

Process Improvement of Wispeco's Distribution Operations

by

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Executive Summary

Wispeco Aluminium has become one of the largest suppliers of aluminium products in the country. Over the years the company has been supplying quality products and services. Since the company have created a positive name for itself, it is now the duty of the company management and employees to maintain the current standard of doing business, or more so even increase the standards further.

The increase in competition in the aluminium industry has prompted the company to improve its performance, so as it could stay ahead of its competitors. With the growing demand of company's products by customers, certain problems emerged that needed management's attention

Problems that arose were

- Space availability
- Increase in returns due to product damage, both internally and externally
- Lots of documentations taking place
- Ineffective communication between departments
- Organisation and arrangement of items and departments within the distribution business unit
- Product security

The aim of the project and this document will be to investigate the above mentioned problems, and generate optimal solutions that will keep the company ahead of its competitors, while keeping their customers and workers satisfied. Deliverables from the project will help attain the required improvements in the distribution process, an improved warehouse layout and a more satisfied customer.

In order to root out the above mentioned problems, one needs to first understand the current process being followed, the current layout and complaints that have been reported.

Understanding the process involves, knowing the stakeholders and their roles throughout the process. The necessity of the process and activities within that process are of vital importance to get started with the research. After all the deliverables are attained, it should be the end of the project, but it is not the end of the improvement process, as that should be a continuous process that strives to keep the company up to date with the changing business world, competitors and deliver quality products and services.

Table of Contents

Chapter 1 Introduction & Background.....	0
1.1. Company Background	0
1.2. Problem Statement	1
1.3. Project Aim.....	2
1.4. Project Scope	2
Chapter 2 Literature Review	3
2.1. What is a Process?	3
2.2. Process Improvement	4
2.3. Methods, Tools and Techniques	5
2.3.1. Process Mapping.....	5
2.3.2. Cause and Effect diagram (Fishbone)	6
2.3.3. Layout Design.....	6
2.3.4. Material Handling	9
2.3.5. 5S Movement Method.....	9
2.3.6. 5W1H Checklist	10
2.3.7. Force Field Analysis.....	11
2.3.8. Conclusion.....	11
Chapter 3 Current State Analysis.....	12
3.1. Background	12
3.2. Process Flow.....	13
3.2.1. Documentation	13
3.2.2. Material Flow	14
3.3. Layout Analysis.....	14
3.4. Departments and their roles.....	15
Chapter 4 Data collection & Analysis.....	19
4.1. Problem Overview	19
4.2. Departmental Analysis.....	19
Chapter 5 Future State Analysis.....	23
5.1. Systematic Layout Planning Analysis	23
5.2. Layout Alternatives	25
5.3. Alternative 1.....	25

5.4. Alternative 2.....	27
5.5. Alternate 3	28
5.6. Evaluation of Alternatives.....	29
5.6.1. Weight Factor Comparison	29
Chapter 6 Solution and Recommendation.....	31
Chapter 7 Implementation and monitoring.....	36
7.1. Implementation Plan	36
7.2. Resulting Improvements.....	38
7.3. Monitoring	39
7.3.1. Records.....	39
7.3.2. Customer Experience Management	39
7.3.3. Key Performance Measurement.....	41
Chapter 8 Conclusion.....	42
Reference List.....	44
Appendix	45
Appendix A: Process Improvement tools and their functional area.....	45
Appendix B Current Documentation Process	47
Appendix C Material/Product flow	48

Table of Figures

Figure 1 A typical process.....	3
Figure 2 Process Improvement Steps (Ishiwata, 1991).....	4
Figure 3 A general Fishbone Diagram (Freivalds & Niebel, 2009)	6
Figure 4Material Handling System Equation (Tompkins et.al, 2010).....	Error! Bookmark not defined.
Figure 5 Force Field Diagram (Gilbert, 2002).....	11
Figure 6 General departments which Products move through	12
Figure 7 Current Warehouse Layout.....	15
Figure 8 Cause & Effect Diagram for the Distribution Operations	19
Figure 9 Short Packed Products	20
Figure 10 recorded Product Damage from Internal Customer.....	21
Figure 11 Average Annual Quality Cost	22
Figure 12 Activity Relationship Chart.....	23
Figure 13 Relationship Chart.....	24
Figure 14 Alternative 1 Layout.....	26
Figure 15 Alternative 2 Layout.....	27
Figure 16Alternate3 layout	28
Figure 17 Example of Labelling Note	32
Figure 18 Force Field Analysis Diagram	36
Figure 19 Difference between CRM & CEM.....	40
Figure 20 Current Documentation.....	47
Figure 21current Material Flow	48

Table of tables

Table 1 Four Basic Principles for Making Improvements (Ishiwata, 1991).....	5
Table 2 5S Movement (Gitlow et al, 2009)	10
Table 3 5W1H Checklist (Ishiwata, 1991)	10
Table 4 Documents used at Distribution Department.....	13
Table 5 Powder coating and Anodizing colours	14
Table 6 Colours Used at Packaging	16
Table 7 Value of Closeness.....	23
Table 8 Reason for Closeness.....	24
Table 9 Different Colours for Storage Areas	25
Table 10 Advantage & Disadvantage of Alternate 1.....	26
Table 11Advantage & Disadvantage for Alternate 2	28
Table 12 Advantages & Disadvantages for Alternate 3	29
Table 13 Factor of Comparison	29
Table 14 Weighted Factor Comparison Form	30
Table 15 example of a Poster for Packaging.....	31
Table 16 Process Improvement tools and their speciality.....	45
Table 17 some of the Process Improvement Tools and their functions.....	46

Chapter 1 Introduction & Background

1.1. Company Background

Situated in Alrode, Alberton near Johannesburg, Wispeco Aluminium has grown from strength to strength in the aluminium supplying industry. Other than the Alrode plant, the company also has small branches situated in Cape Town and Vereeniging. The company began its operation as wires, steel windows and doors producing company.

Over the years, the company restructured its company strategy and focus, in order to be more competitive. The new strategy resulted in the company only focusing its operations on manufacturing and distributing of aluminium extrudes. A make-to-order system was introduced, with the aim of managing the customer orders well. The system also saved the company significant amount of money. The company's mission is to achieve a one day turn around for their customer's orders, i.e. manufacture and ship the product in one day. The company's mission helped customers to run their business more efficiently, knowing that there is no necessity of keeping a lot of stock in inventory. The mission also helped the management manage their company in a better way, which led to a large amount of storage cost being eliminated.

The customers are segmented into two divisions, a local and a coastal division. The segmentation helped the company manage their logistic process better. The local division of the segment is mainly based for Gauteng and the nearby areas. The coastal segment is developed mainly for customers near the coast as the cost of transportation is much higher. This segment is further subdivided into areas, namely the Cape Town area, the Durban area and the Port Elizabeth area. The Cape Town area includes the whole of the Western Cape Province and nearby areas; the Durban includes the whole of the Kwa-Zulu Natal province, but may include Bloemfontein if the need arises. The Port Elizabeth area covers the whole Eastern Cape Province. External and internal trucks are used to get the products to customers. Internal trucks are used for mainly local division, with external trucks serving the coastal area.

This project will be based at the Alberton branch. The branch has four distribution points, where product delivery is organised from. The mill-finish product warehouse is the main and first distribution point. All mill-finish products are stored at this warehouse. Products that need anodizing or powder coating will be sent to the respective departments. The

warehouse has the biggest loading platform as compared to order distribution points, fitted with two 20-ton overhead cranes. The warehouse also provides temporary storage for coastal products from anodizing and powder coating, waiting for delivery. All mill-finish deliveries are handled from this warehouse and only coastal anodized and/or powder coated product are shipped from this point. The project will be done at this warehouse, as the activities happening are almost the same with other distribution points.

The other remaining distribution points are at the powder coating department, anodizing department and despatch warehouse. For anodizing and powder coating departments, all coastal products to be delivered are sent back to the mill-finish products warehouse, only the local products are shipped from these departments. The despatch warehouse orders products from the other departments, and sell the products from that point. Most of the products in the despatch warehouse are usually standard product or products that are of common interest from a lot of customers.

1.2.Problem Statement

As mentioned before, the company's mission is to achieve a one day turn around. It is essential for the company to continually meet and maintain the quality standards it has set. The customers would be expecting the company to maintain its standards or even better the standards it has set. The growing demand for the company's products and services resulted with certain problems for the distribution department. The following problems arise when some the quality standards are not met by the distribution department:

- Space availability and utilisation
- Increase in product returns due to damage
- Increase in order processing time
- An increase in wrong order filling
- Increase in mix-up between products in the warehouse causing confusion
- The decrease in the accessibility of products in storage when retrieved for loading
- Communication breakdown between departments with the distribution operations
- Ergonomics factors during the delivery of products
- Increase of products in the A.S. storage
- Manual Recording of activities

The company decided to research the factors that might be causing the above problems. It was essential for the company to take this step as ignoring the problems might result in a loss of money and potential sale opportunities. The outcome of the research will not only

help the company stay competitive but will also prevent any future loss of sales. The mill-finish warehouse will be used for the research as it is the biggest warehouse the company has.

1.3. Project Aim

The main aim of the project is to investigate the current distribution process, in order to generate and optimised and improved distribution process.

Specific Objectives to be achieved are:

- Maximise storage space utilization
- Improve order cycle time
- Decrease loading and unloading time
- Improve customer satisfaction
- Improve order filling process
- Decrease in product returns
- Improve communication within and between departments
- Improve product security
- Improve ergonomics factors during unloading

1.4. Project Scope

Since distribution operations and their respective individual process are generally very large and tedious to deal with all at the once, the project scope will be narrowed down to a manageable scope. Activities to be considered are activities from packing to until the product is delivered at the customer's destination.

Processes within scope are:

- Packaging and Labelling
- Storage and retrieval process
- Staging and sorting at the loading platform
- Loading and offloading techniques
- Documentation done

Process that won't be in the scope:

- Choosing of delivery truck
- Route followed by the truck

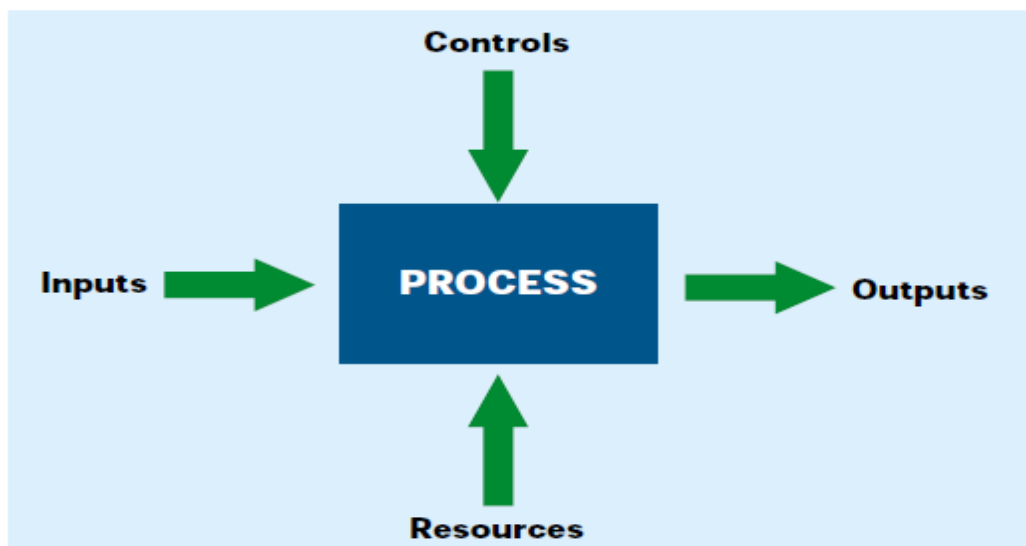
Chapter 2 Literature Review

Process improvement is essential for the Wispeco's competitiveness. Knowing which areas to improve and the improvement tools that should be used are equally essential. First, and foremost we should understand the meaning of process improvement.

2.1. What is a Process?

According to Gitlow et.al (2005), a process is the transformation of inputs into outputs. Susan Page, in her book titled "The power of Business Process Improvement"; said that everything is a process, from making breakfast to building a shuttle. There is always a series of actions being followed. In short, a process is sequence of actions taken to transform inputs into a particular output and also taking into consideration constraining factors. The diagram below indicates that inputs into a process are controlled by the controls and constraint by the availability of resources, in order to yield the desired output.

Figure 1 A typical process



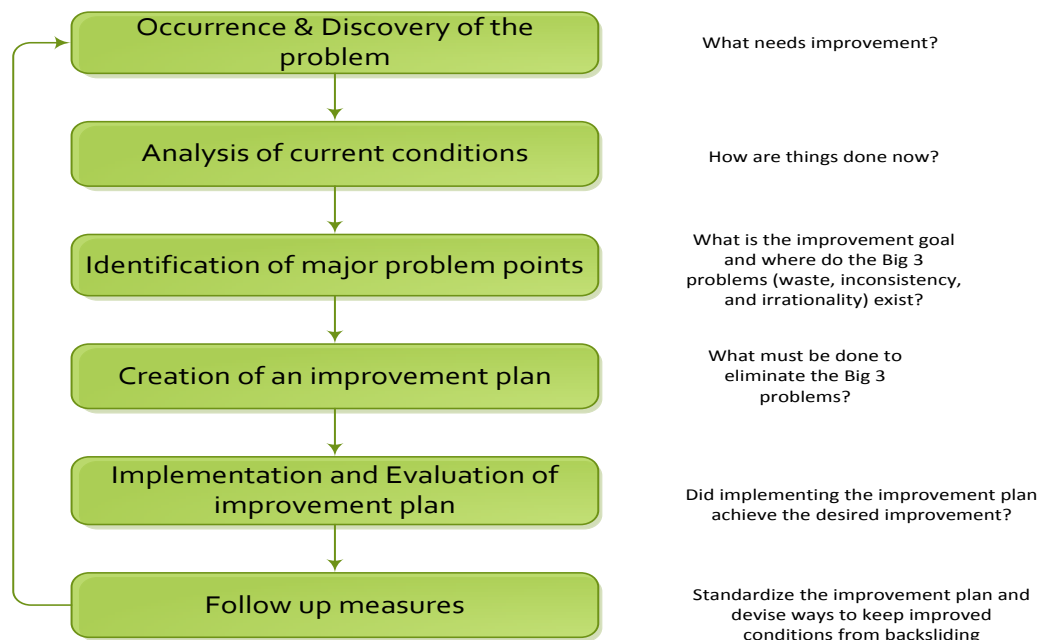
From the figure above, inputs to a process are things that will be altered or processed / transformed into an end product or service, as required by the customer of the process. According to Gitlow et.al (2005), inputs could be, but not limited to; personnel, equipment, material/goods, methods and environment. Outputs are products or service and should conform to customer's specification agreed upon in advance. Controls are laws or regulation imposed on the processing of product or service, e.g. customer specification, government laws, regulations from respective bodies, etc. Resources are all things that a process must have in order to process inputs into outputs. Resources may be tangible, e.g. PC, tables, etc or may be intangible e.g. skills, experience, etc.

2.2.Process Improvement

Business process improvement is vital in enabling a business to stay competitive. Process improvement is all about making things better, not blaming others for problems and/or mistakes occurring (Balanced Institutescorecard, 1996), as that wouldn't add any value to the company concerned. It encourages proactive thinking instead of reactive thinking. Undertaking process improvement, the current state of a process is mapped and understood to the fullest. After learning and understanding what the current process does, the focus is now turned to improvements that could be done on certain parts of the process. Loop holes in the current process will be determined and dealt with in the proposed solution. It is important that all department concerned and management should be involved, as that will aid in determining the right solution and also easing pressure during implementation, as all concerned stakeholders would have approved it during the research and development stage.

Figure 2 shows process improvement steps as presented by Junichi Ishiwata (1991). In short, the steps help to identify what needs to be improved, the current state of the process, the goal of the improvement and how to implement the solution. The figure also indicates that improvements are continuous, by the arrow moving from the bottom of the process to the beginning.

Figure 2 Process Improvement Steps (Ishiwata, 1991)



There are four basic principles according to Ishiwata (1991) that should be kept in mind before starting with improvement procedures. The rules are meant to guide your thoughts as you begin drafting improvements plans. The table is given below

Table 1 Four Basic Principles for Making Improvements (Ishiwata, 1991)

Rule	Questions	Examples
Eliminate	Can this be eliminated? What will happen if we eliminate it?	<ul style="list-style-type: none"> • Eliminate or shorten inspection • Eliminate or shorten transportation by changing layout
Simplify	Can this be made simpler?	<ul style="list-style-type: none"> • Review operations • Automate
Combine	Can two or more process be consolidated into one?	<ul style="list-style-type: none"> • Do two operations at the same time • Combine an operation with inspection
Change sequence	Can this operation be switched with another one?	<ul style="list-style-type: none"> • Increase efficiency by doing a later operation earlier

2.3.Methods, Tools and Techniques

There are numerous methods and tools that may be used to address process improvement problems. All methods have similarities between them, as all depend on the current state of operation in order to focus changes.

2.3.1. Process Mapping

A process map is a pictorial description of activities or actions followed to deliver a product or service to a customer. It's a diagram that uses graphic symbols to depict the nature and flow of activities in a process (BalancedInstitutescorecard, 1996). Process map is essential in planning to collect data or implementing a solution (Bessant et.al, 2005). The process map may also be used to compare a new process with an existing process or to establish an 'ideal' process. In general the process map will aid in understanding the current operation procedures and also evaluating the future operating procedure.

Key factors to achieve success are (BalancedInstitutescorecard, 1996):

- Start with the big picture
- Observe the current process
- Record process steps
- Arrange the sequence of steps
- Draw the process map

Importance of Process Map(BalancedInstitutescorecard, 1996):

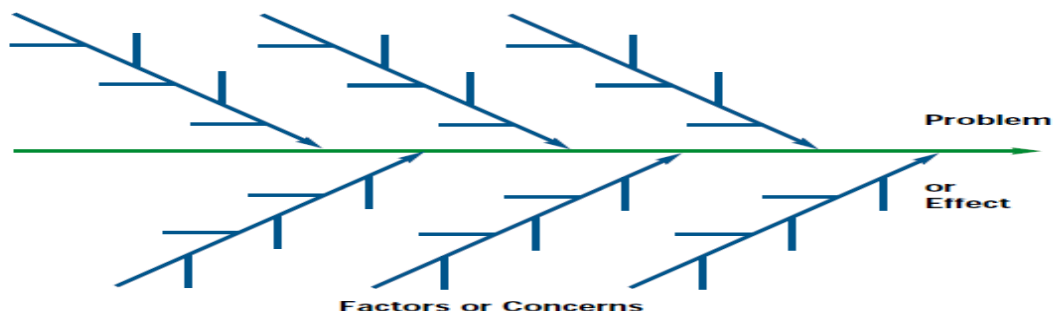
- It provides a better understanding of the process by providing a pictorial explanation of each and every step.
- Shows customer-supplier relationship, helping the process workers to understand who the customers are
- It can help train employees to work according to steps provided by the diagram
- Identifies problem areas and opportunities for process improvement

2.3.2. Cause and Effect diagram (Fishbone)

Fish diagrams were developed by Ishikawa in the early 1950s (Freivalds & Niebel, 2009). According to Freivalds & Niebel, 2009, a fish diagram entails defining an occurrence of typical undesirable event or problem that is the effect, as indicated as “fish head” and determining the contributing factors, that is, the causes, as “fish bones” attached to a backbone and the fish head. It generally explore the links between the effects and the possible cause of the problem (Bessant et.al, 2005)

The fishbone diagram/cause and effect diagram indicates all problems encountered in a facility, and divides the problems according to categories. For example, a delivery problem might be caused by problems from planning, manufacturing or even distribution. Most of the time, there are at least five to eight different categories, of which the categories may be further divided into sub-categories, until the problem is fairly understood in detail (Freivalds&Niebel, 2009). A general structure of a cause and effect diagram is shown in the figure below. It clearly defines the problem and indicates the factors that are responsible for the occurrence of the problem.

Figure 3 A general Fishbone Diagram (Freivalds & Niebel, 2009)



2.3.3. Layout Design

Layout design is one of the most important concepts in the facilities planning process, as the resultant layout chosen will determine the flow of materials and physical relationship between activities and departments (Tompkins et.al, 2010). Layout decision entails the

determination of placement of departments, work centres, the organization of jigs etc. (Chase et.al, 2009). General inputs for a facility design/ layout design are given below:

- Specification of the objectives
- Amount of space and travelling distance required
- Estimates of product or service demand on the system
- Processing in terms of number of operations and amount of flow between the elements in layout
- Space requirement for elements in the layout
- Space availability within the facility itself

There are different methods and procedures developed over the past years to address the layout decision problems. According to Tompkins et.al (2010), there are numerous layout procedures that have been developed to aid in developing layout alternatives.

The layout procedures as stated by Tompkins et.al (2010) are:

- Immer Layout Procedure
- Apple's Plant Layout Procedure
- Reed's Plant layout Procedure
- Muther's Systematic Layout Planning Procedure

Immer Layout Procedure: Immer indicates that changes should be made in small steps, and for every change made, there will be repulsion or resistance by the current users, as many may not appreciate changing from their normal way of doing things

Apple's Plant Layout Procedure: Apple acknowledges that there are no two layout designs which are the same, and there will always be backtracking to recheck steps already done.

The detailed sequence of steps followed in carrying out this procedure is:

- Procure the basic data
- Analyse the basic data
- Design the productive process
- Plan the material flow pattern
- Consider the general material handling plan
- Calculate equipment requirements
- Plan individual workstations
- Select specific material handling equipment
- Coordinate groups of related operations
- Design activity interrelationships

- Determine storage requirements
- Plan service and auxiliary activities
- Determine space requirements
- Allocate activities to total space
- Consider building types
- Construct master layout
- Evaluate, adjust and check the layout with the appropriate persons
- Obtain approvals
- Install the layout
- Follow up on implementation of the layout

Reed's Plant Layout Procedure: uses layout process chart as the most important tools for a layout process design. Required steps for planning and preparing the layout are given below

- Analyse the product or products to be produced
- Determine the process required to manufacture the product
- Prepare layout planning charts
- Determine workstations
- Analyse storage area requirements
- Establish minimum aisle widths
- Establish office requirements
- Consider personnel facilities and services
- Survey plant services
- Provide for future expansion

Muther's Systematic Layout Planning (SLP) Procedure: from-to chart and activity relationship chart, as inputs of data into the layout design process. A space relationship diagram will be developed from the charts, with alternatives being drawn after all the diagrams are complete. It uses an activity relationship chart as the foundation to gathering information in understanding the roles and relationships between activities and departments. A from-to-chart is used to analyse the material flow between activities or departments.

The charts used by SLP are:

- Activity relationship chart
- From-to chart
- Relationship diagram

2.3.4. Material Handling

Tompkins et.al (2010), defined material handling as the art of and science associated with the movement, storage, control, and protection of goods and materials throughout the process of their manufacture, distribution, consumption, and disposal.

Material handling is essential in the manufacturing industry, as according to Tompkins et al, material handling accounts for 25% of all employees, 55% of all factory space, and 87% production time. With that in mind, it will be important to consider the cost associated with that, as material handling represent between 15% and 70% of the total manufacturing cost (Tomkins et al, 2010).Improvements in material handling process will lead to a more efficient distribution flows.

Coyle et al (2005), gives a generalised objectives of material handling, which are

- Increase effective capacity of warehouse
- Minimise aisle space
- Reduce the number of times product is handled
- Develop effective working conditions
- Reduce movements involving manual labour
- Improve logistic service
- Reduce cost

In order to design new or improved material handling, some design steps should be followed. Below is the list that should be followed.

- Define the objectives and scope for the material handling system
- Analyse the requirements for moving, storing, and controlling material
- Generate alternative designs for meeting material handling system requirements
- Evaluate alternative material handling system designs
- Select the preferred design for moving, storing, protecting, and controlling material
- Implement the preferred design, including the selection of suppliers; training of personnel; installation, debugging, and start-up of equipment; and periodic audits of system performance

2.3.5. 5S Movement Method

According to Gitlow et.al (2009), 5S method is developed to promote good housekeeping practices. When 5S method is implemented, everything will be in place and there will be a place for everything. Impact of clearly implemented 5S method is to reduce inventory, reduction in order picking, a clean environment and a better relationship between

employees. The 5S-movement is derived from five Japanese words given on the table below.

Table 2 5S Movement (Gitlow et al, 2009)

Word	English word	Description
Seiri	Sort	Remove what is not needed and only keep what is needed
Seiton	Set in order	Place things in an order that they are easily reached whenever needed
Seiso	Shine	Keeps things clean in the work environment, no dirt should be lying around
Seiketsu	Standardize	Clean and maintain cleanliness, and help in the development of best-practice methods for your area
Shitsuke	Sustain	Self-discipline in adhering to the above mentioned elements and best-practice method

2.3.6. 5W1H Checklist

According to Ishiwata (1991), the 5W1H Checklist method is used to determine the roles of individuals along the process. It also focuses on the reasoning behind their roles, for examples, why is the individual responsible for products retrieval. The table also gives information on how the particular process is carried out.

Table 3 5W1H Checklist (Ishiwata, 1991)

Item	5W1H
Target	What
Operator	Who
Purpose	Why
Place or position	Where
Time or Period	When
Method	How

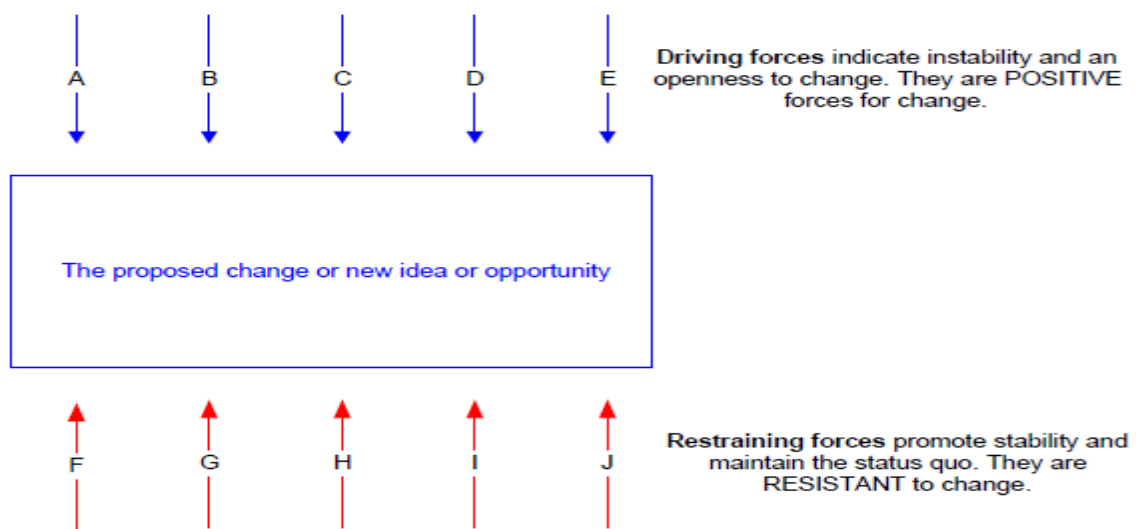
2.3.7. Force Field Analysis

Force Field analysis method involves the identification of factors that would either negatively or positively affect the implementation of solutions for a particular issue or a problem as indicated on figure 5. According to Gilbert, the method does the following:

- Present the positives and negatives of a situation so as they are easily compared
- Forces people to think about all aspect of making a desired change a permanent one
- Encourages honest reflection on real underlying roots of a problem and its solution

The aim is to derive the driving force behind change or resistance for that change.

Figure 4 Force Field Diagram (Gilbert, 2002)



2.3.8. Conclusion

There are still numerous more tools that can be used in process improvement as indicated on table 16 &17 in the appendix. The figures indicate the method and the type of problem is going to solve.

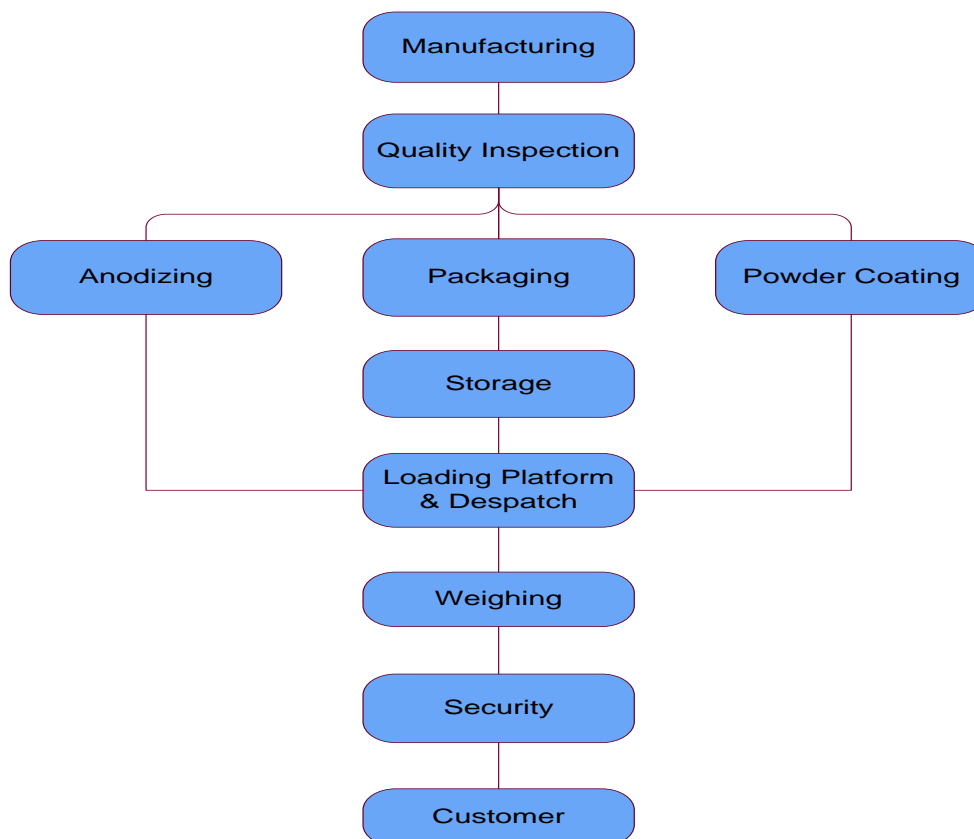
Chapter 3 Current State Analysis

3.1. Background

Wispeco uses a make-to-order system for the production of its products. A job-card is generated for every type of product ordered. The job-card specifies every detail about the component that needs to be produced. The manufacturing department will receive the job-card and prepare for production. After a production run, the manufacturing department will fill in information about production, i.e. the quantity produced, press information and the machine operator. A quality inspector will inspect if the products meet the specification agreed upon on the design.

The manufacturing stations are labelled EP1-EP5, as are their packaging stations which are labelled P1-P5. Packaged products are sent to storage, for temporary storage until a delivery truck is available. The figure 6 below shows the route followed by products to be delivered at the mill-finish products warehouse. As stated on the figure, powder coating and anodizing are to be taken their respective processing department, and will return to the warehouse during delivery.

Figure 5 General departments which Products move through



3.2.Process Flow

3.2.1. Documentation

Figure 20 in the Appendix B, shows the detailed process which the documentation flow in the distribution department follows. The documentation process for distribution begins at the packaging department with the packing information being filled in on the job-card. Packing information includes the packers' name and quantity rejected. A transfer clerk will verify the quantity packaged and acknowledge the number, quantity packed. A transfer slip will be generated, by the transfer clerk and attached to the job-card. The invoicing department will record the quantity electronically. Despatch manager uses the job-cards to plan distribution. Then products are retrieved from storage and the invoicing department will generate an invoice.

The security department approves the delivery documents before the truck exit the company for delivery. The customer will verify the amount then sign the delivery note upon goods being received. Quantity short or any damaged products are indicated on the delivery note. Any complaints after delivery, will be investigated and approved by the planning department, then filled into a complaint form. The complaints manager at Despatch will retrieve the order invoices, and then credit the return of the products.

Documents generated and their roles are shown on table 4.

Table 4 Documents used at Distribution Department

Document Name	Description
Job-card	<ul style="list-style-type: none"> Generated by planning department, and has order manufacturing details, which will be used by manufacturing department
Factory Transfer to Finished Goods	<ul style="list-style-type: none"> Summarise product information during transfer from packing to storage
Tax Invoice (Blue)	<ul style="list-style-type: none"> Contain tax details for the order and will be kept by the Wispeco
Delivery Note (Pink)	<ul style="list-style-type: none"> Serves as invoice during delivery and kept by the company as proof of delivery. It will be used as proof of delivery
Customer Invoice (White)	<ul style="list-style-type: none"> A copy of the delivery note/invoice that is kept by the customer

Delivery Note (Green)	<ul style="list-style-type: none"> • A note kept by security at the gate
Tax Invoice (Yellow)	<ul style="list-style-type: none"> • Contains tax details and is kept by customer
Complains Form	<ul style="list-style-type: none"> • Fills in details of the customer's complains
Load Schedule	<ul style="list-style-type: none"> • Generated by the company, indicates the amount of orders per customer to be delivered.
Route Schedule	<ul style="list-style-type: none"> • Generated by the driver to indicate the sequence of customers, i.e., determine which customer will be first on the list. A copy is kept by the company

3.2.2. Material Flow

Figure 21 in the Appendix B, clearly shows the pictorial representation of the process followed by the products until delivery. Material/Product flow for distribution will began with the completion of the quality inspection process. A transfer clerk will sort out products, which are going for further processing at the powder coating and anodizing department. The following colours are used to differentiate the products going for further processing from the other products.

Table 5 Powder coating and Anodizing colours

Colour	Department
Blue/Purple	Anodizing
Yellow/Lemon	Powder coating

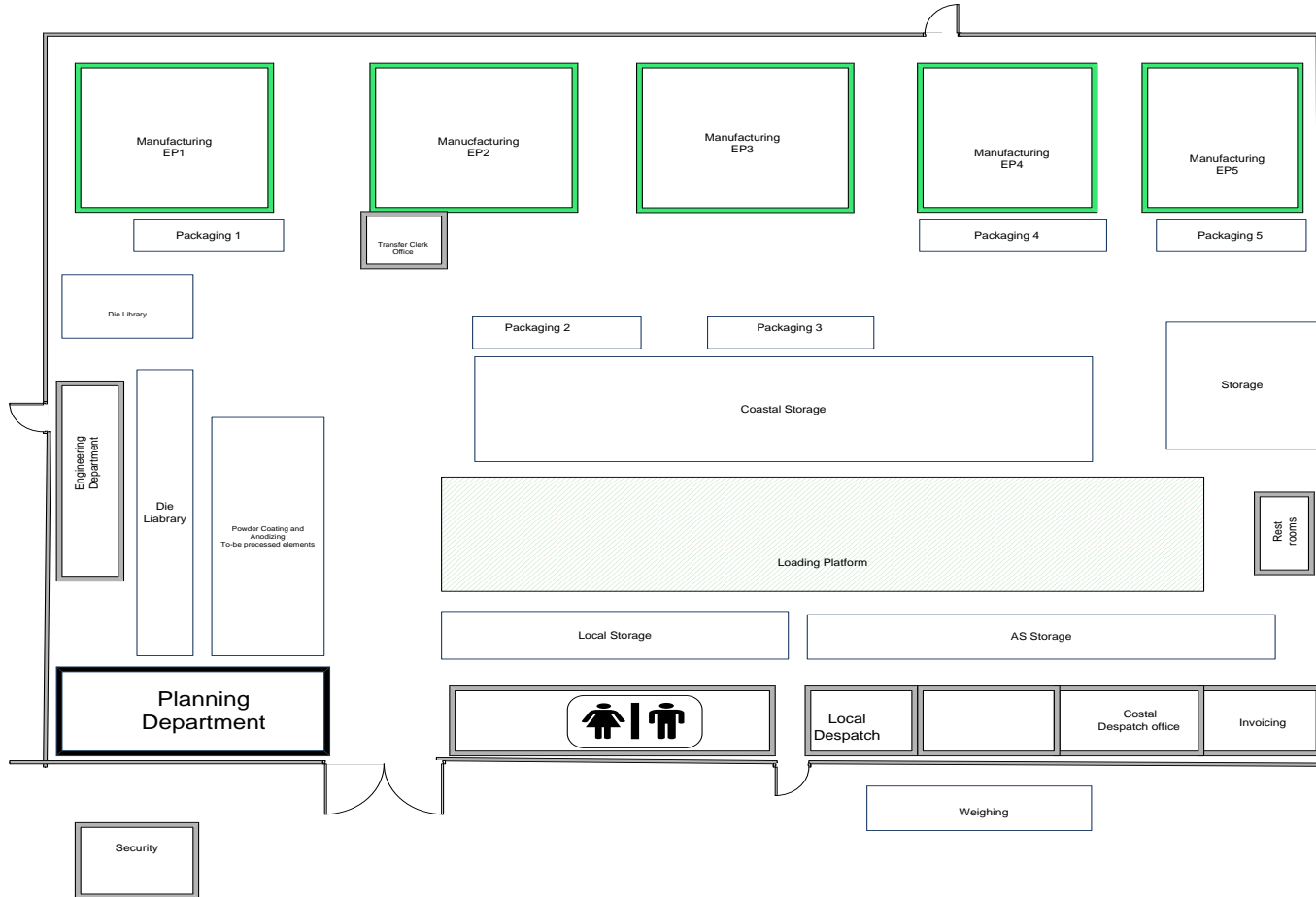
The remainder of products will be taken to the packing along the same manufacturing line. The products from the anodizing and powder coating departments are temporarily stored until the products are invoiced, then sent to the respective departments. Products will be sent to storage then later retrieve during order preparation and delivered to customers. Returned products are inspected as to investigate the nature of damage. Standard products not damaged are taken to storage. Products that were produced according to a particular customer's designs will be checked in order to see if it could be reused in future. Damage products are invoiced and then sold to the remelting department.

3.3. Layout Analysis

The figure 6 below depicts the current layout of the warehouse. All manufacturing machines are aligned to the rear end of the building. Coastal goods are all stored at the same point near packaging. All coastal products are stored at the same point no matter which area of the coast are to be delivered. Security offices and weighing departments are all situated on the outside the warehouse premises. All storage areas surround the loading platform. The

transfer clerk's office is situated next to packaging 2 or EP2. Anodizing and powder coating storage area is located next to the entrance near die library.

Figure 6 Current Warehouse Layout



3.4. Departments and their roles

Using the 5W1H method, departmental roles and responsibilities will be investigated with respect to their roles in distribution operations.

PACKAGING

The packaging department is responsible for packing the products and wrapping them with a plastic cover and labelling the packets. Products are packed in group of the similar products, depending on the type of product. Packet size ranges from as little as two products per packet to as many 20 per pallet. A colour tape is used to wrap around the packet to identify its area of destination.

Below are the different colours, used by the packaging department to indicate the destination area of the packets

Table 6 Colours Used at Packaging

Colour	Region
Red	Local
Blue	Durban
Green	Cape Town
Gold/Yellow	Eastern cape
Black	AS stock

Packaging department also has to fill in the job-card, the quantity of products that have been packed and also the number of items per pack. The packers should also include their names and a sticker indicating their department, for example a sticker with P1 indicating packaging 1.

PALLETIZING

The pallet being used to handle the products is called a stripping, and also shown on figure 7 below. The capacity constrain for the pallet will depend on the product type, but the main rule is, don't fill the pallet until it reaches the forklift carry handle. The packets of products are placed into the stripping. Only products with the same destination point should be stored in one stripping. The stripping has a width of 65 cm and length of 450 cm. Products are taken out of the stripping during the loading period.

Figure 7 A stripping

TRANSFER

The transfer department's role is to approve the amounts that have been packaged. The transfer clerk has to move from one packaging station to another, collecting all job-cards and approving the packed quantity. A pink 'transfer of goods' slip is generated and attached to the job cards, and sent to the invoicing office. The transfer clerks also have to verify and approve the quantity of goods going to the powder coating or anodizing departments. The clerk will add a sticker to help the forklift driver identify the products. All products are transferred with the aid of a stripping which acts as some form of palletisation. Forklift driver will take the strippings to storage.

STORAGE

Storage areas are meant to help in temporarily storing the products while waiting for delivery vehicle. The company uses a make-to-order system to manufacture its products, which means normally the company doesn't have much in storage as the products being produced are quickly shipped. Products that spend sometimes in storage are coastal orders, which have to wait until a truck load is attained. Products in AS storage also spend a lot of time, as this products came to the storage area as a result of over producing or return of some products.

Products are stored in their strippings, as that helps the forklift driver to stack them. Storage areas are divided into coastal storage, local storage, AS storage, and powder coating and anodizing storage.

Figure 8 Products stored inside the strippings



The storage area should also supply space for coastal orders back coming from anodizing and powder coating to be delivered, as the products need to be temporary stored while loading schedule is being sorted out. Strippings can only be stacked up together to 5 or 6

high, as more than will be risky. The forklift also can't reach the necessary height to retrieve items from that height.

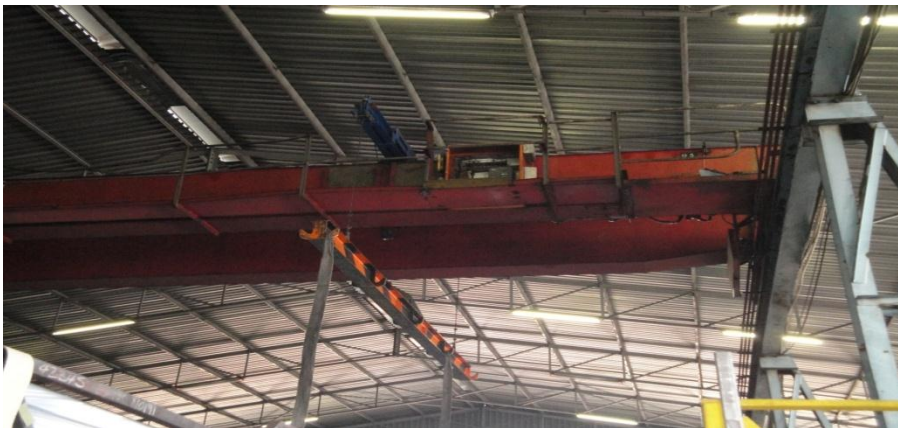
DESPATCH AND LOADING

The duty of the despatch department is to schedule delivery and organise delivery vehicle. Tonnages of the products are summed up and the total weight determined. Products inside their pallets are arranged on the floor with the invoice on top of every stripping.

Trucks for coastal regions are chosen according to their capacity and available load. After loads have been calculated, the products are retrieved from storage and arranged according to the trucks that are to be loaded. The driver will approve the quantity before loading the truck.

Products are loaded according to their destination, e.g. the last destination's order is placed at the bottom during loading. The driver will also generate a route schedule that indicates the sequence of customers

Figure 9 One of the Overhead Cranes used at the loading area



INVOICING

Job-cards are taken to the invoicing clerk to be invoiced before delivery. As the clerk invoices the products to be delivered, the system will automatically subtract the quantity to be delivered from storage. The clerk also generates a loading schedule that will be used during loading. All invoicing documents, as mentioned earlier, are generated. Customer's financial status is also checked before loading.

SECURITY

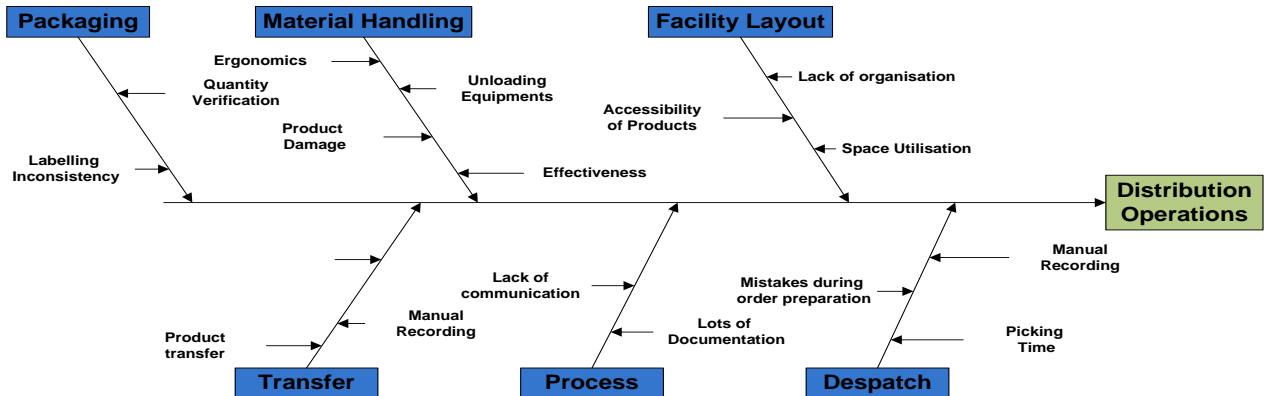
Security approves the quantity and type of products leaving. The security office is situated at the gate.

Chapter 4 Data collection & Analysis

4.1. Problem Overview

There are numerous problems encountered currently with the distribution operations. There are numerous factors that cause the problems, and these factors are summarised in the fishbone diagram below.

Figure 10 Cause & Effect Diagram for the Distribution Operations



From the fishbone diagram above, it could be deduced that almost all departments play a role in the ineffectiveness of the distribution operations. To elaborate on the problem stated in the fishbone diagram, below will discuss them in more details

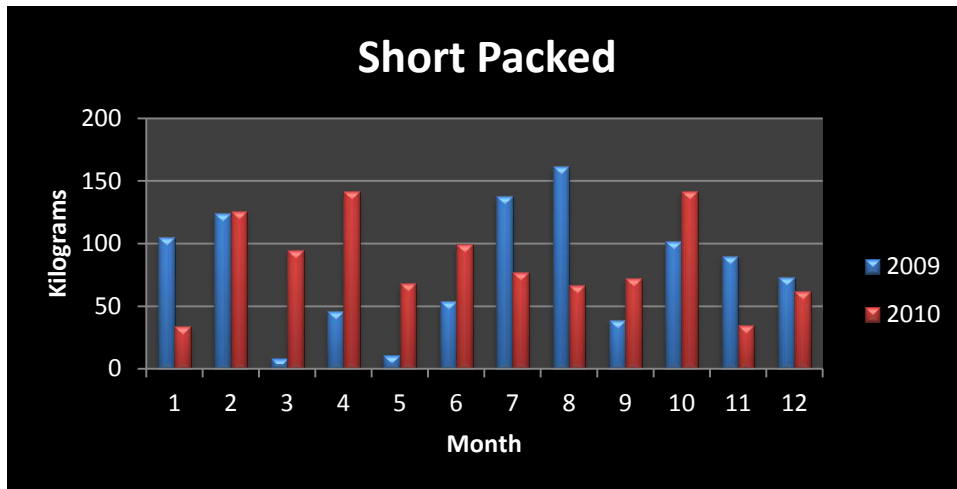
4.2. Departmental Analysis

Packaging

Labelling: The packaging department lacks consistency and clarity in most labels being done. Some of the labels are not clear enough for the picker to interpret from a distance.

Quantity verification: The packaging processes continuously produce packed products where the wrong quantity of products is placed into packets. Figure 11 clearly shows the total amount of short packed products done in the past two years. 2011 figures were not included as most of the information was not recorded as the warehouse manager was on a sick leave for some months.

Figure 11 Short Packed Products



The figure clearly shows that short packaging is clearly a problem for the company as a lot of kilograms of products are short packed. On average, 2010 had a lot of short packed incidents. The figure above clearly shows that the trend of short pack incident doesn't decrease with time, indicating that it will continue to cost the company lots of money.

Transfer

Manual recording: The transferring of goods is recorded manually, and as compared to production and demand increase, this results in a lot of paperwork.

Product transfer: The transfer department doesn't oversee that the recorded quantity of products goes to storage. This activity result in products going to wrong departments, for example products which are sent to anodizing instead of powder coating.

Process

Lack of communication: Most of the time departments perform their duties in isolation because communication between departments is not as strong as it should be.

Lots of Documentation: There is a vast amount of documentation being done or recorded at every stage of order processing.

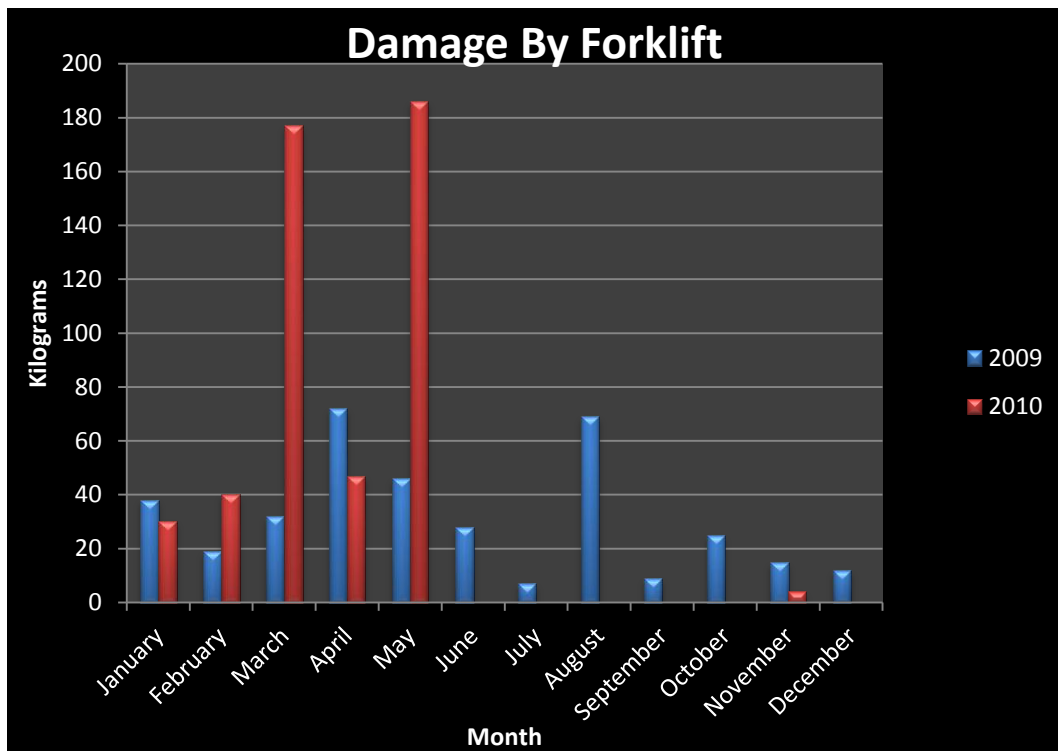
Material Handling

Offloading equipments: There is often a lack of equipment required for the offloading of material at the customer. This results in manual labour, where workers have to offload the goods and transfer the goods to storage shelves. This will influence/affect the company's operations and ergonomics.

Effectiveness: Wispeco’s forklifts are only front loaders, i.e. all forklifts can only carry load in front. As a result of limited space, the forklifts are not effective in some case. The drivers try to push the loads across the floor when a side loader is needed, but it is still no a safe exercise.

Product damage: The current material handling equipments has resulted in more reported product damage incidents. Figure 12 below clearly shows the quantity of material lost internally as a result of forklift damage.

Figure 12 recorded Product Damage from Internal Csutomera



Facility Layout

Lack of organisation: Storage areas are not well organised for easy storage and retrieval of products.

Product Accessibility: Products are not readily accessible and the despatching department has to spend time searching for a particular product.

Space utilisation: Some goods and other materials are place randomly across the storage area and that affects the utilisation of that specific area.

Despatch

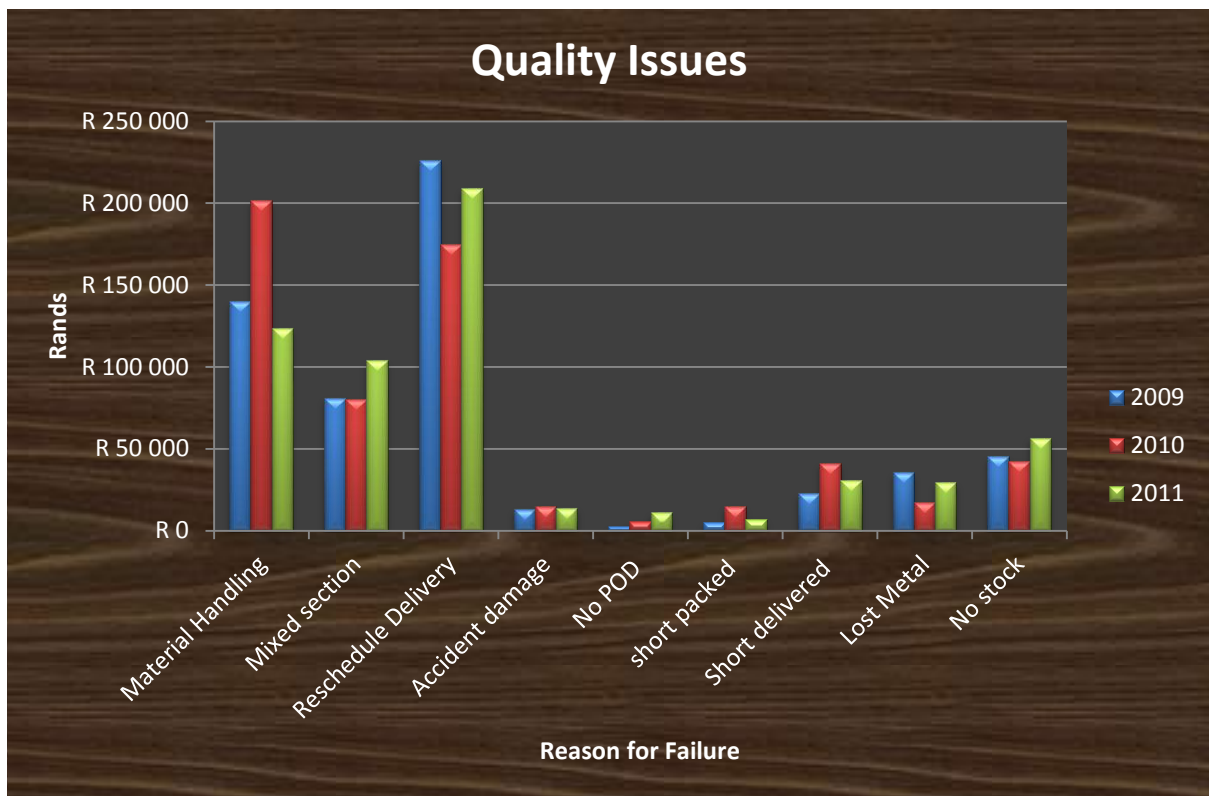
Picking time: The time spent picking products is greater as the storage area is not organized properly to minimize the time

Order preparation: There are numerous errors occurring during picking and loading of the customers' orders.

Manual recording: The despatch department records all the trucks going for loading manually in a notebook.

To summarise the problems experience by the distribution operations of Wispeco, the figure bellow shows all factors causing the distribution operations to fail. The extent of damage is measured in monetary value.

Figure 13 Average Annual Quality Cost



As it could be seen from the graph that material handling and rescheduling delivery accounts for a higher percentage of money

Chapter 5 Future State Analysis

5.1. Systematic Layout Planning Analysis

As it was already outlined, in order to design or improve a layout in Muther's Systematic Layout Planning, an activity relationship chart is needed. The chart will evaluate the necessity of departments being closer to each other. The chart on figure shows that relationship between departments.

Figure 14 Activity Relationship Chart

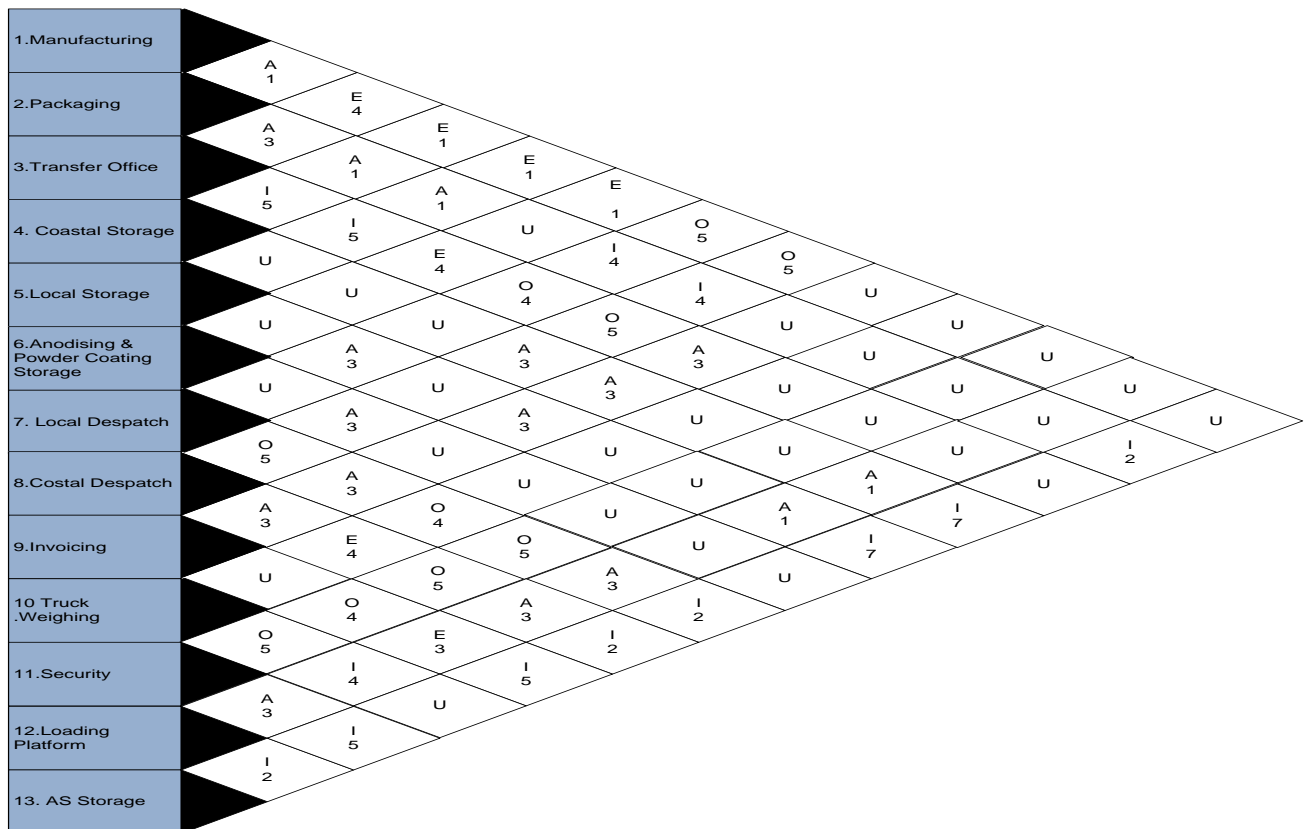


Table 7 Value of Closeness

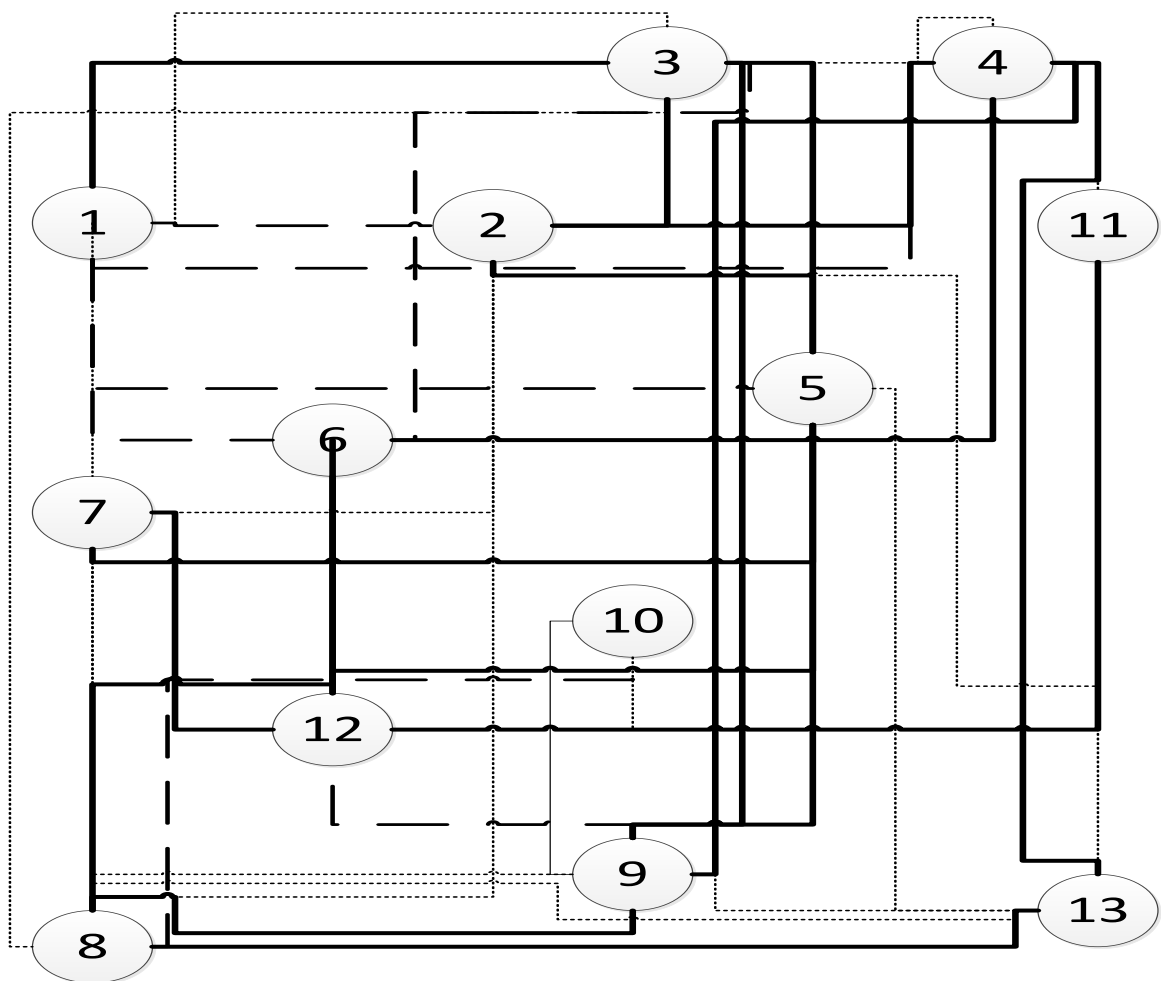
Value	Closeness	Line
A	Absolutely Necessary	————
E	Especially Important	— — — —
I	Important
O	Ordinary Closeness	
U	Unimportant	

Table 8 Reason for Closeness

Code	Reason
1	High Flow of Material
2	Low flow of Material
3	High Flow of Information
4	Medium Flow of Information
5	Low Flow of Information
6	Safety & Security
7	Same Personnel

The relationship chart shown below shows the same information that was indicated on the activity relationship diagram, but only this time the relationship is shown by means of lines between departments. Departments which are ordinarily close or it is unimportant for them to be closed, their relationship lines are not indicated.

Figure 15 Relationship Chart



5.2. Layout Alternatives

Three different layout alternatives were generated as possible solution for the new layout. In all alternatives, different arrangements were done while attempting to keep the cost low. Because of the cost factors the loading platform will not be changed as that will significantly increase the cost. The Offices may be moved by only moving the functionality in the room and not the room itself as that may result in incurrance of unnecessary cost, which will in turn significantly increase the cost. For all layout alternatives, the storages are divided into sections. For simplicity and to decrease confusion, every section of the divided storage will be coloured in the same colour that correlates to the colours used in packaging. The division of the storage areas into different areas will help a lot with product accessibility.

Table 9 Different Colours for Storage Areas

Colour	Storage
Gold	Eastern Cape
Green	Cape Town
Blue	Durban
Red	Local
Purple	Anodizing and Powder coating Products

5.3. Alternative 1

Changes made

- Storage areas are segmented into areas which the order will be delivered at
- Transfer department is placed in between Durban and Eastern Cape storage areas
- Durban, Cape Town and Eastern Cape storage areas are placed in between packaging and loading
- AS and Local storage areas maintain their current positions
- Anodizing and powder coating are subdivided

Figure 16 Alternative 1 Layout

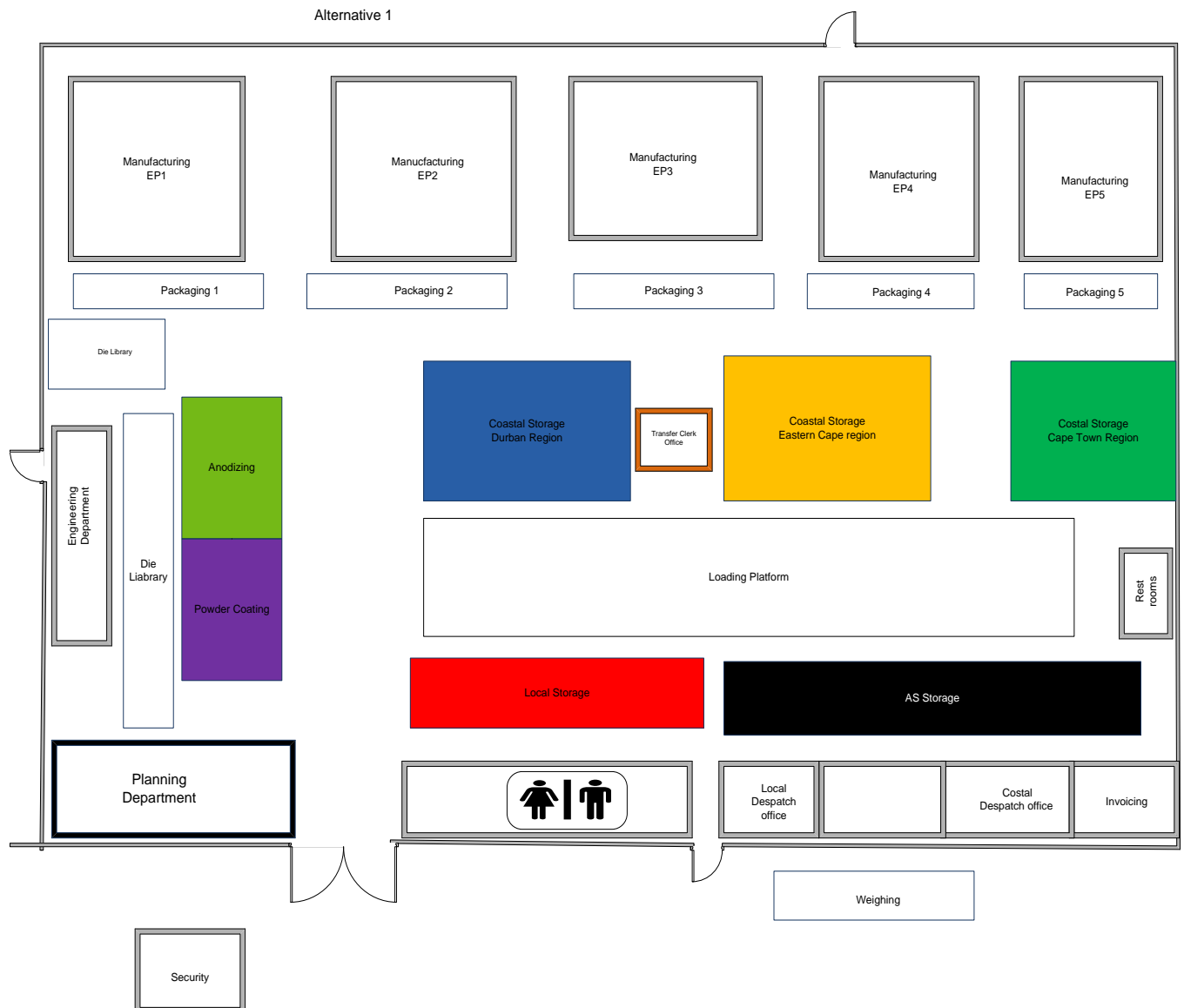


Table 10 Advantage & Disadvantage of Alternate 1

Advantages	Disadvantages
Sorted out storage system	Transfer office in between two storage areas might be a safety issue
Transfer office closer to storage and other related departments	It will take a lot of time to pack every product into its area
Ease in product accessibility	Transfer office may interfere with forklifts operations

5.4. Alternative 2

Figure 17 Alternative2 Layout



Changes made

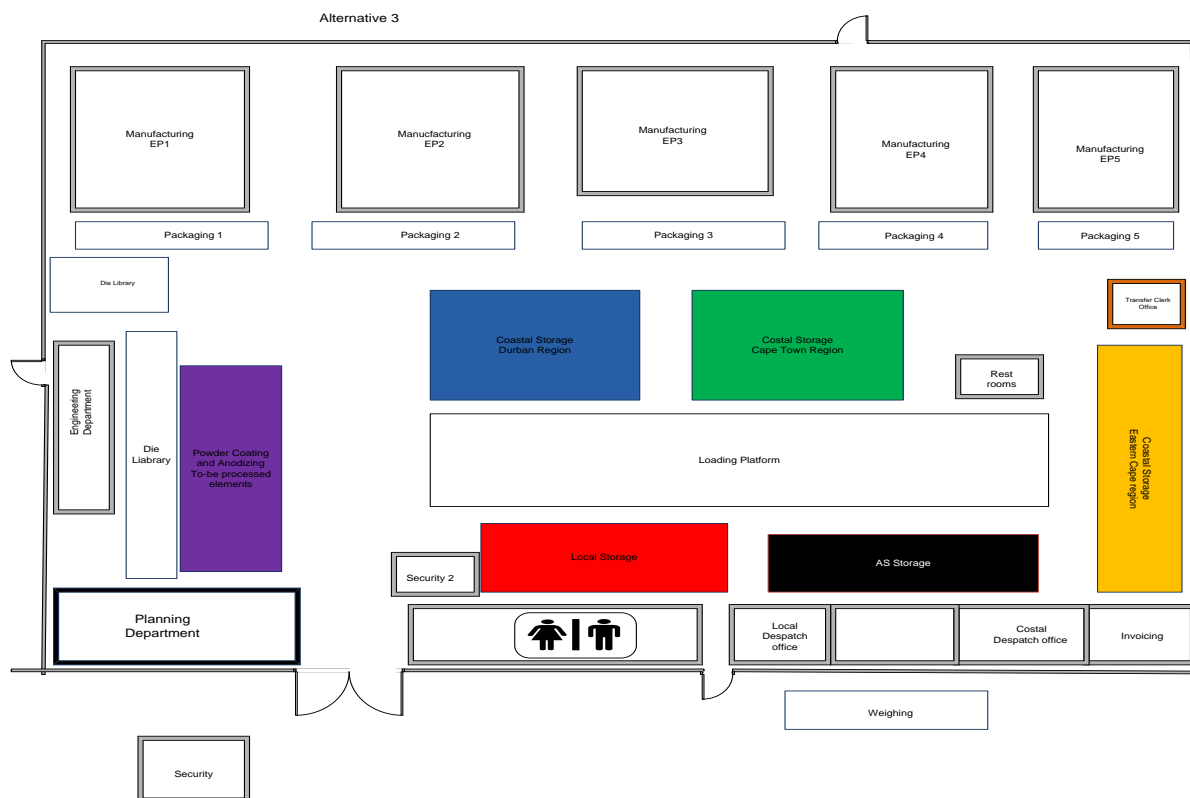
- Security desk included within the warehouse
- AS storage moved to side, place against the warehouse wall
- Transfer office place against the wall between EP5 packaging and AS storage
- Rest rooms placed adjacent to the transfer office
- Eastern Cape storage will be placed next to local storage
- Anodizing and Powder coating product storage moved closer EP1 to create space for security desk

Table 11 Advantage & Disadvantage for Alternate 2

Advantages	Disadvantages
AS storage moved away from loading platform so as not to interfere with loading	Introduction of security might take over space needed for storage
Transfer office in a good position to observe the operation between packaging & storage	No space assigned for product returns
Product security is improved with introduction of the security desk	Anodizing and powder coating storage mix into one

5.5. Alternate 3

Figure 18 Alternate 3 layout



Changes Made

- Security placed by the door next to local storage
- Eastern Cape storage area placed against the wall
- Transfer office placed between the Eastern Cape storage area and EP5 packaging

- Rest room placed next to the Cape Town storage area

Table 12 Advantages & Disadvantages for Alternate 3

Advantages	Disadvantages
Security desk closer to the entrance	Rest room too much into the warehouse and will interrupt normal forklift duties
Transfer office in a good position to oversee the transfer between packaging and storage	Security desk will affect the operations at the local storage area

5.6.Evaluation of Alternatives

5.6.1. Weight Factor Comparison

Weight factor comparison method compares facilities planning alternatives for each factor (Tompkins et.al, 2010). A numerical score is assigned to each alternative based on its performance against particular factor, then multiplied by weights then summed for every factor until a total weight score for each alternative is obtained. Table 13 given below contains comparison factors that were generated based on information from the company. The factors are based on the company's objectives about the new improved layout.

Table 13 Factor of Comparison

Number	Factor of Comparison
1.	Feasibility of the new alternative.
2.	Space Utilisation
3.	Maintenance
4.	Flexibility
5.	Ease product movement
6.	Cost of Alternative
7.	Ease for future expansion
8.	Product Accessibility
9.	Integration with other facilities
10.	Supporting Service needed
11.	Product Security
12.	Risk of damage

The factors stated on the table will be used with the weighted factor comparison method below.

The form used to evaluate the alternatives is given on table 14 below. The weights given on the form are determined with respect to what the company wants to achieve out of the new design. Weights are given a score out of 10. Alternatives are rated also out of 10, and this value will indicate how a particular alternative performs with respect to a particular factor. The scores will be calculated as the weight multiply by the rate for those alternatives. At the end the score calculation for each factor, a sum of the score is taken for all factors. The alternate with a higher value will be considered.

Table 14 Weighted Factor Comparison Form

Factor	Weight(/10)	Alternative 1		Alternative 2		Alternative 3	
		Rt (/10)	Sc.	Rt (/10)	Sc.	Rt (/10)	Sc.
1	10	8	80	9	90	7	70
2	9	6	54	9	81	6	54
3	7	8	56	8	56	8	56
4	8	7	56	8	64	8	64
5	9	9	81	9	81	7	63
6	9	8	72	7	63	7	63
7	8	7	56	9	72	8	64
8	10	10	100	10	100	8	80
9	8	9	72	9	72	9	72
10	9	8	72	8	72	8	72
11	10	5	50	9	90	9	90
12	8	9	72	9	72	9	72
Total			821		913		820

The calculations done on the figure above reveal that alternate 2 is better option as compared to the remaining alternatives, because its total score across all the factors is greater.

Chapter 6 Solution and Recommendation

There are numerous solutions the company should consider. The solutions will be divided into departments and sections for clarity purpose. The solutions found will help attain the objectives stated in chapter 1.

Visual Management

- As stated earlier, storage areas will be segmented into regions, depending on destination. Visual management will help in this regard. Colours and big posters will be used to inform employees the location of products. A summary of the colours used by the packaging department will be displayed in board near the department so that any new employee can easily learn the packaging process.
- Packaging instructions should also be included but on a separate poster. The instructions should summarise the general packaging steps, including all necessary safety steps. To make the instruction poster more reader friendly, pictures of every step with short explanation should be used.

Table 15 example of a Poster for Packaging

Destination	Colour	Example
Durban /KZN	Blue	
Cape Town/ Western Cape	Green	
Port Elizabeth/Eastern Cape	Gold	
Local	Red	
AS stock	Black	

Layout Design

Alternate 2 have been chosen as the best. The performance of the chosen alternative will be evaluated based on the factors from table. The floor should be painted with the colour of the product that will be stored at that particular area. If that is not possible, posters hanging from the roof should be used to indicate the different regions. Pillars should also be used to show the boundary of each region.

Packaging

Constant labelling should be done by packaging. The label placed on every pack should summarise the order details and should display them in a larger font size. An example of the labelling slip is given below.

Figure 19 Example of Labelling Note

Customer Name	Dewald Doors
Product Code	484745KWR
Quantity	25*6000
Factor Order No.	4538
Date Packaged	7/09/2011

Transfer Office

The transfer clerk will have the following responsibility

- Verify the amount packaged by the packaging department correlates to the one on the label
- Approve the transfer of goods to storage on the job-card
- Enter quantity to be transferred and location of goods in the storage area in to the system, e.g. if the space of Cape Town is full and goods are placed on Durban's area, it should be indicated
- Inform the forklift driver as to the destination of the transferred goods
- Collect all job-cards from the respective packaging points and hand over to invoicing department
- The pink transfer slip will no longer be used; the job card will be modified by adding the rack allocation part on the card.

Storage

- All products should be stored in their respective area unless otherwise approved by the transfer clerk.
- All returns will be handled towards the end of the loading platform
- All returned goods will be temporarily stored at the loading platform next to the Durban area, until approved to either go back to storage or re-melting
- Labels to indicate the storage area should be hanging over the product so everyone can see it
- The same stickers should be used to indicate products ready for delivery

Loading Platform & Despatch department

- During the staging process, strippings should be arrange according to the area to be delivered then customer name
- Despatch manager should update the system when products are loaded and are about to be shipped

Security

- The should be security officer during loading to approve the amount being loaded
- The security officer should also approve products going anodizing and powder coating
- The officer should sign, together with the truck driver; to indicate that the amount loaded corresponds to the quantity on the invoice
- Product returns should also been overseen by the security

Material Handling

Customer

Wispeco should suggest to all its customers to purchase at least a trolley, to be used during offloading. Currently offloading is done by hand, and products are taken from receiving point to the shelves by Wispeco's workers, which give rise to ergonomics factors and time consuming.

Figure 20 Example of trolleys in Demand



The figure above shows the example of the trolley needed. The trolley should be flat based trolley and able to accommodate products with length of 7m. The trolley will be used to transport offloaded products in batches from point of arrival to storage or shelves, which will save both companies time. It will help workers to work without them being strained out because of weight over their shoulders.

Products will still be offloaded by hand from the truck because installing hoist at every delivery truck might be a costly exercise because the company have a lot of delivery trucks. The current offloading method doesn't cost the company lot of money as compared to installing new hoists on the trucks.

Company

The company should consider acquiring a new side loader or stacker in the near future, to assist the forklifts with loads moving across the floor and when there is a limited space available.

Figure 21 an Example of a Side loader needed.



The side loader as compared to the forklift can work in a limited space area because of its smaller body structure. As it can be seen from figure 21 above, side loader carries loads on its side and takes load of across the floor.

Information System

An information system is recommended for the distribution department. It will increase product security and improve communication.

Transfer clerk:

- Enter the quantity of products being transferred to storage. This will eliminate the need for the pink transfer slip.
- Enter storage location of an order within the warehouse, this should be done manually on the job-card and on the system
- Approve all quantities coming into the warehouse.

Despatch:

- Will use the system to check which order is ready for delivery

- Will approve all product leaving storage for delivery by subtracting that quantity electronically
- Record the list of internal and external trucks on delivery, and will be used at the end of the month to check the quantities delivered by an external truck per month.
- Records all trucks information on the system.

Warehouse Manager

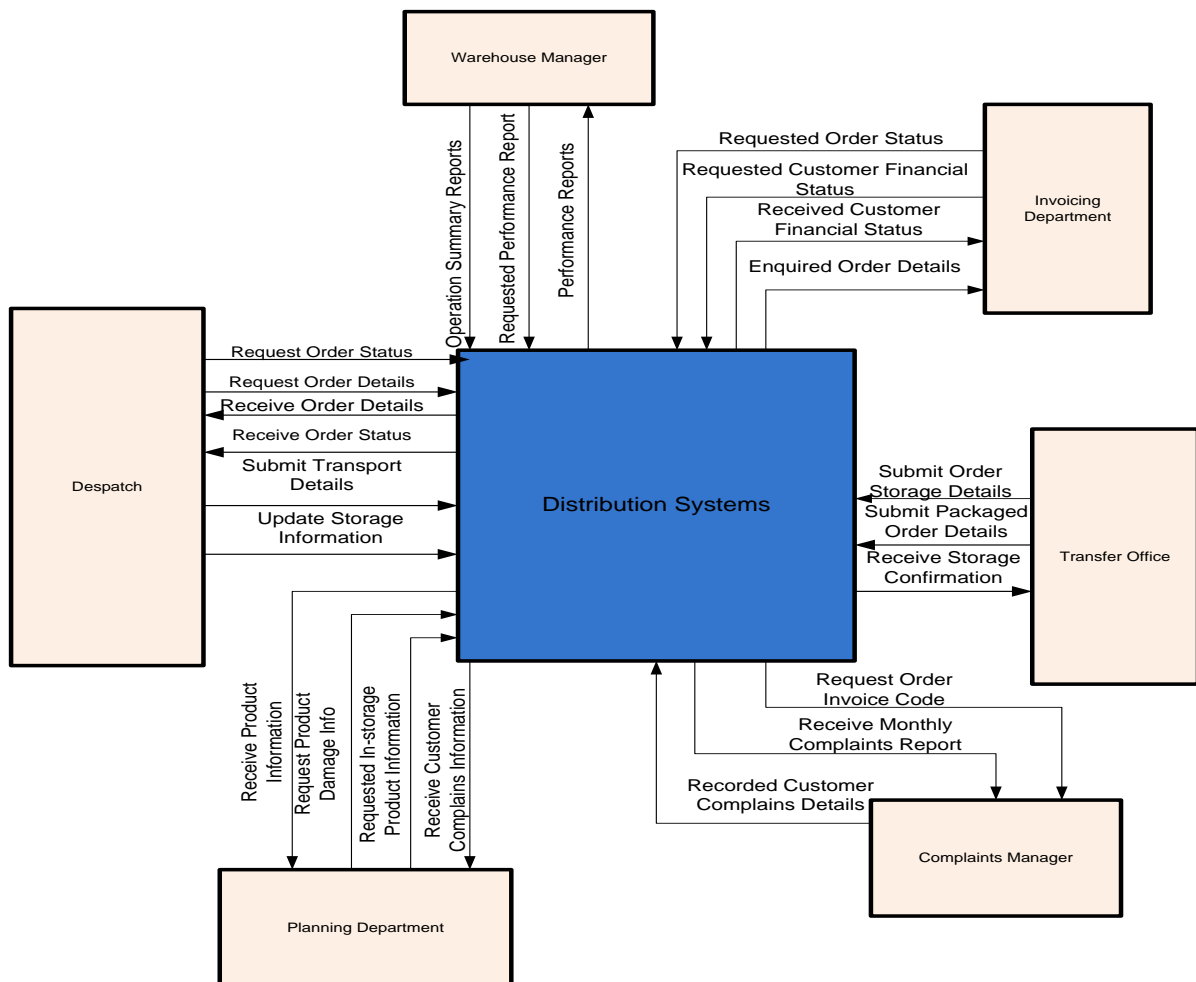
- Request performance report
- Operations summary report

Invoicing

- Request customer financial status
- Check order status

The figure below summarised what the system will be used for by the staff. It shows the data flow between staff and the system.

Figure 22 Context Data Flow Diagram



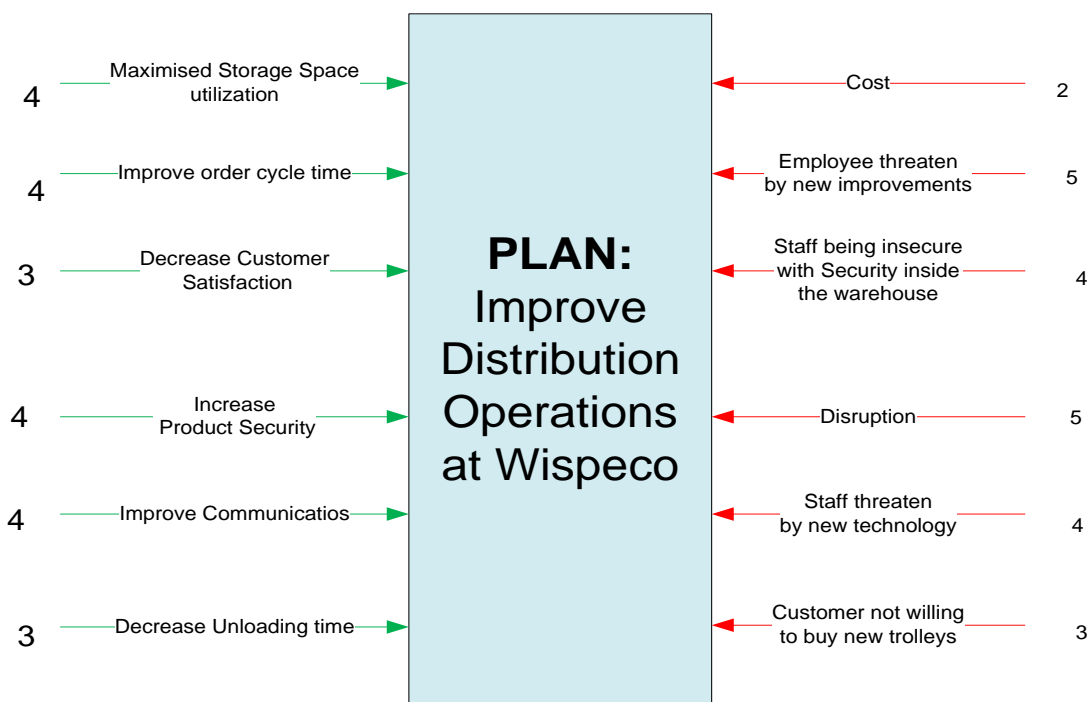
Chapter 7 Implementation and monitoring

Wispeco will need the company to continuously monitor their operation and determine if the solutions' performance are upto standards or there is a need for further improvements.

7.1. Implementation Plan

Since this implementation involves changing what people are currently doing, a force field analysis will be important to do as it will alert us of some possible resistance from people. The force field diagram is given below, indicating all valid reason for implementation and the resistance that may occur. The factors on the diagram are rated out of 5, evaluating the impact of those factors.

Figure 23 Force Field Analysis Diagram



Using this method we should decide whether the plan is viable. Ratings are given for every factor, positive and negative. The current ration of force field analysis is 22:23, and that means that negatives factors slightly overpowers the positives of the improvements. To solve the problems,

- Training on using the new layout and information system will be provided, but that will increase the cost slightly, by +1. So cost will be at 3. Employee's adaption to improvement and new technology will decrease by -3 to 2&1, respectfully.
- Explanation could be done to workers on how the changes will help the company meet their demands and increase sales, that will result in an additional force added to the positive side, that will be called employee motivation, and it will rate 4

- Employees can be shown that this new improvements will results in interesting jobs created, a new force of favour for the new solution with a rating of +3, will be introduced.

The above scores will lead to a ration of 27:18, and then the solution could be easily implemented as the positives outweigh the negative.

All the resistance indicated on the diagram need to be sorted out before implementing the solutions. To get the solutions implemented is either there is decrease of the negative resisting factors or an increase in factors supporting the implementation of the solution.

Implementing the above mentioned solutions should be done with full corporation of the employees concerned. It is essential that the improved systems being implemented in parallel with the old system for some period until the point whereby the employees are fully aware of the new system.

- Improving packaging operation will be the first on the list. This should be easy as it only involves erection of packaging instruction poster and different colours used in this department.
- The layout change will follow, because everything revolves around the layout change. This should take about a month tpo change from the old system. The floor should be repainted, a gold/yellow line should be used to show the safe area which employees or visitors can walk within, when they are inside the warehouse. Labels should hang from the roof, above the respective storage with the name of the area, indicating different storage areas.
- Departmental office movement should atleast be done as soon as the layout change has been implemented. Security desk will be introduced into the warehouse and transfer clerk office should also be moved to the new location.
- After everyone has been moved, computers should be allocated to the transfer and despatch department. A new information system will be placed into operation. The new system should not be run on isolation but should be ran together with the old system to facilitate a smooth transition.
- Customer Relation Management can be established on the new information system

7.2. Resulting Improvements

Order cycle time

A significant decrease in order cycle time, because the new layout divides the storage area into section, making it product much accessible. Since the order cycle time formulae is given as:

$$\text{Order picking time} = \text{order processing time} + \text{interlocation travel time} + \text{pick - uptime}$$

The inter-location travel time and the order processing time will decrease significantly. Previously, for a coastal order, the picker had to go through all coastal orders in storage to come up with the needed order. The new layout help the picker to focus only at the area which order is placed, and that means the picker wouldn't go through the rest of the coastal products, i.e. $\frac{2}{3}$ of the coastal products.

Therefore the new inter-location time will be,

$$\text{interlocation time}(\text{new}) = \frac{1}{3} \text{interlocation time}(\text{old})$$

And that will yield to a decrease by $\frac{2}{3}$ of old interlocation time from the total order cycle time.

Storage Space Utilization

The utilization of space will be maximised because everything will be sorted into categories, and no products will lie across the floor. The new layout will help in this regard, as all products are sorted. The recommended information system will help planning department to be aware of the availability of products on the storage floor, so as production can only be undertaken only if the available products are not sufficient. The information system will contribute to maximising storage space as products which have been on the A.S. storage for a while could be noticed and used up during order processing or be sold to remelting when the time is right. This will insure that there are few products at AS storage area, meaning there is an extra storage space that could be used by other storage areas to store their products if the need arises.

Product Security

Introduction of the security desk inside the warehouse will definitely increase product security, because the security officer will be verifying every product leaving and entering the warehouse. This will also decrease the number of reported cases of in-short items at the point of delivery at the customer's site. The security officer will decrease the amount of extra metal that might be willingly or mistakenly leave with the delivery trucks, as the security

officer will be present at the point of loading of the products, verifying both the type of product and quantity being loaded.

Unloading time and techniques

If customers are encouraged to buy the trolleys as mention earlier, this will decrease the time workers spend offloading and carrying product to storage. The trolley will speed up the unloading process. Also, the ergonomics factors that arose when workers have to carry products on their shoulders at the customer's site will be addressed by introduction of the trolley.

Other Results

The communication between departments will improve with the new layout and information system. Right quantity, right quality, right products at the right time will be delivered to customers, and this result with an increase in customer satisfaction.

Summary

With all the changes been done, here is the summary of how things will look.

- Two-thirds of the old order processing time is saved
- The new layout will utilize 90% of the storage areas
- Improved communication results in less errors been done.
- Decrease in cases of product loss due to the improved products security
- Decrease in storage goods because the new information system makes the planning department be able to access storage information much easier before scheduling production of an order

7.3. Monitoring

7.3.1. Records

Warehouse manager should record the performance of every department within the distribution operations. For simplicity purpose, the warehouse manager might issue instructions to line managers to keep records of events. As for the order processing time, it should be done randomly , but not every event.

7.3.2. Customer Experience Management

According to (Meyer & Schwager, 2007), companies should systematically monitor the experience the company's customers have about the product or services provided to them.

The customer experience will be necessary in taking future important improvement steps, so as the customer can be offered the best products or service.

It will be essential for Wispeco’s distribution department to get the customer experience encompassing all aspects the company offers. For example, to determine their experience with the company’s packaging methods, ease of use, the quality of their customer care and the general service delivery. The customer experience will be essential to determine customer satisfaction. According to Meyer & Schwager,2007, “customer satisfaction is essentially the culmination of a series of customer experiences, i.e. the net results of the good ones minus the bad ones.” Customer satisfaction only occurs when the gap between customer’s expectations and their subsequent experience has been closed.

Since Wispeco’s customers are mainly other businesses, meaning the company will be solving for their customers business problems. Wispeco should use both the Customer Experience Management (CEM) and Customer Relationship Management (CRM) methods to solve the problems. Both methods bring different outcomes to the table. Below is a figure indicating the activities done by CRM compared to CEM.

Figure 24 Difference between CRM & CEM

	What	When	How Monitored	Who Uses the Information	Relevance to Future Performance
Customer Experience Management (CEM)	Captures and distributes what a customer thinks about a company	At points of customer interaction: “touch points”	Surveys, targeted studies, observational studies, “voice of customer” research	Business or functional leaders, in order to create fulfillable expectations and better experiences with products and services	Leading: Locates places to add offerings in the gaps between expectations and experience
Customer Relationship Management (CRM)	Captures and distributes what a company knows about a customer	After there is a record of a customer interaction	Point-of-sales data, market research, Web site click-through, automated tracking of sales	Customer-facing groups such as sales, marketing, field service, and customer service, in order to drive more efficient and effective execution	Lagging: Drives cross selling by bundling products in demand with ones that aren’t

7.3.3. Key Performance Measurement

Apart from the record keeping mentioned above, below formulae are shown which could be used to evaluate the performance. Inventory and transportation measurement are left out as the scope of the project doesn't cover those aspects.

Warehousing

Order picking time

The time it takes in preparing the customer order for delivery. This includes time taken looking for the products in the storage areas, planning route and waiting for the forklift to take the products to staging area

$$\text{Order picking time} = \text{order processing time} + \text{interlocation travel time} + \text{pick - uptime}$$

Warehouse throughput

Measures the performance of the warehouse as to the number of loads the storage systems could handle as that will be influenced by order picking time and utilisation of material handling equipments.

$$\text{Warehouse throughput} = \frac{\text{Number of loads received, placed in storage and retrieved}}{\text{Number of hours}}$$

Utilisation of equipment

Utilisation of warehouse material handling equipment can also be used to determine the warehouse performance

Customer Service

Service reliability

This a measure of how the business manage to deliver within or close to a promised delivery time

$$\text{Service reliability} = \frac{\text{Number of shipments within 'x' hours of promised delivery}}{\text{total number of shipments}}$$

Number of customer complaints

The company should keep in track the number of complaints reported per period to determine if a certain situation should be attended urgently, observing from the number of complains. The complains should be monitored periodically to determine when there is an increase or decrease of complaints

$$\text{Number of customer complaints} = \frac{\text{Number of complaints}}{\text{Period}}$$

General Non-financial

Asset Utilisation

Asset utilisation is the amount of time a particular asset or group of assets are being used productively

$$\text{Asset Utilisation} = \frac{\text{Actual working time in a period}}{\text{Total number of hours in a period}}$$

Total Cycle Time

The time taken from the placement of an order till the order is delivered at the customer's site. In the case of this project, the order cycle time will be measured from delivery preparatory until the customer receives the order.

$$\text{Total Cycle Time} = \text{Order processing} + \text{Delivery time from warehouse}$$

Percentage Defective

In trying to determine the quality of the distribution process, the number of defective items shipped measured. Also the formula can be used to calculate products that are in between department, especially from storage to staging. It will help measure quantity of defectives found after the manufacturing process as products move from one station to another.

$$\text{Percentage Defective} = \frac{\text{Total Number of Defectives shipped}}{\text{Total Number of items shipped}}$$

Percentage Demand Met

This performance measurement can be used to find operational capacity of the business, i.e. to find the quantity of orders that could be met periodically.

$$\text{Percentage of Demand Met} = \frac{\text{Number of orders fulfilled}}{\text{Total Demand}}$$

Chapter 8 Conclusion

This project clearly shows that the problems experienced by the Distribution department can be overcome with the involvement of everyone, from the management to the customer.

Management will need to support these changes as that will encourage all workers to participate too.

Survey and KPI's should be run or determine on monthly basis, to determine if the company is still within their strategy or are they moving away from the target. The company should run a continuous process improvement periodically. With this customer management and performance measurement, the distribution department can continuously be improved.

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Appendix

Appendix A: Process Improvement tools and their functional area.

Table 16 Process Improvement tools and their speciality

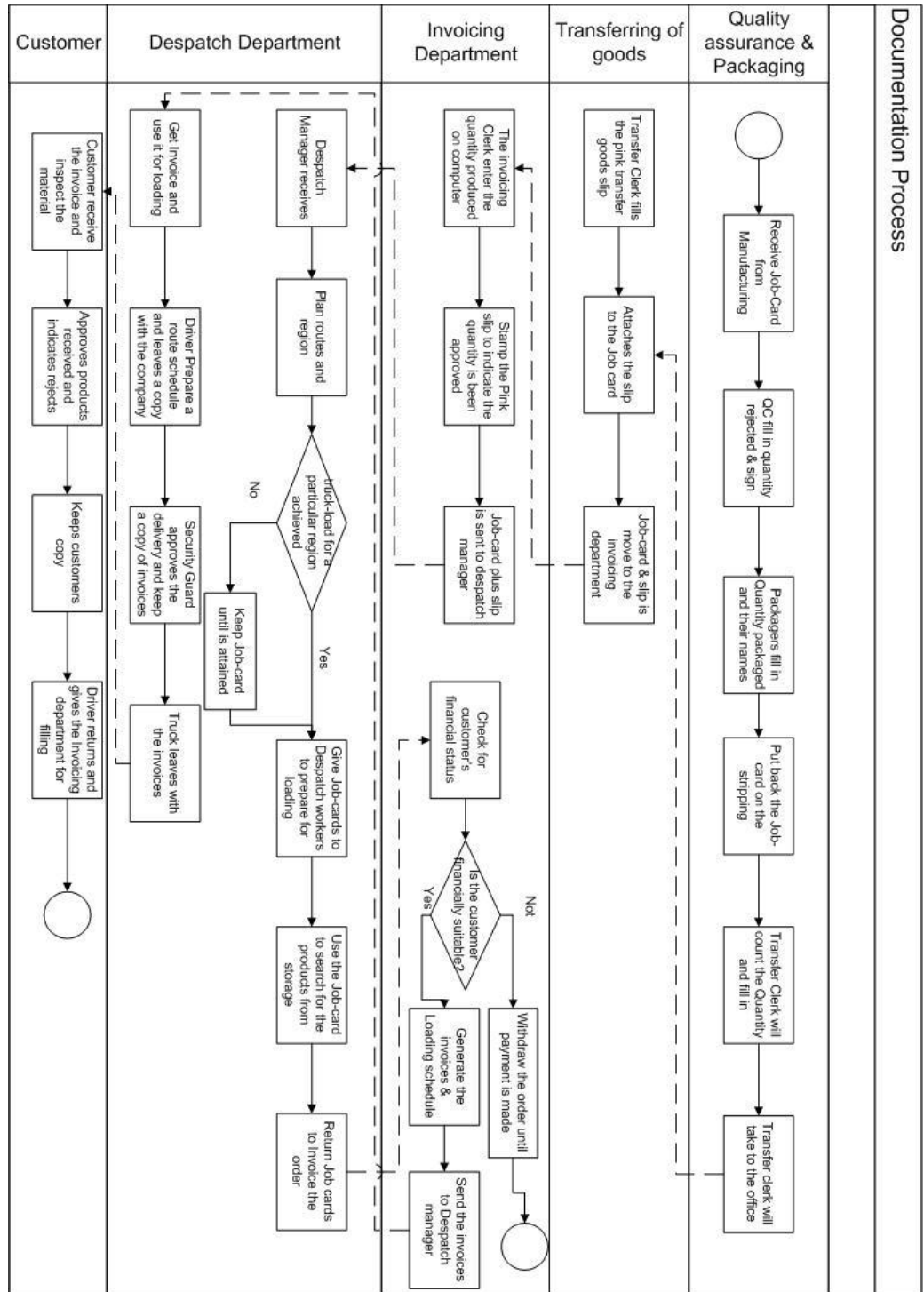
	Ideas			Numbers		Teams	
	Generating	Deciding	Implementing	Counting	Measuring	Improvement Roadmap	Team Roadmap
Activity Network Diagram			X				
Affinity	X						
Brainstorming	X						
Cause & Effect	X	X					
Check Sheet				X			
Control Charts				X	X		
Data Points				X	X		
Deployment	X		X				
Effective Meetings							X
Flowchart	X	X	X				
Force field	X	X					
Gantt							
Histogram					X		
ID	X	X					
Quality Function Deployment	X	X	X				
Matrix			X				
Nominal Group Technique		X					
Pareto				X			
Prioritization		X					
Process Capability				X	X		
PDPC			X				
Radar		X					
Run Chart				X	X		
Scatter				X	X		
Spider		X					
Storyboard Case Study						X	
Tree	X		X				

Table 17 some of the Process Improvement Tools and their functions

Tool/Technique	Process Improvement Methodology Step (refer to section on Processes)					
	Select	Understand	Performance	Review	Change	Capture
DRIVE		X	X	X	X	X
Mapping		X	X	X		
Flowcharting		X	X	X		
Force Field	X			X	X	
Cause & Effect /CEDAC				X		
Brainstorming	X	X		X		
Pareto Analysis				X		
SPC			X			X
Run/Control Charts			X			X
Check Sheets			X			X
Bar Charts			X			
Scatter Diagram			X			X
Matrix Analysis			X	X		
Dot Plot			X	X	X	X
Histogram			X			X

Appendix B Current Documentation Process

Figure 25 Current Documentation



Appendix C Material/Product flow

Figure 26current Material Flow

