

OPTIMIZING PROCESSES AT THE SPARE PARTS WAREHOUSE OF PORT ELIZABETH

Bachelor Thesis

APM Terminals B.V.
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Management summary

The goal of this research was to increase the control over the inventory of spare parts at APM Terminals' Port Elizabeth in New Jersey, U.S.A. This research is conducted by order of APM Terminals Head Quarters.

Absolute inventory inaccuracy at the terminal of Port Elizabeth in 2014, was 56%. Also a depreciation of \$1 million was detected and less than 60% of purchased goods where issued through correctly followed steps. Inventory was stored on different location around the terminal, managed by various departments of Maintenance & Repair.

We started off with a performance check to get an understanding what aspects required most attention. This Warehouse Excellence Scan (WEX) assessed all the main areas for warehousing spare parts; People, Process and Product, through scoring the categories; safety, health, security & environment, people, process, inventory management, workplace organization, CMMS/WMS, performance management and continuous improvement.

The overall warehousing results of Port Elizabeth were low in maturity, 1.86 points of the 5, and required changes mostly in process standardization. Processes scored a mean of level 1, which indicated that there were no warehouse processes defined.

The WEX advised us to increase inventory control by process standardization through implementing Standard Operating Procedures (SOPs). Installing SOPs was, as implementing any change, a phased project with writing the SOPs through specifying, documenting and reviewing. Thereafter we trained staff so they could execute the procedures. Where after we advised the terminal to maintain the SOPs on a yearly basis.

The extent of the SOP implementation can affect the control of the inventory at Port Elizabeth through various ways. Firstly the SOPs steer towards usage of IFS, which increases insight in the movement of parts. Next to that SOPs avoids variations, regardless of the operator and time of operation. Also SOPs help facilitate the transfer of knowledge and skill, so this will not get lost when there is a change of staffing. But SOPs are not all roses, when written poorly the procedures can affect the company negatively.

As result of our efforts in SOPs among other things, the estimation in August 2016 was that a value of \$3,8 million, 75% of the purchases for Maintenance and Repair, went through the STRONGER solution J-cat. This indicated the magnitude of controlled purchasing. The value of inventory that was issued through Work Orders summed up to around \$3 million, which is 80% of all issued material being obtained through the SOP' set way of working.

Recommendations of this thesis are to create more SOPs for warehouse processes, share them with colleague terminals and to take a look at warehousing within other heavy material industries.

Acknowledgements

This research was conducted between September 2015 and February 2016 at both Port Elizabeth, New Jersey and APM Terminals' Head Quarters, The Hague in partial fulfilment of my Bachelor Technical Business Administration. I want to use this opportunity to thank a number of people who contributed to this research.

Firstly I would like to thank André Langendoen of APM Terminals. He gave me the opportunity to make this incredible journey to the United States. He guided me with such care and knowledge. He backed me up in bold choices and gave me space to develop. A real sparring partner that also kept me on track and reminded me of my scoop. Our almost familial band is real dear to me and gives me the power to push through.

Also I would like to thank Peter Schuur of the University of Twente. His witty enthusiasm made the subject even more interesting. The flexible way of working he uses made this thesis a joyful project. The motivation and devotion of Peter Schuur was pleasant for me to collaborate with. Thank you Peter, for all your time.

Special thanks to my love and partner Chiel Poortman. His endless patience and support gave me the capability to finish what I have started. Also thanking Kathy and Maarten for their hospitality, sharing their home and table with me to finish my studies. Thanking Ilse, Sofie and Frederique for their encouraging words and advice to make this thesis structured. Furthermore I would like to thank my family, who I love so dearly, for investing and believing in me.

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List of abbreviations

APMT	A.P. Møller Terminals
BIS	Business Information Systems
COO	Chief Operating Officer, the biggest terminals within APMT
HQ	Head Quarters of APM Terminals
HR	Human Recourses
HSSE	Health, Safety, Security and Environment department
ILA	International Longshoremen's Association (Blue collar Union)
IT	Information Technology
M&R	Maintenance and Repair
MD	Managing Director of the Terminal
MLW	Mean Low Water, water depth at an average low tide
RTG	Rubber-Tyred Gantry Crane
TAM	Department Technical Asset Management
TEU	20 Foot Equity Unit (indication of a 20ft container)
VAL	Value Adding Location
WEX	Warehouse Excellence – Tool to measure performance of warehouse for spare parts

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1 Introduction

“Only if you really want to go to New York” said André Langendoen (2015), after offering the short term assignment.

That is why, in the framework of completing my bachelor thesis at the University of Twente, I conclude my research optimizing processes at the spare parts warehouse of APM Terminals’ Port Elizabeth, New Jersey. APM Terminals is one of the biggest international port operating companies in the world, with Port Elizabeth as one of their most important terminals. This research focusses APM Terminals’ Port Elizabeth (Port Elizabeth) only, where the names APM Terminals and Port Elizabeth are being used interchangeably.

Project STRONGER, a procurement optimization program initiated by the company’s Head Quarters and supervised by André Langendoen, was send to Port Elizabeth to improve purchasing beginning 2015. Port Elizabeth, New Jersey, was a competitive area looking for optimization and cost reduction. Deployment of STRONGER was done both in North America and Europe, but obtained insufficient results at Port Elizabeth. In combination with big financial depreciations in the warehouses, involvement of warehousing specialism in any kind was welcome. Therefor this thesis was a part of a bigger assignment, zooming in on the weakest link within warehousing spares at the terminal.

This thesis consists of multiple chapters, each focusing on a different aspect of the research conducted. Chapter 2 provides background on APM Terminals’ and specifically Port Elizabeth’s area of business. The internal organization, product, market and industry are explained briefly discussed in this chapter. Chapter 3 focusses on the research itself; it sets out the problem formulation and questions, research approach and questions, followed by design and planning. Chapter 4 summarizes the literature review conducted to build a theoretical framework on warehousing of spare parts. Chapter 5 consist of the result of APMT’s Warehouse Excellence scan (WEX), that measured the performance of Port Elizabeth state of warehousing at the time. Chapter 6 addresses the improvement of he weakest point of the WEX, processes. Concluding all prior writing, chapter 7 joins the highlights and recommendations.

Knowledge is power, also in the dynamic world of commercial business. This thesis is a way of passing on the experience of optimizing warehouses for spare parts within APM Terminals. This has not been done before under supervision of its Head Quarters. Documenting the course of events with a theoratical backbone provides a strong tool when reproducing warehouse optimization.

The base is put, now the serious business can follow. Enjoy.

“Read to weight and consider”, advises Francis Bacon (1625).

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2 APM Terminals & Port Elizabeth background

This second chapter provides background for the business APM Terminals and specifically Port Elizabeth operate in. First a general overview of APM Terminals is set out in section 2.1, followed by a more specific description of the Port Elizabeth area in section 2.2. Container freight and the terminal's operations are discussed in section 2.3. The internal organization of Port Elizabeth and the structures within its Maintenance and Repair department are addressed in section 2.4. Port Elizabeth's goals and five year strategy are described in section 2.5. In the last section (2.6) the focus is on culture, the market and the industry.

2.1 General overview APM Terminals

According to Drewry Maritime Research (2015) APM Terminals represented 5.5% of the global container handling market in 2014. APM Terminals is a recognized industry leader in providing terminal services for container ships and port infrastructure. The company operates a Global Terminal Network of operating ports, terminal facilities and Inland Services in 58 countries spread over the world, as well as providing independent Crane Engineering Services to the global port industry (APMT, company-information, 2015).

The company has its headquarters (HQ) in The Hague, The Netherlands and operates among shipping lines, importers, exporters, governments, business leaders and the entire global supply chain. With 20.600 professionals the company provides port management and operations over 60 liner shipping costumers (APMT, company-information, 2015).

As part of HQ, the Procurement department is responsible for the logistic stream within and around the terminals themselves. This extensive view has been adopted recently and comprehends Category Management for Operational Expenditures, Category Management for Capital Expenditures, warehousing, support for business implementations, acquisitions and transactional procurement support.

2.2 Port Elizabeth

Back in 1910 the basis of Port Newark in Newark, New Jersey, United States was constructed (To Make Newark Bay a Big Port; The Jersey Meadow's Being Transformed Into a Busy Spot, with Docks and Reclaimed Land, 1915). To reach the port, ships had to travel through The Narrows and the Kill Van Kull towards the Newark Bay. This route is shown in figure 1 with a black arrow. In those waters the first containership, the Ideal X, set sail for Port Houston on the 26th of April 1956 (Port History, n.d.). What led to the build of the first containerized port in the world, Elizabeth-Port Authority Marine Terminal. Now known as APMT's Port Elizabeth.



FIGURE 1 - MAP OF NEWARK & NEW YORK PORT AREA
 SOURCE: (CUSTOMERSNOW.COM, 2014)

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In 1985 Port Elizabeth was the world's busiest container port. In 2004 it was the largest port on North America's eastside (Lipton, 2004). Currently Port Elizabeth is APM Terminals' largest terminal on the east coast of the United States (Port Elizabeth, 2016). With a terminal area of 142 hectares the port is filled with an 1829 meter berth, yard, hubs, gates, offices, workshops, warehouses and other supporting facilities. The depth at dock is between 13.7-15.2 meter MLW and holds 15 container cranes, 10 of them operated regularly. The neighboring port operators are Maher terminals and Port Newark Container Terminal PNCT. With Maher, comparable to APM Terminals in size, there is a collaboration in terms of the rail (the orange block between the ports shown in figure 1).

2.3 Product

Port Elizabeth's main product, so to speak, is the service of transshipping containerized freight. The terminal operates as an intermediate destination for the containers. At the terminal the mode of transportation for the shipments change. The process of transferring a shipment from one mode of transportation to another is called 'transloading'.

At Port Elizabeth transloading takes place in several ways;

- between sea vessels and inland water vessels;
- between sea vessels and rail or road; and
- between multiple sea vessels.

In the last case multiple smaller shipments are consolidated into a larger one or the other way around by dividing a big load.

For transloading to take place, containers are temporarily stacked at the terminal where different extra services can be performed. The stacking period is a service by itself but also cleaning, repairing and weighing the containers is done at the terminal.

As a company APM Terminals also provides the infrastructure for further transportation. Roads, railways and waterage are conceived, constructed and maintained by APM Terminals. Mostly in collaboration with other terminals, the port authority, local authorities and the country itself. The need of this service depends per terminal. Port Elizabeth has to deal with a strictly regulated port authority which has all infrastructure in their hands.

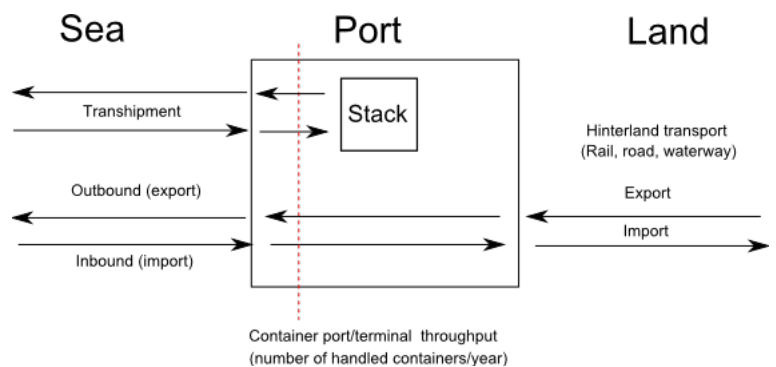


FIGURE 2 – TRANSshipment CONTAINER PORT
SOURCE: (RUTTER, 2009)

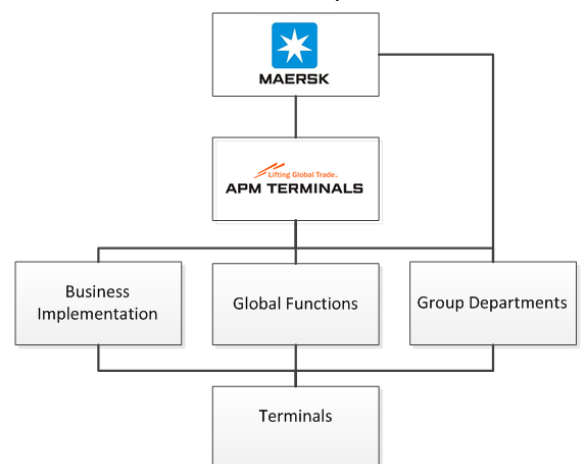


FIGURE 3 – SIMPLIFIED ORGANIZATIONAL STRUCTURE APM TERMINALS
SOURCE: (SOLTANI, SIMPLIFIED ORGANIZATION CHART APMT, 2016)

2.4 Internal organization of APM Terminals and Port Elizabeth

APM Terminals consist of a group terminals around the world. Most of them are wholly owned by APM Terminals, others are joint ventures (APMT, Compliance Manual, 2014).

Port Elizabeth is wholly owned by APM Terminals and therefore reports into HQ. The managing director (MD) Brian Clark, in charge of the entire terminal, communicates into the Chief Operating Officer (COO). The COO portfolio consists of the 65 biggest terminals that are in operation at APM Terminals.

All terminals are self-sufficient with their own departments like Operations, Commercial, HSSE, Finance, IT and HR. This research mainly engaged with both Maintenance & Repair as well as Procurement.

2.4.1 Maintenance and Repair

Led by Maintenance Director Justin Weir, the terminal gets maintained by six departments spread over the terminal. Container maintenance, RTG maintenance (Rubber-Tyred Gantry Crane), Reefer Maintenance, Crane Maintenance, Power Maintenance and Facility Maintenance. All departments have a manager, sometimes an assistant manager and a team of blue collar labor force that do operational work. The organization charts for M&R (Maintenance and Repair), Crane, Power and Facility are to be found in Appendix A in the attached bundle. The current structure within the departments vary because of historic heritage.

Important to know is that the blue collar labor force is united within the International Longshoremen's Association (ILA), which is the union of maritime workers in North America. The labor force of multiple terminals and terminal-related companies are united in this association. Changing structures, job quantities and functions are debated every 3 to 10 years, depending on the contract between terminal and union. This structure prohibits for example management and HQ to touch materials or hire or lay off workforce.

2.5 Goals and Strategy Port Elizabeth

Every five years APM Terminals Head Quarters launches a new strategy plan. This plan is to be conducted at the terminals and therefor affects operations in Port Elizabeth. The current timeframe which runs from 2015 to 2020 is called 'Reach 2020'. Its main pillars are understanding trends, employing the best people, deploying technology, become recognized leaders in the port industry and grow business on best practice foundations. In order to achieve the objectives set in 'Reach 2020' APM Terminals has created four central themes:

- Reach new markets and customers
- Reach safe, industry-leading operations
- Reach results through capabilities and collaboration
- Reach our bold ambition (APMT, reach2020, 2015)

Container freight was booming in 2014. Due to oil price fall back and several other causes the freight rates are at a third of their worth in 2016 compared to 2014 (Container Trade Rates to Decline in 2016, 2016). This was predicted in 2015 and company goals were amended. Not only this, but also a series of fatalities and accidents happened in the last year on the terminal. With regards to safety, Port

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Elizabeth's strategy focusses mainly on results through capabilities and collaboration. The Fatal Five, an APM Terminals safety program, is to be implemented and optimization through modernization is needed for the results.

2.6 Culture Port Elizabeth

APM Terminals is an operation driven company that values their customer's needs to stay within the market. Having low flexibility and external orientation, creates market culture according to Robert Quinn (2015). This culture is result orientated and focusses on competition, achievements and finishing the job. This is the true work ethic on the terminal. Next to that, there is the separation between management and labor. Union and APM Terminals so to speak. This is not always an homogeneous alliance, with strikes, stops and walk outs. Combine that with a bit of the 'New Jersey spunk' and there is a devil to play. But in times of big storms, snow and accidents the terminal is one and united.



Key colors

- Operational terminals
- ★ Terminals with upgrade or expansion projects
- New terminal projects
- ▲ Office

North America

- 1 Port Elizabeth, New Jersey, USA
- 2 Portsmouth, Virginia, USA
- 3 Charlotte, North Carolina, USA
- 4 Jacksonville, Florida, USA
- 5 Miami, Florida, USA
- 6 Mobile, Alabama, USA
- 7 Houston, Texas, USA
- 8 Los Angeles, California, USA
- 9 Tacoma, Washington, USA

FIGURE 4 – APMT PORT FACILITIES NORTH AMERICA
SOURCE: (APMT, COMPANY-INFORMATION, 2015)

largest single proprietary terminal in the world. The 40-acre on-dock rail facility, pioneered by APM Terminals, can accommodate four double stack trains simultaneously with five miles of working track. Overall container traffic at US and Canadian ports was 53.2 million TEUs in 2014, representing 8.2% of global container throughput for that year (Drewry, August 2015).

2.7 Markets

2.7.1 APM Terminals

APM Terminals has its reach over almost the entire world. Drewry's Annual Report (2015) shows that APM Terminals has the most geographically balanced portfolio in the industry in terms of throughput. Next to 18% of the volume handled in the Far East, APM Terminals is concentrated around the coasts of Europe, West-Africa and along North- and South America. In Appendix B of the Appendix bundle, the maps with terminals and inland services gives a visual of the current situation. The majority of the investments in 2015 are done and planned in emerging markets like Mexico, Costa Rico, Nigeria and Ghana (portfinanceinternational.com, 2015).

2.7.2 North America

APM Terminals is the leading terminal operating company in North America, with weighted throughput of 4.42 million TEUs (twenty-foot equivalent unit) in 2014 (Drewry, 2015), and a market share of 9.2%. The company has interests in seven US ports, including the Pier 400 terminal at the Port of Los Angeles, which with an area of nearly 500 acres, and an annual throughput of 2 million TEUs in 2014, is the

Port Elizabeth was ranked first in the United States in the JOC productivity study for the first half of 2014 with 82 MPH with a vessel alongside. The facility handled 1.18 million TEUs in 2013. APM Terminals Houston ranked 3rd among US terminals with 68 MPH with a vessel alongside. APM Terminals was named “Port Operator of the Year” for 2014 at the Lloyd’s List North American Maritime Awards in Houston, in February 2015.

But in 2016 these numbers came to a fall and the all-time low is reached in container freight according to Drewry’s forecast (Consultants, 2016). Because the figures of the first two quarters are not public yet, the details are still concealed. This goes for North America as well as for the rest of the world.

2.8 Industry overview

Drewry’s Annual Report (2015) ranked APM Terminals third place among Global Terminal Operating Companies for 2014 in terms of market share. Following PSA International and Hutchison Port Holdings, APM Terminals has a Drewry-calculated equity-share throughput of 37 million TEUs. While other companies are busy expanding, activity drivers for APM Terminals and DP World (forth in ranking) are acquisitions, selling non-core investments and greenfield developments.

In Appendix C of the bundle the complete NAFTA (North American Free Trade Agreement) Port Rating of 2015 is placed. Here the entire overview of the North American industry is displayed. Figure 5 shows the top three of the 50 terminals, in ranking Los Angeles, Long Beach and New Jersey. This overview also shows the amount of TEUs (Twenty-Foot Equivalent Unit, which is a container the size of 20ft) the ports carried in 2014 and 2015.

NAFTA REGION CONTAINER TRAFFIC							
2015 PORT RANKING BY TEUs							
2015 Rank	Port (State/Province)	Country	2015	2014	Absolute Change	Percent Change	2014 Rank
1	Los Angeles (CA)	United States	8,160,458	8,340,066	-179,608	-2.2%	1
2	Long Beach (CA)	United States	7,192,066	6,820,808	371,258	5.4%	2
3	New York/New Jersey	United States	6,371,720	5,772,303	599,417	10.4%	3

FIGURE 5 – NAFTA REGION CONTAINER TRAFFIC 2015
SOURCE: (NAFTA, 2016)

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3 Research plan

This chapter describes the outlines of the research. Setting a solid base in the first section by formulating the problems and producing the problem statement, optimizing the warehousing of spare parts. Section 3.2 defines the research approach with its stakeholders, resources, guidance and limitations. Whereas section 3.3 distributes Heerkens' (1998) problem cluster, with the main issue being no control over the inventory. In section 3.4 the derived research questions are presented, accompanied with the methodology to answer them in section 3.5. Last, but not least, the construction of the research is explained in section 3.6.

3.1 Problem formulation

During yearly financial review of the terminals, Port Elizabeth fell under the attention of its Portfolio Manager Wim Lagaay. The write-off for 2014 of the M&R department appeared to be 1 million dollar. The current value of these departments inventory was no more than 6 million dollar, which means that the warehouse lost roughly 16% in depreciation.

Project STRONGER, a procurement optimization program initiated by the company's Head Quarters, was send to Port Elizabeth to improve purchasing beginning 2015. STRONGER, already implemented in other North American terminals, experienced difficulties with conveying their methodology and encountered resistance in change. The conclusion was that only changing the procurement department would not adjust the earlier detected depreciation.

Port Elizabeth is a terminal with a rich historical background. Its heritage consists of all the knowledge that is gained through the years, but also of organizational structures that do not fit the current terminal operations. Those formations are visible in the fragmentation of the warehousing of spare parts for maintenance. All six Maintenance and Repair departments (Container, RTG, Reefer, Crane, Power and Facility Maintenance) operate separately. Each department has its separate location(s) on the terminal, at separate workshops, with separate warehouses, with a fixed group of specialized staff. They use the same computer program, IFS, but have their own codes and descriptions for products (nomenclature). Also the vendors they buy from vary, even if items are similar.

Combining and collaboration between departments is made difficult by the Union agreements made in the past. Also tension between departments exist because departments feel treated unequally compared to others. Next to that the feeling towards the Procurement department is hostile and is mostly worked around to avoid collaboration. On top of that, the culture is not open for change.

The problem statement is formulated as:

Optimize the warehousing of spare parts for Maintenance and Repair at Port Elizabeth in such a way that it can be executed in all the divisions of this department, thereby providing an optimized commensurate way of working both physically as digitally in the warehouses.

3.2 Approach

To tackle the problem of no uniformity within the Maintenance & Repair departments of Port Elizabeth, a path was laid out. This road influences people and existing resources,

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needs guides and has its own boundaries; all mentioning worthy and most relevant are disclosed.

3.2.1 Stakeholders

The effect of structured adjustments to minimize depreciation and regain control of inventory at Port Elizabeth affects many players.

First of all the person who took action; the portfolio manager at HQ; Wim Lagaay. In time of cost reductions every penny counts. With the goal of the COO portfolio to generate savings of 10 million in one year, this seemed a big fish.

Because of the reporting line into the portfolio manager, also Port Elizabeth's Terminal MD, Brian Clark, is a stakeholder. He has to provide back-up for Justin Weir, Port Elizabeth's M&R Director, so he can execute change. Also all the managers under Justin Weir's supervision are influenced by these changes, they have to implement and sustain the change together with their staff. In short the entire M&R Department and the terminal MD are considered to be stakeholders.

The optimization also serves the internal customer; Technical Asset Management (TAM). They are the mechanics that work in the M&R department. Every minute that they lose on equipment, the operation is delayed or in the worst case shut down.

Project STRONGER, has invested time and resources the Procurement department at an earlier stage and also needs results based on their efforts. They need success within the North American terminals. Achieving positive results in New Jersey counts as a big win and strengthen their approach.

Together with Project STRONGER, Group Procurement is on the path to change purchasing within all of the APM Terminals. Having this wholly owned terminal organized properly is a must to display the benefits of this change. They will also have to provide help and guidance in the process of the warehouse restructuring.

Next to all the internal stakeholders, the suppliers of the warehouses are involved. This group will be addressed to help in optimizing the warehouse. From reopening contracts, to attracting new stakeholders and saying good bye to others. They are a key stakeholder in making the structure work.

3.2.2 Resources and guidance

This research will be an add-on for Project STRONGER. The STRONGER team, existing of an HQ team and a Mumbai team. André Langendoen, Mahmoud Gamal and Jerry Jansen are the strategical and implementing team in The Hague. They were the first line of help in the new setup. The Mumbai team, which is more report and support, provided the needed information to analyze the situation. STRONGER also provided the possibility to visit the site in Newark, New Jersey when necessary. André Langendoen, project manager, also managed this report and used the findings in later STRONGER roll-outs.

The resources needed to interview and deliberate with staff at the terminal was granted by Brian Clark and Justin Weir, directors at Port Elizabeth. All the departments were willing to work with this project and scheduled sufficient time to do so. Justin Weir's presence was granted during the important sessions, which gave leverage to the process. Also financial resources were acknowledged if deemed crucial for the

implementation of the new structure, if well founded. Justin Weir helped shaping this report to a usable product that can be implemented at Port Elizabeth. Other terminals helped with through sharing their material. Several other terminals indicated to be interested in the results of the thesis, to implement at their own site.

Next to that Peter Schuur from the University of Twente guided this research content-wise as supervisor. He helped in terms of insights, reporting, writing and functioned as sparring partner.

3.2.3 Limitations and constraints

This research is limited by the basic variables of time and money. HQ wanted the project to be fulfilled in Q4 from 2015 (October, November, December). If, and only if, there were financial results booked in the first three months of the research, the timeframe would be extended to end Q1 2016 (March). Next to that the port is located in Newark, New Jersey and most of the work was done in The Hague. Travel from The Hague to Newark was sponsored by project STRONGER, thereby requiring consciously spending resources.

Optimizing the warehousing for spare parts is backed up by the management team of Port Elizabeth, but had to stay in line with the Union agreements. Staff functions and positions could not be altered. Also hiring and laying off personnel was not an option within the labor force. All extra work was done in overtime, this created extra costs and were to be suppressed as much as possible. Another limitation was the prohibition on touching, moving or counting of materials by management or HQ. Only the blue collar labor force was allowed to do this. Also the departments were to keep their individual warehouse, consolidating was not an option. Also implementing technology that takes over manual labor was not allowed.

All the structural changes that are planned must be approved by terminal management and the Union. If management agrees on points that the Union does not, bargaining can be done. This is something this research wanted to stay away from.

3.3 Problem cluster

Structural change has to tackle certain problems. To get to the core of these problems visualization can help. According to Heerkens, (1998) a problem cluster is a professional way to determine if the problem given by the client – in this case APM Terminals – is the real problem. The cluster is a scheme in which the causality of various problems is mapped and isolates the underlying action problems within the reality of the client.

Through interviews with stakeholders, inspecting the different warehouse locations and gaining insight in financial records, various problems surfaced. With the problem cluster in figure 6, the main items are covered. The core problem is displayed in the middle big blue block and is surrounded by the four causes. These causes are also problems and are overarching the arrow pointing towards the smaller blocks.

The main problem, according to this problem cluster, is the lack of control over the inventory, causing the 1 million dollar depreciation. This loss of supervision can be motivated by untrained staff, unclear processes, many storage locations and the disconnection between the Maintenance and Repair departments.

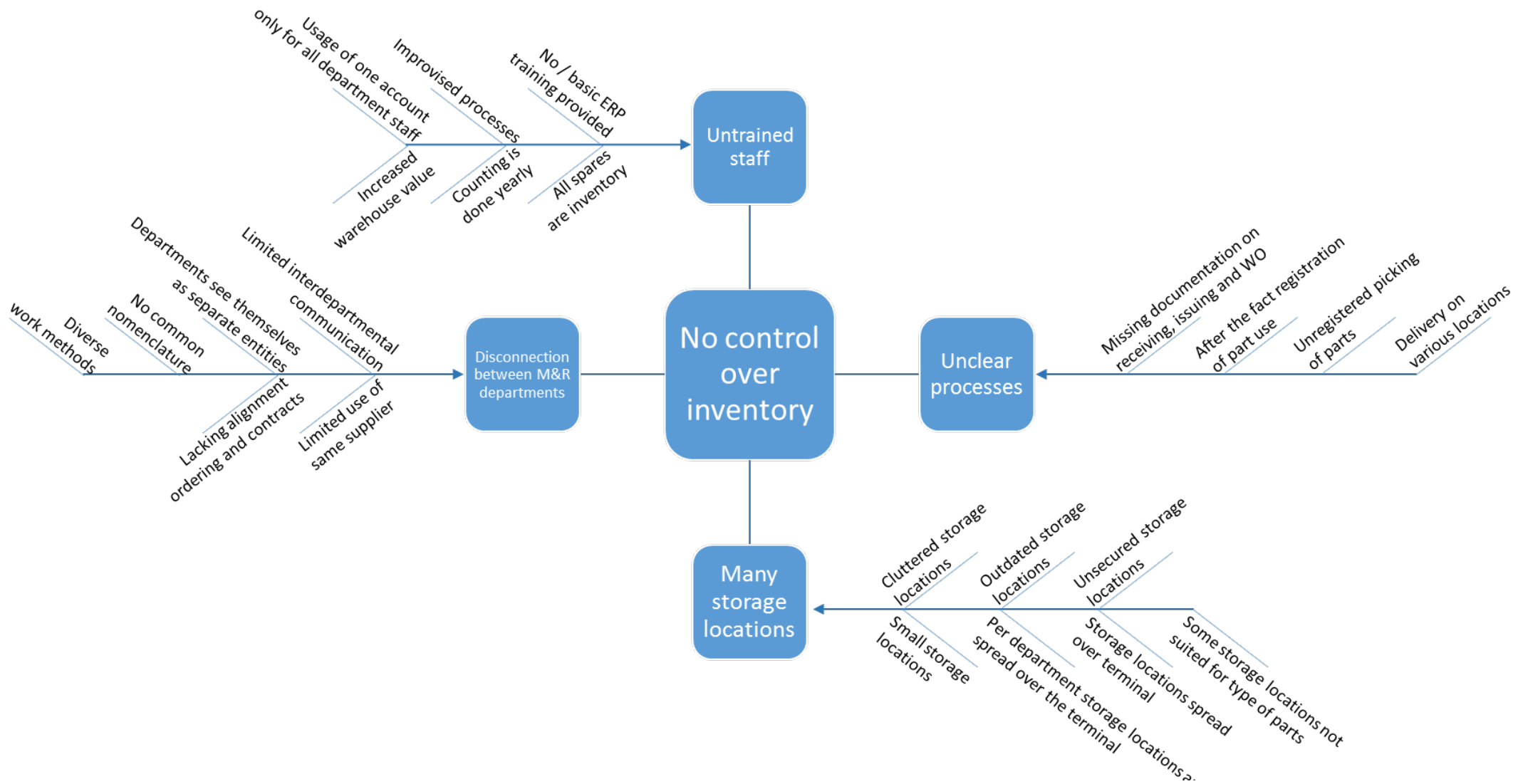


FIGURE 6 – PROBLEM CLUSTER

3.4 Research questions

The problem cluster is the foundation on which the research questions were formulated. The relations that are shown in the cluster are covered thematically and in bottom-up order. Most problems are discussed and derived into research questions.

3.4.1 Untrained staff

One of the main reasons the current inventory was not under control, was because of the people that carry out the task of keeping the warehouse. The blue collar staff is not trained properly in IFS, the used ERP on the terminal. This ERP was not completely warehouse orientated, lacks analytic functionality and was not intuitive, but was capable of keeping track of inventory. Because staff was not trained in warehousing, processes were improvised which led to illogical and unsustainable procedures. In the last two years six people have retired at the M&R departments and had just several weeks to pass on their knowledge to new staff. Also the lack of a critical eye on the inventory in combination with software that does not support those functions at the moment.

3.4.2 Unclear processes

Next to the lack of professionalized processes, there was no standard. Every department and every employee did matters in their own way. The absence of documented ways of executing work, caused misses in delivery, communication, picking, issuing and parts creation. Also responsibility of steps within the process shifted from one to another, when new staff came in. Old members leaving could transfer information by telling them, but so much impressions can last and new staff was not reminded.

3.4.3 Many storage locations

Port Elizabeth reaches over 142 hectares, the size of 282 soccer fields. The operation takes up most of the space. Scattered around the area the workshops of the M&R departments are allocated. A clear visualization is provided in Appendix D in the bundle. Every workshop had a warehouse next to it, but because most buildings are not build for what they were used for, materials could not be stored in one location. So again the storage of parts was done around these workshops in different rooms, containers and outside. The crane and RTG department even had other locations where they store big slow moving articles. Facility maintenance had a small workshop, but the rest was spread over the entire terminal with at least 12 locations. Reviewing, controlling and securing was troublesome because of this spread.

3.4.4 Disconnection

The monthly M&R meeting with Justin Weir and his managers were the only moment for the team to come together. In times of significant problems, like (snow) storms and fatalities, the team is assembled more frequently. The M&R department managers saw little resemblance between their section and other M&R divisions. Mainly because their work methods were different, their type of maintenance was deviating and in IFS they did not understand each other's nomenclature. Warehouse managers from different departments did not get together and procurement, before STRONGER, was done by the departments itself. Multiple times a day the same supplier could travel to the terminal, delivering on different locations to different departments. But also different suppliers provided different departments with the same product. There was no sense of co-operation.

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3.4.5 Research Question 1

What aspects are essential for warehousing of spare parts for Maintenance and Repair at APM Terminals' Port Elizabeth?

Getting a grip on inventory can be done through different channels. Exploring which possibilities can be optimized, gives way to construct improvement. With this research question all the facets of warehousing spare parts are broadly viewed. Also an overview of Port Elizabeth's methods is necessary to get understanding of their operation.

- A. What, according to literature, are the aspects that a warehouse for spare parts consist of?
- B. How is the warehousing for spare parts at Port Elizabeth performing in the aspects given by literature?
- C. What aspect, according to APM Terminals Warehouse Excellence Scan, requires most attention?

3.4.6 Research Question 2

How to approach the optimization of the aspect that requires most attention at Port Elizabeth's warehouse for spare parts?

After getting an understanding of warehousing spare parts and the situation at Port Elizabeth, the second question selects a topic to improve.

- A. What does literature say about approaching the aspect that requires most attention?
- B. What, according to APM Terminals Warehouse Excellence Scan, should be the next step in optimizing the aspect that requires most attention?
- C. To what extent will the optimization of the aspect that requires most attention increase the control of the inventory at Port Elizabeth?

3.5 Research methodology

In this section we describe the methods used in this research.

3.5.1 Literature

Starting off with a literature review by looking at warehousing for spare parts. The keyword (or combinations): warehouse, spare parts, essentials, aspects, setting up. Selected articles or books on generality, referred to more than 20 times, by reading the abstracts and read thoroughly when matching our scope. Also searched for cross references, to build knowledge of the research field. After understanding the current situation literature study was done again. Now the scope was warehouse processes and optimization. Keywords: warehouse, processes, optimization, implementation, standardization. All with the same requirements as before.

Together those two researches led to the answering of two sub-questions and partially sub-question 2C. The literature is described in chapter 4.

Question 1A What, according to literature, are the aspects that a warehouse for spare parts consist of?

Question 2A What does literature say about approaching the aspect that requires most attention?

Question 2C To what extent will the optimization of the aspect that requires most attention increase the control of the inventory at Port Elizabeth?

3.5.2 Current situation

To get an understanding of the processes, resources and organization a workshop was held at Port Elizabeth. Visitations, interviews with stakeholders: M&R manager, department managers, warehouse supervisor, storekeepers, administrative employees, foremen, auditor, TAM representatives and STONGER management. Combining these interviews with personal observations was not enough to measure the performance of the warehouses. The Warehouse Excellence Scan was conducted to compute the overall state of warehousing at Port Elizabeth. All aspects, including finance, were assessed and scored.

The sub-questions 1B and 1C were answered fully. Question 2B was supplemented by a Kaizen meeting with several warehouse people checking and revising the drafted outcome. This is mainly described in chapter 5.

Question 1B How is the warehousing for spare parts at Port Elizabeth performing in the aspects given by literature?

Question 1C What aspect, according to APM Terminals Warehouse Excellence Scan, requires most attention?

Question 2B What, according to APM Terminals Warehouse Excellence Scan, should be the next step in optimizing the aspect that requires most attention?

3.5.3 Designing and implementing improvement

After concluding in sub-question 2B to design and implement Standard Operating Processes (SOPs), literature review was done again as said in section 3.5.1. Gathering material from other terminals, searching for standards within the company and creating SOPs with lean manufacturing in mind and the 5+2 S methodology. Predicting the impact by looking at both financial figures as well as how well procedures are followed in the system. The development, results and forecast are described in chapter 6 and answered sub-question 2C.

Question 2C To what extent will the optimization of the aspect that requires most attention increase the control of the inventory at Port Elizabeth?

3.6 Research design

This section elaborated about how the research is constructed.

3.6.1 Trial population

After financial analysis, the Power Department had most value and highest inventory inaccuracies. Therefore they functioned as trial department to show HQ what an impact this change can make. The department's manager was willing to implement change. Trivial is also that the foreman is able to see optimization as an improvement, not only as a threat.

3.6.2 Results and analytics

The results of this optimization is measured in money. The less money it cost, with the guarantee of quality, the bigger the success of this project. Analyzing this money in terms of inventory turnover, inventory increase, inventory inaccuracies and staff. These results are now obtained yearly, because of the mandatory financial inventory count.

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3.6.3 Deliverables

The deliverable of this report consist of two parts. Firstly a report on the current performance of Port Elizabeth's warehousing of spare parts. This report describes financial and none financial achievement of all warehouse locations. The second part is a tangible product that optimizes warehousing for M&R, both physically and digitally. The product should be applicable for all departments, creating structure and standardization.

3.6.4 Activity planning

To implement a new strategy without disrupting the organization Robert Kaplan and David Norton (2006) state that preparation in the most important part of the change. Aligning goals, theme's and restrictions with management is the first step (STRONGER). Followed by understanding the current situation, its tops and flaws (REVIEW). Third the executive team identifies the strategic initiatives (typically those that span business-unit boundaries) that support each theme and authorizes the resources—money and people—required to implement each initiative (DESIGN). Where after the implementation is done and the new strategy must be sustained (IMPLEMENT).

Because this report is a grip out of the overall optimization of Port Elizabeth's warehousing, the activity planning was adjusted. All subjects that are used in this report are notably marked in the activity planning shown in figure 7 on the next page. All taken actions are bold and in color. Steps that are taken outside of this report, are grayed.

This research is intended to get a grip on the inventory of Port Elizabeth in terms of depreciations and value increase. To get an understanding and visualization of the situation an visit to the terminal is arranged. The basis of the new structure will be a combination of literature study and input from staff. Implementing the change is also based on theory, executed again by staff.



FIGURE 7 - ACTIVITY PLANNING WAREHOUSE OPTIMIZATION PORT ELIZABETH

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4 Literature review

This research has its foundations in literature. Insight was gained in warehousing, spare parts and standard operating procedures. This chapter answers sub-questions 1a and 2a, whom search for aspects that a warehouse for spare parts consist of (section 4.2) and how to approach SOPs (section 4.3). Next to that research, section 4.3 also the extent of SOPs was reviewed. But to start off with some basics, section 4.1 describes the warehouse in general and essential warehousing aspects.

4.1 Warehousing in general

Let us first look at warehousing in general before zooming into spare parts. A warehouse, according to Jeroen van den Berg (2013), should be viewed as a temporary place to store inventory and as a buffer in supply chain. He states that the warehouse serves as a static unit matching product availability to consumer demand and as such has a primary aim which is to facilitate the movement of goods from suppliers to customers. The warehouse should therefore also meet demand in a timely and cost-effective manner. Bluntly said: a transshipment point where products come in, get stored and go out, with suppliers, the warehouse and customers as actors.

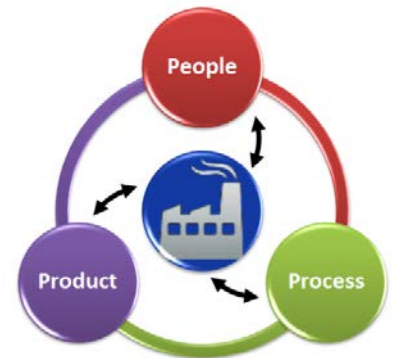


FIGURE 8 – PEOPLE PROCESS PRODUCT
SOURCE: (SOELEN, 2014)

4.1.1 People, Process, Product

To isolate the warehouse in overseeable compartments, an adjusted version of Chihiro Nakao's "New Production Preparation" (NPP) is used (Hamilton, 2012). The 3P methodology is interpreted in different ways. In this thesis the P's stand for People, Process and Product (Soelen, 2014). Together these P's bundle all the activities within the warehouse.

4.1.2 P1: People

Karen Hupe (2014) states that the amount of people you need to run a warehouse, depends on its type. For some fulfillment centers, automated systems, robots, and industrial engineering have taken the human element out of warehousing. For others, it is still a very labor-driven place.

The Material Handlers, the Order Pickers, Packers, Receivers, Stockers, Assemblers are a group of employees that do only one job, are cross-trained for multiple jobs, or do something completely different. But these 'worker bees' in the fulfillment warehouse are the ones that make the operation run efficiently. The inventory clerk is responsible for a variety of clerical duties relevant to warehousing, receiving and shipping materials. In most cases, this person handles relationships with vendors and/or suppliers, and is responsible for monitoring inventory performance and assists in creating purchase orders to replenishment stock before it runs out. They're also heavily involved in keeping inventory counts in check. Next to them the Warehouse Supervisor supervises, organizes and monitors the receiving, storage, and distribution of inventory. He or she oversees the 'worker bees' to ensure that they are on task at all times, performing to the metrics required of them, and often times trains new employees in the process. Managing the entire crew is the Warehouse Manager, who monitors all warehouse activities. His responsibilities involve scheduling tasks to personnel, helping the vice president of operations or COO negotiate rates with carriers, creating daily work logs, collecting

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actionable data related to labor, shrinkage, fill rate, etc. to plan more efficient operations, and of course supervise and train warehouse employees and their supervisors. Next to all these employees, it is commonly seen that warehouses employ safety managers. This person's responsibilities include fostering a safety-minded culture in the warehouse through OSHA training and education, investigating onsite accidents to determine the cause and recommend preventative measures, managing the employee health and safety guidelines set forth by both the company and local/state/federal laws, and implementing and creating programs that promote safety and security of warehouse employees.

The Ministry of Labor of Ontario (2014) states that warehouses can be hazardous places to work. Workers can be seriously injured or even die as a result of warehouse hazards. Health and safety is a big issue and workers are exposed to dangers like slips, trips and falls.

4.1.3 P2: Process

Gwynne Richards explains the basic processes in the warehouse with figure 7. The light grey blocks Cross dock and Packing are not involved in the warehouses for spare parts of Port Elizabeth. The orange arrow is also added, because value-adding services are done more frequently throughout the warehouses, to prepare equipment for use. For instance power cables and cable connectors are mounted when connectors and cables are available. Then get stored again.

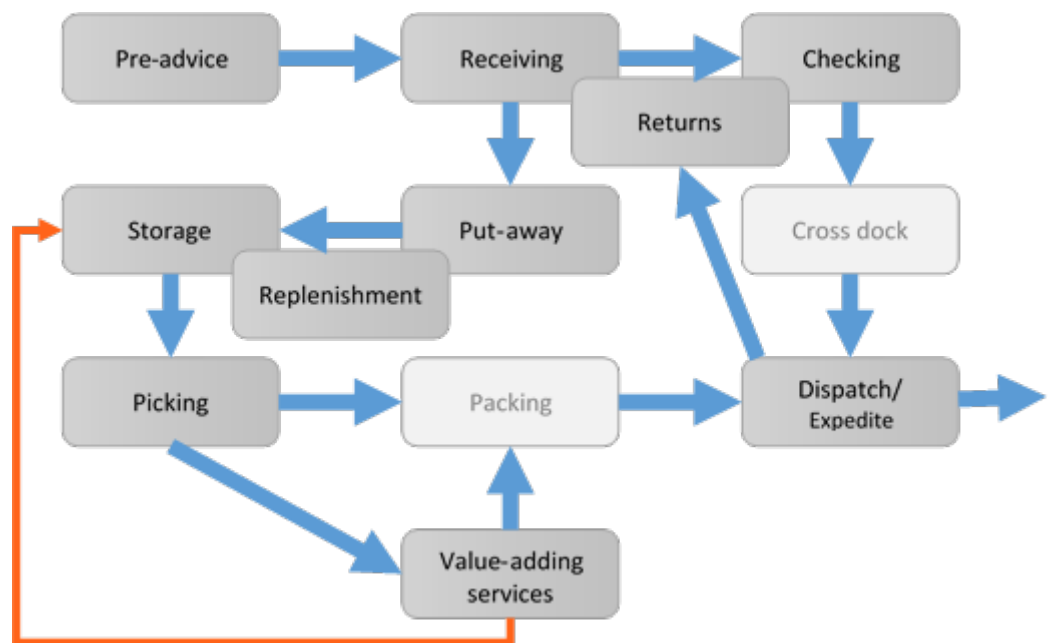


FIGURE 9 – WAREHOUSE PROCESSES
SOURCE: (RICHARDS, 2014)

The flow of materials in a warehouse is described by Jeroen van den Berg in his article about Models for Warehouse Management (1999). He states that goods are delivered by trucks, which are unloaded at the receiving docks. There the quantities are verified and quality checks are performed on the delivered loads by random sampling. Subsequently, the loads are prepared for transportation to the storage area by attaching a label, e.g., a bar code or a magnetic label.

Subsequently receiving the loads are transported to a location within the storage area. Whenever a product is requested, it must be retrieved from storage. This process is called order picking. An order lists the products and quantities requested by a customer or by a production/assembly workstation, in the case of a distribution center or a production warehouse, respectively. When an order contains multiple SKUs, these must

be accumulated and sorted before being transported to the shipping area or to the production floor. Accumulation and sorting may either be performed during or after the order-picking process. Hence, we may subdivide the activities in a warehouse into four categories: receiving, storage, order-picking and shipping. A study in the United Kingdom [2] revealed that order-picking is the most costly among these activities. More than 60% of all operating costs in a typical warehouse can be attributed to order-picking (Fig. 1).

According to Jeroen van den Berg (2014) warehouse management systems are software systems that controls the activities (read; processes) within the distribution center. The system knows which goods are to be received and shipped. It determines which tasks need to be performed to process the goods and sends commands to human operators and automated material handling systems to execute these tasks. Furthermore, the system captures relevant data on orders, shipment, inventory, warehouse layout, staff, vehicles, customers, suppliers and activities.

Another process important within the warehouse is performance management says Gwynne Richards (2014). To ensure customer satisfaction and a culture of continuous improvement within the operation. Performance needs to be measured to discover potential issues before they become major problems. That goes for warehouse processes as well as for staff. With measuring their performance they can be assisted in personal development areas and be rewarded where appropriate.

4.1.4 P3: Product

The third P stands for product, in this case represents the warehouse itself. According Bertorello (2008) the base of today's warehouse is an balance between high customer service level, low cost and lower inventory. Setting up a warehouse the understanding of what kind of scenario most closely resembles the operation must be known. Bertorello presents four basic cases that sketch the warehouse activities:

- Low Activity / Low Storage Requirements
The simple smaller warehouse operation. Rarely automated, Floor storage, stacked pallets, simple pallet racks and/or conventional shelving are utilized within the facility along with manual handling
- Low Activity / High Storage Requirements
High bay, multi-level, high-density storage and random location strategy. Order picking manual or semi-manual
- High Activity / Low Storage Requirements
Condensed forward picking area supported by simple overstock storage. Automated order picking system and automated material handling
- High Activity / High Storage Requirements
Large distribution center with high picking and storage requirements. Heavily automated material handling and sortation systems

To gain the understanding detailed analysis of SKU order line item history and prognoses for the future should be done says Bertorello (2008).

The warehouse as a product is also its layout and organization. Gwynne Richards (2014) discussed in his book 'Warehouse Management: A Complete Guide To Improving Efficiency and Minimizing Costs In the Modern Warehouse' that the design of our warehouses are changing because of the market. With different areas for receiving, quarantine and inspection, reserve storage, carton-picking, item-picking, value-adding,

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packing, dispatching, cross-docking, empties, MHE charging, warehouse offices and staff facilities.

Next to facilitating the surroundings, inventory must also be managed. Richards (2014) said that inventory management is the set of activities that are employed in maintaining the optimum number or amount of each inventory items. Inventory management has the objective to provide uninterrupted productions, sales, customer-service levels, all for minimum cost.

4.2 Warehouse for spare parts essentials

This section zooms in on warehousing spare parts specific.

Gwynne Richards (2014) says that manufacturers store spare parts just in case the production line operation gets interrupted because of a defect. Even though this can be a costly operation, the trade-off is between the cost of the part together with its holding cost, and the potential breakdown of the production line and the consequences that brings with it. These items should be reviewed regularly and decisions taken as to whether to stock them or not. Taking into account are supplier lead time and machine failure rate.

Practice makes perfect, but there is no room for error in this economy where “measuring twice, cutting once” is the only way to survive. Therefore a pragmatic framework for stocking spare parts is developed by René Botter (1998). René Botter (1998) describes the 8 different kind of parts that the warehouse contains. Understanding these, gives more understanding of the product itself. Port Elizabeth deals with all these variations.

1. Low price, short response time, high usage
These fast moving parts have to be stocked in large quantities in local warehouses, i.e. close to the market
2. Low price, short response time, low usage
Also these cheap slow moving parts have to be stocked close to the market, but in lower quantities
3. Low price, long response time, high usage
For these parts inventory costs and transport costs should be investigated, in order to determine whether or not local stocking is better than central stocking. Local stocking of fast moving parts could decrease transport costs, as larger quantities can be shipped by cheaper means of transport
4. Low price, long response time, low usage
These parts are only to be stocked centrally, at the Supply Centre
5. High price, short response time, high usage
These parts require firm management, as stocking is expensive. Owing to the short response time, parts primarily have to be stocked in local warehouses. The quantities should be as low as possible, and depend on the desired customer service level
6. High price, short response time, low usage
Again firm management is needed. It may be worthwhile to consider fast means of transport, even if they are expensive (e.g. taxi). In this case stocking centrally in the countries becomes possible, thus reducing inventory costs
7. High price, long response time, high usage
For these parts a trade-off has to be made to choose between central stocking in the countries and at the Supply Centre

8. High price, long response time, low usage

Owing to the long response time these parts can be stocked centrally, at the Supply Centre, and shipped by regular means of transport when needed

The concluding framework of Botter says that for spare parts management, consumption expressed in *pieces* is more important than consumption expressed in *money*.

Also that choosing parts to stock depends on the criticality of the part. It is important to look at the consequences if a part is needed and not available. This leads to the distinction between Vital, Essential and Desirable parts. Criticality is primarily based on service response time and functionality. Service response time is not a suitable criterion for classifying parts as vital, essential or desirable, because an item can be part of different systems each with its own contracted response time. Botter (1998) advises sorting large amounts of SKUs to limit the number of classes to two, namely functional parts and cosmetic parts. How many items to stock depends on the usage in pieces and the price. Service response time is important as well and has a huge impact on required investments in stock.

4.3 Standard Operating Procedures

This section tries to answer the question what literature says about approaching SOPs.

4.3.1 Reasons for SOPs usage in the warehouse

According to Jeroen van den Berg (2012) clear standard operating procedures are an essential element of highly competitive warehouse management. SOPs help the management and staff understand the process. Process optimization should be discussed when participants do not share the same view. Secondly, the specifications help the manager to look at the processes as a whole. Focus on the bigger picture is more helpful than firefighting individual cases. Also, during documenting processes the differences between executors come to light. Adopting the best practice, makes all the operators more efficient. SOPs also create transparency within the procedures and make way for optimization. Chris Anderson (2016) also states that regulations may require SOPs as part of the compliance. Auditors prefer procedures because it protects both the worker, customer and product.

4.3.2 Content of warehouse SOPs

A written method of controlling a practice in accordance with predetermined specifications to obtain a desired outcome. SOPs are step by step procedures on how to do something that is critical to quality, critical to safe operations, or critical to security (Anderson, 2016).

Jeroen van den Berg (2012) published a set of standard operating procedures for the warehouse. The descriptions can be used as templates for making customized SOPs. Figure 10 shows the processes and flows in distribution centers. This illustration serves as the basis for the standard operating procedures, with orange highlighted which were used for Port Elizabeth.

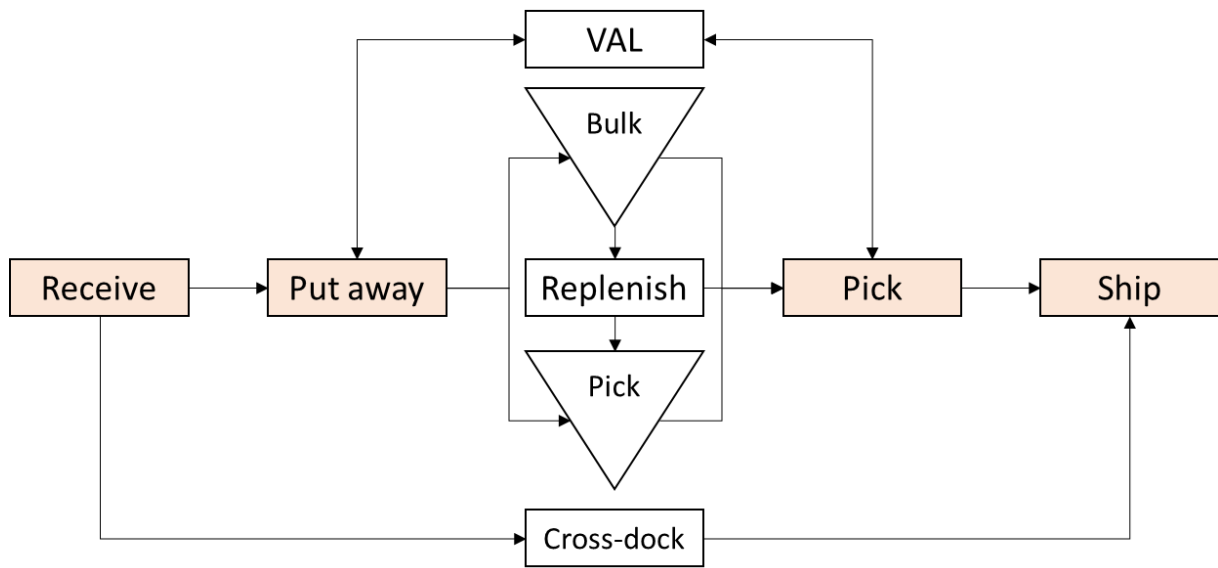


FIGURE 10 – PROCESSES AND FLOWS IN A DISTRIBUTION CENTER
SOURCE: (BERG, 2012)

Receive

Incoming goods are delivered by truck

Unloading

- The ERP electronically sends the purchase order to the WMS.
- The truck driver arrives and hands the freight documents to the receipt operator.
- The receipt operator registers the arrival of the truck in the WMS.
- The receipt operator assigns a receipt dock to the truck in the WMS.
- The truck driver drives the truck to the receipt dock or to a temporary parking space to wait until the dock becomes available.
- The truck driver uploads the pallets from the truck onto the receipt lane.
- The receipt operator verifies whether the number of handling units is correct and if there is any visible damage.
 - The receipt operator marks any damages or missing handling units on freight documents.
- The receipt operator signs off on the freight documents and hands a copy to the truck driver.
- The truck driver departs.

Goods are now at the receipt area in the warehouse. A superficial check on the delivery is done to prevent the truck driver from having to wait for the more detailed review. Agreement with the supplier must include a complaint period during which the distribution center can claim any missing or damaged items.

Receive from truck

- The receipt operator enters on the RF terminal which delivery he is going to receive. He refers to the delivery by the purchase order (PO) number on the freight document.
- When products arrive on mixed pallets or containers, the receipt operator first sorts the goods onto pallets or into containers each holding single products.

- The receipt operator attaches a license plate (LP) label to the pallet or container. The LP label is a unique barcode identification label.
- The receipt operator scans the LP label and registers the product number and quantity received on the RF terminal.
 - For specific products, the operator also enters product attributes such as: lot number, expiration date, quality status and country of origin.
- Once the receipt operator has received all products in the delivery, he closes the receipt of the delivery via the RF terminal.
- The WMS compares the received quantities with the quantities specified in the PO and the reports any overages or shortages.
 - If the quantities do not match, the WMS asks the receipt operator to re-count the goods to check if there really is a difference.
- The WMS electronically sends a purchase order confirmation (POC) to the ERP.

The goods are at the receipt area and they have been registered in the WMS.

Put away

The goods are now ready for put away.

- The WMS assigns a storage location to each handling unit.
- The WMS displays a put away task on the RF terminal of the forklift driver to pick up a handling unit from a specific receipt lane or a production line.
- The forklift driver travels to the receipt lane and scans the LP on the handling unit with the RF scanner.
- The RF terminal displays the destination location.
- The forklift driver takes the pallet from the receipt lane and travels to the destination location.
- The forklift driver scans the identification label on the location with the RF terminal.
- If the forklift driver carries multiple handling units simultaneously, then he travels to each location and scans the location as well as the LP on the respective handling units.
- The WMS updates the inventory level in the location.

The goods have arrived at the storage location.

Pick

An order has come in to for the warehouse to pick.

Case pick

- The order-picker selects a pick task on the RF terminal.
- The WMS displays the pallet type on the RF terminal
- The order-picker takes a pallet.
- The WMS displays the subsequent pick locations on the RF terminal.
 - The WMS sequences the picks so as to create an efficient tour.
- The order-picker scans the location and picks the products.
- When the pallet is complete, the order-picker travels to the label printer.
- The label printer prints a dispatch label.
- The order-picker attaches the dispatch label to the pallet.
- The WMS displays the destination on the RF terminal: staging location or VAL (Value Adding Location) station via the RF terminal.
- The order-picker travels to the location and scans the location label.
- The order-picker deposits the pallet in the location.

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4.3.3 Usages of SOPs in the warehouse

Success factors according to Jeroen van den Berg (2012) for achieving good results are:

- Operators understand and follow the specified procedures
- Inappropriate conduct is actively challenged
- Standard operating procedures are kept-up-to-date

First setting up and documenting the ideal process that keeps safety, ergonomics, hygiene, efficiency and quality highly valued. According to Jeroen van den Berg (2012) having SOPs is not enough. It is essential that the operators understand and follow the procedures, he says. Introduction of the processes and active promotion is a must.

Constantly reminding the executors through posters, mentioning and reviews. Good performance should be celebrated, neglected performance should be addressed. Also when new staff is trained, they should be informed and get copies of the procedures that functions as study material.

It is vital to keep the SOPs up-to-date, constantly streamlining the performance. Each change in the procedures, systems or product flow should be immediately incorporated in the SOPs. Also management has to inform the operators.

4.3.4 Effect of SOPs on the warehouse

When SOPs are well written and staff understand them, SOPs can have several positive effects. The U.S Environmental Protection Agency (EPA, p. 1) states that SOP avoids variations, regardless of the operator and time of operation; provides individuals with the information to perform a job properly; facilitates consistency in quality of an end-result; addresses safety concerns; and minimizes chances for miscommunication, even if there are temporary or permanent personnel changes.

Next to that, de Treville et al. (p.232) also described that SOP ensures that all workers are performing tasks in the same way, which is a necessary condition to obtain consistent output; and asserted that if a workforce cannot operate the parlor consistently, then the whole operation will fail. A modern-day SOP enables organizations to ensure uniformity and consistency in the process, across departments that affect their products and services. Treville et al (2005) also states that SOP is a component of total quality management that plays an integral role in improving the output of a given process consistently and efficiently. SOP ensures compliance, accountability, and efficiency among clinical investigators.

According to Biologic Technological Applications (EBTE) Consultants, SOP standardizes activities of a specific procedure; speeds up the integration of an individual into the organization during an initial phase of an employment; improves transparency within the organization; serves as a valuable structure for internal communication; shares best practices within the organization; and provides valuable background information for management policy development and change.

SOP also helps facilitate the transfer of knowledge and skill. Over a course of time, there is one inevitable challenge that employers face. Talented and experienced individuals may either temporarily be out of work or permanently change their work place or may retire for good for that matter. In such cases, the organization definitely loses its accumulated knowledge and skill and as a result, the organization may suffer from the symptoms of service hiccups. Levinthal & March (as cited in de Treville et al, p.231)

asserted that SOP has the ability to facilitate the transfer of knowledge that leads to variability reduction and organizational effectiveness.

Poorly designed SOPs are of little use for the employees. They can influence the ability to reach customer demand and impact company capacities. The overall quality can be decreased and employees can be brought into dangerous situations. The company's reputation may even suffer because of this.

4.4 Conclusion

To provide a clear value of this chapter this conclusion bundles the answers of three sub-questions.

Answer sub-question 1A; What, according to literature, are the aspects that a warehouse for spare parts consist of?

Every business, and therefore also warehousing for spare parts, can be split in three P's; People, Process and Product. People stands for everyone that works in and around the warehouse. The aspects of safety and health are essential for a warehouse to be an appropriate work environment. Process includes all the warehouse activities from receiving to dispatching. Aspects that help processes in the warehouse are Warehouse Management Systems (WMS) and performance management. The last P represents the product, the physical warehouse. The main aspects that hold the warehouse together are the layout, warehouse organization and management of its inventory.

Answer sub-question 2A; What does literature say about approaching the aspect that requires most attention?

In chapter 5 we see that the aspect processes within component process need the most attention. The Warehouse Excellence Scan directed us towards Standard Operating Procedures. These SOPs are an essential element of warehouse management that provides clarity and efficiency. The approach, according to literature, consists of three steps; firstly a proper documented SOP should be written. Then staff should understand the procedure and be trained in the execution. Also staff should be constantly reminded of the good ways of carrying out the procedure. Next to this, the SOP should be kept up-to-date.

Partial answer sub-question 2C; To what extent will the optimization of the aspect that requires most attention increase the control of the inventory at Port Elizabeth?

The control of inventory is lost in the current situation because of different reasons mentioned in chapter 3. One of the main problems was the execution of processed happening in different ways.

SOP avoids variations, regardless of the operator and time of operation. Inaccuracies drop when staff is provided with the information to perform a job properly. The control of inventory initially was lost because of trained staff got replaced by new inexperienced employees. SOPs help facilitate the transfer of knowledge and skill, so this will not get lost when there is a change of staffing. But SOPs are not all roses, when written poorly the procedures can affect the company in different ways.

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5 Warehouse performance

APM Terminals consists of a large group of terminals and inland services, which makes overview difficult and standardizing expensive. To get a visual and tangible outcome on how terminals are performing conventionally it gets assessed on core business. Terminal strategies differ and ways of reporting are divergent. Next to financial reports and TEUs, APM Terminals' head office decided to assess terminals performance with scans. This chapter describes the scan for warehousing in its first section. Results attained at Port Elizabeth will be discussed in section 5.2. Followed by financial reporting in section 5.3. Finishing this chapter with conclusions that (partially) answer sub-questions 1B, 1C and 2B.

5.1 Warehouse Excellence Scan (WEX)

In recent years multidiscipline teams of APM Terminals have developed the Functional Excellence (FEX) and Maintenance Excellence scan (MEX). The FEX focusses on operational performance, the terminals is assessed at how well it functions as medium that transships containers between two means of transport. The MEX scales the enforcement of upkeep of equipment used at the terminal like cranes, RTGs, straddle carriers and so on. Both scans have as goal to create insight in how a single terminal is coordinated but as greater vision to contain a global view of how APM Terminals is organized. Through benchmarking, sharing best practices and, peer reviewing, APM Terminals hopes to build standards.

Recently the Warehouse Excellence scan (WEX) was built by Frouzan Soltani commissioned by APM Terminals. The scan was added to the performance measurement check list of the Continuous Improvement department of the company. The Warehouse Excellence encloses the storage of spare parts for maintenance and repair of the terminal and its equipment. This scan was developed not only to get insight in warehousing, but also give an entry for HQ to help terminals optimize and reduce costs.

The development and execution of the scan is explained in the 'Creation of Warehouse Assessment' report by Frouzan Soltani (2016). It states that the scan works as following; An Excel file with different tabs representing different categories that combined give a good insight of a warehouse for spares. Every tab consists of sub-categories that can be scored with valid (V), partially valid (PV), not valid (NV) and not applicable (NA). The scoring is from 1 to 5; 1 is low in maturity and 5 is extremely high in maturity. After assessing all the sub-categories a maturity level will appear in the top right corner. Improvements can be derived from the scan, to work towards the description of a level higher. Here below is a brief explanation of all the categories the scan assesses (Soltani, Creation of Warehouse Assessment, 2016).

1. Safety
Safety regarding people, process and machine in and around the warehouse
2. H(S)SE - Health, (Safety), Security and Environment
Health regarding people working in and around the warehouse. Security of the premises and the inventory. The handling of waste and energy belongs to environment
3. People
Regarding the people working for and with the warehouse. From the internal organization to the collaboration with other departments

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4. Processes
Procurements regarding planning, quality and knowledge and how these are set out in the warehouse
5. Inventory management
From the coordination of inventory to warranty handling
6. Workplace organization
The entire physical construction of the storage
7. CMMS/WMS
Systems used for managing the warehouse
8. Performance management
How warehouse execution is measured, visualized and improved
9. Continuous improvement
Attention, methods and collaboration for continuous improvement

To get the complete picture, an example of a sub-category is given of the category 'Process'. The subject Standard Operating Procedures (SOPs) is divided in five levels.

TABLE 1 - CATEGORY 'PROCESS', SUB-CATEGORY 'SOPS' FROM WEX (2016)

	Level 1	Level 2	Level 3	Level 4	Level 5
Standard Operating Procedures (SOPs)	Some specific documented forms defined for SOPs, but are not used	<p>There are written, formal policies covering inventory management, including stock changes, cycle counting and inventory review</p> <p>There are written, formal procedures for receiving, inspection, quality checks, parts issue and return to store control</p> <p>For new equipment, there are documented procedures to ensure parts review, stocking and availability</p> <p>SOPs are somewhat specified</p> <p>SOPs are not actively maintained</p> <p>SOPs are out dated at the moment</p>	<p>All policies/SOPs are reviewed regularly (yearly) on compliance and relevance</p> <p>SOPs are specified</p> <p>SOPs are actively maintained</p> <p>Some SOPs are out dated at the moment</p> <p>All personnel is aware of the SOPs and has access to view documentation</p>	<p>SOPs in place</p> <p>SOPs are up to date and maintained</p> <p>SOPs are followed by all personnel</p>	<p>SOPs in place</p> <p>SOPs are up to date and maintained</p> <p>SOP on process analysis</p> <p>SOP on instructions and operational management of warehouse personnel</p>

The scan is conducted both by someone from the terminal as well as someone outside the terminal, a peer reviewer. Because Port Elizabeth has several warehouses with different people managing each location, a collaborative scan is held that reflects the overall storing situation. With staff members of all locations and the Maintenance & Repair Manager, as well as the warehouse specialist from APM Terminals' Head Office.

5.2 Results

The scan looks at different aspects of the warehouse, scoring them from level 1 to 5. Scoring of one represents that the subject is still in its infancy, three is a rendition of a mature warehouse and five reflects the warehouse of the future. Each level appoints

0.20 points per sub category. So if a sub category gets level one, the point will be 0.2, level 2 will have 0.40 points, level 3 0.60 points, level 4 will have 0.8 points and level 5 is 1 full point. Scoring around 3 in both the overall score as all categories is seen as preferable.

5.2.1 Overall score

Het results of the WEX are represented in figure 9, at the right side of this page. All scores are within the range of 1 to 2.5 points and has an overall mean of 1.86. This indicated a warehouse in the first stages of maturity. To point out the three weakest aspects of the Port Elizabeth warehousing, Continuous Improvement (1.00 point), Process (1.40 points) and Performance Management (1.63 points) lead the way. Categories 8 Performance Management and 9 Continuous Improvement are secondary categories that service the first 7. So when excluding 8 and 9, the three aspects that need attention are:

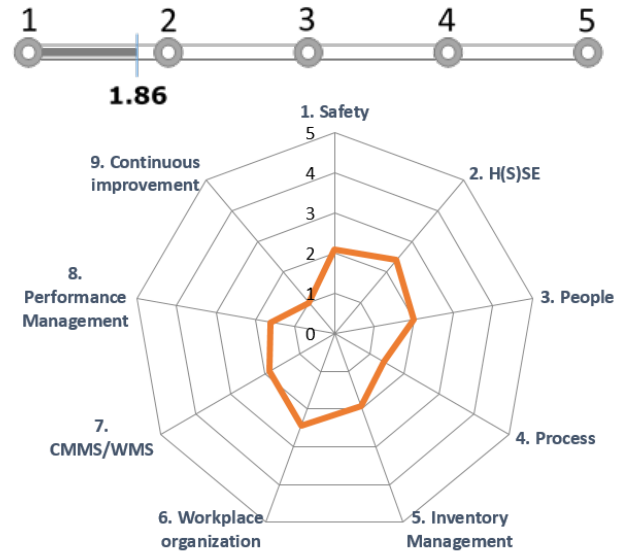
1. Process (1.40 points)
2. CMMS/WMS (1.88 points)
3. Inventory Management (1.92 points)

5.2.2 Categories

Every level in every category has a few basic features. To get a better understanding of the meaning of the given points and therefor Port Elizabeth's warehouse, the level explanation per category is provided.

1. Safety **Level 2**
 - Incidents and near misses are less regular
 - Lost Time Incidents are uncommon
 - APM Terminals safety processes and systems are in use but > 60% adhered to
2. H(S)SE **Level 2**
 - Separation of materials is done around the terminal
 - During office hours security is in place
3. People **Level 2**
 - Warehouse organization in place but different in reality
 - High losses in Labour OEE
 - Competency matrix installed
 - Training and development plan installed, more than 40 % in place
 - Incidental cooperation between departments (TAM, PROC and WH)
4. Process **Level 1**
 - No warehouse processes defined
5. Inventory Management **Level 1**
 - Execution of mandatory inventory policies
6. Workplace organization **Level 2**
 - Different warehouse locations and/or workshops
 - Housekeeping is done when needed

WEX Results Port Elizabeth



Process	Collaborative Score
1. Safety	2.10
2. H(S)SE	2.40
3. People	2.00
4. Process	1.40
5. Inventory Management	1.92
6. Workplace organization	2.43
7. CMMS/WMS	1.88
8. Performance Management	1.63
9. Continuous improvement	1.00

FIGURE 11 – OVERALL RESULTS WEX PORT ELIZABETH

- Layout racking and labelling of warehouse is done through methodology
- Some staff possess Material Handling Equipment licenses
- 7. CMMS/WMS **Level 1**
 - Warehouse activities and processes are not supported by systems
- 8. Performance Management **Level 1**
 - No structural use of dashboards, performance reports or performance meetings
- 9. Continuous improvement **Level 1**
 - No CI processes or tools are in place and used within warehouse organization

5.2.3 Process

WEX Results 4. Process

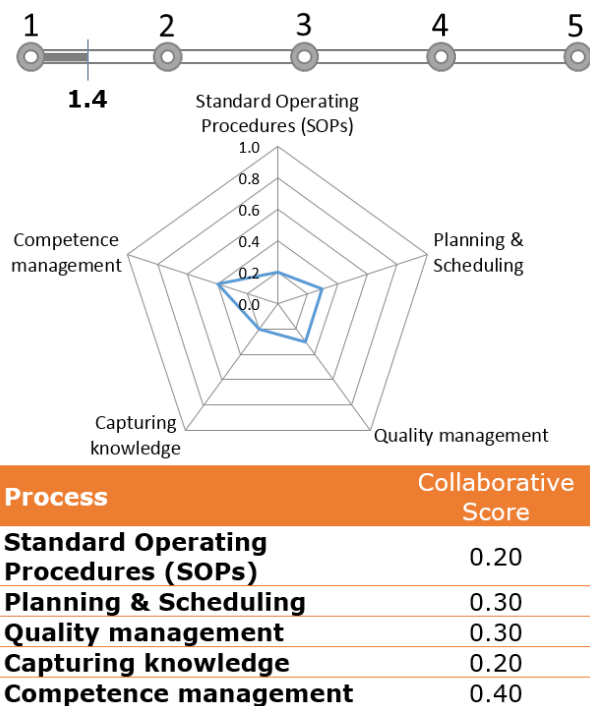


FIGURE 12 – SCORING CATEGORY 4. PROCESS OF PORT ELIZABETH

The Warehouse Excellence scan results of the lowest scoring category, process, is shown in figure 10. Zooming in to sub-category level, it becomes clear that procedures are not standardized and documented. The first priority is Standard Operating Procedures. Different people, different locations and different ways of working are counteracting standardization. There are no specific SOPs defined within the warehouse, for its processes.

Also the capturing of knowledge is done individually and only shared through face to face contact. Now, the different departments of the Maintenance & Repair department of Port Elizabeth only get together monthly on management level. Therefore there is no expertise exchanged from department to department.

There is some planning and scheduling within the warehouse locations. Obviously there are working hours planned out, but the rest is mainly ad hoc. Planning is made for the day

or the week. This is mainly a side effect of the TAM team that operates that way.

There are some ISO controls in place that monitor the quality. These ISO controls are mandatory and a bare necessity to keep the warehouse safe. If these ISOs are not in place, the terminal can risk a fine or has to close that part of the terminal until further improvement.

The workforce at the warehouses of Port Elizabeth accept training in skills and follow a plan. Some departments have a skill matrix for their staff, others do not. These skill matrixes not always get updated properly.

5.3 Financial figures

The warehouse scan is accompanied by a financial overview which investigates the warehouse values, the value increase and decrease in the last two years and also the inaccuracies reported in the yearly count. In the case of Port Elizabeth, where there are several locations, both the total as the most valued are examined. The figures are

attained by the local finance department, who yearly delivers a report to head office and tax authorities. For the complete overview of financial figured, take a look at Appendix G Financial figures. The financial analysis is done in the period January 2014 to November 2015. Next to a total view, this report zooms in on the departments Power, Crane and RTG. Combined these departments consist of 95% of the warehouse value.

5.3.1 Total

The most important parts of the financial analysis is the value fluctuation. How much are figures increasing or decreasing? The timespan is in this case January 2014 to November 2015.

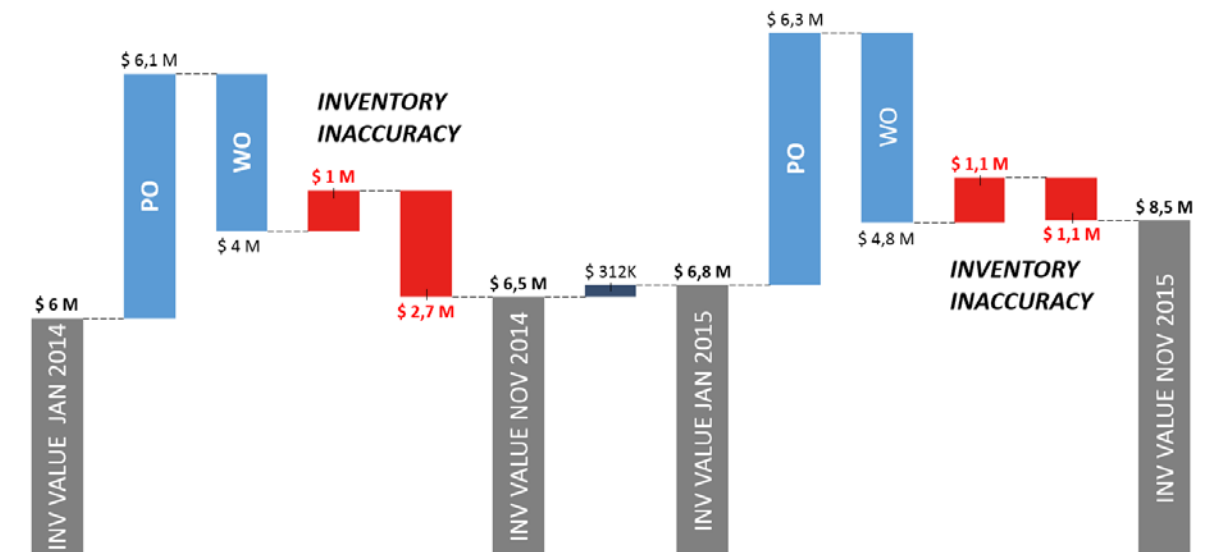


FIGURE 13 – FINANCIAL ANALYSIS OF TOTAL INVENTORY VALUE AT PORT ELIZABETH

Starting with inventory increase. Increase logically happens when there is more bought than used. In the case of Port Elizabeth there are worth \$12,5 million purchase records and worth \$8,7 million issuing records. After all round counting in November 2014 and 2015 a total inventory increase of \$2,4 million was determined. Through questioning around how \$1,4 million had disappeared $((12,5-8,7)-2,4=1,4)$ a few reasons were given. The overall cause was issuing. Administration of taken parts was neglected by some mechanics or not done properly. Also mechanics that shop at other warehouses than their own, would issue material out at their own warehouse or not at all. Although the Power shop had bought new trucks, also procuring is done in abundance. Because there is no to some planning done in the warehouses, most of the purchases are emergency buys. Emergency buys have to be delivered within a short time span, which increases the product price predominantly. There is no point in the week where buys from the warehouses gets consolidated and send out to the suppliers. All the warehouses work on their own and many buys are also stand alone. Then there is also the case of buying of larger packs so the product price goes done, but most are not used.

TABLE 2 - INVENTORY VALUE PORT ELIZABETH BETWEEN JANUARY 2014 AND NOVEMBER 2015

INVENTORY VALUE	
Purchased January 2014 - November 2015	\$ 12,474,913.02
Issued January 2014 - November 2015	\$ -8,715,911.84
Difference Purchase value and Issued value	\$ 3,759,001.18
Inventory increase January 2014 - November 2015	\$ 2,423,542.64

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Next to inventory value, also differences between what is stated in the books versus what is laying on the shelf. One of the triggers to start this research was the write-off in November 2014, mentioned in chapter 3. This write-off was roughly 15%¹ of the inventory value at the time. This was alarming, because their where limited changes in the equipment that needed to be maintained. A big shift in equipment, brands and methodology could lead to big buys for the warehouse. But the financial impact of the functioning warehouses do not reveal the complete picture. Positive counting difference, meaning that there are more on the shelf than is stated on paper, are crossed out to the negative counting difference, meaning that there are less spares on the shelf than is stated in the system. The counting discrepancy in the last two years result in a shocking \$5,9 million. This is around 70%² of the end inventory value of November 2015. Therefrom can be concluded that there is something significantly going wrong at Port Elizabeth and that there is no control over the inventory. Local staff did not understand how this could be happening and there was no understanding. By walking around the locations and asking questions there were a few points that might trigger these counting differences.

First of all, all material in the warehouse was defined as inventory. From nuts and bolts to filters to big crane engines. Mistakes in counting bolts in all sizes is almost insurmountable. Not only in counting, but also in a repair job; mechanics forget to register these bots or write down an incorrect number. Properly all mechanics also have the nitty gritty parts in their toolbox, so they do not lose time if leaving the operation to go to the warehouse for some washers.

Next to that the locations in the system are not always correct. So what is not found in one location (negative difference) is found in another location (positive difference). Some amount of materials that are not fitting in the designated space, are located elsewhere. The parts man is aware of the locations, but do not exist in the system, and therefor are not counted.

Purchasing of material, especially emergency buys, would go around the Procurement Department. Warehouse managers or storekeepers buy the products on their own, partially getting around the system. Warehouse staff claimed that buying through the Procurement Department takes much more time and mostly is not exactly what they asked for; unpractical and low in quality. Example was wet wipes for the mechanics. Normally they used wet wipes in those hard plastic boxes where if one gets pulled out, a following one would jut out. The Procurement Department bought napkins, piled up in plastic foil wrapping. Not the product that was asked for nor the requirements where obtained.

Also value added materials are not handled. Like cables with mounted cable ends by the warehouse, are counted as cables only. Cable ends can be used several times, where cables need to be replaced after breaking. Registration of these cases is done improper.

When asking about personal use of materials, departments showed that most pricy parts cannot be used at home. Gloves and other material can be taken for own use, but they say that it is not in the culture of the mechanics to take material from the terminal.

¹ \$1 million of \$6,5 million = $1/(6,5/100) = 15\%$

² \$5,9 million of \$8,4 million = $5,9/(8,4/100) = 70\%$

TABLE 3 - COUNTING DIFFERENCE PORT ELIZABETH BETWEEN JANUARY 2014 AND NOVEMBER 2015

COUNTING DIFFERENCE	
Positive counting difference January 2014 - November 2015	\$ 2,158,346.09
Negative counting difference January 2014 - November 2015	\$ -3,761,711.58
Cumulated counting difference	\$ -1,603,365.49
Absolute counting difference January 2014 - November 2015	\$ 5,920,057.67

5.3.2 Power

As shown in the waterfall diagram in figure 11, the movements of the financial situation of the department is visible. The inventory value of January 2014 started with \$3,3 million. In that year the Power department purchased spares with a total value of \$3,1 million through Purchase Orders. Work Orders registered \$2,2 million on used inventory for jobs. During the yearly mandatory count, a positive counting difference of \$511K and a negative counting difference of \$1,3 million was registered. The end value of 2014 resulted in \$3,5 million. The absolute value inaccuracy resulted in \$1,8 million, which is 52% of the total inventory value of the department. That years turnover ratio resulted in 1,5 years. Than with a little jump from November 2014 to January 2015 The POs where \$2,8 million and the WOs issued \$2,2 million. Combined inventory inaccuracies decreased to \$1,1 million, which is 26% of the inventory value. Through an inventory increase in these 23 months, the turnover ratio climbed up to 1,7 per year.

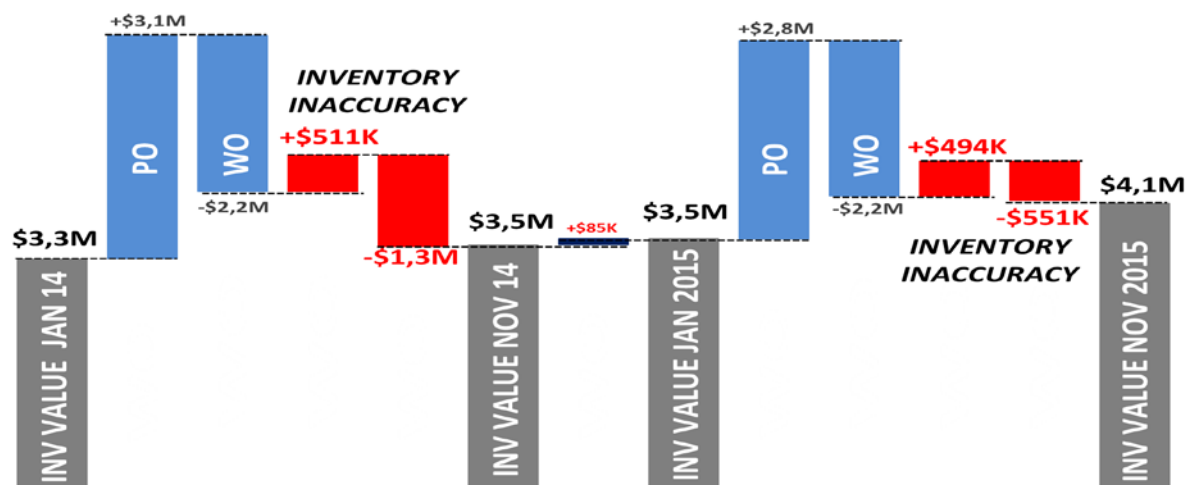


FIGURE 14 – FINANCIAL OVERVIEW POWER DEPARTMENT BETWEEN JANUARY 2014 AND NOVEMBER 2015

But walking through the warehouse, it seemed rather unrealistic to have this amount of inventory laying around. Although car parts, which filled the entire warehouse, can be expensive, the magnitude was not great enough to carry a value of \$4,1 million.

5.3.3 Crane

In figure 12 the waterfall diagram of the Crane department is represented. The inventory value of January 2014 started with \$1,8 million. In that year the Crane department purchased spares with a total value of \$790K through Purchase Orders. Work Orders registered \$428K on used inventory for jobs. During the yearly mandatory count, a positive counting difference of \$28K and a negative counting difference of \$380K was registered. The end value of 2014 resulted in \$1,8 million. The absolute value inaccuracy resulted in \$408K, which is 23% of the total inventory value of the department. That years turnover ratio resulted in 4,2 years. Than with a little jump from November 2014 to January 2015, the POs where \$1,1 million and the WOs issued \$726K. Combined inventory inaccuracies decreased to \$164K, which is 7% of the inventory value. Through an increase in Work Orders in 2015, the turnover ratio decreased to 2,8 year.

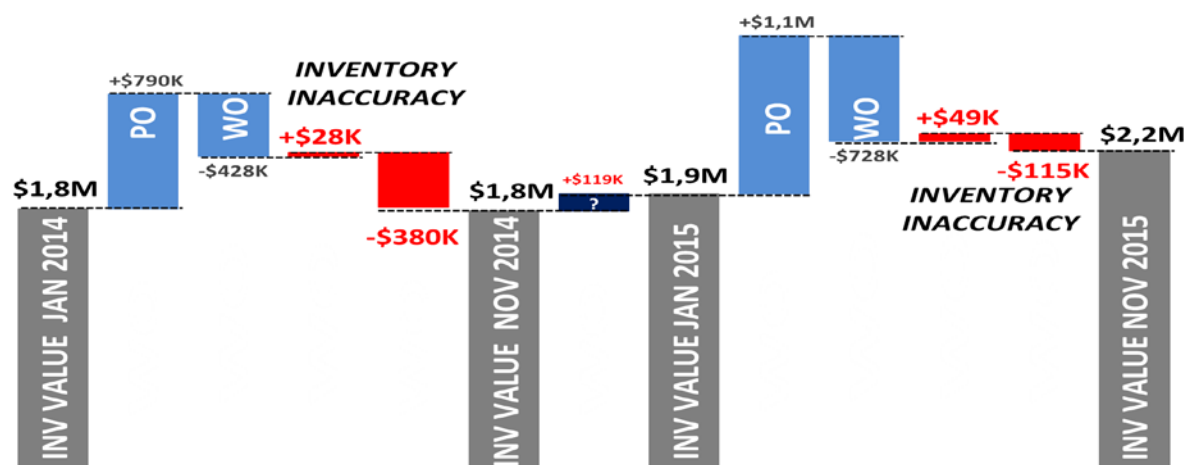


FIGURE 15 — FINANCIAL OVERVIEW CRANE DEPARTMENT BETWEEN JANUARY 2014 AND NOVEMBER 2015

The Crane department had several locations spread on the terminal. This financial figures are plausible to represent the storage of spares by this department. The large object for the cranes that have high criticality but seldom break down, are high in cost. These parts sit and eat dust, with a prospect never to be used. There is one parts man, Bobby Fey, who does all the warehousing. Makes is somewhat more clear.

5.3.4 RTG

The third biggest warehouse, with \$600K as inventory value in January 2014, was RTG. With astonishing large Purchase Orders in 2014, a little under \$2 million, this department looked like a lean warehouse. But just half of the purchased goods get issued in the Work Orders. Also inventory inaccuracies in 2014 are sky high, with \$936K of inventory value that is not corresponding between physical location and registered spot. That means that almost 99% of the warehouse is wrongly positioned, with the end value in 2014 of \$0,9 million. January 2015 the warehouse started with a value of \$1 million and received \$2,2 million Purchase Orders. The parts issued through Work Orders had a value of \$1,7 million. Inventory inaccuracy also at RTG decreased from \$936K to \$758K. In accuracies where calculated to be 43% of the inventory value at November 2015.

These financial numbers caught us by surprise. Having some knowledge of RTGs, it was clear that it was not possible that in the state we found the warehouse, these numbers could match. The warehouse was filled with big engine blocks, gear boxes and expensive cables. Also the amount of inventory value versus the remnant after issuing purchased goods, was too low to be plausible.

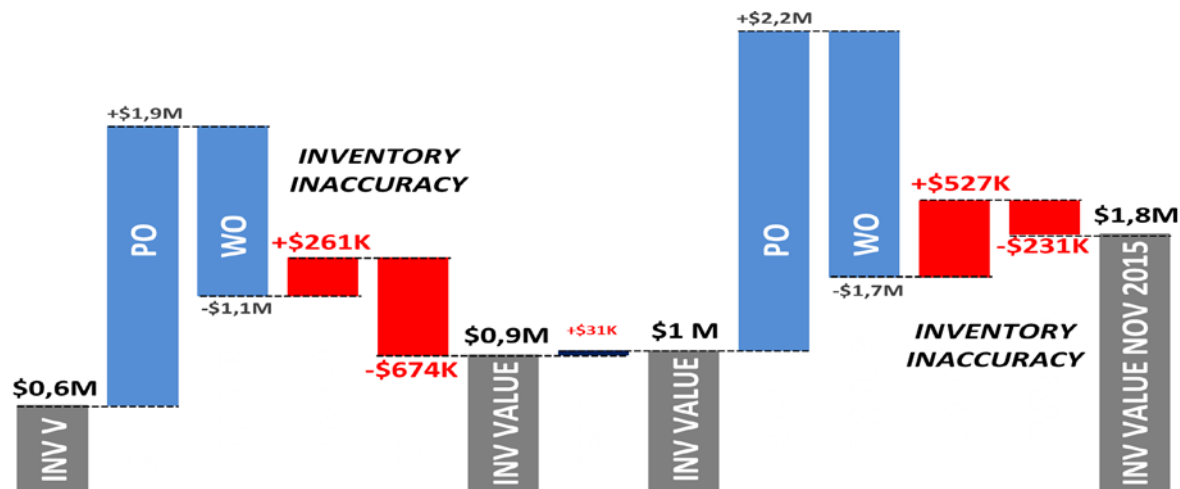


FIGURE 16 – FINANCIAL OVERVIEW RTG DEPARTMENT BETWEEN JANUARY 2014 AND NOVEMBER 2015

5.3.5 Overall analysis

The waterfall diagrams made visible that 2014 was a year where Port Elizabeth was not in control of their inventory. Purchasing was twice the amount that got issued officially. Though the negative counting difference added to the issued value from the Work Orders, in most years and departments where equivalent to the Purchase Orders. With the known results of 2014, 2015 the inventory inaccuracies decreased enormously. All departments halved their miscellaneous. Thanks to the integration of STRONGER the official processes in procuring were reinstalled, resulting in more Purchase Order issuing. But despite all effort, inventory value kept rising, inaccuracies were still obviously present and turnover ratios fluctuating.

5.3.6 Revised figures

The combination of the financial analysis and the visitations, our concern was raised if the figures match the reality. The Power Department and the RTG Department were red flagged. The Master Data Management (MDM) team, who was already involved in the STRONGER project at Port Elizabeth where informed to investigate the situation. Their task was to clean up the ERP and remove all needless parts in the system.

The MDM team took the extra job to investigate the cost center of each part and if this was correctly documented. On January 1st 2016 the revised inventory values were released. It turned out that RTG worked in two folders, one folder on their cost center and another folder on the cost center of the Power Department. Also the inventory of 2016 is cleaned up, so doubles are out and miscellaneous parts deleted.

TABLE 4 – INVENTORY VALUE BEFORE AND AFTER MDM CLEANUP

Department	Inventory value 11/30/15	Inventory value 1/1/16
Power	\$ 4,1 M	\$ 0,4 M
Crane	\$ 2,2 M	\$ 1,6 M
RTG	\$ 1,8 M	\$ 5,6 M
TOTAL	\$ 8,1 M	\$ 7,6 M

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The figures of 2016 were more likely than those from 2015. These amounts explained why the RTG department had such high throughput, compared to their value. Also the absolute inventory inaccuracy of 99% was outrageous. This cleanup revealed a part of what went wrong in 2014 and 2015.

5.4 Conclusion

To give a brief summary of this chapter, the sub research questions will be answered. Also some financial conclusions are discussed in this section.

Answer sub-question 1B; How is the warehousing for spare parts at Port Elizabeth performing in the aspects given by literature?

The aspects given by literature match the categories of the Warehouse Excellence Scan. Safety, health, security & environment, people, process, inventory management, workplace organization, CMMS/WMS, performance management and continuous improvement. Port Elizabeth's overall score was 1.86. This indicated warehousing in the first stage of maturity.

Answer sub-question 1C; What aspect, according to APM Terminals Warehouse Excellence Scan, requires most attention?

Process scored the least of the 7 most important categories, with 1.40 point. Hereby proving its requirement of the most attention. Zooming in on the category Process, the sub-categories Standard Operating Procedures and Capturing knowledge are scoring the lowest possible, 0.20 points. These are the first two subjects that need work.

Partial answer sub-question 2B; What, according to APM Terminals Warehouse Excellence Scan, should be the next step in optimizing the aspect that requires most attention?

SOPs are ranked highest in priorities in the WEX, therefore the next step should be taking action on that account.

Financially 2014 was a year in which Port Elizabeth was not in control of their inventory. Purchasing was twice the amount that got issued officially. In 2015 the inventory inaccuracies decreased enormously, thanks to the integration of STRONGER the official processes in procuring were reinstalled, resulting in more Purchase Order issuing. Also parts cleanup made clear that the RTG department had used the Power shops archives to store their own materials. This led to a misunderstanding on the correct value of both the RTG shop, as well as the Power shop. Still inventory value grew and November 2015 the amount reached \$8.5 million.

6 Process optimization

After analyzing what the current state was at Port Elizabeth, action started. This chapter explains the next step in optimizing processes at the warehouses.

6.1 Standard Operating Procedures (SOP)

As stated in chapter 5, processes needed the most attention at the warehousing of spare parts at APM Terminals' Port Elizabeth. Also the Warehouse Excellence Scan showed that the first priority was Standard Operating Procedures. The overall goal of the WEX is to get the terminal to level 3 in all segments, so also the SOPs.

Level 3 of the sub-category Standard Operating Procedures exists of the following points:

- All policies/SOPs are reviewed regularly (yearly) on compliance and relevance
- SOPs are specified
- SOPs are actively maintained
- Some SOPs are out dated at the moment
- All personal is aware of the SOPs and has access to view documentation

It was known that in the current situation the warehouses did not have any form of SOPs. So the first steps of action were to specify them, get them reviewed and train staff members with the materials. After accomplishing this, the SOP should be actively maintained and reviewed yearly by both the warehouse and the auditor.

6.1.1 SOP specification

In figure 9 and 10 of chapter 4 literature described the overall warehouse processes. Receiving, checking, putting away, picking and releasing are the main warehouse jobs. All these processes are defined in the created SOPs for Port Elizabeth. We investigated the execution of these processes around the terminal and mapped out the steps made. The process map is attached in the Appendix bundle part H.

To start of the chain of actions for the warehouse, input from Technical Asset Management is required. Mechanics therefore have to start every new job with a Work Order (WO). This WO describes the maintenance and repair job itself and the required parts. Because maintenance and repair is mostly done on locations or at the workshop, the current medium to register WOs is on paper. To apply for parts, the WO has to be transferred into the ERP. This is clearly not a warehouse process but the way of requesting. To get control over the inventory flow it was decided that this would be the first SOP. The SOP for WO is to be found in Appendix I

To perform the job, materials could be needed. During the steps of the digital WO form, the possibility to request material is presented. The STRONGER solution that is integrated in this WO form can be opened. A Electronic Catalogue is linked to IFS (the used ERP) and gives the mechanic the possibility to brows trough all APM Terminals okayed suppliers. Also the available material at the terminal is presented. If the parts are not at one of the warehouse locations, they are purchased. After ordering, parts are received. Here does the warehouse start their first process. The SOP for receiving is attached in Appendix I.

If the spare parts are received or available in the warehouse to get issued, a new warehouse process starts. The relieve of inventory by issuing parts in IFS is explained in

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the SOP Issuing in Appendix I. The Swing man is made aware of the necessary parts through the WO in IFS. Material is Man moves the part to the issue shelf, a fixed location in the warehouse where the mechanic can pick up the parts. Issuing in IFS takes place when the mechanic has used the material added to the written WO. So registration is after the fact.

Outside the basis process of receiving and issuing, the warehouse must be maintained. Maintaining can be done in various ways. One of them is to investigate parts that are still in the warehouse, but are not likely to be used. Scrapping these parts can provide storage space, lower the value of inventory and even generate money through selling. The activities, without IFS support, are provided in the SOP Scrapping Parts in Appendix I.

6.1.2 SOP review

After the SOPs were written, the SOPs needed reviewing. First the M&R director, Justin Weir, took a look at the documents. Content wise the SOPs were approved. Lay out had to be altered to a more readable format. Also more screenshots of IFS were required to make the SOPs clear.

A trial run was staged at the Power shop. A mechanic and his foreman followed the step-by-step Work Order SOP without support of the SOP creation team. The same applied to the warehouse Swing man of the Power Shop and the overall inventory foreman. The SOPs were tweaked in formulation for better understanding and thereafter approved by the executing team.

6.1.3 SOP training

The SOP training started at the Power Shop, where the review was held earlier. All mechanics and warehouse personnel were assembled in three sessions. First the reasoning after SOPs was shared with the groups. After that the SOPs were handed out. The trainees were asked to execute a job in the exact same way as was prescribed in the step-by-step guide. They were asked to write comments on the printed SOPs and discuss that with us. The main reaction was that many of them executed these tasks if it were big jobs and slacked in the little repairs.

The M&R managers were assembled in a meeting to get an understanding of the SOPs and their goal to standardize processes in warehousing around the terminal. The Power Shop mentioned the success in their department and advised to remind staff repeatedly on their task execution.

The RTG and Crane department were trained in a similar fashion. Total training time per department was around 3 to 4 hours, depending on the jobs that were done and the discussions afterwards.

6.2 Effect

Cited literature already elaborated on the topic of the effect of SOPs. Chapter 4 stated that SOPs can avoid variations, regardless of the operator and time of operation. Also that inaccuracies can drop and that SOPs can help facilitate the transfer of knowledge and skill. To complete sub-question 2C, on the extent of SOPs on the increase of control of Elizabeth's inventory, this section explains the effect these points have on control.

6.2.1 Expected effect

Port Elizabeth was not in control of the warehouse, resulting in inventory inaccuracies and issuing without proper registration as mentioned in chapter 5. So inventory is in control when inaccuracies are low and the value of Purchase Orders and Work Orders are more or less the same.

Standardization of the warehouse procedures are likely to bring control to the inventory because variations between staff members and departments get eliminated. With SOPs on WO, purchasing and issuing processes this mainly means that everyone registers part movement in IFS. This results in inventory insight. Insight is necessary for bringing issues to light and thereby getting a grip over the inventory.

Also using SOPs as material for teaching and discussion, the transfer of knowledge is more funneled. The capturing of knowledge on paper, ensures that it can be retained. In case of new staff, the transition will be rather smooth as regards to registering parts movement.

6.2.2 Real impact

The estimation in August 2016 by the Inventory manager, was that 75% of the purchases was done through the STRONGER solution J-cat. This indicated the magnitude of controlled purchasing. The value of these POs summed up to around \$3,8 million. The value of inventory that was issued through Work Orders summed up to around \$3 million. Being 80% of all issued material being obtained through the SOP' set way of working.

The goal for the end of 2016 was set at 85% of the purchases through the e-Catalogue and 85% of the purchased value being issued for Work Orders.

6.3 Conclusions

This section concludes the last subject of this report through answering partially sub-questions

Partial answer sub-question 2B; What, according to APM Terminals Warehouse Excellence Scan, should be the next step in optimizing the aspect that requires most attention?

To implement SOPs in and around the warehouse, the SOPs must firstly be specified; which processes to describe. Thereafter the SOPs must be documented, reviewed and tested. The implementation follows through training both managers as well as operators. Executing the processes is the job of the operator, properly sustaining the way of working is part of the manager's job.

Partial answer sub-question 2C; To what extent will the optimization of the aspect that requires most attention increase the control of the inventory at Port Elizabeth?

The effect of the SOPs in the warehouse can be seen as increase in insight in the movement of parts. This was marked as the first step into control, because insight is necessary for bringing issues to light.

7 Conclusion and recommendations

This chapter concludes the report and recommends some other options that could contribute to further warehousing improvements. Section 7.1 answers the two research questions that are asked in chapter 3. Section 7.2 discusses the recommendations made by us for further improvements within the SOP implementation.

7.1 Conclusions

This section concludes the two research questions asked in chapter 3. Both research questions were split in three sub-questions. Per question the answer is given.

What aspects are essential for warehousing of spare parts for Maintenance and Repair at APM Terminals' Port Elizabeth?

According to literature, warehousing for spare parts consists of nine aspects divided in three groups symbolised with a letter P. People, Process and Product. People stands for everyone that works in and around the warehouse. Corresponding aspects are safety and health. Process includes all the warehouse activities from receiving to dispatching. Corresponding aspects are Warehouse Management Systems (WMS) and performance management. Product, the physical warehouse. Corresponding aspects are the layout, warehouse organization and management of its inventory. The performance of Port Elizabeth in the aspects given by literature is measured with APM Terminals' Warehouse Excellence Scan? Port Elizabeth's overall score was 1.86. This indicated warehousing in the first stage of maturity. Because of the lowest score in Process (1.40), The WEX suggested to look into process improvement through SOPs.

How to approach the optimization of the aspect that requires most attention at Port Elizabeth's warehouse for spare parts?

Literature stated that approaching SOPs could be done best in three steps; firstly a proper documented SOP should be written. Then staff should be trained in understanding the procedure and execution. Next to reminding staff of the SOP, the SOPs should be maintained. Applying theory in practice the WEX stated that to start off, firstly the SOPs must be specified; which processes to describe. Thereafter the SOPs must be documented, reviewed and tested. The implementation follows through training both managers as well as operators. This can affect the control of the inventory at Port Elizabeth through various ways. Firstly the SOPs steer towards usage of IFS, which increases insight in the movement of parts. Next to that SOPs avoid variations, regardless of the operator and time of operation. Inaccuracies drop when staff is provided with the information to perform a job properly. Next to that SOPs help facilitate the transfer of knowledge and skill, so this will not get lost when there is a change of staffing. But SOPs are not all roses, when written poorly the procedures can affect the company in different ways.

7.2 Recommendations

During further optimization of the warehouse we recommend some other actions.

7.2.1 More SOPs

The SOPs made during this thesis do not cover all warehouse activities. The more documented SOPs, the more clarity about the why, how and who should execute processes. Therefore we recommend that tasks like cycle counting, Vendor Managed Inventory (VMI), consignment stock and placing new products or suppliers in the warehouse need SOPs.

7.2.2 Share and access SOPs with other terminals

Sharing is caring. Using the internal APM Terminals network to exchange best practices and lessons learned improves not only the terminal connection, but also the SOPs. Getting in contact with other warehouse managers results in more knowledge sharing, SOPs provide a start for the dialog.

7.2.3 Share and access SOPs with colleagues from other spare parts industries

There are similar business to the terminal industry around the world like aviation, energy, railing and other heavy industries. Sharing horizontally with those companies can give new insights and ideas. Because SOPs are a broadly used method, this could be common ground and an opening to more collaboration.

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