Operational Improvement of
Nissan's Parts Warehouse

by

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Executive summary

The Rosslyn parts warehouse is Nissan's sole supplier of parts to all dealers throughout South Africa and sub-Sahara Africa. Management is currently concerned about the effectiveness of the warehouse operation, demanding a comprehensive analysis of the activities and practices. Emphasis should be placed on improvement of the receiving and picking processes.

The aim of this project is to analyse and improve the operations and layout of the Rosslyn parts warehouse. All operations and processes were analysed to ensure optimum flow of parts throughout the warehouse. These operations include all activities from the receiving of parts to the picking and distribution.

Some key deliverables include the investigation of best practices in warehouse operations. Industry visits and a literature study on warehouses can help to determine the best practices applicable to Nissan. Some include placing the most popular items closest to the picking/shipping area.

Develop improvement alternatives for layout such as space planning plays an important role in the final layout. Consideration of popularity, similarity, size and material characteristics should be addressed to develop a layout that will maximize space utilization as well as an acceptable service level.

After implementation of the improvements, the picking operation is expected to be improved from approximately 28 to 82 Lines Per Man Hour. This was achieved by placing a roller conveyor next to the mezzanine and linpic areas to convey picked parts to the shipping area. As well as install three Vertical Lift Modules (VLM) in the mezzanine area, which will be used to house the top 20% of parts. In the H-area, automated picker routing was introduced to minimize the sorting time and optimise the picking route. The total cost of implementation amounts to around R 1 960 000.

The payback period is just under three years, with savings in labour costs (a workforce reduction of four pickers) and damaged/stolen parts cost. The amount of picks per day has increased from 3200 lines per day to 9500 lines per day.

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1.1. Background

Nissan South Africa has been supplying quality vehicles to their customers for over 40 years. The company plays an important part in transportation in South Africa, with models ranging from passenger cars and commercial vehicles to recreational and specialised vehicles. Currently they enjoy an 8% market share in South Africa. In 1999 Nissan joined forces with the Renault group; this alliance made it the fourth largest automotive company in the world.

Nissan SA's warehouse in Rosslyn, situated in the northern part of Pretoria, is the sole parts supplier to all Nissan dealers in South Africa. This comprises all parts needed to manufacture or service any Nissan vehicle. Nissan also ships certain parts internationally. About 70% of parts are shipped internationally from Japan, Europe, India and Mexico. Locally, parts are produced in Pretoria, Durban, Springs and Cape Town. The Nissan warehouse can house around 50 000 parts at any time, with a total area of 20 000m^2-24 000m^2.

The Rosslyn plant is a leader in South Africa in terms of environmental practices employed in its manufacturing process. The plant has won numerous awards, being the first South African motor company to achieve the internationally recognized ISO 9001 and 14001 quality certification. (Nissan SA)

Existing warehouse operations start at the receiving of the various parts. Received parts are grouped into three sections, local, CKD (Completely Knocked Down or international) and RFC (parts returned from dealers). Parts are then checked against the delivery note to ensure that all parts are accurate and delivered to the correct warehouse.

After parts have been received and passed inspection, they are binned into the appropriate section, according to part size and characteristics. The bigger parts are placed in the suitable bins, whereas smaller parts are binned in the mezzanine area.

There are currently around 59 people employed in the warehouse, 15 of which are assigned to the receiving of parts, 11 at the binning area, 23 to the outbound area, 5 in managerial positions and the remaining in maintenance and admin. After the parts are picked, it is handed over to Supergroup for

further inspection, packing and shipping. Supergroup is currently Nissan's logistics service provider and is responsible for all logistics related activities.

1.2. Problem statement

The Rosslyn parts warehouse is Nissan's sole supplier of parts to all dealers throughout South Africa and sub-Sahara Africa. Management is currently concerned about the effectiveness of the warehouse operation, demanding a comprehensive analysis of the activities and practices. Emphasis should be placed on improvement of the receiving and picking processes.

Another concern and important aspect, is the number of line orders (quantity of parts) picked per hour. A picker is given a pick slip, with which he roams the warehouse and picks the correct parts. Currently workers and their union claim that they are only able to pick 27 lines per hour. Management however believes that they should be able to pick up to 36 lines per hour. A reasonable standard for picking line orders needs to be investigated.

1.3. Project Aim & Scope

The aim of this project is to analyse and improve the operations and layout of the Rosslyn parts warehouse. All operations and processes will be analysed to ensure optimum flow of parts throughout the warehouse. These operations include all activities from the receiving of parts to the picking and distribution.

The following aspects will be addressed to achieve the project aim:

- Improve warehouse processes to minimize the total time required from receiving parts to shipping them out to customers.
- Analyse and optimise the picking activities through improved work allocation and reduced travel distances
- Identify and improve gaps in current operations versus best practices.
- Identify and improve key problems, constraint and limitations in operations.
- Improve the warehouse layout, from receiving to the handover area.
- Cost-Benefit analysis (used to evaluate ideas where cost will be incurred).

1.5. Project Approach & Deliverables

The key deliverable of the project is a detailed report based on Industrial Engineering methods and techniques. The report provides a detailed analysis of how the warehouse operations and layout can be improved.

The key activities and resulting deliverables are detailed below:

1. Analyse current warehouse operations – Take the entire warehouse into account (from receiving of parts to handover to Supergroup) to include all processes. Define key performance measurements (objectives). Improved order picking operations, which will in turn improve productivity

   Deliverables: Process and material flow analysis, picking

2. Investigate best practice warehouse operations – Industry visits and literature study on warehouses can help determine the best practices applicable to Nissan. Some include placing the most popular items closest to the picking/shipping area. And by using clear and easy-to-read picking documents.

   Deliverables: Summary of key best practices

3. Define design objectives / criteria (performance drivers of the warehouse operation) against which improvement proposals will be measured.

   Deliverables: Developing SOP's and visual management performance measures

4. Identify areas for improvement at Nissan – Improved binning operations

   Deliverables: Gaps and possible improvements in current operations

5. Develop improvement alternatives for layout – Space planning plays an important role in the final layout. Consideration of popularity, similarity, size and material characteristics should be addressed to develop a layout that will maximize space utilization as well as an acceptable service level.

   Deliverables: Space conservation, Accessibility, Orderliness

6. Evaluate and compare proposed improvements, then select the appropriate layout, material handling systems and SOP's

7. Present proposals and recommendation – report and presentation to management

Chapter 2: Literature Review

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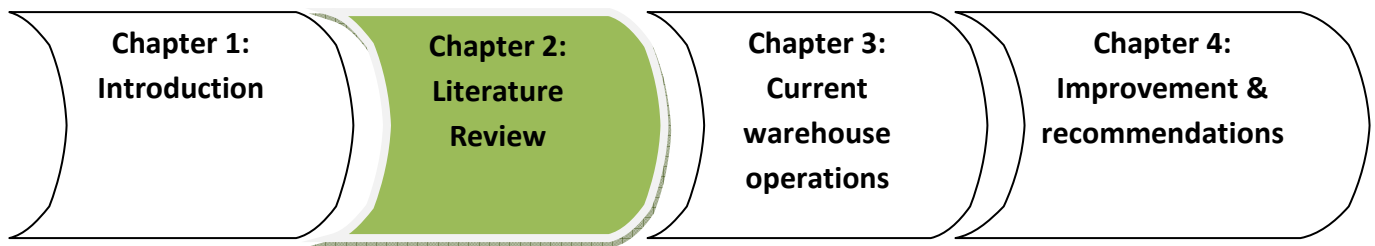
2.1 Introduction

It is critical for the engineer to familiarise himself with the physical environment, and to understand the various processes and methods that are used. It is also important to be aware of the most recent and effective techniques used by competitors or similar companies in the industry.

With the knowledge regarding the project at hand, the engineer should decide which theoretical engineering principles and methods are applicable to the project. The purpose of this literature study is to gather the relevant information and determine the Industrial Engineering techniques to be used in the project.

2.2 Warehouse operations

2.2.1 Mission of a warehouse

The warehouse plays a critical role in supporting a company's supply chain success. The mission of a warehouse is to effectively ship products in any configuration to the next step in the supply chain without damaging or altering the product's basic form. Numerous steps must be accomplished, and hence there are key warehouse opportunities to address. Doing that will optimize the methods used to achieve the mission. (Tompkins et al 2010)

Warehousing opportunities include:

1. *Improving order picking operations* – Successful order picking is critical to a warehouse's success, and supply chain requirements today are driving warehousing operations to develop better order picking solutions.
2. *Increasing productivity* – The first objective of warehousing has always been to maximize the effective use of space, equipment, and labour. This objective implies that productivity is not just labour performance but also includes space and equipment and a combination of factors that all contribute to increased productivity.
3. *Utilizing space* – As the time to find a storage location increases, the proper slotting of products start to disappear. Slow-moving items are stored in fast-moving locations, so then

fast-moving items must be stored in slow-moving locations. The end result is a decline in productivity and an increase in damage and mispicks, all due to poor space utilization.

2.2.2 Functions in the warehouse

The warehouse functions – roughly in the order in which they are performed – are defined as follow by Tompkins et al (2010):

1. *Receiving* – The collection of activities involved in (a) the orderly receipt of all materials coming into the warehouse, (b) assuring that the quantity and quality of such materials are as ordered, and (c) disbursing materials to storage or to other organizational functions that need them.
2. *Inspection and quality control* – This may be as simple as a visual check or as complex as lab testing.
3. *Repackaging* – This is performed in a warehouse when products are received in bulk from a supplier and subsequently packaged singly, in merchandisable quantities, or in combination with other parts to form kits or assortments.
4. *Putaway* – The act of placing merchandise in storage. It includes material handling and placement.
5. *Order picking* – The process of removing items from storage to meet a specific demand. It represents the basic service that the warehouse provides for the customer and is the function around which most warehouse designs are based.
6. *Sortation* – Sorting batch picks into individual orders and accumulation of distributed picks into orders must be done when an order has more than one item and the accumulation is not done as the picks are made.
7. *Packing and shipping* – May include the following tasks:
   - Checking orders for completeness
   - Packaging merchandise in an appropriate shipping container
   - Preparing shipping documents
   - Accumulating orders by outbound carrier
   - Loading trucks
8. *Cross-docking* – Inbound receipts from the receiving dock directly to the shipping dock
9. *Replenishing* – Primary picking locations from reserve storage locations
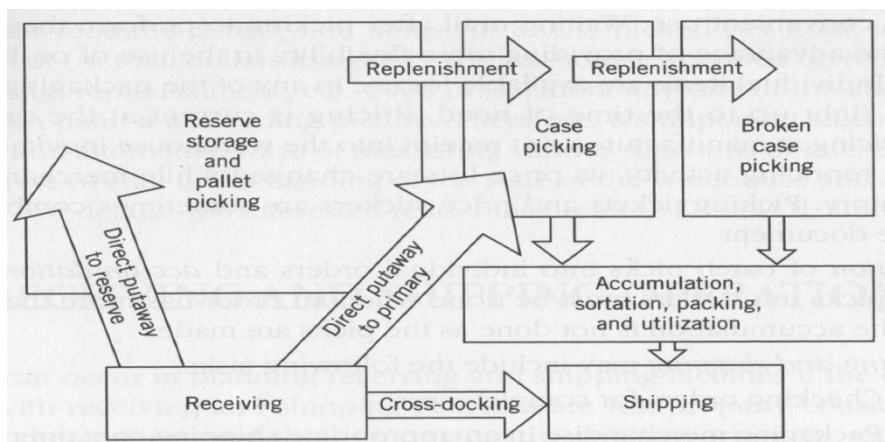
Figure 2.1: Typical warehouse functions and flows (Tompkins et al 2010)

2.3 Methods, tools and techniques

2.3.1 Process Flow Analysis

Schroeder (2008), states that the purpose of a process flow analysis is to describe a process visually to find ways of improving the current process.

- Find repetitive operations
- Identify bottlenecks
- Describe directions and distances of flows (people, material and information)
- Reduce waste

2.3.2 Time Studies

The time and motion study is a business efficiency technique combining the time study work of Taylor and motion study of Gilbreth. It would be used to reduce the number of motions in performing a task (NetMBA 1999). The Author can use this to get a standard time in picking operations.

2.3.3 Order picking

According to Tompkins et al (2010) order picking is the most critical function in distribution operations. Warehousing professionals identify order picking as the highest-priority activity in the warehouse for productivity improvements. Some of the principles involved in order picking include:

1. *Pareto's law* – In a warehouse operation, a small number of SKUs constitutes a large portion of the inventory. Similarly, a small number of SKUs will represent a large portion of the throughput in a warehouse.
2. *Use a clear, easy-to-read picking document* – A picking document should provide specific instructions to the order picker, making the job easier than it otherwise would be. Information should be presented in the order that it is required: location, stock, number, description, unit of material, and quantity required.
3. *Use a prerouted, preposted picking document* – A picking document will control the order picking process. It will cause the operator to travel throughout the warehouse in a random manner if the order is not prerouted.
4. *Maintain an effective stock location system* – It is not possible to have an efficient order picking system without an effective stock location system. To pick an item, you first have to find it. If you don't have a specific location, then time must be spent searching for the product. Without an address, it is impossible to take advantage of Pareto's law.
5. *Eliminate and combine order picking tasks when possible* – The human work elements involved in order picking may include:
   - *Travelling*, to and from, and between pick locations

- *Extracting* items from storage locations
- *Reaching* and *bending* to access storage locations
- *Documenting* picking transactions
- *Sorting* items into order
- *Packing* items
- *Searching* for pick locations

6. *Batch orders to reduce total travel time* – By increasing the number of orders (and therefore items) picked by an order picker during a picking tour, the travel time per pick can be reduced.

7. *Assign the most popular items to the most easily accessed locations in the warehouse* – In a typical warehouse, a minority of the items generates the majority of the picking activity. This phenomenon can be used to reduce order picking travel time and reaching and bending. Popularity storage can also be used to reduce stooping and bending, consequently reducing fatigue and improving picking accuracy.

8. *Assign items that are likely to be requested together to the same or nearby locations* – Much as minority of items in a warehouse generates a majority of the picking frequency, there are items in the warehouse that are likely to be requested together. Examples include items in repair kits, items from the same supplier and items of the same size.

9. *Require pick confirmation* – It is critical for order accuracy that the order picker actively verifies that the quantity picked is the quantity required or report the actual quantity picked if it differs from that requested.
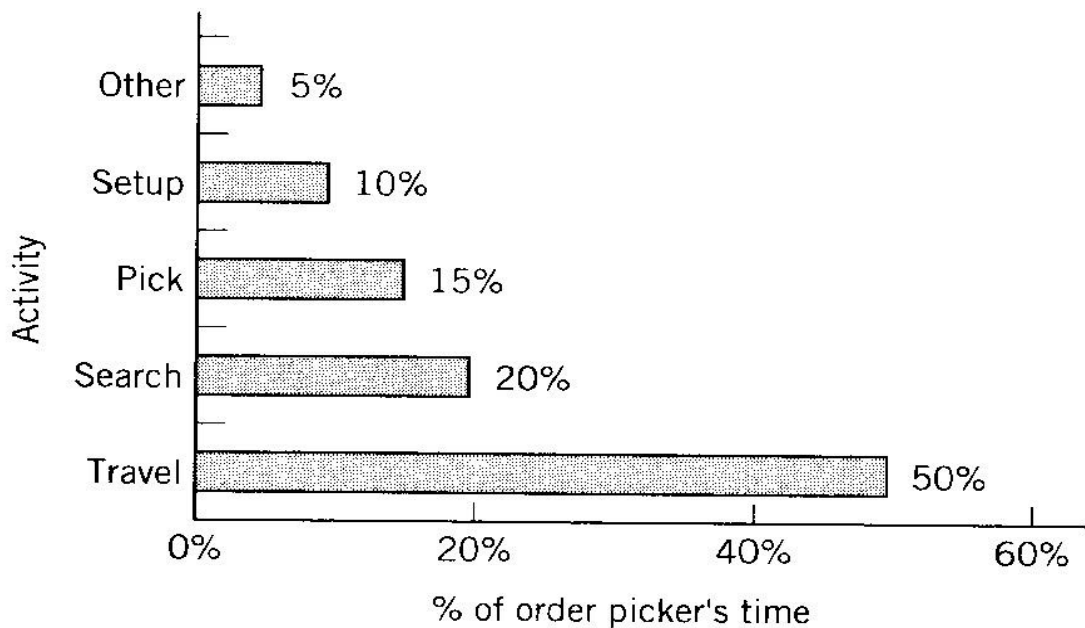
Figure 2.2: Typical distribution of an order picker's time (Tompkins et al 2010)

2.4. Warehouse design and facility layout

Data and information that are required to efficiently design a warehouse, according to Jenkins (1999, p92), include:

- Reliable forecasts of every department that will influence the warehouse functionality. These forecasts should be of the receiving area, order picking activities etc.
- Material handling equipment, tools and methods that are needed in order to execute the warehouse functions.
- Establishing warehouse objectives.

2.4.1 Objective of warehouse layouts

According to Salvendy (1999, P1777) these are critical for an efficient warehouse layout:

- Effective utilization of material handling equipment
- Effective utilization of warehouse space
- To promote good housekeeping
- To provide ease of maintenance and operations efficiency and flexibility

2.4.2 Warehouse layout and size

Warehouse size is typically determined by the number and dimensions of parts it houses. It should also be flexible to accommodate any increase in parts due to growing demand. Parts can either be stored in a multi level storage facility or a single floor warehouse. In a single floor warehouse a very large area is needed to house all the parts and can lead to excessive travelling times. A multi level storage facility is thus ideal for a large number of parts. However, one should keep the receiving and shipping areas on the ground level, whereas offices can be on an elevated level.

2.4.3 Facilities planning process

Tompkins et al (2010) describes the following steps required to establish a facility layout.

1. Define the objectives of the facility
2. Specify the primary and support activities to be performed in accomplishing the objective
3. Determine the interrelationships among all activities
4. Determine the space requirements for all activities
5. Generate alternative facilities plans

6. Evaluate alternative facilities plans
7. Select and implement a facilities plan
8. Maintain and adapt the facilities plan
9. Redefine the objective of the facility

2.4.5 Performance factors of the distribution centre

The performance of a distribution centre can be influenced by a number of factors. The main factors include:

- Material area
- Material Handling Equipment
- Layout
- Inventory strategy

Material area

A great number of diverse parts need to be stored safely within the warehouse. These parts all have unique characteristics, size and dimensions such as height and weight. Certain limitations may exist in storing them, requiring a specific area where it may be stored. Hazardous material should be stored elsewhere to ensure that no damage occurs to other parts. Fast moving items also require a certain storage area, one that optimizes the picking operation and reduces the movement of material handling equipment.

Material Handling Equipment

Material handling equipment is used collect or store material within a warehouse. According to Tompkins et al (2010) material handling equipment is classified into the following categories:

1. Containers and unitizing equipment
   - Containers
   - Unitizers
2. Material transport equipment
   - Conveyors
   - Industrial vehicles
   - Monorails, hoists and cranes
3. Storage and retrieval equipment
   - Unit load storage and retrieval
   - Unit load storage equipment
   - Unit load retrieval equipment
4. Automatic data collection and communication equipment
   - Automatic identification and recognition

- Automatic paperless communication

Layout

The layout of the warehouse can create several problems if not done correctly. The size of the material area should be properly determined to ensure an efficient layout. Factors that should be considered are:

- Product zoning requirement
- Number of aisles
- The height of the warehouse that can be utilized
- Number of material handling equipment
- Employee requirements (Restrooms, kitchen, locker)

Inventory strategy

Managers should ensure that the correct parts and quantity thereof are in storage. This can be done by using an appropriate EOQ (Economic Order Quantity) model. An adequate strategy would also improve the performance of the warehouse and minimize damages and losses. Inventory should be controlled to ensure that operators are aware of parts location and quantity.

2.4 Conclusion

The literature study will serve as a basis for the principles that will be followed. Additional literature will later be used as the project progresses and problems become clearer. Several other documents have been used by the author, not all may be referred to as it provides a general overview of the problem.

Chapter 3: Current warehouse operations

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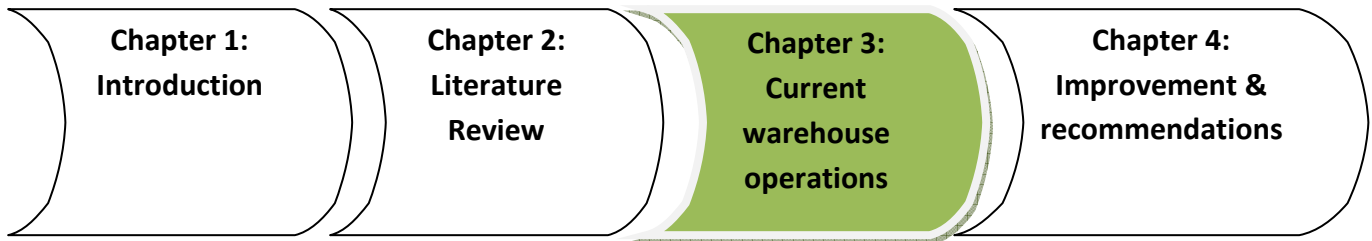
In order to propose accurate and relevant solutions, the current warehouse operation needs to be analysed and well understood. Key processes that need to be investigated include the receiving, binning and picking processes. In-depth analyses of these processes follow, with emphasis on the picking process.

3.1 Receiving

The Rosslyn parts warehouse can accommodate approximately 50 000 parts at any given time. This includes parts of all sizes, from washers to door panels. Several parts received are repacked (by Technopack) in official Nissan packaging at the receiving area before it gets binned. The storage of these parts can be divided into six main areas (refer to *Appendix A.2* for current warehouse layout):

1. High bay area (H area) – For the storage of medium-to-big parts
2. Mezzanine area – For the storage of small parts
3. Area 10 – For the storage of big parts (bumpers, bonnets, etc.)
4. Outside storage – For extra large or heavy parts (Door panels, roll-bars, etc.)
5. Linpic area – For the storage of very small parts
6. Protective store – This storage area was introduced due to theft of the parts. High value parts are stored in the protective store area, in a separate security room. These parts include turbo chargers, starters, remotes etc.

Within the H - area is an area called the "golden aisle". This area consists of two racks with multiple bins inside them. The most popular parts are stored in the "golden aisle", which are mostly serviceable parts. They include oil filters, air filters etc. All other parts are stored according to size.

Parts are either received locally or internationally. The following procedures are followed when parts are received:

- **Local:** When local parts are received, they are offloaded from the truck and checked if it is the correct order. This is done by verifying that the delivery note matches the material case number. Parts are then checked for correctness, damages and quantity. When incorrect

parts or incorrect quantity of parts are received, the receiver keeps them separately. He notifies the foreman who checks the parts and the foreman contacts the buyer. When any of the parts are damaged, the receiver informs the foreman. The foreman checks the parts and takes a photo of the damaged parts. He then informs the buyer about the damages. All invoices and paperwork is then taken to the foreman. Refer to Figure 3.1 for the process flow of local received parts.

- **International:** When international (CKD) parts are received, they are offloaded from the truck. The receiver checks the condition of the crates and records any crate(s) not received or damaged. Crates are then opened and boxes are removed. Boxes and parts are then checked for any discrepancies. Bin advices are then stuck to the parts and taken to the marshalling area. If a crate is damaged, it gets reported to the foreman who takes a photo. The crate is then unpacked and the condition of the parts are checked. If no parts are damaged, the photo is deleted and normal procedure is followed. If parts are damaged, the foreman contacts the buyer with information. Refer to Figure 3.2 for international received parts.

The process flows depicted below are on a high level, showing the basic steps and processes followed. It also includes which person does what. The key aspect in both process flows, are conformation of the parts. It is the receivers responsibility to make sure that the parts received are correct, undamaged, the exact quantity and delivered to the correct warehouse. This is the main focus of receiving parts.
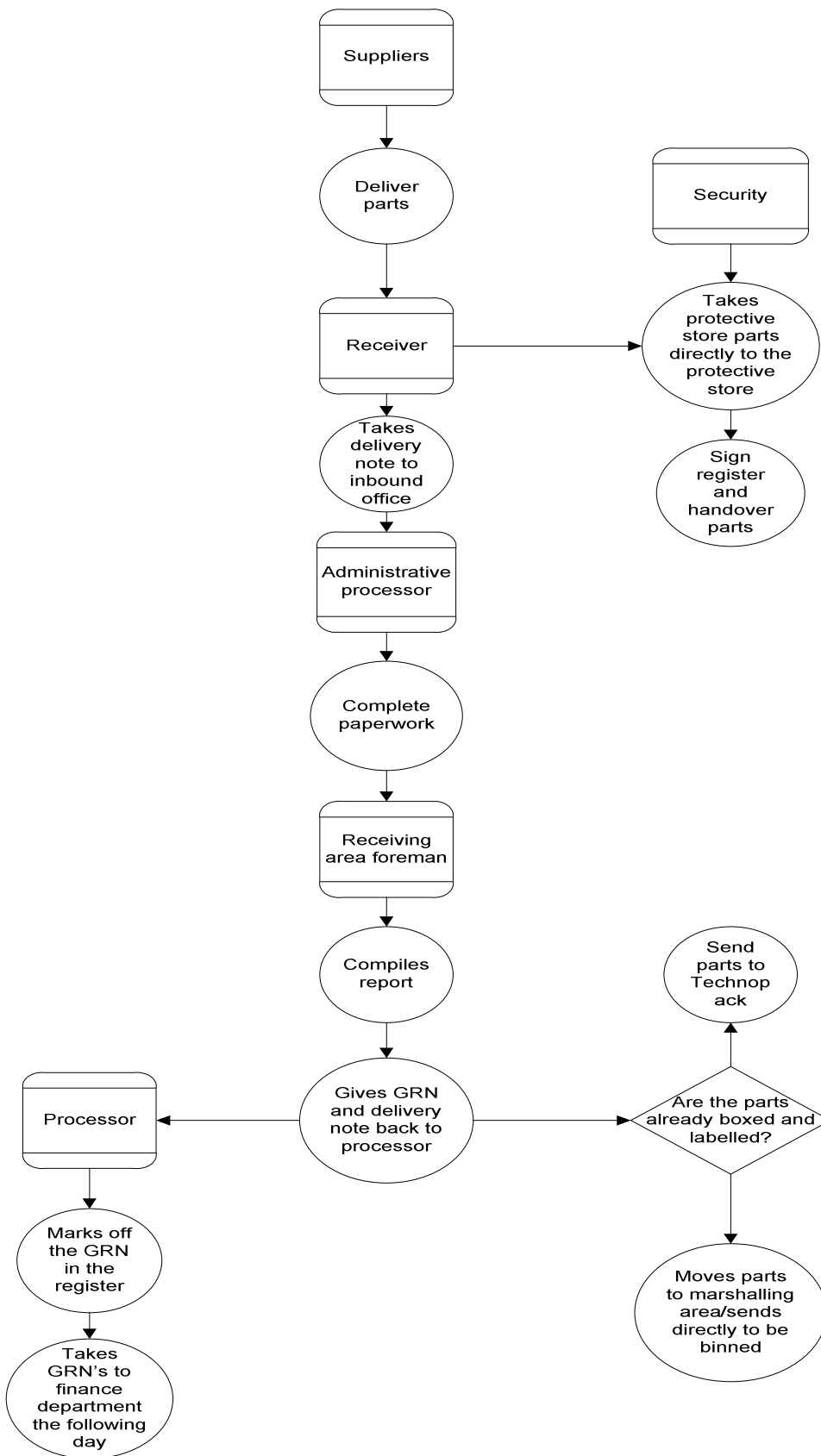
Figure 3.1: Local receiving process

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┌─────────┐                                    ┌──────────────┐
│Suppliers│                                    │Forklift driver│
└────┬────┘                                    └──────┬───────┘
     │                                        ┌───────┴────────┐
   ╭─┴──╮                                   ╭─┴──╮          ╭──┴──╮
  ╱Deliver╲                                ╱Brings ╲       ╱Takes Ad╲
 │ parts   │                              │crates into│    │Hoc parts to│
  ╲       ╱                               │unpacking  │    │Technopack │
   ╰─┬──╯                                  ╲ area    ╱      ╲        ╱
┌────┴────┐                                  ╰─┬──╯          ╰──────╯
│Receiver │                              ┌──────┴──────┐
└────┬────┘                              │  Unpacker   │
   ╭─┴──╮                                └──────┬──────┘
  ╱Takes ╲                                    ╭─┴──╮                ┌────────┐
 │delivery│                                  ╱Unpacks╲────────────▶│ Sorter │
 │note to │                                 │ crates  │            └───┬────┘
 │inbound │                                  ╲       ╱                ╭─┴──╮
  ╲office ╱                                   ╰─┬──╯                 ╱Splits parts╲
   ╰─┬──╯                                      │                   │according   │
┌────┴────┐                                    │                   │to warehouse│
│Inbound  │                                    │                    ╲location   ╱
│foreman  │                                    │                     ╰─┬──╯
└────┬────┘                                    │                   ╭───┴──╮
   ╭─┴──╮                                      │                  ╱Takes   ╲
  ╱Captures╲                              ┌────┴─────┐           │bypass    │
 │delivery  │                             │Forklift  │           │tagged    │
 │notes on  │                             │driver/   │──────────▶│parts to  │
  ╲spreadsheet╱                           │Unpacker  │           │scanning  │
   ╰─┬──╯                                 └────┬─────┘            ╲area     ╱
  ╭──┴──╮                                    ╭─┴──╮                ╰──────╯
 ╱Contacts ╲                                ╱Moves  ╲
│suppliers  │                              │pallets to│         ╭──────╮
│regarding  │                              │marshalling│       ╱Places  ╲
│crates not │                               ╲area     ╱       │other    │
 ╲received  ╱                                ╰──────╯         │parts in  │
  ╰─┬──╯                                                      │marshalling│
 ╭──┴──╮                                                       ╲area     ╱
╱Informs  ╲                                                     ╰──────╯
│processor │
│of order  │
│crates to │
│be        │
╲unpacked ╱
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│Processor│
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  ╱Completes╲
 │paperwork │
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 ╭───┴──╮          ╭──────╮
╱Informs  ╲       ╱Gives    ╲
│forklift   │     │unpackers │
│driver of  │────▶│and       │
│order to   │     │Technopack│
│bring crates│    │bin advices│
│into the   │     │and bypass │
╲warehouse ╱      ╲tags      ╱
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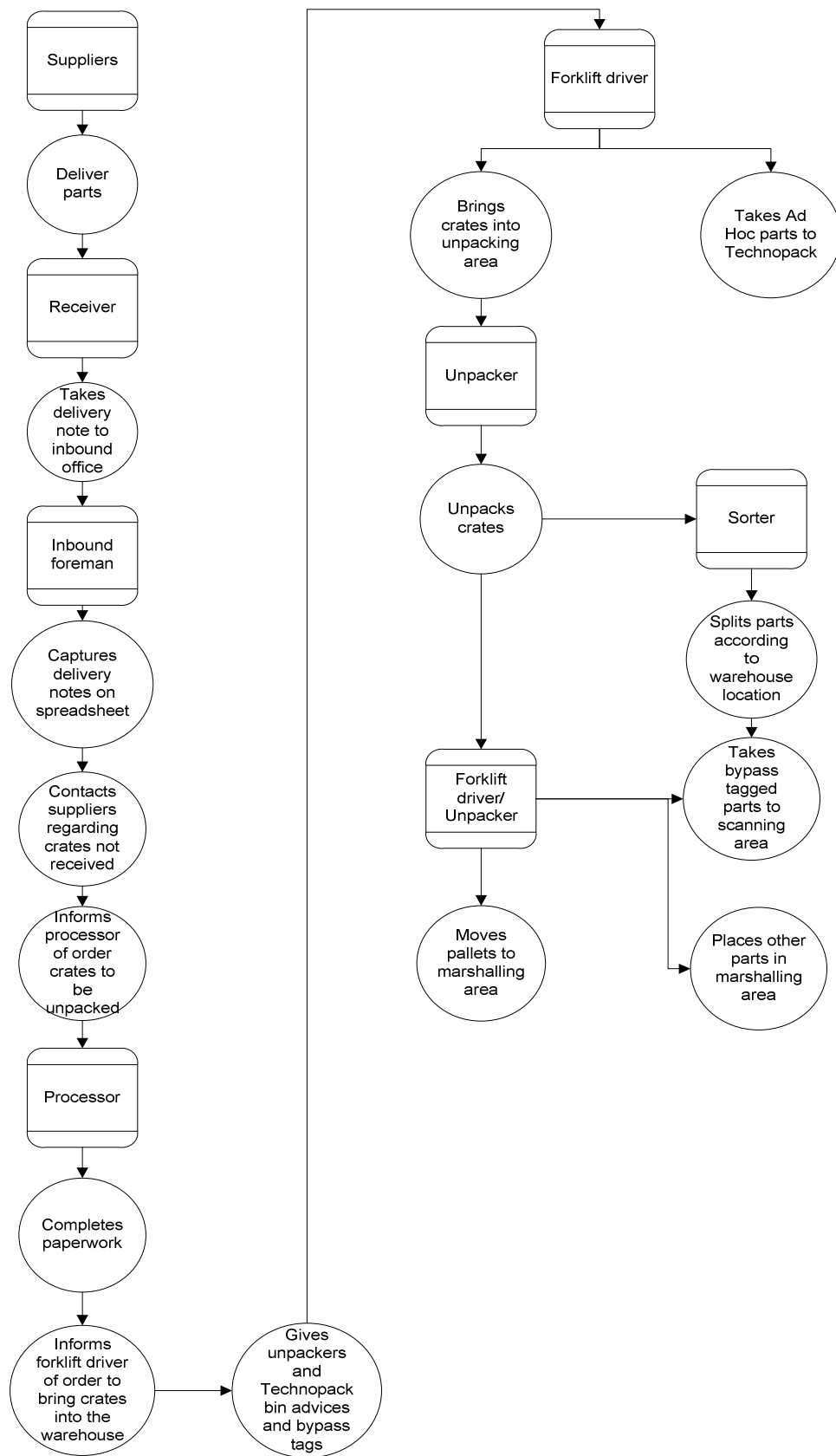
Figure 3.2: International receiving process

3.2 Binning

After parts have been received, they are staged in a marshalling area waiting to be binned. Binners then proceed with the following tasks:

- They check the system to find the parts' current bin location and whether the bin(s) are empty. If there isn't an existing bin, parts are binned to the relevant area (according to popularity or size) and noted by the binner (on the bin advice) to show newly created bin location(s). All details are also loaded onto the system.

- Parts are then collected from the marshalling area and checked for correct part number and quantity. Binners clean the parts and bin them accordingly. After binning takes place, the binner is responsible to take the bin advice to the foreman to keep record of parts.

- In cases of a bin being too small or full, binners are required to find the next available larger or open bin and bin the parts. He needs to record which parts he places in which bin by writing it on the bin advice. The bin advice then needs to be taken to the foreman.

Figure 3.3 below depicts the binning process on a high level. It shows the flow of the process and responsibility.
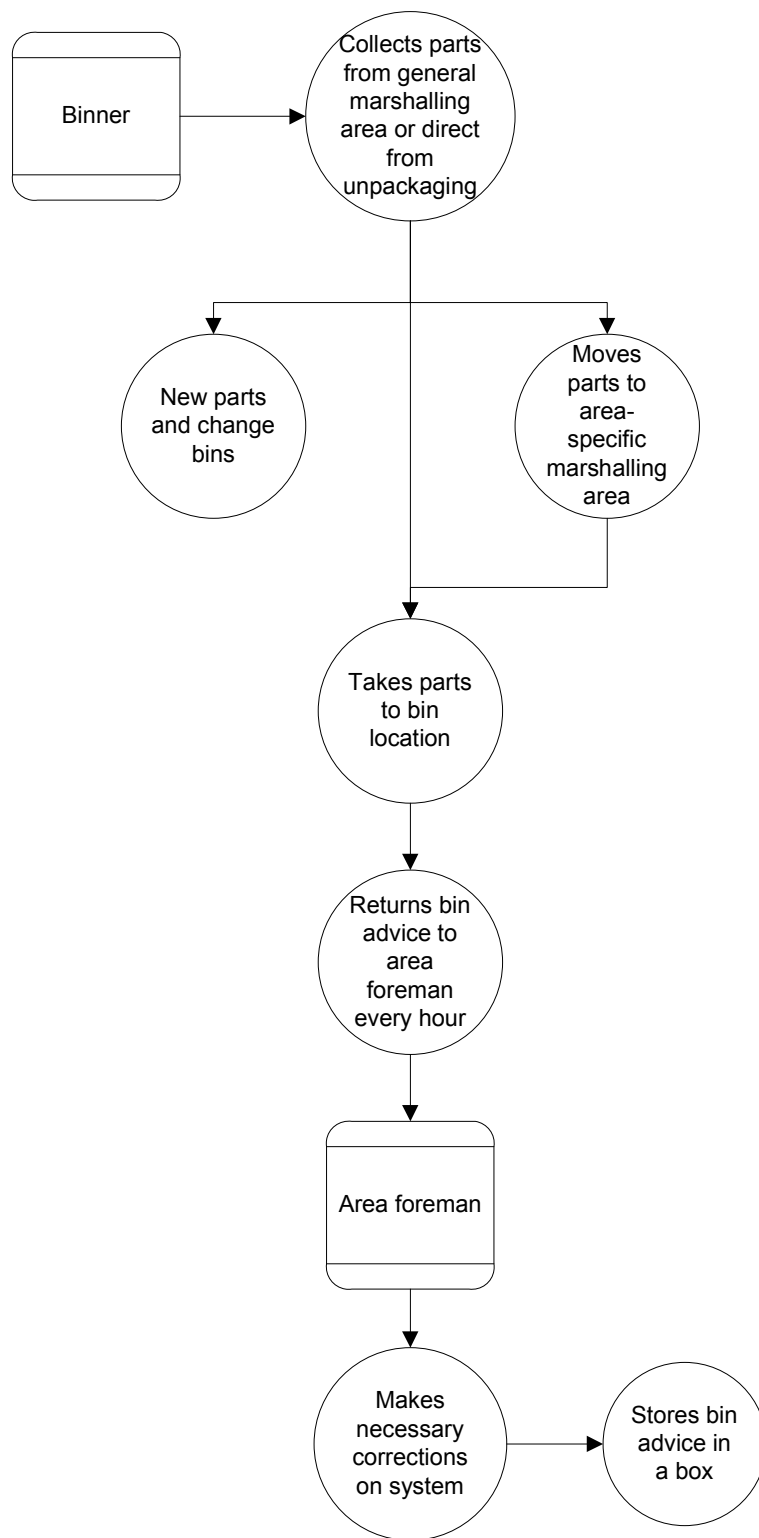
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┌─────────────┐              ╭─────────────╮
│             │              │ Collects parts│
│   Binner    │─────────────▶│ from general │
│             │              │ marshalling  │
└─────────────┘              │ area or direct│
                             │    from      │
                             │ unpackaging  │
                             ╰──────┬───────╯
                    ┌───────────────┴───────────────┐
                    ▼                                ▼
              ╭──────────╮                    ╭──────────╮
              │ New parts │                   │  Moves   │
              │and change │                   │ parts to │
              │   bins    │                   │  area-   │
              ╰──────────╯                    │ specific │
                                              │marshalling│
                                              │   area   │
                                              ╰────┬─────╯
                    ┌──────────────────────────────┘
                    ▼
              ╭──────────╮
              │Takes parts│
              │  to bin   │
              │ location  │
              ╰────┬─────╯
                    ▼
              ╭──────────╮
              │Returns bin│
              │ advice to │
              │   area    │
              │  foreman  │
              │every hour │
              ╰────┬─────╯
                    ▼
              ┌──────────┐
              │          │
              │   Area   │
              │ foreman  │
              │          │
              └────┬─────┘
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              ╭──────────╮        ╭──────────╮
              │  Makes   │        │Stores bin│
              │necessary │───────▶│ advice in│
              │corrections│       │  a box   │
              │on system │        ╰──────────╯
              ╰──────────╯
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Figure 3.3: The binning process

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3.3 The picking process

Order picking can be defined as the process of removing a small (or large) number of goods from storage, to satisfy a specific demand. The picking operation has become a very important part of warehousing, it is seen as the most costly and labour intensive activity. The cost of order picking is estimated at around 55% of the total warehouse expenses. An efficient order picking system can greatly improve customer satisfaction levels.

Nissan parts warehouse currently makes use of zone picking. According to Tompkins et al (2010) zone picking can be described as follow: The total pick area is organized into distinct sections (zones), with one person assigned to each zone. The picker assigned to each zone picks all the lines, for each order, that are located within that zone. The lines from each zone are brought to an order consolidation area where they are combined into a complete order before shipment.

At Nissan there is one picker designated to the "golden aisle", who is responsible for all its picks. Six pickers are assigned to the high-bay and outside area and another six to the linpic, mezzanine and area 10 areas. In cases where a certain picker is idle, he is assigned to an area where he is needed. In the protective store area (for high value parts) there are two Nissan employees and three security guards. The employees are responsible for the binning, picking and packing of the parts. It is then the security guards' responsibility to verify that the orders are filled correctly. From there the guards take the orders to the shipping area (Supergroup).
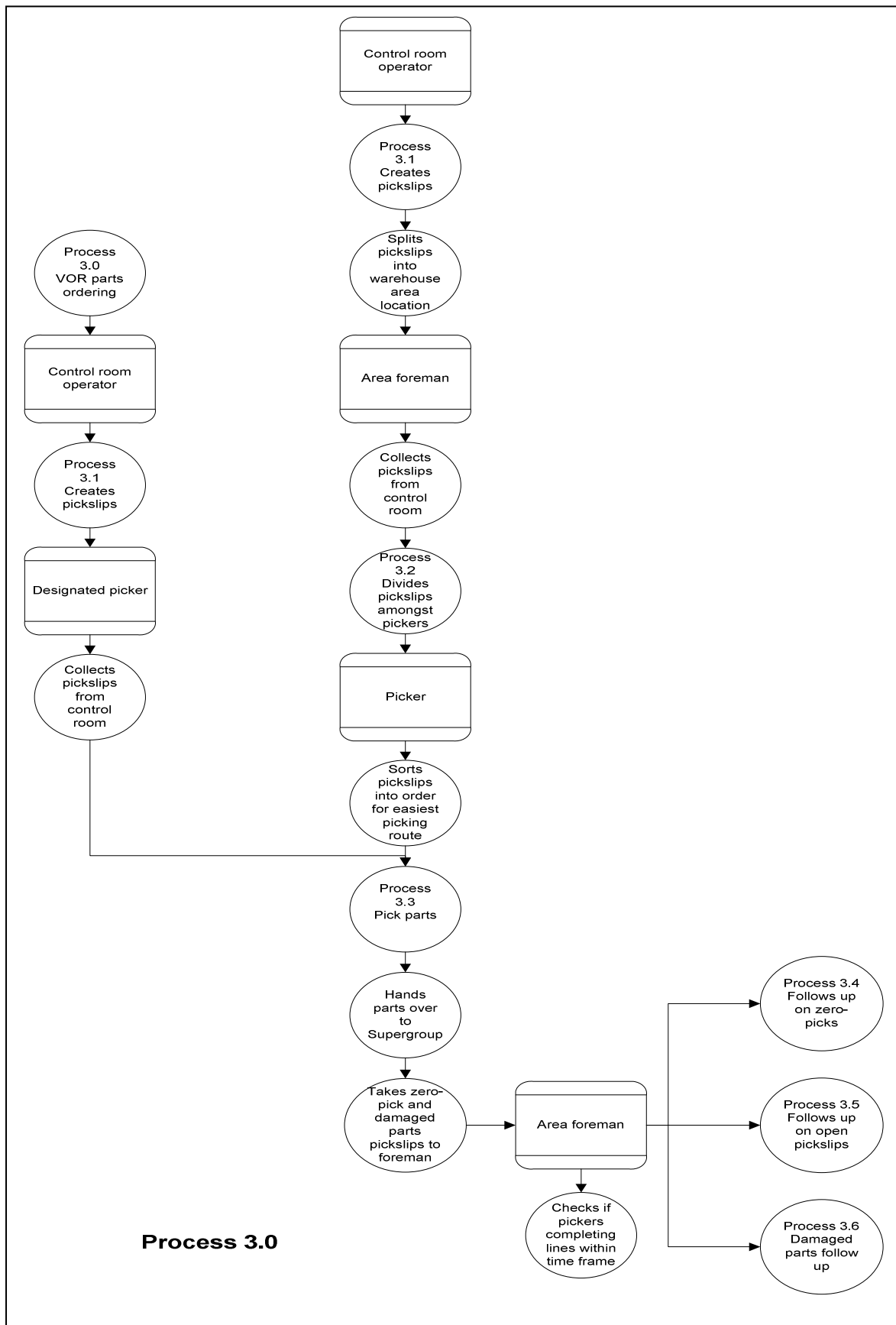
Before the actual picking can take place, pick slips needs to be created. This is done by using the SAP system. Pick slips are grouped into routes, printed and packed according to regions. Pickers collect their pick slips from the foreman and starts picking. There are eight pickers using order picking machines while the rest uses normal pump trolleys. The actual picking requires the picker to find the correct bin location, compare the pick slip to the part number and verify the correct quantity. All of this is done by using a handheld scanner. He then attaches the pick slip to the parts and takes them to the dispatch area.

If less than the required parts are in the bin, the picker records the discrepancy on the pick slip and continues picking. If a part(s) are damaged, it is recorded on the pick slip and taken to the foreman. If there are no parts in the required bin, it is recorded on the pick slip and taken to the foreman who investigates.

In cases where a VOR (vehicle off road) order comes in, the pick slips are grouped into routes, printed and picked immediately. VOR parts are critical to the working condition of a car.

Figure 3.4 depicts the picking process on a high level. It is a detailed analysis of the entire picking operation. Following is each process in more detail and the relevant responsibilities (Figure 3.5 – Figure 3.18). The lower level processes are self explanatory.
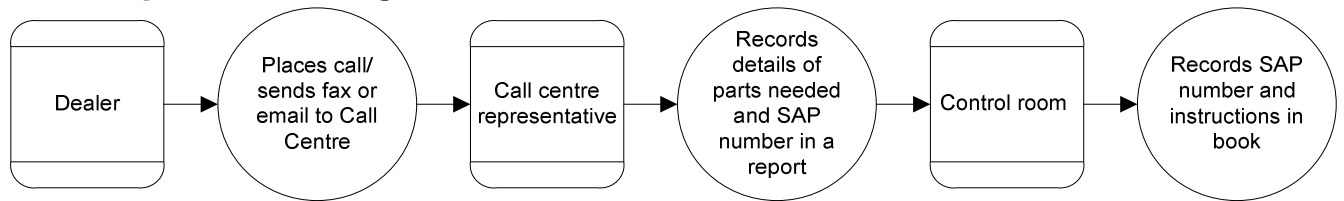
Figure 3.4: The picking process (Process 3.0)

Control room operator

Process 3.1 Creates pickslips

Splits pickslips into warehouse area location

Process 3.0 VOR parts ordering

Control room operator

Area foreman

Process 3.1 Creates pickslips

Collects pickslips from control room

Designated picker

Process 3.2 Divides pickslips amongst pickers

Collects pickslips from control room

Picker

Sorts pickslips into order for easiest picking route

Process 3.3 Pick parts

Hands parts over to Supergroup

Process 3.4 Follows up on zero-picks

Takes zero-pick and damaged parts pickslips to foreman

Area foreman

Process 3.5 Follows up on open pickslips

Checks if pickers completing lines within time frame

Process 3.6 Damaged parts follow up

Process 3.0

23

VOR parts ordering

Figure 3.5: Process 3.0 – VOR parts ordering

Vehicle off road (VOR) parts are parts that a vehicle cannot operate without. These parts include starters, electronics etc.

Creating pickslips
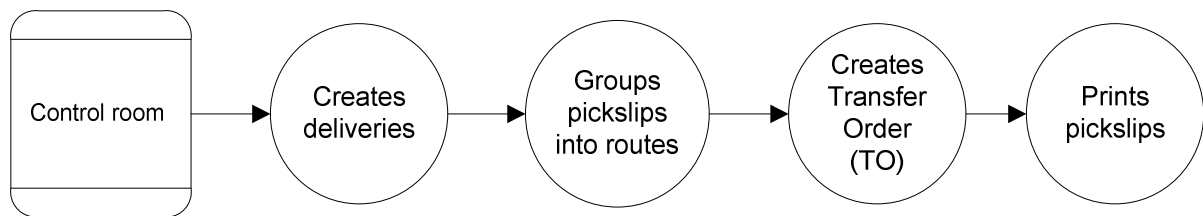
Figure 3.6: Process 3.0 – Creating pick slips

The transfer order refers to the pick list.

Dividing pickslips
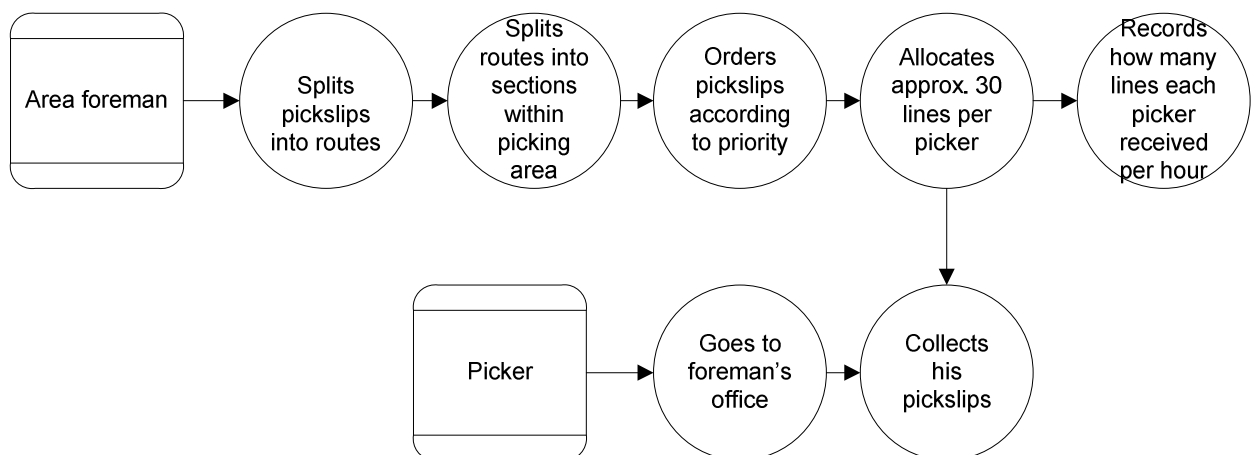
Figure 3.7: Process 3.0 – Dividing pick slips

It is the area foreman's responsibility to gather all pickers and divide the pick slips evenly.

Picking parts
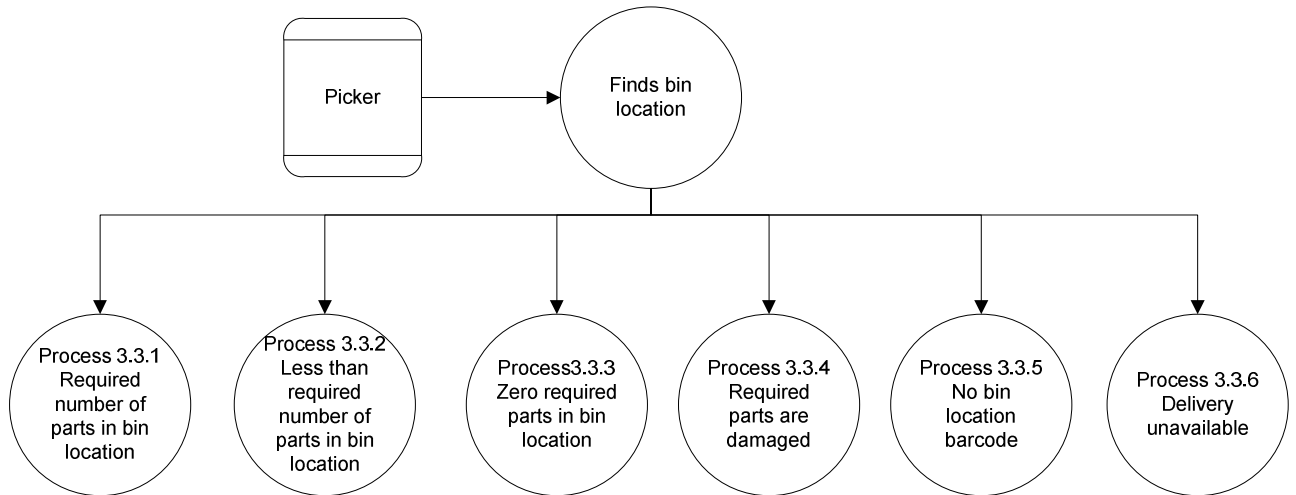
Figure 3.8: Process 3.0 – Picking parts

Figure 3.8 above shows the different scenarios a picker can find himself in. Whichever scenario it is, detailed steps that must be followed are depicted in the figures below (Figure 3.9 – Figure 3.14).

Required number of parts in bin
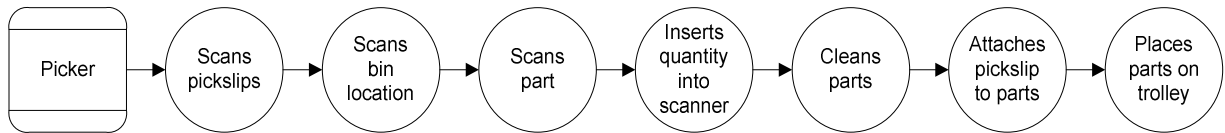
Figure 3.9: Process 3.0 – Required number of parts in bin

Less than required number of parts in bin
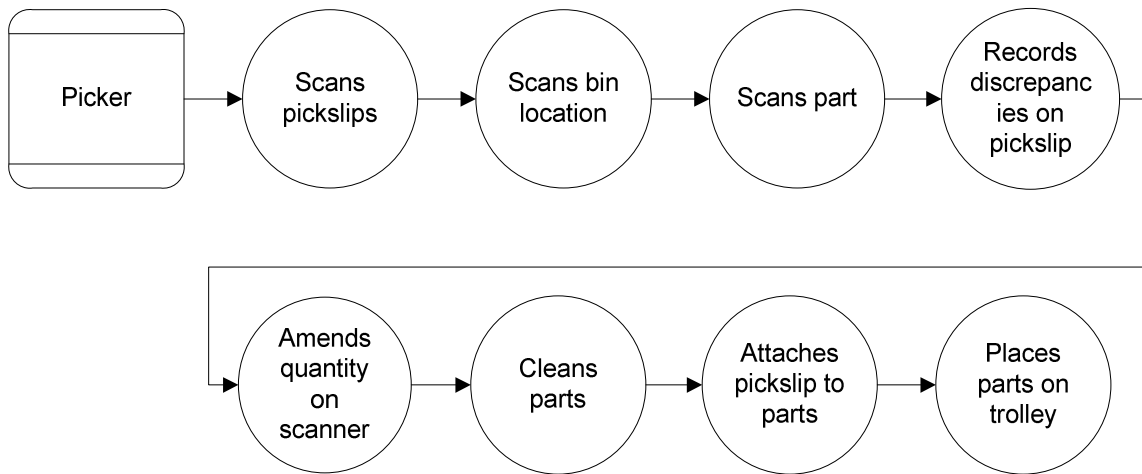
Figure 3.10: Process 3.0 – Less than required number of parts in bin

Zero required parts in bin
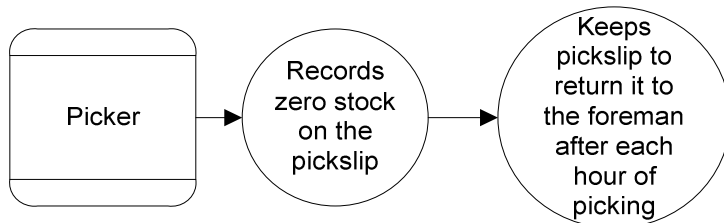
Figure 3.11: Process 3.0 – Zero required parts in bin

Required parts are damaged
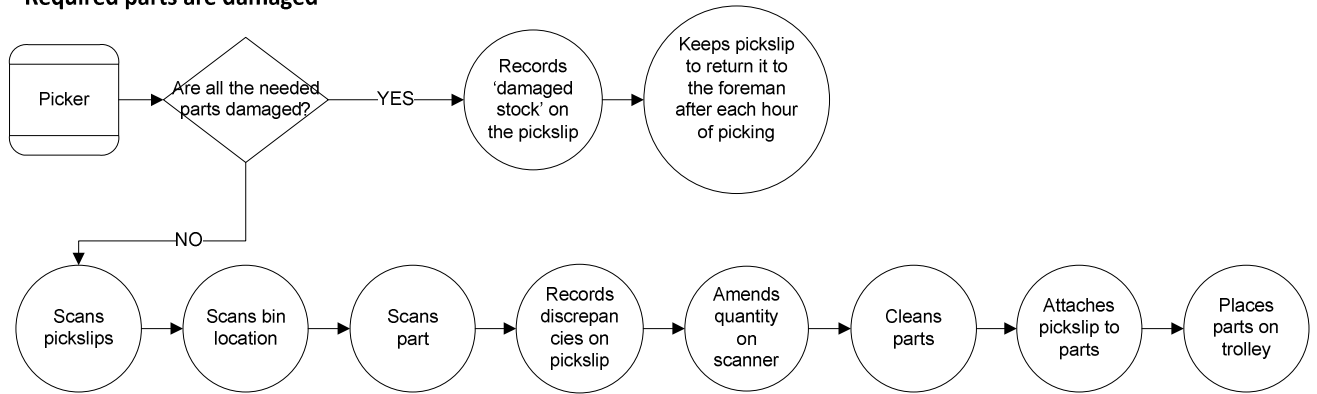
Figure 3.12: Process 3.0 – Required parts are damaged

No bin location barcode
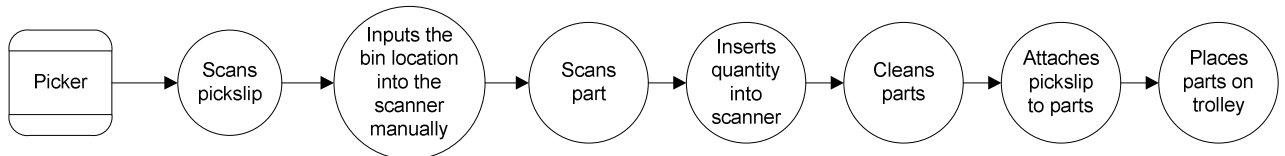
Figure 3.13: Process 3.0 – No bin location barcode
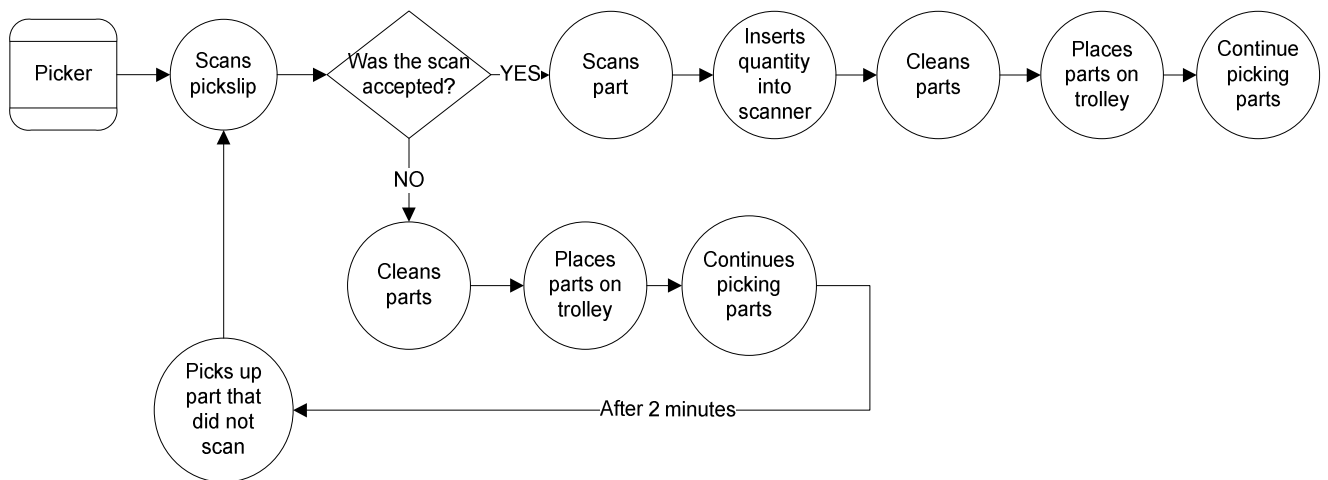
"Delivery unavailable"

Figure 3.14: Process 3.0 – "Delivery unavailable"
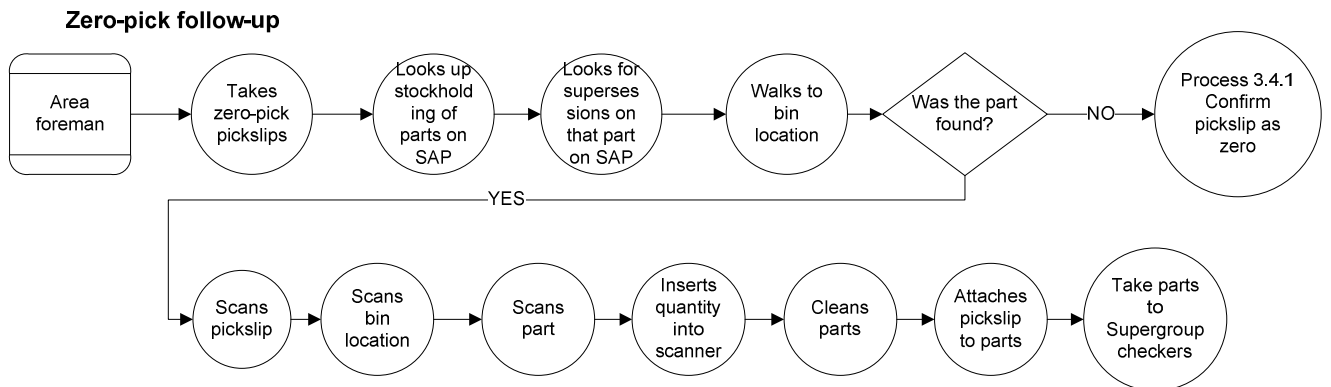
Zero-pick follow-up

Figure 3.15: Process 3.0 – Zero pick follow-up

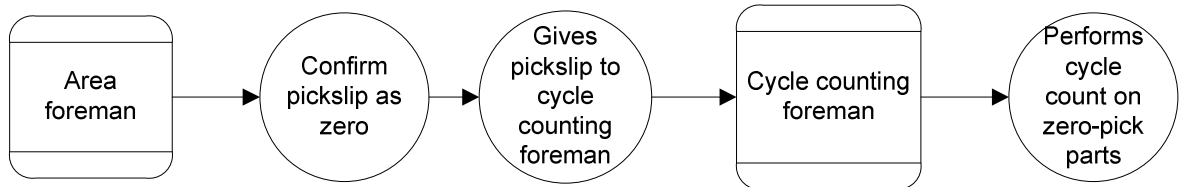## Confirm pickslip as zero

Figure 3.16: Process 3.0 – Confirm pick slip as zero

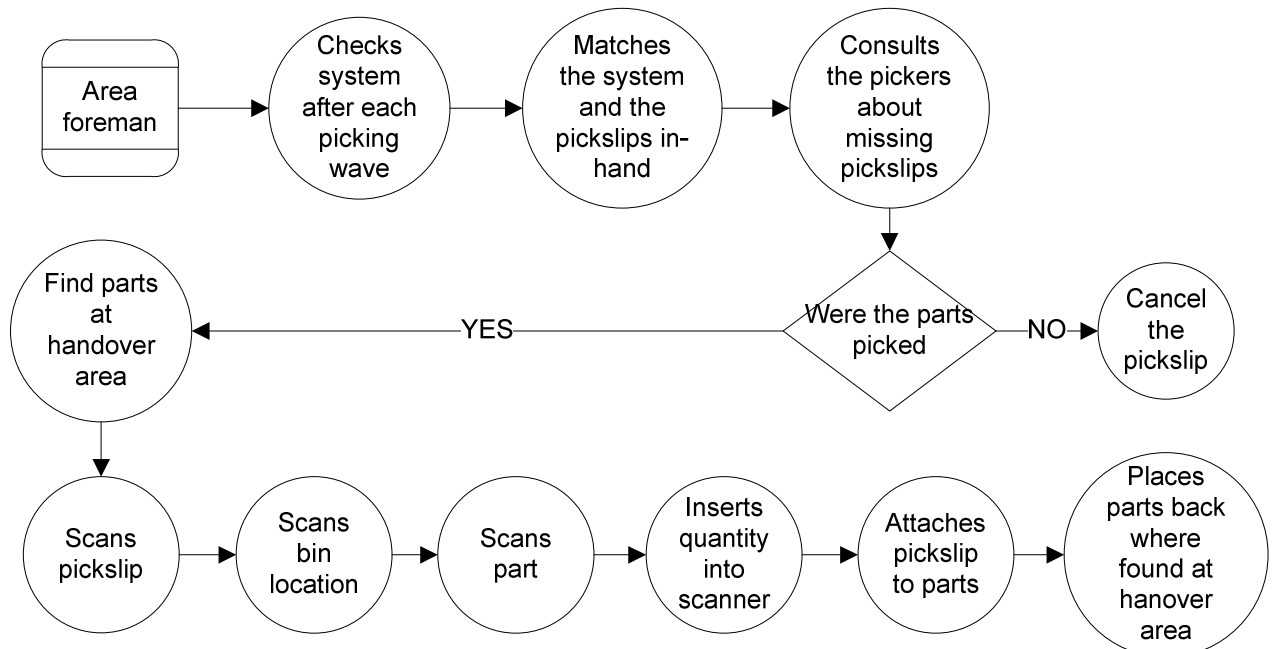## Follow-up on open pickslips

Figure 3.17: Process 3.0 – Follow-up on open pick slips

After a picking wave, the area foreman is responsible for all zero-pick slips. He must investigate the cause and solve the relevant problem(s).
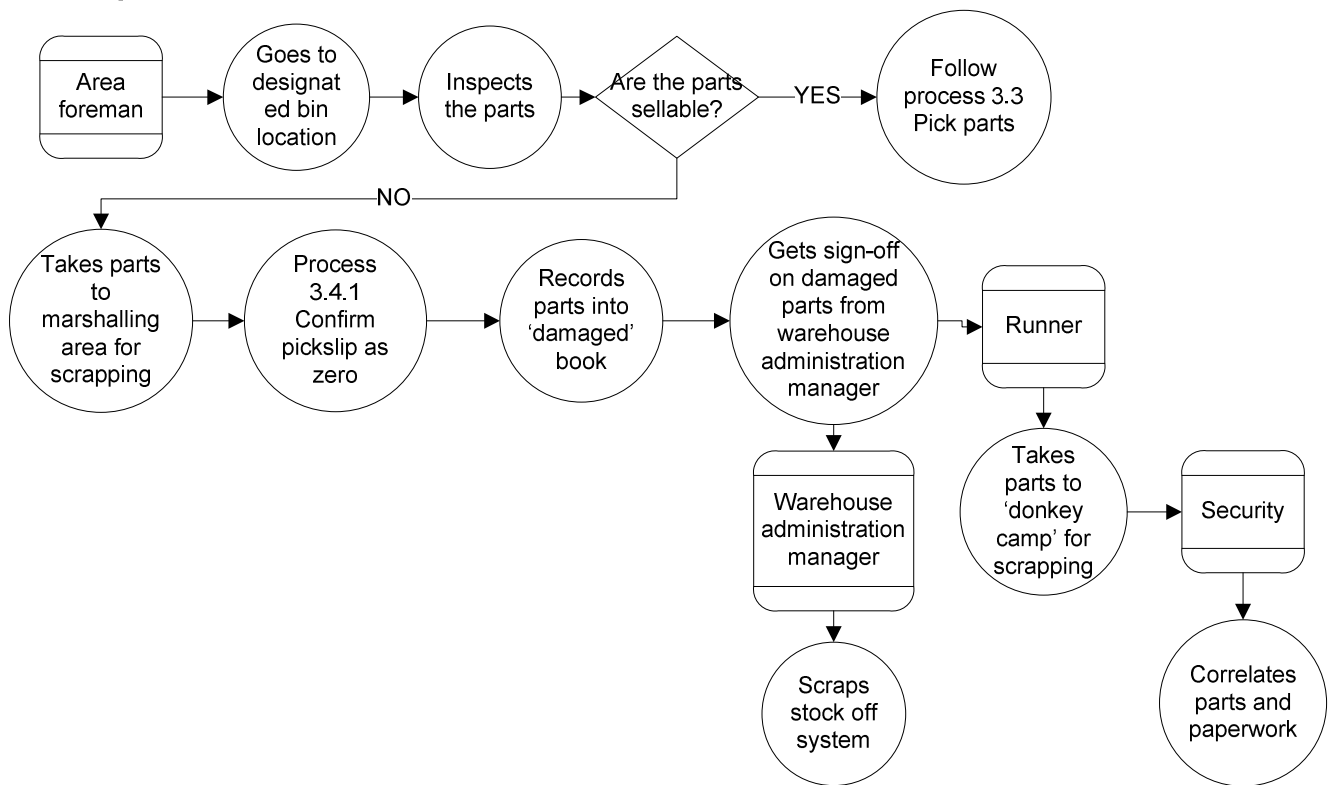
Damaged parts follow-up

Figure 3.18: Process 3.0 – Damaged parts follow-up

Before the picking process can begin, pick slips need to be printed first. If this simple process is optimized it can save time that can directly be used for actual picking. Analysis of the current printing process follows:

Printing Process Analysis

The printing process was analysed using time studies and manually recorded information.

The following inefficiencies were identified:

- Printing waiting time
- Small print batch sizes

Actual printing waiting time accounts for over 2 hours wasted per day for the printing operator. The printing operator is currently not able to print more than approximately 500 lines as it results in the system going down / hanging and a production stoppage. This has resulted in the printing of smaller batch sizes. Printing smaller batches creates inefficiencies in picking i.e.

- Poor picker routing
- Increased pick slip sorting and handout time

A sophisticated IT project needs to be developed to the issues regarding printing batch sizes and printing time. For the scope of this project this will not be looked into further.

3.3.1 Picking analysis

Time studies of the physical picking process in all warehouse areas were undertaken in the analysis of this process.

It includes physical observations of over 10 hours of picking as per the following:

- Classifying total time spent on picking into activities that make up the picking process

- Further classifying picking process activities as either value adding or non-value adding

The Table below represents a breakdown of the picking activities and the percentage of picking operators time taken up by each activity. Activities are classified as either value adding *(VA)* or non-value adding *(NVA)*.

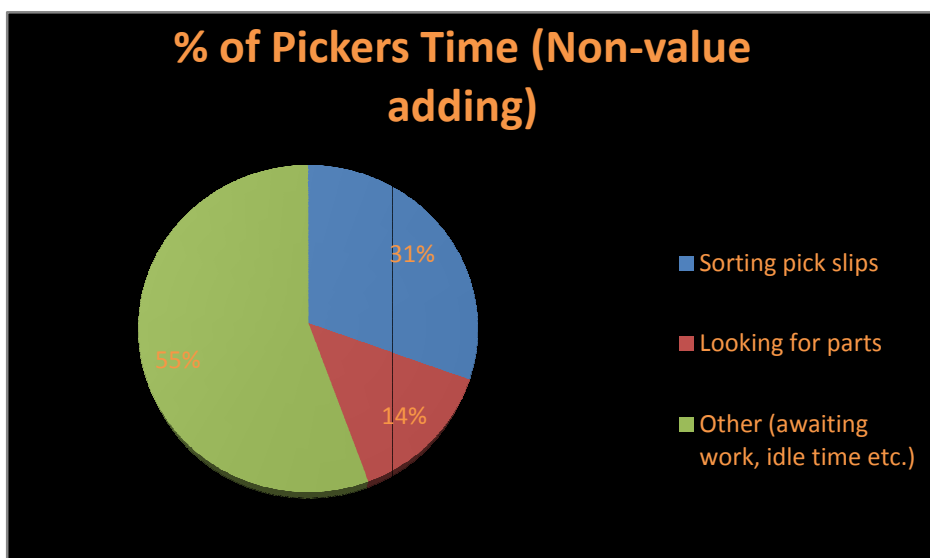| Activity	% of Pickers Time (Value adding)	% of Pickers Time (Non value adding)
Picking time	59%	0%
Delivering stock to dispatch	5%	0%
Sorting pick slips	0%	11%
Looking for parts	0%	5%
Other (awaiting work, idle time etc)	0%	20%
Total	**64%**	**36%**

Table 3.1: Picking time study

Figure 3.19: Non-value adding time

30

Awaiting work and idle time is the largest contributing factors to non-value adding (NVA) time. Sorting of pick slips also accounts for *11%* of NVA time. Total NVA = 36%, and VA = 64%.

The picking process was analysed using the system data as follows:

- Picks per warehouse areas

- Picking per day

- Productive hour picking

Picks per warehouse areas

Analysis of all areas being picked showed that 87% of total lines are picked from the Mezzanine, Linpic and H-Area. These warehouse areas were thus the focus of the picking analysis. Table 3.2 shows the percentage picks in all areas of the warehouse.

Area	% Picks
Mezzanine	34%
H-Area	37%
Linpic	16%
Area 10	3%
Protective store	7%
Outside Area	2%
Total	**100%**

Table 3.2: Area picking percentages

Picking per day

The amount of lines picked per day was analysed to obtain an average or benchmark. This average indicates the number of lines picked at a certain time of day. This amount will serve as a benchmark when improvements and changes are made.

Picking was considered over all areas of the warehouse, but specifically on the Mezzanine and H-area.

The Figures below (3.20 & 3.21) represent a sample of picking in Mezzanine and H area. Points to note are as follows:

- Slow starting / ending picking rates between 07h00 - 08h00 due to 5S management and green area meetings.
- Low picking rates at tea / lunch times, therefore a need to analyse picking only within full production hours.
- High variability in picking. Require more consistency over the hours of the day.
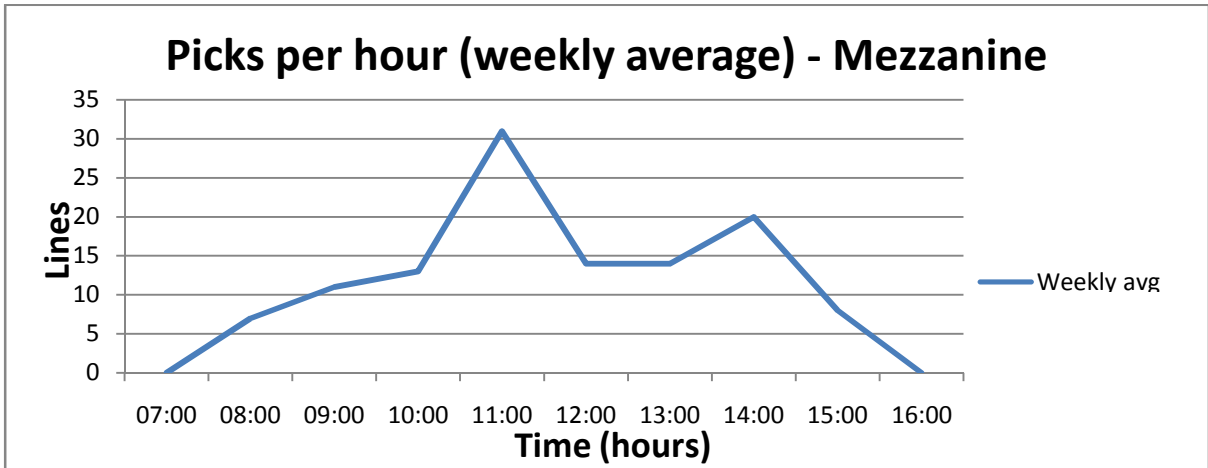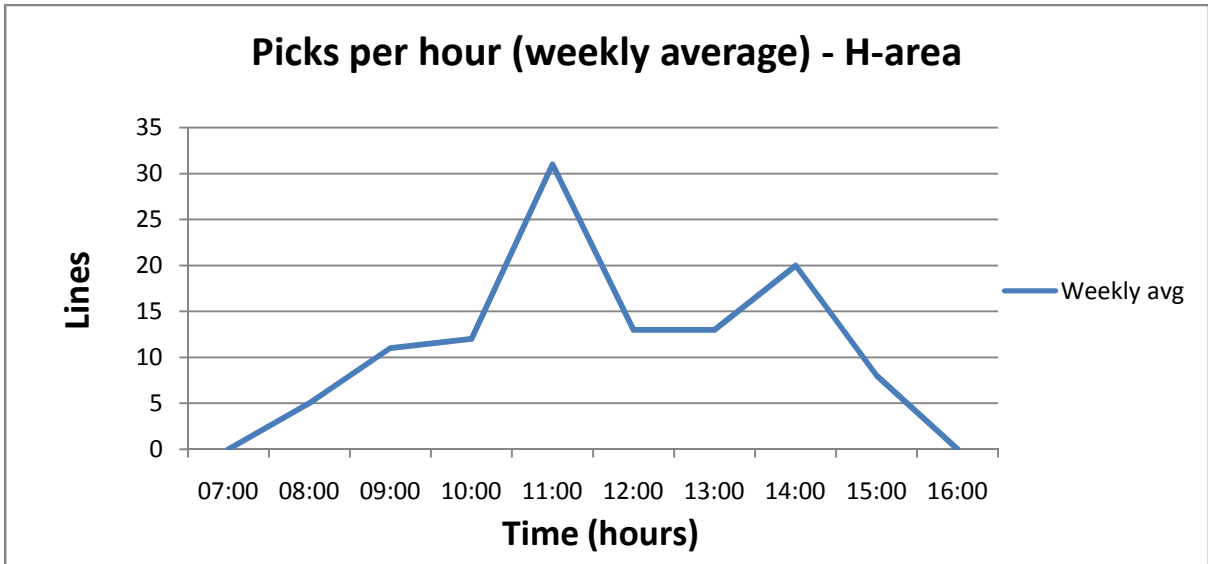
Figure 3.20

Figure 3.21

This represents the average picking rate achieved over the entire day. This analysis does not give a true reflection of what picking rates are potentially achievable per day. This highlighted the need to analyse picking with fully productive hours.

Productive hour picking

The picking process was analysed using system data as supplied by NSA. This analysis was prepared by grouping the picks per hour, then isolating and analyzing only the full productive hours as follows:

- Exclude the following hourly intervals:
    - 07h00-08h00, 09h00-10h00, 12h00 – 13h00
- Include the following "fully productive" hourly intervals:

- 08h00 – 09h00, 10h00 – 11h00, 11h00 – 12h00, 13h00 – 14h00, 14h00 – 15h00, 15h00 – 16h00

The following figure represents the average picking for the productive hours for consecutive days in the mezzanine & H-area.
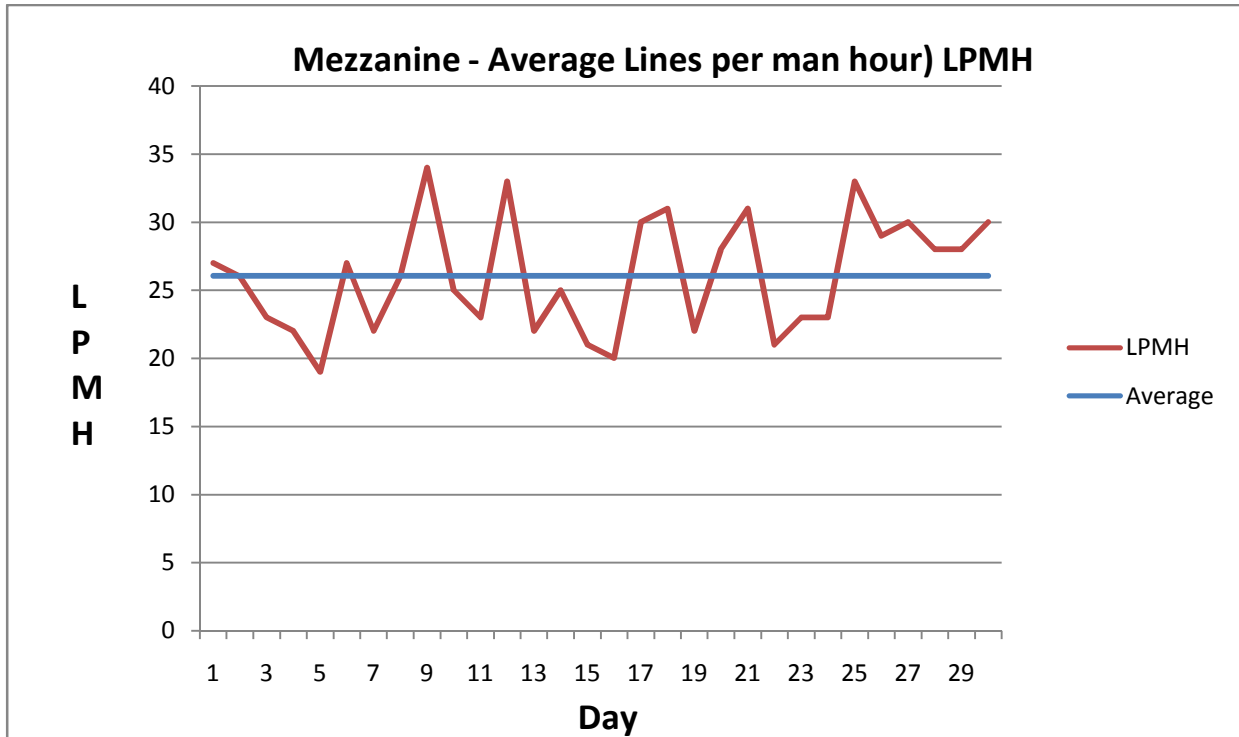

Figure 3.22

Figure 3.22 shows that the average lines picked per hour always remain close to the target of 27 LPMH. This is due to the fact that foremen hand out pick slips to operators in hourly batches of approximately 27 – 30 lines.

The following figures represent the picking performance during certain hours of the day; note that the blue line is the proposed target.
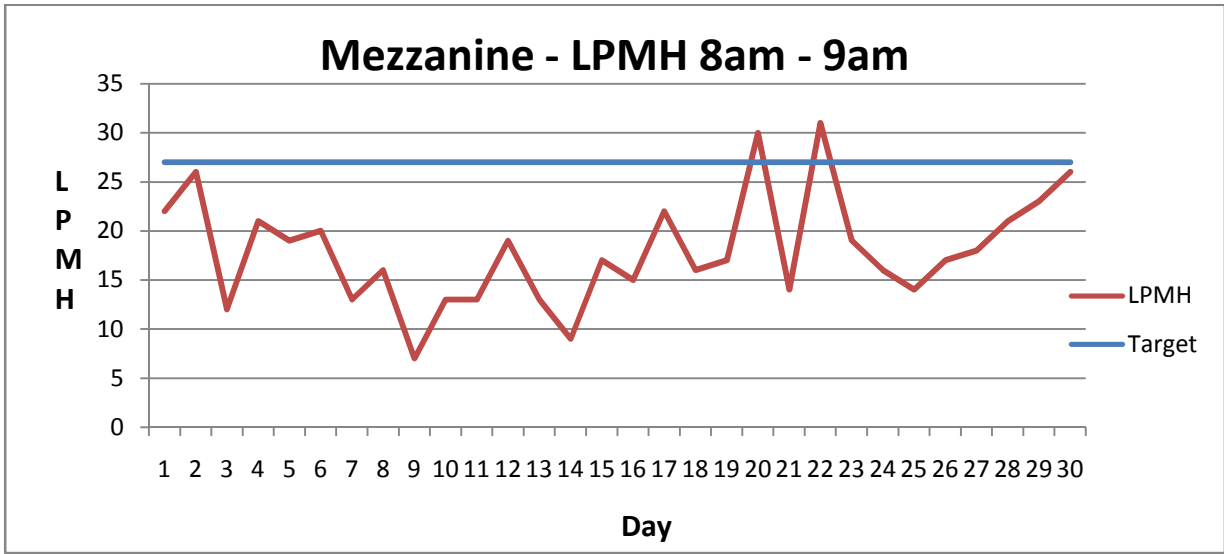
Figure 3.23 shows that the picking is generally slow between 08h00 & 09h00.
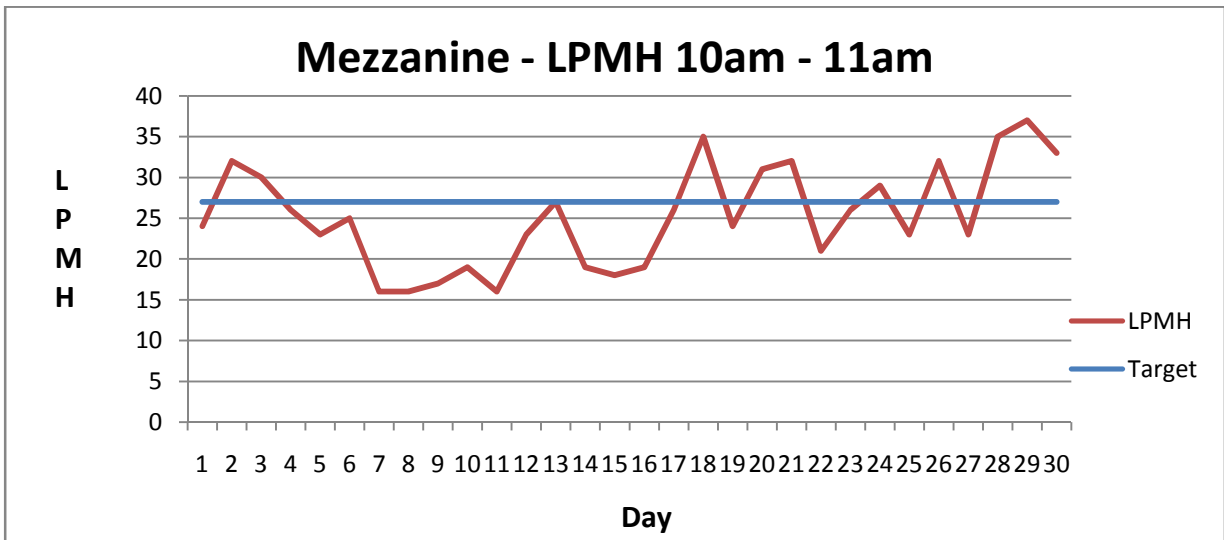
Figure 3.24 above shows that the picking between 10h00 & 11h00 remains around the target of 27 LPMH.

The figures below (3.25 & 3.26) show erratic picking between 11h00 & 12h00 and 13h00 & 14h00, with productivity far above the target being achieved at times.
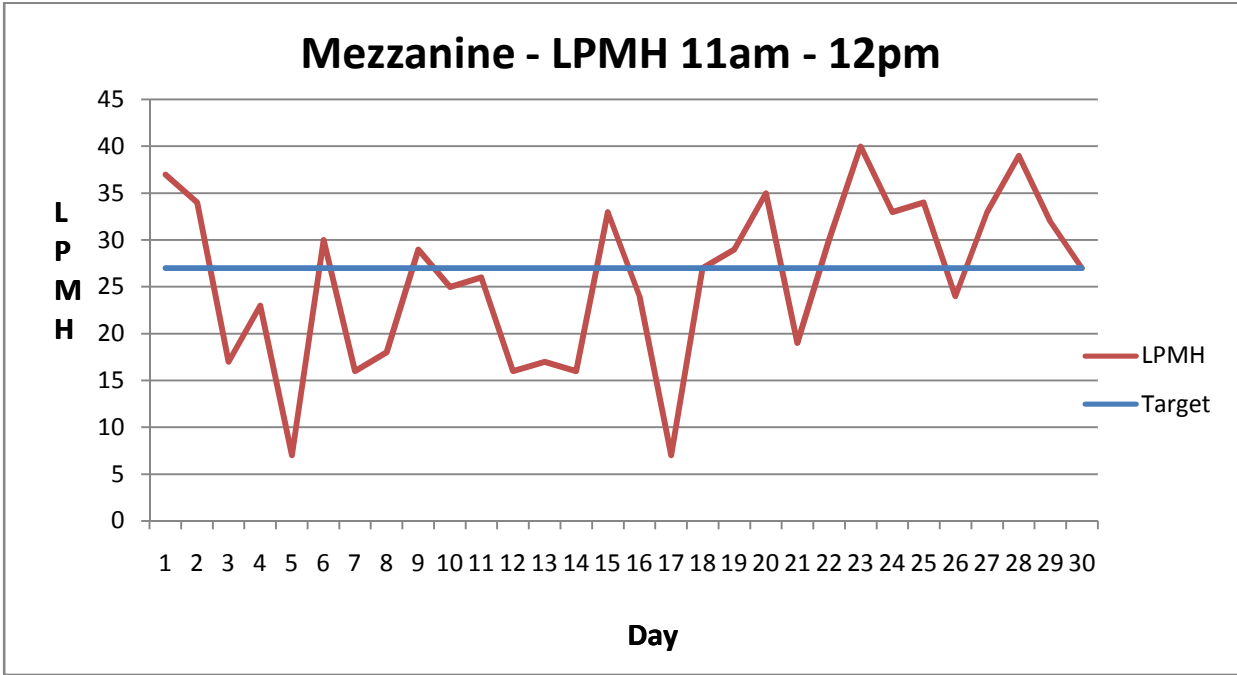
Figure 3.25
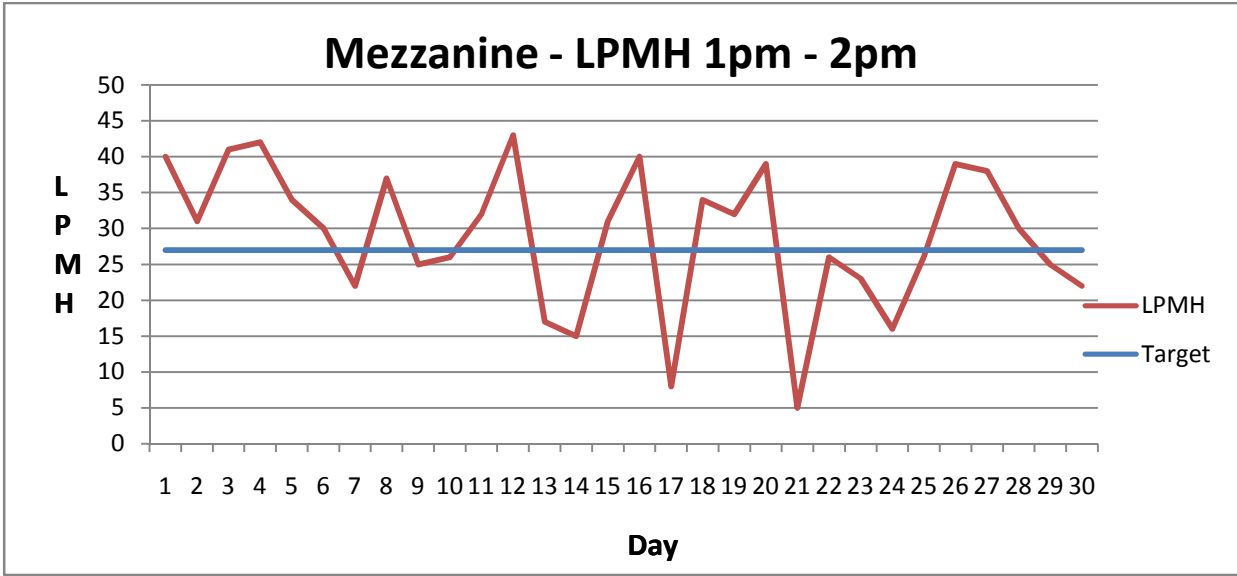
Figure 3.26

All the above information will serve as a basis for improving the picking process.

3.3.2 Analysis summary

Below are the key findings of the picking investigation:

- Awaiting work and idle time is the largest contributing factors to non-value adding (NVA) time. Total NVA = 36%, and VA = 64%
- High variability exists in picking rates achieved. The current picking rate far exceeds the requirement at certain times; however the high incidence of inefficient picking time reduces the overall picking performance of the warehouse. This variability exists because of the different size, weight and dimensions of the parts.
- The picking workload is not evenly spread throughout the day. Because picking occurs in zones, some picker may experience a larger workload. It is important that the workload be divided evenly and to use idle pickers in other zones.

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Chapter 4: Improvement and recommendations

Chapter 1: Introduction	Chapter 2: Literature Review	Chapter 3: Current warehouse operations	Chapter 4: Improvement & recommendations
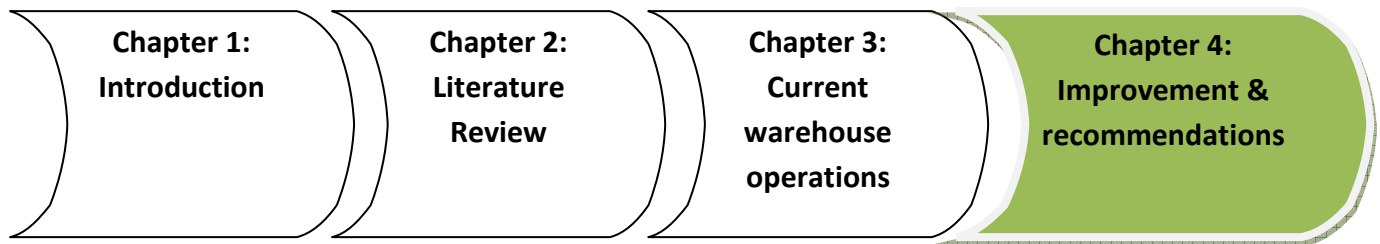
4.1 Areas for improvement

Based on a detailed analysis of the current warehouse operations, several opportunities were identified for improvement. These opportunities are divided into the different aspects of the warehouse. They include:

Receiving

- There is insufficient space in the receiving and sorting area. This is the starting point of the operations and needs to be improved.
- After parts are sorted, they are not properly stored when waiting to be binned. This can cause parts to be misplaced or damaged.

Picking

- Pickers still spend too much time walking, further inspection is required.
- Introduction of conveyors into the picking process can improve productivity.
- Automation at certain parts of the process can provide much faster and more accurate picking (pick-to-light system)
- Automated picker routing

Binning

- Part locations need to be managed according to their size.
- Information such as weight and dimension regarding parts should be known to establish its optimal storage location.
- When parts are stored, it is important that the label (barcode) faces forwards. This will maximize efficiency when identifying parts.
- Longer parts can rather be stored in an upright position to ensure maximum floor space.

- Some parts are hanging out of bins. This may be a result of wrong bin sizing or bins being over stored. Inspection is required to pin point the exact causes.

Management

- Standard operating procedures should be put in place and enforced daily by the relevant personnel.
- Standard times should be set for all activities and managed effectively.

5S Standards

The 5S control cycle at NSA is a great initiative to ensure a safe and clean environment for all to work in. This includes:
1. Sort – Clearly distinguish needed items from unneeded items and eliminate the latter.
2. Set in order – Keep needed items in the correct place to allow for easy and immediate retrieval.
3. Shine – Keep the workplace clean and free from waste.
4. Standardise – Maintain a condition for the first 3 S's by setting the standards and educating staff to these standards.
5. Sustain – Make 5S a habit and part of everyone's daily work.

It is the responsibility of every employee to take it upon himself to follow the 5S activities. But management must ensure and encourage them to keep applying these standards for ongoing efficiency.

4.1.1 Receiving

The Nissan parts warehouses' demand for all car parts has increased by 11% since 2010. This increase will result in even less available space for operations. The current warehouse layout does not allow any extra space for receiving activities. NSA would also like to keep the facility unchanged, and focus on how to maximize available space.

People, managers and workers, often neglect the little things that can make a huge impact on operations. They also require almost no investment, just good discipline. In the Nissan parts warehouse this is the case.

Proper training of employees is inexpensive and can save a lot of money. Ensuring that all employees are capable and knowledgeable, it will ultimately save money. Sufficient communication between employees and management will results in further improvement of operations.

Good housekeeping is another aspect that can make a difference. It will improve productivity and safety. The 5S standards mentioned earlier addresses these shortcomings. By placing posters depicting the 5S standards in the receiving area (and all over the warehouse where good

housekeeping is critical) it can greatly improve employee awareness which will lead to an increase in productivity.

Regarding tools, the last thing the manager needs is for an employee wandering the warehouse looking for the appropriate tools. Workers spend most of their time at their workstation, therefore by having their tools nearby at an accessible area is essential. An easy to access trolley needs to be placed in the receiving area containing all the relevant tools.

Finally after parts have been received, they need to be properly stored before being binned. At Nissan there are several goods standing openly on the floor in the marshalling area, and are prone to damages. A specific area needs to be laid out (by way of paint on the floor will suffice) where the goods can be placed while waiting to be binned. The goods can also be placed on wooden pallets for further protection. By doing these simple things, damages and misplacement of goods will be virtually eliminated.

4.1.2 Binning

Currently the time spent by parts standing in the marshalling area waiting to be binned is too long. The receiving and binning processes need to be integrated. This means that stock is binned as it is received and that the receiving and binning processes are managed as one, with the daily objective of unpacking and binning all receipts for the day so that the floor is clear at day end.

Throughout the warehouse there are bins where parts are hanging out of them. It is recommended that the current bin maintenance team place more emphasis on this issue. This will reduce binning discrepancies and allow for an optimised binning process.

As with the receiving process, by focusing on the little things, improvement in productivity can be achieved. By simply making sure that the binned products faces forward (with barcode), the productivity of the picking process is increased. Big and heavy parts should be stored in the bottom bins, this will ease the picking process as well as protect the bins (currently, bulky parts are stored in higher placed bins and damage the bins and racks). Ultimately it will also decrease maintenance issues.

4.1.3 Picking

4.1.3.1 Automated picker routing

Automated picker routing is an initiative that ensures all pickers follow the most efficient route for each pick wave. It changes the sequence of pick slip printing in order to optimally route pickers automatically. This means that when a picker acquires his pick slip, the parts are listed in such a way that allows him to pick the first part on the pick slip, and continue on to the next one. Thus parts are picked in the same order as they appear on the pick slip. It will eliminate current picker sorting time by up to 20% and reduce walking time by 18%. See Table 4.1 (Current operations) and Table 4.2 (With automated picker routing).

Current operations

H - Area picking				Time per line (s)	Time per batch (s)	%
Current process as observed on 43 lines picked						
Process						
Sorting & tearing slips				13	580	15
Walking time				36	1538	40
Looking for parts				2	106	3
Scan Bin, Part and quantity				24	1020	26
Stick slip and place item on pallet				15	632	16
Total time				**90**	**3876**	seconds
Lines picked		43				
LPMH		40				

Table 4.1 Current operations

With automated picker routing

H - Area picking			Time per line (s)	Time per batch (s)	%
Current process as observed on 43 lines picked					
Process			Time per line (s)	Time per batch (s)	%
Sorting & tearing slips			10	450	13
Walking time			30	1280	37
Looking for parts			2	106	3
Scan Bin, Part and quantity			24	1020	29
Stick slip and place item on pallet			15	632	18
Total time			**81**	**3488**	**seconds**
Lines picked	43				
LPMH	44				

Table 4.2 With automated picker routing

It is evident from the two tables above that by simply introducing automated picker routing the picking output can increase by 4 lines per man hour, a 10% improvement.

4.1.3.2 The pick-to-light system and Vertical Lift Module (VLM)

The main focus of this study is on the picking process and how to improve productivity. NSA still uses handheld scanners and hardcopy pick slips for all their picking operations. This is not very efficient and it's prone to human error. This can be combated by introducing a pick-to-light system.

In a pick-to light system the picker will scan a barcode label that is attached to tote/carton. The system will then show a digital display in front of every bin. This display will notify the picker the part and quantity that needs to be picked. By implementing this system, productivity can be greatly improved, up to four times. And human errors are practically totally eliminated, with picking accuracy of up to 99.5+%.

The question however, is in what areas to implement a pick-to-light (PTL) system. It is a very sophisticated system and will be a huge investment. It is thus critical to only introduce a pick-to-light system where it is urgently needed.

Figure 4.1 below shows how a typical digital display looks. It shows the quantity that needs to be picked and has an increment/decrement and send button. The increment/decrement button is used when the amount that needs to be picked isn't available. The picker then inserts the quantity that he has picked. Finally the send button is used when picking of the product is finished. All picks are recorded in real-time.
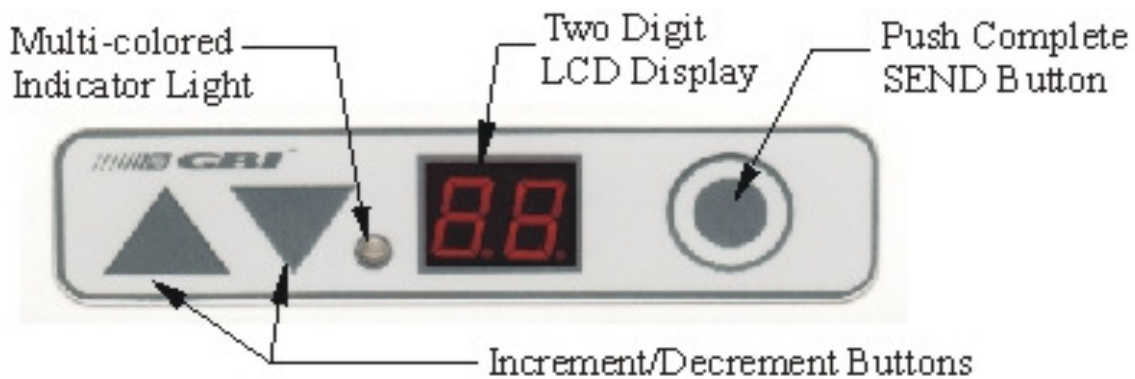
Figure 4.1

From Table 3.1 it is evident that most picks occur in the H-area, mezzanine and linpic areas. It would thus make sense to implement a PTL system in these areas.

Linpic

The linpic area uses an automated carousel to house parts, and pickers wait on average approximately 1 minute to pick a certain part. A PTL system will be especially beneficial here. After the barcode has been scanned the picker doesn't need to wait for a certain part, but simply continue picking until that part is available. With picking of such small parts, productivity can be improved by up to four times.

Mezzanine

Another area where a PTL system can be very valuable is the mezzanine area. This area houses relatively small parts and account for 34% of total picking.

Current picking operations for Mezzanine area

Mezzanine Picking			Time per line (s)	Time per batch (s)	%
Current process as observed on 32 lines picked					
Process			**Time per line (s)**	**Time per batch (s)**	**%**
Sorting & tearing slips			6	189	8%
Walking time			35	1112	47%
Looking for parts			7	213	9%
Scan Bin			3	107	5%
Scan Part			7	221	9%
Confirm quantity and place part			9	291	12%
Stick slip			7	237	10%
Total time			**74**	**2366**	seconds
Lines picked		32			
LPMH		49			

Table 4.3 Current operations

Mezzanine picking with conveyor

Mezzanine Picking			Time per line (s)	Time per batch (s)	%
Current process as observed on 32 lines picked					
Process			**Time per line (s)**	**Time per batch (s)**	**%**
Sorting & tearing slips			6	189	8%
Walking time			22	710	30%
Looking for parts			7	213	9%
Scan Bin			3	107	5%
Scan Part			7	221	9%
Confirm quantity and place part			9	291	12%
Stick slip			7	237	10%
Total time			**61**	**1968**	seconds
Lines picked		32			
LPMH		59			

Table 4.4 With conveyor

Table 4.3 & 4.4 show the difference in time (seconds) between the current process and one with the implementation of a conveyor. It is evident that the same amount of lines has been picked, but the time in which it happened decreased. The LPMH have increased from 49 LPMH to 59 LPMH, representing a 21% increase in productivity/efficiency.

The lines per man hour (LPMH) were calculated as follow:

1 hour = 3600 seconds

Thus 3600 s / 1968 (total time) x 32 (lines picked) = 59 LPMH

H –area

The H – area houses medium-to-large parts. Included in this area is the "golden aisle". This area includes the parts that get picked most often. It is thus recommended that a PTL system be installed here as well. However, it is not necessary to implement a PTL system throughout the entire H – area, but only the "golden aisle" and the first few bins of this area. This is because fast-moving parts are stored in these first few bins and not the entire area.

VLM

According to APC Storage Solutions, the CLASIMAT Automated Vertical Warehouse works on the basis of the "product to man" principle and uses the available height to the maximum extent, occupying a small area. It consists of a vertical load-bearing structure, in which trays with products are stored. Thanks to the use of a shuttle, the movements of items delivered to the picking station and picked from there are carried out automatically.

Some advantages include:

- **Space saving.**

    The loads are stored vertically, which is why it occupies a small area in the stockroom. The optimisation of free spaces for trays (the height of a load is taken into consideration) enables the maximum use of the available volume.

- **Time saving.**

    The product is transported directly to the operator, who does not have to change his place or use any auxiliary lifting devices. It considerably reduces the time of order preparation.

- **Cost saving**
    Owing to the time saved on preparing orders, the reduction in the amount of unnecessary stock (constant inventorying), the reduction in errors and merchandise

damage which occur during preparation of orders, the warehouse management related costs are also decreased.

- **Computerised management of the stored merchandise.**

  The central computer equipped with specially designed software controls all the movements of a product. Each operation is registered in the system (receptions and deliveries, picking etc.). In this way the inventorying is carried out systematically and the stock management is very simple.

- **Safety of the stored merchandise**.
  Loads stored inside the automated warehouse are protected against improper manipulation (the occurrence of unbalanced warehouse), becoming dirty, chemical products action, collisions and theft. The software registers the data of each user operating the warehouse and all the warehouse movements that have been carried out.

- **Minimum number of errors**
  The process of identification of merchandise on the tray is carried out with the use of a coordinate system (numbers at the front and letters on the side), which indicates to the user the position of a specific item on the tray.
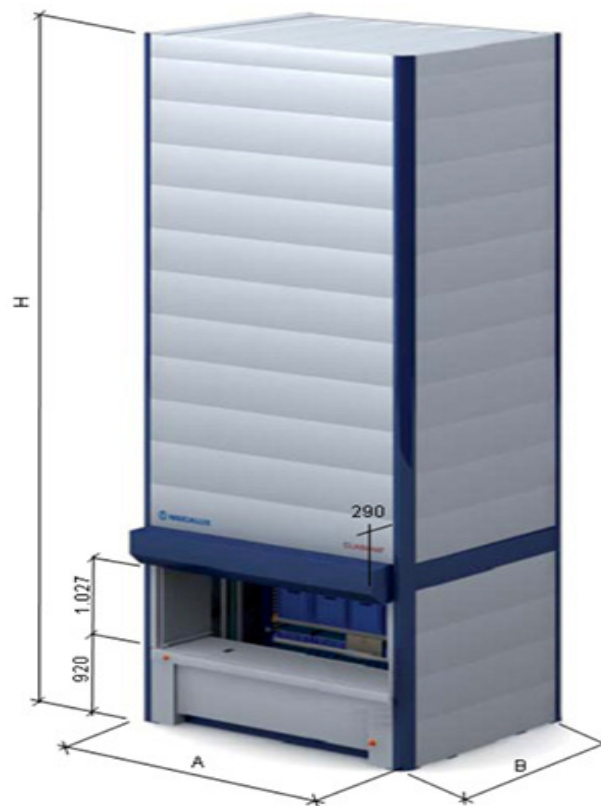

Figure 4.2 CLASIMAT

The control panel is a single-user computer. It has a TFT 17" screen, on which all the information required by the operator is perfectly visible, and a keyboard with an integrated mouse. The panel enables work and improves the management system. (APC Storage Solutions)

Figure 4.3 Control panel

Maintenance

The picking station along with all the electrical and control components can be moved, thanks to which convenient and direct access to most mechanisms is obtained. The control cabinet can be accessed from the upper part of the table. After the removal of the lid above the table, direct and convenient access to the electrical and control components of the machine is obtained. If necessary, it is possible to disassemble some outer cladding panels in order to obtain access to the other mechanisms. (APC Storage Solutions)

Where to implement

The CLASIMAT is ideal for smaller components, such as the ones to be found in the mezzanine and linpic areas. The CLASIMAT allows the picker to stay positioned in one area and the parts are brought to him. The picker scans the order pick slip and all parts are picked by the VLM. This completely eliminates walking time, scanning and looking for products. According to APC Storage Solutions, the CLASIMAT can pick up to 750 LPMH, which is 28 times more than the current average.

According to APC Storage Solutions, it will require 12 VLM warehouses to provide enough space for all parts in the mezzanine area. Because of the relatively large initial investment (R 596 457.32 per CLASIMAT), it is suggested that only the top 20% parts (most popular parts) of the mezzanine area be placed in the VLM warehouse, that is 3 VLM's.

Another benefit is that all parts stored in the VLM warehouse are safe, thus the current protective store area (area for high value parts with high risk of theft), can now be replaced by the VLM warehouse. This will decrease the man power in the current protective store by 3 security guards and 2 Nissan employees, and improve warehouse space utilisation.

4.1.3.3 Layout changes to improve picking

One of the main factors contributing to the total time in the picking process, is the time (distance) spent walking by pickers. If the walking distance of pickers can be reduced, the time saved can contribute to the actual picking of parts.

Currently pickers walk from the point of receiving their pick slips, through the picking of parts and finally to the dispatch area. By introducing conveyors at key parts of the warehouse, walking distance will be reduced.

Because of the size of certain parts in the H – area, introducing a conveyor here will be impractical. For the linpic and mezzanine areas however, it will make sense. Because pickers pick according to a customer order in their zone, the entire order still needs to be consolidated at the dispatch area. This requires even more time to get the final order right.

Take the linpic and mezzanine area for example. If all pickers in these areas pick for the same order, they can pick the required parts and place them in a tote/carton and move them on to the next zone. Each picker then fills the tote/carton with parts from his zone for that specific order. After the order is complete, the tote/carton gets conveyed to the dispatch area. This saves a lot of time in walking distance and increases the LPMH. (Refer to *Appendix A.3* for layout changes in terms of conveyors)

The ideal conveyor would be a normal stainless steel roller conveyor. Because parts in this area are quite light, it can be passed on easily to the next picker. Roller conveyors are affordable and easy to maintain.

Currently, actual picking time accounts for 59% of the process. Approximately 30% of the total 59% is walking/travelling time. Implementation of conveyors at the correct areas will reduce walking time and in return improve productivity.

Steel roller conveyors can be placed on the west side of the mezzanine and linpic areas (refer to *A.3 Layout changes (Conveyor)*). Upon completion of a pick slip, the picker simply places his tote/box on

the conveyor that moves the package to the shipping area. This will allow pickers to stay in their designated zones and spend more time on pure picking and significantly reducing walking time.

4.1.3.4 Proposed solution

After detailed analysis and careful consideration, the optimal solution to improve picking operations is to combine the vertical lift module (VLM) with the conveyors, and implement the automated picker routing system (specifically in the H-area). Three VLM warehouses should replace 20% of the most popular parts in the mezzanine area, while a conveyor should be placed next to the mezzanine and linpic areas (west side) that lead all the way to the shipping area. Refer to *A.3 Layout changes (Conveyor)* for the visual layout.

Considering 87% of the picks in the warehouse (H-area, mezzanine and linpic areas), the following conclusions can be made:

Area	% Picks and Lines Per Man Hour	Number of picks
H-area	Accounts for 37% of total picks @ approximately 28 LPMH	Picks coming out of H-area = 28 LPMH x 37% = 10.0 LPMH
Mezzanine area	Accounts for 34% of total picks @ approximately 28 LPMH	Picks coming out of mezzanine area = 28 LPMH x 34% = 9.2 LPMH
Linpic area	Accounts for 16% of total picks @ approximately 60 LPMH	Picks coming out of linpic area = 60 LPMH x 16% = 9.6 LPMH
Total	**87%**	**28.8 LPMH**

Table 4.5: Current picking productivity

Thus for 87% of the warehouse the current productivity is 10.0 LPMH + 9.2 LPMH + 9.6 LPMH = 28.8 Lines Per Man Hour

With implementation of 3 VLM warehouses, automated picker routing and conveyor:

Area	% Picks and Lines Per Man Hour	Number of picks
H-area	Accounts for 37% of total picks @ approximately 31 LPMH	Picks coming out of H-area = 31 LPMH x 37% = 11.5 LPMH
Mezzanine area 1	Accounts for 20% of the 34% of total picks @ approximately 750 LPMH	Picks coming out of mezzanine area 1 = 750 LPMH x (34% x 20%) = 51.0 LPMH
Mezzanine area 2	Accounts for 80% of the 34% of total picks @ approximately 37 LPMH	Picks coming out of mezzanine area 2 = 37 LPMH x (34% x 80%) = 10.0 LPMH
Linpic area	Accounts for 16% of total picks @ approximately 60 LPMH	Picks coming out of linpic area = 60 LPMH x 16% = 9.6 LPMH
Total	**87%**	**82.2 LPMH**

Table 4.6: Proposed picking productivity

The mezzanine area is split into two, because only the top 20% of parts (mezzanine area 1) are going to be housed in the VLM warehouses. The other 80% (mezzanine area 2) are stored normally.

Thus for 87% of the warehouse the productivity is increased to 11.5 LPMH + 51 LPMH + 10.0 LPMH + 9.6 LPMH = 82.1 Lines Per Man Hour. That is an improvement of 53.3 Lines Per Man Hour. It is mainly because of the vast increase in picking due to the VLM warehouses; however this is the maximum productivity that can be achieved and a little less is practical. It is reasonable to assume that an average of 70 Lines Per Man Hour can be achieved.

Total cost of proposed solution

Improvement proposal		Cost
VLM warehouses	3 x R 596 500.00	R 1 789 500.00
Conveyor	75m x R 2 250 / m	R 168 750
Automated picker routing		0
Total cost		**R 1 958 250.00**

Table 4.7 Total capital cost

4.2 Conclusion

With the suggested solution implemented, Nissan can reduce their picking force from 17 pickers to 13 pickers. That is a direct saving of R 2 400 per picker per week, based on Nissan wage information.

Assuming that employees work for a total of 48 weeks per year, Nissan will save R 460 800 per annum on direct labour costs. Another improvement is that parts are stored safely. Currently about 1% of parts gets damaged or stolen. With the VLM warehouses, about R 222 000 [2] is saved per year. Financially it means that the implemented system will be paid for in 2.2 years.

The overall productivity has also increased drastically, from approximately 3200 lines picked per day to 9500 [1] lines per day, an increase of 197%. This will establish Nissan as a market leader and retain more customers due to the speedy service at which they will operate.

Improvement proposal	Cost	Benefit
Vertical Lift Module (3)	R 1 790 000	• Labour saving • Stock accuracy and preservation
Conveyor	R 168 750	• Reduced walking distance
Automated picker routing	R 0	• Picking productivity improvement
Total	**R 1 960 000**	

Table 4.8: Cost/Benefit

Savings	
Direct labour costs (4 pickers)	R 2 400 x 48 weeks = R 460 800
Stock preservation	R 222 000
Total	**R 682 800**

Table 4.9: Savings

9. References
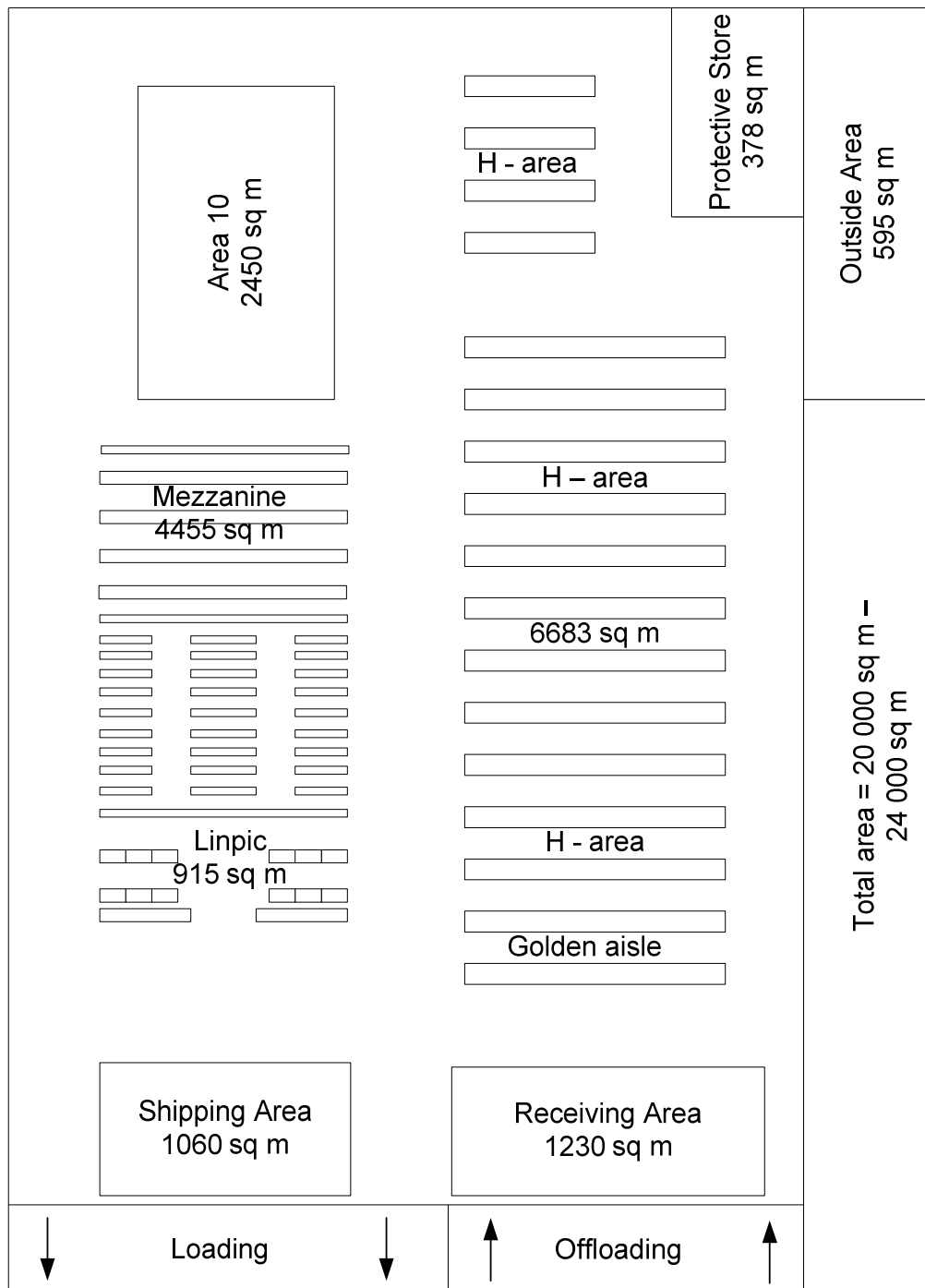
[1] Corporate information, Nissan South Africa, viewed 15 July, 2011, <http://www.nissan.co.za/en/web/header/header_1351.htm>.

[2] Gray, S. (2011, October 6). Sales manager, APC Storage Solutions. (Interview)

[3] Jenkins C., 1990, *Complete guide to modern warehouse management,* Prentice Hall, New Jersey

[4] Modiselle, P, Haffner, C, Krause, J, (2011, June – October), Nissan South Africa. (Employees)

[5] NetMBA 1999, NetMBA Business Knowledge Center, viewed 25 July 2011, <http://www.netmba.com/mgmt/scientific/>

[6] Order picking, viewed 2 October, 2011 <http://www.inventoryops.com/order_picking.htm>

[7] Pick-to-light system, and Figure 4.1, viewed 12 September, 2011, <http://www.gbisorters.com/paperles.htm>.

[8] Salvendy G. (Editor in Chief),1992, *Handbook of industrial engineering,* 2nd Edition, Wiley, Canada

[9] Schroeder, 2008, INTRODUCTION to Operations Management, 4th ed, The McGraw-Hill Companies, Inc.

[10] Tompkins, J, White, J, Bozer, Y & Tanchoco, J 2010, Facilities Planning, 4th ed, J. Wiley & Sons, Inc.
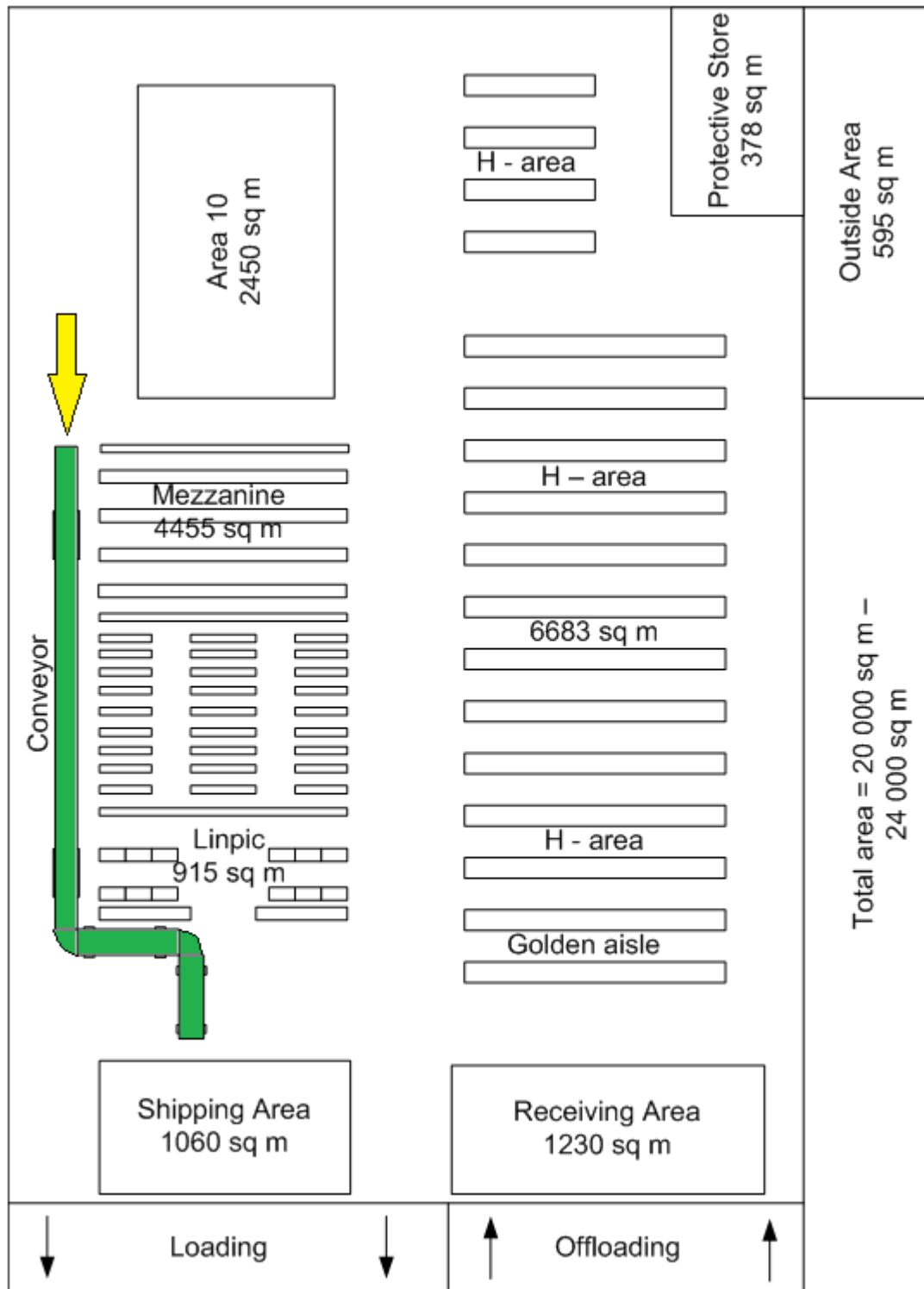
Appendix A

A.1. Gantt chart

ID	Task Name	Start	Finish	Duration	Jul 2011				Aug 2011				Sep 2011				Oct 2011				Nov 2011
					10/7	17/7	24/7	31/7	7/8	14/8	21/8	28/8	4/9	11/9	18/9	25/9	2/10	9/10	16/10	23/10	30/10	6/11
1	Project proposal	2011/07/20	2011/08/10	16d																		
2	Preliminary literature review	2011/07/15	2011/08/01	12d																		
3	Preliminary project(Interim project report)	2011/08/12	2011/09/12	22d																		
4	Final project report	2011/09/14	2011/10/10	19d																		
5	Improvement of report	2011/08/10	2011/10/10	44d																		
6	Final presentation & oral exam	2011/10/12	2011/11/01	15d																		

A.2. Current warehouse layout

Area 10
2450 sq m

Protective Store
378 sq m

Outside Area
595 sq m

H - area

H – area

6683 sq m

H - area

Golden aisle

Mezzanine
4455 sq m

Linpic
915 sq m

Total area = 20 000 sq m –
24 000 sq m

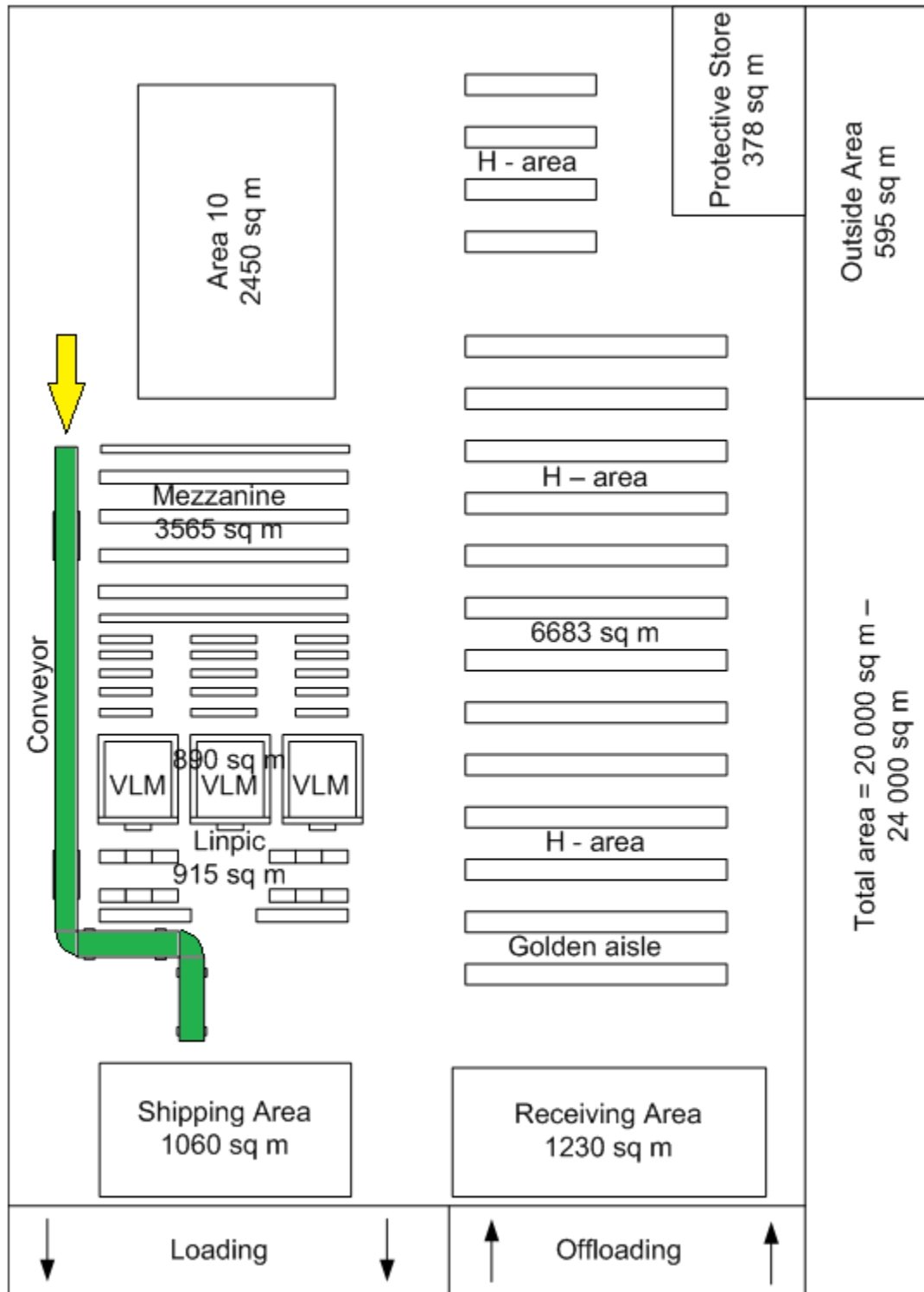Shipping Area
1060 sq m

Receiving Area
1230 sq m

Loading

Offloading

A.3. Layout changes (Conveyor)

A.4. Layout changes (Conveyor & VLM)

A.5. Calculations

1. Lines picked per day:

H – area = 31 LPMH x 8h x 5 pickers = 1488 lines per day

Mezzanine area = (750 LPMH x 8h x 1 picker) + (37 LPMH x 8h x 3 pickers) = 6888 lines per day

Linpic area = 60 LPMH x 8h x 1 pickers = 480 lines per day

 Other areas = 27 LPMH x 8h x 3 pickers = 648 lines per day

Total = 9500 lines per day

2. Amount saved in damaged/stolen parts:

 R 2 500 000 (value of parts picked per day) x 5 days a week x 48 weeks = R 600 000 000 per year (value of picks per year)

Thus, R 600 000 000 x 0.5% = R 3 000 000 per year (lost due to theft/damages)

> R 3 000 000 x (37% x 20%) (VLM warehouses will house only some parts) = **R 222 000 saved per year**