**POLITECNICO DI MILANO**

**Scuola di Ingegneria Industriale e dell'Informazione - MI**

**Master of Science in Management Engineering**


# IMPROVE MATERIAL FLOW

**at**

**Cameron Italy S.r.l – Ledeen Facility**

**SCHLUMBERGER**

**Supervisor:** Prof. Alberto Portioli Staudacher

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## Acknowledgement

I am very thankful to **Professor. Alberto Portioli Staudacher** for giving this opportunity and for believing in me that I can able to make changes and optimize the process in an esteemed organization like Schlumberger. I would like to thank Academic supervisor **Ms. Fabiana Dafne Cifone** for the continuous support and valuable guidance throughout the project.

I would like to thank everyone involved in this thesis in Cameron's Ledeen Facility at Voghera, especially to Company tutor Grazia Morella and Warehouse Supervisor Mr. Marco Saccardi and his warehouse team.

Milan, February 2020

**This document does not contain any classified information**

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## 1. Abstract

Schlumberger has several manufacturing units across the world and each of them is managed individually to deliver products to internal/external customers within its locality and beyond. Schlumberger's Ledeen Facility at Voghera (PV) is specialized in Manufacturing of Actuators for Oil & Gas and Process Industries. Higher Lead Time in inbound material flow and Picking are the main issue of the Plant. The specifications for the Actuators are defined by the Customers and there are more than 400 components from different suppliers needed to assemble one. Such a high level of customization made it extremely difficult for Warehouse Operation to standardize the material movement inside the plant and streamline them for improved material flow.

This project deals mainly the flow management activities of the warehouse at Ledeen Facility and can be divided basically as follows:

Phase I: Inbound flow

Phase II: Outbound flow

The initial focus was to study the process involved in Inbound material flow and Picking activities and to map the current situation of each phase of the project. Cycle time was manually measured considering the Process and Queue activities for each process, as well as the Lead time for each activity. The A3 framework is followed as guideline for this project report. To identify the Root Causes of the problem quality tools were used such as Ishikawa diagram and 5 Why Analysis. Counter measures are proposed and impacts of the countermeasure on the current situation are studied and explained in detail. Effect and Benefit analysis carried out to prioritize the counter measures proposed. The future situation of the process is updated in Makigami Diagram and Spaghetti Chart by incorporating all the improvements.

## 2. Executive Summary

Understanding the power of A3 framework the companies adopts in several fields of operation in order to seek for continuous improvement process and make the process efficient by reducing lead time, scrap rate, improve productivity etc., This project work focuses on the improvement of the material flow in a warehouse at Cameron's Ledeen Facility at Voghera (PV), Italy. The work is structured into five sections following the A3 framework model.

The first part of the report briefs the company and context in which it operates, considering various aspects that can lead to a different strategic decision.

In the second part the report focuses on the Background of the problem as per the A3 framework. In this section, the current situation of Ledeen Facility warehouse department is explained in detail. Excessive Lead Time to Store the incoming materials is the main problem faced by the company. The problem of the excessive lead time in storing the incoming materials is indirectly affecting the performance of the Assembly department performance.

The analysis of the process was carried on by deeply examining the current situation and manually observing and measuring the cycle time of all the process involved in these two phases. Established the time sheet for tracking the cycle time for each activity involved. The activities are categorized as process and waiting/queuing.

Project target is to minimize the higher waiting with respect to the Assembly in inbound material movement and the average outbound material movement lead time in the warehouse department. further the targets are classified into must-to have and nice to have goals for ease approaching.

The target that was set out to be achieved needed an in-depth analysis of the root causes of the problem which was done in a systematic way. The root cause analysis (RCA) was carried out using Quality tools such as Ishikawa Diagram, 5 Why analysis and ABC Analysis. These methods were used to investigate the core of the problem having different perspectives to compare and integrate.

The Ishikawa diagram narrows down the problem by categorizing it under man, machine, method, measurement, material and management.

ABC analysis carried out to check the storage location based on the frequency of retrieval of the materials and compared it with the existing SAP data, which allocates the storage location for the materials.

The next part discusses the countermeasures which were decided to be implemented. Effect and Benefit analysis carried out to prioritize and implement the counter measures proposed.

The future makigami diagram is created with the proposed countermeasures which decrease the waiting time in the process.

In follow-up and conclusion part of the report summarise the entire project in Schlumberger, stating the problem, its root causes and the improvements. Also discuss some improvements for the future which can be made upon our proposals once all the recommendations are in place.

## 3. Description of the Company

Schlumberger is the world's leading provider of technology for reservoir characterization, drilling, production and processing to the oil and gas industry. Schlumberger supplies the industry's most comprehensive range of products from exploration through pore to pipeline for hydrocarbon recovery that optimize reservoir performance.

Focusing on the products, in Italy, there are three manufacturing units operating under Cameron, a Subsidiary company of Schlumberger. In Voghera there are two manufacturing facilities are in operation, Ledeen Facility and Grove Facility. Cameron's Ledeen facility at Voghera manufacturing plant manufactures different types of Actuators based on their applications. Cameron's Grove facility at Voghera manufacturing plant produces different types of valves. Another facility which is located near Bergamo is dedicated for the manufacturing of Sub Sea components.

The Actuators used to support major equipment's like separators and injections pumps, used to reduce large emissions of hazardous gases. Hence it is considered one of the main components in operation of Oil & Gas and Process industries. There are two main categories of Actuators at the Ledeen Facility: Subsea Actuators and linear Actuators, each of which are assembled by 300 to 400 different components from many suppliers. As of today, more than 500 companies supply the components needed in the Ledeen Facility.

The specifications for an Actuator are provided to the Company by Customers. As the production is totally tailored on customer request, there are very less standard Actuators and the supplier for each individual component differs from one another.

## 4. A3 Framework

The A3 framework lead the project, enabling to completely investigate the entire aspects of the problems in Schlumberger Company. A3 template examines each section of the A3 model, presenting tools, new proposals and the achieved results.

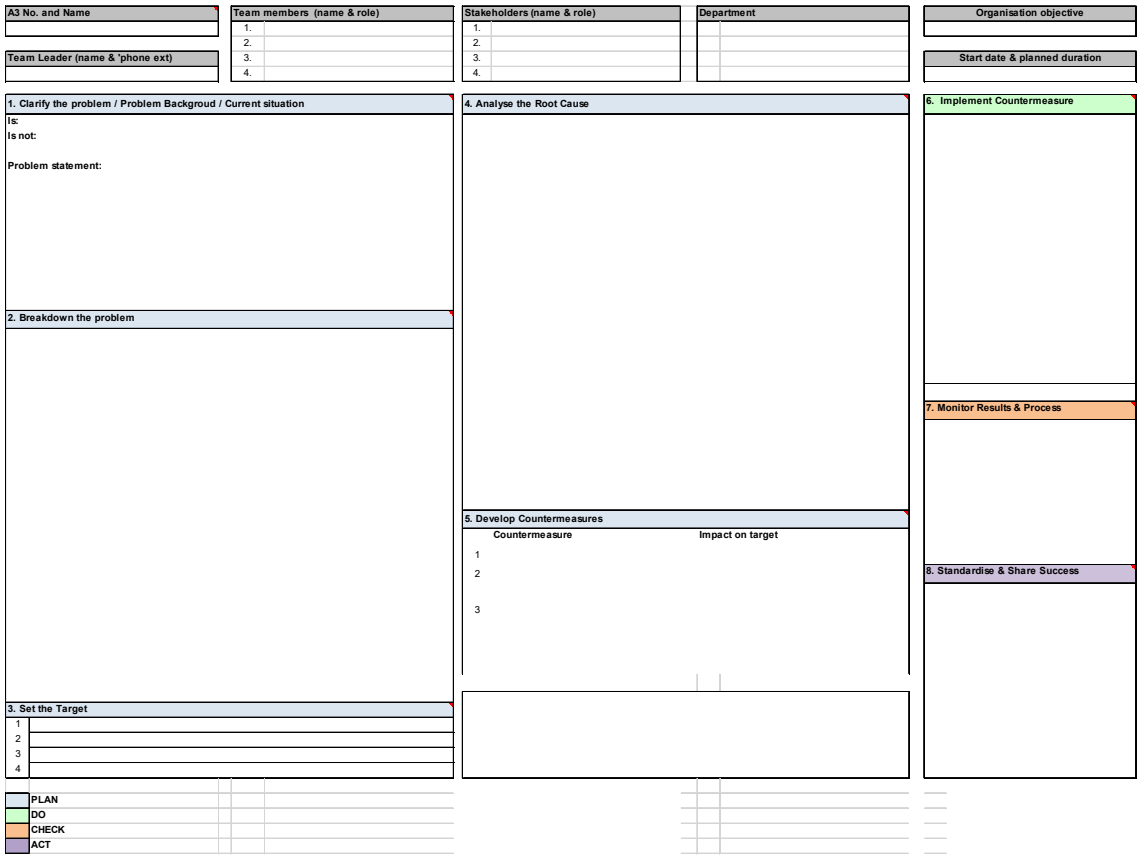



**Fig.1 Initial A3 Model**

### 4.1. The Problem Background

Schlumberger's Ledeen Facility is specialized and dedicated for manufacturing of Actuators for Oil & Gas and Process Industries. The higher waiting time for in the inbound and outbound material flow are critical factor in Ledeen Facility. Schlumberger intention is to focus on the Warehouse department to improve the material flow, hence the warehouse is the backbone of the Ledeen facility. In order to saturate the Assembly unit by timely delivering materials as per Planning department direction. In the current situation, the waiting time in inbound materials flow of a Warehouse department is more than the lead time to assemble a standard actuator.

The Assembly of the Actuators is carried out manually and a full assembly of a Standard Actuator takes 5 hours on average and buffer for a day to keep the Assembly department saturated. Buffer at the Assembly area are constrained to increase due to the space availability inside the assembly area.

### 4.2. Current Situation

#### 4.2.1 Warehouse Management at Ledeen Facility

Warehouse being the backbone of any plant, proper care and attention are made to make it most effective for salvage to the best possible extent. Timely availability, quality of material, controlled inventory of good documentation system, traceability of material needs helps to avoid monetary loss and plug profit leakage and wastage. The Warehouse at the Ledeen Facility enables the management of receiving, put away, Storage location and picking.

The existing Warehouse management operation consists of many Key Performance Indicators, which are Safety, Quality, People, Delivery, Cost. Existing Tools implemented and used in the Warehouse are PDCA, Problem Solving techniques and CPI. These KPI's are updated on different time pace according to their priority.

From the Operation point of view of the Warehouse starting at the receiving dock, the following are the Main and Sub-activities performed:

The Procurement Department communicates regarding the consignment expediting status to Warehouse operation team in order to make necessary arrangement for Unloading the Carrier. Upon the one-day forecast provided by the Procurement department, the Warehouse Operation Team plans its daily work. The general steps involving the Warehouse operation at Ledeen facility are as follows:

#### 4.2.2 Inbound Flow

The inbound flow of this project considers the process starting from the receipt of the material from the supplier till the storage of the pallets and data updating in the system. The incoming materials are stored both inside and around the warehouse area. Inside the warehouse standard materials are stored and outside nonstandard materials like spring hanger, large diameter piping materials and Euro standard empty wooden pallets. In this project the focus is only on the materials which stored inside the warehouse area are studied.

Upon the arrival of the carrier from the supplier, the warehouse attendant receives the Delivery note. The forklift operators start to unload the pallets from the carrier to the entrance using Forklift (Capacity 20 MT). since the 20 Mt capacity forklift cannot swing over inside the warehouse another aid of forklift has been deployed to move inside the stocking area. So, shifting of the Pallets from Entrance to inside the Warehouse at desired location for Unboxing the Pallets using Counterbalance forklifts has been done.

Once the pallets moved inside the operators unbox the pallets to check for any damage. The operators compare physical quantities with respect to Delivery Note. Once the check has been made the operator submit the checked deliver note to the warehouse attendant for updating and to release B.E. (Buono d'entrata) to carry out the consequent processes.

Often the suppliers send the pallet loads in non-standardised pallet due to unsized materials and small materials. But some suppliers send regular dimensional materials that can accommodate in the standard pallets are sent in the non-standard ones. Due to this reason, the operators repalletizing / Shifting of materials from cotton box to the Wooden pallet manually for light weight products and for heavy items shifting carried out by static crane (500 kg capacity) using magnet weightlifter.

As a standard operating procedure, once the material received inside the warehouse, they undergone Quality checks. Before storing at the racks, all the materials are quantity verified with respect to the Delivery Note and for applicable materials quality checks are done. Hence the operators shift materials

to Quality department using counterbalance forklifts. Once the quality check has been done, the pallets are shifted near the Storage area using Counterbalance Forklift for the storage at racks.

The racks are dedicated to the specific suppliers and material category. The operator identifies the Storage location before the pallets for standard suppliers which were allocated in the SAP system. But the things at warehouse were different during the pallet's storage at racks. The SAP fails to allocate the storage location for many pallets. In some cases, SAP Application allocates the desired location to store the materials which has been prepared by Warehouse operation team while making the Receipt note for Delivery but in most of the cases the operator decides where to position the pallet inside the racks.

On the contradictory the operators allocate the pallets location based on the material/ supplier criteria. Each Racks is specific to the type of the material that is being stored. In general, from the Ground level to the top level of the Rack, materials are stored based on the weight of single pieces. For example, heavy thickness plates of 500 kg are stored at the Ground floor and light weight parts like nuts weighting 1 kg are stored at the top level of the rack.

Once the pallet location defined the operators move the pallets to desired location at the Storage Racks using Side Loader. After that the operator submits the updated pallet location note to warehouse data operator for further updating in SAP system.

The components are associated to the racks as detailed below:

B – General materials

C – Kanban Materials & Subsea Materials

D - GS Material /Material for Control Panel

E – Brackets & Logs

F & G – Cylinder Material

H & I – Carter Materials

L – Piston and Flange Materials

M – Springs Container

Inside the Warehouse, the medium size items like Plates, bolts, cut pieces pipes, pipe fittings are stored in the Storage Racks and "O" Rings and other small items like gaskets, bolts, nuts and instrumentation items are stored in the Carousels. Heavy items like Springs, supporting structures, Tubes, Wooden Pallets are stored in the open storage area outside the warehouse.

### 4.2.3 Outbound Flow

In this project the outbound flow has considered as an internal activity of a company having the scope of picking the materials / pallets from racks and carousels. And shifting it to the Kitting area. From the kitting area the pallets are shifted by assembly department.

The prime work in this phase is managing Picking Order Information from Planning department (Order Picking). The picking lists are sent to warehouse department through SAP system based on the customer order by the planning department.

The warehouse supervisor prints the picking list and placed in the da wise rack for the ease of workmen for the picking process. The picking list are allocated to the pickers subsequently. The operators pick

the materials using Trilateral Forklifts which are stored in the racks. The picking list contains the details of the materials, quantity and storage locations pertaining to a customer order.

The operator picks the required items from the pallet and shifting it to another pallet (if all the quantity in the pallet are not required to retrieve). The operators usually do the internal packing for small items like Bolts, Nuts, "O" Rings and small accessories. Labelling the details of the product has been done by the operators, mandator details like item code, specific location to shift the items, etc.

Once the picking list has done with withdraw of components, the operators move the pallets to the Kitting area using the Counterbalance Forklifts. The small items are also placed in the same pallet in order to send. From the kitting area, assembly department operators move the pallets to the Assembly area using Counterbalance Forklifts.

**Warehouse Layout**

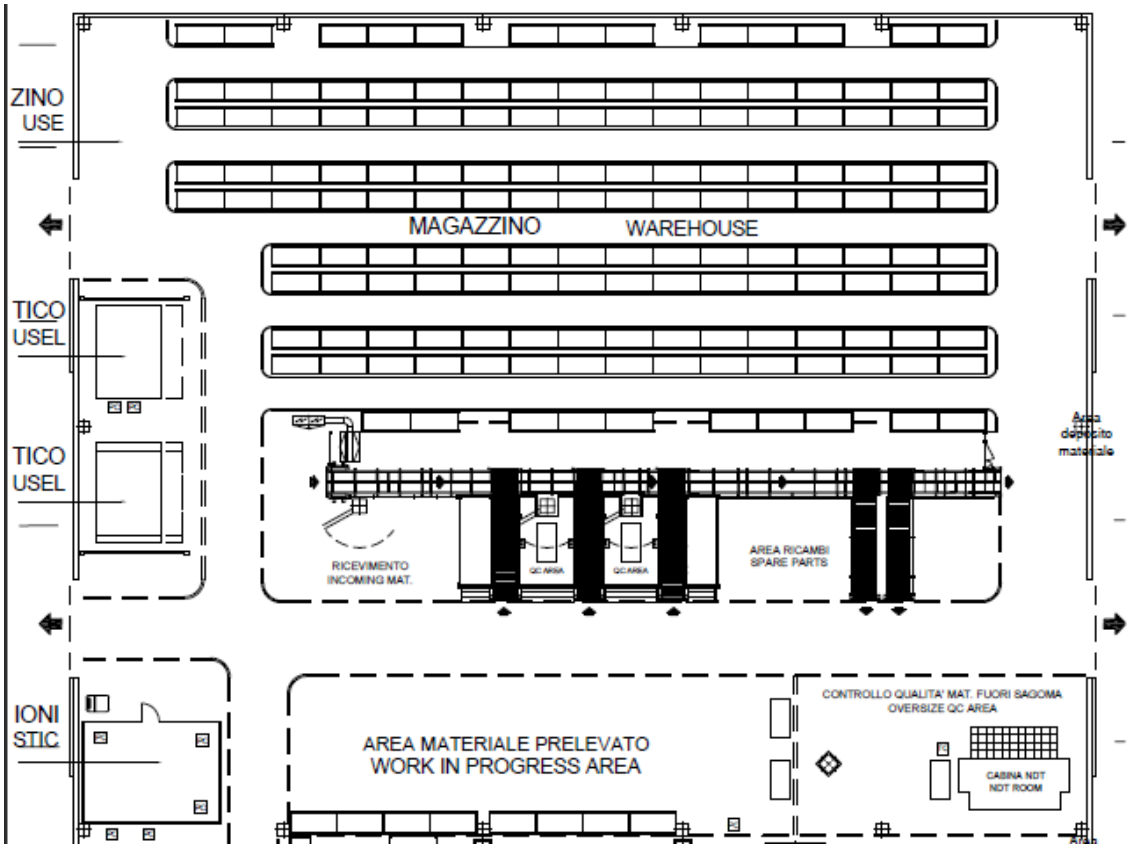



**Fig.2 Warehouse Layout**

**Resources in the warehouse**

**Table.1 Machineries Details**

| Sl. No | Description | Capacity | Quantity | Remarks |
|---|---|---|---|---|
| 1. | Trilateral Forklift | 1.6 MT | 02 | |
| 2. | Counterbalance Forklift Truck | 20 MT | 01 | |
| 3. | Counterbalance Truck | 1.5 MT | 02 | |
| 4. | Pallet Jack | 1.5 MT | 03 | 2 Electric and 1 Manual |
| 5. | Static Crane | 500 KG | 01 | |

Working Area: 80 sqm
Prepare to store area: 52.8 sqm
Total Capacity of the Storage Racks: 2606 pallets
No of Vertical Carousels: 03
Total Capacity of the Vertical Carousel: 60 MT each

The activities involved from unloading of pallets to the storage of materials at the racks (10 Unit Loads) take a Process time of 27 minutes, but the overall lead time is 34 hours due to the waiting time between each step of the process. Also, the number of material movements involved are also high, due to many factors which are as listed below:

1. New item code for each component to be created by the Engineering department when there is a new supplier assigned for supply and when there is new component foreseen
2. Consequently, if there is a new item code foreseen by the Engineering, it needs to be undergone Quality check as per Company's Quality procedures
3. The Quality procedures of the incoming raw materials take considerable time due to change in item code
4. 20 MT Forklift is not good enough to turn easily, hence it is used for unloading of pallets from trucks and pallets are unloaded in front of the entrance, so 1.5 MT Forklift which is used to move the pallets from the entrance to the un-boxing area.
5. The Pallets received from the Suppliers are made of Carton Box which can't be directly stored at the Racks due to Safety reasons, so after the Quality checks, each piece has to be shifted to Wooden Box pallet, which takes considerable time
6. From the unboxing area, after the quantity check the pallets are shifted near the storage racks area. The Planning department organizes to send the Daily Order Picking List to the Warehouse in an electronic format, i.e. through an e-mail communication. Warehouse team takes print of the Picking list by incorporating the desired location of the stored material and hand it over to Picker.
7. The Lead time to satisfy an order to assembly by warehouse is more than 2 days on average. Hence, considering the overall Leadtime from the Inbound to Assembly area, the warehouse operation takes more Lead time to support the Production department.

Due to the existing operational process at the Warehouse department, underutilization of warehouse area and the long waiting time for Storage and Kitting area to assembly area has been observed.

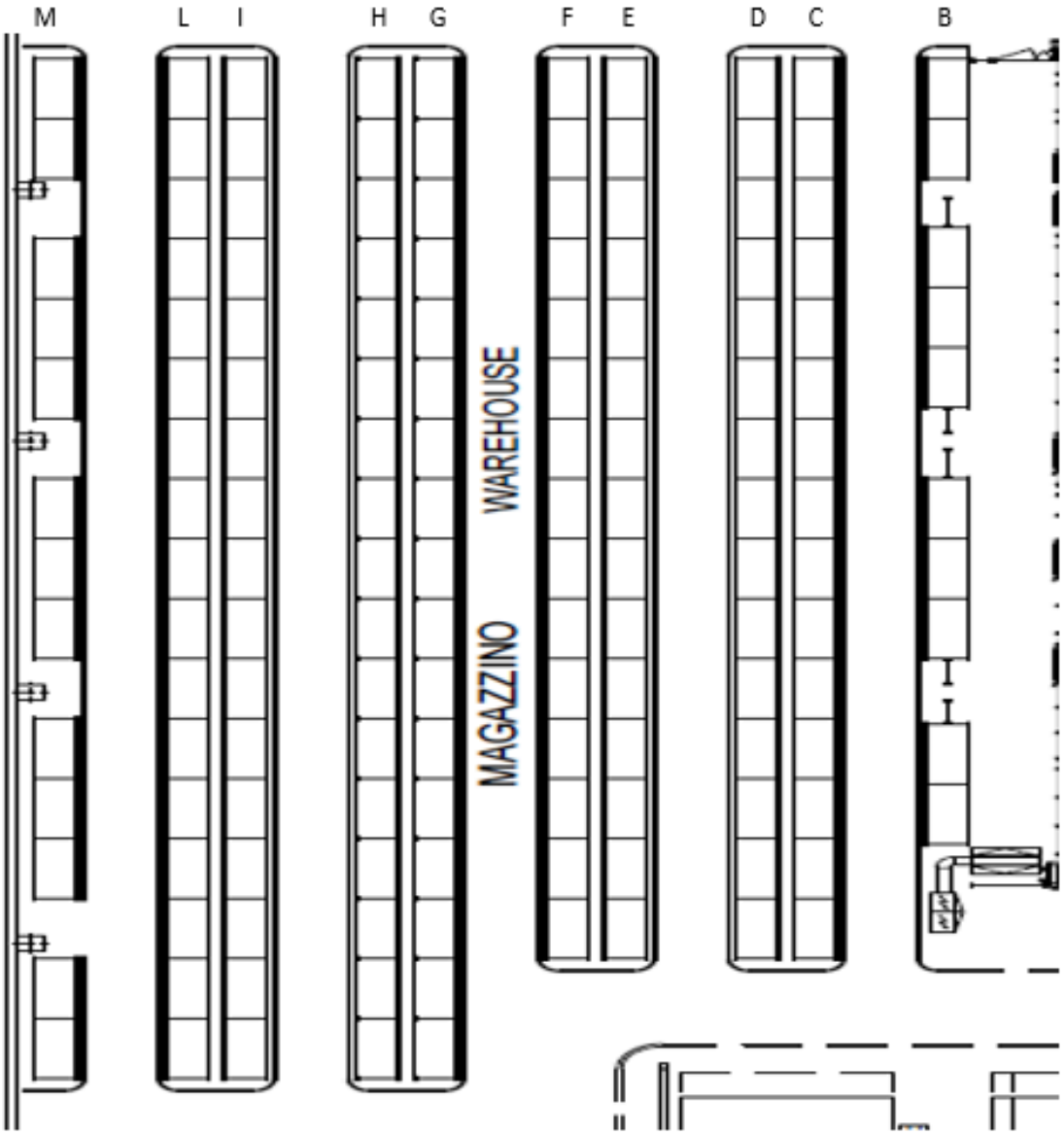



**Fig.3. Warehouse**

There are Ten racks available for the storage of materials received from the suppliers. The Racks are termed as starting from B, C, D, E, F, G, H, I, L and M.

### 4.3. Breakdown of the Problem

In order to understand the breakdown of the problem, carried-out the Gemba walk in the warehouse tracing the operator and forklift movement. Realized

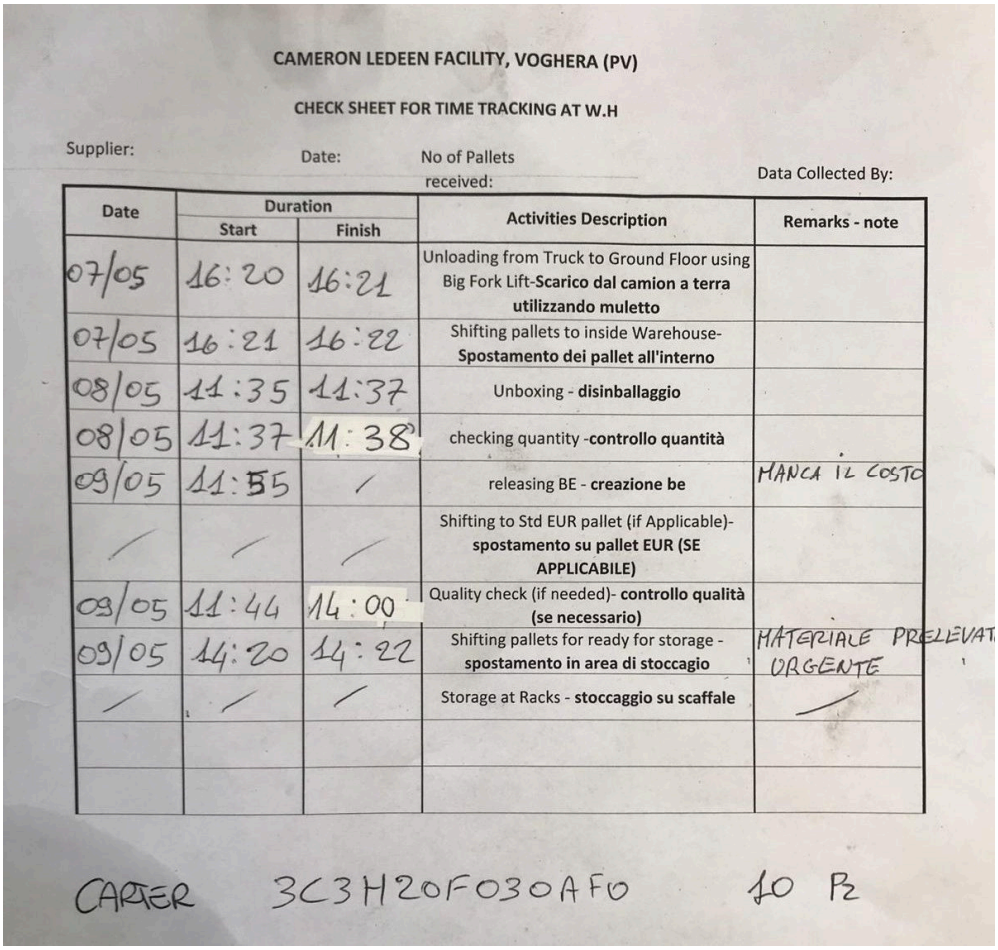
### Makigami diagram

Makigami diagram is a tool that allows to show the entire streamline of the process, underline the Process and waiting/queuing activities that are performed in the storage process thanks to the timeline.

To calculate the whole amount of Waiting / Queuing time Check sheet has been prepared incorporating the list of all activities performed from the unloading of the pallets from trucks until the storage of the

items in the racks. In this Check sheet, I've noted down the start and finish time of each activity, remembering to specify the type of product, the code and the number of pieces in a consignment.

The shown below is the sheet that has been implemented to track the time in hours/minutes for a consignment. The material received from the major supplier Carter has been tracked as reported below. And for various suppliers the same sheet used for recording the time consumed in the process.



CAMERON LEDEEN FACILITY, VOGHERA (PV)

CHECK SHEET FOR TIME TRACKING AT W.H

Supplier: Date: No of Pallets received: Data Collected By:

| Date | Duration | | Activities Description | Remarks - note |
|---|---|---|---|---|
| | Start | Finish | | |
| 07/05 | 16:20 | 16:21 | Unloading from Truck to Ground Floor using Big Fork Lift-**Scarico dal camion a terra utilizzando muletto** | |
| 07/05 | 16:21 | 16:22 | Shifting pallets to inside Warehouse-**Spostamento dei pallet all'interno** | |
| 08/05 | 11:35 | 11:37 | Unboxing - **disinballaggio** | |
| 08/05 | 11:37 | 11:38 | checking quantity -**controllo quantità** | |
| 09/05 | 11:55 | / | releasing BE - **creazione be** | MANCA IL COSTO |
| / | / | / | Shifting to Std EUR pallet (if Applicable)-**spostamento su pallet EUR (SE APPLICABILE)** | |
| 09/05 | 11:44 | 14:00 | Quality check (if needed)- **controllo qualità (se necessario)** | |
| 09/05 | 14:20 | 14:22 | Shifting pallets for ready for storage - **spostamento in area di stoccagio** | MATERIALE PRELEVAT URGENTE |
| / | / | / | Storage at Racks - **stoccaggio su scaffale** | / |
| | | | | |
| | | | | |

CARTER 3C3H20F030AFO 10 Pz

**Fig 4. Check Sheet for Time Tracing**

After analysing tables of different products, classified the process and Queuing activities and made the Makigami diagram.

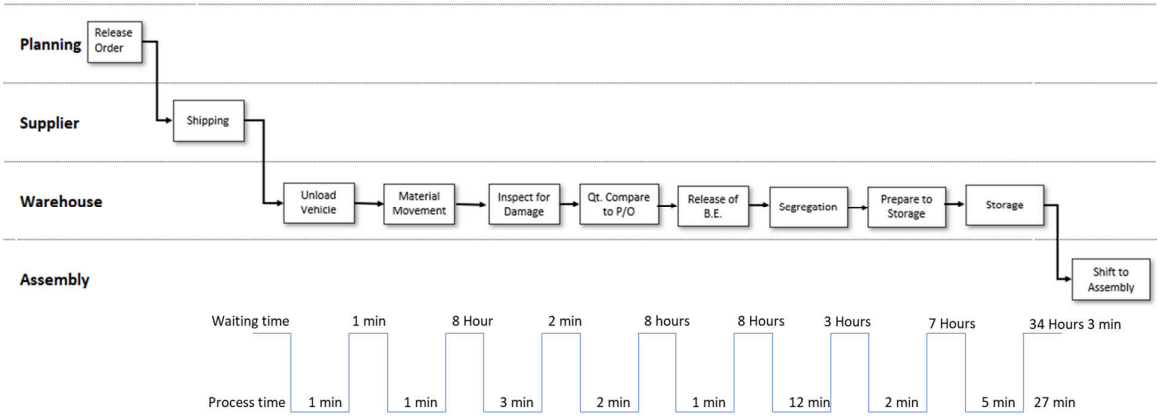



**Fig 5. Makigami Diagram – Current State**

The total Process time from the unloading of the truck till the storage are 27 minutes and the total Waiting/queuing is 34 hours 3 minutes.

### Spaghetti Chart

Upon the Gemba walk carried out in the warehouse the Forklift along with Manpower and Material movement are recorded over the Layout Plan. Green colour represents the forklift movement during the unloading activity and the orange colour represents the forklift movement during the storage of pallets from the area where pallets are stocked read for storage. From this chart it's observed that huge movement inside warehouse is carried out for a single consignment and it is noted.

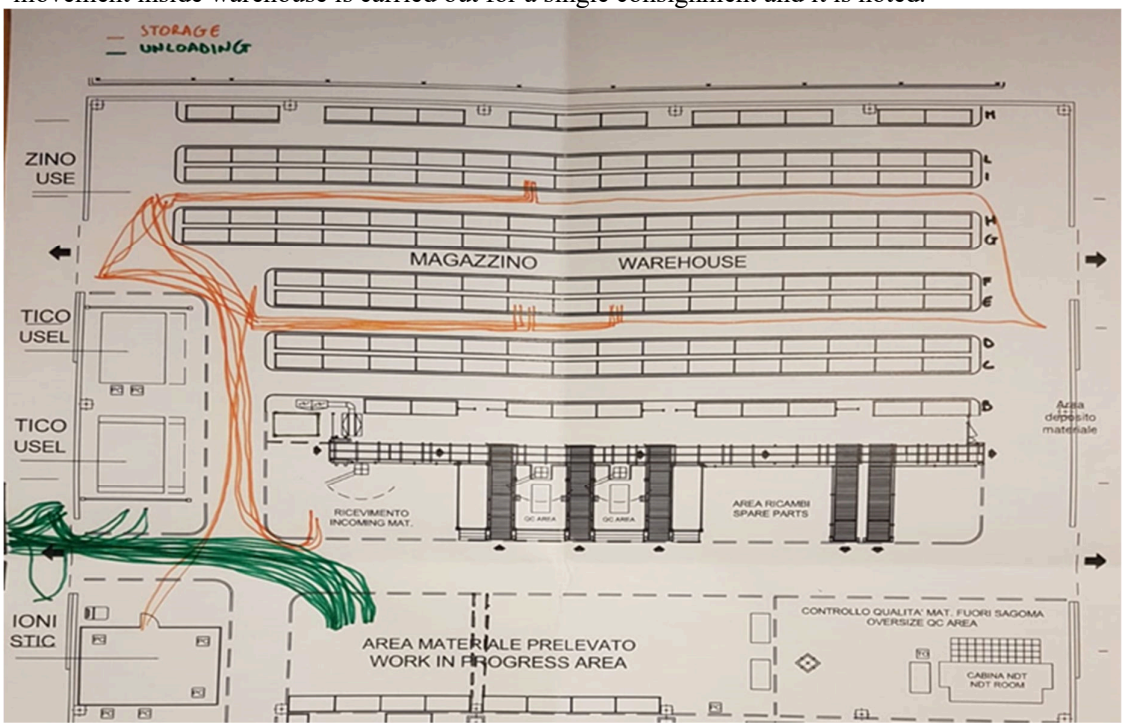



**Fig 6. Spaghetti chart**

**Phase I: Inbound Flow**

The problem that company faced was presented to me as improving the material flow in the warehouse since the warehouse team lacks to send the materials to the assembly department. Upon the Gemba walk I've made spaghetti chart, detailed study of the entire processes is done and mapped in Makigami diagram.

In order to analyse the real situation inside the warehouse and to identify the real cause of the problem, a detailed activity of measuring the lead time of every process in the warehouse department was performed. The current state of the inbound material flow was built considering the operator and flow of materials from receipt to storage as main driving factors.

The flow of material tracking tells the saturation level of the workmen and the material handling equipment's. It is also main indicator to identify the process and waiting time in the process. The data analysed for the lead time consumed per consignment. Consequently, it's been identified that the higher waiting time in the process is the huge bottleneck to slow down the operation. The measure waiting time in the incoming material management per consignment is 34 hours which so huge than the company expected. Since the lead time for assembling a Standard actuator is 5 hours.

Furthermore, it's been observed that the storage of pallets in the racks are not followed as per the operating procedure. Improper allocation of the pallets has been recorded and huge manual work has been carried out in the data handling process in the warehouse.

The main problem identified is due to the delay in data handling the physical flow of components are undergoing waiting in the warehouse floors. This become the major problem that identified.

Detailed process flow has been created below for the incoming materials grouping the different resources involved and their corresponding process.

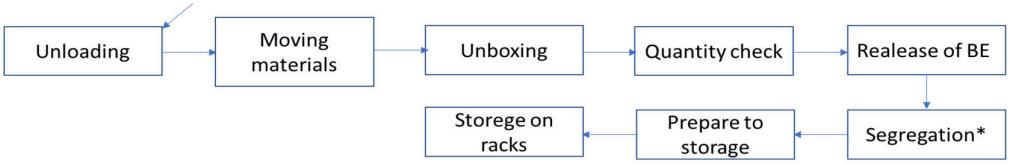



**Fig 7. Inbound Process Flow**

**Phase II**: **Outbound flow**

The picking activity in the warehouse are done manually by means of forklifts and other material handling equipment's. the picking list are defined based on the customer order-based picking list. As same as the incoming material flow tracing, all the process involved in the outbound flow has created below.

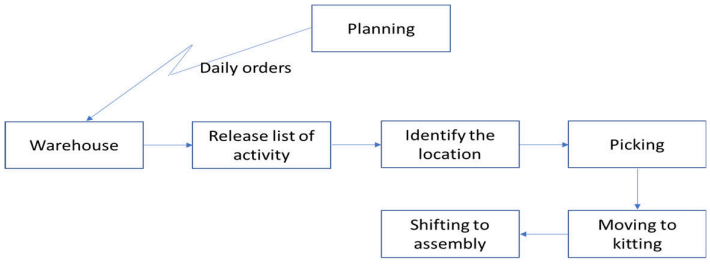



**Fig 8. Outbound process flow**

In this phase the manual shifting of pallets has been observed during the withdraw of material from racks. This operation has done b the forklift operator, so the operator has to do more than one operation at a same time. This leads to the higher process time in the process.

In this phase also the data management lacks to push the material flow. In turn it becomes the hurdle due to the manual updation in the SAP system. For this manual updation a dedicated manpower has been deployed with no value-added purpose.

### 4.4. Target

Initially the project target set by the company are revaluated in order to focus on the time to implement the interventions proposed and its benefits sought in terms of elimination of waiting time. the targets are defined with involvement of company's representatives and academic tutor are as follows:

Must-Have Goals

- Elimination of the average Inbound Materials movement waiting time (from the Incoming material receipt till the storage of pallets at the racks) by 40%
- Elimination of the average Outbound materials movement waiting time (Picking) by 30%

Nice to Have Goals

- Increase throughput capacity of outbound flow from 8 UL/Hr to 12 UL/Hr
- Warehouse Optimization (Space Saving) 15%

The stud has conducted to fix the target percentage because of the result of one target must not affect the another one. For example, concentrating more on the space saving will indirectly affect the performance of warehouse. This has strictly considered before freezing the indicator's value.

### 4.5. Root Cause Analysis (RCA)

The Root cause analysis of the A3 framework analyse in detail the waiting activities, using different tools that highlight the possible causes. Quality Statistical tools like Ishikawa Diagram is used for identifying the causes of the problem. The several causes which are leading to the primary problem of higher waiting time in inbound material flow, that is storing incoming materials at the Racks and out bound material flow that is picking, have been identified and then classified under different major categories such as man, machine, method, material and management.

#### 4.5.1. Phase I – Inbound material flow

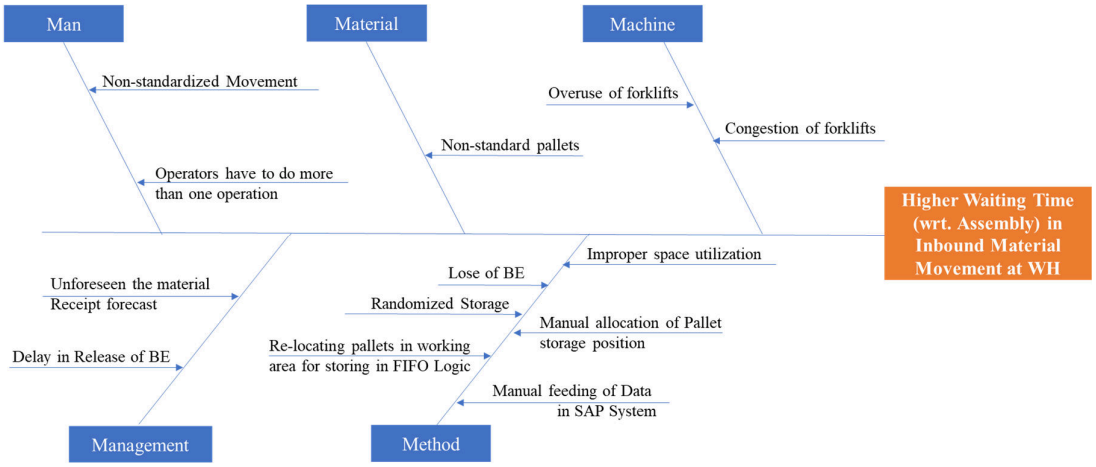



**Fig 9. RCA for Phase I inbound material movement**

The delays which are related causes by factors related to the incoming materials receipt till storage (inbound material flow) at the racks are considered here. All the proposed countermeasures are detailed below in the main category

1. Machine
   a) Warehouse adopted the FIFO logic in storing the materials received from the Suppliers. As elaborated in the Phase I current situation, the pallets are handled 8 to 10 times using Forklifts. The same Pallets are often shifted to different locations in the working area in order to follow the FIFO logic. This leads to overuse of Forklifts in around warehouse at the Ledeen Facility.
   b) Considering the Plant Layout of the Ledeen Facility, warehouse area, Sub-Sea Actuator Assembly area and Quality control area are designed in a single building. Moreover, in warehouse forklifts are used mainly for unloading of pallets from Truck, inter shifting pallets within warehouse premises for Quality control and Sub-sea assembly area and empty pallets are being shifted to outside area to keep housekeeping.
2. Material
   a) Often materials received in the warehouse are in Non-Standard Pallets due to the material dimension which cannot be accommodated in standard pallet and small/medium size packings. Operators before shifting items to quality check, the materials are moved from a Non-Standard Pallet to a Standard Pallet in order to store in the Racks since the racks are designed to accommodate standard pallets only. Due to this reason the manpower and machinery deployment are become nonvalue added. Subsequently affects the performance of the warehouse.

3. Measurement
    a) Delivery Note receipt, Release of B.E. after conformance of Quantity checks are to be uploaded in the SAP system. Planning department refers only the SAP data and releases the Picking Order to the Warehouse. As per the Current Situation, the data feed to SAP system are by manual operation & faces in huge delay due to many reasons like missing cost in Delivery note. The major problems are in Delivery Note, the cost of materials is not mentioned by suppliers; without cost details, SAP doesn't allow to update the status which leads to high waiting time.
4. Methods
    a) Pallets are placed in the area reserved for work in process for long period of time to perform Quantity check with respect to the Delivery Note. After the Quantity and Quality checks the pallets are moved to incoming materials receipt area, here the pallets waiting time is huge due to saturation of manpower and machine. This waiting time of pallets at the work in process area and incoming materials receipt area causes underutilization of working area in warehouse
    b) Warehouse department releases the B.E after physical Quantity check with respect to Delivery note from the Supplier. B.E is printed and placed inside the pallets with temporary supports like placing a bolt over B.E. in order to avoid paper blow in air. Size and shape of the materials received differ and due to wind flow inside the warehouse the B.E. placed inside the pallets are misplaced due to environment factors, leads to lack of tracing of materials in order to store the pallets in desired location.
    c) FIFO logic has been adopted for storing the pallets received from the Suppliers. In order to follow this logic, often changing the locations of pallets in the working area is carried out using forklifts which is a long queuing activity and it require lot of effort.
    d) Location for materials are fully not allocated by system, hence it requires more attention for the search of right location for materials every time. Most of the times the workmen decide the location based on the saturation of Racks and after they place the material, they make a note and update it on SAP system manually by not following any Storage procedure. This causes high waiting and improper storage of pallets.
5. Man
    a) Operators at the warehouse are performing more than one operation during their working hours. Most of the workmen are trained to operate the Forklifts. Especially during storage of pallets in racks, the operator must perform Trilateral forklift and Counterbalance forklift operation in order to move pallets from the incoming materials receipt area to storage area and storing pallets at the racks which leads to higher waiting time between.
    b) Non-Standardized movement of workmen in warehouse.
6. Management
    a) Due to the lack of coordination, standard follow up procedure to be carried out in practise with Suppliers, the Delivery Note received are not compiling all relevant information that are required by SAP application. It becomes bottleneck in release of B.E and leads to higher waiting time in the process of Storing incoming materials at the Racks.
    b) Lack of Control over Suppliers related to documentation works like missing/mistakes in delivery note and other documents. For example, suppliers are not specified the exact quantity of the items that is been delivered to Ledeen facility warehouse.

### 4.5.2. Phase II - Outbound material flow

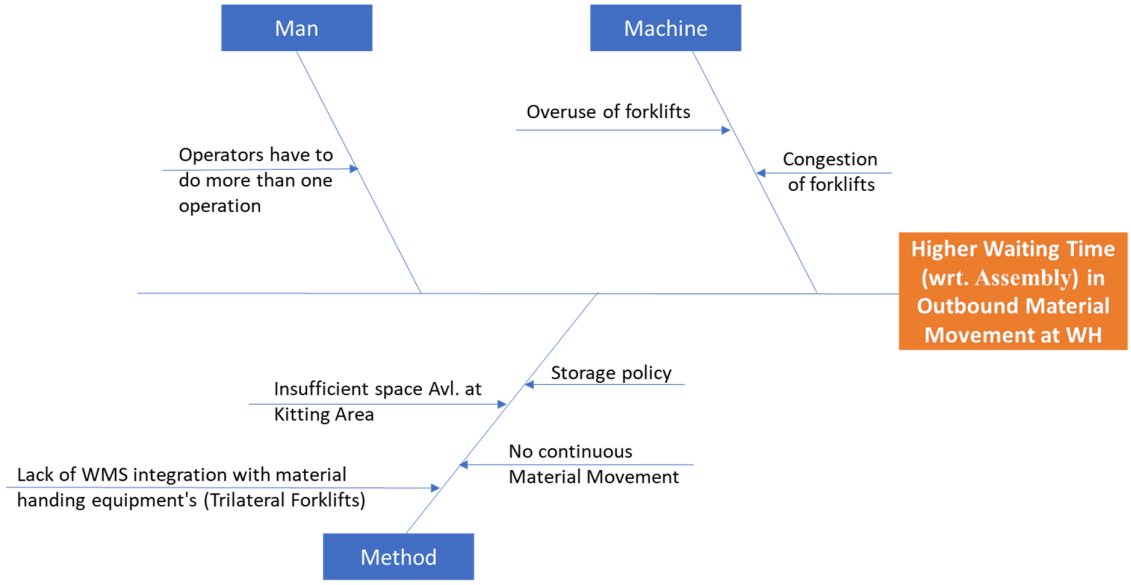



**Fig.10 RCA Outbound**

1. Machine

a) Congestion of Forklifts: Counterbalance Forklifts are used to shift the empty pallets stored outside the warehouse to inside the warehouse nearby the storage racks in order to keep the materials as per the Picking Order List. After Picking pallets are not immediately shifted to Kitting area, which leads to congestion of Forklift movements during Picking.

b) Overuse of Forklifts: Other than Forklift there is no possibility of engaging a device to shift pallets from Racks to Kitting area, so Forklifts are always used to shift pallets from Racks to Kitting area and storage pallets.

2. Method

a) Concrete storage policy is not available for storage of all materials like tubes, storage based on Suppliers and documentation related to warehouse. Items are not stored with the support of SAP, so the operator is the one deciding where to store the items ignoring the different velocity codes for the picking phase.

b) Trilateral forklifts have the screen mounted in it, where the operator can able to view and update the picking list. However, the information flow inside the warehouse are by means of documented paper. This leads to lack of using the facilities available in the forklifts. As the consequence, the picking lists are updated manually by a dedicated workman in a full-time basis. Also, its observed that this practice takes considerable time and error in manual entry of data in the system. Moreover, rectification for these issues normally takes more time,

c) In the warehouse there are areas not properly divided, kitting area is one of these. In the kitting area we can find not only the pallets that have just picked but also the pallets with the items that need the quality check.

d) Operators only have a paper picking list; they are not using a screen that is already implemented on the trilateral forklift because it is not working.

3. Man

a) This point is strictly correlated to the non-continuous materials movement flow point but underline perfectly the fact that operators don't have a standardize path to follow.

### 4.6. Counter Measure

The countermeasure is developed considering the Makigami diagram's process and waiting time accountability as well as the Ishikawa's Root cause Analysis. The countermeasures proposed are had some relevant and irrelevant. But, largest part of the root causes is linked with the warehouse management system integration from the Ishikawa diagram, hence clear that it is the main bottleneck. The countermeasures are developed considering the elimination of higher waiting time focusing on the major constraint and the counter measures that are proposed considering its time to implement and its benefits, that is the Quick win interventions. Since Quick wins can be implemented in the short-term period and can able to foresee visible improvements.

Each counter measures are been discussed with the corresponding users, that is the operators of the warehouse, supervisor and managers; their valuable suggestions/comments are incorporated and listed below:

1. Class based Storage: Reorder the storage location of pallets in Racks
2. Updated storage procedure
3. WMS Integration with material handling systems and picking systems
4. Usage of Screen available in the trilateral Forklift
5. Integration of SAP with Carousels
6. Acceptance of Euro Pallets from Suppliers
7. Supplier Rating
8. Kitting – GS materials

**1. Reorder the Storage location of pallets in Racks**

From the observation in the warehouse, it is found that sometimes the same item is stored in different locations in the Racks. SAP allocates the Storage location for some materials that can be stored at the Carousels like O Rings, gaskets, small size bolts and nuts. For other items, the Storage locations are decided by the operators at the time of Storage and they update the System manually after they place the pallet in some location.

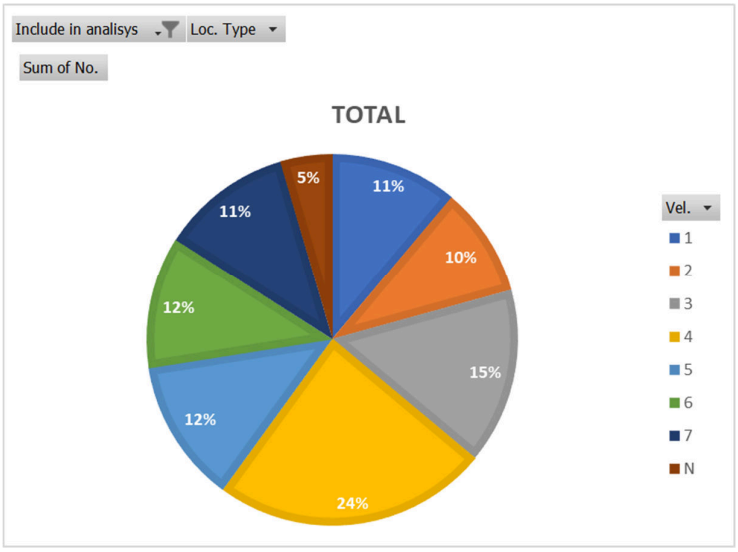



**Fig.11 Clustering Analysis**

Collected the SAP data for analysing the Storage Policy at the Racks, based on the Velocity Code and SAP ABC based on the cost of materials.

First, noticed that even if an item has an A in SAP ABC classification the item could be stored in the last pallet position of the rack and if an item has a C in SAP ABC classification we can find this product in the first pallet position of the rack. Known this fact I can affirm that operators store materials in the first free spot they find because on the BE there is no specified location of storage.

Knowing the power of ABC classification tool, wanted to improve SAP's ABC classification merging this with the ABC classification based on the velocity code (underline how many times an item was picked in the last year. E.g. 1. Picked more than 9 times in the last year. 6. Picked in the last 24 month) of each item.

| | C | D | F | G | H | I | J | K | M | N | O | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Material | VC (velocity code) | MY ABC (based only VC) | | Concatenata (my full abc and vc abc) | MY ABC (based on VC and SAP ABC) | concatenata (my full abc and sap abc) | | CC phys. inv. ind. | Storage Bin | MRP Cont roller | Material Descript |
| 2 | 77006289 | 5 | C | TRUE | CC | C | CC | TRUE | C | H0602B | ST3 | (EX)SOLENOID V |
| 3 | 2096011-03-01 | 2 | A | TRUE | AA | A | AA | TRUE | A | H0907A | PB1 | SPRING HOUSIN |
| 4 | 2096060-06 | 3 | B | TRUE | BB | B | BB | TRUE | B | H0707B | PB1 | RETAINER RING |
| 5 | 2096062-23 | 5 | C | TRUE | CC | C | CC | TRUE | C | H0709B | PB1 | CLAMP RING, 7- |
| 6 | 2125418-05-05 | 4 | B | TRUE | BB | B | BA | FALSE | A | H0104B | PB1 | SPRING HOUSIN |
| 7 | [illegible] | | | | | | | | | | | |
| 8 | 9E-25204KG1A0000 | 4 | B | TRUE | BB | B | BA | FALSE | A | H1404B | FR2 | 1/4 TURN FRAM |
| 9 | 9E-25208LIA0000 | 4 | B | FALSE | BC | C | CC | TRUE | C | H1505B | FR2 | 1/4 TURN FRAM |
| 10 | [illegible] | | | | | | | | | | | |
| 11 | 9E-25300FG1A0000 | 3 | B | TRUE | BB | B | BB | TRUE | B | H0408A | FR2 | 1/4 TURN FRAM |
| 12 | 9E-25300FG1A0000 | 3 | B | TRUE | BB | B | BB | TRUE | B | H0907B | FR2 | 1/4 TURN FRAM |
| 13 | 9E-25300FG1A0020 | 3 | B | TRUE | BB | B | BA | FALSE | A | H0405B | FR2 | 1/4 TURN FRAM |
| 14 | 9E-25300FG1A0020 | 3 | B | TRUE | BB | B | BA | FALSE | A | H1203A | FR2 | 1/4 TURN FRAM |
| 15 | 9E-25300FG1A0020 | 3 | B | TRUE | BB | B | BA | FALSE | A | H1506B | FR2 | 1/4 TURN FRAM |
| 16 | 9E-25300FG1A0020 | 3 | B | TRUE | BB | B | BA | FALSE | A | H1708B | FR2 | 1/4 TURN FRAM |
| 17 | [illegible] | | | | | | | | | | | |

**Fig.12 ABC Analysis**

The first step was making the ABC classification for VC (velocity code),

After that concatenating the ABC based on VC and SAP-ABC we observe the differences between the two different classification. Practically speaking the ABC classification based on the VC is more meaningful because every item after passing the warehouse entering door have the same price and the only importance is deliver the item in time to the assembly, but for Schlumberger internal policy we have also to consider the SAP ABC.

So, obtained the result merging the two precedence ABC classification giving more importance on SAP ABC. Concatenating the final ABC and SAP ABC we can observe the differences.

A standard rack in Ledeen facility is composed by 17 pallet positions (PP) and 9 levels, each position can contain two pallets. Items with an A classification should be stored in first five PP (red), items with a B classification should be stored from PP n°6 to PP n°10 (yellow) and last items with C classification should be store from PP n°11 to PP n°17 (blue).


**Fig.13 Updated Storage Location based on ABC Analysis**

**2. Updated Storage Procedure**

The existing Warehouse procedure provides guidelines only for the receipt of incoming material from Suppliers. Procedure to store materials in the Racks, Picking and material handling procedures are not available.

To solve this problem, we proposed to write a new Procedure for Warehouse operation by involving Ledeen Facility Management. The procedure needs to be circulated to all employees at the warehouse and always made available for implementation and follow-up.

**3. Warehouse Management System integration to material handling equipment's**

The solution presented here is adopted from the Grove facility with latest technics in the market. Visited the Grove facility to overview the adaptability of Warehouse management system integration with the material handling equipment's. the storage racks are automatic, and they use Bar code scanner for the tracing of materials. The integration of Bar code scanner and Warehouse management system is found not functioning due to privacy issue with the Bar code scanner provider. The implementation at the Grove cannot be directly compared to Ledeen since the components at Ledeen facility are considerably more than Grove, flow of materials also high. So, at Ledeen needed the advanced technological devices needed for the implementation of Warehouse Management System with material handling equipment's.

At Ledeen, in current situation, the item codes for each component are written over the materials using paints for tracing. For some materials item code is hard punched, especially for Pipe materials. There is considerable time taken by the Workmen to read the item code clearly and work on it.

Implementation of integration of WMS to the material handling systems & picking systems will lead to record the materials' transactions efficiently and avoid mistakes associated with manual interpretation of Item code and entry in the System. It leads also to obtaining the Real time data and accurate inventory count in all locations.

Identified three different level of implementation: First possibility in incoming material process, second level is also adding the storage and third level is to add picking process too.

**4. Usage of Screen available in the trilateral Forklift**

During the observation in the warehouse, identified that a Trilateral Forklift with an inbuilt screen was available; this can be used to substitute the paper picking list that the operators use. The advantage consists in having the picking list directly on the trilateral and when the list is finished, they can close

the list directly on the trilateral instead of going to the warehouse office to deliver the list every time. This counter measure is also thought to exploit a resource that is already available but is not used.

In this way, the elimination of waiting time related to the manual updating of the data and human error in updating status is highly possible. Consequently, this intervention enables to redirection of one operator dedicated for the manual updating to the other value-added activity. Moreover the real time data can be obtained without an interference.

**5. Integration of SAP with Carousels**

In Current situation, the SAP data are not directly linked to the Carousels. Inventories are updated in the System manually after picking, but not immediately. Proposed to integrate SAP with the Carousels in order to better manage the inventories and to get real time data.

Integration of warehouse management system in this context enables the elimination of waiting time related to the manual updating of the data and human error in updating status is highly possible. Consequently, this intervention enables to redirection of one operator dedicated for the manual updating to the other value-added activity. Moreover, the real time data can be obtained without an interference.

**6. Acceptance of Euro Pallets from Suppliers**

As noticed in many occasions during the observation of current situation, materials are received in nonstandard Euro Pallets from the suppliers. The materials are shifted to Standard Euro Pallet in order to store at the Racks, since the racks are designed for the storage of Standard Euro Pallets only. Shifting the materials takes considerable time and manpower deployment. To eliminate this non-value-added activity, we proposed to reiterate the procedure and to reject/send back the pallets to the suppliers. Being strict with procedures and advising Suppliers to be strict with Ledeen Facility requirement, lead time for this operation can be eliminated. Nonstandard pallet received from the supplier is illustrated below.

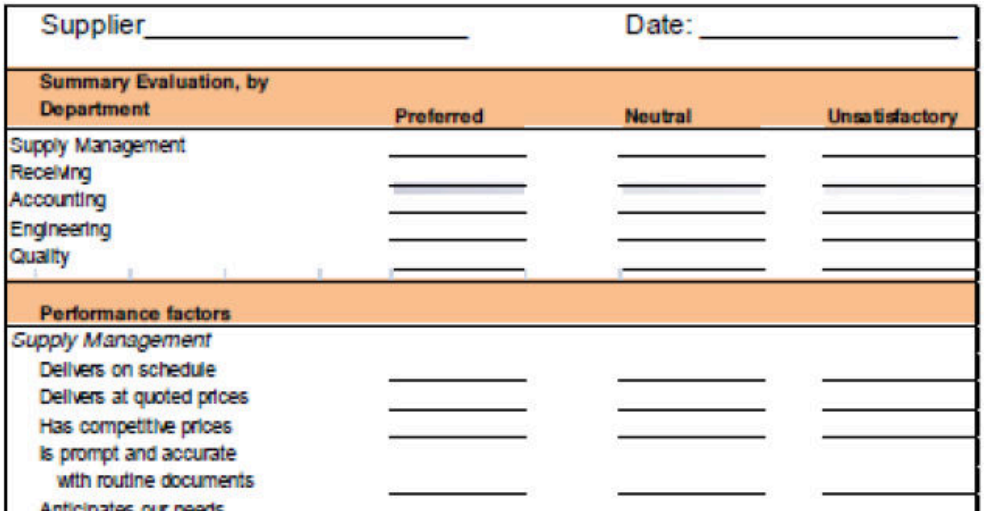
**Fig.14 Non-Standard Pallets**

**7. Supplier Rating**

As observed in the warehouse, realized there is lack of control over the suppliers b the company. The company's personal requested to send the materials in standard pallets but the suppliers send the material in the nonstandard pallet. The suppliers won't provide the amount that need to be incorporated in their delivery note, but often it was missing, due to this warehouse attendant not able to generate the

Bouna Entrata. Moreover, there are materials often found or not meet the quality requirement that are sent back to the suppliers. this in turn affects the performance of the Ledeen facility.

Hence, proposed to monitor suppliers' performances also Ledeen facility management is interested in six-sigma tools. Both proposals take care about price, quality, service and delivery.



Supplier_____ Date: _____

| Summary Evaluation, by Department | Preferred | Neutral | Unsatisfactory |
|---|---|---|---|
| Supply Management | | | |
| Receiving | | | |
| Accounting | | | |
| Engineering | | | |
| Quality | | | |
| **Performance factors** | | | |
| *Supply Management* | | | |
| Delivers on schedule | | | |
| Delivers at quoted prices | | | |
| Has competitive prices | | | |
| Is prompt and accurate with routine documents | | | |

**Fig 15. Supplier Rating**

Categorical plan is the first proposition. This system gives a 360 monitor of the supplier because every area of the client company can give their vote. E.g. accounting can judge the stability of the price in time, quality control can judge the overall quality of the product, warehouse can judge the consistency of product quantity and the delivery lead time. After an established period, the black belt or the CMS leader collects this paper from every area that is involved and makes their considerations about the supplier.

Weighted ratio point plant is the second proposition. For every factor of evaluation, the company gives a proper weight depending on their factor of interest. Like the precedence tool the factors are price, quality, delivery and service. The final grade for the supplier can go from 0 % up to100 %.

E.g.

| Weight | Factors | Measurement Formula |
|---|---|---|
| 50% | Quality performance | =100% - percentage of rejects |
| 25% | Service performance | =100% - 7% for each failure |
| 25% | Price performance | = $\frac{\text{lowest price offered}}{\text{price actually paid}}$ |

**8. Kitting – GS/Carter materials**

Kitting is the process of assembling individual components of the Actuator, but related items are grouped together as one unit. This counter measure is proposed, anticipating the customer orders by planning department. the GS materials and materials supplied by Carter are selected to make sub-assembly. This leads in reduction of storage space and in other way this activity enhances saturation of the assembly department. After the Kitting process, while storing the sub-assembly the fasteners are also stored together for ease of picking when the customer order arrives. The images shown below indicates that kitting components are picked and kept in kitting area ready to shift to the assembly

department. the assembly of a single box contains many components as shown. The other image indicates after the receipt sub-assembled box together with fasteners are ready for storage at warehouse.

**Fig 16. Kitting**

### 4.6.1. Prioritization matrix

In order to implement the countermeasures listed above need to prioritize based on the impact that a countermeasure can eliminate the higher waiting time in the warehouse processes.

Prioritization matrix is a tool that aimed at analysing the benefit of the interventions in terms of impact on the performance in the y axis. In this project the benefit is measured in terms of time since it is the driver for targets. On the X axis the effort of the interventions in terms of impact on the performance is derived in time to implement the proposed counter measure.

Further the interventions are classified into four categories based on the two attributes. Those are

1) Quick wins require minimum time period for the implementation of proposed interventions
2) Stars are the list of proposed intervention with medium effort with high benefit in realising the elimination of waiting time.
3) High impact are the interventions that require more effort from the management point of view like obtaining approval for the WMS integration from their headquarters and can impact heavily in elimination of the higher waiting time.
4) Excessive efforts are the list of countermeasures that require huge effort from the management like building new or modifying the infrastructure with the lower impact on the waiting time elimination.

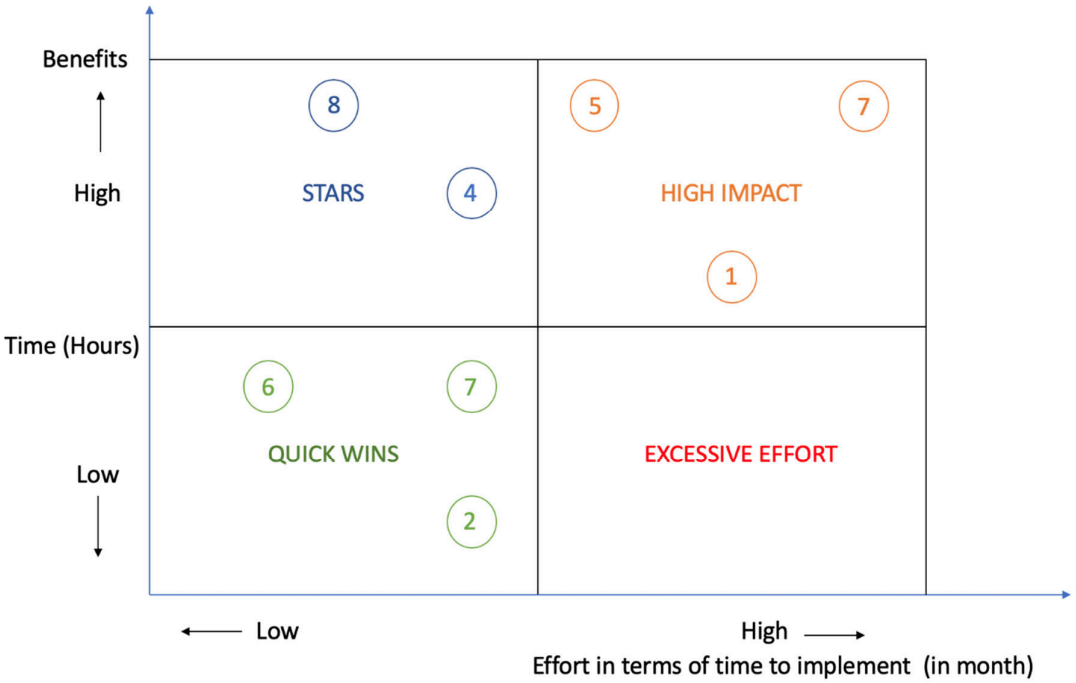



**Fig.17 Intervention prioritization**

For all the proposed countermeasures defined effort in terms time in months that required to implement and defined the benefit in waiting time elimination in hours (time). As like the perpetual map plotting, here the countermeasures are plotted in this map in order to prioritize the interventions proposed for the implementation.

Thanks for this matrix to figure and sort out the countermeasure in the two-classified attribute. Based on this matrix, the quick wins are firstly targeted to implement since they are visible, and it provides

immediate waiting time elimination with low time requirement for the implementation. After that the countermeasure that plotted in stars category are focused to implement which are highly impact on the elimination of waiting time with medium efforts. Refer the countermeasure list in 4.6 countermeasure for the ease of understanding the chart.

### 4.6.2. Future Situation

In this section elaborated the advantages that will bring the application of the counter measures into the process.

**1. Reorder the Storage location of pallets in Racks**

After deciding the correct layout, calculated the savings in terms of time obtained with the new configuration compared to the old one. First, we had to identify the variable time for a retrieving process in each area, so the horizontal and vertical speed.

After many observations I've able to affirm:

- Time between enter of the lane to PP n°3 = 2 seconds
- Time between enter of the lane to PP n°8 = 6 seconds
- Time between enter of the lane to PP n°14 = 10 seconds
- Time to reach level n°5 = 4 seconds
- Fixed time = 6 seconds

This data means that every time a pallet that should be stored in the first five racks was stored in the last seven rack the company lose 16 seconds. Considering an entire picking list, the saving in term of time is 10 minutes on average.

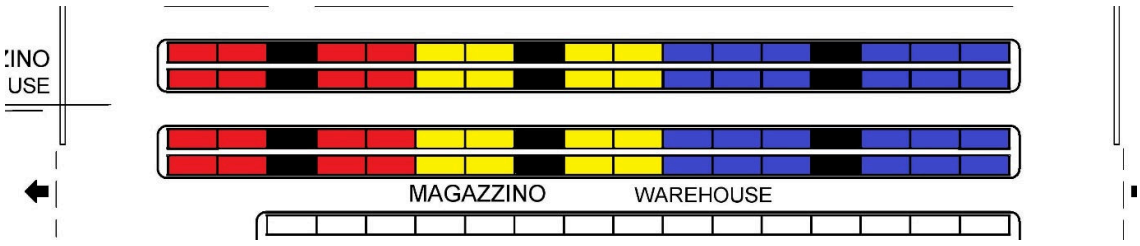



**Fig.18 Updated storage Position**

**2. WMS integration to the material handling systems**

-At first level the implementation will be done only in incoming material process with a big advantage in term of time, in fact the company can save from a minimum of 8 hours to a maximum of 15 hours. The whole process remains unchanged, but the speed will increase. Operators, after moving the items inside the warehouse to prepare the Bar Code / QR Code / RFID code of the product, have to print it and attach it on the item. After this operation they scan the Bar Code and the stocks will be immediately updated, this is possible only with the collaboration of accounting department that has to preventively prepare the cost associated to each item, otherwise operators cannot print the Bar Code.

-Second implementation is in storage process.

The waiting time of pallets in Prepare to storage area remain unchanged but the real improvement is the real time updating data on SAP, without the manual intervention.

-Third implementation is in picking process

The advantage of implementing the WMS integration to the material handling system in picking are the same of the storage.

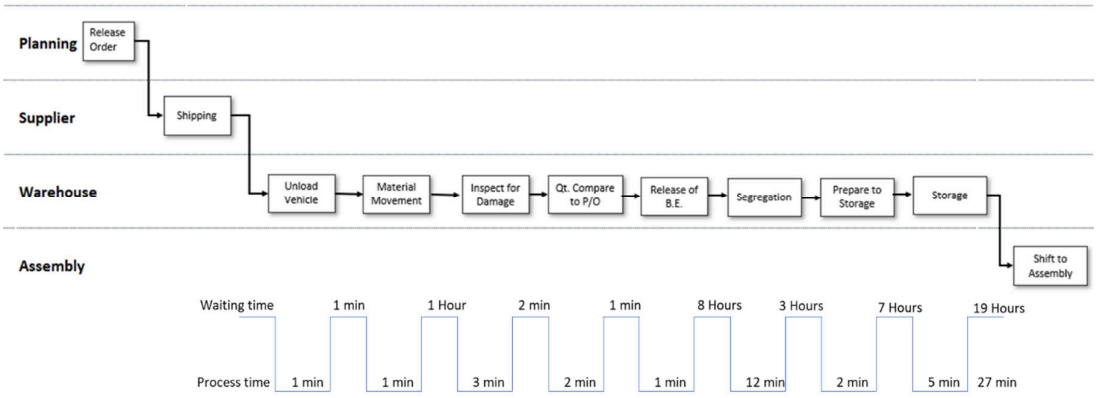



**Fig.19 Makigami Diagram - Future State**

At the end of this process the total saving of time is 15 hours so the waiting time from receiving an item until the storage is 19 hours compared to the initial 34 hours. We decrease the inbound flow time by 45%. The main advantage of WMS integration implementation is the elimination of manual data entry. In the current situation a dedicated operator is engaged to update stocks and the entrance can perform other activities. They can dedicate on the stocks of the spare parts that now is managed by an other supplementary operator. This last can re-equalize the number of people in the two team of picking/storage.

### 3. Acceptance of Euro Pallets from Suppliers

When ever Ledeen warehouse receives a Non-standard pallet from the supplier, one operator loses an average of 10 minutes of their time to shift materials to a Standard pallet. This time can raise up to 15 minutes if the items on the Non-standard pallet weight more than 15 kg because in this case the operator has to use the magnet lifter (Schlumberger policy). Elimiantion of this activit leads to the redution of waiting time or non value added activit time upto 15 minutes.

### 4.7. Implementation Plan

Ledeen facility adopt a Deming cycle for setting the new upgrade.

Plan: Set the objective of the experiments that you are going to do.

Do: Do the experiments and collect the results.

Check: Review the results and check if they are coherent with the prediction.

Act: If results are satisfactory, implement the procedure.

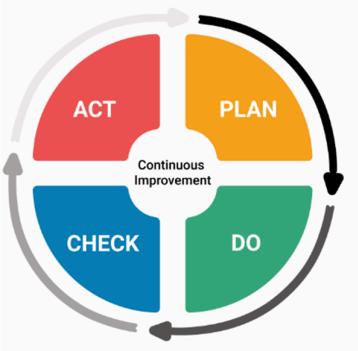



**Fig 19. PDCA Cycle**

Before starting implementation of the interventions proposed, all the proposed interventions are explained to the concern operator/supervisor involved in the operation. Received the valuable comments, suggestion from them and incorporated in the counter measure. Some are further taken up and some countermeasures are found not suitable to implement, which are withdrawn like the reallocation of tubes area near the bar bending machine. This intervention has not implemented since the accountability will be missing if the tube rack has shifted in the assembly area.

Once the intervention is fit with the concerned, the experiment of the sample has been made and record the Leadtime in the time tracking sheet formulated and standardized for measuring the process and waiting time. soon after the implementation of the sample the measured time is compared with the expected time elimination. If found perfect with the intervention the same has been standardized operation. In this project, reorder of pallet and Kitting are standardized by the end of October 2019.

This implementation plan is concerned with all warehouse operation team involved. Received positive comments from the worker for the implementation of WMS integration since the also fed up with the data that handled in the warehouse. For the reordering of pallets, the operators are initially felt uncomforting due to improper allocation of their work since they did both their regular picking works and re-ordering of pallet's. Then dedicated operators are deployed to smoothen and fasten the process of re-ordering of pallets.

Presented the results to Ledeen facility management and they agreed to implement the interventions proposed. Starting from the Quick win interventions, the company planned to deploy the additional operator per shift for the picking activity. As stated in the problem breakdown and further RCA analysis, it's been discussed with the company's warehouse supervisor, the were the responsible to deploy. They deployed one operator additionally in a shift. So total two additional operators started working from August 2019.

The major intervention pertaining to the Stars category is Kitting – sub assembly of GS material. With the help of planning department, the sub assembly has been studied and decided to carry out with standard GS material. The sub assembly has implemented all the operating teams collectively from October 2019 and it will be continued as a Standard operation in order to saturate the assembly department as well. The GS materials box is assembled and brought back to the warehouse and the are kept along with the fasteners in order to kept as a lot. In this way the company has saved more time and optimized the assembly and improved the movement of the material. Consequently, saturation of the assembly department.

Focusing on the high impact interventions, reordering of pallets location a dedicated meeting has been conducted along with the warehouse manager, warehouse supervisor and company tutor. As an outcome of the meeting the dedicated team has formed for the reordering of pallets and implementation has carried out in bay wise. the velocity code and annual movement of each component studied and drafted the ABC analysis. Firstly, the non-moving items are listed and transferred to the rack "B". the non-

movable items from all the racks are shifted to the rack “B”. this way of working helped the warehouse management to foresee the clearance of materials from the company which are pending for long time. This non movable items shifting has done by September 2019. The warehouse supervisor is the responsible to reorder the pallets in other racks as per the ABC analysis by October 2019. During this implementation the operator who does the picking and regular activity are involved. The operators involved in this operation are in bit confusion and for them it become nonvalue added activity since it does not satisfy a customer order. This turns in agreed with the operator for the reshuffling of pallets with their time schedule.

And another intervention highly impact on the target is the implementation of warehouse management system integration with the material handling equipment’s. During June 2019 the dealer for the bar code scanner is called for the meeting. The devise is not the regular with the gun type, it is mounted in the operator hand can be used as hand gloves, devised to read the bar code. With the help of Bluetooth facility in the reader the data updates automatically in the system once it merged with SAP system. The alternatives of this integration like RFID and QR scanner also proposed to the tutor for comparison and checking the ease of use at the warehouse. From the Ledeen facility management point of view, there is threat in the data handling of the devises. This intervention taken up to the senior/corporate level for the approval of such devises. The responsible for this intervention are help with the Black Belt and planning department. this intervention impact heavily on the elimination of waiting time. The operators embraced that they used such kind of bar code scanner few years before and the procedure has changed when the company’s operation ownership has changed. The operators also suggested to implement in order to save their time, especially the operators who updates Bouna Entrata in SAP. Since this proposal eliminates manual data entry error too.

### 4.8 Results summary

Detailed comparison has made with respect to the current situation and future situation scenarios and outcomes of the time measurement using Check sheet established for both the must to have and nice to have goals.

| | Current | Future | Target | Achieved |
|---|---|---|---|---|
| Inbound Flow | | | | |
| Process Time | 27 Min (1%) | 27 Min | | |
| Queue Time | 2040 Min (99%) | 1140 Min | 40% | 44% |
| Outbound Flow | | | | |
| Process Time | 5 Min (20%) | 5 Min | - | |
| Queue Time | 20 Min (80%) | 10 Min | 30% | 40% |
| Space Saving | | | | |
| Throughput Capacity of Picking | 8 UL / Hr | 12 UL / Hr | ↑ 4UL /Hour | ↑ 4UL /Hour |

**Table. 2 Target comparison**

The total waiting time in the inbound flow is decreased by 44% that is 900 minutes. The throughput capacity of the warehouse is increased 4-unit loads, the revised throughput capacity of the warehouse become 12 unit loads per hour due to the major contribution by implementing reordering of pallets at the racks. The result summary has detailed below with corresponding to their countermeasure and its impact on the elimination of higher waiting time.

| Root cause | Counter measure | Impact |
|---|---|---|
| -Manual allocation of pallets storage position<br>-Storage policy | -Reorder the storage location of pallets in Racks | -Operators already know where store the pallets<br>-Save time in picking operations |
| -Non-standardized movement | -New procedure to be prepared for storage | -Every rack is dedicated for a certain type of item. |
| -Delay in release of BE<br>-Lose of BE<br>-Delay in data entry on SAP | -WMS integration to the material handling systems | -Save time in release of BE<br>-Paper BE are substituted from a Bar Code<br>-Through an emulation process data are automatically updated on SAP.<br>-Releases one operator |
| -Integration of data with trilateral forklift | -Usage of Screen available in the trilateral Forklift | -Elimination of paper picking list |
| -Delay in data entry on SAP | -Integration of SAP with Carousels | -Data are automatically updated on SAP |
| -Non-standard pallets | -Accept only the Euro Pallets from Suppliers | -Save time<br>-Respect Schlumberger policy |
| -Operators have to do more than one operation | -Add / Hire one operator per shift | -Rebalance the two teams of storage/picking |
| -Non-standard pallets | -Supplier rating to be done | -Highlight the difference between good and bad suppliers |
| -Congestion/ overuse of forklifts | -Kitting | -Save time / Effort / Machine hours. Effective use of Available space at Racks. |

**Table. 3 Result Summary**

### 4.9 Follow up and Conclusion

The project was aimed to reduce the higher waiting time in incoming and outgoing material flow of internal warehouse by 40% in Ledeen Facility at Schlumberger′s Manufacturing unit. The higher waiting time leads to the unsaturation of the assembly department and lower its production. Developing the Makigami diagram for the current situation the problem has been identified in the process. performed the root cause analysis for both the incoming and outgoing material flow in a warehouse as the consequence the root cause has been spotted. Higher waiting time in the process is observed due to the lack of warehouse management system integration and involvement of manual operation instead of SAP system. The manual operation leads to the slower the process time since it requires more effort and more chance of having error since the item code are more than ten digit and it was hand-written by operators.

Counter measures are proposed to eliminate the higher waiting time in incoming and outgoing materials flow of the warehouse. Some eliminations had direct impact on the higher waiting time and some improvements impacts on the warehouse management system indirectly improving the working environment. A future situation incorporating the all the eliminations on the higher waiting time. The base of the future makigami was the warehouse management system integration which has been proposed to eliminate the major waiting time in both the process of a warehouse.

Effort and benefit analysis made to identify quick wins are directly implemented in the company. The stars and high impact countermeasures require investments. The company acknowledged the proposal suggested and along with company stared searching for a supplier for the suitable Warehouse management system integration.

The company is worried about the security of the data been handled by the warehouse management integration provider like bar code/ QR code scanner equipment′s supplier. The proposal was sent to the Company headquarters for seeking approval from their end and in concern with data privacy management in the warehouse.

The implementation of countermeasures is proposed in phases, firstly WMS will be implemented in the incoming materials handling process. The proposed time saving will be checked with reference to after implementation process time. The time sheets are made and provided to the warehouse supervisor for the close monitoring of the result. The time saving will be measured and will be taken to the implementation in the second phase in Storage and final in the Picking process.

For the implementation of warehouse management system, the company need to employee the dedicated personal for the SAP interference and data management work under planning department. this may enhance the speed of implementation and to eliminate an issue arise when the integration has made. It has been discussed to the managers to take up with senior to seek for approval and engagement.

**5. References**

1. Gemba walks – Womack J. – Lean Enterprise Institute, 2011

2. Lean Thinking – Womack James P, Daniel Jose T. – Guerini next,2008

3. Managing to Learn – Using A3 management process – John Shook

4. Slides of the course Industrial Management Toolbox

5. Slides of the course Industrial Management Lab

6. Understanding A3 Thinking: A Critical Component of Toyota's PDCA Management System"

-Durward K., Sobek II. Smalley - Standards media, 2008.

## 6. Appendix

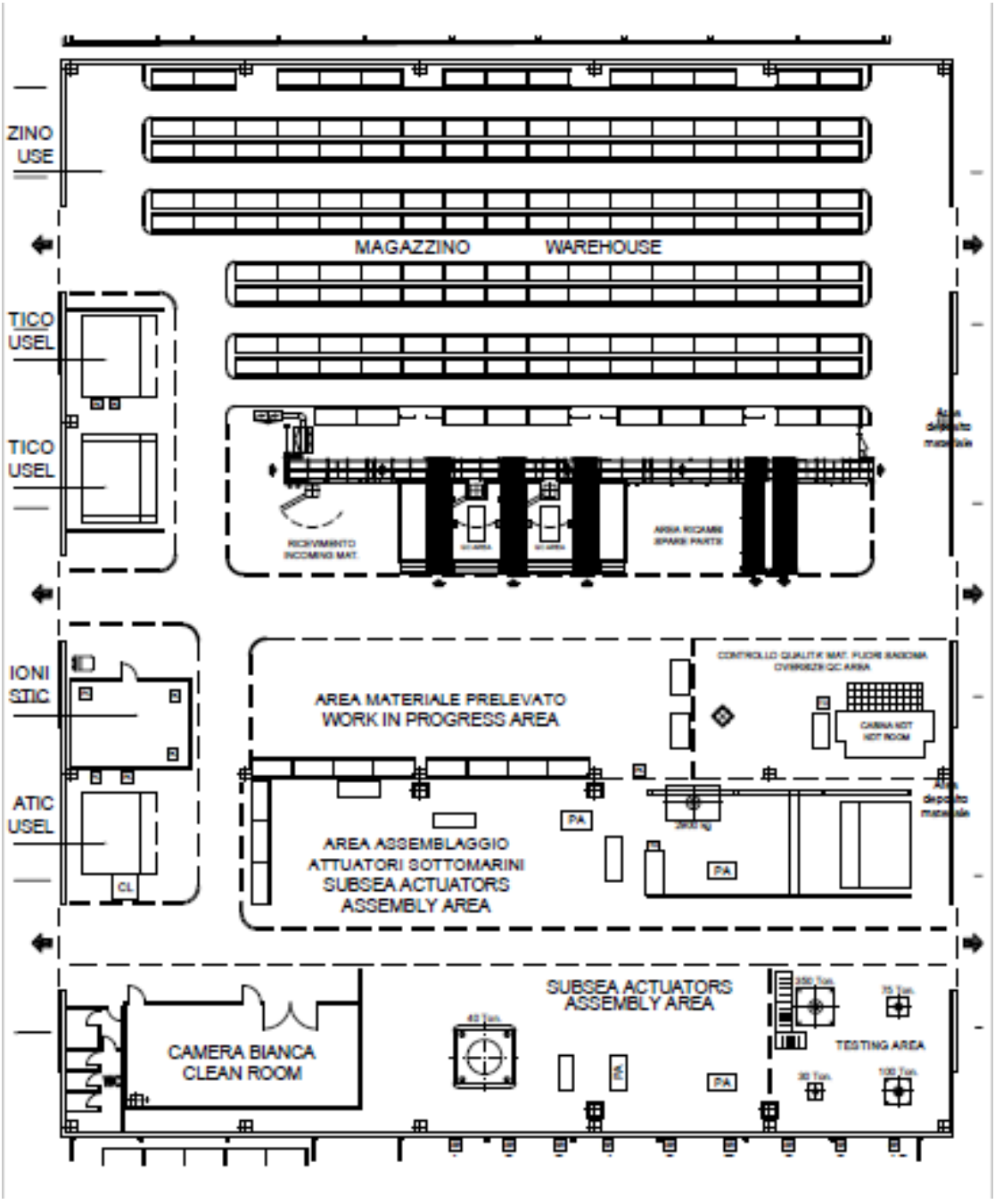
Appendix A: The project was conducted in Warehouse department of an Actuator Manufacturing unit.

“Warehouse” means indoor storage facilities

“Open Storage Area” means outdoor storage facilities

“Plant” means the whole of process unit and other associated facilities and assembly of products

“Materials” means that items such as “O” Rings, bearings, gears, pipes, pipe fittings, electrical equipment and fittings, instrumentations and accessories for assembly work.



Appendix B: The sample check sheet for time tracking at the warehouse for the use in implementation phases.

**CAMERON LEDEEN FACILITY, VOGHERA (PV)**

**CHECK SHEET FOR TIME TRACKING AT W.H**

Supplier: Date: No of Pallets received: Data Collected By:

| Date | Duration | | Activities Description | Remarks |
|---|---|---|---|---|
| | Start | Finish | | |
| | | | Unloading from Truck to Ground Floor using Big Fork Lift | |
| | | | Shifting pallets to inside Warehouse | |
| | | | Unboxing | |
| | | | checking quantity | |
| | | | releasing BE | |
| | | | Shifting to Std EUR pallet (if Applicable) | |
| | | | Quality check (if needed) | |
| | | | Shifting pallets for ready for storage | |
| | | | Storage at Racks | |
| | | | | |
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