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Waste Management in Hospitals, Case Project with Ecosir Oy and Eksote

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Abstract

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This thesis was created to evaluate the current situation in hospital and health-care waste management, and to give solutions and improvement ideas, with the help of a case project. The case companies in this thesis are Ecosir Group Ltd and Eksote, which was involved in the project to evaluate South Karelian central hospital's current waste and laundry management. The research problem was defined in the following way: How is waste management in hospitals handled in the current time, and how can we improve in these aspects from the hospital's point of view, as well as patients. Also, what are the future plans for waste managing in hospitals?

The study includes information collected both from literature and from the results found in the case project. The theoretical part was mainly based on existing information found on books online, and it was written alongside the empirical parts, to compare and combine theory and practice together.

The thesis will present current working methods on waste management in hospitals and will evaluate them from different aspects. The theoretical part focuses on answering why waste management in hospitals is wise to keep in good control. Empirical part will focus on giving ideas how to improve from this and give a case example.

Keywords: hospital, waste management, hospital waste management, logistics

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1 Introduction

The topic of the thesis is based on figuring out hospital waste management. It also includes facts and information about hospital logistics focusing on waste and laundry management, giving inside information on South Karelia central hospital's management. The basic theoretical parts are gathered from several online publications, while the general empirical part is based on a case project demonstrated in this thesis.

1.1 Background

The topic chosen for this research came first of all from my own involvement towards South Karelias Central hospital. Secondly I was involved in doing a group project to Ecosir Group Ltd and to Saimaa University of Applied Sciences. The project was focused on waste and laundry management of South Karelia Central hospital, and will be focused with more information in the latter parts of this thesis. The third part for choosing this topic is the current logistic situation in facilities, and my own interest in increasing my knowledge of these areas. The logistic process in facilities, mainly in hospitals is a difficult, but very important for companies in the current world, as it involves parts from all around the business process. The decision to choose this topic was not easy, but came to be quite a settlement, after first finishing the project itself, and getting a more in-depth picture on hospital waste and its management.

1.2 Objectives

The objectives of the thesis are to find out what is meant by waste management in hospitals, and how it affects hospitals and their customers. What can be done to make hospital waste management more efficient. The main objective for this thesis is to give some insight on what is going on in the hospitals from waste logistic side, and how the process works. The case project was optimal for this, as we were able to review how waste was being handled at the South-Karelia central hospital. The objectives to demonstrate what types of waste are created in hospitals, and how they are detrimental to human health, and hospitals cash flow. The objective was to find some kind of a link between waste and costs, but

the possibilities to demonstrate this option were little, so information from those parts was minimal.

Focusing on the project aspect of this thesis, there have been previous theses concerning the same subject from different hospitals by other students. These theses give their own image of hospital logistics, but only to a certain degree.

1.3 Delimitations and limitations

The study focuses on South Karelian area, prior to the focus on the project accompanied with Ecosir Group. As the South Karelian Central hospital resides in Lappeenranta, a town of approximately 73 000 occupants, the thesis may not give a realistic picture on for example Finland's other hospitals waste management and logistics, although the information given and presented in the thesis will have opportunities to be associated with similar studies.

The main focus of the project are the people associated with hospital logistics, and people who can perhaps take this idea onwards to other facilities, as it now will give an image of the hospital logistics only. Also as Ecosir Group has done similar projects in different cities in Finland earlier with different student projects, the data gathered from these projects may differ depending on focus of the project group. A quite noticeable limitation for this thesis, is the fact that it does not technically focus on the business side of waste management processes. The fact that the thesis comes out more as an ecological and ethical text, is based on the fact that not much information was found on the costs of hospital waste management in other areas. Also the figures that were calculated for the case project, were considered confidential and could not be included in the thesis.

1.4 Project companies Ecosir Group and South Karelia Central hospital

The project which will be discussed in the thesis will include these two companies as a practical part for the thesis. Ecosir Group Ltd is specialized in energy-efficient vacuum waste pipeline transfer solutions (called AWCS/PWS systems). The wide system portfolio includes number of automated solutions for mixed and organic waste (BIO waste), energy waste, paper/cardboard material and linen/laundry. (Ecosir Group 2015.) The company itself has over 25 years of working history

from environmental technology, making it one of the oldest companies in the business. Shortly their revenue is around 3million, and employ12 people. As for the South Karelian Central Hospital, they have around 1250 employees and has been operating on its premises since 1955.

1.5 Theoretical framework

The theoretical framework was built around hospital waste management, and its effects on people and hospitals themselves. The main source for this thesis is the book Safe Management of Wastes from Health Care Activities by Chartier, Emmanuel and Pieper 2014.

The theoretical framework in this thesis, will give a small insight into waste management in hospitals from the case projects point of view. The basis hypothesis in waste management in hospitals, is that the waste is not handled in the most efficient way, at least in Finland.

1.6 Study questions and research method

The main study questions to be investigated in this report will be:

- What is meant by hospital waste?
- How is it managed?
- How can hospital waste be managed more efficiently in the future from hospitals perspectives?
- How is waste collected and sorted in the case project?

The research method was to gather the theoretical part of the thesis from several online sources. Mainly online books focusing on waste management, such as Safe Management of Wastes from Health-care Activities by Chartier et al. 2014, were used. Also theoretical part for the thesis was found from online publications. The case project itself was used to give an insight on what's actually is going on in hospital waste management, and the project gave a decent image on the problems and methods on waste logistic processes.

1.7 Study structure

The thesis consists of an introduction part which will first answer questions concerning the basic idea of the thesis; such as the main questions and basic information about the case. The theoretical part of the study will involve information about hospital waste management, meaning how waste is handled in hospitals from the starting to the end point. Examples of this will be given out as well.

The empirical part includes the group project part made together with Ecosir Group and Eksote (Social and health care district of South Karelia). The empirical part gives an image of the waste- and laundry management in South Karelia's Central hospital, and the logistic findings; by not forgetting to mention the results from the project. Also with the information gathered from the project, the thesis will give a deeper insight on possible future logistical solutions for hospitals to consider. As running a hospital is also a lot about handling money, it is possible to give out new ideas for upcoming hospital constructions or expansions, as in Lappeenranta. Research results will also be included in project results, with possible pictures of the projects progress depending on the companies' approval.

2 Wastes in Hospitals

Waste created in hospitals and health-care centers is large in quantities. When a person goes to the hospital to get a blood test, that itself creates waste from the needle, its packaging, tape and possible disinfection items. When thinking about hospital waste, most of it is your everyday waste, cardboard from the packages, plastic etc.

Waste created in the health-care area is not only your everyday waste, but also the special and hazardous waste, which causes a risk throughout the waste management process. This is why hospitals in Finland are constantly reminded to take care of their waste management processes, to ensure their safe handling, transportation and landfill, as well as proper marking of hazardous waste. The need for proper waste management in hospitals can be listed down to several points, when focusing on the health point of view. The U.S Health-care system creates around 5,9 million tons of waste from health-care facilities annually. (Valerie 2015)

- Injuries from sharp wastes, such as needles can lead to infection for both hospital personnel and waste handlers.
- Risk of infection for people that come across waste from hospitals. Possibility for this is higher in third world countries, where scavenging for valuable wastes is also a thing.
- Risks associated with hazardous chemicals; drugs to persons handling wastes at all levels.
- Air, water and soil pollution directly due to waste or defective incineration. (Praveen Mathur et al. 2012.)

As for why waste management in hospitals is a thing to be mentioned for hospitals as well, is the sheer fact that of what waste can do to cause financial costs. The main goals of a hospital are to treat its patients in the most efficient way, including the treatments and basic wellness as well as comfort in the hospital. Waste is being created every second in hospitals, and if the logistic part is not handled correctly, it can start to cause problems for the hospital staff and patients. Waste piling up in the waste containers in the hallways or in the garbage rooms cause odors, safety risks in many different categories, and are basically a waste of space.

The work done in hospitals and health-care centers is vital for our life and health, but the waste created to make mankind healthier represents a real problem for nature and humans alike. It is a known fact that improper management of waste generated in hospitals causes direct health impacts on the community (WHO 2015).

What is meant by health-care waste is that it is waste that does not come across in other walks of life. Even though some of the waste created in health-care section is not considered to be hazardous, they are still treated as such, and the waste amount created from this is approximately five percent of the total waste amount.

2.1 Finland and waste

There has been a set goal for national waste management in Finland by the ministry of environment, leading to the point that in year 2016 only half a million tons

of community waste would end up in the landfill. This is when the landfill/garbage dump directive case will come into effect, prohibiting organic matter from landfills. (Ministry of Environment 2016). According to the said organization, the main goals for the national waste plan are:

- To prevent waste from being created
- To enhance material recycling and biological reuse of wastes
- To increase incineration or unrecyclable waste
- To ensure safe handling and landfill management
- To decrease the emitting of greenhouse gases associated with waste and its management.

It is to be mentioned that incineration of waste in Finland can be more difficult than thought to be. As a great amount of hospital waste are handled as hazardous waste, it requires incineration. Back in 2013, there were only two waste incinerator plants in Finland that take organic waste to incineration. As the upcoming directive states: hospital waste must be burned, meaning blood, fabrics, amputated limbs and dead fetuses. (Kankaanpää 2013.)

As for what comes to the incineration plants in Finland, appropriate plants locate only in Riihimäki and Vantaa. It means that waste created in hospitals north from the Southern part of Finland would have to find a way to transport their waste to these plants. The upcoming directive change will more than likely increase the costs of waste management in hospitals, creating a marketing window for waste transport companies and upcoming incineration plant plans. In the year 2013 there were plans to build an eco-power plant to Northern-Savo, Leppävirta; but the plant does not provide the possibility of incineration of hospital waste. The newest incineration plant opening for productional usage opens in 2016 in Tampere. The new plant has set equipment for the upcoming waste management directive, making it the third incineration plant that takes hospital waste to incineration in Finland. (Vikman 2015.) The costs of the two upcoming plants were estimated to be around 100 million euros, making waste managing a costly business.

Ministry of Social Affairs and Health in Finland is tenacious to advance Finland's landfill directive and hospital waste is regarded as a serious case amongst min-

istries. The Ministry of Social Affairs and Health has brought up its concerns regarding the counties lack of preparation for waste incineration. As pointed out earlier, only one plant is currently in construction and three more in development, which basically is just not enough. Even though waste usage in Finland has increased rapidly in the past 10 years that amounts of close to three million tons of community waste are now turned into power and heat. (Haimi 2014., Paunio 2012.)

2.2 Waste Types from health care activities

Health care waste includes all waste that is generated within health care facilities, research centers and laboratories. All these aspects are going to be mentioned in this text, but the main focus will stay in the hospital area.

There is a listing on medical waste created in hospitals that is covered on the site of World Health Organization (WHO 2015). Key facts about the waste generated from health-care activities give a small image for people to think about, when talking about medical waste. The health-care/hospital section generates a lot of waste, of which 80% is considered as general waste. (WHO 2011.) The definition of general waste is regarded as anything non-hazardous, infectious, toxic or radioactive. In the hazardous 20% waste amount, we can mention medicinal waste, operational waste, syringes etc.

2.2.1 Types of waste

The different types of medicinal / hospital waste can be distributed into several different categories, as the waste diverse from a range of materials. The listings of waste are according to the World Health Organization, and the percentages mentioned here are an approximate value. (WHO 2011.)

- Infectious waste: waste contaminated with blood and its byproducts, cultures and stocks of infectious agents, waste from patients in isolation wards, discarded diagnostic samples containing blood and body fluids and contaminated materials, such as swabs and bandages and equipment used for medical operations.

- Pathological waste: recognizable body parts.
- Sharps: Syringes, needles, disposable scalpels and blades etc.
- Chemicals: mercury, solvents and disinfectants.
- Pharmaceuticals: expired, unused and contaminated drugs, vaccines and sera.
- Genotoxic waste: highly hazardous, mutagenic, teratogenic (capable of producing fetal malformation), or carcinogenic, such as cytotoxic drugs used in cancer treatment and their metabolites.
- Radioactive waste: glassware contaminated with radioactive diagnostic material or radio therapeutic materials.
- Heavy metals waste: such as broken mercury thermometers.

The approximate percentages on the waste categories are as follow: 15 % for infectious and anatomic waste. 1% for sharps, but sharps being the major source of disease transmission. 3% for chemicals and pharmaceuticals, and 1% for radioactive matter and heavy metal content.

It should be noted that the medicinal waste mentioned here are gathered from several different sources, while the main focus of this report is on hospital waste. None the less health-care waste is contributed from (WHO 2011):

- hospitals and other health-care establishments,
- laboratories and research centers,
- mortuary and autopsy centers,
- animal research and testing laboratories (which will be left out of the report),
- blood banks and collection services,
- nursing homes for the elderly.

When talking about hazardous waste in Finland, there are laws that categorize such of waste types. Medicinal waste can also imply to be dangerous chemical waste, which is categorized to be hazardous for man and nature alike.

According to the Finnish law system (Finlex) parts of health-care waste are considered to be dangerous chemical waste. Qualities of dangerous chemicals for health are its:

- imminent, continuous or long-term exposure to toxicity
- corrosiveness or irritating exposure
- sensitivity
- possibility to lead to cancer
- harm to reproduction; and
- harm to genome/genetics.

As for what is considered as dangerous chemical for the environment are its:

- toxicity
- constancy in the environment; and
- accumulation to organisms (Finlex 620/1990)

2.3 Marking and handling of health-care waste

It is defined that health-care waste are to be marked/signified clearly to ensure their safe handling, transportation and landfill. This chapter will focus on these aspects, giving out instructions and regulations in the Finnish health-care waste management system.

At hospitals and other health-care facilities, waste is generally sorted into color-coded bins or bags, where the colors imply the different waste stream or waste type. (Windfeld et al. 2015.). Some hospitals differ in their sorting of wastes, but ultimately the differences are small.

2.4 Packing and defined sticker models for health-care waste

Class A infect risked waste is packed to UN-approved packages and labeled as such.

1. Patient waste class A
2. Laboratory waste class A
3. Patient- and laboratory waste class B
4. Special waste
5. Hazardous waste

In Finland the committee of contagious diseases (Tartuntatautien neuvottelukunta) has approved that waste should be considered contagious, if it has been contaminated with anything that can lead into fevers such as Ebola, Lassa and Marburg, plagues or anthraxes.



Picture 1 Waste labels (OYS 2012)

3 Waste management regulations

Waste management policies vary from one country to another around the world. More developed countries have stricter policies and regulations when it comes to waste managements, but also developing countries are progressing to make hospital waste management more important and more efficient.

The first step in creating a more efficient waste management cycle to a country usually begins from active government intervention. Ministries describe the needed important steps to be made in national health-care waste management, which is then given to health-care centers around the nation, as guidelines or directives to achieve/work towards to. (WHO 2014). One example is the national waste management laws, set out by the Ministry of Environment, which follows the set guidelines set out by the European Union on waste management. Basic regulations concerning the topic in waste management in Finland are the waste law 646/2011 (Finlex 2011), Environment protection law 527/2014 (Finlex) and the Environment protection agreement 713/2014 (Finlex).

3.1 Guiding Principles

According to Chartier et al (2014), there are five principles that are widely used by several countries in their legislative and political systems.

- The “polluter pays” principle is a policy implying to the basic rule of that one should take responsibility of their own waste. Meaning that companies and individuals are legally and financially responsible for safe and efficient disposal of waste they produce.
- The “precautionary” principle takes heed in governing health and safety protection, taking after the principle 15, set by the Rio Declaration on Environment and Development (UNEP 1972) *“Where there are threats of serious or irreversible damage to the environment, lack of full scientific certainty should not be used as a reason for postponing cost-effective measures to prevent environmental degradation.”* (Chartier et al. 2014)
- The “duty of care” principle creates a connection between the individual handling and managing wastes, thus creating an ethical responsibility for the person. Most efficient way to keep this principle operating, is to include working environments with people with proper education and knowledge in this area of business.
- The “proximity” principle recommends that waste is to be treated and disposed in the nearest possible location to its source. This way risks are minimized for the health category, but also logistic costs for waste managing are diminished.

- The “prior informed consent principle” the principle is mentioned in various international treaties, and it is designed to protect the environment and public health from several kinds of hazardous wastes.

3.2 Agreements and conventions

This chapter will shortly discuss the current agreements and conventions relating to the waste management from health-care facilities, environmental protection and development, pointing out issues to be taken into account when preparing legislative and political waste management directives.

3.2.1 The Basel Convention

The Basel convention covers the Control of Trans Boundary Movements of Hazardous Wastes and their Disposal, being the most well-known and informational environmental treaty on hazardous and other wastes. (Chartier et. al 2014) The convention includes members from 170 countries and *“aims to protect human health and the environment against the adverse effects resulting from the generation, management, transboundary movements and disposal of hazardous and other wastes”*.

The convention obligates countries and parties to greatly focus on their import and export of wastes and general overall reduction of waste generation. The convention focuses specifically to waste created in hospital, medical centres and clinics as well as pharmaceutical and medicinal wastes. The rulings made in Basel Convention are periodically altered and assessed via regular Conference of the Parties included in the Basel Convention. (Chartier et al 2014.)

3.2.2 The Bamako Convention

Focusing on the African regional area, and the waste imported and exported in Africa, the Bamako Convention includes 12 nations who together negotiate in prohibiting hazardous waste movement in Africa. The Bamako Convention came to be in early 1991, and seven years after that came in force in 1998. The Bamako Convention was established due to criticism towards the Basel Convention, and

its lack of prohibition towards hazardous wastes moving into undeveloped countries; so the Bamako Convention was established to create more strict rules to ensure the wellbeing of more undeveloped countries. (Chartier et al. 2014)

3.2.3 The Stockholm Convention

First, when discussing the Stockholm Convention, POPs or Persistent Organic Pollutants are a case to explain. POPs are “*chemicals that remain intact in the environment for long period, become widely distributed geographically, accumulate in the fatty tissue of living organisms and are toxic to humans and wildlife*”. (Chartier et al. 2014.). Medicinal waste in some parts can be categorized to be as POPs due to some of medicinal wastes’ hazardous qualities and from their incineration. The Stockholm Convention affects Finland’s current situation with its incineration plants, or the lack of them to be more precise. Due to the fact there are not enough incineration plants in Finland creates an expensive investment for Finnish governments and counties. (Jaakkola 2014).

4 Case Project: Waste management at South Karelia Central Hospital

The case project included in this thesis about Hospital Waste Management was conducted as a group project alongside four other students from different lines of studies, located in Lappeenranta, Finland. The Project was conducted alongside Eksote, (Etelä-Karjalan sosiaali- ja terveystoiminta) a Finnish company working in the line of social- and health-care, and Ecosir Group Oy, a company which focuses on assisting hospitals to create a safe and clean environment with automatic waste and linen pipeline transfer solutions. The project lasted from 3 April 2014 to 4 November 2014 and the results were introduced to the hospital board of staff and Ecosir Group Ltd at a final seminar in November 2014. Similar projects have been done earlier in other cities as well, for example in Oulu and Kotka.

The goal of the case project was to examine the waste and linen management at South Karelia Central hospital, and to chart out the current situation how it is handled; meaning the methods of waste transportation, staff involved in the process and the general outlines and rules of the hospital’s waste management. The main focus of the project was on the acute hospital side, including policlinics, ER,

Nova, X-ray, laboratories and wards. The project was handled by five students from the Saimaa University of Applied Sciences; with three of the students from the degree programme on of International business, one physiotherapy student to examine the ergonomics of the staff involved in the project, and one engineer student to create a 3D-modelling of the hospital, to give a understandable picture of the waste- and linen movement throughout the hospital. The project research covers approximately 90% of the hospitals laundry/linen and waste, but in this thesis, the main focus will be on the results found on the waste management side, and will be assessed and compared to general standards and waste management methods.

Several sources to find the information were used in this project to find out useful information to gather a solid background to be used in achieving solid results. The students were mainly responsible for gathering information themselves, but were provided with guiding from the Ecosir Group Ltd's side by Kimmo Määttä, who is the Sales Area Manager for East & Northern part of Finland. Also guidance from the University of Applied Sciences was gained from the teachers involved in the project as well as the hospital's side through the former logistic chief of Eksote.

4.1 Basic project information

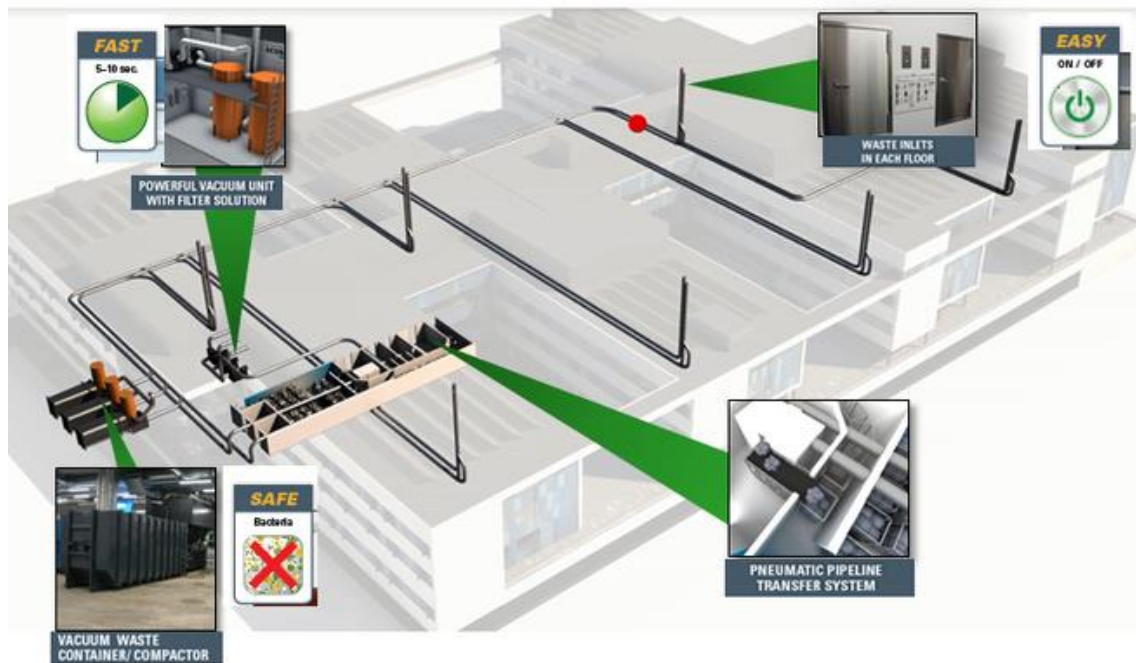
The project was carried out at South Karelia central hospital which was built in 1955. The staff who were working in the acute hospital (the area which was covered in the project) were 1250 staff members, this involves the doctors, nurses, cleaners and generally everyone working. Out of the 1250 staff members 139 persons work with waste- and linen management; of which 133 work doing basic work focusing on waste and laundry gathering in the hospital, three workers handled the linen transportation in the hospital and three for the waste management in morning- evening and weekend shifts. The average age of the staff was 52 years.

South Karelia Central hospital is a part of Eksote, operating within the area of approximately 133 000 people, creating health-care services for the people in South-Karelia. The current situation in the hospital is that the number of visitors is on a, which has created a need for a new hospital building. The case project

was created to gather information for this purpose as well, whether the new hospital should be built with automatic waste and linen pipeline transportation systems or not. The new hospital building is currently under construction, but it is still unsure whether the transportation system is to be installed in the new hospital. Information covering the hospital project case was gathered from sources and contact members from different companies operating in cooperation with the hospital, as well as from a questionnaire distributed to staff working in waste management. The questionnaire included questions on hospital staff on their actions with waste management, and matters concerning it, such as injuries resulted from waste management, sick leaves due to them etc.

Ecosir Group Oy is a company focusing on waste and linen pipelines transportation systems. They are specialized in creating logistical solutions for health care facilities, to create a more efficient and faster logistic process for waste and laundry, with an experience of more than 25 years in environmental technology. As a company Ecosir Group is one of the oldest in its field, and company's yearly turnover is up to 6.3 Million euros (Ecosir 2015). With their waste and linen transfer systems, health-care centers achieve better hygienic solutions faster and more efficiently. The transportation method at South Karelia central hospital will be introduced later in the thesis, as well as Ecosir Group's technical side of the waste management process, basically how everything works in modernized health-care centers. The company creates solutions for mixed and organic waste, energy and paper materials as well as consultation for waste and laundry management.

Ecosir Group provides different solutions for hospitals and care centers, which will be explained shortly; due to their relevance to the topic of the thesis. Ecosir's automatic vacuum transfer solutions for waste and linen: *"Diapers, mixed waste bags and organic waste that is generated on the wards can be removed with the automatic XMIT CARE transfer system from the source point to the waste stations."* (Ecosir 2015). This means that the staff are no longer needed to handle heavy and unhygienic waste bags, creating more time for care work towards patients. The second invention from Ecosir Group that is used in waste management services is the semi-automatic waste and linen transfer system: It is used in vertical transfer of wastes and laundry for smaller hospitals. It saves a lot time from current waste and linen management, at least in several hospitals.



Picture 2 Ecosir Group's XMIT CAREMASTER



Picture 3 Ecosir's semi-automatic waste and linen transfer

4.2 Case Project: Waste at South Karelia Central Hospital

First, it is good to come to terms with the fact that every waste in South Karelia central hospital is moved manually. There is no mechanical machinery to aid in this task, and also there are not that many workers who focus on the waste transportation inside the hospital.

The first step in South Karelia central hospital's waste management is the waste rooms, where the waste coming from the wards is gathered (Appendix 2). The hospital staff is involved in waste management, who gather the waste from wards, transport the trash bags into these rooms, and into the waste container. This technique is used in pretty much every hospital, since there has to be some staff, who transfer the waste into one spot where it is either transported elsewhere, or in some cases, automatically moved through mechanical inventions, such as vacuums to the final waste gathering destination. The waste gathered in these containers contains different kinds of medicinal wastes from bandages and bloody cloths to sharps and needles, which are obviously distributed into different containers, to make the waste cycle safer. Even though there are set rules how the waste should be moved to the waste rooms, and in which kinds of bags/containers/ sealed packages the waste should be packed; there are also mishaps, amongst the hospital staff, resulting in injuries amongst them who handle waste. When considering the fact that waste is handled by most of 133 persons in the hospital, it can be seen as a risk factor as well, requiring proper knowledge of the wastes, their disposal and safe/hygienic disposal. The hospital staff focusing on the waste and laundry are from an outsourced company called Saimaan tuki-palvelut, technically not making them as "hospital staff", but will be regarded as ones in this topic.

The second step covered in the project was the movement of the waste from waste storage rooms to the end point, at the loading platform of the hospital, which was used to storage the waste in large containers and compressors. The transportation of the waste was done manually by one person in each shift using waste containers located in different waste storage rooms, or in some cases, the person had to transport the containers from the endpoint to the starting point. (Appendix 3). In several Finnish hospitals, the transportation of waste containers is done using some help from a mechanical vehicle. When considering waste

transportation in hospitals, in how much time it takes for one person to walk around the hospital pulling and pushing several waste containers; versus using some kind of advantageous technical items to do the same thing, the time and money used and wasted is seen as something to cut on.

The waste handling in South Karelia central hospital was done in three shifts from 7am to 7pm, which required different kinds of settlements from the hospital's point of view. Scheduled times were used for using the elevators in the hospital, which also were used to transfer patients. This can be considered as a hinder and expense for hospital staff, who have to wait for moving patients or equipment, while waste management is occupying the elevators. These things can be handled with scheduling, or by constructing new waste management techniques, such as semi-automatic disposal systems.

The last step at South Karelia central hospital waste management process for the hospital's responsibilities is the distribution of wastes at the end point (Appendix 4). The hospital uses normal sorting for the waste created, and uses different colored bags for different wastes. Energy waste and common waste were sorted into orange and black bags, which were sorted into different waste compressors at the end point, making sure that proper recycling is followed. The hospital does not follow the amount of waste that is created, which was also a goal of the project. The amount of waste created annually was counted to be approximately 316 tons of common and energy waste. The amount of waste was counted from several weightings done at the hospital premises, giving the average weight for one waste bag. After several weightings and observations, the average amount of waste bags for both waste categories was found out, and afterwards calculated into the yearly amount.

There are also several different kinds of waste that is created at the hospital, and its premises, which was not counted into the project, as that type of waste cannot be transferred using semi-automatic systems, such as Ecosir Groups pneumatic waste transfer system. When comparing the current waste management transportation in South-Karelia hospital and comparing it to the existing possibilities in waste management, it can be seen as outdated and laborious. The case project resulted in some possible solutions for waste management for South-Karelia's hospital, and will be discussed later in chapter 5.

4.3 Ecosir automatic techniques

Ecosir Group provides several solutions for waste and linen removal for hospitals and different facilities. These automated vacuum transfer systems are helpful for hospitals, by creating better hygiene, logistic efficiency and more time for care work. Ecosir Group provides different solutions for large hospitals and campus areas, and for smaller hospitals and care centers.

The larger hospitals and campus areas are offered a solution of automatic pipeline transfer system. (Ecosir 2016). These automated transfer systems give hospitals the option to simplify and modernize their waste management to another level. From using automated techniques, hospital will save time, money and increase hygienic levels of the hospital, since waste is managed in different ways. Ecosir Group itself has created several solutions in Finland already. For example, Kuopio City University and education hospital has undergone (still under work) a fully automatic pneumatic waste transfer system.

ESA Espoo new hospital-part of Helsinki University hospital district is another example of Ecosir Groups projects. The hospital is to be installed with fully automatic pneumatic waste and linen transfer and collection systems. According to Ecosir Group, it is supposedly the most modern and largest hospital solution on the market (Ecosir 2015)

The automated techniques mentioned are obviously more expensive methods to install than staying on hospitals' current methods for waste management. The waste management systems currently used in Lappeenranta are mainly done in manual labor, making the process dependent on humans. The work is heavy, it takes a lot of time, but it gets done. This process can be made simpler and safer, if invested into.

5 Case Project Results

The case project lasted for several months, which was supposedly a long time for the project. Some parts of the project could have been done more efficiently, such as information gathering and measuring of wastes. Several results were gathered from different categories, such as waste measurements of the hospital as of how much waste is created at the hospital in a week, and a year as an

estimation. Several calculations for waste amounts and estimated times for the waste that is moved in the hospital was made.

First of all, the results that will be discussed will be the cost based results for the hospital. The project team gathered information on the costs that waste management create for the hospital in different areas. Part of the hospital staff involved in waste management were given questionnaires (Appendix 2). The questionnaire included basic questions on the staffs age, gender and employment at the hospital. The main idea of the questionnaire was to gather information on how many of the respondents had had a work related accident or injury. The answers from these questions concerning work related accidents or injuries were used to calculate costs for the hospital, in how much money is used to occupational health care. The hospital staff are required to list in if they are involved in a work related accident or injury, and from what the incident occurred from.

Some information about Ecosir Group and the South-Karelia's central hospital is regarded to be confidential. However according the information gathered for the project, the costs for occupational health care was 1 847 413€ in 2013 and the cost of sick leaves was 7 432 590€. The amounts were calculated from the information gathered from Eksote and companies working together with Eksote. The cost for one day off from work without social-expenses, governmental or health care costs was 114€/day. This includes the costs for hiring a substitute to work in place of the sick worker. However, the costs can increase up to 300€ a day, when facts considering using a substitute worker are included. Things such as slower work pace, possible mistakes and the degradation of working environment. (Case project results 2014.)

The case project was conducted to come up with answers to Ecosir and the hospital, so they could come up with a solution together. The solution that these companies aimed to achieve with the project was: "is Ecosir Group's suggestion for the new hospital waste management a profitable investment in the long term?" Also the hospital's board of staff was using the case project to find out faulty matters, or things that could be improved in the hospital.

The questionnaire was distributed to 139 staff members of which 49 answered. The 49 staff member who answered work as faculty worker (cleaning mainly), textile workers and waste handler i.e. the garbage man. Results found on the questionnaire considering injuries from waste-/ linen management were of seven

incidents in the past 5 years. Alas, the total incident number was 39, according to the hospital statistics. One incident included a staff member getting stuck from a needle through a garbage bag. This incident is a good example on the outdated and dangerous waste management system that is going in several hospitals. When considering that a simple task as handling waste can cause health hazards to staff members and to patients, means something should be done. These incidents have a direct impact to the hospitals costs, and can be managed with proper waste management methods. When considering hospital costs and staff members' safety, it was noted that the current waste management methods can be dangerous. Some of these safety deficiencies are due to human error, but also the methods are to blame. The first shortage in South-Karelia's central hospital is the way the waste is moved. (Appendix 2) As seen on the picture, trolleys are used to move waste from point A to point B, and these trolleys are filled with several different kinds of hospital waste.

The case project results in the working environment of South-Karelia's central hospital showed several points to improve on. First point to improve was noted by several employees and even board members. Several waste bags and different waste was left in hallways and staircases, sometimes blocking the stairs. (Appendix 4) This picture shows that the waste gathered in the hallways is a flammable risk, and the staircase is also regarded as an exit route, creating a safety violation. "The waste stand in the hallways for several hours, dripping fluids and emitting strong smells" – several staff members stated. A human error which was also noted in the results was the wrong sorting of hospital waste.

- The hospitals current premises are unconventional and narrow considering the current waste management. For example, moving waste trolleys have to be moved around the hospital and waste rooms to make space for the waste.
- There are far too few elevators
- The waste stays far too long in waste rooms and in the hallways causing – Fire safety detriment, working environment comfort drops and the work safety suffers.
- Handling waste manually is physically depleting

5.1 Case results and time savings

The results timewise from the case project were as of following: The garbage bags stay in the waste room or in the hallway from 2h 50minutes to 12hours 30minutes max. The time estimates were calculated from the schedule in which the wastes are gathered in the hospital. This time lapse causes danger of infections, smell and possible fluids falling in to the hallways. Logistic wise, these issues could be handled faster using an automated vacuum system.

Giving an example of the current situation at South-Karelias Central hospital, when the estimate time of transporting waste from waste rooms to the exit point is done manually by one person. The number of steps the person handling waste management at the hospital is approximately 45-50 kilometers a week. This was calculated using a pace counter. The time itself used for moving garbage in one day depends on the routes the waste collector handles their routes. Different waste rooms are not gathered three times a day, because only few of them are in the acute hospital area, meaning where all the action happens. The time schedule for waste management starts at 6 in the morning lasting till 15, and the evening shift is handled by another person. This means that two persons are in almost constant movement looking after the hospital's wastes. With automated waste management systems, such as the one Ecosir Group offer, time could be saved from these workers and the hospital would end up saving money in long term.

6 Future

The future of waste management in hospitals is a thing that should be given more of a thought. It can be seen that hospital waste is a nuisance to hospitals, patients and countries around the world, if it is not handled correctly. The possibilities of creating a solid logistic process for hospitals, creates a chance for upcoming businesses to grab into. The process itself should not require much of a thought itself in the future. It should be created to be as fluent as possible with the help of technological equipment, that the waste itself does not come in contact with people after leaving the operation room, ER or any other hospital ward. As medical waste disposal is considered as a very costly way to get rid of the waste, companies are in discussions about different methods to get rid of the waste. (Windfeld 2015.) In their publication Journal of Environmental Management Windfeld and

Brooks explain the options of autoclave waste treatment as a future direction for waste management. In autoclave waste treatment the infectious waste is “treated with the addition of dry heat or steam to raise the temperature of infectious waste to levels sufficient to kill microbial contamination, with these systems generally operating at temperatures between 121 and 163°C” (E.S Windfeld et al. 2015). As of yet, the autoclave process has not taken wind under its wings, due to several setbacks. Few mentioned by Windfeld and Brooks in their review being, inefficient heat to kill pathogens and destroy the waste, usually requiring an incineration afterwards due to landfills not accepting autoclaved waste into their sites and so on.

The autoclave waste treatment as it is now, is not enough to replace incineration. As incineration, as bad as it is for the environment and such, still gets rid of around 70% off the waste brought to be incinerated. As for another future direction for hospitals and waste management, Windfeld and Brooks review the option of substituting medical equipment. The option of creating medical equipment that do not release dioxins or mercury, is an option to consider in the future. (E.S Windfeld et al. 2015)

As for hospitals, the waste costs are quite high as they currently are. Some hospitals still use manual labor to move the vast amounts of waste around the hospital. In the near future, several hospitals should consider moving onto automated waste management processes. As an investment, it is a rather large one, and will require hospitals to weigh the pros and cons of automated systems. But still, creating a hospital, where all the cons of waste management are minimized, is a must in the future. (Deschenes 2012)

A point to take into consideration in Finnish hospitals is that many hospital buildings are rather old, and may not have the possibility of creating an automated waste management process. This is also an opportunity for the future, to come up with new techniques for safe, efficient and profitable solutions in the long run.

7 Conclusions

After going across several waste management issues and explaining the deficits in current waste management methods at South Karelia central hospital, it is time to come to some conclusions. Basically waste management is still handled manually in South Karelia central hospital, but the logistical issues are going to need

updating. The hospital building itself is already a rather old building, making some of its logistical managing old fashioned. The hospitals in Finland are already going through a change in waste management logistics and the change is seen as a good thing.

The first study question in the thesis was: “What is meant by hospital waste?” This question was answered with the help of theoretical investigation from different sources. First of all, health care waste includes all waste that is generated within health-care facilities, research centers and laboratories. This means different kinds of wastes, such as sharps, hazardous wastes, basic energy waste and so on. The types of wastes were discussed in the second chapter of the thesis considering waste types. The types of wastes found in the investigation did not give any new answers when thinking about hospital waste. Since hospital waste is followed and categorized by World Health Organization, the waste types are well known to the healthcare facilities. (WHO 2015.)

The second study question was:” How is it managed?” As for how waste management is done in hospitals there are differences between the answers. Some hospitals manage their waste with several employees, who work handling and sorting the waste. At South Karelia central hospital, the waste was mainly transported using manual labor and trolleys that were pushed around by the waste management worker. In general, we can come to a conclusion that the waste management processes are handled with certain care and expertise amongst the hospitals. However there have also been some waste management accidents, which point to the fact, that the process can be dangerous, if not done correctly. This means how the waste is sorted in the starting point of the logistic process; as in the operating rooms, ER and so on.

The third study question was “How can hospital waste be managed more efficiently in the future from hospitals perspectives?”

For this question there are actually several answers. When first considering the situation Finnish hospitals currently are in their waste management, there are differences between hospitals. Some smaller hospitals are bound to use manual waste logistics, which means the waste is moved manually in waste trolleys. This question required a bit more thought, because there are no simple solutions. First of all, the location of the hospital comes into the picture. Depending on where in Finland the hospital locates, it affects directly to the waste management. The

amount of staff and patients in the hospitals affect the logistic of waste management. South Karelia central hospital serves as a part of Eksote, and there are over 130 000 potential customers in the area for hospital services. The central hospital was built over 60 years ago, creating a need for the new hospital building, which should be ready in 2017-2018. Currently the hospital is being built in with an automated vacuum system to transfer waste and laundry in the hospital, and most likely it will be implemented to the older hospital building as well, if the companies come to an agreement.

The fourth question was: "How is waste collected and sorted in the case project?" The answers that were found to this question were made by observing South Karelia central hospital's waste logistic processes and employees. The results found at the hospital were later on reviewed with hospitals lead staff and Ecosir Group, to give insight on the basic process, time consume of the process and how these things can be made better.

When first focusing on the current waste management logistics in hospitals, a few points of improvement can be brought out. When discussing about South Karelia central hospital, in its current form, the hospital waste management is basically in the hands of a few persons. Of course there are several staff members dealing with the cleaning of wards and hospital area, but the logistic process of waste is handled by only a few employees. These staff members (waste management personnel) are under heavy physical stress from handling the waste. As mentioned in the thesis, the waste is managed manually in this hospital, where as in several hospitals they use motorized vehicles to move the waste. Unfortunately, this option is not possible in South-Karelia's central hospital. The narrow hallways and small number of elevators deny the option of motorized vehicles. As such, the waste has to be moved manually in the hallways where customers and employees move alike. The second part which is a hindrance at South Karelia central hospital, is the sorting of different wastes. Obviously the wastes are sorted in the starting point of the logistic process, but all waste at the end point is sorted manually by one person only. This means the sorting of different waste bags into their proper containers, before they are transported out to their end points.

It is time to discuss why this topic should be discussed and why it should be researched more in the future. As we all know, the world is becoming more and more populated with its current population around 7,4 billion (2016). The increase in population is directly bound to the amount of waste produced in the world, and

obviously the health-care provision as well. The amount of waste in hospitals is bound to increase due to the fact that more and more people are in need of hospital care in the future.

When considering the current state of some hospitals and their waste management, an increase to the waste produced in the hospitals can create problems to the staff and patients alike. This creates a need to research the possible problems yet to come in the future, and how these things can be thwarted beforehand. By optimizing the logistic process of waste management in hospitals, properly educating the staff in the deficits of ignoring proper waste management, and updating the process with more advanced techniques, are steps towards the right direction. Obviously we can assume that hospital waste management costs are going to increase in the future, creating some tension between hospitals and governments for more funding, but it is a step that has to be taken at some point. Hospitals are a place which require precise, functional and clean waste management, so that the logistic process is efficient and swift. These things can be achieved in the future, but more research has still to be done, before the most optimal solutions can be made.

8 Pictures

Picture 1. page 13 waste labels Oulun seudun ympäristötoimi

Picture 2. Page 19 Ecosir Group

Picture 3 Page 19 Ecosir Group

9 Appendices



Appendix 1 Waste room at South-Karelia hospital



Appendix 2 Waste movement trolleys and narrow hallways



Appendix 3 Waste end point



Appendix 4 Waste in the staircases

Kysely:

1. Ikä
2. Sukupuoli
3. Ammattinimike
4. Työtehtävät
5. Kuinka monta vuotta olet työskennellyt Eksotella tässä työtehtävässä?
6. Työnantaja
 - o Eksote
 - o Muu: _____
7. Onko teille sattunut **työtapaturmaa** viimeisen:
 - o vuoden aikana
 - ei
 - kyllä (mitä ja missä, kuvaile tarkasti): _____
 - lukumäärä: _____
 - o viiden vuoden aikana
 - ei
 - kyllä (mitä ja missä, kuvaile tarkasti): _____
 - lukumäärä: _____
8. Onko teille sattunut **läheltäpiti tilannetta** viimeisen:
 - o vuoden aikana
 - ei
 - kyllä (mitä ja missä, kuvaile tarkasti): _____
 - lukumäärä: _____
 - o viiden vuoden aikana
 - ei
 - kyllä (mitä ja missä, kuvaile tarkasti): _____
 - lukumäärä: _____
9. Jouduitko olemaan töistä sairauslomalla tapaturman takia?
 - o ei
 - o kyllä (kuinka pitkään): _____
10. Oletko huomannut työympäristössäsi riskitekijöitä/tapaturma-alttiita paikkoja/asioita?
 - o ei
 - o kyllä (mitä, missä): _____
11. Oletko huomannut ohjeistuksesta poikkeavaa käytäntöä esim. jätteiden/pyykin väärin sijoittaminen:
 - o jätteiden käsittelyssä
 - kyllä
 - ei
 - o pyykin käsittelyssä
 - kyllä
 - ei
12. Koetko, että sinulla on työstäsi aiheutuneita kipuja?
 - o ei
 - o kyllä

- niska/hartiakipu
- selkä

13. Uskotko imujärjestelmän helpottavan työtäsi?
 - o kyllä
 - o ei
 - o en osaa sanoa
14. Koetko työtilasi viihtyisäksi?
 - o kyllä
 - o ei (miksi): _____
15. Uskotko imujärjestelmän lisäävän työympäristösi viihtyvyyttä?
 - o kyllä
 - o ei
 - o en osaa sanoa

Appendix 5 Questionnaire

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