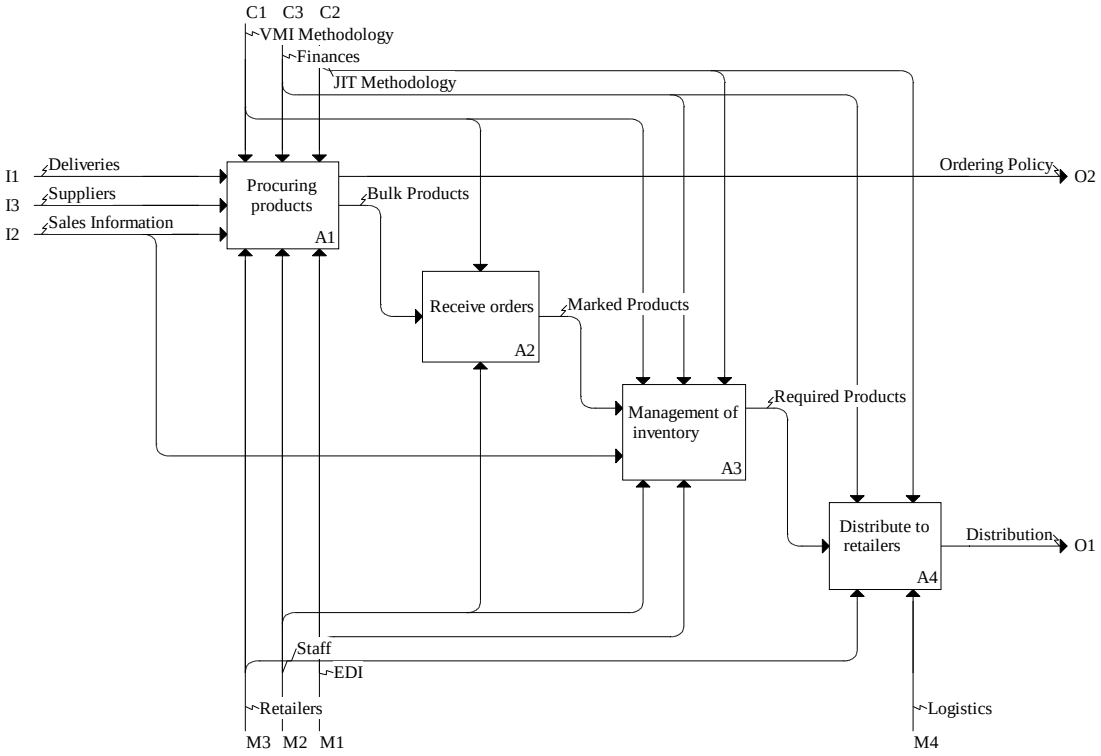


Figure 25: Functional diagram of distribution centre

Appendix C

C.1 Input Analyser Data

	$-0.5 + Weib(3.2, 0.842)$
	$-0.5 + Weib(2.42, 0.751)$
	$-0.5 + Logn(3.72, 5.44)$
	$-05 + Weib(4.2,0.633)$
	$-0.5 + Weib(4.9, 0.43)$
	$-0.5 + Logn(4.75,6.3)$

Table 2: Input Analyser Data 1

	$-0.5 + Weib(5.33,0.827)$
	$-0.5 + Weib(5.47,0.827)$
	$-0.5 + Weib(3.92, 0.442)$
	$-0.5 + Weib(4.9,0.837)$
	$-0.5 + Weib(6.5, 4.3)$
	$-0.5 + Weib(5.31, 2.5)$
	$-0.5 + Weib(3.2, 1.1)$

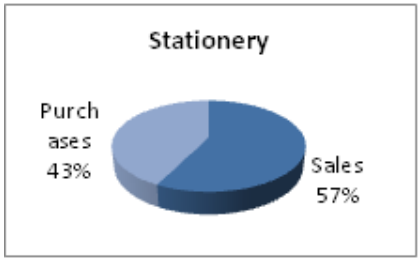
Table 3: Input analyser data 2

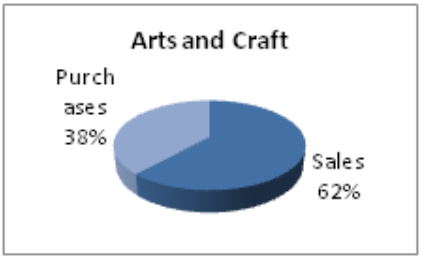
Appendix D

D.1 Purchases and Sales Data

	Sales	Purchases	
Stationery	12419611	9205618	
Books	5315160	4178939	
Arts and Craft	4015570	2488331	15872888
Christian Books	2761599	1442898	
Gifts	1688037	948582	
Magazines	1023920	909546	
Toys	684874	478005	
Carlton Price Group	531132	298219	
Cards	266295	151565	
Music	177825	121309	
		20223012	0.784892

Table 4: Data of purchases made





Shop Code	Store Capacity	m^2
Wierdapark	15x10	150
PTA North	6x3	18
Centurion	8x3	27
Wonderboom	15x7	105
GL	6x3	18
Hazeldean	8x4	32
Total		**350**

Table 5: Data of store capacity

D.2 Distribution Centre

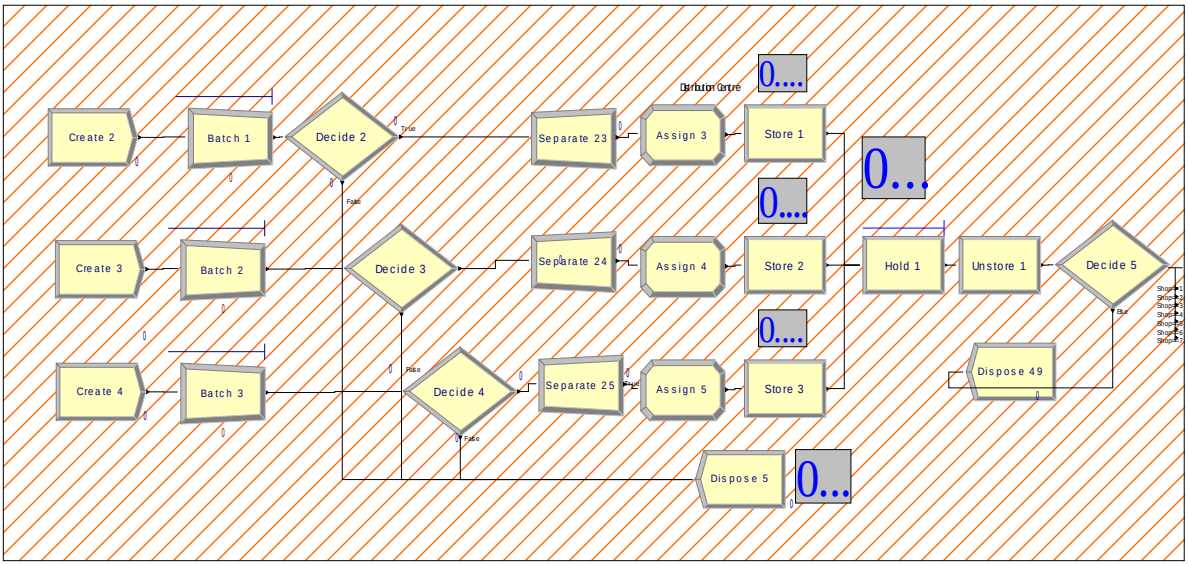


Figure 26: Distribution Logic

D3.Retailer

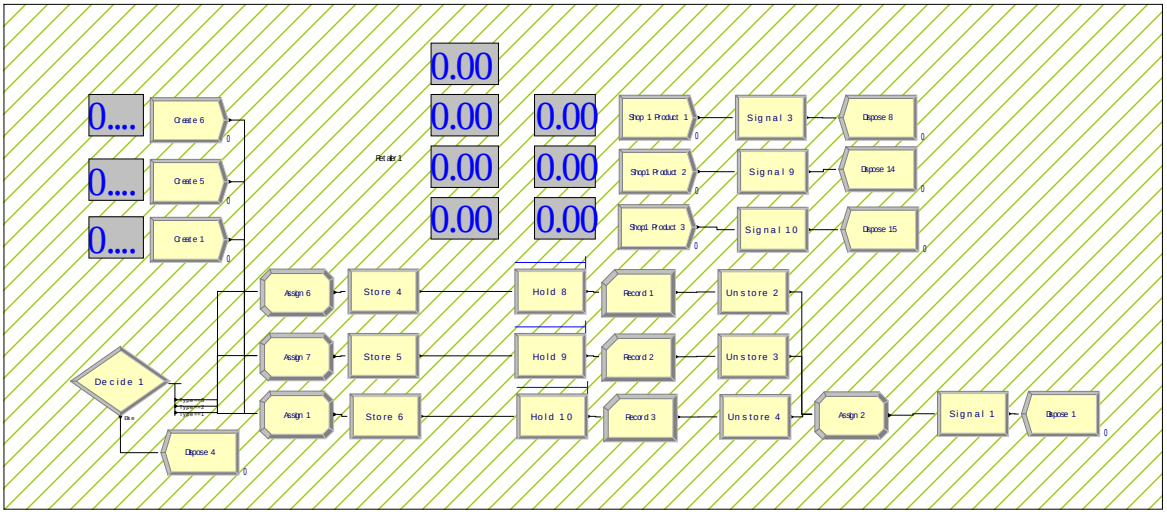


Figure 27: Retailer Logic

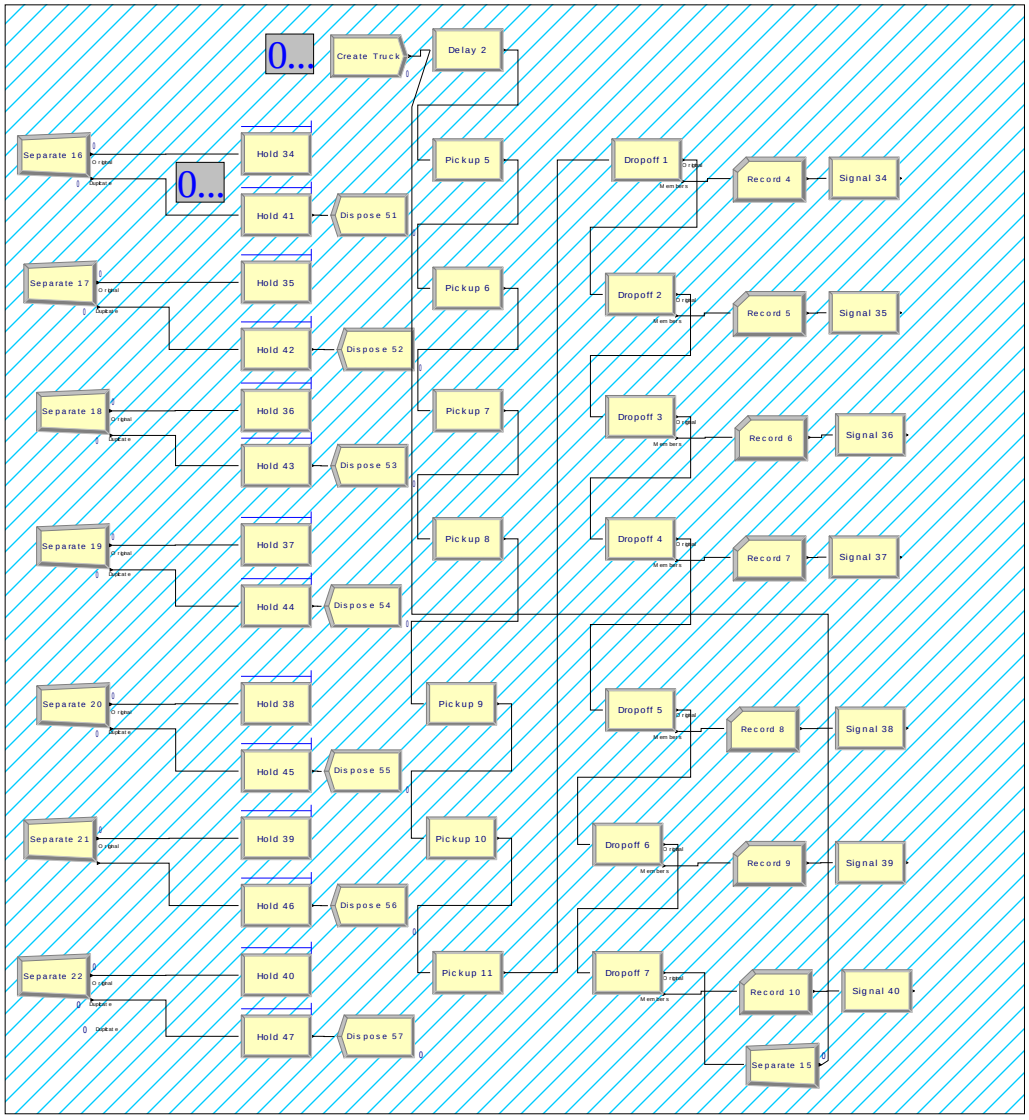


Figure 28: Distribution Logic

Appendix D
D1.Analyses of Simulation

Figure 29: Additional analysis of simulation

		Wierdapark	Wonderboon	Silverton	Centurion	PTA Noord	Hazel Dean	GL			
1	With DC	20	40	54	23	29	35	32	Required	233	
	Individual	31	69	150	40	120	123	76	Overstocked	609	376
		Wierdapark	Wonderboon	Silverton	Centurion	PTA Noord	Hazel Dean	GL			
2	With DC	54	56	28	76	56	77	111	Required	458	
	Individual	74	101	98	81	124	87	100	Overstocked	665	207
		Wierdapark	Wonderboon	Silverton	Centurion	PTA Noord	Hazel Dean	GL			
3	With DC	108	67	83	50	29	64	82	Required	483	
	Individual	205	155	120	55	95	67	115	Overstocked	812	329
		Wierdapark	Wonderboon	Silverton	Centurion	PTA Noord	Hazel Dean	GL			
4	With DC	45	31	87	12	24	18	114	Required	331	
	Individual	102	112	194	180	227	70	200	Overstocked	1085	754
		Wierdapark	Wonderboon	Silverton	Centurion	PTA Noord	Hazel Dean	GL			
5	With DC	48	82	131	70	96	76	31	Required	534	
	Individual	210	110	407	34	270	374	207	Overstocked	1612	1078
		Wierdapark	Wonderboon	Silverton	Centurion	PTA Noord	Hazel Dean	GL			
6	With DC	69	95	65	80	75	43	92	Required	519	
	Individual	180	483	342	85	291	87	303	Overstocked	1771	1252

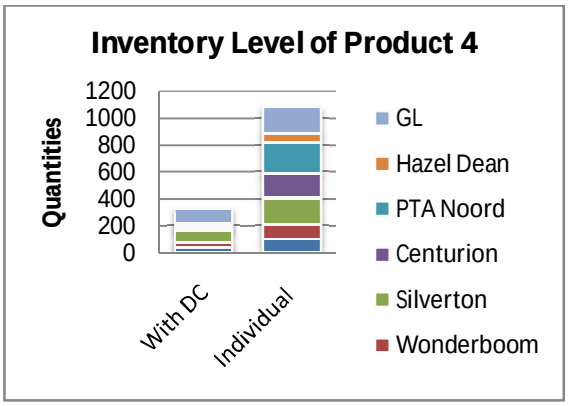


Figure 30: Inventory level product 4

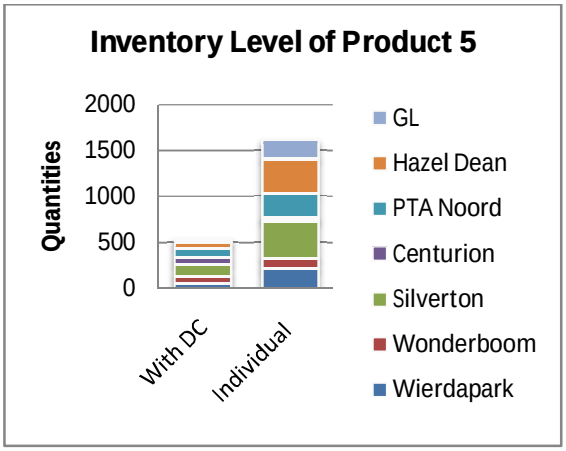


Figure 31: Inventory level product 5

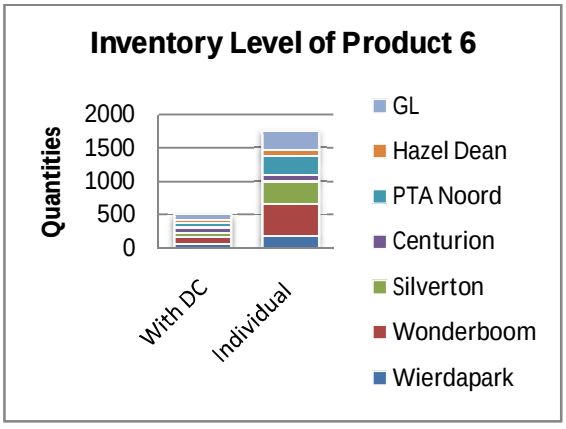


Figure 32: Inventory level product 6