

REDESIGN OF A DISTRIBUTION CENTRE TO INCREASE  
OPERATIONAL CAPACITY

by

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Submitted in partial fulfilment of the requirements for  
the degree of

BACHELORS OF INDUSTRIAL ENGINEERING

in the

FACULTY OF ENGINEERING, BUILT ENVIRONMENT AND  
INFORMATION TECHNOLOGY

UNIVERSITY OF PRETORIA

October 2012



## Executive Summary

Incomati Warehousing and Distribution specialises in different Supply Chain Services namely Warehousing, Logistics, Distribution, Information Technology and Management Consultancy. It is a relatively young organisation, growing at a very rapid rate. Its current Distribution centre is situated in the East Rand. During the peak period of 2011, the organisation received such volumes that the Distribution Centre was unable to process the goods at an adequate rate. As Incomati Warehousing and Distribution is experiencing substantial growth, it is necessary for the Operational Capacity of the organisation to be increased to prevent a repetition (or worse) of the peak period of 2011. Trends such as centralizing of warehouses are discussed and fundamental Principles and Procedures.

In order to design an improved facility layout, the project will include the application of the Facilities Planning process as set out by Tompkins, White, Bozer & Tanchoco (2010:14) and Muther's Systematic Layout Planning (SLP) Procedure. Furthermore, the alternative layouts would be evaluated by the Computerised Relative Allocation of Facilities Technique (Tompkins et al 2010:314).

It is imperative that it be kept in mind that a newly designed and implemented facility does not conclude the planning effort entirely. A facility must be continually adapted and modified over time for it to align with its ever changing requirements and specifications.

The larger, newly designed facility plan will have the capacity to process future volumes of stock. It will accommodate the growth and process needs of the company. Redesigning the Distribution centre to increase Operational capacity is the most practical, cost effective solution to this problem.



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## **1. Introduction and Background**

Incomati Warehousing and Distribution was founded in 2009 and specialises in the various Supply Chain services namely Warehousing, Logistics, Distribution, Information Technology and Management Consultancy. The aforementioned specialities allow the organisation to aid the Footwear Industry Supply Chain to a great extent. Although the organisation is relatively young its Management has more than 50 years' collective experience in the Warehousing and Logistics Industry.

It currently delivers goods across South Africa as well as export to neighbouring countries namely Namibia, Botswana, Swaziland and Lesotho.

The Head Office and current Distribution Centre are situated on the East Rand, Boksburg. The company benefits from the advantages of a geographically centralised position between the Northern and Southern regions of Southern Africa.

Establishing strategically located depots corresponding to the growth of the company are one of the next steps in the expanding organisation.

With the necessary expertise in the different logistical fields, clients served by Incomati Warehousing and Distribution are organisations of various sizes and different positions in the Footwear Supply Chain. The Clients range from footwear retailers to footwear wholesalers.

### **1.1. Problem Statement**

Growing at a rapid rate, the existing facility used by Incomati Warehousing and Distribution as a Distribution Centre is proving inadequate. The size of the current facility is 1000 m<sup>2</sup>. It is evident from Table 1 and Table 2 that a significantly higher stock volume is expected for the peak period (November) of 2012.

The organisation had been compelled to offload, sort, check and label goods outside of the Warehouse during the peak period (September- November) of 2011. The Warehouse did not have the capacity to process the volumes received.

Tables 1 and 2 and the aforementioned fact are paramount evidence that the current Operational Capacity and ultimately the facility had become completely inadequate.



Facilities Planning is not the only solution to the problem, but the most cost effective one. This type of business revolves around its Distribution Centre, hence the focus on Facilities Planning.

		Stock Received:		
		Annual number of cartons	Annual Volume (m <sup>3</sup> )	Annual growth (%)
Forecasted Data	Time Period			
	March 2010 - February 2011	98678	8881.02	
	March 2011 - February 2012	158391	14255.19	61
	March 2012 - February 2013	465410	41886.9	194
	March 2013 - February 2014 **	535222	48169.935	15
	March 2014 - February 2015	615505	55395.4257	15

**Table 1 – Operational growth of Incomati Warehousing and Distribution (adapted from “Income Statement per period”)**

Note that the growth declines considerably from 2013 \*\*. The reason for this is that Incomati Warehousing and Distribution will be consolidating their current clients and assets until 2015 in order to maintain sustainable growth and avoid cash flow problems in future.

Volume source	Estimated cartons to be processed	Growth %
		March 2012 - February 2013
Current client	182149	15
New client	283261	-
<b>Total</b>	<b>465410</b>	<b>194</b>

**Table 2 - Breakdown of forecasted growth for next financial year (adapted from interview with D. Smith)**

Figure 1 illustrates the percentage of stock received during each month. The sum of these percentages make up the total annual volume received. During September the peak trading period is entered, that reaches its zenith during November.

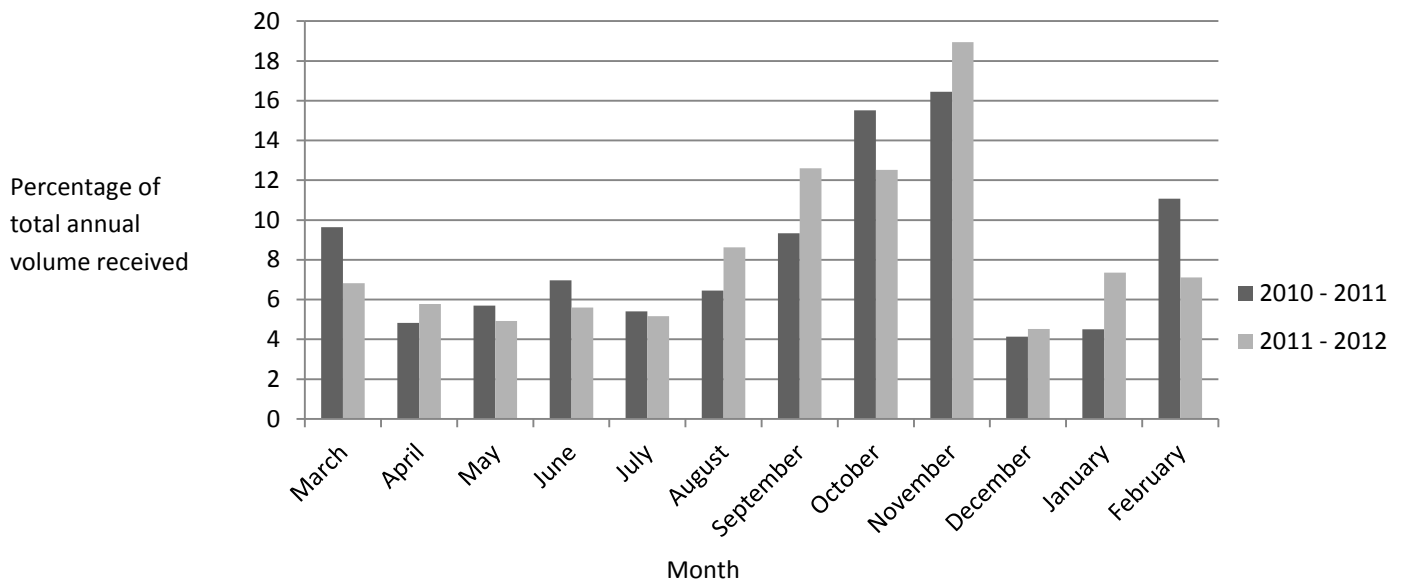


Figure 1 – Monthly percentage breakdown of volumes received (adapted from Income Statement per period, Incomati Warehousing and Distribution)

## 1.2. Project Aim

The aim of the Project is to design a larger Distribution Centre for the organisation, being a cost effective, practical solution to accommodate the growing needs of the organisation. The space requirements of this larger Distribution centre will be calculated according to the space required during November 2014. This ensures that the facility will be adequate during the peak period as well as making provision for future growth. More specifically, the objectives of the project include:

- Analysing the Distribution Centre layout and operations in order to redesign an improved facility accommodating the growth, processes, stock volumes, budget and other requirements of the company.
- Determining the growth rate of the organisation as well as the volumes expected at various annual stages.
- Applying Facilities Planning principles (including Material Handling) in accordance to standards of professional practice.



- Compose documented rules and procedures of Warehousing Processes (Receiving, Sorting and Inspection, Put Away, Storage and Shipping) and of Material Handling to establish standards and policies in order for the company to acquire the advantages of Best Practice.
- Investigate the planning procedures and potential of improving the organisation's preparation for peak periods.

### **1.3. Project Scope**

The project will include supplying the organisation with documented Material Handling equipment and techniques appropriate to the environment as well as possible suppliers of the equipment. It would also include an alternative, larger Distribution Centre design and the required staff compliment for the facility. The project will not however, include implementation of any techniques or Facility Plans or investigation of the logistical aspects of operation outside of the Distribution Centre.

### **1.4. Deliverables**

- An improved Facility layout accommodating the growth, processes, budget and other requirements of the organisation. The objective of this layout will be to optimise space usage, flow and warehouse processes especially during peak periods.
- Documented Warehousing standards and principles.
- Reliable Material Handling principles, methods and techniques.
- Staff compliment necessary to run the new Distribution Centre.



## 2. Literature study

### 2.1. Facilities Planning

The capacity of an operation is represented by the facility in which it is executed. This is according to Kjell B. Zandin (2001) in Maynard's Industrial Engineering Handbook. Facilities can either improve or prohibit the total efficiency of an organization's operations. The goal in facilities planning is to design a facility that will in turn strengthen operational strategies implemented by the company. The designing, planning and physical plan behind operational areas within a facility amounts to the "Facility Layout". Good housekeeping within a facility is cardinal. A facility should be free from obstacles and other impediments that disrupt flow and other operations, hence the Latin expression *facilis* meaning "easy". Not only material and process flow is accommodated by a well-designed facility, but also resource optimization, upholding of the required quality standard and a well projected company image. A well-designed facility is a complicated goal, as many factors are to be considered and numerous types of facilities to be designed. In addition to this, customer requirements, budget and different processes to be accommodated increase the complexity behind Facilities Planning.

The business environment and the changes therein have a significant impact on Facility Management (Eric Teicholz, (2001)). These changes include minimization, growth, consolidation and mergers. The transformation experienced by businesses, bring about physical change to the facilities they are run in. A provision or modification of workspace must be carried out to accommodate the transformation.

Facilities planning is an ever evolving discipline; designs aim to provide the smoothest flow of goods, supply flexibility, improve productivity and space usage whilst reducing the number of facilities together with operating costs. A few of the current trends are mentioned below:

- Facilities supplying more than a single receiving dock, in smaller sizes.
- Minimizing centralized storage areas and more decentralized storage areas. This principle accommodates smaller and lighter loads.
- Decentralized material handling equipment at docks meant for receiving.
- Containers that are visible, durable, recyclable, readily transferable and collapsible (optimizing space).



- U-shaped assembly lines and fabrication cells.
- Standardized material handling equipment (pallets, containers and trays)
- Facilities design process applied as a coordinated design process between many people (Tompkins et al (2003:476).

### 2.1.1. Methods, Tools, Techniques

Facilities planning has transformed over the last decade into more of a strategy than a science as it was perceived earlier. (Tompkins et al (2003:3)) Numerous methods, tools and techniques are available to design facilities.

A facility might be planned only once, but it is constantly re-planned to meet its changing objectives. The conventional engineering design process can be applied to formulate a Facilities planning process according to Tompkins, White, Bozer & Tanchoco (2003:13) and also the method that will be used to this specific project:

- *Clearly define the problem.* This step is carried out by defining the facility's objective and specifying the primary and support activities that would accomplish the objective.
- *Analyse the problem* by determining the interrelationships among all activities.
- *Determine each activity's space requirements.* Followed by the determination of space requirements, alternative facility plans are generated.
- *Evaluate alternative facilities plans.* According to the client's requirements and other criteria, rank the plans specified.
- *Select the preferred facilities plan.* Use the information from the previous step to enable a good selection.
- *Implement the facilities plan.* The facilities plan must be *maintained and adapted* and the *objective of the facility must continually be redefined.* (These steps however, are not included within the scope of the project)

The Facilities Planning process is executed within three phases that are schematically represented in Figure 2.

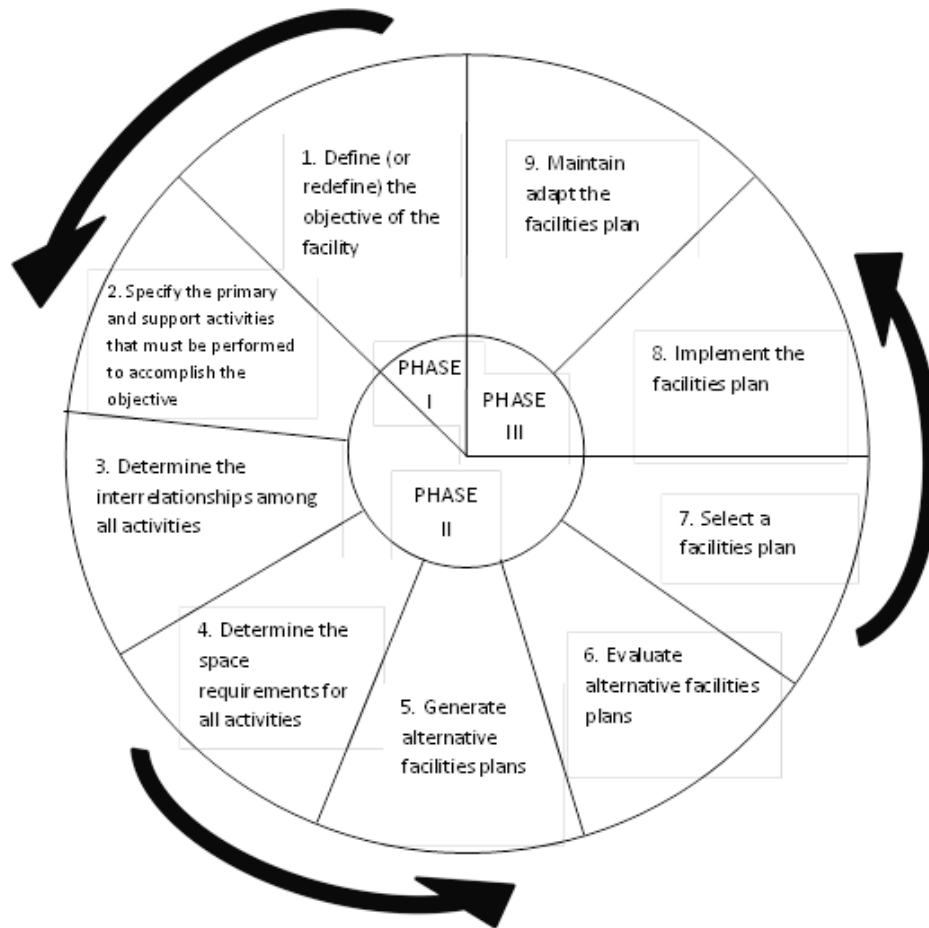


Figure 2 - Facilities Planning for general facilities (adapted from Tompkins et al 2010:19)

#### 2.1.1.1 Muther's Method

The different tools used to apply the Facilities Planning process is found in "Muther's Systematic Layout (MSL) (Tompkins et al (2010:300)

An Activity Relationship Chart will be used to establish the relationships between the activities (section 2.2.2.) The explanation behind the Activity Relationship Chart is behind the steps of constructing one:

- All departments within the facility must be listed on the relationship chart.
- Conduct interviews or alternatively interviews with persons that work in each department.
- After interviews, define the criteria for conveying closeness relationships and record the reasons for the values on the relationship chart.
- Use the departments and assign a value of importance of relationship for each pair. (this will determine the proximity)
- Each person having input into the Activity Relationship Chart must be allowed to evaluate and suggest changes to the chart.

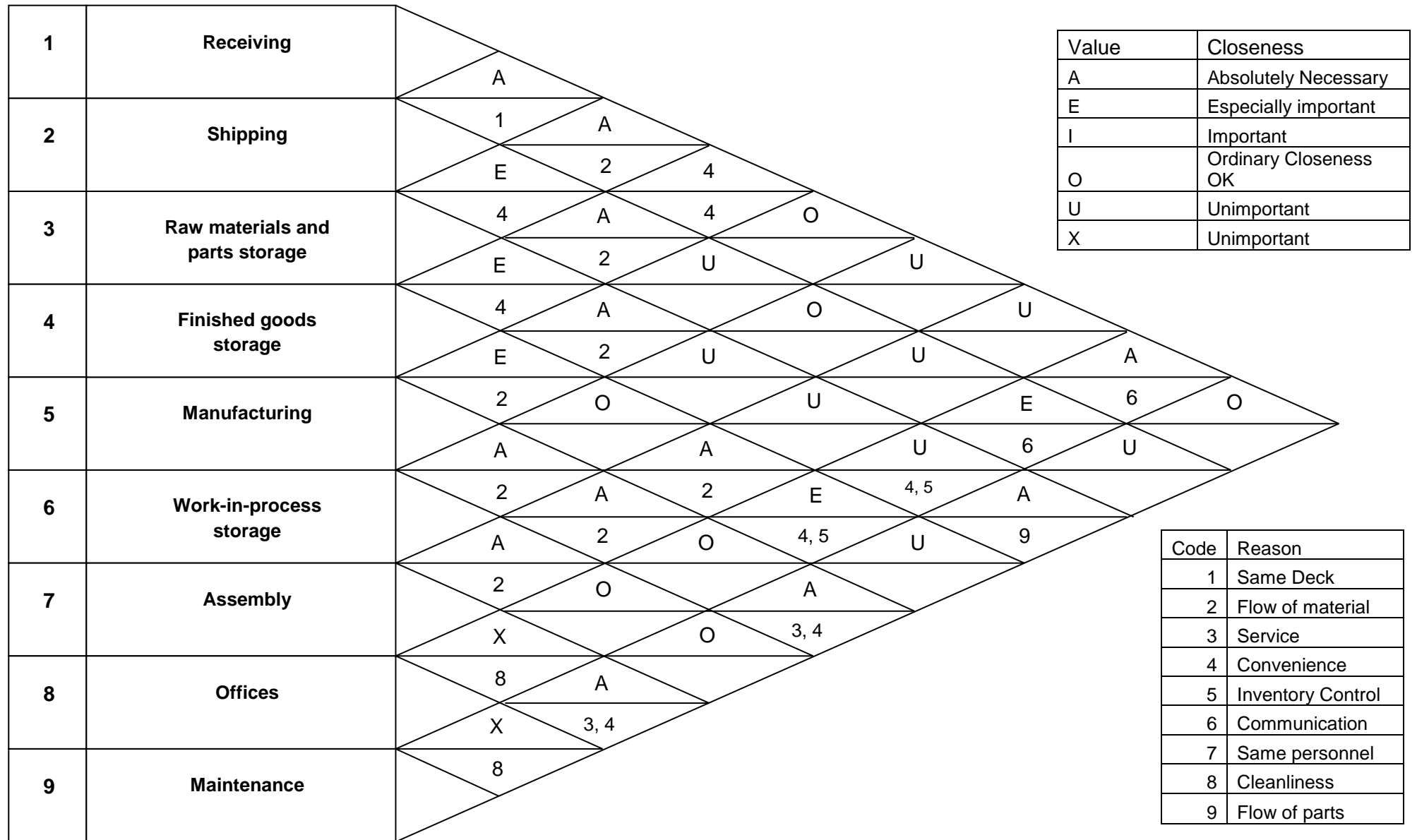


Figure 3 - Activity Relationship Diagram (adapted from Tompkins et al 2010:300)

From the Activity Relationship Diagram, a Relationship Chart is created (Figure 4). Each 'bubble' represents a department and the proximities between them represents the relationships between activities (and ultimately the departments they are performed in) the thickness of the lines connecting the departments are also an indication of the importance of their proximities.

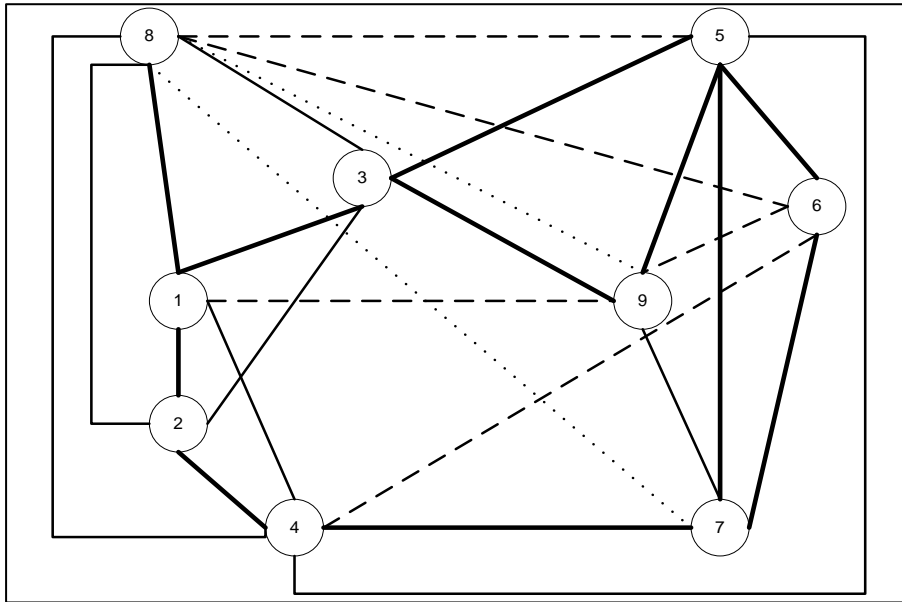


Figure 4 - Relationship Diagram (adapted from Tompkins et al 2010:301)

After the Relationship diagram has been developed, the space requirements for each activity need to be established and entered into the Space Relationship Diagram (2.2.3) (Figure 5).

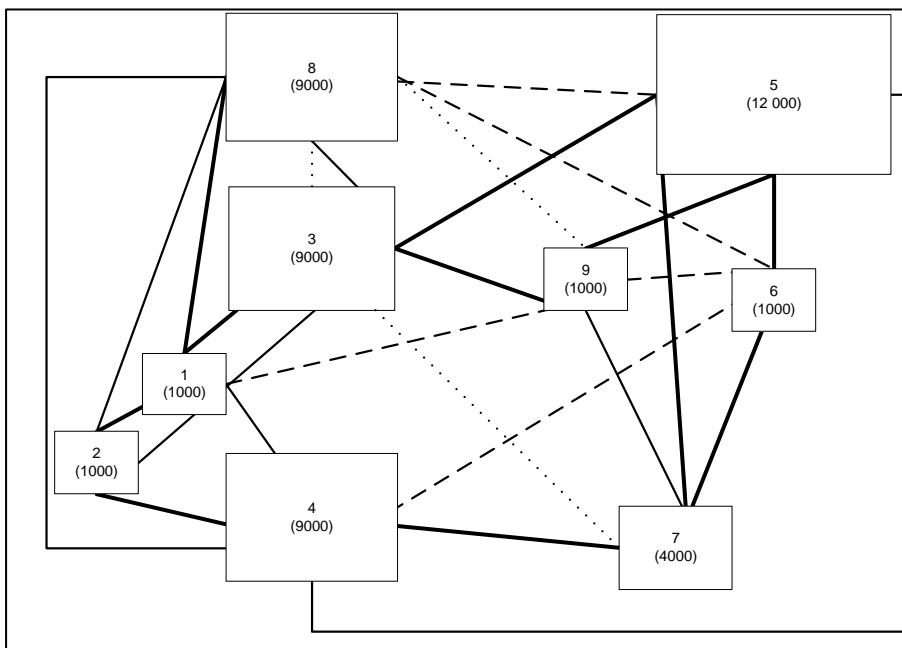


Figure 5 - Space Relationship Diagram (adapted from Tompkins et al 2010:301)

The Facilities Planner then needs to consider practical limitations and other modifying considerations and generate different layout alternatives (Figure 6)

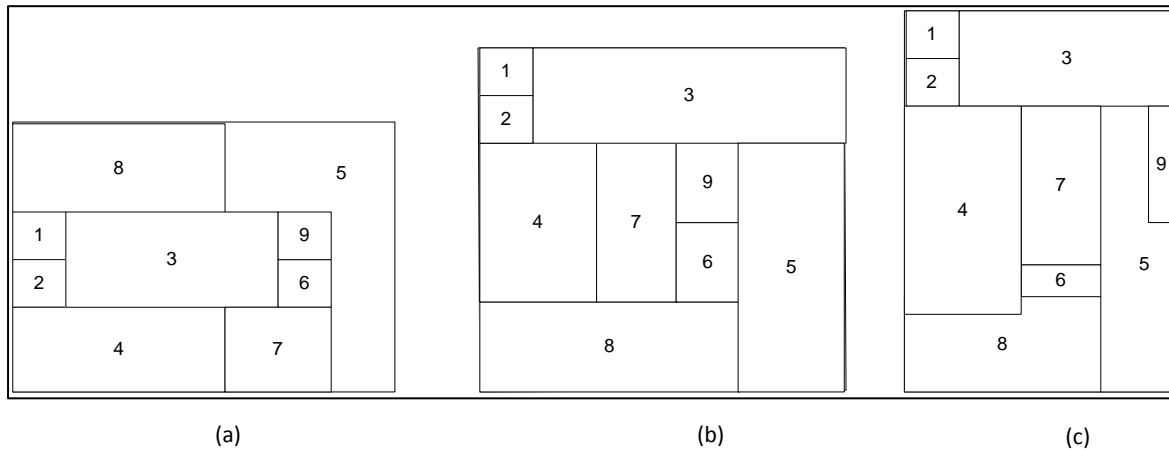


Figure 6 - Alternative Block Layouts (adapted from Tompkins 2010:302)

#### 2.1.1.2. CRAFT

CRAFT had been one of the earliest layout algorithms within this literary area. The Computerized Relative Allocation of Facilities Technique had been introduced in 1963 (Tompkins et al 314:2003).

The cost of a layout is determined by multiplying the number of units transferred between departments by the distance of the movement. This technique does not restrict one to rectangular shapes and the facility is presented in a discreet manner. The input data of that unit flow is extracted from a From-To chart.

CRAFT is initially used to improve existing layouts of actual facilities. The technique however is not confined to improvement-type applications and can also be used to represent a prospective layout that had been developed by a different algorithm or Facilities Planning Technique.

It commences by determining the centroids of the departments within a facility. The rectilinear distance between the centroids of department pairs is calculated next and stored in a Distance Matrix. To determine the initial layout cost, the unit flow from the From-To chart is multiplied by the corresponding values in the Distance Matrix. Furthermore, CRAFT identifies all pairwise and three-way department exchanges and establishes the department positions that minimises the layout cost. After CRAFT had identified the best exchanges, it updates the layout plan and recalculates the centroids of the departments and a new layout cost. This completes the first iteration.

The following iteration commences as CRAFT continues to exchange departments and calculates the exchanges that yield the best layout cost. The final layout plan is obtained when

no further reduction in layout cost can be achieved. This layout is also known as a two- or three-opt layout since no two- or three-way exchanges can further reduce the layout cost.

## 2.2. Warehousing Fundamentals

A warehouse is the point in a supply chain where an organization stores its raw materials, semi-finished or finished goods. In the past, warehousing was used for long term-storage of goods, some up to 90 days' worth of supply. In the current millennium, the focus of warehousing has shifted somewhat. Theories such as just-in-time and strategic alliances has influenced warehousing objectives in the direction of lower inventories, shorter cycle times and improved customer service. Today, focus is placed on the speed and accuracy at which a product moves through a facility as stated by Coyle, Bardi & Langley (2003:284).

An essential function performed by warehousing in the macro-economic sense, is the creation of time utility for the products that moves through it. By having a close proximity to its customer, warehousing can produce shorter lead times when delivering the product. It also expands the utility of goods by increasing their time availability to its customers. Warehousing can be interpreted as a dynamic, value-adding (Table 3) tool as it enables organizations to supply their customer with the product when and where it is in demand (Coyle et al (2003:285)).

<b>Value adding Roles</b>	<b>Trade-Off Areas</b>
Consolidation	Transportation
Product Mixing	Order filling
Service	Lead times, stockouts
Contingency protection	Stockouts
Smooth operation	Production

**Table 3 - Warehouse Value-Adding Roles (adapted from Coyle et al 2003:286)**

Warehousing allows companies to consolidate less-than-truckload shipments of goods into more profitable loads by cutting transport costs. For an "Inbound Logistics System", the warehouse would consolidate the goods received from different suppliers and transport it to the company's plant. An "Outbound Logistics System" consolidates the shipments from different plants and transports it to the company's warehouses, from where goods are distributed to the clients. Figure 7 illustrates the aforementioned concepts.

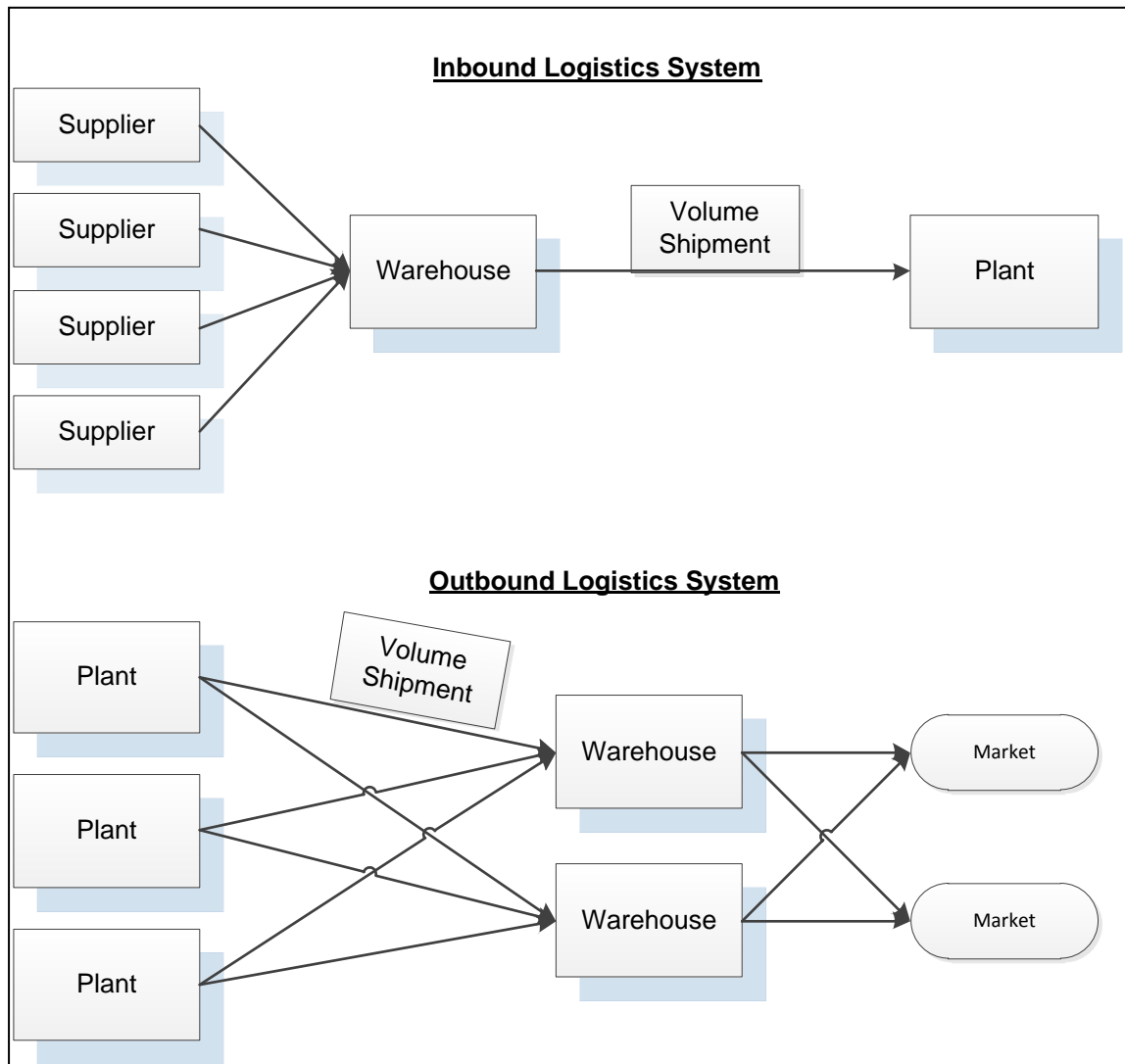


Figure 7 - Transportation Consolidation (adapted from Coyle et al 2003:286)

Incomati Warehousing and Distribution is an organization that has fused the Inbound- and Outbound Logistics System as it receives goods from its clients' different suppliers, consolidates the stock and distributes it to the retail outlets of the client.

There are many different applications warehouses are used for and it results in numerous different types of warehouses. For the purposes of this project only "Distribution warehouses and distribution centres" will be discussed.

Distribution centres have the function of accumulating and consolidating products from various different manufacturing points. These points can be within a single firm or spread throughout several firms. The accumulated and consolidated shipments are shipped to common customers. Goods moved from these types of warehouses are typically moved by full pallets or cases in and



full cases / broken cases out. A distribution centre usually responds to weekly or monthly orders (Frazelle 2002:3).

- All departments are cardinal to a proper functioning warehouse. However, Receiving and Despatching Departments functioning inefficiently would impede the operations to a great extent. According to Botha (2010:13) there are different pros and cons to centralizing Receiving and Despatching Areas.

The Advantages include:

- Common space utilisation is achieved.
- Common equipment is used to perform the functions required by these departments.
- Common personnel with the same level of training and skills are equipped to perform receiving and despatching tasks.
- By centralising these departments, the cost of facilities is reduced.

However, centralization of these departments has disadvantages that include:

- The material flow generated by the different departments is obstructed.
- Bottlenecks and congestion are caused.

It is important to note that it is possible for organisations to take advantage of the benefits that centralizing the Receiving and Despatching areas supply whilst simultaneously providing solutions to the disadvantages mentioned. By designing the facility in such a manner that the Receiving and Despatching Areas are adjacent rather than centralised, common equipment and personnel are still utilised to perform the required functions of the departments. This also reduces cost. Congestion and material flow problems are avoided by this slight modification although common space utilisation is not achieved.

Companies need to make a number of Basic Warehousing Decisions that are key to Warehouse Management. These decisions include ownership, number, size, stocking, layout and location.

The ownership decision fundamentally supplies an organization with two alternatives; public or private warehousing. The outcome of this decision, impacts an organization on both the balance sheet (facility investment) and income statement (warehousing cost). Lower output volumes compel organizations to choose public warehousing. When companies can process larger



volumes, private warehousing becomes the more profitable option as the fixed costs are spread across the large output volumes (Coyle, Bardi & Langley 2003:290).

At the rapid growth rate currently experienced by Incomati Warehousing and Distribution, private warehousing is the better alternative. There are also specific processing requirements by some of the stock received, that increases potential pilferage and theft were it in public warehousing.

The number of warehouses also depends greatly on the volumes processed by the company. As stated by Coyle et al (2003:297) with more warehouses, lead times are decreased as the product is closer to the customer. Transportation costs decrease as loads are consolidated. On the other hand, warehousing- and inventory cost increases as total warehousing space and inventory carried increases. These costs need to be justified by the volume outputs. However, an increasing trend of decreasing warehousing facilities is emerging. Usually, an increased number of facilities are used to reduce transport costs, improved customer service and provide storage space for increased product volumes (during peak times). Companies have started to move in the direction of decreasing their number of facilities whilst still meeting the same needs. By joining a dependable transportation system with the usage of fewer warehouses, unnecessary costs of additional facilities are cancelled out.

Consolidating less-than-truck loads into truckloads that are sent on a specific route is a principle applied by Incomati Warehousing and Distribution. The company does not as of yet turn the volumes required to make it worthwhile to open strategically located depots. In the near future, as and when the business' growth entails it, additional depots would be considered.

Another important warehousing decision is the layout and design behind the warehouse. There are six principles of warehouse layout design recommended by Coyle et al (2003:305):

- *First Principle:* Use one-story facilities if possible, it costs less to construct and provides more usable space per investment rand.
- *Second Principle:* Implement direct or straight-line flow of goods. This principle applies to goods flowing in and out of the warehouse.
- *Third Principle:* Efficient material handling equipment and operations are crucial as it improves operations in general.



- *Fourth Principle:* Ensure that an effective storage plan is utilized. Space must be employed as efficiently as possible whilst simultaneously, providing accessibility and protection to goods in storage.
- *Fifth Principle:* Minimize aisle space without constraining the size, type and turning radius of material handling equipment.
- *Sixth Principle:* Make efficient use of the facility's cubic capacity. This is usually accomplished by incorporating the materials handling equipment into the facility plan.

A facility's layout and design is not only subject to Principles, but also to different objectives it has to fulfil. It is very important to completely use the cubic capacity a facility renders. Also, the layout and design must accommodate protective objective a facility must satisfy. It must be such that goods in storage must be separated from hazardous materials and objects and safeguard the stock against pilferage. A facility must satisfy the dual objective of efficiency that encompasses both effective space utilization and effective placement of stock. Continual optimization of productivity must be attempted in the form of goals for cost and order handling efficiency (Coyle et al (2003:307)).

### **2.3. Materials handling**

Materials handling can be described as the short distance movement within or in between a building. The four dimensions involved by Material handling are movement, time, quantity and space (Coyle et al (2003:309)).

The general objectives of Material handling do not only apply to logistics and has varying importance to Warehousing. A basic Materials handling objective is to increase the effective capacity of a warehouse. As mentioned before, aisle space must be minimized as far as possible. Goods must never be handled more than necessary. It is an organizations' responsibility to supply effective working conditions to its labourers. Generally, reducing cost and improving logistics service is a common objective, but it also applies to material handling (Coyle et al (2003:310)).

Pallets are basic material handling equipment, used to hold individual items together. They comprise of a number of different types and are generally wooden structures. Pallets are moved



by forklifts or pallet jacks from one point to another. The downside concerning pallets is that most companies that use pallets do not recycle the damaged and redundant pallets.

Other materials handling equipment relevant to this project are conveyors. There are two basic types of conveyors are roller- and belt conveyors as explained by Coyle et al (2003:327) Roller conveyors can be inclined and goods move by force of own weight. Belt conveyors are driven by power equipment. The high automation opportunities that conveyors pose, Make them an advantageous option as handling costs are eliminated. Coyle states that before an organization decides to implement conveyor systems (especially automated conveyors) an analysis regarding the appropriate Material handling approach should be made. The organization has to decide whether the approach would be labour- or capital intensive. When a company is large, it usually follows a capital-intensive approach as it reduces labour costs and distribution time.

Incomati Warehousing and Distribution also makes use of pallets (4-way entry- and single faced pallets) as Materials handling equipment. The company does not recycle their pallets and would be suggested the alternative materials as to the wooden pallet. At present, only roller conveyors are used as the cost of belt conveyors are not justified by the current volumes turned by the organization. Furthermore, South African labour is relatively inexpensive compared to international standards and job-creation is a high priority, therefore roller conveyors are the better option for Incomati at present

At Incomati stock is not picked per se, rather, the stock is pulled when it is to be dispatched. Bin shelving, horizontal carousels or mini-load AS/R systems meant for smaller parts is not an appropriate option for this company.

From a Materials handling design perspective Coyle et al (2003:333) places material handling equipment into three main categories:

- *Flexible path equipment* that includes manual hand trucks (pallet jacks) and forklifts. The design advantages supplied by this category are flexibility and versatility.
- Equipment within this category is highly automated and efficient. It is called *continuous-flow fixed-path equipment*, such as conveyors or draglines.
- *Intermittent-flow fixed-path equipment* includes cranes, monorails and stacker cranes. In this category, the efficiency of continuous flow equipment is extracted whilst stopping unneeded equipment.



According to Frazelle (2002:6) in World-Class Warehousing and Material Management there are a common set of denominators that set world-class warehouse operations apart from middle- and no-class warehouse operations. These principles are;

- *Profile.* Order-, item activity- and planning profiles are to be created and maintained.
- *Benchmark.* Performance, practice and infrastructure gaps are to be determined by benchmarking warehouse performance, practices and operating infrastructure against that of world class organizations. Benchmarking allows exposure to affordable, new material and information handling systems that could possibly be invested in.
- *Innovate.* Constant innovation needs to be applied to material and information handling as these activities constitute most of the work in a warehouse. As much of the work content as possible need to be simplified.
- *Automate.* Automation basically means to computerize and to mechanize.
- *Humanize.* Warehouse operations are humanized by creating individual and team performance goals as well as applying ergonomic principles in every manual activity in the facility. This principle is also achieved by having warehouse operators involved in redesigning warehouse processes.

Warehouses have different roles and names but they have a fundamental set of activities in common. The following activities are generally found in most warehouses (Frazelle, (2002:10)):

- *Receiving.* Three activities are included in receiving;
  - receipt of all goods inbound into the warehouse
  - providing assurance that the goods are of acceptable quality and quantity ordered
  - distributing goods to storage or other functions needing them
- *Prepackaging.* Usually performed when goods were received in bulk from the supplier. Repacking with other goods or specified quantities might be necessary to form kits or assortments.
- *Putaway.* Placing stock into storage by material handling, location verification and actual goods placement.



- *Storage.* This function is the confinement of merchandise awaiting a demand. The storage method depends on the goods' container and the quantity and size of goods.
- *Order picking.* This entails removing merchandise from storage to satisfy a demand.
- *Packaging and/or pricing.* Optional after picking process. More flexibility in the use of on hand inventory is provided when performing this step after picking.
- *Sortation.* Batch picks are sorted into their individual orders and when picks for one order is made at different stages and are not accumulated immediately.
- *Unitizing and shipping.* The following tasks might be included:
  - Checking orders for completeness
  - Packaging goods into their appropriate shipping containers.
  - Determine shipping charges by weighing
  - Accumulating orders by outbound carrier
  - Loading delivery vehicle



## 3. Conceptual Framework

### 3.1. Introduction

Facilities Planning and more specifically, the planning and design of a warehouse, can be compared to piecing a puzzle together. It is difficult to fully assemble the puzzle before all the pieces have been put together and defined. Defining the puzzle pieces represents the purpose of benchmarking, profiling, simplifying, automation, mechanising and computerising warehouse systems.

The purpose of this chapter is to incorporate tools into a conceptual framework capable to solve the problem of the distribution centre that has grown too small. This framework will define the processes within the facility and their relationships in order to design a facility with efficient flow and storage capabilities.

The method that will be used is known as “Muther’s Systematic Layout Planning Procedure”. The reasons this method was chosen are:

- Every department is identified and analysed.
- The method clearly establishes the relationships between departments.
- The method enables one to determine the proximity of the departments with one another.
- Even though department positions in relation to one another are stipulated, the method is flexible in allowing departments to be moved in order to accommodate practical limitations.
- Different flow alternatives can be analysed in the “Alternative Block Layout” step.
- The advantage of systematic layout planning is to deliver an end product where all stakeholders had been involved in. Working with all the stakeholders ensued a Facility Plan accommodating all their needs and requirements.

Muther’s Method is an appropriate method to apply to Facilities Planning for general facilities and will be the method incorporated in the framework. The method will be applied as specified by Tompkins et al (2003:297) (see section 2.1.1.1. for detailed explanation of the method).



Muther's Systematic Layout Planning Method does not supply an appropriate evaluation technique of the Alternative Block Layouts that had been generated during application of the method. For the purposes of this project, the Alternative Layouts that had been generated will be evaluated by a slightly modified CRAFT (Computerized Relative Allocation of Facilities Technique). As mentioned in the Literature Study, the CRAFT can be applied to a layout developed by another algorithm altogether.

The technique will be applied as follows:

- A From-To chart will be drawn and the units that flow between departments entered into it.
- The centroids of every department in the Alternative Block Layouts (generated in section "4.1.4. Step Four: Generate Alternative Block Layouts") will be determined.
- After determining the centroids, the rectilinear distances between department pairs (that exchange material) will be determined and entered into a Distance Matrix.
- To calculate the "Layout Cost" the corresponding values in the From-To chart and Distance Matrix will be multiplied and the answers summed. This value represents the Layout Cost.
- No pairwise or three-way exchange will be carried out as the "Layout Cost" of each Alternative Layout is sufficient for determining the most cost effective layout alternative.
- The units of the values entered into the From-To chart will be cubic metres and not mere "units" as originally specified in the technique.
- The units of the values entered into the Distance matrix will be metres. The Craft technique uses "grids" as distance values, not specifying a unit.

The reasons for selecting CRAFT as the alternative layout evaluation technique:

- It had been initially designed to be an improvement type algorithm, but can be used to evaluate a proposed layout, designed by another algorithm with equal success.
- Departments are not restricted to rectangular shapes only.
- The Layout is represented in a discreet manner.
- This technique allows the Facilities Planner to motivate why their selected layout is financially feasible.
- It captures the initial layout with acceptable accuracy (Tompkins et al 2003:316).

### 3.2. As-Is Analysis

An investigation of the current Facility space usage was carried out – APPENDIX A and Table 4, thereafter a space requirement analysis for the peak season of 2012 was done (see Data Analysis).

Department	Current Space utilization (m <sup>2</sup> )
Receiving Department	130
Processing Department	200
Sorting/ Staging Department	500
Despatching Department	Receiving Department
New Stores	50
Administrative offices	30
Support Activities	90
Total	1000

Table 4 – Current space utilization of Distribution Centre

Job title	Number of workers
Warehouse Manager	1
Administrative clerk	2
General worker	5
Drivers	6
Assistants	5
Total number of workers	19

Table 5 – Current staff compliment

The current staff compliment (Table 5) comprises of a Warehouse Manager that is responsible for supervising the loading and offloading of delivery vehicles. Also of the administrative work relevant to despatching and receiving of stock, as well as coordinating general warehousing activities (sorting, labelling, stock pulling, etc). The two administrative clerks are responsible for receiving stock onto the system and releasing it to headquarters (on a systematic level) for distribution instruction purposes. They also check documentation after deliveries to validate stock distribution and create border documentation by using Corefreight, an import- export program working together with SARS.

It is the responsibility of the General workers to load and offload delivery vehicles, sort cartons onto sorting lines and into appropriate sorting lines. The general workers also have to ensure



that good housekeeping is kept and not only keep the different Departments neat, but also clean and hazard free.

Each Driver has an assistant that accompanies him on a delivery. Assistants occasionally fulfil the duties of general workers, depending on the number of trucks out making deliveries.

The current staff members are also permanent workers and are sufficient when the company is trading out of season. As mentioned in the Problem Statement, during high- and peak season, casual workers are taken into service to alleviate the workload.

The current facility does not have change rooms or lockers for workers to securely stow away their possessions during work hours. Workers have adequate sanitation facilities on site and an acceptable level of hygiene is maintained. The warehouse is being rented within a secure business park that has a canteen and informal traders sell food outside of the business park.

The current facility does not have a sprinkler system for extinguishing fires and due to the nature of inventory (cardboard cartons) this is a high priority consideration for the new facility.

### **3.2.1. Current Process Overview**

At present stock is received in the form of cartons from local and international suppliers in the Receiving Department (APPENDIX A). The stock is quantity controlled and sorted according to order and pre-packed sizes onto pallets. Thereafter the cartons are transported by means of pallet-jacks to the Processing Department where it is sealed with security tape and placed on the sorting lines according to order and pre-packed size.

After the sorting inventory on the sorting lines, distribution of the orders (cartons) are received in the form of labels, the cartons are labelled. General workers then sort the cartons according to route onto pallets. The cartons are then manually transported (via pallet jack) to the Despatching Area. Cartons are sorted in the Despatching Area into the appropriate rows and bays. Each store is represented by a bay on the warehouse floor.



Row Number	Route Serviced
1	Botswana
2	Botswana
3	Botswana
4	North west
5	Polokwane
6	Polokwane
7	Mpumalanga
8	Namibia
9	Kwa-Zulu Natal
10	Mpumalanga
11	Mpumalanga
12	Namibia
13	Gauteng
14	Lesotho & Free State

**Table 6 - Regions represented by row numbers (APPENDIX A) (adapted from interview with D. Smith, Systems Developer, Incomati Warehousing and Distribution)**

To despatch stock, the Warehouse Manager orders the stock to be pulled to the Receiving Area (stock is also despatched from the Receiving Area). The cartons are taken by store by pallet jacks and on pallets. The stock is loaded onto the truck and sent to the appropriate stores.

#### 3.2.1.1 Current Layout evaluation (see APPENDIX A for current layout)

- Receiving Area:
  - The loading bay of the Receiving Area is not level to delivery vehicle bodies and cartons need to be handled excessively.
  - The yard outside of the facility (Receiving Area) does not accommodate a delivery vehicle parking perpendicular to the receiving door, it has to park parallel to the facility. This causes unnecessary time spent lining the vehicle up with the loading bay and also excessive handling by workers.
- Processing Area:
  - See general
- Despatching Area:
  - The Receiving and Despatching Departments are currently using the same area within the facility. This causes material flow problems and delays in loading and offloading activities. If cartons are staged for despatching and



Receiving is taking place it also causes a bottleneck in and around the Receiving/ Despatching area.

- Staging/ Sorting Area:
  - Due to the incompetent space capacity of the facility, loading bays are overloaded and cartons topple into inappropriate bays and pose a threat to workers' safety.
- Administrative Area:
  - The Administrative Department does not support admin activities with enough workspace. Administrative workers run into one another and there is only a single printer/copier/fax machine available.
- New Stores Storage:
  - The entrance leading to the new stores storage area is not wide enough to allow a pallet and pallet jack to pass through. Workers need to carry outbound cartons out of the entrance and place it onto a pallet. This causes unnecessarily fatigued workers.
- Personnel Requirements:
  - The watercloset- and sanitary facilities are only used by Management at present, the workers are required to walk to and use sanitary facilities within the secure business complex that the facility resides in. In other words, the actual facility does not accommodate sanitary facilities for workers.
  - There is a small kitchenette available with a sink and microwave, but no further space for the workers to eat in and enjoy recreational activities during their luncheon.
  - Workers do not have locker facilities or privacy to get dressed before or after work. Stolen food and personal items have been reported by employees.
- General:
  - The warehouse floor is uneven and hampers smooth material flow.
  - The warehouse is too small for the installation of permanent conveyors in order for material to be moved.
  - The facility is surrounded by windows (1.5 metres from ground level and up) without adequate burglar proofing. Needless to say, this poses a security risk for the inventory kept.



- The neighbouring warehouse is used to manufacture furniture and the fumes of the painting activities seep through the walling and into the Distribution Centre. These fumes are hazardous to workers' health and incidences of workers with headaches, dizziness and slight nausea have been reported.
- The Distribution Centre is completely inadequate for racking purposes as the roof is situated too low to the floor.
- The facility does not have a sprinkler system or adequate fire extinguishers, some of the loading bays are positioned in front of the fire escapes.

### **3.2.2. Current Material Handling equipment**

Incomati Warehousing and Distribution uses a roller conveyor to offload stock from suppliers and also to load the stock during despatching. The general method for movement of cartons is by pallet and pallet-jack. This organization employs a labour intensive approach to material handling and not a capital intensive approach.

#### **3.2.2.1 Current Material Handling equipment evaluation**

- Pallet jacks (manually driven)
  - Manual pallet jacks have to be pushed, stopped and tuned physically. This causes fatigue and poses the risk of Repetitive Strain Injuries for workers.
  - The facility floor is also uneven and brings the pallet jack to a jolting halt causing cartons to topple over. The floor could cause injuries to workers by falling or by being struck with falling cartons.
- Pallets
  - The company uses wooden pallets for stacking of cartons. After the pallets had completed their usage lifecycle, they are just discarded and not recycled. It is every individual and company's responsibility to ensure a greener future and recycle recyclable materials
  - As the pallets reach the end of their lifecycle, the wood splinters and nails stick out at angles that could cause injuries to workers.
- Conveyors (roller, non-automated)
  - The conveyors being used at present cannot be set into a stationary mode. They are held in place by wood and cardboard chips.
  - Their height cannot be adjusted and workers cannot use gravity in order to assist with material handling

## 4. Application

### 4.1. Application of Muther’s Method steps

#### 4.1.1. Step one: Develop Activity Relationship Diagram

During the As-Is Analysis (p 18) all the relevant Departments functioning within the Distribution Centre Incomati Warehousing and Distribution were identified and investigated. In addition to this, the different activities - and the relationships between them - in and around each department being performed were also examined. Aforementioned being the grounds for the additional departments included in the Recommendations and new facility plan.

The gathered information was used to develop an Activity Relationship chart.

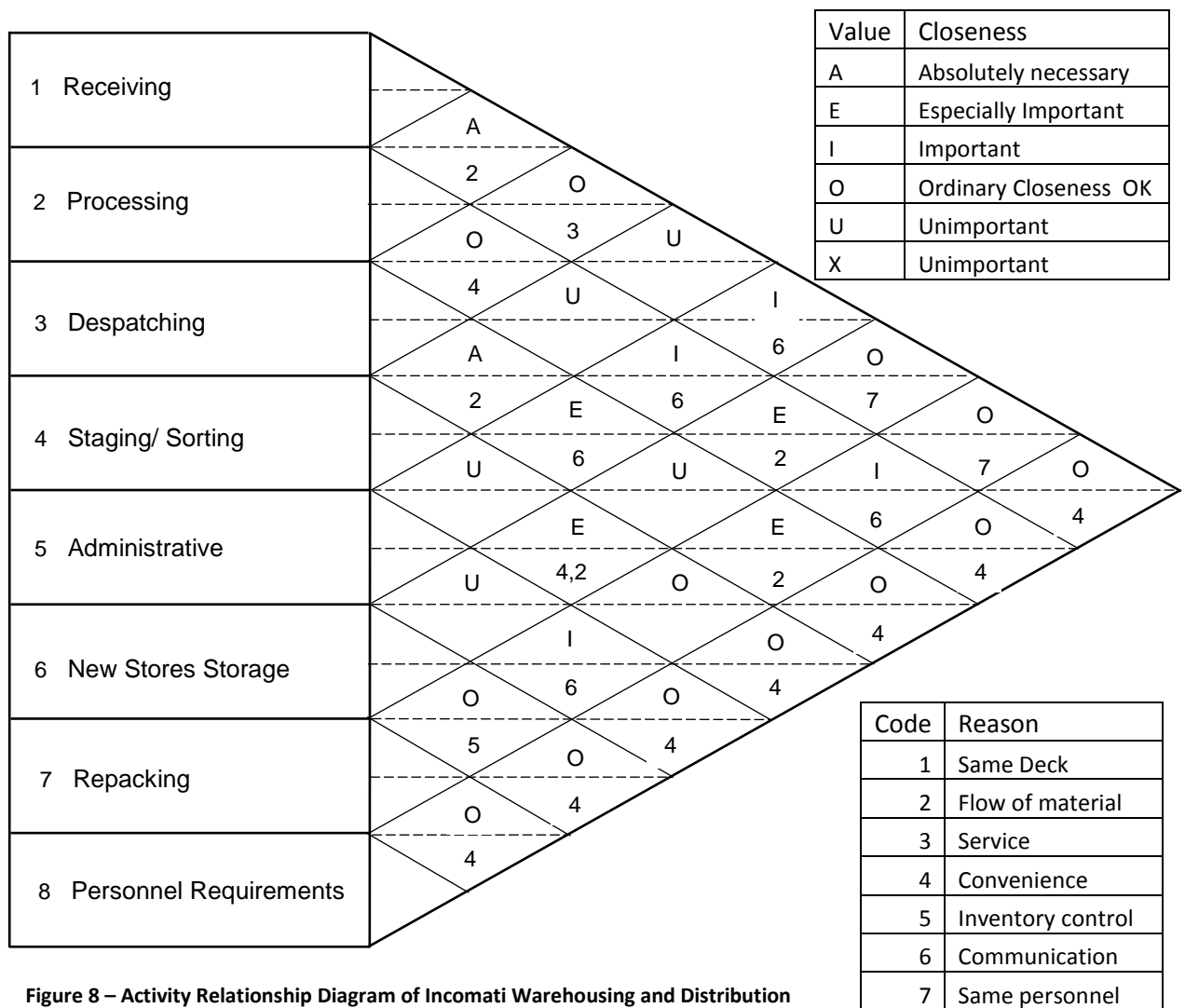


Figure 8 – Activity Relationship Diagram of Incomati Warehousing and Distribution



The activity Relationship Diagram not only shows the closeness rating of departments but also supplies the reason why Departments are located nearer or further from one another.

It is of paramount importance that the Receiving Area is in close proximity of the Processing Area, as all stock received flows from the Receiving Area to the Processing Area. The Receiving and Despatching Departments would most probably be adjacent to one another as most existing facilities' roll up doors are in the same "line" and function into and out of the same yard. However adjacency between these departments is not crucial to the functioning of the warehouse. It is important to note that these Departments cannot be operated from the same space. Needless to say it would cause major operational crises and affect the levels of customer service. Two separate areas need to be allocated for the functioning of these Departments.

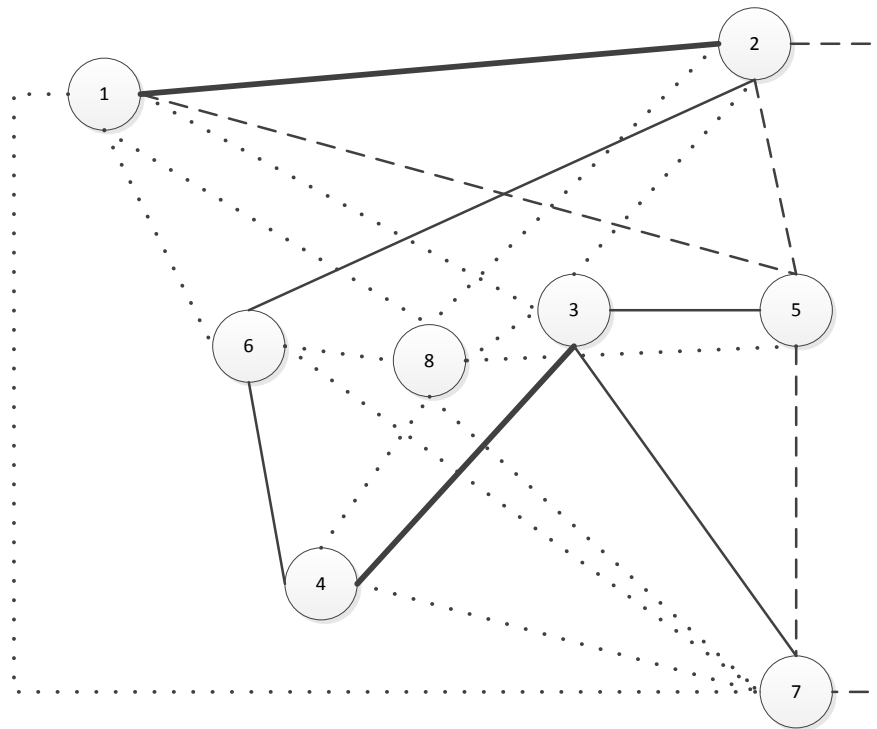
The Despatching Department needs to be placed in a logical arrangement with the Staging Department, as there is a high frequency flow between these Departments. All stock exiting the warehouse that moves into the Despatching Area, had been moved from the Staging Area. If these two Departments were adjacent or in close proximity to another, excessive material handling could be cancelled out for an improved working environment for workers.

The Despatching Department proximity to the Administrative Department is a higher priority than the Receiving- and Administrative Department proximity. A high communication flow occurs between these Departments that include route planning, border documentation generation as well as physical documentation that have to be transferred between these Departments. The communication flow between the Administrative and Receiving Department includes acknowledgement of received orders and notification of certain suppliers' stock received.

The Repacking Department interacts with two key Departments within the Distribution Centre. These include the Receiving Area, from where stock is received into the Repacking Department and the Processing Area to which repacked cartons are moved. The Repacking Area should be placed in a central position between these Departments to promote efficient flow within the facility.

#### **4.1.2. Step two: Draw a Relationship Diagram**

The information entered into the Activity Relationship diagram supplies the key data required to draw a Relationship Diagram. The Code-Reason and Value Closeness tables act as a guide in order to illustrate the appropriate relationships departments have with one another.

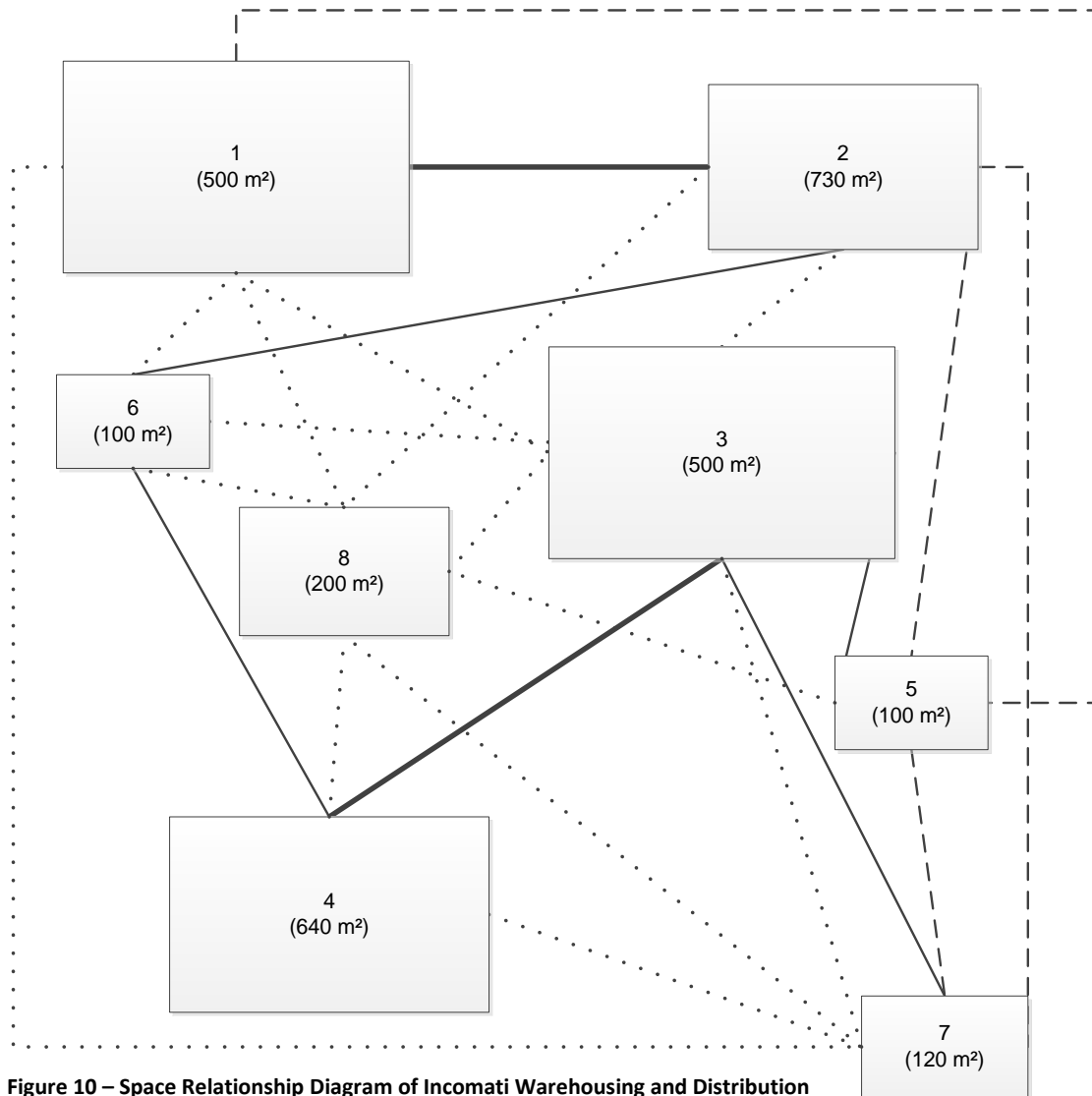


**Figure 9 – Relationship Diagram of Incomati Warehousing and Distribution**

The Relationship Diagram (Figure 9) shows that the Receiving Department (1) and Processing Department (2) as well as the Despatching Department (3) and Staging /Sorting Department (4) need to have a very close proximity. This is a very good guideline as to where departments should be situated relevant to one another.

#### **4.1.3. Step three: Develop a Space Relationship Diagram**

A Space Relationship Diagram illustrates not only the relationships between departments but also the respective space requirements that each department has (Figure 10).



The Space Relationship Diagram shows the space requirements that each department will have in the new facility. This gives the facility Designer a more complete picture of the Departments' sizes relevant to one another in the end facility.

The following sections contain the support calculations and motive behind each department size selected for the new facility. Also, the following general information pertains to each section:

- Average carton size:  $l \times w \times h = 0.5 \text{ m} \times 0.4 \text{ m} \times 0.45 \text{ m}$
- Average volume occupied by carton =  $0.09 \text{ m}^3$
- Average area occupied by carton =  $0.2 \text{ m}^2$
- Average number of cartons to be stacked onto one another (prevent slipping, toppling and ensuring readability of carton labels) = 5 cartons



- Therefore, average stacking height = 5 cartons x 0.45m = 2.25 m
- Average size of a pallet used: l x w = 1.2 m x 1 m
- Average area of pallet = 1.2 m<sup>2</sup>
- Average number of cartons pallet base level can accommodate: 1.2 m<sup>2</sup> / 0.2 m<sup>2</sup> = 6 cartons
- Average number of cartons stacked onto one another: 5 cartons
- Therefore the average number of cartons a pallet can accommodate: 6 x 5 = 30 cartons
- Average volume that a pallet can accommodate: 30 cartons x 0.09 m<sup>3</sup> = 2.7 m<sup>3</sup>/pallet
- Average daily volume expected throughout November 2014: 470 m<sup>3</sup>
- Average volume carried by a 12 m container: 80% utilisation of 90 m<sup>3</sup> = 72 m<sup>3</sup>
- Therefore it can be assumed that an average of 470 m<sup>3</sup> / 72 m<sup>3</sup> = 6.5 containers will be received per day during November 2014

The forecasted volumes to be received for the following three years are supplied in Table 7. The company does not receive equivalent volumes right through the year. During November the peak of trading activity for Incomati Warehousing and Distribution is reached. The highest volume (on average 17.5 % of the annual volume, see Figure 1) is received, processed and despatched during this month. For this reason the annual forecasted volume could not simply be divided by 249 days (number of working days/year) because an inaccurate figure would have been calculated (far too small a figure). Different stock volumes are received at different times of the year; higher volumes during peak season and vice versa; therefore a facility able to process the volumes received during peak season needed to be designed.

In other words space requirements for the new facility must be proficient to process 17.5 % of the annual forecasted volume to be received. Note that provision for growth is included in calculations of space requirements for the new facility (space requirements will not be calculated on the forecasted volumes for November 2012, but for volumes forecasted for November 2014).

Time Period	Number of cartons received	Volume of cartons received (m <sup>3</sup> )
March 2014 - February 2015	615505	55395
November 2014	615505*0.17	55395*0.17
	=104636	=9417
Daily (November 2014)	104636/20	9417/20
	=5232	=470

Table 7 – Stock volume history and forecast (adapted from Incomati Warehousing and Distribution Income Statement)

#### 4.1.3.1 Receiving Department

The following information is relevant to the Receiving Department (refer to 4.1.3 for general specifications):

- The receiving Department will be designed to accommodate the stock of four containers. It is assumed that no more than four containers' stock will be in the Receiving Area at any time. (As the containers are offloaded, a team will be moving offloaded and checked cartons to the Processing Department).
- One
- Number of pallets required for the stock of four containers:  $(72 \text{ m}^3 \times 4) / 2.7 \text{ m}^3 = 107$  pallets
- Pallets are arranged in parallel lines, back-to-back with aisles allowing two pallet jacks to pass one another at a time (Figure 11).
- Aisles between pallet lines are 3 metres wide and each pallet line contains 15 pallets (15 m in length).
- Space requirement for Receiving Area =  $500 \text{ m}^2$ .

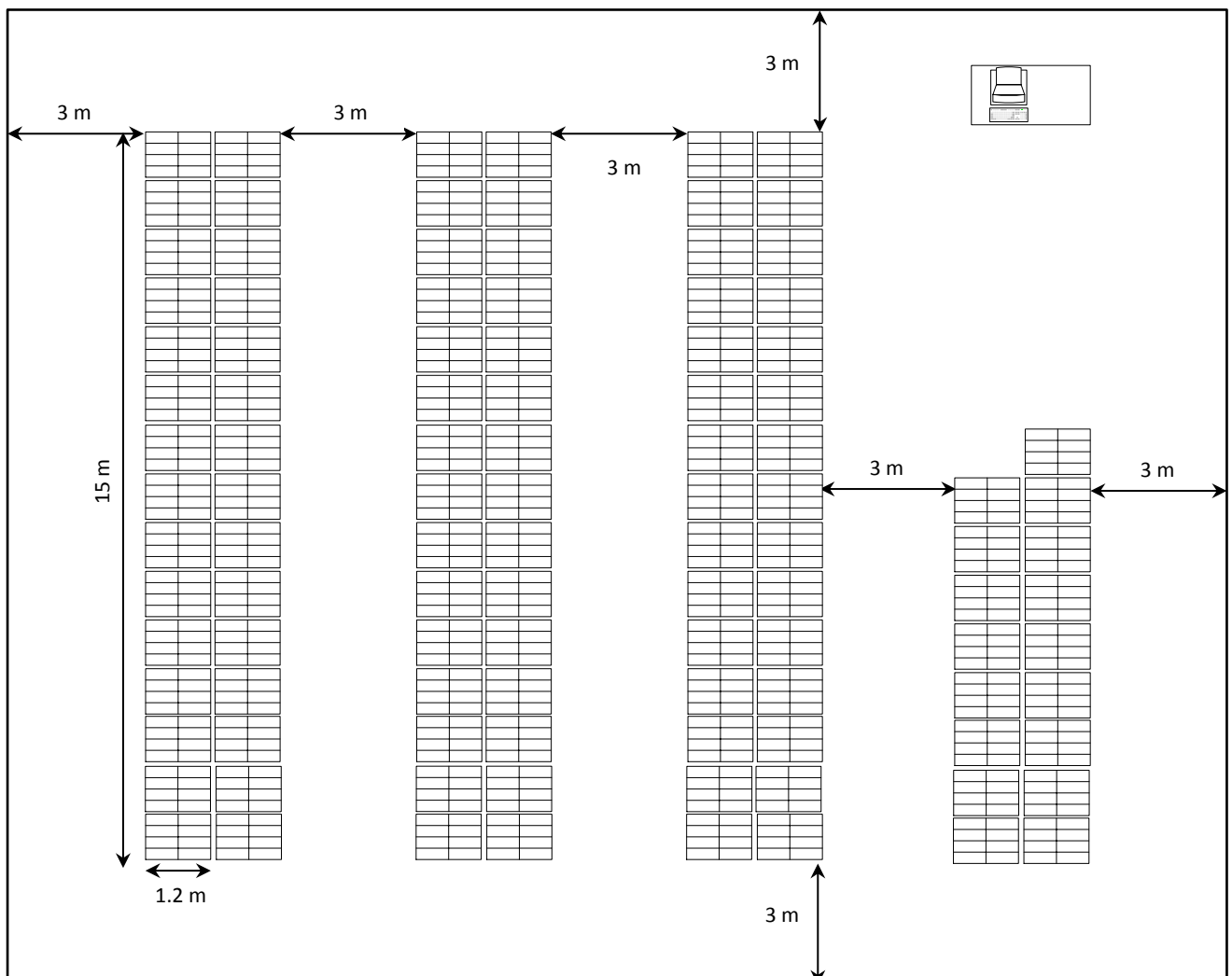


Figure 11 – Schematic representation of proposed Receiving area

#### 4.1.3.2 Processing Department

The following information is relevant to the Processing Department:

- After stock had been received and checked in the Receiving Department it is moved to the Processing Department to be labelled and sorted into the appropriate sorting bay.
- Average stock volume sorted onto one sorting line:  $l \times w \times h = 20 \text{ m} \times 0.8 \text{ m} \times 2.25 \text{ m} = 36 \text{ m}^3$
- Average daily volume to be received during November 2014:  $470 \text{ m}^3$  (Table 7)
- Average number of sorting lines required in the Processing Area:  $470 \text{ m}^3 / 36 \text{ m}^3 = 13$  lines.
- Sorting lines are arranged in parallel rows with 1.5 m aisles in between sorting lines, aisles between parallel sorting lines are 3 m wide (Figure 12) .

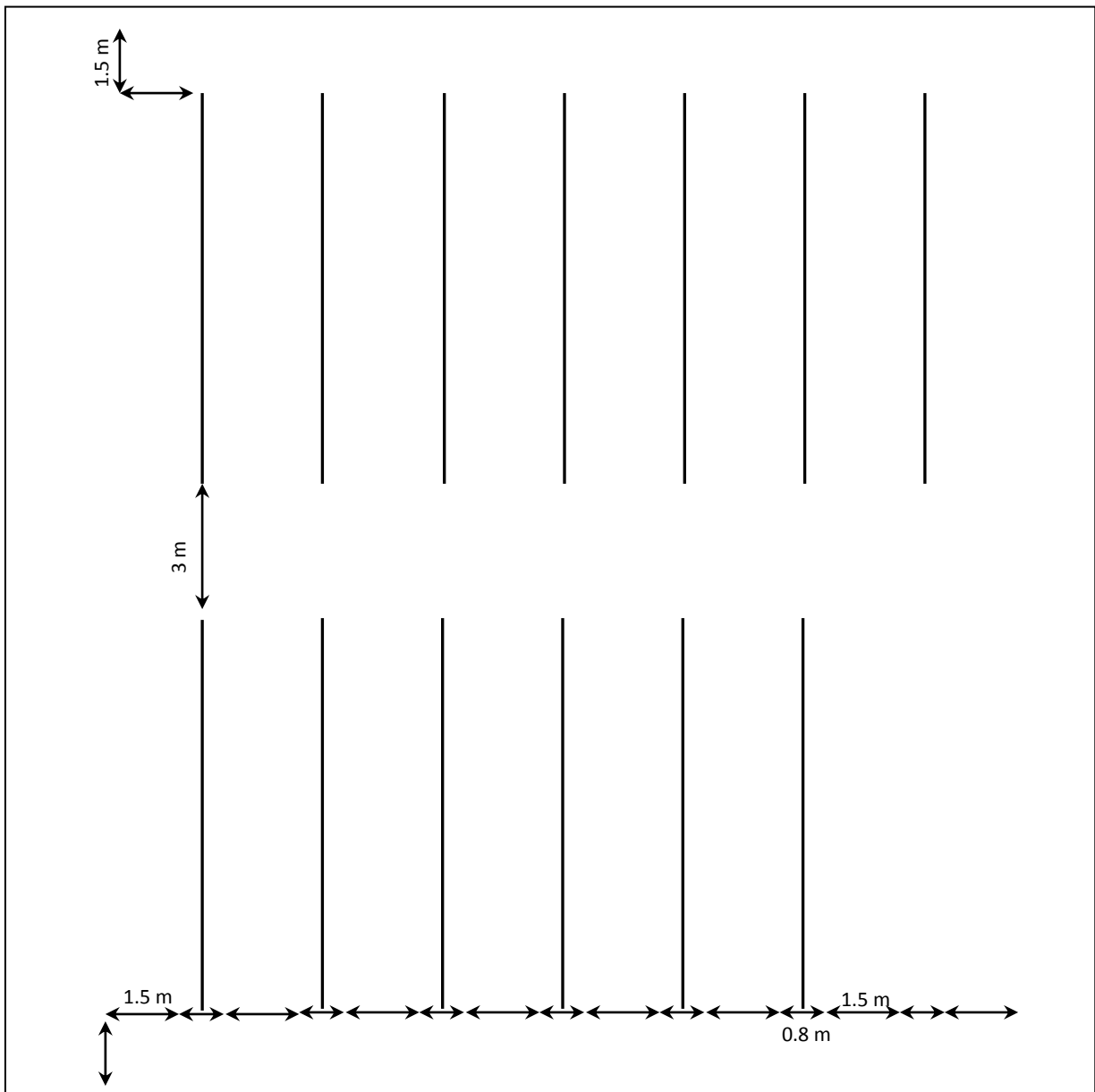


Figure 12 – Schematic representation of proposed Processing Area



- Space requirement for Processing Area = 730 m<sup>2</sup>

#### 4.1.3.3 Despatching Department

To ensure continuous flow of goods and prevent a bottleneck from forming, the same volume of cartons need to be despatched (on average) per day as received. The Despatching Area will therefore have the same space requirement as the Receiving Area.

Cartons are staged in the same manner as received in the Receiving Area.

- Space requirement for Despatching Area = 500 m<sup>2</sup>

#### 4.1.3.4 Staging/ Sorting Department

The following information is relevant to the Staging/ Sorting Department (refer to 4.1.3 for general specifications):

- A single sorting bay is dedicated to a retail store.
- Sorting bay size:  $l \times w = 2 \text{ m} \times 1 \text{ m}$
- Sorting bay Area = 2 m<sup>2</sup>
- Average number of cartons to be stored on bay base level:  $2 \text{ m}^2 / 0.2 \text{ m}^2 = 10$  cartons
- Average number of cartons stacked onto one another : 5 cartons
- Average number of cartons occupying one bay = 50 cartons
- Average volume stored in a bay = 50 cartons  $\times 0.09 \text{ m}^3 = 4.5 \text{ m}^3$
- Average number of stores owned by Retailer during March 2014 – February 2015 = 132 stores
- Average daily volume to be sorted/ staged per day during November 2014: 470 m<sup>3</sup>
- Sorting bays are arranged in parallel rows, back-to-back, right next to one-another with aisles (1.5 m) in between (Figure 13).
- Note that the volume received does not drive this space requirement, rather the number of retail stores owned by the retailer.
- Space requirement : 640 m<sup>2</sup>

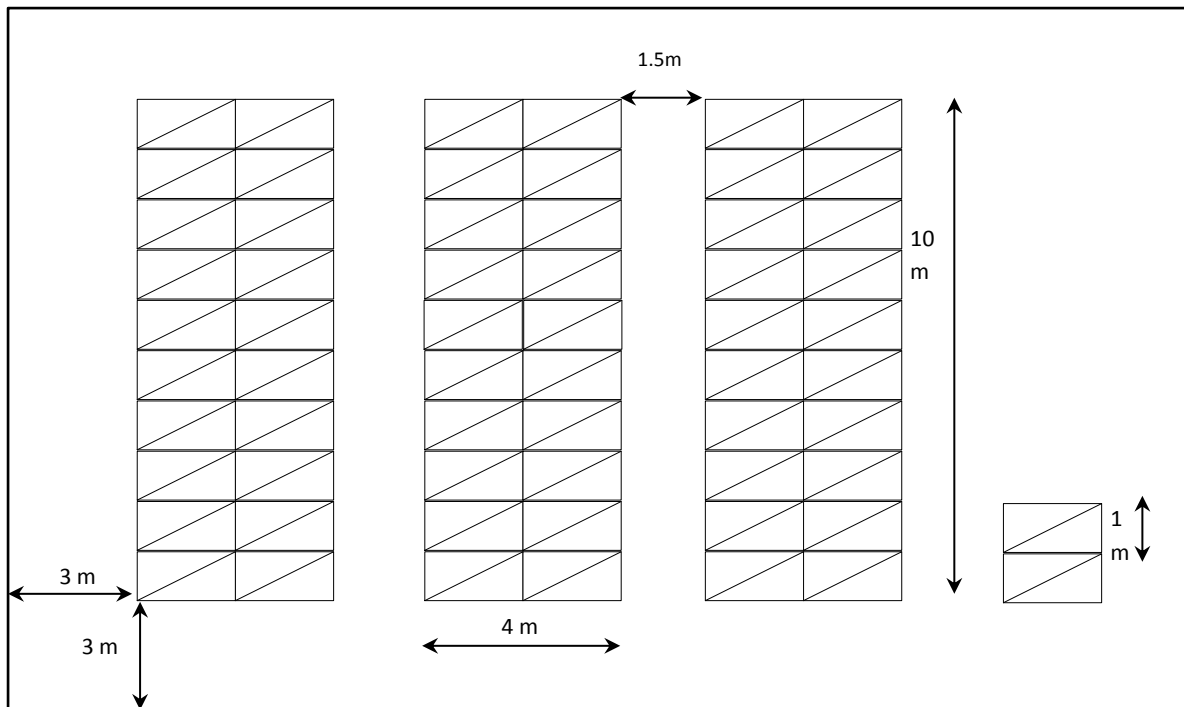


Figure 13 – Schematic Representation of proposed Sorting / Staging Area

#### 4.1.3.5 Administrative Department

The organisation will need to employ two additional clerks to process the increasing workload. At present the extra labour will not be necessary as the existing admin staff will suffice. The additional employees will most probably be needed during 2014, however it is the management's discretion as to when exactly they should be employed.

Clerks can share an open plan office for better workflow, communication and morale.

- Space requirement: 100 m<sup>2</sup>

#### 4.1.3.6 New Stores storage

- According to the Management of Incomati Warehousing and Distribution, the space requirements for New Stores storage would amount to 100 m<sup>2</sup> by November 2014.
- Stock destined for new stores are stacked and arranged in rows with the Distribution label visible. As soon as the retail store had been fitted, and the allocated stock had been accumulated, a consignment is sent to the store for opening.
- The layout of the New Stores Storage area is dependent on the space available within the facility and will be determined with the final Facility Plan.

#### 4.1.3.7 Repacking Area

- The organisation does not have a Repacking Area at present, although some repacking is done for the client.
- The average number of cartons requiring repacking during November 2014 are 75 cartons per day.
- The Repacking Area must accommodate empty cartons, footwear arranged according to size and style, aisles for workers to move in and also an area for repacking and sealing of cartons before sent to the Sorting/ Despatching Area.
- Note: repacking is executed per order. Once an order had been completely repacked, another order will be unpacked.
- A space requirement of 120 m<sup>2</sup> is allocated for this purpose.

#### 4.1.3.8 Personnel requirements

- Restrooms, lockers and basic mess facilities will be made available for the workers to utilize.
- Space requirement: 200 m<sup>2</sup>

#### 4.1.4. Step four: Generate Alternative Block Layouts

Based on the guidelines set by the Relationship Diagrams and other practical considerations, a number of different block layouts are generated. These layouts are evaluated and the preferred layout is selected and recommended.

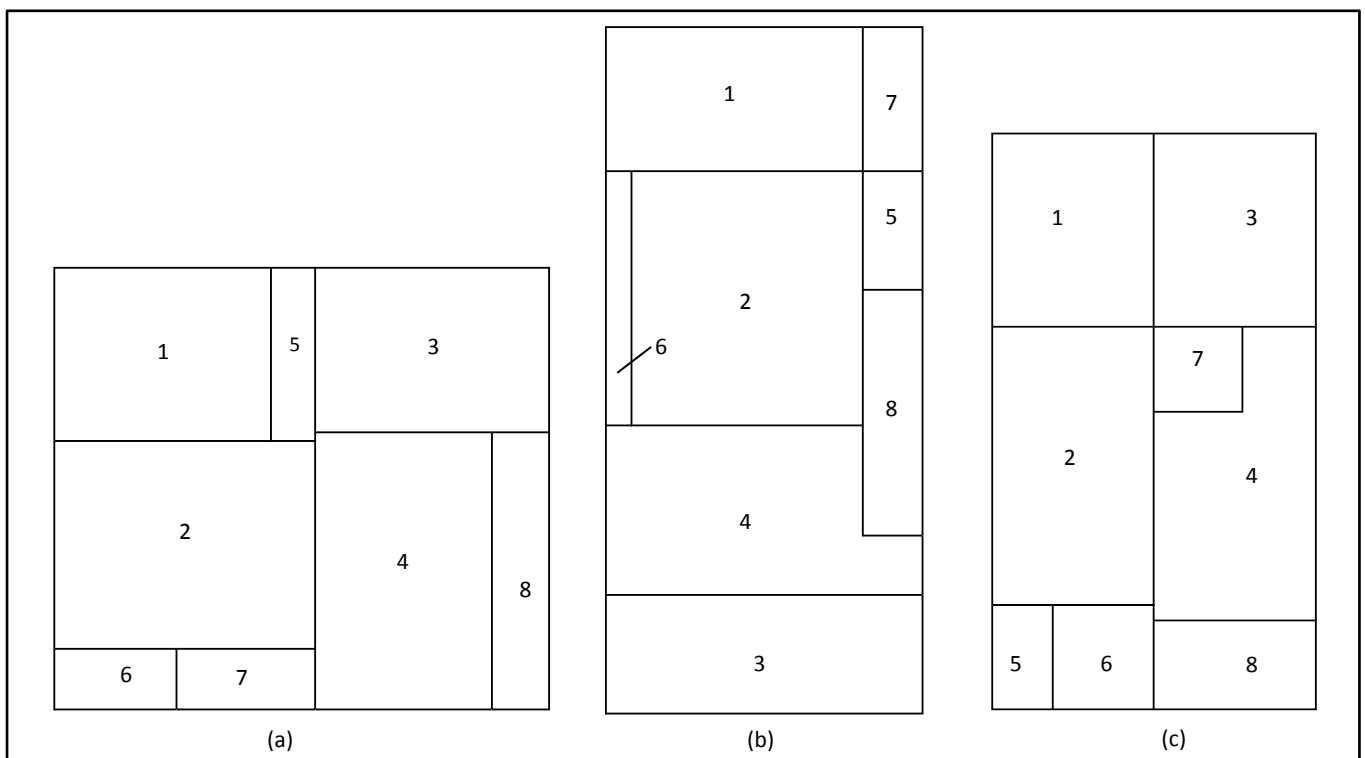


Figure 14 – Alternative Block Layouts for Incomati Warehousing and Distribution

## 4.2. Evaluation of Alternative Block Layouts

### 4.2.1. Introduction

As discussed in the Literature Study (section 2.1.1.2., p 10), CRAFT is used to evaluate the Layout Cost based on the volume of inventory moved multiplied by the distance of the movement. This analysis is applied to every department pair. The movement costs are added and this figure represents the “Layout Cost”. The volumes moved between departments are recorded in a From-To chart and the rectilinear distances between departments in a Distance Matrix.

The Layouts are also compared to another in terms of Quality (process quality and reliability), Flexibility and Delivery (speed reliability).

### 4.2.2. Step one: From-To Chart

Department Name		Area (m <sup>2</sup> )	Inventory Flow (in m <sup>3</sup> )								
			1	2	3	4	5	6	7	8	
1	Receiving Department	500	0	464	0	0	0	0	0	6	0
2	Processing Department	730	0	0	0	465	0	5	0	0	0
3	Despatching Department	500	0	0	0	0	0	0	0	0	0
4	Staging/Sorting Department	640	0	0	470	0	0	0	0	0	0
5	Administrative Department	100	0	0	0	0	0	0	0	0	0
6	New Stores Storage	100	0	0	0	5	0	0	0	0	0
7	Repacking Department	120	0	6	0	0	0	0	0	0	0
8	Personnel Requirements	200	0	0	0	0	0	0	0	0	0

Table 8 – From-To chart for inventory flow of Incomati Warehousing and Distribution

The Space Requirements that were calculated for the departments that function within the Distribution Centre includes additional space that allows for growth up until November 2014. Therefore, the From-To chart (Table 8) had also been drawn up on the assumption that the daily volume processed within the Distribution Centre would be that of the daily volume expected to be processed during November 2014. This volume equals 470 m<sup>3</sup>.

Therefore the Receiving Department receives 470 m<sup>3</sup> on a daily basis. From the Receiving Department, 464 m<sup>3</sup> is moved to the Processing Department. The 6 m<sup>3</sup> that are left from the received volume is moved to the Repacking Department for the necessary repacking requirements those orders might have. The repacked inventory is sent to the Processing Department after the repacking had been done.

From the Processing Department, 465 m<sup>3</sup> of the stock is moved to the Staging/Sorting Department to await despatching orders. The other 5 m<sup>3</sup> is moved into the New Stores Storage Department. Once a new branch is shop fitted and ready to be opened, all the accumulated stock for that branch is sent in a single consignment to the designated store. For the sake of this project, it will be assumed that the inventory in the New Stores Storage Department is moved into and out of the Staging/Sorting Area on the same day.

All inventory leaving the Staging/Sorting area, enters the Despatching area. Therefore 470 m<sup>3</sup> of the cartons are moved from the Staging/Sorting Department to the Despatching Department. Once the cartons have entered the Despatching area, it would not return to any other area within the Distribution Centre, as it is destined for transport to its designated branch.

Note that no inventory is moved between the Administrative- or Personnel Requirements area to other areas within the facility. Some paperwork is transferred from and to the Administrative Department, but it is of such small volume that it is considered negligible in this instance.

#### 4.2.3. Step two: Calculate Department Centroids of each layout alternative

The centroids of the departments within each alternative block layout had been calculated from the zero point of the x- and y-axes, represented by the bottom left corner of each layout. The centroids were calculated from that point using the measurements (in metres) of the departments. The rectangles representing the departments as specified in the application of Muther's Method were numbered accordingly.

##### 4.2.3.1 Alternative Block Layout (a)

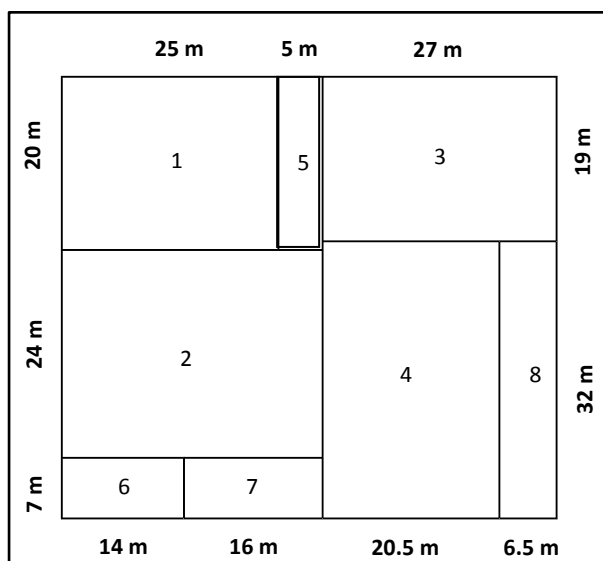


Figure 15 – Alternative Block Layout (a)

The coordinates for the centroids of the Departments for Block Layout Alternative (a) are:

- 1: (12.5, 41)
- 2: (15, 19)
- 3: (43.5, 41)
- 4: (40, 16)
- 5: (27.5, 41)
- 6: (7, 3.5)
- 7: (22, 3.5)
- 8: (54, 16)

#### 4.2.3.2 Alternative Block Layout (b)

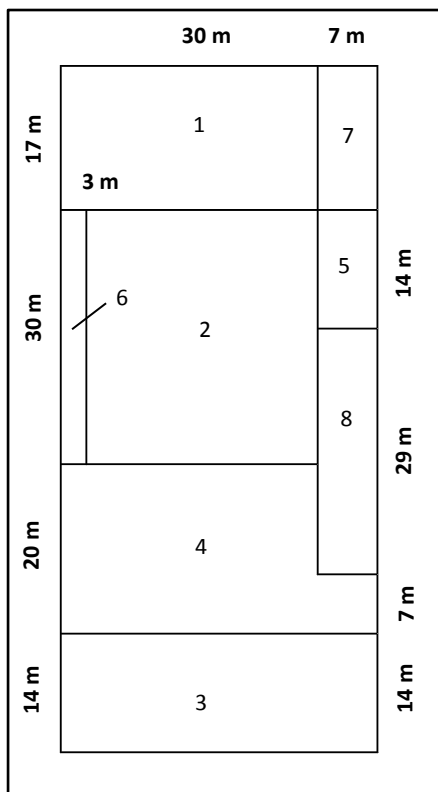


Figure 16 – Alternative Block Layout (b)

The coordinates for the centroids of the Departments for Block Layout Alternative (b) are:

- 1: (15, 72.5)
- 2: (16.5, 49)

- 3: (18.5, 7)
- 4: (17, 22)
- 5: (33.5, 57)
- 6: (1.5, 49)
- 7: (33.5, 72.5)
- 8: (33.5, 35.5)

4.2.3.3 Alternative Block Layout (c):

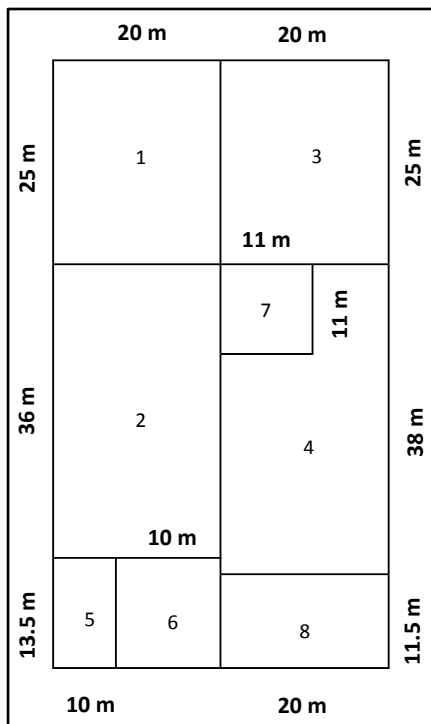


Figure 17 – Alternative Block Layout (c)

The coordinates for the centroids of the Departments for Block Layout Alternative (c) are:

- 1: (10, 62)
- 2: (10, 31.5)
- 3: (30, 62)
- 4: (31.5, 29)
- 5: (3.75, 6.75)
- 6: (12.5, 6.75)
- 7: (25.5, 44)
- 8: (30, 5.75)



#### 4.2.4. Step three: Calculate Rectilinear Distances between departments

The rectilinear distances between pairwise departments were calculated using department centroids. The distances between departments are in metres. Note that only rectilinear distances between departments that interchanged inventory were calculated and entered into their respective Distance Matrices.

The rectilinear distances were calculated by subtracting the x- and y-coordinates of two department centroids from another and taking the absolute values differences. The positive values were added and equals the rectilinear distance between the two departments.

$$(x_1, y_1) - (x_2, y_2) = |x_1 - x_2| + |y_1 - y_2| = \text{Rectilinear distance}$$

##### 4.2.4.1 Rectilinear distances between departments of block layout (a):

- 1: Receiving Department to 2: Processing Department:  
(12.5, 41) to (15, 19) = 24.5 m
- 1: Receiving Department to 7: Repacking Department:  
(12.5, 41) to (22, 3.5) = 47 m
- 2: Processing Department to 4: Staging/Sorting Department:  
(15, 19) to (40, 16) = 28 m
- 2: Processing Department to 6: New Stores Storage Department:  
(15, 19) to (7, 3.5) = 23.5 m
- 4: Staging/ Sorting Department to 3: Despatching Department:  
(40, 16) to (43.5, 41.5) = 29 m
- 6: New Stores Storage Department to 4: Staging/ Sorting Department:  
(7, 3.5) to (40, 16) = 45.5 m
- 7: Repacking Department to 2: Processing Department:  
(22, 3.5) to (15,19) = 22.5 m



Department Name		Area (m <sup>2</sup> )	Rectilinear Distance (m)								
			1	2	3	4	5	6	7	8	
1	Receiving Department	500	0	24.5	0	0	0	0	0	47	0
2	Processing Department	730	0	0	0	28	0	23.5	0	0	0
3	Despatching Department	500	0	0	0	0	0	0	0	0	0
4	Staging/Sorting Department	640	0	0	29	0	0	0	0	0	0
5	Administrative Department	100	0	0	0	0	0	0	0	0	0
6	New Stores Storage	100	0	0	0	45.5	0	0	0	0	0
7	Repacking Department	120	0	22.5	0	0	0	0	0	0	0
8	Personnel Requirements	200	0	0	0	0	0	0	0	0	0

Table 9 – Distance Matrix for block layout (a)

4.2.4.2 Rectilinear distances between departments of block layout (b):

- 1: Receiving Department to 2: Processing Department:  
(15, 72.5) to (16.5, 49) = 25 m
- 1: Receiving Department to 7: Repacking Department:  
(15, 72.5) to (33.5, 72.5) = 18.5 m
- 2: Processing Department to 4: Staging/Sorting Department:  
(16.5, 49) to (17, 22) = 27.5 m
- 2: Processing Department to 6: New Stores Storage Department:  
(16.5, 49) to (1.5, 49) = 15 m
- 4: Staging/ Sorting Department to 3: Despatching Department:  
(17, 22) to (18.5, 7) = 16.5 m
- 6: New Stores Storage Department to 4: Staging/ Sorting Department:  
(1.5, 49) to (17, 22) = 42.5 m
- 7: Repacking Department to 2: Processing Department:  
(33.5, 72.5) to (16.5, 49) = 40.5 m



Department Name		Area (m <sup>2</sup> )	Rectilinear Distance (m)								
			1	2	3	4	5	6	7	8	
1	Receiving Department	500	0	25	0	0	0	0	0	18.5	0
2	Processing Department	730	0	0	0	27.5	0	15	0	0	0
3	Despatching Department	500	0	0	0	0	0	0	0	0	0
4	Staging/Sorting Department	640	0	0	16.5	0	0	0	0	0	0
5	Administrative Department	100	0	0	0	0	0	0	0	0	0
6	New Stores Storage	100	0	0	0	42.5	0	0	0	0	0
7	Repacking Department	120	0	40.5	0	0	0	0	0	0	0
8	Personnel Requirements	200	0	0	0	0	0	0	0	0	0

Table 10 – Distance Matrix for block layout (b)

4.2.4.3 Rectilinear distances between departments of block layout (c):

- 1: Receiving Department to 2: Processing Department:  
(10, 62) to (10, 31.5) = 30.5 m
- 1: Receiving Department to 7: Repacking Department:  
(10, 62) to (31.5, 29) = 24 m
- 2: Processing Department to 6: New Stores Storage Department:  
(10, 31.5) to (12.5, 6.75) = 27.25 m
- 4: Staging/ Sorting Department to 3: Despatching Department:  
(31.5, 29) to (30, 62) = 34.5 m
- 6: New Stores Storage Department to 4: Staging/ Sorting Department:  
(12.5, 6.75) to (31.5, 29) = 41.25 m
- 7: Repacking Department to 2: Processing Department:  
(25.5, 44) to (10, 31.5) = 28m

Department Name		Area (m <sup>2</sup> )	Rectilinear Distance (m)								
			1	2	3	4	5	6	7	8	
1	Receiving Department	500	0	30.5	0	0	0	0	0	33.5	0
2	Processing Department	730	0	0	0	24	0	27.25	0	0	0
3	Despatching Department	500	0	0	0	0	0	0	0	0	0
4	Staging/Sorting Department	640	0	0	34.5	0	0	0	0	0	0
5	Administrative Department	100	0	0	0	0	0	0	0	0	0
6	New Stores Storage	100	0	0	0	41.25	0	0	0	0	0
7	Repacking Department	120	0	28	0	0	0	0	0	0	0
8	Personnel Requirements	200	0	0	0	0	0	0	0	0	0

Table 11 – Distance Matrix for block layout (c)



#### 4.2.5. Step four: Multiply corresponding From-To chart and Distance Matrix Values

The evaluation technique (CRAFT) calculates the Layout “Cost” is measured by a distance based objective function. The “cost” calculated by this technique does not represent the actual cost of a layout but supplies one with a figure that represents the amount of movement of different volumes to be made in that layout. In other words, this calculated figure gives an indication of the amount of material handling that one could expect to take place in a specific layout design.

As the material handling activities of Incomati warehousing and Distribution is extremely labour intensive, this technique proves appropriate. The rectilinear distances between departments are multiplied with the volume of inventory to be moved between them each day (see Table 8 – From-To chart). This figure represents the movement “cost”. The movement “costs” are added and the layout “cost” is calculated for each alternative block layout.

##### 4.2.5.1 Layout “cost” of Alternative Block Layout (a):

Department Name				Rectilinear Distance (m)	Units moved (m <sup>3</sup> )	Movement cost (distance x units moved)
From		To				
1	Receiving	2	Processing	24.5	464	11368
1	Receiving	7	Repacking	47	6	282
2	Processing	4	Staging/Sorting	28	465	13020
2	Processing	6	New Stores Storage	23.5	5	117.5
4	Staging/ Sorting	3	Despatching	29	470	13630
6	New Stores Storage	4	Staging/Sorting	45.5	5	227.5
7	Repacking	2	Processing	22.5	6	135
Total Layout Cost						38780

Table 12 – Layout “cost” calculation for block layout (a)

##### 4.2.5.2 Layout “cost” of Alternative Block Layout (b):

Department Name				Rectilinear Distance (m)	Units moved (m <sup>3</sup> )	Movement cost (distance x units moved)
From		To				
1	Receiving	2	Processing	25	464	11600
1	Receiving	7	Repacking	18.5	6	111
2	Processing	4	Staging/Sorting	27.5	465	12787.5
2	Processing	6	New Stores Storage	15	5	75
4	Staging/ Sorting	3	Despatching	16.5	470	7755
6	New Stores Storage	4	Staging/Sorting	42.5	5	212.5
7	Repacking	2	Processing	40.5	6	243
Total Layout Cost						32784

Table 13 – Layout “cost” calculation for block layout (b)



4.2.5.3 Layout “cost” of Alternative Block Layout (c):

Department Name				Rectilinear Distance (m)	Units moved (m <sup>3</sup> )	Movement cost (distance x units moved)
From		To				
1	Receiving	2	Processing	30.5	464	14152
1	Receiving	7	Repacking	33.5	6	201
2	Processing	4	Staging/Sorting	24	465	11160
2	Processing	6	New Stores Storage	27.25	5	136.25
4	Staging/ Sorting	3	Despatching	34.5	470	16215
6	New Stores Storage	4	Staging/Sorting	41.25	5	206.25
7	Repacking	2	Processing	28	6	168
Total Layout Cost						42238.5

Table 14 – Layout “cost” calculation for block layout (c)

**4.2.6. Layout Selection:**

From Tables 12, 13 and 14 it is evident that Alternative Block Layout (c ) would be the most cost effective layout option in terms of material handling and movement. As stated earlier in the document, the company carries out labour intensive operations and their material handling equipment is completely manually operated. Therefore the layout cost in terms of material handling carries substantial weight when selecting the best alternative.

Furthermore, the cost of laying out the different alternatives would not differ greatly. The same expenses in terms of floor marking supplies and labour, possible roller door installations, network equipment requirements etc, would be incurred.

All layouts had been designed according to the departments’ required proximities as acquired from the Activity Relationship Diagram. Therefore the integrity of the process is not jeopardised in either alternative and each alternative would supply process quality and reliability.

In terms of flexibility it is important to note that the organisation would most probably rent an existing facility. It had never been their intention to build an entirely new facility. The design of Alternative (a) and (c ) (see Figure 14) includes the receiving and Despatching Areas in the same line. Usually, existing warehouses have Receiving and Despatching roller doors in one line; the same wall in the warehouse is used to receive and despatch goods from. Alternative (b) displays the Receiving and Despatching Areas at opposite ends of the warehouse, this design is much less common in existing warehousing facilities.



All alternatives had been designed to supply proper inventory flow. However, the alternative layouts would require different material handling intensity levels as proved in sections 4.2.5.1, 4.2.5.2 and 4.2.5.3. This might affect the speed of delivery, as increased physical material handling, performed by the same workforce would be more time consuming.

From an academic perspective, Block Layout Alternative (b) would be the most appropriate option as the evaluation technique proved it would be least expensive. The material handling operational cost however, is not the only criteria when selecting the best alternative. Layout (a) is the second most cost effective alternative and layout (c) the most expensive, almost 10 000 units more so than alternative (b).

From the Literature study it is evident that with the proper practical modifications, adjacent Receiving and Despatching Areas is more beneficial than having these two areas split in the layout design.

The best layout alternative would therefore be layout alternative (a). It is not the most expensive layout alternative in terms of material handling cost and has a generic design that could be applied to most existing facilities (with roller doors in one line (one wall) of the facility). A floor plan for layout alternative (a) is drawn up in APPENDIX B and the flow throughout the facility is demonstrated in APPENDIX C.

#### **4.2.7. Problem Mapping**

Layout alternative (a) had addressed the problems identified throughout the project. It had been expanded to such a size that the operational capacity had been increased to the required level and accommodation for growth had also been made. Table 15 illustrates how the solutions given by the selected layout can be traced back to the initial shortcomings the facility had exhibited.



<b>Problem:</b>	<b>Solution</b>
<i>Receiving Area:</i>	
- loading bay is not level to delivery vehicle bodies (excessive material handling)	- levelled docks with bumper pads for rear delivery vehicle protection
- small yard (delivery vehicles have to park parallel to facility and not perpendicular to loading bay)	- yard size (?????) had been specified for adequate manoeuvring space for delivery vehicles
<i>Despatching Area:</i>	
- same space allocation as Receiving department (bottlenecks, congestion, order mix-ups, missing cartons)	- layout alternative (a) has two separate, adjacent areas allocated to the Receiving- and Despatching Departments
<i>Staging Area:</i>	
- limited space, results in overpopulated loading bays, cartons toppling over into wrong bays and pose a threat to worker safety.	- the alternative layout had been designed to supply the necessary space required for the operational activities (room for growth had been included)
<i>Administrative Area:</i>	
- the administrative area of the current facility is too small with poor lighting and ventilation.	- a space allocation of 100 m had been made to the administrative area, this area had been placed next to a wall with windows where proper lighting and ventilation is available
<i>New Stores Storage:</i>	
- entrance to the storage area is too small for a pallet jack to pass through	- adequate aisle space had been allocated and the entrance broadened for ease of material movement
<i>Personnel Requirements:</i>	
- inadequate sanitary facilities for workers	- appropriate sanitary facilities is included in the layout design with separate restrooms for the sexes.
- workers have no locker or changing facilities in which to change into and out of work clothes	- separate change rooms with lockers for workers to store their personal belongings in
- recreational area is non-existent, except for a small kitchenette with a sink and microwave	- the layout design includes a recreational area with refrigerating and cooking facilities to store and prepare food with
<i>General:</i>	
- windows at eye level surround the current facility	- care should be taken when selecting the new facility to rent, that as little as possible windows are in the facility. Light should come through translucent panels installed in the warehouse roof
- there is a lack of a sprinkler system in the current facility and no fire extinguishers	- fire extinguishers are installed at strategic positions throughout the layout design

**Table 15 – Mapping of problems to solutions**

## 4.3. Material Handling equipment

### 4.3.1. Introduction

Material handling system design is an important aspect of the facilities planning process. It is impossible to view layout design and material handling system design as separate entities. It is critical that these design functions are integrated during the planning of a new facility (Tompkins et al 2003:175).

Appropriate material handling equipment and techniques can improve the operations of any organisation. Therefore it would be beneficial for any organisation's space utilisation, productivity and efficiency to implement best practice material handling principles.

### 4.3.2. Application

- Pallet:
  - Pallets are by far the most commonly used piece of material handling equipment when it comes to unitising. They are cost effective and easy to procure (Figure 18).
  - Wooden pallets are not very environmentally friendly; pallets manufactured from alternative materials (plastic pallets or composite pallets made from sawdust, plastic and wood chips) are the greener alternative.
- Pallet jacks:
  - Non-automated pallet jacks are very labour intensive and require a lot of physical exertion to move materials with (Figure 19).
  - Automated pallet jacks are used for the same purpose as non-automated pallet jacks with the exception that they can move heavier loads over larger distances as it requires almost no labour to operate. Automated pallet jacks are significantly more expensive than non-automated pallet jacks and require some sort of fuel to be driven.



Figure 18 – Wooden pallet  
Source: [www.poppytalk.blogspot.com](http://www.poppytalk.blogspot.com)



Figure 19 – Manual pallet jack  
Source: [www.cranetech.co.za](http://www.cranetech.co.za)

- Roller (non-automated) conveyors:
  - When loading and offloading delivery vehicles, pallets and manual conveyors are used to push cartons to its destination (over long or short distances) (Figure 20).
  - Gravity can be utilised by employing a height adjustable conveyor and lessen the labour intensity of the operation.



Figure 20 – Non-automated roller conveyor  
Source: [www.titanconveyors.com](http://www.titanconveyors.com)

- In the industry, automated conveyors and forklifts are used for the same application as manual forklifts and non-automated roller conveyors (of moving palletised or loose cartons within a facility (Figure 21 & Figure 22).
- Automated options are more expensive but less labour intensive.
- When using a forklift to move palletised material, shelving is additional material handling equipment that can be implemented for better space utilization of a facility.
- More stock can be moved in less time with automated equipment than non-automated equipment and physical labour.



Figure 21 – Automated belt conveyor  
Source: [www.cornerautosys.com](http://www.cornerautosys.com)



Figure 22 - Forklift  
Source: [www.stupidknows.com](http://www.stupidknows.com)

- A direction adjustable conveyor can be utilised around bends in aisles. (Figure 23).

- Height adjustable roller conveyors can be used to employ gravity during material handling and alleviate the physical exertion required by workers to move cartons (Figure 24).



Figure 23 – Direction adjustable conveyor  
Source: [www.alpinehandlingsystems.com](http://www.alpinehandlingsystems.com)



Figure 24 – Height adjustable roller conveyor  
Source: [www.gmpindia.com](http://www.gmpindia.com)



## 5. Recommendations and Conclusions

### 5.1. Introduction

A newly designed and implemented facility does not conclude the planning effort entirely. The Facilities Planning process is that of a continuous one. Due to the fact that a facility's requirements and specifications are constantly changing the facilities plan also needs to be adapted and modified over time. This revision of the facility plan involves an in-depth investigation of the facility location, design and material handling equipment (Tompkins et al (2003:836)).

#### 5.1.1. Recommendations

The larger, newly designed facilities plan (APPENDIX B) will have the capacity to process future volumes of stock. It will accommodate the growth and process needs of the company. It is crucial that the organisation implement some form of space expansion and the Redesign of a Distribution centre to increase Operational capacity is a practical, cost effective solution to this problem.

##### 5.1.1.1 Aisle space

- Aisles within the facility are specified to be a width of 3 m. The reason therefore is that two pallet jacks (with a loaded pallet) can pass one-another at the same time. The average width of a loaded pallet will equal 1.2 m.
- Aisles between sorting/ staging bays and sorting lines are specified to be 1.5 m. Pallets are to be loaded in the aisle (between sorting lines or sorting/ staging bays) and removed single file from one end of the aisle to the other.

##### 5.1.1.2 Material Handling

- The current material handling equipment (pallet jacks, pallets and non-automated roller conveyors) are the most cost effective for the current business size.
- A forklift and automated conveyors would prove too expensive even though they promise more material movement in less time.
- In future automated roller conveyors can be considered as the travel distance of cartons increase.
- Incomati can however consider direction and height adjustable conveyors for ease of material handling (Figure 20 & Figure 21).



### 5.1.1.3 Staff compliment

Job title	Number of workers
Warehouse Manager	1
Supervisor	2
Administrative clerk	4
General worker	7
Drivers	9
Assistants	8
Total number of workers	31

**Table 16 – Suggested staff compliment**

As the business and facility grows, so does the staff compliment also. The number of general workers in Table 8 would not suffice during November 2014. The organisation employs casual labour during peak periods that the company could otherwise not afford to employ.

The additional permanent staff listed in Table 8 need not be employed immediately (during 2012) but only as the workload increases and enables the company budget to do so.

### 5.1.1.4 Sprinkler system

It is highly recommended that the company install a sprinkler system as the commodity being stores is highly flammable and insurance will not cover the loss if the necessary precautions were not taken to prevent a fire (or extinguish the threat in event of a fire).

## 5.1.2. Conclusions

The initial formulated problem, states that the operational side of Incomati Warehousing and Distribution had outgrown its Distribution Centre completely. There are different ways of increasing the operational capacity of an organisation such as this. These ways include:

- Installing shelving into the warehouse.
- Redesigning the layout to improve material flow.
- Purchasing additional delivery vehicles or outsourcing some of the transportation over peak periods.
- Expanding the operations into an additional facility. Therefore there would be two Distribution Centres.



- Moving the whole operation into a larger facility and designing that facility according to Facilities Planning Principles.

The reasons for selecting the option of redesigning a different, larger facility altogether was that this option was the most financially feasible one.

- Shelving options would have been inappropriate in the current facility, as the roof is only 5 metres high and two - three shelves at most could have been installed. Furthermore, this option would require the purchasing of reach-trucks. The organisation is not at a size where reach trucks are a realistic option.
- The layout of the current Distribution Centre affords ease to the flow of goods and a redesign thereof would not increase the organisation's operational capacity to the required level.
- If the organisation were to greatly expand their delivery fleet in order to process the volumes received during November 2014, these vehicles would only be operational for two to three months of the year. This is an unrealistic option as the organisation would not be able to generate enough cash flow in order to support the labour and monthly instalments that these vehicles would require. It would however be advisable for the organisation to purchase two additional delivery vehicles, as larger volumes of inventory turned, would not only require a larger Distribution Centre, but also a proportionately larger delivery fleet.
- Outsourcing some of the loads during the peak period is not a good alternative either. The organisation is at a stage where expansion is inevitable.
- If the organisation were to open an additional facility, it would require another warehouse manager, trained employees, IT equipment and would incur duplicate costs on many counts that were unnecessary.

By continually ensuring a well-designed facility and resource utilisation, the following advantages are obtained by an organisation (Tompkins et al 2003:13) :

- Lead times are minimized whilst customer response is maximised.
- Customer satisfaction is improved because an organisation follows through on its promises and responds favourably to customer needs.
- People, space and equipment are used efficiently and effectively.
- Supply clients and employees with the security of sustainable and resilient business.
- Ensure maximum return on investment of capital expenditures.

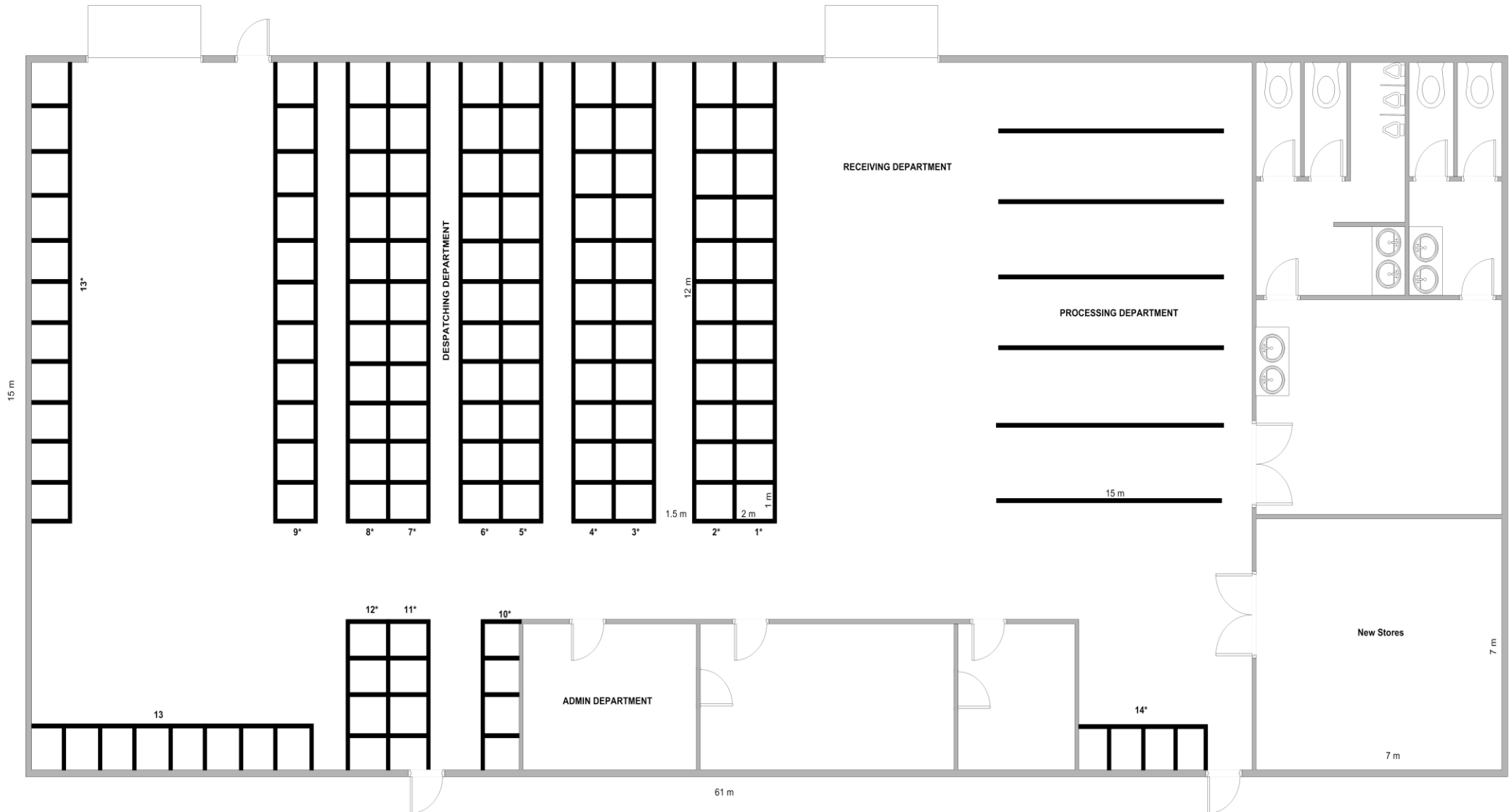


The organisation would obtain these advantages by implementing the facility plan and slight modifications to their material handling equipment.

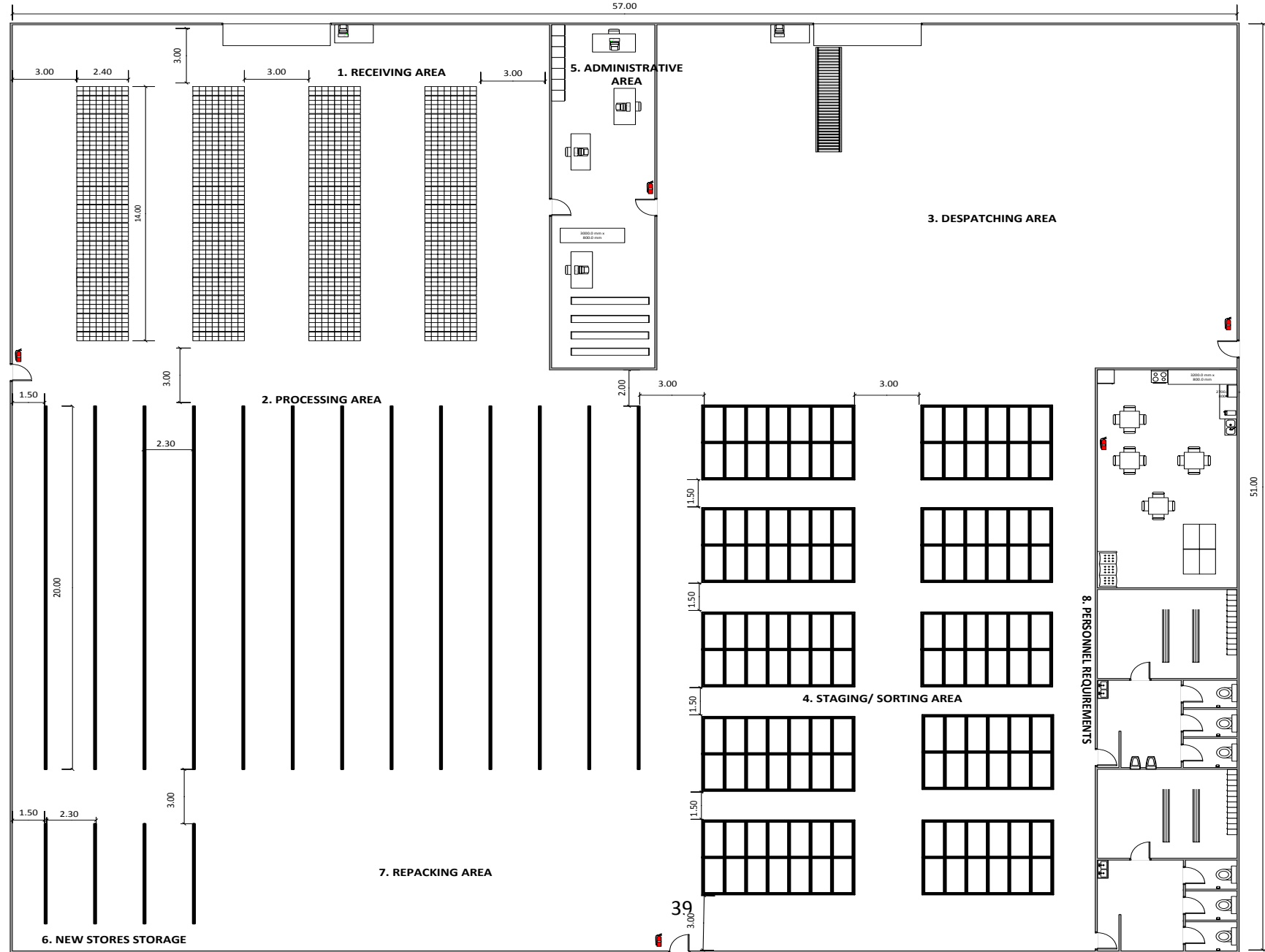


## 6. References

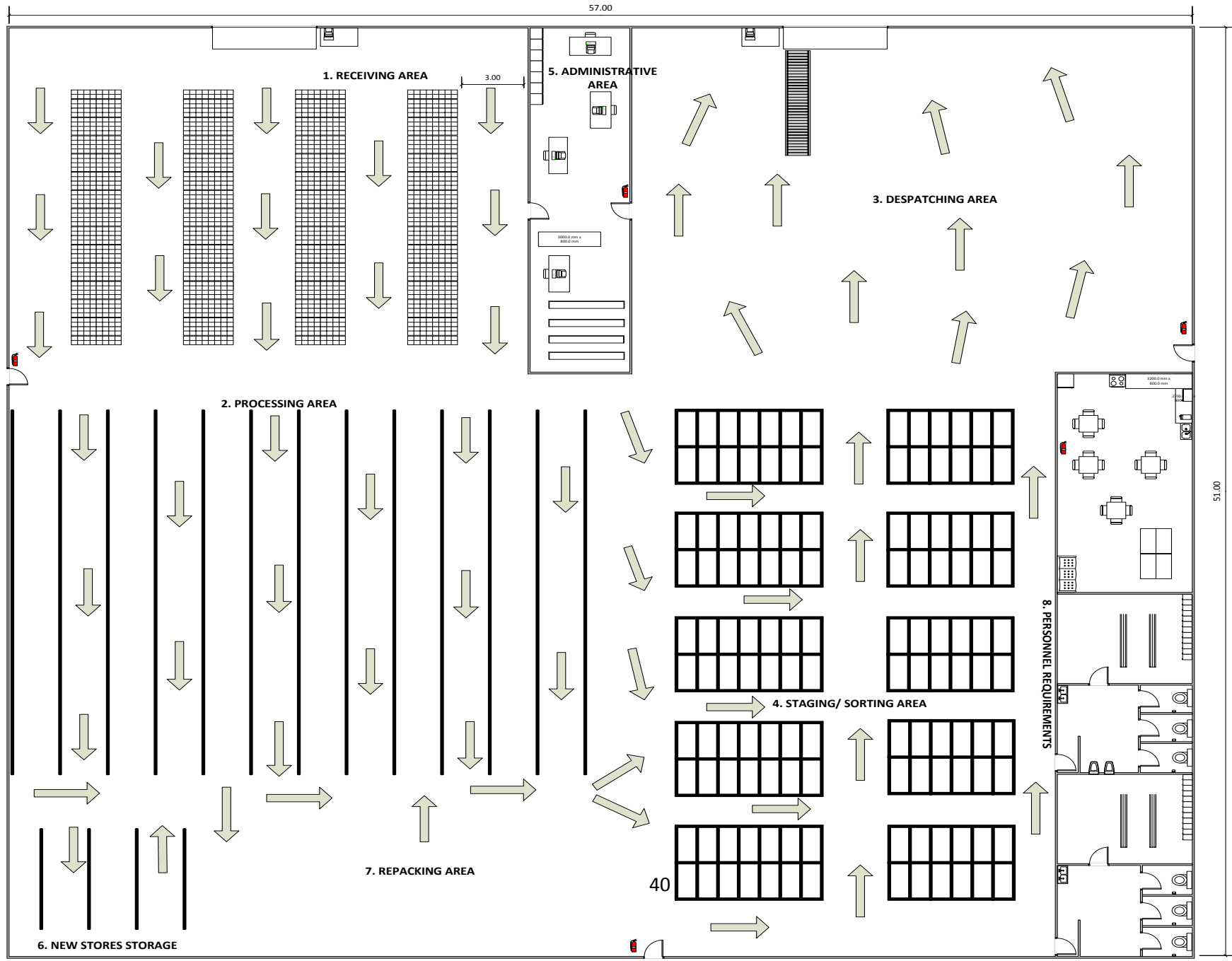
- Botha, G.J., 2010. *Theme 5 Warehousing*, BFB 320 - Facilities Planning.
- COYLE, J.J., BARDI, E.J. & LANGLEY, C.J., 2003. *The Management of Business Logistics, A Supply Chain Perspective*, 7<sup>th</sup> ed. Canada: South-Western, Thomson Learning.
- TOMPKINS, J.A., WHITE, J.A., YAVUZ, A.B. & TANCHOCO, J.M.A, 2003. *Facilities Planning*. 4<sup>th</sup> ed. John Wiley & Sons.
- FRAZELLE, E.H., 2001. *World-Class Warehousing and Material Management*. U.S.A: McGraw-Hill Companies.
- TEICHOLZ, E., 2001. *Facility Design and Management Handbook*. U.S.A: McGraw-Hill Companies
- ZANDIN, K.B., MAYNARD, H., 2001. *Maynard's Industrial Engineering Handbook*. 5<sup>th</sup> ed. New-York: McGraw-Hill Companies.



APPENDIX A - Current Warehouse Facility plan



APPENDIX B – Recommended Warehouse Facility plan



APPENDIX C – Material flow in Recommended Warehouse Facility plan