ANALYSIS AND OPTIMISATION OF A MATERIAL HANDLING SYSTEM

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PREFACE AND ACKNOWLEDGEMENTS

This master thesis presented by the central stock division of SSAB Oxelösund, Sweden was conducted over the period from November 2007 until April 2008.

We would like to extend thanks to our supervisor at KTH, Ove Bayard for his continuous support and understanding throughout this project. His kindness to always accommodate, and willingness to go out of his way were much appreciated.

To project supervisors at SSAB, Anders Berg and Seija Koivusaari, special thanks for taking their time to allow us to conduct the research, as well as making us feel welcome within the company. Much appreciation to Seija for her guidance throughout our time on site and probing ideas.

A thank you is extended to the operation personnel working in the central stock at SSAB, for their helpfulness and patience in understanding our limited Swedish. Thanks to Kicki Karlsson, for her enthusiasm to provide us with a sound understanding of the process within the central stock. Gratitude is due to those within the Stock business group who gave of their time for interviews and meetings; namely Therese Wiburg, Anna Thorburn, Carin Josefsson. For all the other staff who provided us with their time to provide us with information, thank you.
EXECUTIVE SUMMARY

The demand for steel is increasing everyday and also the quality specifications make the market even more competition oriented. In order to survive within the market, high quality and profitability are essential. With regards to the increasing demand, SSAB Oxelösund (Swedish Steel) is planning to double their production over the next few years; however the current storage areas are not enough for this future capacity.

An improved or new stock management system is necessary to handle the increasing number of articles and the production quantity. Therefore, SSAB Oxelösund would like to have an analysis and optimisation of their material handling system currently in operation within the central storage (Central Lager) division of SSAB Oxelösund. Some of the main aims are space efficiency and better performance for 'slowmovers'. Better traceability and improved article identification were also stated throughout the meetings.

After having studied one year at Production Management and Engineering, the authors were educated in various areas regarding production. Among these areas, Toyota Production System (Lean Production), Quality Management and Operational analysis had a huge effect for the methods applied to this thesis work. Furthermore, during the project, a variety of literature was studied.

The project started with examining the current system through interviews, continuous meetings and observations. After gathering sufficient information, an analysis of the results is made. Through this analysis, the key parameters found lacking in the current system were identified. These were presented at an informal presentation in February; enabling involved personnel to comment on the progress made. These points were thoroughly studied, which led the authors to understand the process in detail and finally getting possible solutions for the system.

One of the most important outcomes of this project is the recommendation of a Visualisation System for better traceability and decision making, which will finally improve the space efficiency and increase the effective working time.
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CHAPTER 1

1 INTRODUCTION

1.1 Subject of this project

This project concerns the analysis and optimization of a material handling system currently in operation in the central storage (Central Lager) division of SSAB Oxelösund (Swedish Steel.)

1.2 Presentation of the Company

SSAB is a leading producer of high-strength steel sheet and steel plate. The Group’s steel operations consist of three divisions, of which the plate division is based in Oxelösund, Sweden. In 2007, the Group’s turnover was approx. SEK 48 billion, with 13 000 employees in operations or offices in over 40 countries and a worldwide sales presence.

SSAB Oxelösund is the largest Nordic manufacturer of heavy steel plate, and produces well-known brand names such as HARDOX, TOOLOX and WELDOX.¹

SSAB Oxelösund is located on the east coast of Sweden, about 120 km south of Stockholm. The company is the biggest employer in the region. The entire company has 2,785 employees (average number of employees 2005), and 20% are woman. SSAB Oxelösund is the only steelworks in Sweden to have an entire production line stretching from raw materials to rolled plate. They produce around 586 000 tons of heavy plate (2006), of which about 90 percent is exported. Germany is the biggest single export market.

SSAB Oxelösund is one of the world’s cleanest steelworks, and their aim is that environmental work should put themselves amongst the forerunners in environmental issues within the steel industry.
1.3 Specification of the Project

1.3.1 Background

The SSAB Oxelösund plant is on the forefront of today’s high-strength steel production and has an ever increasing production demand. Today the production capacity lies at approximately 590 000 tons/year, and in the near future is planning to have this ramped up to 1 000 000 tons/year.

![Figure 1: Overview of SSAB Oxelösund Central Stock](image)

The current production line offers 281 articles, considered standard articles, extending in thickness from 3.2 mm upwards, that are stored in various section of the central storage area. This storage area and system, implemented over 15 years ago, alone are struggling with the production capacity and material handling of today. With an expected increase in the number of articles of about 10 % over the next few years, there will be an added pressure on the storage facility. Therefore, SSAB Oxelösund would like to develop a system which can handle the increasing amount of articles and their production sum, and at the same time reduces the storage area by 10-15 %.

In the company there has been a discussion about old stock that is piling up and utilizing much of the necessary space.
1.3.2 Objectives

Based on the information presented for the research study, the following objectives for the report are to:

- Increase efficiency of material handling by reducing the working time.
- Better traceability and improved article identification, especially old stock.
- More effective use of storage area in order to create empty storage space.

1.3.3 Scope and Limitations

Although other issues emerged during the course of the study, the scope of the study was to analyse the systems in place only for the central stock that handle standard articles. The primary storage areas were considered, namely area 31, 32, 33 and 34.

Additionally for the scope of this study, the available space for the central stock is limited to the currently available space.

Limitations to the research include that due to the study being completed in English, with limited knowledge of Swedish, misunderstanding during meetings and interviews may provide incorrect analysis of information. Other limitations were that the duration of the study and the available time spent on site, due to site location, did not provide the possibility to grasp a total awareness of the whole process of the SSAB’s central stock.

1.3.4 Plan of Development

The report starts with a various methods of research applicable followed by a literature review on topics of the study. The report proceeds into providing details on the primary information gathered. This information is then analysed to develop the key parameters and ideas for optimization. An optimised system is then proposed that details how the various parameters are able to be implemented.

Finally from the findings and results obtained, conclusions are drawn from which the necessary recommendations are made.
CHAPTER 2

2 METHODOLOGY

This chapter will describe the methodology that was used in this study. Various research approaches will be briefly described and an argumentation for why implementing the ones chosen in the research presented.

2.1 Research Problem

The *Oxford English Dictionary* (2004) defines research as the systematic study of materials and sources in order to establish facts and reach new conclusions. Now this may sound straightforward, but in practice research is often an open-ended process that is likely to generate as many questions as it does answers.

According to O’Leary² the first step when doing a research is to reflect over what the problem really consists of. This will guide the choice of which theory, methods and material to use in the research. Problems can be noticed scientifically in a lot of different ways: by observation of not formerly known phenomenon, by diverges between former knowledge and new observations, and because new methods and theories make it possible to deal with problems that were unworkable before.

When speaking of a problem in the scientifically point of view it doesn't necessarily have to mean that something is problematic or confusing, but that it is something one seeks knowledge about and that can be expressed so clearly that that it can guide the process of choosing methods, and that one can know afterwards if the solution is reached or not.

To be able to formulate a good problem it takes a lot of experience. In postgraduate (research) studies the future researcher learns how to use different methods quite easy, but it will take a lot of experience to be able to find important and feasible problems.

To be able to choose a research problem and solution proposition in a satisfactory way, it can help to take the following questions into consideration:

- What makes one consider something as a problem: knowledge background, pre-comprehension, frame of references?
- In what way is the problem interesting both from research and practical point of view? Is it possible to perform a research on the problem?
• Of what nature is the problem? Is there suitable theory and methodology?
• Which assumptions and delimitations need to be done?
• How will choice of methods, choice of research material or selection of subject to experiment on be performed?
• What will it take of allowances, equipment and personnel?
• What will be approved as an acceptable solution? Which relationships exist between problem and purpose?
• Which criteria should be used for evaluating the results?

2.2 Research Methods

Methodology is normally separated in to two different perspectives. This is made out by the foundation whether hard facts or soft figures are being sought. These different methods are called quantitative and qualitative respectively. The most important difference between these two is how figures and statistics are being handled. The choice of methodology should be selected on basis of the problem that is investigated.

The word quantitative is originally from the Latin's quantum – which means quantity. An observed phenomenon that has been summed up to a few variables, which are later (possibly) processed statistically. With Quantitative methods you concentrate on things that can be measured. The view on reality is static and people are seen as objects. E.g. laboratory experiments, measurements and statistics.

Qualitative methods are the methods that are use in order to process qualitative data, often-different kind of texts so that the results come out entirely linguistically, which means not based on quantitative calculations. With qualitative methods, one concentrates on the features and characteristics on something. it investigates the why and how of decision making, as compared to what, where, and when of quantitative research. Qualitative researchers typically rely on four methods for gathering information: (1) participation in the setting, (2) direct observation, (3) in depth interviews, and (4) analysis of documents and materials.3

In this paper a qualitative approach will be used. Quantitative and qualitative methods are nothing that is mutually exclusive, as stated by Ghauri and Gronhaug4. It often happens that researchers collect their data through observations and interviews, methods normally related to qualitative research. But the data may be interpreted in such a manner that would allow statistical analysis. In other words, it is quite possible to quantify qualitative data.
2.3 Research Perspectives

There are two principal scientific approaches regarding how research-work should be pursued. These two main directions are called positivism and hermeneutics respectively. Even though they are often described as diametrically opposed, it is possible for one and the same researcher to be influenced by both approaches.

*Positivism* alludes to that researchers are to draw conclusion solely from information that is positive and objective, i.e. reliable, exact and intelligible. Everything else, especially subjective knowledge is to be considered as unscientific. The positivist approach claims that there are two sources to knowledge, empirical, i.e. what we can observe with our senses and logic i.e. what we can calculate by means of logical conclusion.

*Hermeneutics* is a research direction where interpretation constitutes the main research method. No absolute truths are sought within the framework of hermeneutic research tradition, because there are none. Instead the researcher seeks new and more productive ways to understand phenomena. Soft and subjectively experienced phenomena of that kind can hardly be studied on a conventional positivist manner, but is nevertheless a part of our reality. A hermeneutist often prefers qualitative methods to try to analyze and understand the problem as a whole5.

2.4 Approach of Research

When the problem is defined it is also indirectly decided what approach the research should have. There are basically three different approaches; *explorative*, *descriptive* and *illustrative*.

Investigating (*explorative*) studies is often concerned with fundamental research. An explorative approach is particularly warranted if there is limited knowledge in the subject at issue. The object is to gather a lot of information and to attach great importance to general view. Describing (*descriptive*) studies are meaningful especially when the problem field is well investigated. Then can the description be concentrated to certain particular aspects without the connection to comprehensive picture gets lost. *Illustrative* researches aim is to elucidate why something is in a certain way.

In the light of these facts this investigation can be described as explorative, with descriptive attributes, since the purpose is to optimise a system of a specific field.
2.5 Secondary and Primary Data

An important part in the research process is the data collection. A researcher should always start by examining if there already are documents (secondary data) available covering the subject issue. If there is, and if it is possible, these should be used. In the document category is e.g. written information, photos, movies and computer-based information.

If there is no existing data it can be necessary to set off for the field to study reality. Then the researchers have to rely on their own first-hand observations (primary data).

Gathering primary data through field investigation can be done in three different ways, by interviews, observations or by experiments.

2.5.1 Interviews

Before performing interviews there are some important consideration that has to be made e.g. how the interviewees should be reached? By personal meetings, by phone or by mail etc.? In what ways is it suitably that the subject of the interview answers? If personal interviews are to be made should the answers be written down or maybe captured with a tape-recorder? Which method of selection should be used when choosing interviewees? Another consideration that has to be made is which degree of standardisation and structuring that should be used. In entirely standardised interviews the interviewer asks the exact same question in the exact same order to every person that is interviewed. And in the contrary case, with non-standardised interviews are totally improvised conversations. With a totally structured interview the respondent gets a number of answer alternatives for instance yes or no questions. With unstructured questions it means that the subjects of the interview can answer freely and express their opinion of something with their own words.

A lot of primary data will be used in this project. In the beginning of the project personal interviews with division leaders and workers will be performed. The interviews will have a low degree of standardization and a low degree of structuring to get so many viewpoints at the problem as possible, since the problem is of an unknown territory. The persons to be interviewed are to be chosen so that they will provide an overall view of the problem; people with different backgrounds, working experiences and work tasks will be interviewed in order to get a clear view of the situation. Later on, while the project develops, more structured interviews will be performed to narrow down the problem. Telephone, questionnaires and e-mail will also be used to ask complementary questions.
2.5.2 Observations

Using observations, the researchers are able to spot what they need for their investigation themselves. There are several ways to perform observations. Bengtsson and Bengtsson list four different observation possibilities: time and motion studies, peephole observations, participation observations and the Wallraff method.

Time and motion studies are often used in the industry to, for instance to count the number of stages in an operation or to measure the elapsed time for certain jobs. Information about elapsed time for an operation, parts of operations etc. is among other things required for planning, piecework rate fixing, work comparison, work organisation, evaluation of utilization rate, and calculation of delivery time and assessment of staff requirement. The times that in all are registered during a time and motion study is divided into work content and contingency allowance. Work content is such time that can be assigned to a certain work task. Contingency allowance is time that is common for several work tasks and shall be distributed among these.

When using peep hole observations the researcher can make direct observations without the observed knowledge, this can be accomplished by using for instance one-way mirrors and microphones. In participation observations the researcher stays in the environment that is being studied for a long period of time, sometimes up to several years. When using the Wallraff method the researcher goes undercover, gets a false identity and a disguise to be able to observe things that in normal circumstances would be impossible.

In this project, a time and motion study will be performed to get a view over the existing system in order to see how much time various operations take and to get correct input data for the system optimization. Peep hole observations will also be carried out to obtain the processes and manners in which tasks are carried out.

2.5.3 Experiments

Experiments are the most important method in natural science. According to Oxford English Dictionary (2004) experiment means: "a scientific procedure undertaken to make a discovery, test a hypothesis or demonstrate a known fact." The question an experiment seeks is often: what happens if?

In this investigation no real life experiments will be performed but all ideas and changes in the system optimization will be suggested.
CHAPTER 3

3 LITERATURE REVIEW

Before going into any theory, it is important to define certain terms of the supply chain that are important for purposes of this research.

Materials handling involves the moving of materials through the operations within an organisation. It moves materials from one operation to the next, and also moves materials picked from stores to the point where they are needed. The aim of materials handling is to give efficient movements, with short journeys, using appropriate equipment, with little damage, and using special packaging and handling where needed. This might even lead to changing the factory layout to improve the material handling situation7.

Order picking finds and removes materials from stores. Typically materials for a customer order are located, identified, checked, removed from racks, consolidated into a single load, wrapped and moved to a departure area for loading onto delivery vehicles.

Location: Some of the logistics activities can be done in different locations. Stocks of finished goods, for example, can be held at the end of production, moved to nearby warehouses, put into stores nearer to customers, passed on to be managed by other organizations, or a range of alternatives. Logistics has to find the best locations for these activities – or at least play a significant role in the decisions. It also considers related questions about the size and number of facilities. These are important decisions that affect the overall design of the supply chain.

Communication: Alongside the physical flow of materials is the associated flow of information. This links all parts of the supply chain, passing information about products, customer demand, materials to be moved, timing, stock levels, availability, problems, costs, service levels, and so on. Co-coordinating the flow of information can be very difficult, and logistics managers often describe themselves as processing information rather than moving goods8.

All of the above mentioned points are important parts of the supply chain. With the aid of a good supply chain management, an organization is able to get the right goods to the right locations where they are required at the right time with the proper quantity and at an acceptable cost.
3.1 Warehouse Management

A warehouse management system is a key part of the supply chain and primarily aims to control the movement and storage of materials within a warehouse and process the associated transactions.\(^9\)

3.1.1 Warehouse Space Optimization

Another important consideration in storage space requirements planning is the portion of warehouse locations that will be occupied for planning purposes. As the utilization of storage locations exceeds 85 percent in warehouses, the productivity and safety of the operations trail off dramatically, as can be seen below in the illustration.\(^{10}\)

![Productivity vs Storage Occupancy](image)

*Figure 2: Productivity versus Storage Occupancy*

3.1.1.1 Reducing stock levels

There are a number of methods which are used to reduce stock levels, of which two are highlighted below\(^{11}\).

- *Reduce the amount of old stock* - Slow or non-moving products begin to cut into productive space.
- *Reduce number of Stock-keeping Units (SKU)* - Make every new item "fight" for its space. Holding one item versus 3 or 4 can reduce inventories significantly, thus savings in space, holding cost and obsolescence.
3.1.2 Centralised versus decentralised warehousing

If a warehousing strategy is used, one has to decide whether to select a centralised or a decentralised system. In centralised warehousing, a single warehouse serves the whole market, while in decentralised warehousing the market is divided into different zones, each of which is served by different (and smaller) warehouse. 12

Decentralised warehousing leads to reduced lead times since the warehouses are much closer to the customers. On the other hand centralised warehousing is characterised by lower facility costs because of larger economies of scale. In addition, if a customer’s demands are uncorrelated, the aggregate safety stock required by a centralised system is significantly less than the sum of the safety stock in a decentralised system, known as risk pooling. This phenomenon can be explained qualitatively as follows: if the demand from a customer zone is higher than average, then there will probably be a customer zone whose demand is below average. Hence, demand originally allocated to a zone can be reallocated to the other and as a result, lower safety stock required.

Finally, inbound transportation costs (the costs of shipping the goods to warehouses) are lower in a centralized system while outbound transportation costs (the costs of delivering the goods from the warehouses) are lower in a decentralized system.

3.1.3 Crossdocking

Crossdocking (or just-in-time distribution) is a relatively new logistics technique that has been successfully applied by several retail chains. A crossdock is a transshipment facility in which incoming shipments are sorted, consolidated with other products and transferred directly to outgoing trailers without intermediate storage or order picking. As a result, shipments spend just a few hours at the facility.

In pre-distribution crossdocking, goods are assigned to a retail outlet before the shipment leaves the vendor. In post-distribution crossdocking, the crossdock itself allocates goods to the retail outlets. In order to work properly, crossdocking requires high volume and low variability of demand (otherwise it is difficult to match supply and demand).
3.2 Toyota Production Principles

Toyota Production System is a way of thinking which is described by Toyota\textsuperscript{13} as ‘A production system that is steeped in the philosophy of the complete elimination of all waste and that imbues all aspects of production with this philosophy in pursuit of the most efficient production method.’

Starting from this very point, it was found that was suitable for the project to use Toyota Production System philosophy and its principles in order to achieve the best results with the right thinking. These principles are briefly explained below.\textsuperscript{14}

The theory of the Toyota model and how it fits to the research study, with regards to the problems that were encountered during meetings and observations, will be discussed at a later stage chapter 5.

3.2.1 Long Term Philosophy

\textit{Principle 1:} Base your management decisions on a long-term philosophy, even at the expense of short-term financial goals.

- Have a philosophical sense of purpose that supersedes any short-term decision making. Work, grow, and align the whole organization toward a common purpose that is bigger than making money. Understand your place in the history of the company and work to bring the company to the next level. Your philosophical mission is the foundation for all the other principles.
- Generate value for the customer, society, and the economy it is your starting point. Evaluate every function in the company in terms of its ability to achieve this.
- Be responsible. Strive to decide your own fate. Act with self-reliance and trust in your own abilities. Accept responsibility for your conduct and maintain and improve the skills that enable you to produce added value.

3.2.2 The Right Process Will Produce the Right Results

\textit{Principle 2:} Create continuous process flow to bring problems to the surface.

- Redesign work processes to achieve high value-added, continuous flow. Strive to cut back to zero the amount of time that any work project is sitting idle or waiting for someone to work on it.
• Create flow to move material and information fast as well as to link processes and people together so that problems surface right away.

• Make flow evident throughout your organizational culture. It is the key to a true continuous improvement process and to developing people.

**Principle 3:** Use pull systems to avoid overproduction.

• Provide your down line customers in the production process with what they want, when they want it, and in the amount they want. Material replenishment initiated by consumption is the basic principle of just-in-time.

• Minimize your work in process and warehousing of inventory by stocking small amounts of each product and frequently restocking based on what the customer actually takes away.

Be responsive to the day-by-day shifts in customer demand rather than relying on computer schedules and systems to track wasteful inventory.

**Principle 4:** Level out the workload (heijunka). (Work like the tortoise, not the hare.)

• Eliminating waste is just one-third of the equation for making lean successful. Eliminating overburden to people and equipment and eliminating unevenness in the production schedule are just as important yet generally not understood at companies attempting to implement lean principles.

• Work to level out the workload of all manufacturing and service processes as an alternative to the stop/start approach of working on projects in batches that is typical at most companies.

**Principle 5:** Build a culture of stopping to fix problems, to get quality right the first time.

• Quality for the customer drives your value proposition.

• Use all the modern quality assurance methods available.

• Build into your equipment the capability of detecting problems and stopping itself. Develop a visual system to alert team or project leaders that a machine or process needs assistance. Jidoka (machines with human intelligence) is the foundation for building in quality.

• Build into your organization support systems to quickly solve problems and put in place countermeasures.
• Build into your culture the philosophy of stopping or slowing down to get quality right the first time to enhance productivity in the long run.

**Principle 7:** Use visual control so no problems are hidden.

• Use simple visual indicators to help people determine immediately whether they are in a standard condition or deviating from it.
• Design simple visual systems at the place where the work is done, to support flow and pull.
• Reduce your reports to one piece of paper whenever possible, even for your most important financial decisions.

**Principle 8:** Use only reliable, thoroughly tested technology that serves your people and processes.

• Use technology to support people, not to replace people. Often it is best to work out a process manually before adding technology to support the process.
• New technology is often unreliable and difficult to standardize and therefore endangers flow. A proven process that works generally takes precedence over new and untested technology.
• Conduct actual tests before adopting new technology in business processes, manufacturing systems, or products.
• Reject or modify technologies that conflict with your culture or that might disrupt stability, reliability, and predictability.
• Nevertheless, encourage your people to consider new technologies when looking into new approaches to work. Quickly implement a thoroughly considered technology if it has been proven in trials and it can improve flow in your processes.

3.2.3 **Add Value to the Organization by Developing Your People and Partners**

**Principle 9:** Grow leaders who thoroughly understand the work, live the philosophy, and teach it to others.

• Grow leaders from within, rather than buying them from outside the organization.
• Do not view the leader’s job as simply accomplishing tasks and having good people skills. Leaders must be role models of the company’s philosophy and way of doing business.
A good leader must understand the daily work in great detail so he or she can be the best teacher of your company’s philosophy.

**Principle 10:** Develop exceptional people and teams who follow your company’s philosophy.

- Create a strong, stable culture in which company values and beliefs are widely shared and lived out over a period of many years.
- Train exceptional individuals and teams to work within the corporate philosophy to achieve exceptional results. Work very hard to reinforce the culture continually.
- Use cross-functional teams to improve quality and productivity and enhance flow by solving difficult technical problems. Empowerment occurs when people use the company’s tools to improve the company.
- Make an ongoing effort to teach individuals how to work together as teams toward common goals. Teamwork is something that has to be learned.

**Principle 11:** Respect your extended network of partners and suppliers by challenging them and helping them improve.

- Have respect for your partners and suppliers and treat them as an extension of your business.
- Challenge your outside business partners to grow and develop. It shows that you value them. Set challenging targets and assist your partners in achieving them.

3.2.4 **Continuously Solving Root Problems Drives Organizational Learning**

**Principle 12:** Go and see for yourself to thoroughly understand the situation (genchi genbutsu).

- Solve problems and improve processes by going to the source and personally observing and verifying data rather than theorizing on the basis of what other people or the computer screen tell you.
- Think and speak based on personally verified data.
- Even high-level managers and executives should go and see things for themselves, so they will have more than a superficial understanding of the situation.
**Principle 13:** Make decisions slowly by consensus, thoroughly considering all options; implement decisions rapidly (nemawashi).

- Do not pick a single direction and go down that one path until you have thoroughly considered alternatives. When you have picked, move quickly but cautiously down the path.
- Nemawashi is the process of discussing problems and potential solutions with all of those affected, to collect their ideas and get agreement on a path forward. This consensus process, though time-consuming, helps broaden the search for solutions, and once a decision is made, the stage is set for rapid implementation.

**Principle 14:** Become a learning organization through relentless reflection (hansei) and continuous improvement (kaizen).

- Once you have established a stable process, use continuous improvement tools to determine the root cause of inefficiencies and apply effective countermeasures.
- Design processes that require almost no inventory. This will make wasted time and resources visible for all to see. Once waste is exposed, have employees use a continuous improvement process (kaizen) to eliminate it.
- Protect the organizational knowledge base by developing stable personnel, slow promotion, and very careful succession systems.
- Use hansei (reflection) at key milestones and after you finish a project to openly identify all the shortcomings of the project. Develop countermeasures to avoid the same mistakes again.
- Learn by standardizing the best practices, rather than reinventing the wheel with each new project and each new manager.
CHAPTER 4

4 EMPIRICAL FINDINGS

In order to comprehend the problem presented, a thorough study of the problem background needed to be investigated. Understandings of the basis, as well as the surrounding areas needed to be created.

Meetings were set up with the various divisions that are involved with the central stock, namely the stock business group, the central stock management as well as operational staff. Interviews were conducted in a non-standardised way as to provide free an open communication. The interviews were used to create on overview of the big picture with an objective viewpoint of the problem.

4.1 Stock Business Group

The stock business group, headed by Anna Thorburn, is made up of stock coordinators and stock developers.

The stock coordinators work with supplying the global stocks with material. They must forecast the need in the stock and register orders. They also have a close contact with the stock personnel and the salesmen. The stock developers work with optimizing the stock business. They work a lot with implementation, education and developing of the order entry system Jeeves. They also follow up the statistics connected to the stocks.

The stock coordinators are each responsible for various regions of the constantly changing stock locations, about 60 in total.

The regions are split up as follows:

- AW (west) – all the Americas
- AN (north) – northern Europe
- AC (central) – central Europe, including Russia
- AS (south) – southern Europe, including northern Africa (Mediterranean countries)
- AE (east) – Asia
- AY – southern Africa
The stock coordinators assigned to each of these regions are:

- Carin Josefsson, (retired on 21st Dec 2007)
- Kjell Andersson (AW, AY)
- Maud Fröjner (AE)
- Jonas Karebring (AS)
- Lotta Johansson (AN, AC)

### 4.1.1 Stock Supply Channels

There are two different supply channels from SSAB Oxelösund to its customers. There is direct to customer and to sales stock. For the stock business group, there are two means of supply; called PUSH and PULL, as illustrated in Figure 3 below.

- **Direct to Customer (DKU)**
  - Direct orders that are produced and delivered from Oxelösund direct to customers. These are normally customised items.

- **Sales Stock**
  - PUSH, Forecasted standard items that are pre-produced for the Central stock in Oxelösund and distributed to Sales stocks based on an order point system.
  - PULL, Direct orders that are produced and delivered from Oxelösund direct to stock. Can be customised dimensions for small customers or "local standards".

The central stock (CL) in Oxelösund supplies all the sales stocks with standard items. They also function as a sales stock for the close markets (Sweden, Norway, and Iceland) and some far-away markets that do not have their own stock (e.g. Morocco.) The sales stock in Antwerp is owned by SSAB, and is a distribution point for Europe.
The ‘PUSH’ system comprises of 50% of the stock material, which are standardised dimensions that are pre-produced in accordance with the forecast. All standard items, about 300 articles, are stored in the central lager in Oxelösund and are supplied to the global sales stocks according to an order point system. The PUSH system gives a high service level but on the other hand, the assortment is limited and standardized.

The remaining 50% of stock material (‘PULL’ system) are customised for a certain customers or markets and these items are ordered in the same way as for the direct customer business (DKU). This material has a much longer lead time from order to stock, as it includes the production as well as the transport lead-times.

Below is an overview comparing the two supply channels, highlighting the lead-time from once an order is made to delivery to stock.
4.1.2 Order Entry System

To keep the stocks in order the Stock group works in an order entry system called Jeeves. They can see the requirements in the different stocks and make the orders as needed. It can be seen what the inventory balance is in Oxelösund and other regional stocks. Previously Jeeves was mainly used a means to manage stock, now it is becoming a more complex ordering system. Many of the other stocks use Jeeves at present, though it is intended that all stocks all over the world use the Jeeves system to enter orders and report sales.

A very important function in Jeeves is the ability to provide a forecast for the standard articles. As the PUSH flow is depended on the forecast, being able to pre-produce these standard items the lead-time can be shortened.

4.1.3 Areas for improvement

There are various issues that the Stock Business Group, from their perspective, would like to improve or pursue. These are mentioned below.

- Identify Slowmovers
  - Defined as material that is older than 6 months.

- Highlight oversupplied material
  - Stocks are used as leveller for production
Sub-contractors makes batches of material = a lot of material in a short period of time

- Improvement of stock management
  - Service level measurement
  - Improved safety stock management
  - Classification of articles and diversification

- Improvement of article management
  - Reduce the number of articles
  - Distinct handling of creating articles
  - Optimise articles according to production and transport mode

Many of the above mentioned points are not directly related to the defined problem for this study, though are important in understanding any problematic issues of the organisation as a whole.

4.1.4 Better information required by Stock group

There are a couple of areas that the stock group feel that could be improved within central stock that would improve their effectiveness.

4.1.4.1 Inaccuracy in Stock Levels

At present the stock levels of the central stock are maintained by Ellen, a stock management program, from which information is passed onto Jeeves. It is noted that there are discrepancies between what the system says is in stock as to what is actually in stock. This inaccuracy could be denoted to either inaccurate methods of recording the stock in Ellen, or to the communication errors between the two programs, as well as the different information desired by the users. It is noted that at present different terms are used by the programs to describe similar fields.

The differences into the two programs is also that Jeeves manages all the stock balances with regards to individual plates, whereas the central stock always work with number of pallets in the Ellen system.

Discussions held with the operating personnel in the central stock mentioned that any unclassified material is not shown in the same manner in the two systems.
4.1.4.2 Inaccuracy in Picking Dates

Picking dates are the dates that the material is required to be ‘picked’ or collected for loading at the transport terminal. The picking dates currently provided in Jeeves is incorrect and not clear to personnel what dates are referred to.

This is an issue that is not directly related to the problem, however highlights the issue of communication between the two departments. It is suggested that this issue be solved directly between the personnel involved between the two departments.

4.1.4.3 Overstocking Sales Stock

Due to the constant demand on increased production, there is a greater pressure on central stock to handle and store the material. It is found that there is often much more material sent to global sales stocks than required. This can have the effects that there is not enough stock of certain articles in central stock when a customer places an order.

This has the result effect that the material must be transported from the oversupplied sales stock to the sales stock in another location, onto the customer, as shown in the figure below. From the stock group’s perspective it would be better to have as much stock as possible in the central lager. This will allow stock to be sent to the sales stock as required.

![Figure 5: Incorrect flow of stock material](attachment:image)

The above issue is a controversial issue between the stock business group and the central stock. As mentioned earlier in chapter 3.1 - Warehouse Management, there are various benefits in having stock centralised or decentralised. There are contradicting areas of benefit for each department; sales stock require availability of stock whereas the central stock are restricted to space and time limited in operation to fulfil orders.
4.2 Customer Service Division

The customer service division (DKU) deals with providing plate directly to customers worldwide. They fall within the stock business group, mainly dealing with ‘PULL’ supply. There are three main areas that they cover:

- **New rolling:** Customised material for client, which has no article number.
- **LP2:** Standard material sent from central stock (CL) direct to customers.
- **Stock:** Customised items that are given article numbers, specifically for customer stock.

The customized material is the main area of business for the group, with a smaller percentage being the LP2. In the cases of LP2, this is when there is no sales stock available in the location of the final customer (i.e. Norway or Morocco.) In these instances the central stock in Oxelösund is the sales stock for these clients, and orders are sent direct to clients.

Orders are entered into the central ordering system *Jeeves* in the same way as the standard items, though these items can’t be forecasted for production, resulting in a longer lead-time.

4.2.1 Order Planning

Order planning for the customized material is very dependent on the production capacity, whereby the sales teams are given ‘allocations’ of what and how much is possible to produce, through a program *demand planning*. The customers are promised a **delivery week**, not day, which is the time the material is ready for transport from Oxelösund, regardless of the means or time of transport. There is a close collaboration between the stock group and the customer service group, as it is important to know what stock is where.

The customer service group deal mainly with the following departments:

- **DLA** – to check if there is enough stock available to provide for clients
- **Central Stock (CL)** – checking if there is stock available
- **Master Planning** – provide the stock allocations for sales
- **Production Planning** – manage production in the mill and providing production lead times
- **Forwarding** – arranging transport and providing delivery lead times
- **External logistics** – small dealings; determining freight costs
4.3 **In-Field Observations and Meetings**

During the period of the research, much time was spent onsite having informal meetings, discussions with personnel involved with the central stock. The entire data gathered during this time has been presented below in outline approach.

**4.3.1 Ellen – Central Stock Management System**

In order to understand more about the system used by the central stock, *Ellen*, a meeting was arranged with the system developer, Ingegärd “Kicki” Karlsson and Björn Ågren.

Insight was given to how the system is used and what information is available. The system has been in place for many years and is possible becoming outdated. The system provides a numerical representation of what is in stock. All information about orders, plates; both standard and customised, and transport.

As Kicki has had much experience working with Ellen, she has a good insight to the operations of the central stock and provided many ideas or possibilities to research. Her comments of the process are added into the section below.

For the duration of the study, the researchers were allowed limited access to the system in order to gather data. In the figure below, is a screenshot of the Ellen system used by the central stock.

*Figure 6: Start screen of Ellen - the stock management system for the central stock*
4.3.2 Following the Process of an Order

Forecasted orders are entered in Jeeves by the stock business group, from which a production plan is sent to the mill. Produced plates are loosely packed onto cassettes, which are then collected in the ‘utlastningshal’ (collection area) to be delivered to the central stock.

In order the store the plates in the stock area, individual pallets are created. Each pallet, which has its own 6 digit pallet number, contains plates of all the similar articles loaded onto the cassette. Each plate has a unique “löpnummer” (serial number) that includes a control number as its last digit. This number is painted on the upper side of the plates, and for the thicker plates, is visible on a sticker label displayed on the edge.

The pallets, which are still “oklassad” (unclassified from quality tests), are delivered to available “lagerplats (LP)” (storage spots) in the appropriate “transport område” (storage area). Once this has occurred, information is entered into Ellen, including pallet number and information, article information and into which lagerplats. The “läge” (level) of each pallet is recorded, though at present there is no information stored in Ellen as to which lage each plate is on in the pallet.

A sample of each article batch is sent for testing at “provberedning” (testing centre) after production, to ensure that only the highest quality is produced. Once the sample is approved (which could take two to six weeks), the pallets containing plates of the same batch are considered “klassad”) classified, and a message is sent to both Ellen and Jeeves that the pallets are available for sale, and it is possible to connect them to customer orders.

Pallets can only be delivered to lagerplats that contain pallets of the same article and are not “bruten” (full or blocked storage spot). A bruten lagerplats can be due to that a pallet in the lagerplats has already been “kopplad” (connected to a customer order) or there is a safety risk of adding more pallets to the lagerplats. Through the onboard computers in the forklifts, Ellen suggests a lagerplats that the pallet can be delivered to. This suggestion is based on the last lagerplats that a pallet of the same article was delivered to. This suggestion does not however indicate whether the lagerplats is bruten or not, and the age of the pallets already in the lagerplats. There is also no possibility that the central stock is able to make suggestions in the system or the driver to indicate a preferred lagerplats for delivery. If the suggested lagerplats is not able to take the pallet, a second suggestion is given. However, it is often found that there are errors in the system or that the pallets are delivered to the incorrect storage area.
When an order is received through Jeeves by the stock business group (or DLA), this order is sent to the central stock via Ellen. The operating personnel are then required to fulfil this order by selecting the relevant articles from stock and prepare them for delivery. This process is known as connecting orders, and below a screen shot view from Ellen can be seen. For each order, every article is shown as a separate “order rad” (order row), thus a different record in Ellen.

In the figure it can be seen that there has only been 1 plate ordered of article number, 6475. It is shown that there is only a pallet containing plates of this article, which is in lagerplats number 5079. This pallet, pall # 377454, contains 7 plates and was created (manufactured and delivered to stock) on 2008-04-19. Noticeably, one can see that a pallet, pall # 1650249, (only containing 1 plate in this scenario) has already been kopplad for this order. This pallet has a 7 digit pallet number which concludes that this pallet has been the product of a split pallet. Splitting of pallets is discussed below in section 4.3.3.

Figure 7: Order information view in Ellen when connecting pallets to an order

Once the order has been kopplad in the system, it is up to the operating staff to physically prepare the pallet for delivery. This should be done simultaneously, as once the order is kopplad in the system, a message is sent via Ellen to the forwarders that the order items are ready for collection. It is up to the forwarders to arrange transport and collection of the order, which is either done by road, railway or sea; either large orders on a boat or containers.

Orders delivered by truck are available 24 hours a day, 7 days a week, however it is found that there is a peak collection time every afternoon with stack-up effects.
4.3.3 Pallet Splitting

Pallet splitting occurs when in an order a different number of plates are ordered that exist in the various pallets that are in stock. When a pallet is split, the new pallet that is created is allocated a new *pall number* that contains 7 digits, and the remaining pallet retains its original number. In the above scenario, it could be assumed that the new pallet that was kopplad to the customer order was the result of a split from the pallet that was in stock, assuming which would have had 8 plates initially.

Every order has a minimum and a maximum number of plates that can be delivered. Usually the min and max number will correspond to the number of plates actually ordered, however there are a number or circumstances where the min and max number will be 1 and 9999 respectively. This indicates that the customer is not particular to the exact number of plates order, but a mere indication of their demands. In this case, the operating staff are able to connect a pallet to the order that most closely resembles the number of plates ordered.

For example, looking at the screenshot shown in the figure below, the order row states that 4 plates of article 4778 is required, though a min and max number of 1 and 9999 respectively. This allows a variable number of plates in a pallet to be connected. Looking at the three pallets displayed, from lagerplats containing the oldest stock, it can be seen that each pallet contains 6 *klassad* (classified) plates. This means that either of these three pallets could be connected to this order, with the result of saving the operation personal much time in not having to physically split the pallet, which could take on average 15 – 20 minutes to split, longer if bad weather.

![Figure 8: Ellen screen shot displaying the variable number of plates for an order row](image-url)
Another noticeable detail from the above figure is that the three pallets shown with 6 plates each, is that they are also *bandad*, which means that they are bound by strapping. If this order where one that had a fixed order quantity, then one of the above shown pallets would have to be split (if there were no other pallets containing 4 plates.) Because of the pallet being bandad, it means that it would take even longer to prepare the pallet for the order. Having bandad pallets is optimal for storage and transport and it diminishes the risk loose plates and safety, however much more time is required if splitting is needed.

There are a numbers of customers who are unspecific in the number of plates that are ordered, which is allowed to differ by maximum 10 – 15 percent of the order quantity. This significantly reduces the amount of working time spent on each order as minimal splitting is necessary, however for the customers with specific orders there is much splitting required.

![Splitting a pallet for a particular order](image)

*Figure 9: Splitting a pallet for a particular order*

There was much discussion amongst the central stock personnel about splitting pallets, especially from the operating perspective. A suggestion would be to be able to increase the number of unspecific customers, even if the range of difference in the ordered number was limited, for instance to max 1 - 2 plates for an order. This possibility would radically diminish the average time to connect orders, as fewer pallets would be required to be split.
4.3.4 Data obtained from Ellen

Using Ellen, data was able to be obtained providing information of the age of pallets, the number of pallets in a lagerplats, the number of empty lagerplats as well as the number of pallets split over time.

In the figure below, one of the tools in Ellen is shown, that was used to extract the majority of the information. Using this, data was able to be exported to Microsoft Excel and analysed, as partly demonstrated in the section below in Figure 13.

With this Ellen tool, one is able to extract live stock data for a particular article, in a particular range of storage areas, within the selected lagerplats. Using the entered variables as below, data was given for all standard articles located in all the storage areas, including every lagerplats. This data is analysed and presented in the following chapter, which is found in Attachment A.

Different tools within Ellen were used to determine the accuracy of the system, by comparing observations made in the storage area, to data within the system. For example, checking that the correct material in located in the proper lagerplats or that the number of pallets match, etc.

![Figure 10: Ellen picture to obtain information for analysis](attachment:ellen.png)
4.3.5 Pointers of information gathered

During the period of gathering data, a number of points were noted during observation and casual interviews. A questionnaire was compiled for the operating staff of the central storage, which provided a valuable insight to ‘on-the-floor’ issues within the current system. The questionnaire can be located with the Appendices. These are highlighted in point form below, some of which have been mentioned in the findings above.

- CL (central lager) no idea of:
  - forecast/demand of orders
  - stock in other lagers – global sales stock
  - forecast of production
- CL not enough LP (lager plats)
  - Results in mixing with other storage areas / wrong articles
  - Increasing size of no of articles (281 now) – requires approx 900 LP
- Often having to ‘split’ pallets to satisfy orders
  - Orders often to be redone/changed – double work.
- Uncertified plate in LP – requires extra moving time
- Old plate in stock, not moving through
- Many single pallets in LP, often only containing single plates
- Slow movers need to be organized and better stored
- Not enough preparation time for boat orders (1-2 days at present)
CHAPTER 5

ANALYSIS AND OPTIMISATION OF A MATERIAL HANDLING SYSTEM

CHAPTER 5: ANALYSIS OF INFORMATION

Based on all the information gathered and presented above, an analysis was made. From this preliminary suggestions were made and further observations were able to be conducted. These are all detailed below, with regard to each key parameter identified.

5.1 Overview of Process

Before any analysis could be made on the information, it was essential that one had the correct viewpoint of the process and the systems in place. Below this perspective of the system is outlined. Discrepancies may occur due to limitations as detailed in chapter 1.

Similarly as that to explained above in section 4.3.2 ‘Following the Process of an Order’, a forecasted is made from by the sales stocks, which is sent to production planning. After production the plates are sorted into pallets and delivered to the central stock. Once a material sample is tested and cleared a notification is sent to the central lager via Ellen and to the stock group via Jeeves that the material is ready to be sold. When an order is made central ordering system, Jeeves, by DLA, an order record is created in Ellen which is used to connect the material and prepare for delivery. From here the material is sent to the sales stock and finally onto the customer.

![Figure 11: Perspective of the DLA order process](image-url)
In much the same way orders made by DKU are sent to the mill, though with no forecast and is based on production capacity. Once the material is produced, the goods are sent directly to the customer. In areas where there are no sales stocks, standard articles are delivered direct from the central lager to the customer. The product flow is shown below from the DKU perspective.

![Figure 12: Perspective of the DKU order process](image)

**5.2 Analysis of Data obtained from Ellen**

Using the data as explained above in section 4.3.4, it was possible to interpret and analyse the information to provide an insight into the current situation of the storage area.

**5.2.1 Visual simulation of Storage Area 31**

Using Excel, a map of storage area 31 is reproduced (of which a sample is presented in the figure below) to attempt a visual simulation of the numerical data Ellen provides. From the data extracted, the map represents the data according to how the material is actually located in the storage area. By this, meaning that each lagerplats is identified on the map, and shows which article is found in that lagerplats (in any articles present otherwise shown as #N/A). Additionally the map displays how many pallets are in the lagerplats, as well as the total number of plates and finally the date of the oldest pallet in the lagerplats.
Using colour coordination, it is possible to highlight in red whether there is a pallet in the lagerplats that is older than 6 months (180 days.) The map does not however indicate how many pallets are older than 6 months, but only shows the oldest. The number of plates is highlighted in pink if there are less than 5 plates present in the lagerplats; however this is not dependent on the number of pallets. It could be that there are only 4 plates, but there could also be only 4 pallets, meaning 1 plate in each pallet. Regarding the number of pallets in the lagerplats, the map indicated the lagerplats that contain pallets in blue, and highlights the empty lagerplats in green.

<table>
<thead>
<tr>
<th>Act #</th>
<th># Pal</th>
<th># Plates</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>6562</td>
<td>6</td>
<td>6</td>
<td>2007/11/14</td>
</tr>
<tr>
<td>6578</td>
<td>6</td>
<td>1</td>
<td>2006/06/23</td>
</tr>
<tr>
<td>6388</td>
<td>1</td>
<td>1</td>
<td>2007/06/18</td>
</tr>
<tr>
<td>N/A</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 13: Analysis of data from Ellen using Microsoft Excel

From the data used in the above mentioned map, it is possible to present the percentage of lagerplats that are occupied by 5 plates or less for area 31 as shown in the figure below. Of the 185 lagerplats allocated for area 31, it can be summed that 43, which is over 23 %, of these lagerplats contain 5 plates or less, which is a significant number.

Figure 14: Number of plates located in lagerplats for area 31
It is however noted that this figure does not include any empty lagerplats. From the data it was obtained that 48 LP (almost 26%) did not contain any pallets. These figure seemed ambiguous, which after investigation deemed true. From observation made in the field, it was noted that many of the identified lagerplats actually contained pallets. However when checking the lagerplats status in Ellen, it was found that many of these lagerplats contained non-standard articles, which is material that should be stored in different storage areas. This was further evidence to show that there is poor inventory management. It was found that of the 48 empty lagerplats; in fact 32 of these were containing incorrect stock. Thus, 16 of the lagerplats in storage area 31 were empty in reality, which is close to 10%.

5.2.2 General Analysis of the main Storage Areas

Using the same data as mentioned above, information was able to be processed to provide the current situation for the central stock. With the information provided in the table below, it was possible to see the amount of stock that is in each storage area compared to one another.

Table 1: Number of lagerplatser and size per storage area

<table>
<thead>
<tr>
<th>Storage Area</th>
<th>31</th>
<th>32</th>
<th>33</th>
<th>34</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lagerplatser</td>
<td>185</td>
<td>255</td>
<td>61</td>
<td>47</td>
<td>548</td>
</tr>
<tr>
<td>Size (m²)</td>
<td>8,999</td>
<td>17,336</td>
<td>8,428</td>
<td>4,000</td>
<td>38,763</td>
</tr>
</tbody>
</table>

As displayed in the figure below, it is seen that storage area 32 (storage for medium sized plates; 5500 – 8000cm) contains the majority of the central stock as does the unnamed areas that fall under other (predominantly storage for large plate; over 8000cm).

Figure 15: Percentage distribution of total stock
When using this data to compare the usage ratios of the various storage areas, it is noticeable that storage area 33 has an extremely large ratio of number of plates to a lagerplats compared to the other areas.

![Usage of Storage Area](chart.png)

**Figure 16: Usage of storage areas with respect to number of pallets and plates**

Below is an example of a lagerplats that is overloaded. It is however noted that the lagerplats has been stacked in an orderly fashion, with the wooden blocks aligned vertically under each other. In cases were they are not aligned correctly, especially when the pallets contain thin plate, much bending can be expected, as well as an increased safety risk, especially in poor weather conditions.

![An example of an overloaded Lagerplats](image.png)

**Figure 17: An example of an overloaded Lagerplats**
5.3 **Findings of Key Parameters**

Based on all the information and data obtained, the key parameters of the problem, with respect to the objectives of the study, could be identified through a brainstorming session that extruded any points observed. With two of the primary objectives being to use the storage area more effectively and to increase the efficiency of handling material and working time, it can be noticed that some of the key parameters identified, as shown below, would fulfil both of these objectives.

![Figure 18: Influencing Factors of Central Lager](image)

Each of the above represented parameters are discussed below, detailing the current situation observed and what issues should be addressed. Suggestions are made to how these issues can be achieved based on theory as well as experience of the researchers.

Despite some of the suggestions made not being practical or able to be implemented after presenting them to involved departments, they are included for reference purposes. The application any importance of the parameters are mentioned and the relevant issues are implemented into a proposed solution as outlined in the next chapter.
5.3.1 Slowmovers

One of the problems that were revealed at the beginning of the study was that items that have been in stock for too long, also known as *slowmovers*, accumulate much of the storage area. Additionally the slowmovers that have been in stock for too long have degraded in quality, often resulting in that they are required to be repainted. The original coating of paint is guaranteed to last 6 months, after which it may need to be redone.

Slowmovers can be defined into two categories:

- *Old Stock* – plates of ‘selling’ stock that is not sold / moved out from stock.
- *Slow selling* – articles that are not commonly sold (phased out / large articles).

To fully define slowmovers, a time constraint must be appended. Due to having two categories, these are defined separately.

- *Old Stock* – plates older than 6 months need to be repainted – rework
- *Slow selling* – articles that are sold less than twice a year could be considered slow selling.

Thus could say that if a pallet containing plates is older than 6 months, the pallet should be prioritised to ‘move’ out of stock.

5.3.1.1 Current situation

At present the only method of notification to the operating personnel of old stock, is that the oldest pallet an article is shown at the top of the list when an article is to be connected to a customer’s order. This is shown in Figure 19 below. There would be the added benefit if the system were to highlight the pallet number when a particular pallet is classified as old stock.
In Figure 20 below we can see the distribution of pallets with respect to their age as at the beginning of 2008. The figure shows pallets of all the standard articles distributed throughout the whole central stock. It can be shown in the figure that more than 50% of the total central stock is less than 1 month old. Additionally, approximately 80% of the stock is under 3 months old. In terms of slowmovers, only about 10% of the stock is older than 6 months. This amount of old stock could be considered satisfactory, as 7.2% of this is between 6 and 12 months of age. Noticeably, there is less than 1% of the total stock that is older than 18 months.
In the figure displayed below, one is able to see the quality effects of the paint of pallets of old stock. It was mentioned during a meeting that due to company policy, plates of diminished quality would not be delivered to customers, even at a reduced price. This means that any old stock would be required to be sent in for repainting if does not meet the quality standards. This both increases the cost and requires more time, with a result of no extra value added to the product.

The next four figures below show the percentage of age of plates for each of the four main storage areas for central stock, namely area 31, 32, 33 and 34. The values for each area are shown in Table 2 below. The areas that are excluded from the below table (although included in the total for ‘All’ areas) count for about 30 % of the total stock, as shown in Figure 15 above, which in most cases contain pallets with plates that are larger than 8 m in length.

Table 2: Age of Pallets, by area, shown as percentage

<table>
<thead>
<tr>
<th></th>
<th>All</th>
<th>31</th>
<th>32</th>
<th>33</th>
<th>34</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 1 Month</td>
<td>52,7</td>
<td>33,3</td>
<td>65,8</td>
<td>62,5</td>
<td>32,4</td>
</tr>
<tr>
<td>1--3 Months</td>
<td>28,2</td>
<td>15,3</td>
<td>26,9</td>
<td>23,2</td>
<td>53,2</td>
</tr>
<tr>
<td>3--6 Months</td>
<td>9,4</td>
<td>20,4</td>
<td>2,4</td>
<td>12,6</td>
<td>13,3</td>
</tr>
<tr>
<td>6--12 Months</td>
<td>7,2</td>
<td>23,3</td>
<td>3,6</td>
<td>0,6</td>
<td>1,1</td>
</tr>
<tr>
<td>12--18 Months</td>
<td>1,5</td>
<td>6,1</td>
<td>0,6</td>
<td>0,0</td>
<td>0,0</td>
</tr>
<tr>
<td>&gt; 18 Months</td>
<td>0,9</td>
<td>1,6</td>
<td>0,7</td>
<td>1,0</td>
<td>0,0</td>
</tr>
<tr>
<td>100,0</td>
<td>100,0</td>
<td>100,0</td>
<td>100,0</td>
<td>100,0</td>
<td>100,0</td>
</tr>
</tbody>
</table>

It is obviously noticeable that storage area 31 has a significant larger percentage number of slowmovers compared to any other area. This can be clearly seen in the figure below, that
storage area 31 has over 31% of its articles as old stock. It can be seen that almost 8% of the stock in area 31 is older than 1 year. This is a greater percentage of stock compared to the amount of total stock in all areas than is older than 6 months. Looking at the data obtained in Ellen, there were two pallets over 5 years old and three pallets almost 4 years of age.

Due to the high percentage of old stock in area 31, a comparison is made over time to obtain any change in the status for the area. As can be seen in the figure below, the pallet age is represented for three different dates, namely 20/12/2007, 04/01/2008 and 08/04/2008. It can be seen that there is a large improvement from the oldest date to the most current.

For plates that are older than one month there is an improvement of about 10%. For plates that are older than three months, there is a large improvement shown from about 62% to 50% and finally down to about 31% on the 8th April. For pallets considered slowmovers, older than 6 months, there is an improvement from about 30% down to approximately 20% on the 8th of April.

For plates that are older than nine months, it is noted that there are minimal changes to the percentages, in some case there are increases. Much of the stock reductions of the pallets that were not that old could be denoted to the fact that there was a large build up in stock of already connected orders to customers that were not able to be delivered before the end of the year, which were then moved out of stock during the beginning of January 2008.
Looking at the next two figures, showing the age of pallets for storage area 32 and 33 respectively. It can be seen that for both these areas that the percentage of pallets less than one month old is over 60 %, also showing that the pallets less than 3 months is approximately 90 %. For area 32, merely 5 % is considered to be slowmovers.

Figure 23: Comparison of the age of pallets at three points in time

Figure 24: Percentage age of old Pallets for Area 32 in Central Stock
For area 32 it is noted that there are only nine pallets (each containing 8 plates) that are older than 2 years of age, of which only one pallet of a single plate is older than 3 years. For area 33, there are only seven pallets, each with only one plate that is 2 years old. Other than these 7 pallets, there are no other pallets that were older than 9 months at the beginning of 2008.

![Percentage age of Old Pallets](image)

**Figure 25: Percentage age of old Pallets for Area 33 in Central Stock**

The last figure, representing data for area 34 has similarities to that of area 33, in that it has 85% of its stock less than 3 months old. Additionally, it can be seen that for area 33 and 34 that barely 1-2% of its stocks have slowmovers. It is noted that both the two areas are the storage areas for stock to the USA.

This identifies that these last three areas; 32, 33 and 34 respectively, which contain over 50% of the total stock, have a significantly low portion of slowmovers. It could be mentioned that much of the focus should lie upon area 31.
In the data presented thus far on slowmovers, there has been no distinction made between the two types; old stock and slow selling. Even though there has been mention of stock that is *old stock*, this has signified that the material has been in stock for more than 6 months. The pallets that are defined as *slow selling*, have not been differentiated due to the ambiguity of which articles are considered slow selling or not. Further investigation would be required to determine this, by identifying which articles are rarely sold. It was however noted that numerous of the lagerplats that contained only a couple of pallets, were the only pallets of that particular article in stock. This was the same for the 2 pallets in area 31 that were over 5 years of age: they were both the only such article in stock.

5.3.1.2 **Proposed ideas**

If a system were able to clearly identify which article are slowmovers; both *slow selling* and *old stock*, then this information could be used both to minimise the number of slowmovers and to combine articles considered slow selling in order to save space.

To be able to reduce the number of slowmovers, the user of the system should be able to easily and clearly see which articles are slowmovers, and were they are located. If a colour coding method were to be used to identify once the article is older than 6 months, it would be more obvious to the user that that pallet should be connected to a customer order. In the same sense if the user is wanting to identify which pallets are perhaps requiring to be repainted, he or she would be able to extract a list of these pallets are be able to easily locate them for a visual check if required.
For the items that are considered slow selling, there are clear possibilities that these articles could be combined and grouped together to be able to save space. If a shelving system, similar to that mentioned below in chapter 5.3.7, then the items that only contain a small number of plates / pallets, could be loaded onto these shelves. An alternative solution would be to combine the pallets and stack them in the same lagerplats (LP). If the latter were to be the case, the *Ellen* would have to be able to show multiple articles in one LP.

The benefit of combining and grouping these items together is that despite more worked being required when needing to collect a pallet, even if at the bottom of the stack, would be that the a significant amount of space would be saved. As these articles are considered slow selling, i.e. less than twice a year, then there would not be much work required on an annual basis. Additionally, these could be grouped into LPs that are in the more unobtrusive areas, such that the more accessible LP could be made available, thus further reducing the daily working time.

### 5.3.2 Expanding Storage Area

As the production capacity is going to be increased within a few years, expanding the storage area is another option for the Central Stock.

One possibility considered would to be to physically increase the storage area. An option proposed is a piece of land next to Aspaleden, below the Isbergs Hill. This option has large financial constraints, among other issues that would have to be investigated separately. For the scope of this project it has been decided to limit the storage area to the current area. This opportunity should be kept in mind as a second alternative (after making the storage more efficient) as purchasing land might be costly. It might be a very good idea for the future.

Another possibility would be to decrease the amount of stocked stored in the central lager. This would be achieved by sending larger quantities at a time to the lager sales stocks (i.e. Antwerp for Europe, USA for Americas). The issue of centralisation versus decentralisation is something that could be addressed separately.

### 5.3.3 Grouping articles for same customer (e.g. *Crane Company*)

At present there are a numbers of articles that are produced, as standard products, specifically for certain customers (i.e. *Crane Company*). This is due to the high number of products that these customers order. These articles are considered standard articles and stored in the central stock, and reserved only for their specified customers.
At present it is noticed that these items are scattered across the central storage. A proposed idea would be to group them to a similar area, or possibly use a shelf system (as detailed below) for each of these specific customers.

A potential solution might be as shown below, using the visualisation system. We can see the Crane Company articles (a fictitious example), as identified by the red spots, and the green spots locate empty lagerplatser. This will allow us to gather these articles closer together to ease handling and reduce working time.

![Crane Company and Empty LP diagram]

*Figure 27: Visualisation system to be able to group articles of the same customer*

Another suggestion made regarding the size of the pallets for these customers due to many pallets being split as orders do not follow a routine. For instance if only one plate is ordered from the storage and the pallets in stock normally contain 2 plates each, a customisation might be made for the actual demand and maybe the pallets should only contain 1 plate for each article. This will save time as the need for splitting will be reduced significantly.

### 5.3.4 More order deliveries

The deliveries ought to be as fast as possible as, if not, it causes overstocking. There is not enough transport to collect orders, which causes too much extra stock in storage. Over the Christmas period, the Mill was required to stop to reduce storage overflow, which of course is a big expense for the company.
Extra deliveries for same customer are one of the reasons of overstocking: Pick-up times are delayed for more plates and receiving late orders are the main reasons behind this. The best thing to be done is to reduce number of orders and make sure the collecting orders are working well. In order to ensure this, a forecast of outgoing deliveries of a certain period (i.e. 2 weeks) is needed. Furthermore, the outgoing transportation might be increased in an optimized way in order to balance the truck collection and to work wisely.

5.3.5 Reduce pallet splitting

As described in section 4.3.3, pallet splitting is the most time consuming operation for central stock, especially when there is ice and snow. The most time consuming factor is having to identify each plate that is to be part of the new pallet, as there is no information on which plate is located where in a pallet. In certain instances, when the plate is thicker than 8mm, a identification tag is attached to the edge of the pallet. However, if this tag is not present, then it is necessary to lift each plate in order to read the löpnummer on the upper surface of the plate. This is the most time consuming part of having to split pallets, especially when there is a large number of thin plates required.

A suggestion that goes together with pallet splitting, would be that all plates could be identified with individual tags (possibly using the barcode system) as well as the system being able to manage what läge (level) the plates are in a pallet. If this information could be known, then splitting a pallet would only require having to split the pallet in the position required and create the new pallet number. This would save a considerable amount of time, and the issue of splitting pallets would not be as significant.

Plates are damaged
There is also the risk of damage to the plates when they are split, as can be seen in the figure above. From a quality perspective, this is something that is required to be reduced too.

Another phenomenon encountered, is the number of customers for the same VM group is increasing, which has the result of extra splitting. This is due that the VM is acting as a distribution point for the plates, and previously the VM would receive the entire order, from which they would be self responsible to splitting the pallets and preparing new pallets for the final customer. However is now being noticed that there are a larger number of smaller order going to the same VM, meaning that the pallets for the final customers are being split and prepared by the operating staff of the SSAB central stock.

The full extent and reasoning of this could be investigated. It is however suggested that the full order be sent directly to the VM where they would split and deliver the final pallets to the end customers. Alternatively, a premium could be levied in circumstances where extra splitting is required.

5.3.6 Forecasting Flow

As mentioned in the Toyota Production System, principle 3 indicates ‘Provide your down line customers in the production process with what they want, when they want it, and in the amount they want. Material replenishment initiated by consumption is the basic principle of just-in-time.’ If the central stock is able to have the forecast of what is coming out of the mill and of upcoming deliveries, needful arrangements can be made to optimise the material operations to obtain the best flow possible.

A suggestion was made to the stock business group for providing better information to the Central Lager; to be able to know the stock levels at the global sales stocks. This was considered as a non feasible option as it was not desired that the Central Lager operational staff should make the decisions on what to be able to send to sales stocks.

5.3.7 Using Shelves

There are a number of shelves used by the Central Stock today. Gathered in the meetings and interviews, they are really appreciated by the staff as they save storage place and are easy to use. They are currently used for the orders which go by trucks.
Shelves can be used for storing slow selling articles, as shown in the figure below, to save space.

![Shelving System](image1.png)

*Figure 29: The shelving system for storing slow selling articles.*

Although the shelves are very functional, they are not able to carry heavy loads. One arm as seen in the figure below is limited to carry 2 tons. Thus each side can only take a maximum of 8 tons excluding the bottom shelf which can take more as it is the base.

![Shelving System in Use](image2.png)

*Figure 30: The shelving system currently in use when loading trucks*.

Small orders can be put on the shelves directly from the mill as to be loaded on the trucks, as shown below.
Figure 31: Shelf system for small orders

Figure 32: A side view of the shelving system
5.3.8 Visualization System

With the aid of a visualization system, the user is easily able to see where the specific articles are located within the central lager. This idea is presented in detail in the next chapter; however some of the key benefits are outlined below.

- To have a better overview for the storage.
- Will help to see instant situation in the stocks easily.
- Easy to understand and adapt to (for seasonal workers, etc.)
- Helps personnel to be more efficient during work hours (fewer things on their minds).
- Easy to rearrange, or improve, the layout of stocks, creating more available space.
- Helps the central lager to be more flexible
- Helps the user to be more efficient when working with pallets, reducing working time.
- More fun.

5.3.9 Correct Data entry of Stock

Today there is inconsistency in stock levels in Ellen and Jeeves as Ellen is working with pallets whereas Jeeves is dealing with plates. This fact creates misunderstanding among the related departments.

It is also noticed that entries are forgotten or incorrectly made when moving pallets within the central stock. This creates conflict between Ellen and the actual stock area. In order to make the flow smooth and flawless, a very easy-to-use function can be added to the Visualisation System.

Ellen doesn’t show if there are pallets of mixed articles on a lagerplats. At present, this situation is not wanted, as one lagerplats can only have one type of article. But due to the limited space and/or using the resources in an inefficient way results this kind of problem. The actual stock should be seen on a system to avoid problems. If a customer has an order and it is seen on Jeeves that the related articles are at hand but actually are not, the customer might get annoyed.

In order to have correct data of entry, a better system of entering data is needed. A barcode/scanner system might solve such problems especially when it is combined with the visualisation system. Furthermore, the personnel should be ensured to enter correct data.
5.3.10 Continuous Meetings

Currently it can be noticed that the departmental communication is not frequent as noticed from the meetings and interviews.

One of the internal objectives of SSAB is to have high performance culture and motivated employees. The best thing to do for this purpose might be to develop leadership and integrity within the company, so that by taking an active role, employees will enjoy the participation and strive for excellence. A lot of problems, which stem from the lack of communication, will naturally decrease or end; also the hidden problems will find answers.

In the beginning, there might be meetings every other week to discuss the current situation and the problems, also with the help of brainstorming, possible solutions can be created which will probably make the daily work easier and more economical. With regards to the 13th and the 14th principles of Toyota Production System (making decisions slowly by consensus, thoroughly considering all options, and becoming a learning organization through relentless reflection and continuous improvement), very solid decisions can be made and the time for implementing processes decrease significantly. The meetings of the scope might be widened for better linking among the related departments. This fact will noticeably have a gradual increase on the overall quality of the company.

Also by the development of leadership, successful teams might arise which can achieve great results and also create more leaders from within for the future.

Considering the Company’s strategy and the principles of Toyota (esp. Principles 9, 10, 13, 14), it could be suggested that this strategy be implemented.

5.3.11 Personnel

Today there are three operational personnel working within the Central Stock. They are responsible for organising the stock of standardised articles and connecting pallets to customer orders.

Temporary personnel are hired during summer time due to yearly holidays. These staff are required to be trained in order to adapt to the current situation and to avoid potential mistakes. For this purpose an easy-to-use system might be very useful. Also during the night shifts, extra staff can be hired for optimising the organisation of the stock.
5.3.12 Trucks

At present the capacity of one forklift is not enough for peak times and if this forklift breaks down, a 4-ton forklift is the only alternative, which doesn’t satisfy the requirements. Operation is slowed during winter time due to snow and ice, such as having time consuming problems with painting the templates. Furthermore thin plates (3mm) are pretty tough to handle; these cannot be loaded into the shelf system and they bend too much.

According to the Toyota Production System, the flow (material and information) plays an important role for the whole system as they link processes and people: The faster and the more continuous the flow the easier to surface the problems.

Moreover having the truck costs money every second, therefore it should be used in an effective way by which the idle time is diminished as much as possible. Levelling out the workload (less peaks) might help to be lean in the process. (Plan and Work wisely) It was mentioned that the forklift is used by other departments during the off time; if it is used by the Central Stock, it may reduce the work at peak times.

When the production increases extra resources will most probably be needed to keep the Central Stock in order and to make the flow more rapid. The precise problems of the trucks should be pinpointed and a solution should be resolved immediately to avoid possible future problems.

5.3.13 Reducing the number of ‘Bruten’ lagerplats

At present, much of the storage space is limited due to having too few empty lagerplatser. One of the reasons of this is that the new pallets delivered from the mill cannot be delivered to the lagerplats as suggested by Ellen, as described in the previous chapter. One of the main reasons this not being possible is because the lagerplatser are deemed ‘bruten’.

In order to a lagerplats to be considered ‘bruten’, it should either contain koppelad (connected) pallets and/or unclassified plates, and of course if the lagerplats is judged unsafe.

If it were possible to reduce the number of bruten lagerplatser, the number of lagerplatser occupied by one article would also be reduced. A possible suggestion for this would be to deliver all connected pallets to the final transport loading areas, as well as combining the remaining bruten pallets into the same lagerplats, especially those for the same customer order. Thus resulting in more ‘available’ lagerplatser to receive new pallets.
From the safety perspective, if the system could warn the personnel that the lagerplats has reached a too high level, a warning signal or if exceeding a restricted height, danger signal could be displayed. This is another suggestion that could be implemented within the visualisation system described below.

5.3.14 Identify Articles

The need to identify articles has been touched upon in the section discussing pallet splitting; though its importance is too greatly diminish the working time when handling the material. If a system, as the likes of the visual system, could display to the user exactly where each plate could be found in the storage area; i.e. what storage area, lagerplats, pallet and läge, it would make operations considerably easier.

5.3.15 Renaming LP

Today some of the lagerplats do not follow an order; some of the lagerplats are missing due to the changes in the physical layout of the storage area (buildings etc.) At times there is confusion where a specific lagerplats is located. A basic and logical numbering system, as demonstrated below, might make it easier for everybody to handle, especially for new and seasonal workers.

![Diagram](image)

This solution however has its limitations and might not be feasible, but it is an idea for making the central stock more efficient. Limitations to the solution include that if the desire to extend a storage row by including an extra set of lagerplats at the end of the row, then the whole storage area would have to be renumbered to maintain the numbering system.
CHAPTER 6

6 VISUALIZATION SYSTEM

Through the aid of a visual display the numerical data presented in Ellen, it would be possible to obtain the big picture of what is happening in the central stock.

6.1 Background of a Visual System

The idea of trying to present the data from Ellen graphically came about due to the complexity of trying to visualise what was happening in Ellen when trying to use the many screens of numerical data. For the purpose of the study, it was very much needed to be able to easily gain an overall grasp of what was happening in the central stock, especially for new personnel.

As the idea propagated, it became more transparent how such a solution could solve many of the current problems of the central stock. One of the first hurdles to overcome would be to ascertain whether it would be possible to display the data graphically in Ellen or not? This was an important step, as the graphical representations would be the backbone of the proposed solution.

6.2 Initial Solution

With the aid of a visualization system, the user (normally forklift driver or operating personnel) is easily able to see where the specific articles are located in the central lager. When needing to work with an article (i.e. article # 4310), the system will first provide an overall picture of where the articles are positioned in the whole storage facility, with the option to zoom on a specific transport område (storage area), for example område 31 in the below example.

The map below shows that there are 5 lagerplatser (LP) occupied by article 4310. Three of the LP are marked in red, noting that they are bruten (blocked from loading more pallets.) A LP can be either bruten because it either contains a kopplad (connected to customer) pallet or is deemed unsafe. The remaining two cells are marked in blue and green, to identify that they are pågående (currently in use) and tom (empty) LP respectively. This will give the user the idea of which LP he will work with. If he has new pallets to deliver, he will use either the pågående or tom LP. If the user needs to collect a kopplad pallet, he will know in which LP the pallets could be.
If the user positions the marker over a LP, a pop-up window will display the layered view of the LP detailing the pallets in the LP. In the above example it can be seen that for LP 3738 there are 5 pallets, of which 1 is kopplad to a customer. This is further discussed below.

The user also has the possibility to have an overview of all the lagerplatser (LP) that contain, or have contained, the specified article number. In the figure below, the system shows the user the same five LP as mentioned above for article # 4310.

In this view, the system provides details of each LP, showing how many pallets are in the LP and which are kopplad or okopplad. A colour coding method indicates which are kopplad. If the pallet is red, then the pallet is kopplad and the same for okopplad pallets which are marked black. If the user positions the marker over a pallet, a pop-up note will display the pallet number as well as how many plates are contained in the pallet. This can be seen for pallet # 576423 in the pågående LP # 5027. The same method is used for pointing at a kopplad pallet; the pop-up will also display the customer (VM) that the pallet is connected to.
The user could additionally click on the pallet to view the contents of the pallet. This view will provide the user with all plates stacked in the pallet. In the same manner as above, if the user highlights a specific plate, the system will show details of the plate (i.e. löpnummer & date created.) In the example below, the plate with löpnummer 194 144 3, is shown as orange.

If the plate is older than 6 months, the system will highlight that the plate is a slowmover. This predefined function is imposed as the painting of the plates is not guaranteed after 6 months. This function can be used to show the user which plates should be used to connect the future customers, such that they do not ‘get stuck’ in the stock. The time for which the system will display plates as ‘old stock’ must be defined by the system. For the purposes of this study slowmovers are defined as stock older than 6 month, because once they are older than this they may need to be repainted, as was described above in section 5.3.1.
6.2.1 Advantages of System

There are a number of advantages of using the visualization system.

- To have a better overview for the storage.
- Will help to see instant situation in the stocks easily.
- Easy to understand and to adapt (for seasonal workers, etc.)
- Helps personnel to be more efficient during work hours (fewer things on their minds).
- Easy to rearrange, or improve, the layout of stocks, creating more available space.
- Helps the central lager to be more flexible
- Helps the user to be more efficient when working with pallets, reducing working time.
- More fun.

The various functions of the system can be further defined or created depending on the system capability. These are ideas of what was initially envisaged of what the system should be able to do. There are more than likely other functions that current users would like to use, which could also be implemented, as further discussed below.

6.3 Incorporation of Key Parameters

Based on the initial solution proposed for the visualisation system, it was identified that there was a keen interest shown for the idea by the central lager management. Many of the parameters present above in chapter 5 were decided to be included in the visualisation system for optimal usage.

It is again noted that the visualisation system presented is a foundation of the ideas given, as opposed to a complete system to be implemented. Further investigation would be required as to what and how exactly the system could be implemented. This is due to the technical restrictions of the authors to develop such a system.
6.3.1 Main Menu

As there will be multiple users for the visualisation system, the user needs to be able to choose the perspective from which he or she is working with.

![Visualisation System Menu](image)

*Figure 37: Main menu for visualisation system*

With the help of the ‘Visualisation System Menu’, as depicted above, the user can choose the main areas, which have been distinguished as the most important and more used ones.

The user can either enter the visualisation system, and select the chosen filed to work within from the main menu. Another alternative is to have a direct link with Ellen, that takes the user to the related data within the visualisation system. This option is enabled by clicking on the visualisation system symbol as demonstrated below. An example of this is shown in section.

![Symbol of Visualisation System](image)

*Figure 38: Symbol of Visualisation System*
6.3.2 Slowmovers

In order to distinguish the ‘Slow selling stock’ from the ‘Old Stock’, as described in the previous chapter, the system is required to analyse the stock data in store as shown below in Figure 40. This function will help the user to categorise the slow moving items.
In the figure above, both ‘Slow selling stock’ and ‘old stock’ are highlighted orange and red respectively, from the bird’s eye view.

The user can also choose to view each of the described stocks. Firstly, it is assumed that the ‘slow selling stock’ is wanted to be seen with the ‘Side View’ function.

**Side View**

Article # 1, 2, 3, 4

![Diagram showing pallets representing slow selling stock](image1)

*Figure 41: Side view of selected pallets representing slow selling stock*

The location for these ‘grouped’ lagerplats can be chosen such that they are in the least prominent areas of the storage area, thus freeing up the prime storage area.

**Side View**

Article # 1, 2, 3, 4

![Diagram showing the combining of slowmovers](image2)

*Figure 42: Side view showing the combining of slowmovers*
In the pictures above, four different articles are shown that are marked as slowmovers. They are arranged by their dimensions, thus enabling the user to easier decide which slowmovers could be grouped together into which lagerplatser. In the second figure, it is shown how the selected articles are grouped. In this circumstance, it is possible to free three extra lagerplatser.

Another alternative is that these items can be grouped onto a shelving system, instead of onto the same lagerplats (can be seen in the following sections describing shelves.) There is however the weight factor to consider for which articles could be loaded onto the shelves, as each arm can only carry two tons. The advantage of using the shelves is that the articles can still be kept in unique lagerplatser, however still saving the same space when grouped together.

If the ‘old stock’ is wished to be seen, the appropriate LPs will be highlighted in Red, as explained above in Figure 40. There might be a search engine as well, which will help the user to define how old the stock be and in which area it is located. For instance, the user wants to see the articles which are more than 6 months old in the area 31.

**Old Stock**

![Figure 43: Top view displaying the all the LP containing old stock in area 31](image)

As shown above, it is very easy to see all the chosen articles according to our example. If we click on the *LP 3738*, the side view of the lagerplats pops up on the screen, in which the pallets are shown, viewed in the figure below.
Side View for Old Stock

Article # 4310

We can see the LPs which contain the same article

Last Plate: 3738 3740 3794 5027 3760

Old Stock

8 months old
Pallet No.: 408393
created: 2007/08/20
Weight: 3545 kg
Date: 3000x1500x4.5
Contains 5 plates

So that can be sold first

Figure 44: Side view of pallets showing old stock

It is also easy to swap from the top view to the side view, by which the user can get detailed information about the pallets and the plates, if needed. This function enables the user to see the lagerplatser that contain the same article in the same stock area. It will make it easier to decide rapidly in comparison with the current system.
6.3.3 Grouping Articles for same Customer (G.A.S.C.)

With the help of the search engine, specific articles for the specific customers might be seen, which makes it easier to group these articles near each other in order to save time and space.

As seen in the picture below, when searched for Crane Company and empty lastplatser. This allows the user to be able to gather the pallets for the particular customer into a close area.

We can see Liebherr articles and empty LPs so that we can gather them close to each other for better handling. This will give better results as gradually these articles are gathered in one particular area.

*Figure 45: Top view of area 31 displaying articles of a particular customer*
### 6.3.4 Pallet Splitting

The pallet splitting function will make it simpler to plan when pallets are going to be split. In the figure below a screen shot from Ellen shows that a customer has order 4 plates of article 4778. Ellen has provided the user with the choice of the selected articles, naming the oldest pallet first. Noticeably, the shown available pallets have 6 plates in each pallet, thus it can be concluded that the user is required to split a pallet to make a new pallet for the customer.

In order to make pallet splitting easier for the user, one can click on the visualisation symbol in the top right hand corner (the eye) and the user will then be shown a top view of the selected storage area, as shown in the figure below.

---

#### Figure 46: Screen shot of Ellen when connecting an order, with visualisation symbol

In the top view, as in the figure below, the user can see all the lagerplatser that containe the selected article. The highlighted lagerplasts and pallet from the Ellen view above, is shown as a small pop-up window, clearly showing where the specified pallet lies within the lagerplats. From this the user is able to select the chosen lagerplats / pallet, or could view the pallets within other lagerplatser.
Once the user selects the chosen lagerplats, a new view pops up that displays the a side view of the lagerplats, with its pallets. Here the user can see clearly which pallets he is required. When clicks on that pallet, a pop-up of the selected pallet will be displayed, detailing all the plates within the pallet. As can be seen in the below figure, there are six plates in the chosen pallet, though only four are required for the customer. Through the improved *article identification*, the user is provided with the information on each plate and where it is place in the pallet (läge). Through this system improvement, the user does not need to physically check the löpnummer of each plate, but instead make an easy split, by selecting just the plates that are needed.

After the pallet has been split, the user can do an easy manual check of the plates that have been selected, by using a barcode scanner to reading the löpnummer of each of the plates, located on a small tag on the side of each plate. This will then do a cross check with the system to ensure that the correct plates have been taken and that the system has the correct information stored. This cross check is shown in the figure on the following page.

With these improvements to the system, time required to split pallets will be radically reduced and not placing such a large emphasis on it.
3 months old
Pal nr.: 774431
created: 2008/01/20
Weight: 4242kg
Dms: 6000*2500*6
Contains 6 plates

Figure 48: Side view of splitting a pallet

These the plates we

Only need 4 plates – need to split pallet, but want löpnummer for top four

New created pallet

Figure 49: Cross checking of split pallet

Barcode and System Double Checks

Article # 4788

Pal: 774431

3 months old
Pal nr.: 4867518
created: 2008/01/20
Weight: 707 kg
Dms: 6000*2500*6
Contains 4 plates

Barcode checked
# plates: 4
--------------------------
Löp #1: 111111
Löp #2: 222222
Löp #3: 333333
Löp #4: 444444

System checked
# plates: 4
--------------------------
Löp #1: 111111
Löp #2: 222222
Löp #3: 333333
Löp #4: 444444
6.3.5 Shelves:

Shelves system can be used to have different LPs at each arm for 'slow selling stock' or any other particular reason, and these LPs can easily be controlled through the Visualisation system as shown below.

![Figure 50: Representation of how the shelves could be used for slow selling articles](image)

6.3.6 Bruten Lagerplatser:

As explained in 5.3.13, in order to a lagerplatz to be considered 'bruten', it should either contain *kopplad* (connected) pallets and/or unclassified plates, and of course if the lagerplatz is judged unsafe.

Unclassified plates are mentioned under Klassad/Oklassad (chapter 6.3.7).

Overloading the LPs is not wanted as it is very risky. So the Visualisation system might warn the user if the height of the LP exceeds a certain limit such as maximum height is 2 meters but the system notifies the user when the height reaches 1.5 meters.
Warning signal for the Truck drivers. It is possible to pile up until 2 m but with the help of this function they will be able to decide better.

Figure 51: Warning signal for lagerplats being stacked over 1.5m

When the plates are moved, this signal should automatically pop up if the all pallet is higher than 2 m

Figure 52: Danger signal for lagerplats being stacked over 2m
Connected items should also be identified for moving to delivery areas or they should be grouped together to make more LP available for deliveries from the mill.

**Article in different Lagerplats**

![Figure 53: Top view showing the lagerplats occupied by a certain article](image)

### 6.3.7 Kopplad & Okopplad pallets

This menu will help the user see quickly not only where the 'unclassified' articles are located, but also enable them to see the detailed information both for the pallets and the plates. Furthermore, the age is available on the menu, which is basically a signal in order to prevent the central stock from having articles older than 6 months old.
Side View Oklassad

Article # 4310

Figure 54: Side view of lagerplatser with Klassad pallets

In this example, Article 4310 is checked by user and it is noticed that in the LP 3780, there is/are unclassified items. If the pointer is dragged on the blue pallet (The unclassified pallet is illustrated with blue colour), the detailed information is shown, as above.

Figure 55: Side view of Oklassad pallet
This view can also be chosen in order to create a clear working area.

![Figure 56: Details of the plates within a Oklassad pallet](image)

The blue pallet has unclassified plate(s), when clicked on it, the content pops up on the right side of the screen, on which the information for each pallet is seen.

In this example, ‘löpnummer’, date of creation, weight and dimensions are preferred, but as these menus are customisable, different criteria can be chosen.

### 6.3.8 Advanced Search:

Advanced search allows users to be able to look for any item or LP in the system to be shown in a top or side view. The specifications above are very helpful, yet can be improved.

![Advanced Search](image)
CHAPTER 7

7 CONCLUSIONS

This chapter covers the thoughts, reflections of the authors as well as the experience gained whilst carrying out this study. The difficulties handled and achievement of goals discussed. The proposed solution and concerns of the project are addressed.

7.1 Project

From the data collected throughout the research study, it was possible to make various analyses of the results. Through this investigation, a number of suggesting parameters could be drawn from which a proposed solution could be presented.

By using the proposed visualisation system, SSAB Oxelösund are able to easily correctly manage the central lager in such way that they are able to greatly increase the number of available empty lagerplatser and at the same time increase the efficiency with which they work. The benefit of this system is that it is easy to use, and is plugged in directly to the current stock management system; Ellen.

Throughout the period of the study, many changes occurred, mainly due to the understanding of a key areas changing. This was put down to communication barriers due to the multiple languages used. Misinterpretation of both spoken and written sources is always a risk, as are unreliable sources. It was usually attempted to clarify information gathered from interviews or observations.

Since a vast amount of the results are based from opinions within the company, a generalisation of the result is complicated, but the ideas proposed should be useful to spark further ideas for optimisation. However more data could have been collected to motivate parameters or ideas proposed. Due to lack of specified theory on the topic, and tools to measure performance, it was found difficult to support suggestions proposed, which were predominately based on personal ideas and experience of the authors.

At times it was felt that the scope of the project became too extensive, by covering a too large range of issues. This created unfocussed areas that without the correct supervision was misleading and created unnecessary analysis. The result of this many of the parameters detailed have only been flagged upon to be investigated further by the company, than giving specific suggestions for improvement.
7.2 Comments from the Authors

It has been a most valuable experience performing the research study at SSAB Oxelösund, which is an international company of high standard and of the world’s largest supplier of quality steel plate. It was an opportunity to gather real life experience of the processes involved during the supply chain.

7.3 Future Work

The authors believe that the results achieved are most useful for the central stock at SSAB Oxelösund, and other departments. The results could be used not only for the visualisation system proposed, but also to trigger questions and ideas for other issues of concern within the company.
CHAPTER 8

8 RECOMMENDATIONS

As pointed out many times throughout this project, the Visualisation System, according to the authors, might play an important role for the efficiency of the Central Stock. With the help of different menus and of different views, the system is thought to have full control over the stocks. Furthermore, it will not take a long time to see what is not in place and potential mistakes, therefore the number of ‘Slowmovers’ will decrease and the number of empty lagerplatser will increase.

The further ideas, mentioned at chapter 5, should also be considered and if possible be implemented as articulation to the visualisation system. Especially, forecasting flow and continuous meeting might have a great impact for the future. To be able to know the forecast by the Central Stock, will make the arrangements easier and the process will be under control, which will create a stage for a better decision making. Furthermore, the continuous meetings will help the company to have high performance culture; by creating leadership, increasing communication and brainstorming.

Since the capacity of the production is planning to be increased, the company, with all its departments included, should work efficiently. The recommendations made by the authors may be seen difficult to implement, but if started, the company will harvest its benefits in the near future.
CHAPTER 9

9 BIBLIOGRAPHY


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