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AN ASSESSMENT OF THE CURRENT WASTE MANAGEMENT SYSTEM IN CABB KOKKOLA AND COST ANALYSIS

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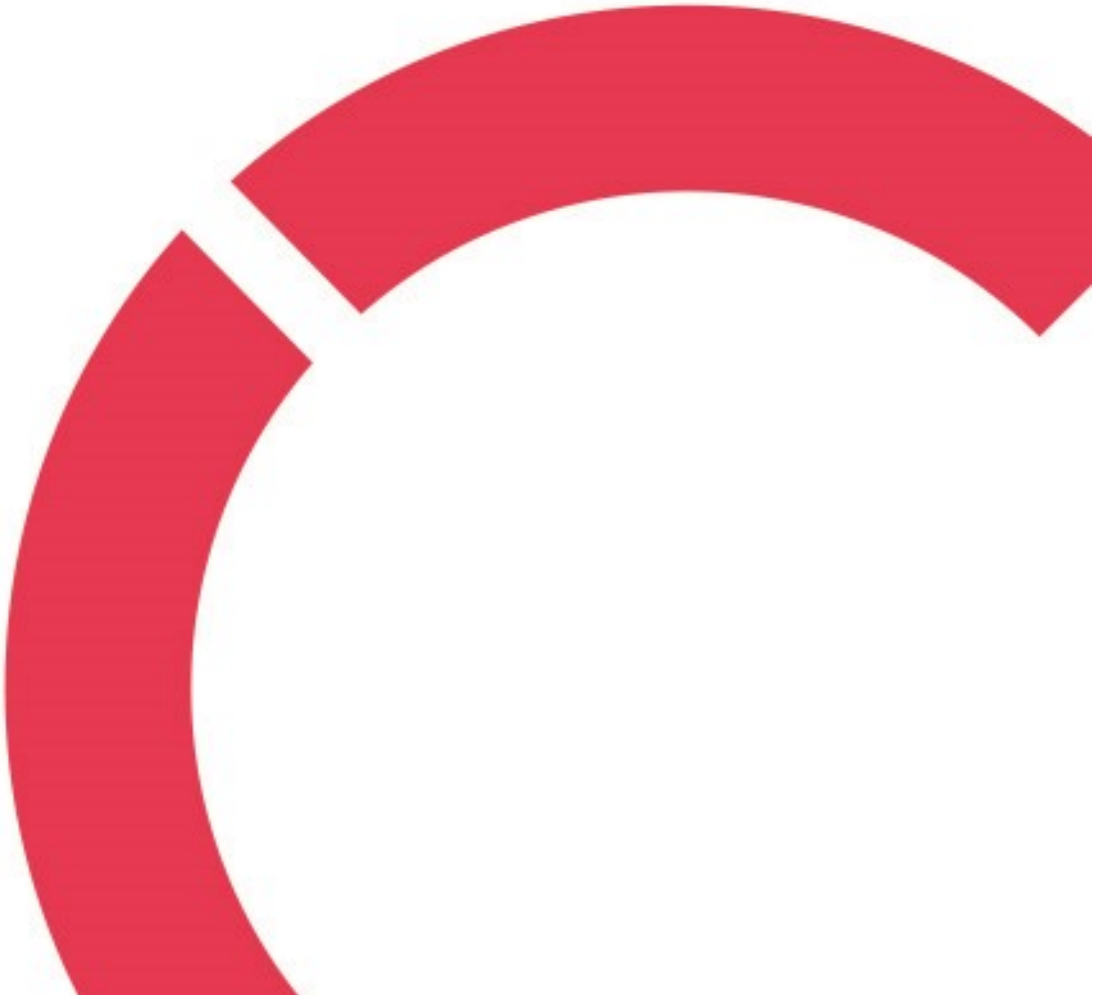

ABSTRACT

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Chemical manufacturing companies often face challenges with managing and organising excessive waste. It is essential to investigate waste management practices consistently in order to uphold a sustainable and healthy environment. CABB Kokkola, a leading custom manufacturing company in Central Ostrobothnia, aims to address this issue by conducting a study on its current waste management system. This study aims to investigate the current waste management system at CABB Kokkola Oy. The study aimed to find the waste sources and quantities within the company, review compliance with the new law and regulations, and do a cost analysis. The 5S method was discussed in this study. A precise updated sorting method and the waste collection points were provided in the study. Different waste management companies and the waste end life were reviewed in this study. The thesis contains confidential information in appendices, which was omitted from the public version. This research used quantitative methods to analyse a wide range of data from the company and external waste handlers. The analysis categorised and quantified various waste streams and identified different waste costs. This study will help in planning an efficient waste management system for the company, resulting in reduced costs and improved environmental sustainability.

Key words
5S method, environmental pollution, end life, hazardous, law and legislations, municipal waste, process waste, waste management

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CONCEPT DEFINITIONS

* - Hazardous waste

EU - European Union

Fe - Iron

Kg - kilogramme

POP - Persistent Organic Pollutants

PVC- Polyvinyl Chloride

WEEE- Waste from electric and electronic equipment

WMC- Waste Management Company

PICTURES

1 INTRODUCTION

Chemical industries produce significant number of waste, thus a proper waste management practices are a crucial aspect. Chemical manufacturing company produces two types of waste: hazardous and non-hazardous waste and the waste can be in solid, liquid, or gaseous form. Improper waste management escalates environmental pollution and creates a potential health threat. On a continuous basis, organisations must monitor their waste management practices and develop effective and sustainable waste management systems to tackle this problem. The thesis topic was suggested by CABB Oy Kokkola. CABB Oy Kokkola is one of the leading fine chemical manufacturing companies in Central Ostrobothnia (CABB presentation 2023). As a chemical manufacturer, they produce considerable amounts of waste. Proper waste organisation and management are essential for the company to maintain sustainability and reduce environmental pollution and potential health risks. The main objective of the thesis is to organise and follow up the current waste management system. The following questions will lead the thesis.

What types of waste are generated within the company currently?
What is the updated law and legislations regarding waste management?
How is waste stored, handled, transported, and disposed of?
Who or what external companies are taking care of those?
What is the cost of waste handling?

Currently, the company's waste management system is challenging to follow as many external companies are working with them for waste handling. Furthermore, the waste law is being amended and went into effect on July 19, 2021 (‘Jätelaki uudistui - mitä se tarkoittaa käytännössä?’2023). As a result of the amendment, the company need to organise and keep track of all existing waste streams and their levels in accordance with the law and legislation. The thesis required for CABB Oy Kokkola is to gain a detailed understanding of their current waste management system in order to reduce and manage their waste and provide a clear understanding of their waste management system to their customers and site workers. Through the thesis research, CABB Oy Kokkola can improve the waste management practices according to the requirements of the new law and have an increased understanding of its current waste management system. Moreover, the thesis aims to determine the efficiency and cost analysis of the current waste management system. It can also help in identifying the main issues in their waste

management system, understanding their current procedures, and will help them to plan a new waste management system that can be implemented in future to reduce waste and the cost of handling.

The theoretical framework in the thesis can be divided into four main sections. In the first section, an overview of the company's history, an organisational structure will be discussed. In the second section, the updated legal requirements, and an overview of 5S will be discussed. The waste generated within the company will be classified and quantified in the third section. In the final section, the waste management system of the company will be discussed in detail, which will include the handling, storage, and end life of waste. The final part will also cover the information regarding the external waste management companies. In short, the thesis will look into the company's waste management system. This will include a review of the company's history and organisational structure, a detail of the types and amounts of waste it produces, an analysis of its waste management system, and an evaluation of the legal requirements that go along with it. The findings of the thesis will provide valuable insights for the company in developing a more effective and sustainable waste management system.

2 THE OVERVIEW OF CABB OY KOKKOLA

CABB Kokkola Oy is a custom manufacturing company of the CABB Group. The company is one of the leading manufacturing companies that produces fine chemicals in Central Ostrobothnia. The company is located in Kokkola Industrial Park, approximately 5 km away from the city centre. They produce plant protection products and intermediates for the agricultural sector. CABB group serves almost all sites in the chemical industry. They serve their customers by helping to feed the world's growing population (food and nutrition) and improving people's quality of life (health and personal care). CABB Kokkola exports all of their products. Their annual net sales are around 83 million euros. (CABB Presentation February 2023.)

2.1 History

Kemira began its journey in 1984 as a fine chemical manufacturer at Kokkola. At that time, they produced an herbicide for sugar beets at the Moni-1 facility. Later, in 1987, they expanded their business with the Moni-2 plant's production. Their first intermediate was produced in 1993, and they began providing custom manufacturing services to international companies in 1995. The company also produced pharmaceutical intermediates for some time in the past. However, they now focus on custom manufacturing fine chemicals for crop sciences. Between 1996 and 2011, the company underwent ownership changes that led to name changes from Kemira-to-Kemira Fine Chemicals and later to KemFine. In 2011, CABB AG acquired KemFine, and it now operates under the name CABB Oy as part of the CABB Group. (CABB Presentation February 2023.)

2.2 Production sites

CABB Oy Kokkola has three factories with a total of six production lines. The synthesis plant has four production lines; the MAP plant has one production line; and MONI-1 has one production line. Furthermore, they have an incinerator on site. CABB places a high value on safety, quality, sustainable development, innovation, and collaboration. The company has ISO 9001 quality certification, ISO 14001 environmental certification, ISO 45001 health and occupational safety certification. CABB has integrated with Responsible Care sustainability Program which focuses on sustainable use of natural

resources, production and product safety, worker well-being, and open communication and collaboration. Customers also conduct audits within the company. (CABB Presentation February 2023.) These certifications and audits demonstrate CABB's commitment to providing the highest level of services, products, and customer satisfaction. Picture 1 shows the area of CABB Oy Kokkola which is adapted from CABB Presentation February.

PICTURE 1. CABB’s production areas (adapted from CABB Presentation February 2023)

They have corporate sustainability targets for the climate, energy, products, society, people, and water. CABB group's goal is to reduce CO2 emissions by 30,000 tons every year, which is about 10 % compared to 2019 and a 10% GHG reduction per year by 2030. They are planning to increase energy efficiency by 20,000 MWh by 2025 and increase renewable electricity to 70% by 2030. By 2030, they aim to produce 99% flawless products and reduce waste by 10 % compared to 2019. In addition, by 2025 and 2030, they expect to have covered 90% and 60% of raw material suppliers with annual procurement over €200,000 by TfS, Eco Vadis, CDP evaluation, or CABB audits, respectively. They intend to increase the number of women in management positions by 25% by 2025. For workplace safety and health, they anticipate zero accidents, or an LTAR below 0.3%, by 2025. Finally, to save water, CABB expect to withdraw 10% less water as in 2019 by 2025, and 10% less wastewater by 2030. (Corporate sustainability target 2023.)

3 WASTE LAW AND LEGISLATION

Several changes have been made to the original Waste Law 646/2011 and the decrees on this act throughout the years as waste production has increased. Due to constant changes in legislation governing waste management, it is crucial that businesses ensure that their operations are in full compliance with the latest rules and regulations. The new waste act aims to encourage circular economy through waste reduction, recycling, and proper disposal practices to minimize the negative impact of waste on the environment and public health. The new waste act is based on the EU waste framework directive, where the mission is to prioritize waste generation prevention, reuse, recycling, and recovering the waste over incinerating and landfilling. The new amendment has become stricter to minimize waste generation and littering as much as possible. It also sets out measures for the prevention and reduction of waste and provides a target for achieving the highest possible recycling and recovery of specific waste streams. (FINLEX 714/2021.) The chapter will review the updated law and legislation. Picture 2 is the EU waste hierarchy published on the EU waste directive framework, where a guideline for managing waste in order is provided.

PICTURE 2. The EU waste hierarchy (Adapted from Waste Framework Directive 2023)

3.1 The new waste laws

According to the new waste law 714/2021, Section 5, "waste" is defined as any material or thing the holder discards, wants to discard, or is obligated to discard. Subsection 5b states that when waste is recycled or recovered, it is no longer considered waste. This is because the material has been transformed into a new product or material that can be used for a different purpose or the product has market demand with the technical competence of other equivalent materials or products. Finally, it is important that, the end material does not impose any threat to health and the environment. (FINLEX 714/2021.) Additionally, the subsection 5b states that, waste that has been through a recovery operation can be used for certain things if it meets certain criteria, such as acceptable waste input materials and allowed treatment processes and techniques. The recovered product from waste also need to meet certain standard including a limit value for pollution, management system standards that explain compliance with end waste criteria, and a statement of conformity. The company must rely on the environmental permit authority for deciding the end-of-waste status. The authority will decide that on a case-by-case basis and will consider the limit values for pollutants and any possible hazards or harm to health, or the environment caused by the material, in accordance with the provisions of European Union legislation, government decrees, and the Environmental Protection Act. (Waste act 494/2022.)

According to the act, the initial user of the material must ensure its safety and compliance with laws relating to chemicals and products (Waste act 494/2022, § 5). The amendment waste act (714/2021) section 8 obligated the product producers to design a process that uses a small number of raw materials, raw materials from waste, reuses the product, or uses the recovering components in the process. The producers should avoid using hazardous raw materials as much as possible. The process must prevent hazardous waste generation and create nonhazardous waste. Moreover, the packaging of the product should be limited. To maintain the new act a producer should produce more efficient, durable, recyclable, and reusable products. A producer should not make any product that will be harmful to the environment or be a waste. The regulation of placing the product on the market should have clear labeling, sorting, and waste management information. (Waste act 714/2021.)

Additionally, the users and waste management companies should have necessary information and spare parts should be available for safe re-use. Whoever sells the product must ensure it meets the legal requirements, and if the product creates harmful waste at the end of its life, it will be restricted or conditioned.(Waste act 714/2021, § 8.) The new act says that the polluter should pay the waste management and other operation costs. Municipalities and waste collectors are required to offer companies a

fair opportunity to obtain eligible waste for re-use with a signed agreement and cost-effective collection. Nevertheless, these entities must also guarantee that no adverse impact will befall companies seeking to re-use waste. To prioritize re-use, recycling, and recovery, various types and forms of waste must be collected separately. Exemptions from separate collection are permitted under those conditions only. Professional waste operators are required to eliminate hazardous contaminants before or during recovery. (Waste act 494/2022, § 15).

3.2 Targets for preparing for the reuse and recycling of municipal waste

Under the Waste Act, the government requires that people recycle at certain rates and within certain time frames. The first target is to recycle at least 55% of municipal waste by weight by January 1, 2025, at the latest. The second target is to recycle at least 60% of municipal waste by weight by January 1, 2030. The third and final target is to recycle at least 65% of municipal waste by weight by the end of 2035, at the latest. (FINLEX 978/2021, § 23.) According to the waste decree 978/2021, it is necessary to calculate the waste generated by recycling and reusing in order to reach the goal. Municipal waste prepared for re-use is calculated as the weight of products that have undergone necessary checks, decontamination, or repairs allowing re-use. The weight of recycled municipal waste is calculated as the weight of waste that is transformed into new products, materials, or substances, after unsuitable waste materials have been removed. The calculation of municipal waste prepared for reuse and recycling must comply with the Waste Framework Directive and Implementing Decision (EU) 2019/1004 of the European Commission. (FINLEX 978/2021, § 24.)

3.3 Municipal waste legislations

Waste collection is the first and most important step for the waste management system. In the new waste decree, clear instructions about waste collection area, collection and transported method are given. According to the Waste Decree 978/2021, the waste collection area should be in a place that is easily accessible and there are enough sealed containers, deep collection tanks, waste pallets, or other waste containers that are appropriate for the different types of separated waste collection. A waste container's lid or front wall should prominently display information about the waste being collected, collection details, and sorting instructions. In addition, the collection system will be safe so that using and

emptying waste containers does not put any person in danger. Regional reception points are responsible for keeping records on how full containers get and making sure those containers get the regular maintenance and cleaning they need. Moreover, the decree obligated to keep the reception area and its immediate surroundings clean and make sure the storage area has a solid foundation including sturdy ground to support the weight of the waste, weatherproof roofing, and water discharge and treatment facilities to avoid any potential damage. Lastly, it is suggested to stop unwanted waste from being delivered and to make sure that anyone who brings waste follows the rules by putting it in the right waste containers. Section 11of the waste decree says that the waste must be transported in sealed containers or vehicles that cannot leak to protect the environment and avoid accidents. (FINLEX 978/2021, §§ 10-11.)

The new law became stricter about segregated waste collection. The law requires that collectors collect all the packaging waste, such as glass packaging, cardboard packaging, and metal packaging, separately. The act also recommended separating out textile waste. According to the new Waste Act, the remaining waste that cannot be separated after collecting all the separated waste is called "mixed waste". (Waste act 494/2022.) According to the Finnish Waste Decree 978/2021, every workplace must arrange separate municipal waste collection for each property. This applies to organizations that generate more than ten kilograms of biowaste per week and do not process it on a limited scale on their premises. Additionally, if an organization produces at least 2 kilograms of glass packaging waste or 2 kilograms of metal packaging waste and other small-sized metal debris weekly, they must arrange separate collection for these wastes. It is advisable to separate plastic, paper, cardboard, glass, and metal, garden and park waste, textile waste, and bulky end-of-life goods wherever possible to reduce the amount of waste sent to landfills and promote a more sustainable and environmentally friendly society. To ensure proper recycling or reuse, waste with the same materials should be collected together. (FINLEX 978/2021, § 21.)

3.4 Hazardous waste legislation

CABB generated hazardous waste from chemical processes, therefore this subsection is crucial. According to the new waste act, hazardous waste is defined as waste with a hazardous property, whereas non-hazardous waste is defined as waste without a hazardous property. The legislation aims to regulate the generation, transportation, treatment, and disposal of hazardous waste to protect human health and

the environment from its harmful effects. It also imposes penalties for non-compliance with the regulations. The Center for Economic Development, Transport, and the Environment can decide that waste classified as hazardous is not hazardous if the waste holder proves it does not display hazardous properties or if the waste is hazardous if it has harmful properties. The Regional State Administrative Agency makes decisions on environmental permits and notifies other authorities. Additionally, the Finnish Environment Institute sends summaries of decisions to the Ministry of the Environment every six months. (Waste act 494/2022, § 108). Hazardous waste cannot be mixed with other waste or substances unless it is for treatment and has a permit from the authorities (Waste act 494/2022, § 17).

If hazardous waste is accidentally mixed, it is required by law to separate the waste to ensure the safety of both the environment and people (Waste act 494/2022, § 17).The Waste Act decree 978/2021 says packaging for hazardous waste must be tightly sealable and resealable so that it can withstand repeated stress, transportation, and storage. Containers and sealants must not react with hazardous waste. The name of the waste, the holder's identity, and any warnings or instructions required for management and safety must all be printed on the packaging of hazardous waste. The compounds that produce the primary hazardous properties and the warning labels required by the CLP Regulation must be included on the package if the hazardous waste has one of the hazard qualities HP 1-8, 10, or 11. When dealing with hazardous waste of unknown compositions, it is advisable to label the packaging with suitable danger pictograms and hazardous statements. The danger pictograms can be identified as GHS02, GHS06, and so on, along with hazard statements such as H225, H228, H301, H311, and H331. Additionally, precautionary statements such as P233, P235, P280, P403, and P405 should be included to ensure the safe handling and disposal of the waste.(FINLEX 978/2021, § 8.)

3.5 Waste transporting and record keeping legislation

The new waste act (714/2021) obligates waste shipping operators to keep track of waste information and send a summary to the Finnish Environment Institute every year. If an operation produces hazardous or POP (Persistent Organic Pollutants) waste, is subject to an Environmental Protection Act permit, or creates at least 100 metric tons of waste annually, the operator is required to preserve waste records. The rules about keeping records and explaining them apply to transporting, brokering, and collecting waste as well as treating it professionally or at certain installations. Section 118, subsection 1 of the new waste act says that records must be kept about the waste that is made, collected, transported,

and treated. (Waste act 494/2022.) These records must include information about the type, amount, origin, and delivery site. The records must also include information about how much waste is made compared to the amount of revenue gained, the number of employees, or some other measure that is similar, as well as information about the products and materials made through waste recovery. According to the new Waste act, before transporting hazardous waste, a transfer document must be prepared, detailing the waste's nature, quantity, origin, delivery site, treatment method, waste receiver, and transporter. The file must be in an electronic format that a computer can read, with the ability to track changes and make it easy to find any important information. Data must be confirmed by the waste holder, carrier, and transferee, and it must be kept for at least three years. There is an obligation on the part of the trash holder or carrier to report information from the transfer document to the registry. (Waste act 494/2022, § 119.)

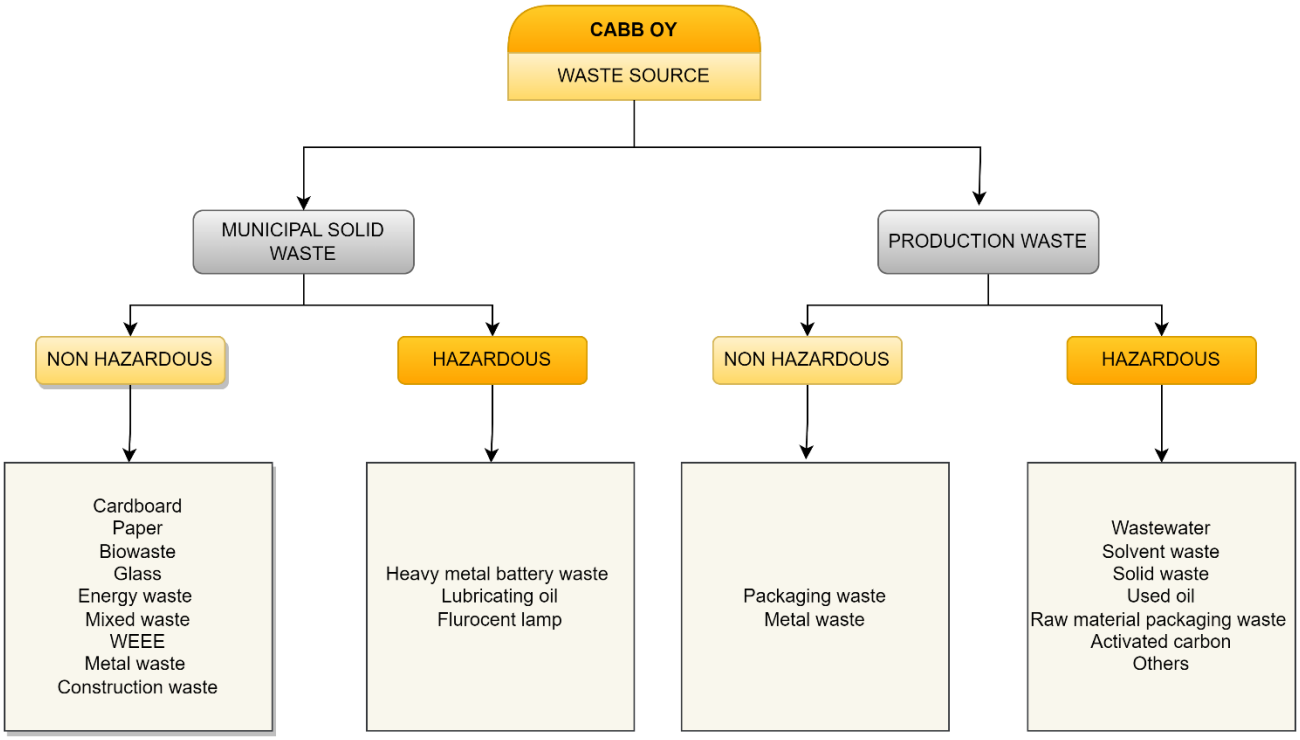
4 THE OVERVIEW OF 5S PROJECT

Currently, CABB Kokkola has started the 5S development within the company. The 5S initiative is an excellent tool for workplace organization, visible management improvement, and process standardization (Michalska and Szewieczek 2007). By implementing the 5S methodology in waste management, the company can ensure a systematic and organized approach to waste collection, sorting, and disposal. This can lead to improved efficiency, reduced costs, and a safer working environment for employees. The 5S method in the waste collection will also help the company keep the same ideology as new laws and legislation since it will help reduce unnecessary waste generation and promote the uniform waste collection. The fundamental goal of 5S is to eliminate non-value-added processes by developing standardized procedures for carrying out tasks. Therefore, an effective 5S program enhances productivity, quality, workflow, and worker safety.(Visco 2017.) In this chapter, we will provide a brief overview of the 5S method. Further details regarding the proper method for separate waste collection, in compliance with laws and regulations related to 5S, will be discussed in chapter 6.

For the 5S to work well in the company, everyone needs to understand what it means. The Japanese words that start with the letter S inspire 5S. The 5S project involves five steps: sort, set in order, shine, standardize, and sustain. Each step is crucial in creating a clean, organized workplace that promotes efficiency and reduces waste. In Japanese, it is called Seiri. Sorting is the practice of going through tools and materials and keeping only essential items, resulting in fewer hazards and clutter. Seiton emphasizes the importance of arranging tools, equipment, and materials in order for efficient access. In Japanese companies, Seisho is a daily activity to keep the workplace clean and neat. Seiketsu standardizes organization, storage, and cleanliness to ensure control and consistency. This step is basically to ensure that the first three steps have been followed. It means always doing things the right way and making sure everything is in working order and safer at the location. (Michalska and Szewieczek 2007.)

5 THE CLASSIFICATION OF WASTE GENERATION

This chapter will discuss the waste generation, collection, and end-of-life at the site. As a custom manufacturing company, CABB Kokkola involves many processes, such as manufacturing, processing, and packing various chemicals, and thus generates a significant amount of waste yearly. CABB Kokkola has around 250 employees. Every year, waste increases as the manufacturing location expands. The majority of waste that CABB produces is hazardous waste. (Appendix 1) All of the waste made on the production lines, labs, storage areas, and offices can be put into two groups. The first category is municipal waste, which includes paper, bio waste, packaging waste, plastic, and other mostly recycled or recovered materials. The second category is production waste, wastewater, solvents, and other hazardous waste that is disposed of safely. Picture 3 shows the classification of waste generated at the company.



PICTURE 3. The classification of waste sources that generated at the company

5.1 Process waste

The production process generates a considerable amount of process waste. Along with the process waste, different fractions of municipal waste, such as packaging waste and metal waste, is produced. Most process wastes are hazardous waste. However, manufacturing waste quantities fluctuate annually based on the products being made. CABB incinerated most of the process waste in own incineration plant. About 20% of all production waste goes to other waste management companies. The types and amounts of process waste that goes to other company in 2022 were presented in Appendix 1. Figure 1 illustrates the composition of production waste that goes to other waste management companies. The figure shows that about 62% of the production waste that goes to other waste management companies is wastewater. Solvent waste is the second largest amount generated, accounting for approximately 33 percent of the total production waste that goes to other companies which end in landfilling eventually. Moreover, the activated carbon waste is only 4%, and the solid residue waste is 1%. The other waste includes cleaning waste, used oil, and laboratory wastes, which are less compared to the solvent waste and wastewater. The recovery rate for the Process waste that goes to external companies is 42% while rest are incinerated.

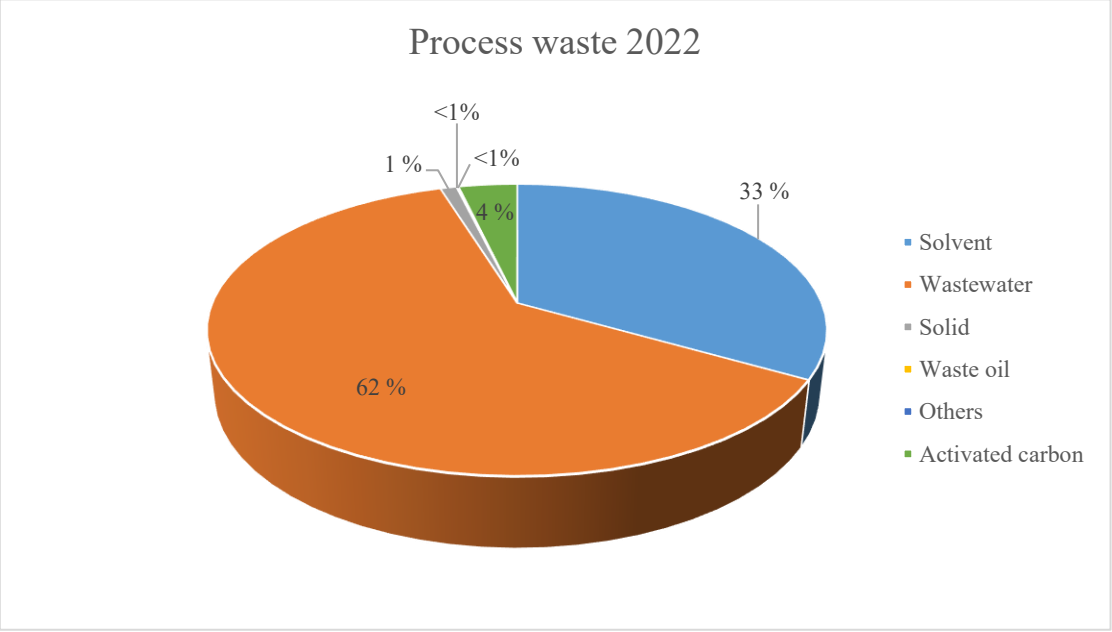


FIGURE 1. The process waste composition that goes to external company.

5.2 Municipal waste

Every year, a substantial quantity of municipal waste, such as biowaste, paper waste and other municipal waste, is generated in production areas. Nearly all of the municipal waste is recycled by external waste handlers and all of those are recycled or recovered. The types of municipal waste and the quantity of waste generated in the CABB area in 2020-2022 were discussed in appendix 1. Figure 2 displays the waste composition the company produced in 2022. The most significant fraction of municipal waste is packaging waste, which includes wood packaging, containers, barrels, laboratory vials, and glass packaging. Almost 80% of the packaging waste is recycled or recovered. In addition, the metal waste fraction is slightly smaller than packaging waste, which is 37% and includes ferrous (iron and steel) and non-ferrous metal waste. Another noticeable waste fraction is energy waste, which contains plastics, rubber, light straps, dirty papers and cardboard, paper towels, etc. The percentage of energy waste production is 14%, cardboard waste is 5 %, and mixed waste is 4%. In addition, biowaste is only 2 per cent of all MSW. Municipal hazardous, electrical, construction and glass waste are less compared to other waste.

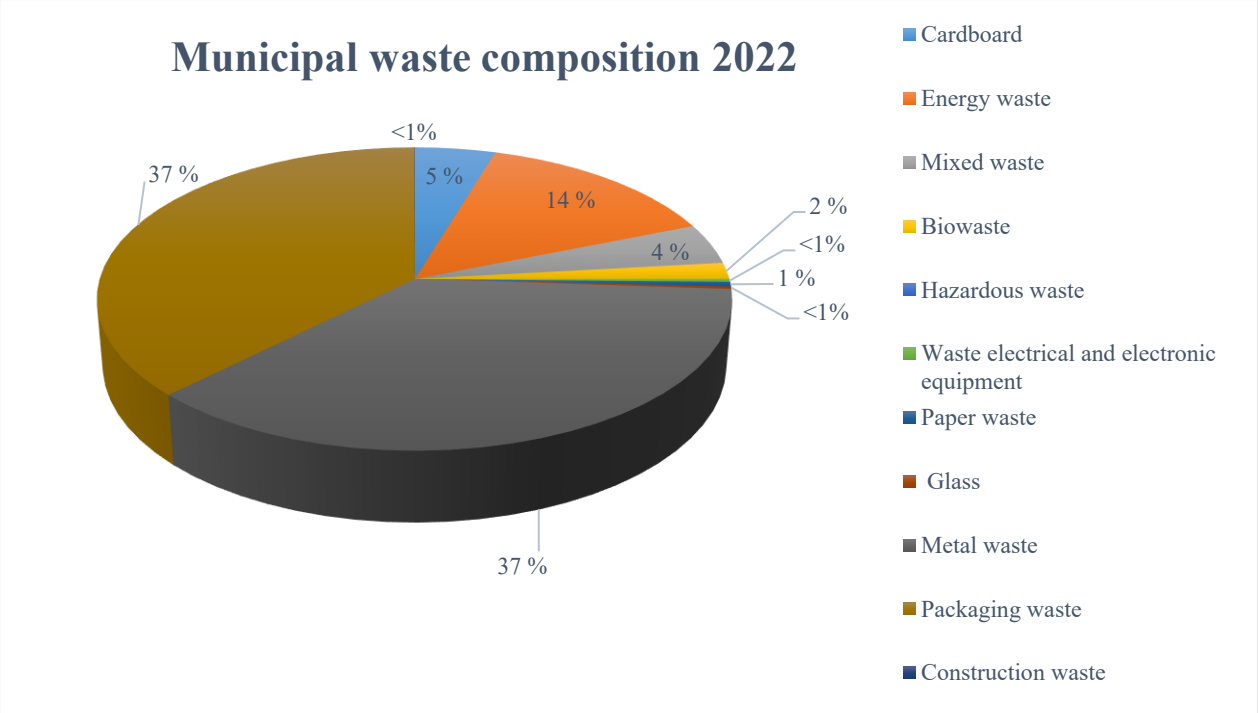


FIGURE 2. Municipal waste compositions in 2022

6 WASTE MANAGEMENT SYSTEM WITHIN THE COMPANY

Currently, all the municipal solid waste are handled by the external company. The CABB Kokkola has own incineration plant, where only process waste such as solvent waste and wastewater is incinerated. A small portion of process waste goes to other company for recycling and disposal. In 2022, around 20% of total waste went to external companies for recycling or disposal. This chapter will review the current waste management situation within the company and will provide waste sorting instruction.

6.1 Waste sorting and collection point

The CABB Kokkola area consists of three factories, an office building, temporary office barracks, a fire station, tank area, packaging, and warehouse building. Each places have indoor, outdoor waste collection points, for example each building has indoor waste collection points in every floor. The outdoor waste collection points scattered all over the CABB area. Currently 5S method is being integrated in the company. As a result, the working places and waste collection points are getting more organized. Recently, the 5S method is only implemented in the synthesis plant. At least five types of waste containers are on every floor in the synthesis plant. They are energy, mixed, cardboard, hazardous incinerable waste, and metal. Later on, the 5S is planned to implement in the whole area.

In picture four, the waste collection points at CABB are depicted in the map. CABB has designated four primary waste collection locations, identified as points one, two, eight, and nine in the accompanying images. Additionally, scattered throughout the area are other waste collection points, each marked with one or two types of waste accepted. The images use color-coded dots to represent the different waste types: red for hazardous, black for mixed, blue for metal, green for cardboard, orange for energy, brown for wood, light blue for electronic waste and purple for packaging. The first main waste collection point is situated in front of the synthesis plant and offers four types of waste compactors for hazardous, mixed, energy, and cardboard waste. Another significant waste collection point, labelled as point two and located in front of Moni-1 in the images, accepts nearly all types of waste containers. The final main collection point is located near the hazardous waste storage area. In addition to these primary collection points, a large wood waste collection point is situated in front of the MAP factory, while a large metal collection point can be found at the rear of the synthesis plant.

PICTURE 4. The map of the waste collection points at CABB Kokkola

Before transporting the waste, most solid waste is pressed in the compactors. There are many waste compactors all over the area labelled in the map. There are four types of waste compactors for different waste streams (energy, mixed, cardboard, hazardous incinerable solid) located in front of the synthesis plant. There are three rest compactors, with two waste compactors situated near the Moni-1 region and the third one located near the incinerator area, one smaller waste compactor for big raw material bags is located inside the synthesis plant. Usually, when the waste containers get full, they are dumped into the waste compactors and pressed. When the waste compactors fill up, the waste management company transport the waste to be recovered or disposed. After processing, the harmful liquid waste is kept in IBC containers and barrels and stored in a designated hazardous waste storage area. The process waste intended for onsite incineration is stored in the tank farm area within a storage tank.

6.2 Separate waste collection

Waste collection is the first stage of waste management. Picture 5 shows the separate waste collection point according to 5S method in the synthesis plant. In this picture, the orange container contains energy waste, the black container contains mixed waste, the red one contains solid incinerable hazardous waste, and the green container contains cardboard waste and the blue container contain metal waste. (CABB Intranet 2023.) In this section the waste sorting will be discussed.

PICTURE 5. Waste collection point in synthesis plant following the 5S method. (CABB Intranet 2023)

6.2.1 Energy waste

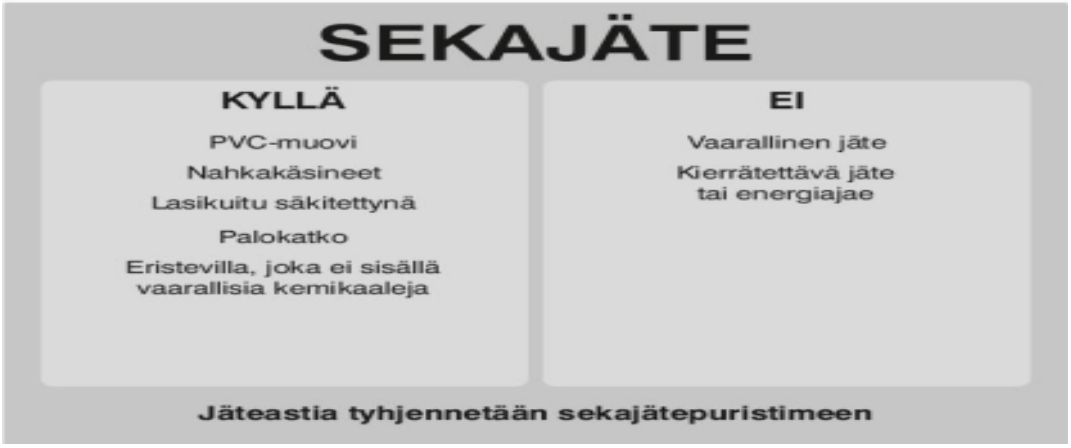
Energy is a kind of waste that cannot be recycled but can be recovered as fuel. (Energiajae - yritysasiakkaat, 2023) The energy waste includes all types of plastics, under gloves, nitrile-coated work gloves, small wood waste, dirty or wet cardboard and paper, rubber waste, and other waste that cannot be recycled. However, the waste does not include PVC plastic, leather gloves, chemical gloves, protective equipment contaminated with chemicals or metal, hazardous waste, or waste that can be recycled

or recovered. Energy waste should be emptied into the energy waste compactor. (CABB Intranet 2023.) Picture 6 explains what types of waste can be collected in energy waste bins.

PICTURE 6. The energy waste sorting instructions (CABB Intranet 2023)

6.2.2 Mixed waste

According to the new waste law, mixed waste is waste that cannot be separated. The mixed waste includes PVC plastic, leather gloves, fiberglass, fire insulation and insulating wool containing no hazardous chemicals. The waste does not include hazardous, recyclable, or energy-related waste. Mixed waste should be emptied into the mixed waste compactor. (CABB Intranet 2023.) Picture 7 explains what types of waste can be collected in mixed waste bins.



PICTURE 7 . The mixed waste sorting instructions (CABB Intranet 2023)

6.2.3 Metal waste

Metal waste includes waste that contains more than half metal, envelop seals, all grades of steel, empty aerosol cans, and empty paint cans. The waste cannot contain hazardous waste. The waste container should be emptied onto big metal waste containers. (CABB Intranet 2023.) Picture 8 explains what types of waste can be collected in metal waste bins.

PICTURE 8. The metal waste sorting instructions (CABB Intranet 2023)

6.2.4 Cardboard waste

Cardboard waste only includes brown cardboard, corrugated board, kraft paper, and other clean and dry cardboard. There is no need to remove tapes, staples, and hooks, and the container should be emptied into a cardboard compactor. (CABB Intranet 2023.) Picture 9 explains what types of waste can be collected in cardboard waste bins.

PICTURE 9. The cardboard waste sorting instructions (CABB Intranet 2023)

6.2.5 Solid incinerable hazardous waste

This type of waste consists of used chemical gloves and protective overalls, cleaning tools, ABEK filters, personal protective equipment contaminated with chemicals, and product and raw material dust packed in a waste bag that was collected during cleaning. However, the waste does not include aerosols and other pressurized packages, liquids, waste oil, or significantly contaminated waste such as used absorbent mats, hazardous chemicals containing insulated wool, or liquid oozing waste. The significantly contaminated liquid containing waste packed in a barrel. The hazardous waste bins are emptied into the hazardous waste compactor. The barrels are stored in the waste storage area. (CABB Intranet 2023.) Picture 10 explains what types of waste can be thrown in Solid incinerable hazardous waste bins.

PICTURE 10. The solid incinerable hazardous waste sorting instructions (CABB Intranet 2023)

7 METHODOLOGY

In Finland, it is mandatory to keep records and track the waste management system within the company (Waste act 494/2022). Otherwise, it will harm the company's reputation and grant environmental permits. The thesis identifies waste generation sources and organises and categorises all kinds of waste streams. In addition, the thesis analyses the cost of the waste management system over the past two years. The thesis study is done using the quantitative research method. Most of the information is collected from the company's internal database system or intranet. The waste generation data, including the waste amount and cost for different waste management companies, was collected from the CABB's personnel and other waste handling companies' personnel. To observe the company's current situation and understand the raw data, the entire CABB factory area was visited twice in this research.

In the first part of the thesis, the data was summarised and categorised into different waste streams, and the analysis results were presented in tables and graphs in the waste generation chapter. The recovery rate and the total waste amount from the data analysis help to better understand the waste management system within the company. It also helps organise their waste categorization. In addition, the area's map was analysed and used in this thesis. In the second part, the cost of each type of waste was calculated in Excel. Based on the calculated data, different graphs and charts are used in this thesis. The study's limitations the amount of data that was analysed was extensive, and some expense files failed to identify waste accurately. As a result, summarising was often complicated.

8 DATA AND RESULTS

As previously discussed in Chapter 5, CABB generates different fractions of waste. A brief summary of the company's waste generation and amount was presented in Chapter 5. This chapter presents a comprehensive analysis of the cost of the waste management system for five external companies. The purpose of the cost analysis is to find the per unit cost of each type of waste and using the findings for minimizing the waste cost and optimizing the better strategies for waste management practices in future. The per unit cost includes transport, sorting, and other types of costs associated with that waste handling. For each company, at least two-year costs were calculated, summarised, and compared. (Appendices 3 and 4.)

8.1 Process waste

As previously discussed, CABB primarily incinerates the majority of their process waste in their own incineration plant. The remaining sent to WMC (waste management companies) for disposal or recovery. Most of the waste are incinerated. The study compared the own incinerated waste cost with waste management company’s waste handling cost. Comparing the prices for waste handling between WMC and CABB's incineration plant, it is notable that using own incinerated plant is more cost efficient. (Appendix 3). The study analysed two-year waste cost, which is presented in appendix 3. The waste varies in the past two years as it depends on the different production (Appendix 3). WMC assess all kinds of waste carefully and incinerated them accordingly. The most expensive waste in 2022 was laboratory waste, and the cheapest waste was wastewater.

8.2 Municipal waste

CABB has connected with many external WMC. As previously discussed in Chapter 5, the largest amount of municipal waste was metal waste and wood packaging waste. CABB gets a benefit from the sale of metal waste (Appendix 4). Interestingly, the majority of municipal waste is recycled, which is great for the environment. However, recycling hazardous waste can be quite costly compared to regular paper waste. The study investigates the amount and cost of different municipal waste fractions in appendix 4.

9 DISCUSSION

The key findings of the analysis (Appendices) will be discussed in this section. The aim of the cost analysis was to find the per unit cost so that it would be easier to identify the expensive costs and plan effective waste management strategies to reduce waste and save money where it is possible. Since CABB send their chemical waste to two different companies, the cost of waste disposal may depend on the policies and practises of individual companies. Through the analysis, it has been discovered that disposing of hazardous waste is significantly more expensive than non-hazardous waste. Interestingly, utilizing CABB's own incineration plant proved to be a cost-effective solution compared to outsourcing to external companies. It should be noted that the composition of process waste varies each year, making it difficult to compare prices consistently. Additionally, prices for the same types of waste have fluctuated over the past two years. This can be attributed to the fact that the waste may contain different types or quantities of hazardous properties from the previous year.

For instance, the cost of laboratory waste has decreased in 2022. In terms of municipal waste, mixed waste costs more than twice as much as energy waste. Here in this thesis work, only the total amount and total cost were calculated. The waste cost includes sorting, storage, transportation, and weighing costs. As the waste cost associated with other cost, this could be another reason for price variation in similar types of waste. Another important reason is that the waste end life plays a significant role for increasing the waste cost. Some waste might go through multiple processes for disposal or recovery. Besides, some waste needs to be sorted, thus increase the disposal or recovery cost.

10 CONCLUSION

The main goal of the thesis was to determine the sources of waste production, its quantity, end life, and the expenses of the different waste streams at CABB Kokkola. Due to the company's agreements with multiple external waste management companies and a high volume of waste generation, it was challenging to track all waste-related information. In addition, educating employees on the entire waste management system, from generation to disposal or recovery, is crucial to maintaining the company's operation and transparency of sustainability to their customers. Therefore, the study analysed all the above-mentioned aspects of the company's waste management system. Moreover, the study highlighted the importance of complying with new regulations, which is essential for the company's operations. The company has consistently followed legal requirements, and it was necessary to review and ensure compliance with updated regulations and laws continuously. As previously discussed, the law encourages to collect uniform waste as much as possible to maintain circular economy. A discovery of this study is that a considerable quantity of plastic waste is disposed of in energy waste containers, ultimately leading to incineration. The study proposes a solution that involves separating plastic waste into dedicated containers and processing it through plastics recycling. This approach is not only beneficial for the environment but also cost-effective.

The study also emphasised the significance of the company's recent adoption of the 5S methodology. This approach has proven to be highly effective in ensuring workplace safety and reducing waste. The study provided valuable insights into proper sorting procedures and waste disposal locations. Adopting these guidelines can help create a more organised and efficient work environment that ultimately increases worker productivity. The author conducted extensive research by gathering data from both internal and external sources, reviewing and comparing documents, and analysing them. The amount of waste were calculated and categorised based on the collected data and its associated costs. The analysis revealed that hazardous waste exceeded non-hazardous waste. It was also found that non-hazardous waste could be recycled or recovered, whereas hazardous waste was costly to dispose of.

The study discussed the external companies' waste management practices and end-of-life waste disposal. It provided a clear picture of expensive, cheap, and unnecessary waste that was being managed externally. To save money and lessen its impact on the environment, the company can adopt sustainable practices and reduce waste. A great way to achieve this is by finding ways to reuse waste material.

It is also helpful to use the own incineration plant for production waste whenever possible. Furthermore, implementing effective hazardous waste segregation, sorting mixed waste to the best of the company's ability, and adopting a uniform waste collection system can significantly lower expenses. By proactively managing waste, the company can improve its bottom line and contribute to a healthier planet for future generations. Overall, a comprehensive waste management system is crucial for ensuring a sustainable future. By incorporating updated laws and conducting cost analyses, CABB can effectively manage its waste and reduce its environmental impact. Continuous research and reorganising of waste management practices are needed to improve efficiency and maximise environmental benefits in the future.

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