

Improvement of warehousing operations

Case: “CKBM” Ltd, Russia

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Abstract <p>The subject of the thesis was improvement of the current warehousing situation in the storage facility of "CKBM" Ltd, Russia. Warehousing is(was) a weakest link of the company's supply chain. The purpose of desired changes was to increase the overall performance of the company by optimization of warehousing activities.</p> <p>The aim was to analyze the current state in a way, that after the analysis I am able to come up with a better layout supported by machinery and equipment, understanding of raw metal storage features, tags for the inventory control and developments concerning workforce of the facility.</p> <p>Main part of the thesis concentrates on the case company and problems of the warehousing caused by layout, labeling system and absence of KPIs to evaluate the workforce.</p> <p>The thesis provides information about current situation in several areas: layout, machinery and equipment, labeling, KPIs. There are also problems listed in these areas and proposal for improving the situation.</p>		
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1 Introduction

The Theme of the thesis is the investigation of possibility for optimizing warehousing operations through the change of material flow and space utilization. Influence on the change on financial results of the Company is also considered.

The Company providing all the data for the research is “CKBM” Ltd, located in St. Petersburg, Russia. I have been working for the Company during the time of writing. I have started as a trainee in purchasing department getting familiar with main operations and doing various tasks concerning warehousing operations, material flow and internal communication between departments of the Company. My supervisor was the purchasing manager with a background of a warehouse worker and I have learned a lot from his experience.

At the moment, “CKBM” Ltd is at the process of self-development. Two years ago management has decided to implement new strategy while producing pump equipment. Now key concepts of the Company are Lean manufacturing and MUDA allocation of recourses. So far these principles are applied to the manufacturing process only. I believe those same principles are to be applied in administration including software and warehousing.

The idea behind the thesis was to find weaknesses in current warehousing process in order to eliminate faults and decide of changes lead to the improvements in overall performance.

The aim of the thesis was to analyze the current warehousing situation. In a way, that after the analysis I am able to come up with a better layout, understanding of raw metal storage features and developments concerning workforce of the facility.

Among the implemented improvements are:

- New space planning
- Equipment rearrangement
- Development of Key Performance Indicators (KPIs) for human resource
- New product-shelf labeling system

It was known in advance, that warehousing is troublesome and changes are desirable. My task was to find what operations are all right and what are the obstacles preventing good performance. Coming up with ideas for the improvement of the situation was part of my work as well.

The company tends to make constant improvement and get customer satisfaction. My aim was to contribute to optimization of warehousing processes and smoothening of material flow to make it more Lean type for the best performance.

1.1 “CKBM” Ltd as a Company

My thesis topic is provided by “CKBM” Ltd. This is a Russian company part of Corporation, which produces electric pumps and pump equipment for nuclear plants. They do not only have the production facility for pumps, they also do a lot of research and design every their product. Aside from pumps there are leakage finders and reloading equipment for fuel designed and produced.

Work of the Company is really knowledge intense, this is the reason why most of the employees are coming from the scientific field. Products of "CKBM" Ltd are unique and there is no market competition for the company, anyway, they seek for customer satisfaction, new orders and more profit.

The Company is focused on producing pumps for power plants; this is rather material and work consuming process. In terms of logistics, main troubles are coming from raw material supply and scrap-metal utilization (in and out flows). From my side, I will be working on a process of optimizing material flow from the point of warehousing.

Since the last few years company is trying to apply Lean production and administration philosophy, MUDA and 5S theory in their production, but there is still a lot to be improved aside. There is a possibility to implement the theory of Lean production to the warehousing, so main benefits of the strategy will be kept.

1.2 Research methods

I have spent four months working for the Company while writing this thesis work. Case company has provided me with some basic data, financial accounting tables, and some reports. I took part in everyday work of the organization and it caused my observations, which are included in the thesis. This work also contains information taken from the knowledge and working experience of company employees taken as a questioner for Balanced Score Card.

The theory is taken from books, articles, and Internet publications. The thesis also includes my own knowledge, experience, and ideas. The work is based on available information, which I have worked on and got assumptions, tables, and analyses as a result. Research methods in this thesis work are qualitative; data was collected, analyzed and preceded with new ideas as a result.

2 Logistics

Logistics is the strategic management of movement, storage, and information relating to material, parts and finished goods in supply chains, through the stages of procurement, work-in-process, and final distribution. Its overall goal is to contribute to maximum current and future profitability through the cost-effective fulfillment of customer orders. (Cooper, ed, 1994)

Logistics is the positioning of resources at the right time, in the right place, at the right cost, at the right quality. (UK Institute of Logistics and Transport, 1998)

As I have learned, there are many tasks of logistics that vary depending on needs, systems, markets, companies etc. Logistics is really flexible and dynamic thing that in any case has a close relation to supply chain, material management, and distribution.

Key components of logistics can be seen in the figure.

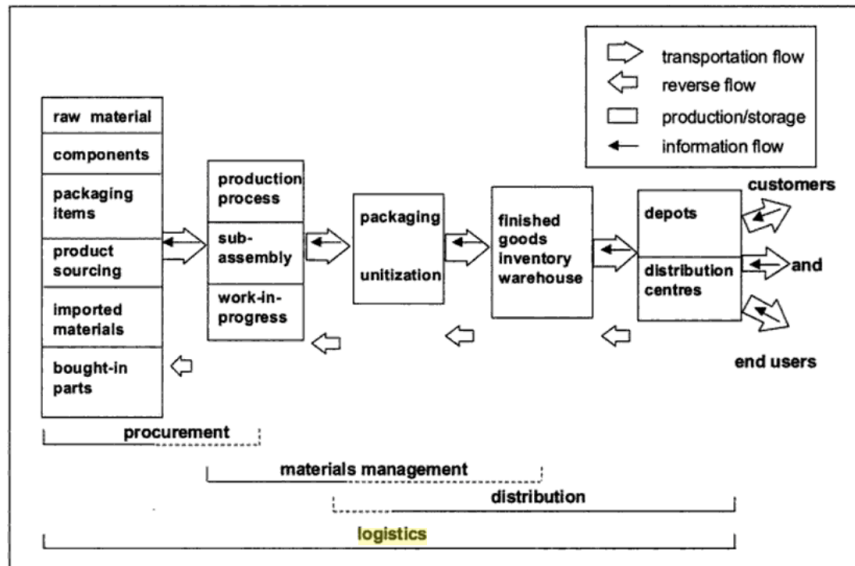


Figure 1. Key components of logistics

2.1 Supply chain

Supply chain is a number of independent companies that are involved in the process starting with a search for materials, followed by manufacturing and physical distribution to end customers. The term "supply chain" originated in parallel with the term "supply chain management", but it should be noted that the supply chain exists independently, regardless of whether or not pieces of the chain are controlled.

Hugos (2003) describes in his book that the supply chain is made up of three or more parties involved in the upstream and downstream movements of products, materials, or information from the sources of raw materials to the final customer.

Logistic chain stretch between logistics units to show the organizational structure of logistics systems. In the simplest case, when the logistics system is characterized as a system with direct links, logistic chain consists of the supplier and the consumer. In more complex cases, a train system operating conditions the circuit can have a tree-like structure, which is also known as flexible logistics system.

In general, the supply chain is the chain, which forms the material and information flow from the supplier to the consumer, with the following main units:

- Supply of materials, raw materials, and semi-finished products;

- Storage of products and raw materials;
- Production of goods;
- Distribution, including the shipment of goods from the warehouse;
- Consumption of the finished product.

A supply chain is only as strong as its weakest link. And by knowing how to be a part of a strong supply chain being strong itself, a company can increase its competitive advantage and develop itself as a market leader. (Wailgum, 2007)

In my work, I am focusing on warehousing as a part of the supply chain in the company. These piece of the chain must be reinforced by optimization of its' processes. To start improvements Lean principles were chosen to be a role model for optimal storage solutions.

2.2 Lean

Defining of Lean philosophy can be done in a popular way, so "Lean is the set of "tools" that assist in the identification and steady elimination of waste (Muda), the improvements of quality, and production time and cost reduction."

By Lean the process can run:

- Using less material
- Requiring less investment
- Using less inventory
- Consuming less space
- Using fewer people

The processes are usually characterized by a flow and predictability that severely reduce the uncertainties and chaos of typical manufacturing plants. People work with a greater confidence, with greater ease, and with greater peace than a typical chaotic manufacturing facility. (Lonnie Wilson 2011, 10)

2.2.1 Lean warehousing

Warehouse as part of the supply chain can generate both good and waste for the company. Waste generated affects operations and results in cost increase. To prevent having waste in time, money, staff or area utilization it is wise to use Lean principle for the warehousing.

“In the manufacturing process, if a defective item is produced, it merely ends up as a waste and thrown into the scrap which is disposed of afterward. To generate scrap as good as ordering things which will remain in the warehouse until they are disposed of. These also occupy a lot of space in the warehouse which cannot be utilized for some other operations.” (Emmett, S. (2005))

Total Quality Management (TQM) is the approach in the management of an organization, aimed at quality, which is based on the participation of all its members (staff in all departments and at all levels of the organization) and aims to achieve a long-term success through customer satisfaction requirements.

The goal of TQM: achieving long-term success by maximizing customer, employee and society satisfaction.

TQM objectives: constant quality improvement through regular analysis of the results and adjusting operations, the complete absence of defects and non-production costs, the implementation of planned just in time.

The tactics of TQM: preventing the causes of defects; the involvement of all employees in the efforts to improve quality; active strategic management; continuous improvement of the quality of products and processes; the use of scientific approaches to solving problems; regular self-esteem.

Methodical tools of TQM: tools for data collection; data presentation tools; statistical treatment; theory of general management; motivation theory and the psychology of interpersonal relations; KPIs; economic calculations.

Formulated TQM goals are areas of development, not the end result. This is due to the fact that the needs of consumers, and society are constantly changing; the company must constantly monitor, predict and respond to the changes with a certain

advance in time. The approach is designated by a special term "quality improvement" ("continuous improvement").

To be able to follow general rules and regulations standards for documents and activities are developed. ISO is the International Standards Organisation, which publishes standards to be followed worldwide. (Lysons and Farrington, 2006)

“Many of ISO standards are made for a particular process, product and material. But ISO 9001 and ISO 14001 are generic and can be applied to any organization regarding any activity. ISO 9001 is a set of requirements for a quality management system and ISO 14001 lists requirements for an environmental management system.” (Discover ISO ,2010.)

2.2.2 Approach in terms of Lean strategy

This time, I have seen on a life example that flow must be balanced, so planning and control must be of a high quality. All the main principles of Lean include reduction of waste and it is an obvious tool for the improvement. Waste can be found in various aspects including excessive stock, unnecessary processes, overproduction, stuff wastage, which are stress and low motivation.

The task of management is to find areas of improvement and take actions. The worst waste point is usually overproduction, which is excessive movements in this particular case since it leads to high storage costs, too much work in process and not enough cash. Overall it is quite obvious that any waste should be reduced or even eliminated if possible, so company works for value creation of a particular customer order, without exceeding expectations and amount.

Main questions to be answered before changes are made:

Is material flow smooth?

Is area enough for all the needs?

Is equipment enough?

Are there enough employees involved?

Do employees know their tasks and how they perform them?

2.3 Impact of the warehousing to the financial state of the company

To identify possible ways of logistics costs reduction, efficiency of logistics services should be evaluated and analyzed. Logistics costs can have a large share of the price decision of the goods sold. However, it should be understood that a high level of logistics strengthens the relationship between the enterprise and its customers. It may be a reason of attraction for new customers and, as a consequence leads to an increase in sales and earnings. Therefore, during the analysis of the overall performance of the logistics system, it is found that not only cost of processes is driving factor. There is a whole range of indicators to be precisely studied while assessing the state of logistics department and its activities in the company.

In my case, transportation services were nearly neglected and the main focus was on warehousing, since this service is fully owned by the company and transportation is partly outsourced.

If the company decides to change the structure of the accounts receivable and inventory, it is reasonable to consider a model of strategic profit. This method allows determining the impact of ongoing systemic changes on earnings and returns on assets. In general, this model shows that the profitability is controlled by three factors: net profit, asset turnover and financial leverage (earnings and losses) (see Figure 2). Consequently, strategic profit model shows how a change in one of the indicators affects the financial results overall inside the company. This model is also applicable to the assessment of the impact of changes in logistics costs on the financial performance of the enterprise, returns, and equity capital.

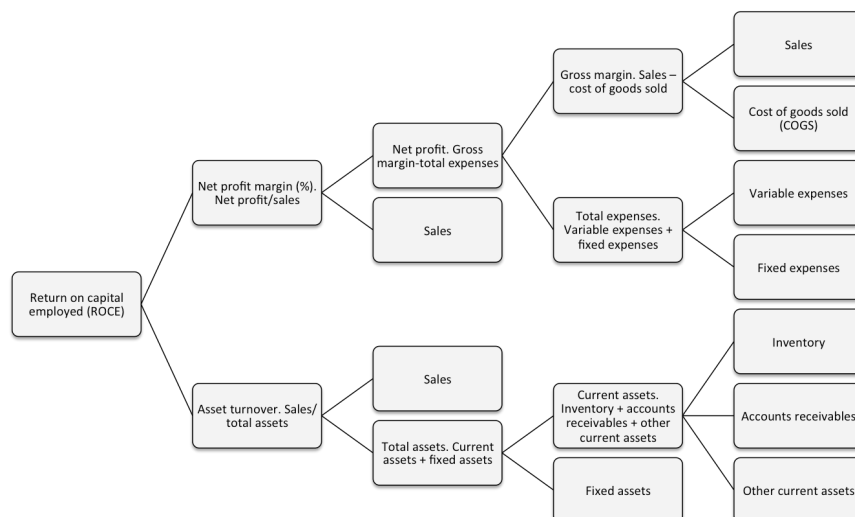


Figure 2. Strategic profit model (DuPont Model)

3 Warehouse

The main focus of my thesis is warehousing operations and processes around storage activity. Warehouse is a central element of the logistics system. The way it is organized has an influence on all other processes in the company.

There are several basic principles of warehousing:

- Maximum possible mechanization and automation of operations;
- Optimal use of space and capacity of storage facilities;
- Organization through "continuous-flow" of goods;
- Planned system of storage operations;
- Safety of goods.

It is obvious that warehouses are not just rooms for the storage of goods, they are transport and storage facilities, they process three types of flows - input, output and internal. Warehouses contribute to the transformation of cargo flows by changing the parameters of accepted and issued consignments in size, composition, physical characteristics of the incoming goods, and time spent.

The specifics of the warehouse system provides the presence of reserves considered as an essential factor in ensuring a certain level of customer service. In turn, consumers believe causes the formation of reserves to ensure the continuity of the production process, the pursuit of smooth flow and provide fast shipment at the unexpected demand of various products. Logistics tends to minimization of inventory, so warehouses provide lifting mechanisms and special devices for the storage of materials, in order to fulfill desires of logistics network. (Langevin & Riopel, 2005).

3.1 Warehouses as part of the logistics system in the supply chain

Warehouse as part of the logistics system operates on the same principles as the system overall. Goals and objectives of the logistics system determine goals and ob-

jectives of the warehouse. The main conditions for the effective functioning of a warehouse as part of the bigger system, coming from the general principles of its design, can be considered as following:

- Storage should not be considered separately, but only as part of the logistics system. The effectiveness of the warehouse must serve the interests of the efficient functioning of the system.
- It is necessary to take into account the interaction and relationships of the warehouse at the level of the entire external environment.
- It is necessary to link technical and technological possibilities of the material flow passing through the warehouse, with the external transport, as well as with direct suppliers and buyers.
- Reduction of warehouse handling of goods costs should not lead to a lowering of the level of customer service.
- Technical and technological solutions in the warehouse should not come from trends but should be efficient and cost-effective.
- To reduce labor costs associated with the document, it is advisable to provide a unified approach to documentation between all participants of the system.
- To automate the flow of information in the system and in a warehouse in particular, it is crucial to implement bar coding of goods in manufacturing plants.

In recent years, the main focus of the development of warehousing has been the increased flexibility and efficiency of the use of information technology is necessary to meet the growing demands of consumers to the range and conditions of supply. Improving the information technology, automation of storage processes to increase flexibility, enabling warehouse operators to respond quickly to changes and to assess the results of activities in a variety of settings. (Richards 2011)

3.2 Why to focus on warehousing

The basic principles used to build a distribution logistics system:

1. Planning and management of material flow in terms of independence and interdependence of all elements in the production process.

2. Control of product distribution processes, from the planning of production volumes to the delivery of products to final customers.
3. Inventory Management to satisfy consumer needs.
4. Description of logistics inventory management processes, distribution of products and their integration into the overall system of processes going on in the company.
5. Analysis of logistics costs throughout the supply chain.
6. Development of logistics services.

When developing a model of the distribution logistics enterprises use a systematic approach. It is done because the main objective of the logistics system is managing the material flow, starting with order and ending with the delivery to the customer.

The main functions of distribution logistics are:

- Planning, organizing, and management of freight moves during the production process and after the product is ready for the customer;
- Inventory management;
- On time processing of customer orders;
- Assembly, packaging, and fulfillment of other logistics operations preparing the final products for distribution;
- Proper arrangement of shipment;
- Delivery management and control over the execution of transportation process.

Functions of planning and control of material flow in the company are executed by the logistics department. The main task is to serve as a bridge between the sales department and production units of the enterprise, to ensure timely and full implementation of customer applications.

Before making actual changes I have learned and highlighted the importance of several factors of logistics department and warehousing processes for the success of the organization itself. There is a close interaction between activities of the warehousing department and processes in the company overall. Since in broken piece of chain makes the whole chain broken.

To solve distribution network connected problems it is necessary to keep every step of the product moving process under precise control. While deciding optimal logistics processes from starting point to the end customer following factors should be considered: minimum delivery times, a level of logistics services, profit, minimum cost.

Objectives to be achieved by logistics department:

- Merge of production planning and distribution planning processes for effective inventory management;
- Creation of common order processing system that allows good order handling within the company;
- Development of a unified transport and warehouse system to ensure on-time delivery of products to the consumer;
- Optimization of product distribution schemes, to reduce time and costs of customer order implementation;
- Development of optimal warehousing system with suitable penetration points.

According to the stated objectives logistics department should focus on the following tasks:

- Specification of needs for transportation and warehousing;
- Optimization of inventory management system;
- Development of order receiving and order processing steps;
- Decisions on appropriate shipment for goods sold;
- Delivery optimization and transport control;
- Development of optimal warehousing management;
- Reduction of overall logistics costs;
- Improvement of logistics services quality.

Separation of structural business units is done due to differences in their functions performed. One of the main tasks of the logistics department is to create an integrated system of effective regulation and control of material and information flows, providing high-quality delivery of final products.

The result of successful work done by logistics department is to the reduction of total logistics costs for the company. Evaluation of the department working results is usu-

ally carried out by using key performance indicators (KPI) according to the BSC method. The list and the estimated value of key performance indicators are unique for every company and can be changed when necessary.

3.3 Types of warehouses

Warehouses form one of the major subsystems of the logistic system. Logistic system generates organizational, technical and economic requirements for warehouses, sets goals and criteria for the optimal functioning of the storage system, defines the terms of material handling.

In turn, the organization of the storage of materials (choice of warehouses location, method of storing) has a significant impact on the costs of circulation, the level and movement of stocks in different parts of the supply chain.

The objective necessity of the acquisition, maintenance reserves exist at all stages of the material flow, ranging from the primary source of raw materials to the end customer. This explains the presence of a large number of various types of warehouses.

With respect to the basic functional areas of logistics there are: supply logistics warehouses, production, and distribution logistics warehouses. By type of products are distinguished warehouses:

- The raw material, semi-finished products and components;
- Semi-finished production (stocks of work in progress);
- Finished products;
- Residues and waste;
- Equipment.

The shape of accessories distinguish warehouses for such purposes: individual use, one belonging to the enterprise; cooperative built several businesses that share its warehousing; leased warehouses, own company warehouses, state or municipal facilities. (Richards 2011)

3.4 Organization of storage

Most of the books state, that for the smooth production process good warehousing is essential. In most cases, the design of lean manufacturing processes gives the optimal solution with the accumulation of raw materials, semi-finished products in a particular part of the supply chain for a time period. Warehouses are organized in the logistics system. The manufacturer needs warehouses of raw materials and required starting materials which are provided for a non-stop production process. Storage with finished goods allows keeping the stock, ensuring the continuity of distribution. Good organized logistics system cannot exist without warehouses. Harmony in logistics is achieved by the right mix of storage and right methods of transportation of goods from the primary source of raw materials to the final consumer. (David E. Mulcahy 1993.)

The role of the warehouse is to create the conditions for optimization of material flow. Logistics poses the problem of well-organized processes inside of a warehouse, as well as the task of technical, technological and organizational planning of warehouse's processes with processes which have an effect on the economic environment. Warehouse logistics is considered as elements of a physical distribution system and as an independent system at the same time.

3.5 Operations of warehouse

Layout of the warehouse is planned according to the operations performed. Traditionally warehouses were regarded as places for long-term storage of goods, and their main function was considered as warehousing, consisting of the maintenance and preservation of stocks. Currently, the role of warehouses has changed, they are now considered more as an intermediary through which the material flow is converted and moved as quickly as possible, that justifies expansion of the operations in the warehouse activities.

Thus, the basic functions of the warehouses are:

- Storage of goods;
- Movement of goods;

- Information management;
- Protection of goods;
- Risk bearing;
- Financing;
- Processing;
- Grading and branding; (Neumann and Morgenstern (1944))

3.6 Warehousing costs

Being part of supply chain warehousing brings costs to the company's financial reports.

General overhead cost

This cost involves the cost of used space per cubic meter and supporting infrastructure. Security devices and safety equipment also belong here.

Delivery cost

This cost includes the cost of transportation of the product by some outside company. It includes cost of fuel, delivery truck and insurance.

Labour cost

This is the cost, which involves the cost of the labor operating in the facility on a daily basis performing both physical and administrative activities.

Processing costs

These are the costs of such activities as receiving, storing, picking, packaging and shipping. Some costs from the assembly activities could be involved here.

Storage costs

These are the costs needed to store and handle the products and they are also known as inventory handling costs. (Ezinearticles.com)

3.7 Warehouse management system

With the development of IT technologies, most of warehousing operations turn into being connected to some software. Utilization of computer systems is beneficial, since it makes tracking easier and mistakes are simply avoided. It was noticed, that warehouse management affects employee productivity, overall efficiency, and even storage capacity.

The development of automated systems is characterized by the expansion of the relationship of individual systems and subsystems that integrate process control, operational management, operational and current planning, administrative and economic activities, design and testing of products. It tends to their unification into a common multi-level system of integrated facility management in general. Such multi-level hierarchical automated system must ensure a consistent and coherent management of all types of activity, such as industrial plant, including management of the main industrial and technological processes, and supporting of non-industrial companies.

Warehouse management systems are aimed to control the process of storage and movement of materials within a warehouse. It makes detecting and control of stock possible, since employees always have real-time information after every performed activity like transportation, picking or putaway.

The system works with computer technology supported by barcode scanners and tags to control the flow of products. The database is collected to provide accurate information about product status. Usage of computer technologies helps to link logistics and warehousing management, brings more control over the facility and mistakes are avoided.

4 Layout

Warehousing layout should always support activities. Materials and products must be properly placed to be accessible, so staff can avoid mistakes and delays carrying their tasks. Proper utilization of space is another key component that effects efficiency and keeps costs closer to the desired minimum.

The goal of the warehouse layout is to optimize the warehousing functions and achieve maximum efficiency and space utilizations. (Richards 2011)

4.1 Inventory layout

Warehouse should be designed so that inventory does not need to be moved more than once. Extra movements do not make sense in most of the cases, there are exceptions due to particular needed, but the less is number of product movements, the better.

Organization within a warehouse facility is fundamental for smooth operation. The more time staff spends locating something, or finding a place to put something, the more it costs the company. In order to get everything done in the minimal amount of time, the organization must be a priority. (David E. Mulcahy 1993.)

In a well-organized warehouse material and products can be picked up and put away quickly and easily. A good floor plan of a facility should present an overview of a warehouse, indicating most important tasks to be performed. These tasks are then subdivided into sub-activities to be carried out. Commonly used and necessary resources are allocated to each activity in the most suitable place.

4.2 Warehouse space planning

Planning of a storage space is based on the type of storage facility, and the existing design: it can take the form of open areas, semi-closed, or be completely closed, like full size building. Closed storage facility is a standalone building with a warehouse inside; this type of storage facility is the most common.

Warehouse building may have one or more floors. Single floor, depending on the height can be: conventional, high-rise and mixed.

One of the main tasks when developing the system of storage is to maximize the use of the entire area of the warehouse and its total volume. During the construction of the building features of the warehouse are taken into account, which directly affect its capacity. In modern warehousing one-floor warehouses are preferred, and the increased cost of land is taken into account.

Total costs in the high-rise warehouse several times less than the cost of storage with the same volume, but less in height. If the height of the storage load is approaching the height of the warehouse, the entire volume of the room used most effectively.

A large area of the warehouse makes it easier and more rational to place storage equipment and technical means used. This means that there are opportunities to improve the level of mechanization.

To create optimal conditions for the work of the handling machines and mechanisms warehouse space without too much separated, closed areas, and with a minimum number of columns are desired. But during the planning of storage space it is required to allocate storage or separate areas intended for the implementation of the basic operations of the warehouse process.

4.2.1 Shelves

Warehouse is not just a big free area under the roof in most of the cases it is separated according to the tasks. For good storage conditions, accessibility and safety warehouses are commonly equipped with various shelves and aisles. As with most of the warehousing equipment decision of shelves to be used is based on needs.

To ensure quick product availability having a system of aisles and cross aisles that make it easier to move around the warehouse is important. Long and continuous aisles can make it difficult in getting from one part of the warehouse to another. However, cross aisles that allow access to the main aisles, help create a grid that is more efficient and easier to navigate. At this point, it is crucial to understand specific needs of a particular facility to choose a proper equipment for needed operations. (David E. Mulcahy 1993.)

Warehousing is intended to ensure the acceptance of materials with the definition of quality and quantity; positioning and rational distribution of materials considering their physicochemical properties; mechanization of loading and unloading; improvement of equipment storage materials, structures and products; minimizing material losses during the process of storage; organizing routes of material flow and recording materials.

The organization of storage facilities includes:

- Calculation of need for materials and structures and definition of an adequate supply of materials (for example there are 4 needed to assemble a pipe connector meaning necessity to store 92 cell round bars). Initially expected to place the rolling racks W-shaped, however, when this arrangement was assumed that one cell is located rolling with different diameters, which revealed disadvantages associated with constant cell sorting during the production work. On this basis, it was decided to place rental 8 racks such as "The street" and 3 shelves Type W to contain the rolled diameter over 190mm.
- In order to visualize the amount of material to be stored in the warehouse, it was decided to use easily adjustable shelves, as they allow tracking the movement and availability of the material, as well as equal flow or possible missing of the material.
- For general information on the availability of particular materials information from "actual balance" is used as it only includes tested materials.
- To accommodate forgings weighing less than 15 kg. There are 4 racks provided on which forgings are stacked. Customized shelves are currently underway and available ones are equipped with only 1 rack.
- Pieces weighing more than 15 kg are placed on the floor for mechanized loading. There are driveways and walkways provided. All forgings as custom placed, labeled on each forging order number seen from a label.

4.2.2 Machinery

For movements of low weight products in the warehouse pallet trucks are used. The most common type of warehouse equipment is forklifts and manual pallet trucks. They are mostly used for the transportation of goods on pallets. This truck can easily carry goods to 3 tons with the assistance of only one person.

In small stores electric pallet truck are often used. They may have a step for the driver or not. These trucks have a top speed of 15 km/h but usually operate at 5-7 km/hour. The truck can move loads of up to 2.5 tonnes and lift it to a height of 4.5 meters.

Another common warehouse machinery is loader, also known as stacker. Stacker has small wheels and, in contrast to the truck, it does not have a weighted rear. Due to

this, the size is significantly reduced, which allows the machine to operate in fairly narrow aisles. This type of technology is able to move loads of up to a height of 12 m. Often there are stackers with elevating cabin, where the operator is. They could also be equipped with camera and monitor, where driver can keep track of all the actions.

The pallet truck is more likely to be inside the storage equipment, and the forklift is more suitable for outdoor work. To counterbalance it is equipped with a weighted back, and has a lift mast with forks. The truck can also leave the warehouse, but their movements are limited by various kinds of bumps in the road. Machines running on the territory of open warehouses are equipped with winter version cab, heater and wipers. In the summer period the doors removed, enabling users to work in hot weather.

5 Bar codes

Going to the grocery store we always see barcode scanners while paying, but this application is widely used for the warehousing also, to keep track of the inventory. Using bar codes in warehousing operations makes it possible to reduce labor and improve efficiency in as many areas of the fulfillment process as possible.

Bar codes are used to ensure that products are put away in the right bin location and orders are filled properly. Bar coded tags can be used for both products and locations in the warehousing facility, while tags are attached to the both of them.

Bar code technology eliminates hard-to-account or “floating” material in a warehouse. Floating material occurs in facilities that only use paper-based documents. With bar coding, it is easy to pinpoint where any quantity of any item is located at any time. (Jon Schreibfeder, 2010)

5.1 Inventory Control

Because nearly every package features some sort of the barcode, company can use the technology to maintain tight and accurate control over inventory. Warehouse can scan barcodes on packages as they enter and exit the facility to maintain a record

of every package at the warehouse. Later when a particular piece of inventory is required staff can locate it for picking and packing with a computer program in a moment. (Cooper, ed, 1994)

Poor inventory control and neglecting of supporting technologies can be a reason of low productivity, creation of inventory control issues, mistakes in shipping and undesired safety risks.

5.2 Technology and equipment for barcoding

A bar code is a set of systems for automatic identification of goods, which also include digital media, magnetic, radio frequency, acoustic and visual identification (magnetic card, tag). Its main advantage over other means of automatic identification is the ability to quickly transmit information about the product to the electronic communication system. The bar code is an effective mean of telecommunication.

By bar coding technology meant a set of tools and automated methods for collecting, recording, storing, processing, transmission and use of the information encoded by a barcode.

Bar coding technology is a technology based on the use of the latest achievements of optoelectronic technology, a fundamentally new software and hardware, computer technology, automation, information systems and communication networks of all kinds.

Today bar coding technologies cover all spheres of human activity, they are a universal means of business cooperation with all participants in the global economic system.

The technology in general comprises the following steps:

- Object identification by giving it a digital, alphabetic or alphanumeric code;
- Representation of the code in the form of bars with a certain symbolism;
- Application of the bar code on physical media (product, packaging, labels, documents);
- Reading bar codes;

- Changing of bar codes into machine representation letters, numeric or alphanumeric data and transfer them to the computer.

Performing these operations may be carried out on the basis of standard rules, regulations and requirements to ensure their full compatibility. Usually, while company decides to implement the technology, together with purchasing the know-how and equipment staff is trained.

The implementation of bar-coding is performed with the use of many different devices that can be divided into four groups: for the application of the barcode; for reading barcodes; for the collection and storage of data; for data transmission. This division is conditional, since many devices provide multiple operations. A striking example of such devices are electronic shop scales, which provide weighting explanation, printing labels coated with a bar code, keyboard input, data accumulation and transfer them over the network.

To use the technical means used in bar-code technology some supplies are needed. These supplies are: label paper of various sizes for printers, ink ribbon and labels for thermal printing, and self-adhesive labels in various formats. The quality of consumables depends on the quality of the applied bar codes, their reliability and durability.

5.3 Cost

When barcodes first appeared the technology and equipment were expensive, extra training for the employees was needed, so only huge facilities were able to invest in it. Today, barcodes are available for everyone, equipment is affordable and training is minimal. Now tags can be individually planned by a particular facility according to their needs with no outsourcing required. In large organizations, barcode technology can be significantly cheaper to deploy than other inventory control methods, but even a small warehouse can implement it and get more benefits rather than costs.

Usually, costs of a barcode label itself are really low. Company can decide and cut down on training time and labor, improving productivity. It will also lower the costs of capital for carrying excess inventory since knowing exactly what is in stock will

help avoid ordering an abundance of anything. Knowing the exact amount of inventory, allows making deductions accurately and benefit on a financial performance. (Jon Schreibfeder, 2010)

Barcodes help to track the what, who and when for all warehouse activities. As a result, potential savings can occur in the following areas:

- A decrease in clerical costs due to reduced need for manual data-entry functions;
- Fewer errors thanks to improved inventory tracking and positive verification of activities;
- Increases in overall inventory accuracy;
- Ability to track employee performance that can increase productivity;
- Improved scheduling of warehouse activities.

As a result of being able to use barcode applications, the company reduced the warehouse staffing level by up to 50%, reducing inventory-handling cost at the same time. (David E. Mulcahy 1993.)

6 Key Performance Indicators

Initially, the most important factor for the prosperity of any company is the presence of qualified personnel and skilled management. But there must be something in between these parties to provide efficient interaction and to establish responsibility indicators, targeting managers and artists to achieve the common goals of the company. Staff at all levels must necessarily know for what purpose they work and what can they do to implement the overall strategy of the enterprise. In most cases, the such financial indicator as profit margin is used. But to achieve business success in the future, it is needed to also address some non-financial aspects, such as customer loyalty and service level. These indicators are called Key Performance Indicators of business performance (KPI), and were initially considered as a management tool in the methodology of Balanced Scorecard (BSC).

For each generated target KPIs are developed. With the selection of key performance indicators, which are reachable goals, the company receives a well-balanced picture of the short- and medium-term goals, financial and non-financial performance indicators, direct indicators or symptoms indicators.

There are target KPIs, which show how close the company is to achieve the goal. Process KPI shows how effective the process is. They can be used to assess whether it is possible to make a process faster and requires less cost without sacrificing quality. Project KPIs are associated with the specific objective of the project and show how well executed the project as a whole as well as individual works inside it. KPI environment is a performance, which can not be directly affected, but needs to be considered when planning targets.

KPIs are usually assembled into a Balanced Scorecard. Establishment of the Balanced Scorecard concept refers to 1990, when Nolan Norton Institute, a research center of the world-renowned audit and consulting firm KPMG Peat Marwick, began to seek opportunities and tools to enable measuring and improving management effectiveness. Today this tool is used world wide for business in general and for separated parts of it, like Human Resource department or Warehousing department.

6.1 Importance of KPIs while planning workforce

According to the study, the most common KPI for the company are: the implementation of the budget for personnel (84.5% of companies use), turnover (83.3%), quantitative and qualitative staffing of personnel, compliance with the requirements for maintenance of personnel documentation (86.9%). There is a number of other indicators that describe various aspects of the company's functions.

Workforce planning is an essential tool for every company since people are considered to be a huge asset. To be able to estimate needs for human resource, follow up and be flexible performance indicators are used. Planning is based on the evaluation of the current state, comparison with historical data and aiming for the future improvements, that is where KPIs are needed. Workforce planning is a proactive planning to provide:

- the right number of people,

- with the right skill sets,
- in the right location,
- at the right time,
- at the right cost

to secure successful completion of business objectives. Workforce planning and follow-up of employee's activities adds value by turning business strategy into action. (Tracey Smith, 2012)

In workforce planning is often influenced by fluctuations in the company's needs, changes in the structure of demand for manufactured goods and services. Planning of labour should be in interaction with changes in the life cycle of products and influence of the technical development of the production. So measures are to be taken in planning the labor potential of the organization, they cover the strategic development of staff and incentive system, strengthening the participation of employees in management, purposeful selection of frames with the knowledge and skills necessary to meet future challenges.

To be able to plan workforce of a facility or department in a proper way some requirements are to be considered:

- The flexibility of planning, the ability to adapt to alternative situations;
- Troubleshooting information gaps and uncertainties in the initial situation;
- Coordination of certain plans and their interdependence;
- Identification and registration of the weakest links of the organization processes that can affect people;
- Availability, analysis and accounting of in-depth information about the frames;
- Risk analysis and follow-up.

Planning can be done in various ways, one of the options is estimation followed by analyzing if staff taken is enough and if the workload is balanced. In the implementation of human resources planning organization has the following objectives:

- to get and keep the right people in the right quality and quantity

- the best use of the potential of its employees
- to be able to anticipate problems that arise due to possible excess or shortage of staff

When planning purposes it is necessary to take into account legal provisions as well as the basic principles of organization policies.

The most common tool of workforce planning is predicting staffing. It needs analysis and based on forecasts of supply and demand of human resources. The main objective is to establish the influence of predicting market development trends in the changing staffing needs.

Thus, the benefits of workforce planning include the following:

- The organization is better prepared to overcome environmental factors;
- It allows you to find new and more effective ways of managing staff;
- Helps avoid both excess and shortage of workers;
- Enables the creation and development of the teaching staff and management succession;
- Avoid duplication and improve coordination.

6.2 Stages of workforce planning

Workforce planning is an important activity, which is based on knowledge about the company and needs. While planning a number of factors should be considered and the process must be conducted step by step in order to be flexible.

Stages of planning staff in the company are as follows:

- Assessment of financial state, reports analysis and structure;
- Assessment of future needs; tracking changes in professional and qualification structure of personnel, identifying labor requirements with an indication of quantitative and qualitative indicators;
- Development of a program of future needs.

Important part of planning is the development of needed KPIs for employees and departments, so balanced scorecard can be assembled for tracking of the performance. Staff development plan is to be implemented as early as possible in the second stage of planning. When planning the use of personnel, company should seek

to achieve an optimal degree of employee satisfaction of their jobs, taking into account their abilities, skills, motivation. It can be divided into educational planning, staff development and career planning.

The crucial element is planning of time it allows to develop plans of work shifts, supports staff, and management of the employees in unstable operating cycle such as those associated with changes. It is also necessary to pay attention to planning vacations, scheduling of employees to participate in various educational programs.

6.3 KPIs for workforce

To be able to evaluate previous and current performance and to prepare for future changes when needed indicators are considered to be a great tool. Approaching workforce analysis using KPIs can bring benefits for the better understanding of the situation. An important output from the human resource strategic plan is properly stated key performance indicators for the company.

KPIs represent a set of measures focusing on those aspects of organizational performance that are the most critical for the current situation and future success of the organization. KPIs are usually shown as a ratio of actual to target and are designed to instantly let a business user know if they are on or off their plan without the end user having consciously focus on the metrics being represented. (Harold R. Kerzner, 2013) In business life, KPIs can be used in every area, for my thesis work KPIs for the planning and assessment of the workforce were developed and used. It is a great tool to keep up with the current situation in the department and be able to make right on time actions in terms of workload adjustments.

To be able to collect the best possible data for a scorecard, which is honest and trustworthy but desired for the company at the same time staff involvement is essential. Warehousing staff must be involved in decision making relating to facility layout, operation planning and they must be able to come up with own solutions and ideas. People who are closest to the process usually understand it the best.

6.4 BSC

Balanced Scorecard method (BSC) helps to determine the logistics strategy of the enterprise in terms of operational objectives, which determine company's behavior in the market and its financial well-being. This method defines a set of key performance indicators (KPIs), to evaluate the degree of successful achievement of the purposes inside the company, its departments and each employee. Using this strategy analysis of business process efficiency is possible. Having a good overview of achievements often works as a motivation for future progress and hard work.

When evaluating logistics activities with Balanced Scorecard method I would like to apply six steps:

1. State of logistics strategy goals;
2. Finding the main objectives of the efficiency of logistics department and ranging the goals according to the objectives and their importance
3. Definition of method to calculate the objectives (KPI);
4. Development of a program to achieve the goals and objectives of the logistics department;
5. Creation of an information system for accounting and control, development of reporting forms;
6. Possible changing of KPI set depending on environmental influence.

7 Current layout of "CKBM" warehouses and improvement ideas

Every company wants to be profitable, efficient and successful but having a severe competition on the markets these goals are harder and harder to get accomplished. Some companies invent new strategies and techniques; some change their set of mind, other buy new machinery, so various approaches are used to satisfy customers and improve the financial state. In the case of "CKBM" Ltd a few years ago top management has decided to change their philosophy of production to be more Lean type.

It is possible to implement Lean in production, administration and warehousing, which is my perspective. In my thesis I would like to see, how tips of lean philosophy could change current warehousing department of the company. Layout affects effectiveness of warehousing operations, that is why it is worth pay attention to it and make possible improvements.

7.1 Current warehouse layout

"CKBM" is the company that owns both production and warehousing facility. For the storage of raw material, semi-finished goods and finished products company has 2 buildings that are located next to the production plant.

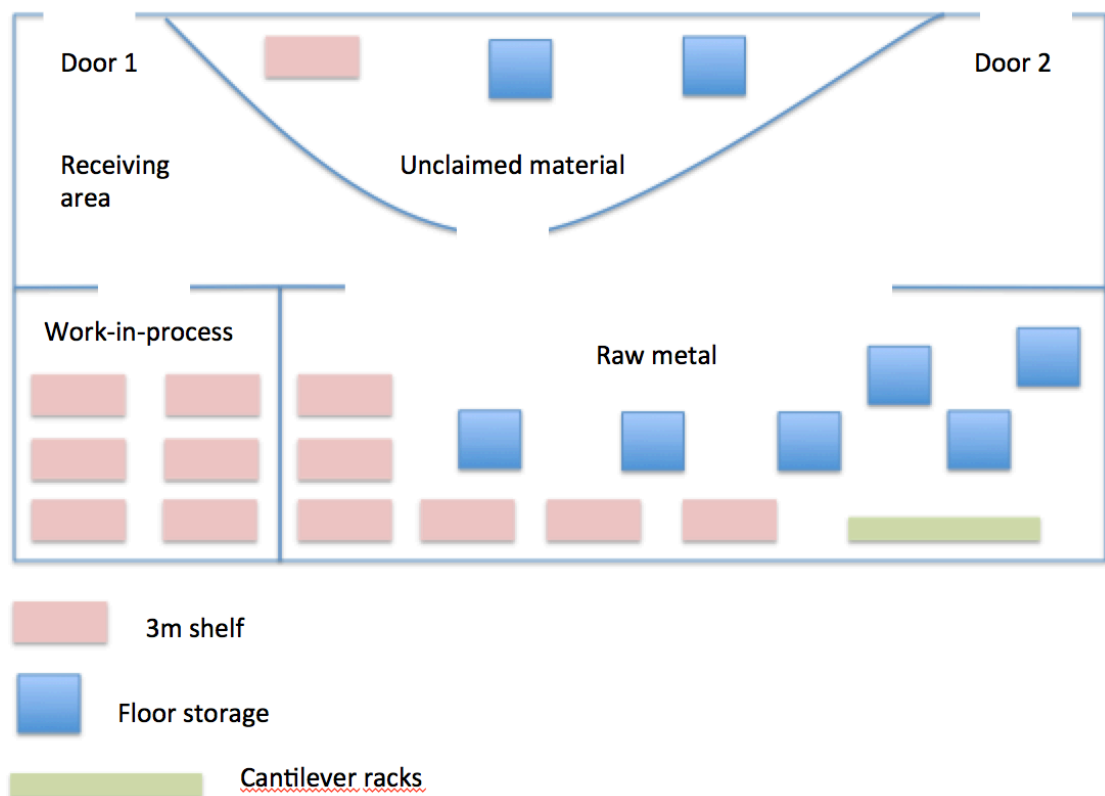


Figure 3. Facility A

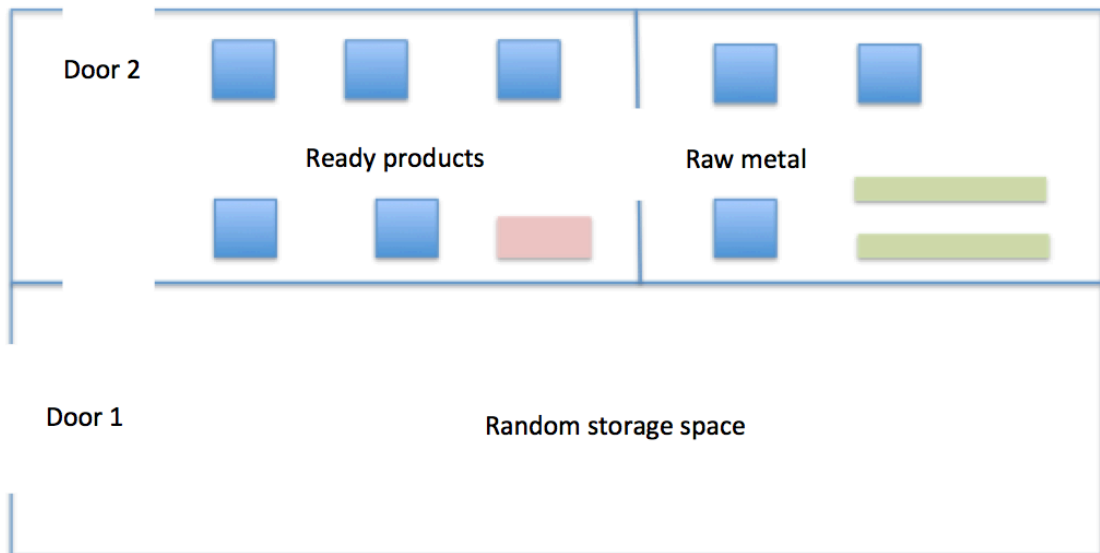


Figure 4. Facility B

Both buildings share similar features. They are one-floor warehouse buildings with no basement and known as flat stores. Its height is stackable and equal to 6 m. The area is 1200 m² and 800 m² for A and B buildings. The height of the shelves is 3m max, which results in a waste of useful space. This is done due to the reason of warehouse being focused on heavy raw material and weight limitations.

Warehouses are equipped with shelves but some of the products are kept on the floor.

For technological operations for receiving, storing and shipping of goods in warehouses following main areas stand out: the unloading; acceptance of goods by quantity and quality; storage; packing of goods; picking and picking of customer orders; loading of road transport. These operating area of the warehouse are not wisely linked by walkways and passages. Vehicle unloading area is close to the area of acceptance of goods, which is convenient for needed operations.

The storage area is the major part of the area in warehouses. It consists of an area occupied by goods, and the area of the passages. The ratio of these areas is not balanced and equal to 3,2:1 when this ration is recommended to be 2:1 allowing enough space for actual movement.

The space reserved for the operating passages is minimal, and it does not provide normal conditions for the movement goods and equipment.

It is necessary to take into account relationships and interdependencies between the incoming and outgoing warehouse of his trade flows, as well as internal storage object streams in the development of storage systems. Current warehousing layout serves as a storage area with some supportive equipment, but it is not wisely planned.

7.2 Problems of the layout

Current layout serves needs of the company, but it does not support efficient operations. The main problem of the current layout may be absence of any warehousing structure. This makes material movement inconvenient.

I have noticed, that there is no proper division of area, products block passages and access to each other. This results into addition of extra movement of inventory while picking.

It is obvious, that warehouse area is used inefficiently. There is an overall mess. Aisles are not planned to be in a ratio with shelves which makes a smooth movement of equipment impossible. Even doors are partly blocked, which is not only effects space utilization, but what is more important brings up the safety issue.

Here I would like to list problems that have to be approached:

- Poor space utilization
- No area division
- Unbalanced aisle-shelf ratio
- Limited movement possibility
- Blocked doors
- Safety regulations neglected

To explain the listed problem, I would like to describe causes and results of present problems. The space of the facility is under the roof located on one floor, inside it has most of the raw material owned by the company, without consideration of required storage conditions. Some pieces of raw metal can be stored outside to bring more free space and increase aisles size for better space utilization.

The area of the facility is randomly divided into rooms, but most of these rooms have no particular purpose. Aisle-shelf ratio is not even close to the desired 2:1. Wrong ratio makes movement of machinery limited and there is no access of the equipment for some of the shelves. Door 2 in the facility A is often blocked by incoming or outgoing materials, door 3 in the facility B is completely blocked with raw metal sheets, so it is not even counted as a door. Blocked doors bring up safety issue.

7.3 Improvement ideas for the layout

With problems noticed I have suggested some improvements that are meant to make warehousing operations more smooth and efficient. These changes include planning and division of the area, changing aisle-shelf ratio, making the place easy to move and navigate, proper decisions to support arrangement of products and raw materials according to the current needs.

During the try round it was identified, that storage layout causes unsmooth operations in the warehouse. Materials can be stored in a different way to provide better access and faster response to any order.

To be able to improve the warehousing situation in the company, I feel an urge to investigate the process of metal storage before actual actions. As raw metal and products of this material are the main matter of storage in the warehouse it is important to understand basics of metal storage and see possible limitations to avoid mistakes.

In my thesis work, I would like to investigate into the storage of raw metal such as material, rather than on storage of finished goods or work in process.

Proper storage of metal keeps the properties of material constant and allows a consumer to use it for future purposes without any doubt of quality. While planning new layout and equipment needs were driving the decision of implemented changes.

7.3.1 Warehouse plan

Having a good understanding of needs for storage of products and materials, we were able to replan a facility in a way that it meets requirements and allows more optimized processes and smoother flow.

The new layout has balanced available space and dock doors, it brings better utilization of equipment and workforce. Planned and easy to navigate space helps to see if there is unclaimed material in stock arrangement. Layout gives a chance to see control inventory separation, so there is "stock", which should be in the facility and "stuff"-everything else.

The warehouse facility and the material handling processes within the warehouse are affected by the product requirements. So new layout is based on the needs.

Floor plan

The warehousing facility is located near to the production and serves all the needs of manufacturer and customers.

Warehouse in Sosnovy Bor

Warehouse buildings 253a and 253b

Staff:

- Warehouse workers - 2 employees
- Work in process keeper - 1 employee
- Worker from the production facility involved into the warehouse processes - 1 employee

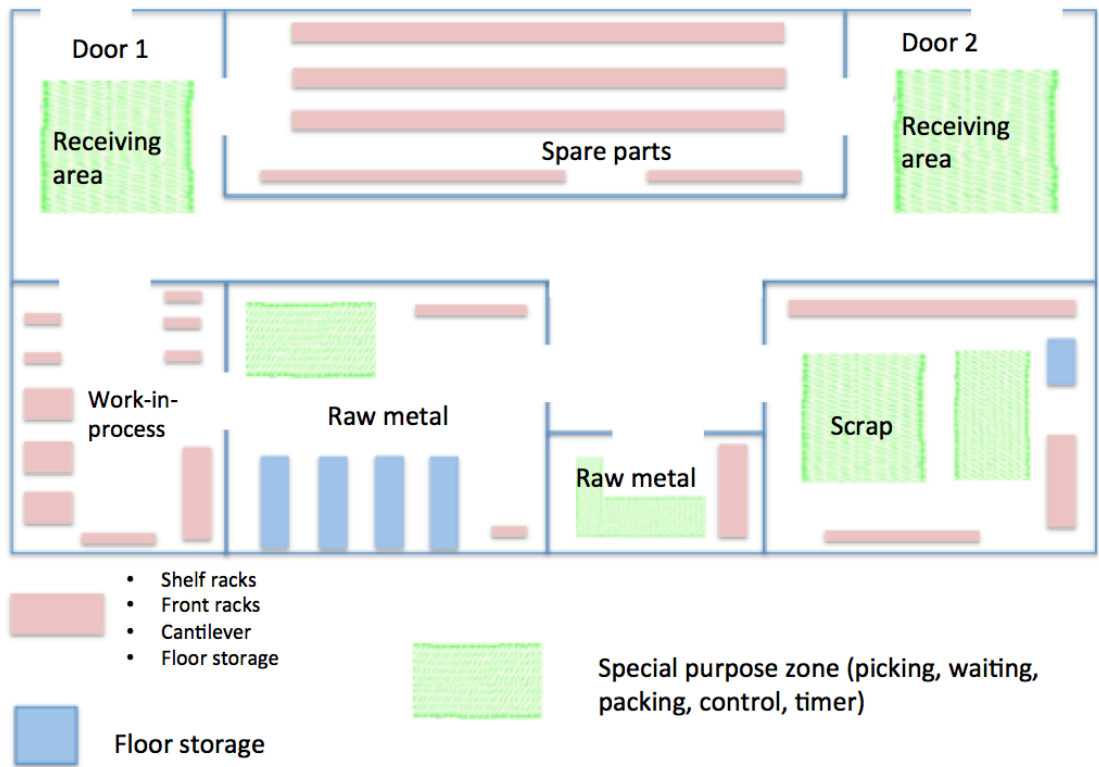


Figure 5. Facility A

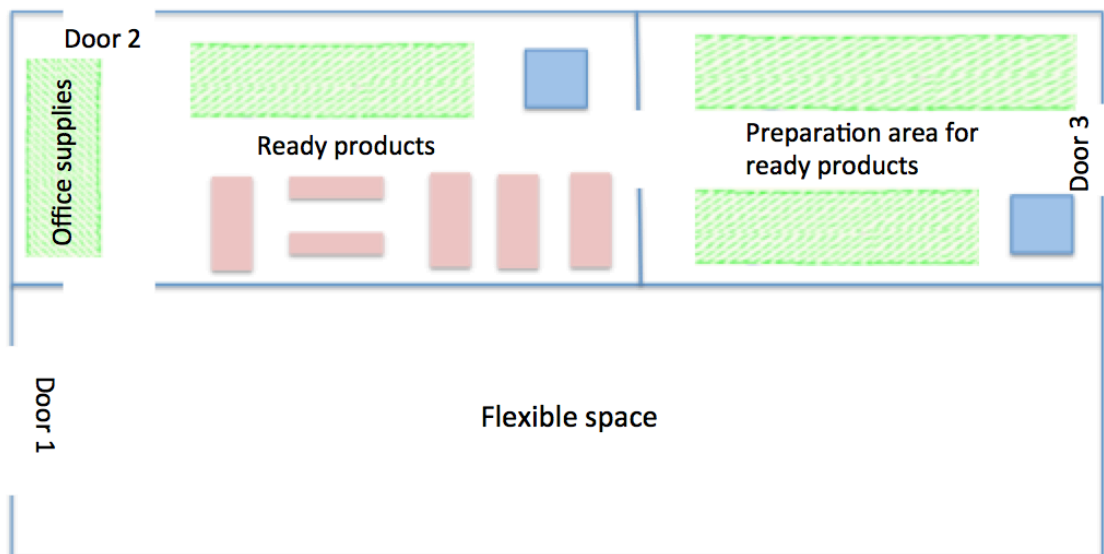


Figure 6. Facility B

The exact number of rows, as well as their placement in the section will be approved at the beginning of the actual implementation stage.

The storage area was divided into separated rooms, to make product placement more logical according to needed equipment and storage conditions. In addition, there is an area for outside storage. The warehouse is not planned for constant ma-

terial movement rather than storage, so rooms are planned to make a through the warehouse move possible, but still separate products by their meaning. Facility B now has a reserved space, which is kept free in order to be flexible if some unpredictable warehousing situations occur.

The width of the passages between the shelves is dependent on the applied technology. In the facility A passages take 52% of the warehouse area at the height of 6m. And for the facility B it is 42% with the same height.

Planning of the facility was based on searching for the most optimal solution. I have to admit that not all the bottlenecks were avoided, and my task was not to eliminate all of them.

8 Current equipment and improvement ideas

The main objective of a warehousing is supporting of a production facility with appropriate material resources to ensure their safety and minimize costs associated with the implementation of storage operations.

In warehouses equipment is used for storage of goods, for the movement of goods, processing, sorting and packing. Deciding the storage equipment is it necessary to consider a particular kind of stored products. Equipment of a standard warehouse usually consists of technical and stationary devices that are used for product placement and movement. One part of the equipment is various machines by which the loads are moved within a warehouse and its boundaries.

The second part of the equipment is a place of storage of goods: shelves, boxes, containers or pallets, archive cabinets. Type of this equipment, size and number depends on the range of products placed on the stock.

8.1 Current equipment

In warehouses equipment is used for storage of goods, for the movement of goods, processing, sorting and packing. The equipment for storage of products is presented by tools: for stacking and storage of goods in the container and by piece and stable storage of bulk goods.

Equipment	Number of items
Pallet truck	2
Forklift	2
Hydraulic stacker	3
Heavy range lifting crane	4
Mid-range lifting crane	2
Weighing machine	2

Table 1. Current equipment

Facilities share the equipment in a way that pallet trucks, stackers and forklifts do not belong to any of them, they are shared. Cranes and weighing machines are divided equally between two warehousing buildings.

Not all the machinery is in use. Hydraulic stackers are no longer used due to the end of the life cycle. Stackers are used for long goods like raw metal, and critical for this warehouse since most of the stock is raw metal. Weight machine the Facility B is broken and require maintenance.

For the actual storage such tools are used:

- Front racks (pallets);
- Shelf racks;
- Cantilever racks for storage of pipes;
- Free storage area on the floor.

Shelves and racks are adjustable, meaning that their number and location is not the same during the operational time. I have explained the approximate placement of storage equipment in the layout figure.

Different types of storage are applied in the facility according to the peculiarities of goods stored. There are floor storage, shelving, and pallet assembly used. As for handling, manual, forklifts and cranes are used, depending on current needs.

As I first faced the warehousing processes in the company, there were: receiving of goods or material, storage, local movement inside the warehouse and departure. Stages of warehousing processes are different for raw material; work in process and subassemblies, scrap, rework and finished goods.

For raw material, it is: receiving, storage, picking and delivery to the production facility.

For work in process and sub-assemblies: receiving, storage, packing, picking, and delivery to the production facility.

Scrap: receiving, storage, separation, delivery.

Finished goods: receiving, storage, inspection, picking, packing, and delivery to the final customer.

The processes and tasks were built in a way that even inexperienced worker can perform well there. Some operations needed more than one person to be accomplished, so work in a sequence was used.

8.2 Problems of the equipment

Properly planned equipment supports warehousing activities, but when equipment does not meet the requirements situation of the warehousing gets worse. For the case with "CKBM" warehouse I have noticed some problems that limit proper performance:

- Not enough of machinery
- Machinery used for a wrong purpose
- Lack of maintenance
- Unlabeled shelves
- Unflexible storage equipment

After an overview of the current state I have realized that facility has some items of machinery that are unused and at the same time workers lack another piece of equipment for handling. This has happened with pallet trucks, they are widely used

for manual loading, unloading and inside movements, but there are only 2 of those. Having more would allow more operations to be performed at the same time. On the other side, there are hydraulic stackers, there are 3 of them and only one is actually used in facility A. The stackers not just lean, as was found out, they have to be changed since being worn.

Other equipment like forklifts also require scheduled maintenance, since it is a serious safety issue.

8.3 Improvement ideas for the equipment

New plan of equipment gives the facility some advantages, they include higher efficiency of workers, better reliability and safety. Equipment is planned according to needed functions and still flexible to perform if some new tasks appear.

Equipment	Before	Suggested
Pallet truck	2	4
Forklift	2	2
Hydraulic stacker	3	2
Heavy range lifting crane	4	4
Mid-range lifting crane	2	2
Weighing machine	2	2

Table 2. Equipment

After changes of the layout equipment was adjusted to the facility needs. Cranes and weighing machines were kept, since they belong to buildings themselves. Two more pallet trucks were added, allowing simultaneous operations inside and outside the facility, which sometimes require the same equipment. Hydraulic stackers were changed for a new ones, now each facility has a stacker for raw metal on its own.

Weighing machine in the facility B was repaired. Now each facility has a weighing machine for inspection of incoming goods in the waiting zone next to the first door.

The process of improving warehousing machinery took about a week for purchasing new equipment, disposal of old items and maintenance of weighing machine. I have placed approximate spendings to a table to make investemnts better to read.

Item	Amount	Price/item
Pallet truck (300Ah)	2	3000 €
Hydraulic stacker (240Ah)	2	9000€
Disposal of used hydraulic stacker	3	400€
Maintenance of weighing machine	1	500€
Total		25700€

Table 3. Equipment investement

All purchased equipment was decided in order to meet the requirements of the facility, so pallet trucks are able to handle weight up to 1800kg and have enough battery capacity. Hydraulic stackers were chosen regarding new storage equipment, with the improvement the warehouse has implmented higher shelves, so new macinery can reach up to 4,5m.

8.4 Storage equipment

Using higher shelves in the warehouse helps to take and advantage of available space from floor to ceiling. So some of 3 meter shelves were changed to shelves up to 5 meters. Pallet racking is used for pallet loads, mostly spare parts and semi-finished goods, and it supports simplicity in storage.

Optimal placement of raw steel in stock can reduce the costs of handling and increase the productivity of warehouse employees (ex. customer service, conducting inventories).

When placement of metal rolls is considered, it should also be done in the most optimal way, when stock allows more efficient use of available storage space, which ultimately has a positive effect on the total cost of storage, resulting in a reduction of the rent cost, electricity and transportation expenses. For rolls, I suggest using racks and pallets under the roof.

Wise use of machinery for loading and unloading operations helps to reduce the deformation of the metal, avoid cracks, and keep original properties of the metal needed for further production processes.

Some countries as Russia and my case warehouse, in particular, should also consider the point of crime. Proper organization of storage in a warehouse will reduce the possibility of metal being stolen by the company personnel or third party and improve the safety of metal rolling stock as a whole.

Rolled metal storage includes a number of specific features. It is the characteristics of the storage facility that effects on material properties state before actual production. Optimal conditions for metal storage starting with the reception.

I assume, that the best way is to store metal as separate parties. For each consignment, which is stored on a shelf or group of shelves, a tag must be attached to the passport data for products (manufacturer, name, parameters and product designation, weight and number of items, the standard number, year). This helps employees to easily navigate through the warehouse, avoid unknown products and optimize work processes while picking the needed place of metal. The current warehouse does have a bar code, but a tag with written information is more convenient.

It is important to consider the peculiarities while placing individual groups of rolled products and pipes in stock. When storing individual sheets or raw metal it is necessary to share bars with special spacers. This provides free access to air and, therefore, metal surface will be less susceptible to corrosion. Enclosing bars facilitates settlement of the sling under the sheet for a better placement and picking. Long-rolled sheets are better to place, avoiding bending and deformation of the sheet. Thus, labor-intensive processes of aligning the sheet prior to the production can be avoided. If lengthy sheet products already have troughs, they can be corrected by means of additional spacers.

Small diameter pipes, fittings and other metal rolling are stored in bundles. They are easier to load, transport and sort. In this case, less metal deformation, less shock, bending and other negative impacts are obtained. For storage of large diameter, pipe racks fit well. For large arrays of pipes, use is limited by design. This ensures the in-

tegrity of the array. Thy array of pipes should not be too high, otherwise, there could be stingrays and deformation of pipes, structures and other types of rental.

The equipment for the storage of metal is to be considered. Storage racks make a good use of space. They also deliver the visibility of stored volume, which is especially important while applying lean strategy, since it helps to reduce time and movements needed for finding and picking the one needed material having a wide range of varieties.

For optimal movement of vehicles and personnel in the warehouse, racks should be placed at a distance from each other. The optimal distance is 1.5 meters this allows to carry out loading and unloading operations at the warehouse easily. To increase the effective working area of the warehouse raw material can be placed on a metal pallet racks or cantilever. On metal shelves console it is better to store profile pipes, fittings, beams, steel sheet and other rolled metal products.

8.4.1 Equipment according to storage conditions

As "CKBM" is able to change the layout of the facility due to the current needs it was essential to decide what conditions of storage every product or material require.

Most of the materials are not sensitive to the temperature and humidity, so options of outside storage were considered for better space utilization.

Among the most important points of consideration for metal storage are:

- The room temperature should not be below 12-16 ° C;
- Relative humidity should not exceed 40-60%;
- Ventilation of the room should be uniform.

Outside storage areas should be concreted or paved floor and have sinks for atmospheric waters. When concreting the floor of open and closed warehouses load corresponding to the storage of ferrous and non-ferrous metals in the stacks or shelves of a certain height must be taken into account.

Very often, in spite of the creation of favorable conditions for storage, stock occurs stale product. The main reason for this fact is not a mistake in reception or delivery by warehouse workers. The reason is that the employees tend to operate with the

products that posted closer. To avoid this situation I suggest a regular update of the metal to allow the smooth flow in last -in first -out way. This allows the warehouse to constantly update the inventory and reduce the percentage of stale metal keeping it minimum.



Figure 7. Before



Figure 8. After

9 Current warehouse tags in “CKBM” and improvement ideas

The effect of the introduction of new labeling technology to “CKBM”'s operations is obvious not only for managers and employees, but also to the companies standing in the next stage of the movement of finished products to the consumer: they get a product with full information about it, recorded in the bar code, and use it for storage and operations with the goods at their own warehouses.

9.1 Current labeling

The address system is as simple and enough for a medium size facility. Incoming goods get their tags when received by general software application working on a cell number principle:

A1234



Figure 9. Tag

A1234, where:

A, B - storage area (facility);

12 - serial number of the rack;

3 - serial number of the vertical section of the rack;

4 serial number of shelves.

Such principle is suitable for the numbering of the racks 99 and each rack can be no more than the vertical sections 10 and not more than 10 shelves

The introduction of a system includes a markup on the layout, production and free rooms, entering addresses in product specifications, application numbers of the specifications in the computer data or account card base. In this case products and materials get their barcode when received and shelves are labeled without a barcode but with a sticker showing a corresponding number.

Warehouse worker has to find items by name and address, not even knowing the appearance. Some addresses are permanent, it enables rapid screening or product placement, as well as control of their movements. But when something does not go as planned and changes are needed, the system is not efficient. Employees having a statement at hand with information with addresses are not able to handle the picking job without mistakes.

The layout of the racks and stacks indicating storage addresses hang on the walls, to the warehouse employees can study them and easy to navigate.

9.2 Problems of tag system

Existing labeling system does not support needs of the warehouse. The system was developed long time ago and with the time it turned that changes are needed to add flexibility and simplicity for processes.

Main problems include:

- No barcode for shelf to checks it inventory
- Barcodes for products only

- Limited information capacity of a tag
- Hard to read
- Low flexibility

The main problem is associated with the fact, that tag can not hold enough information about the product specification, so it must be changed. From the side of employees, it was noticed, that a solid number of the tag is hard to read, meaning, that locations are better to be written separately.

As results of the simplest process simulation, I have found some troubles. When warehousing workers receive a request for storage or picking from the logistics or purchasing department of a company, paper with tag and specification is very hard to read. It contains a lot of information needed during the way of a product, and warehousing number for picking is not even in bold. I see that papers of customer orders and requests could be better since it is hard to see what is actually needed without spending a significant time with the document. Workers have difficulties reading and understanding one single request, and they usually receive several of them. Highlight the tag number on delivery papers.

The lack of user-friendly tools for the automated identification of goods makes warehousing operations messy. The need for properly planned barcodes in a warehouse with a large flow of goods and materials is beyond doubt.

9.3 Improvements in labeling system

As part of my actions for the improvement of the warehousing situation, I was developing the coding system for stored material and places in the storage facility. This was my action after defining such problem as unclaimed material, wrong labeling, and insufficient material flow control.

More logical and structured codes on material reduce the number of handling mistakes and time for material turnover. With a proper labeling operating within the facility is more efficient and fast.

New labeling system was developed in order to improve inventory control and warehousing efficiency. Before the improvement tags were only planned for the material,

now, there are two types of tags: one for the stored item, another one for the location.

Making every piece of the tag include the number from 00 to 99, rather than 0-9 has increased the capacity of the tag. Such principle is suitable for the numbering of the racks 99 and each rack can be no more than the vertical sections 99 and not more than 99 shelves.

For the employees format of the tag was changed, so numbers are separated by “-“ sign making reading and copying easier, so mistakes are avoided.

Location tag kept the features of an old product tag, and new product tag tier number was added increasing capacity. New labeling is supposed to increase inventory accuracy and detect unclaimed materials. Apart from listed advantages tags on material and equipment reduce time spent checking and looking for the inventory.



Figure 10. Product tag

Where:

A - warehouse building

06 - the number of storage sections

03 - shelving or storage area in the section

07 - section

4 - tier

Tags are also used to identify the location and check its inventory. These tags are attached to shelves and can be found on the floor. Bar codes on shelves are put into

card holders, it makes changing of the tag more convenient and helps to avoid losing the tag, as could be with a sticker.



Figure 11. Shelf tag

A - warehouse building

01 - the number of storage sections

02 - zone storage section

03 -section

For organized coded storage of materials in the warehousing facility of "CKBM" all the storage capacity was divided into storage areas (cells). It was planned to assure a precise control over the movement of goods and materials when in/out/inside the storage areas.

To implement the system coded storage and uniquely identify the storage location of inventories in the stock label (tag) are used, coated with bar code symbols.

Placement of materials and products is also tagged. For storage of goods and materials different types of labeled storage systems are used:

- Front racks (pallets);
- Shelf racks;
- Cantilever racks for storage of pipes
- Outdoor storage racks like forgings, shells, sheets;
- Marked storage area on the floor.

When marking the rack, or the rack of the cell marking tags are used. These tags are attached to the support rack.

When marking outdoor storage areas plaque-light tags are used, they are attached to the floor in the storage area. Tags are barcodes with information identifying the storage area.

10 KPIs of “CKBM” and improvement ideas

At the moment warehousing facility is not a priority of the company, so warehouse workers lack attention and control of their activities and working conditions. There are no KPIs to evaluate their performance and make needed changes.

Thy "CKBM" warehouse is currently operated by 2 employees at the facility and 2 employees at the main office in the logistics department. Both facility employees share similar tasks managing receiving, inventory control, picking, and put-away.

Office employees are in charge of recording the warehousing operation with ERP system. One employee is in charge of deliveries of finished goods from the warehouse according to packing lists, his tasks also include communication with ones who receive the goods and arrangement of transportation from the facility. The second office employee is managing materials that are stored in the facility, he makes a follow-up and inventory control together with facility workers.



Figure 12. Activities

10.1 Problems to be addressed by the development of KPIs

The warehouse employees are reporting to the logistics department but they also keep communication with purchaser and production facility. The information flow goes through ERP system but there are claims from the warehouse about more in-

formation demanded. Production managers do not use ERP system in a proper way due to lack of skills and control. The purchasing department is not able to follow the stock and production facility happened to have wrong information about the inventory of needed material.

I have noticed that some employees are not even sure about tasks they are doing, they do as they feel it. I believe that it is a huge disadvantage that employees are not willing to achieve better performance and improve themselves. Due to the lack of interest in their work I see the lack of involvement.

It is noticed, that workload is not balanced and employees lack directions and control. There are simple tasks that include waste of time and paperwork and on the other side, there are tasks that are neglected and need to be brought up. Clear directions from management are only received in urgent cases, all the other time facility is operating just randomly.

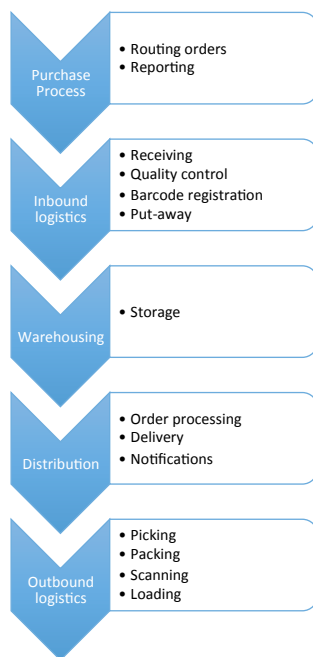


Figure 13. Current tasks of warehousing employees

10.2 Improvements in terms of workforce planning

From the first day of my stay in the company it was noticed that workforce in the warehouse is not planned sufficiently in terms of workload and responsibilities. And at the same time, there is no tool to plan and control activities of the staff. The com-

pany has never used any KPIs to evaluate the performance of the employees and keep updated with their working conditions and results.

The workforce was decided to be presented by 4 people, 3 of whom were full time in the facility and one was an office worker operating as a connection bridge between business processes and storage operations.

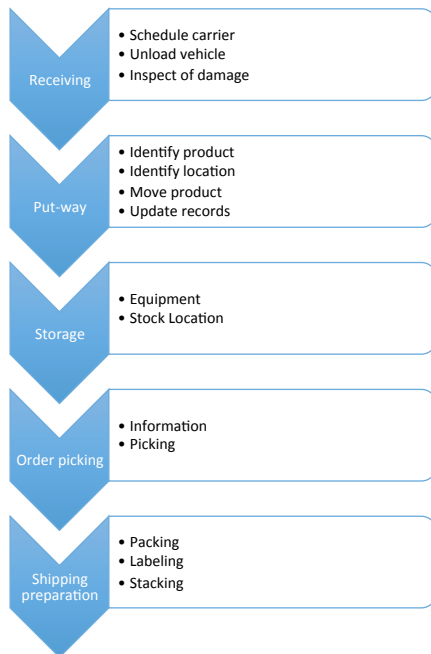


Figure 14. Tasks

Due to the tasks that are needed to be accomplished staff was planned:

- Warehouse workers - 2 employees
- Work in process keeper - 1 employee
- Worker from the production facility involved into the warehouse processes - 1 employee

First of all, I had to set responsibilities of warehouse workers, who are basically in charge of inventory excluding work in process pieces. There are two people who share similar tasks, making it possible to switch tasks when needed.

Main responsibilities include:

- Receive and process incoming inventory
- Control unloading

- Keep tracking inventory
- Prepare loads for delivery
- Maintain optimal state of the facility according to Lean principles
- Preparation of storage receipts and filling of orders when needed
- Tag stored items

Responsibilities of the third employee are similar but they only include operations with pieces of work-in-process that are received from the production facility. These person reports directly to the production facility and has a different access to the ERP system than others. Responsibilities of the employee also include a simple quality check to ensure quality and quantity.

The space of the warehouse is optimized in advanced and responsibility of employees is to follow 5C rule keeping everything in its place.

Before the new set of responsibilities there were troubles understanding where do warehouse employees report and how they are supervised. Now there is a particular person in the purchasing department who has a responsibility for them. This situation adds some complexity and hierarchy, but it could not be avoided since logistics department is not strong enough to handle more tasks.

There is the fourth employee who belongs to the logistics department in the head office of the company. His responsibilities include:

- Planning and follow-up of the goods received and delivered
- Communication with customers and other departments in terms of stock
- Keeping stock control
- Planning future capacity
- Track needed maintenance for the equipment

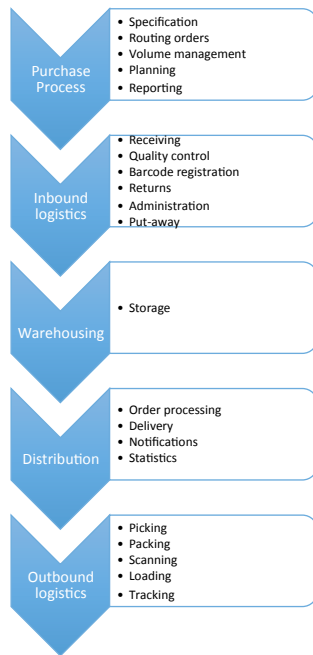


Figure 15. New tasks specification

To be sure that tasks are planned properly and the workload is balanced I have developed KPIs for employees making it possible to track the performance with the Balanced Score Card.

10.2.1 Development of new KPIs

Workforce is a key resource of the company, to make the best of it workforce must be planned properly to make the best of a reasonable number of people with appropriate skillset. For my thesis, I was making a decision of number and tasks of warehousing employees. The decision was done based on the estimation and comparison with the previous situation. To be sure that planned staff is enough I have developed BSC and KPIs for employees to have an advantage of being updated with who people feel and perform. It all done for making needed changes as soon as possible and as smart as possible.

The first step to assess the efficiency of logistics at "CKBM" Ltd is to define the purpose of sourcing. The company is focused on growth through product range expansion using the corporate growth strategy.

Currently, company is focused on the following objectives apart from production processes:

1. Providing customers with high-quality logistics services.
2. Organization of transparency of work and good communication between the departments.
3. Formation of the bonus system for the staff.

Taking objectives into account main targets of the logistics strategy should be selected as:

- Reduction of the total operating costs of logistics and warehousing;
- Increasing productivity and logistics infrastructure;
- Improving the quality of warehousing activities;
- Maintaining a minimum cost at a qualitative level of service.

To be able to estimate the results of first step implementation of the strategy using Balanced Score Card I have decided to make a primary questioner including KPI for a different level of managers.

I assume, that all the managers are responsible for several indicators and these indicators are determined by the weight in terms of their priority.

For each indicator, the branch manager determines the planned (target) value. The target value is calculated on the basis of the available statistics on this indicator, with a tendency to improve it, but keeping it realistic. Planned values for indicators can and should be changed regularly, providing the necessary dynamics of the entire enterprise.

Weighing Terms are:

- The more important objective of KPI the greater its weight;
- Irrationally measured KPI should not have a lot of weight;
- Must be a multiple of 5 and integers;
- It is not advisable to assign the same weight for different KPIs;
- The sum of the weights of all tasks must be equal to 100%.

The assessment was done for receiving an overview of current processes from a logistics manager point of view.

Example of calculating the efficiency for the manager of logistics department using KPIs

Indicator	Plan	Actual	Weight	Limit	Implementation	Effectiveness
Percentage of customer orders processed	100%	96%	0.4	>90%	96%	0,384
Cost of transport per ton of transported products	1292000 rub/t	1265500 rub/t	0,2	-	97,9%	0,2
Inventory turnover between warehouses by commodity groups in days	5 days	7 days	0,4	1-5 days	7 days	0
Total	0,584					

Table 4. Example

In the future, the company is willing to use the same processes so I have prepared the weight and KPI for other employees.

KPIs for the manager of the logistics department

Key Performance Indicators	Weight
Percentage of customer orders processed	0,4
The average cost of transport per ton of transported goods	0,2
Inventory turnover between warehouses	0,3

by commodity groups in days	
Stock index deficit	0,1

KPIs for the main specialist in the organization of transport

Key Performance Indicators	Weight
Delivery ratio	0,5
Route planning efficiency	0,2
On time paper works	0,1
Own transport costs per ton of transported goods	0,2

KPIs for the logistics department employee

Key Performance Indicators	Weight
Quality of the logistics service	0,4
Miscalculations	0,3
Efficiency of equipment utilization	0,3

KPIs for the warehouse manager

Key Performance Indicators	Weight
Accuracy of accounting	0,3
Shortage	Must be avoided
The average loading time of 1 ton	0,4
The presence of the delayed goods	0,4

KPIs for marketing employees

Key Performance Indicators	Weight
Request processing	0,3
Implementation of the sales plan	0,4
Turnover of inventory between warehouses by commodity groups in days	0,3
Distribution logistics costs	0,2

KPIs for sales employees

Key Performance Indicators	Weight
Implementation of the sales plan	0,5
The share of receivables	0,4

The tables above are to be used for the future follow-up of the operations. These indicators make it possible to see if changes made inside the company affect financial and operational results in the desired way.

Currently, there is no data available for assembly of a real BSC, which will be done by the end of the year to see the overall picture of processes. I have tried to make an example based on Balanced Scorecard methodology, where I put a percentage of estimated performance in comparison to actual results. The value for each title in the figure is estimated separately and assembled together in order to have a mindmap of the situation.

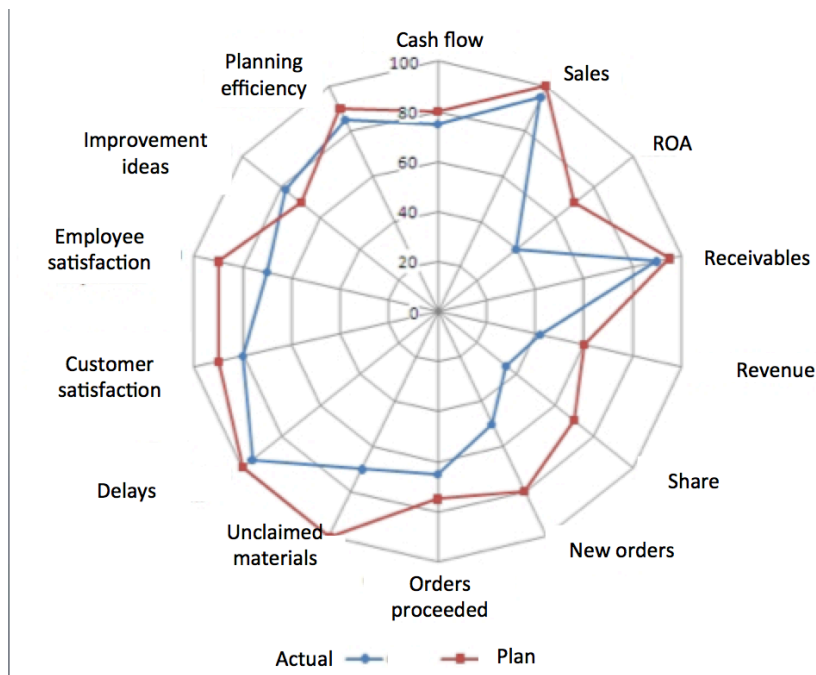


Figure 16. System of indicators

During my stay in the company, I was not able to develop a Balanced Score Card using the KPIs but I strongly believe that my research on the topic is trustworthy and will be used later during the lifetime of a company not only during an implementation of Lean practices but also for sales and transportation department purposes.

11 Conclusion

Before I have started my project for the "CKBM" Ltd I knew that the main aim of the work is an improvement of the warehouse situation to increase warehousing efficiency and balance workload of the employees.

After my stay in the company and completing this thesis work, I have learned, that warehousing is an important piece of the company's activities and even if the main focus is on production, warehousing operations should not be neglected. More optimal storage activities lead to the reduction of facility operating costs and better efficiency by smart area, equipment, and staff utilization. Now it is expected, that implemented changes will reduce facility-operating costs at an annual rate of 10-15% and release of the area up to 20%.

My contribution to the improvement of the warehousing situation included detecting some problems and coming up with solutions.

	Problem	Cause	Suggestions
Layout	Obstructed material movement	Warehousing area is not divided by the activity performed	Balanced floor plan, with proper aisles-shelves ratio
Equipment	Inefficient equipment utilization	Lack of machinery and maintenance, wrong storage equipment options	Inventory, maintenance and adjunction of machinery. New storage equipment
Labeling	Inventory mistakes and unclaimed material	Poor inventory tracking	New product-shelf tags
KPIs	Inefficient work planning	Absence of KPIs to evaluate performance of human resources	Development of KPIs

Table 5. Conclusion

Improvements already have a significant impact on the processes in the facility, and as time goes, the contribution of the study will only get bigger. The research results can be used in the further development of the Lean warehousing inside the organization giving a competitive advantage to the “CKBM” Ltd.

Performed research and development are considered to be the initial stage of solving the problem of optimizing the placement of goods and materials in the warehouse of “CKBM”. Continuation of the project is related to the following areas:

1. Introduced improvements for the optimization of warehousing have to be supported by corresponding activities from a side of purchasing and production departments.
2. I suggest choosing the most efficient version of ABC analysis for goods placement. Even though it was not a part of my thesis work, I assume, that better analysis of inventories may be beneficial in the future.

3. Testing adequate zoning techniques (division into sections) warehouse space.

Since some changes after follow-up are welcome to be made.

4. Improvement of the methods used to optimize the results of the assessment of economic product placement;

5. Development of requirements to improve the information support

I believe, the implementation of these development ideas, aside from already implemented ones will not only increase the efficiency of the warehousing processes but also be beneficial in terms of the financial state.

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