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THE IMPORTANCE OF ENVIRONMENTAL SUSTAINABILITY IN PUBLIC PROCUREMENT OF MEDICAL DEVICES IN HEALTH CARE SECTOR

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ABSTRACT

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The aim of this thesis was to examine the role of environmental sustainability in the procurement of medical devices in health care sector. Current literature is mainly focused on other product groups and medical devices have been left without sufficient attention. Nevertheless, EU has recently developed green public procurement criteria for medical devices (EU GPP criteria for health care EEE) in order to support and offer guidelines for purchasers in hospitals. In this study, the criteria were used as a framework in order to examine the most significant environmental aspects for medical devices. The empirical research was executed in Finnish public hospitals with mixed method approach; quantitative data was collected by a survey and qualitative data was collected by interviews held for procurement specialists. The focus was on understanding the importance of environmental sustainability in the procurement of medical devices and which environmentally sustainable features would be the most significant. Of interest was also the medical device supplier view and how they could take environmental sustainability into consideration.

TIIVISTELMÄ

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Avainsanat: ympäristöystävällisyys, lääkintälaitteet, julkiset hankinnat, ympäristöä säästävät julkiset hankinnat, EU:n ympäristöä säästäviä julkisia hankintoja koskevat kriteerit terveydenhuollon sähkö- ja elektroniikkalaitteille, terveydenhuoltoala

Tämän tutkielman tarkoituksena oli pyrkiä ymmärtämään millainen rooli ympäristöystävällisyydellä on lääkintälaitteiden hankinnassa terveydenhuoltoalalla. Aikaisempi tutkimus on keskittynyt lähinnä muihin tuoteryhmiin ja lääkintälaitteet ovat jääneet vähemmälle huomiolle. EU on kuitenkin hiljattain kehittänyt ympäristöä säästäviä julkisia hankintoja koskevat kriteerit terveydenhuollon sähkö- ja elektroniikkalaitteille tukeakseen ja motivoidakseen julkisia hankkijoita ympäristöystävällisyyden huomioimisessa. Tässä tutkimuksessa tätä kriteeristöä on käytetty viitekehyksenä lääkintälaitteiden ympäristöystävällisten ominaisuuksien määrittelyssä. Empiirinen tutkimus toteutettiin suomalaisissa julkisissa sairaaloissa hyödyntäen sekä kvantitatiivista että kvalitatiivista tutkimusmenetelmää; kvantitatiivinen data kerättiin kyselyillä ja kvalitatiivinen data kerättiin haastattelujen kautta. Tutkimuksen kohteena oli ympäristöystävällisyyden tärkeyden sekä lääkintälaitteiden eri ympäristöystävällisten ominaisuuksien merkittävyyden selvittäminen hankintaprosessissa. Lisäksi tutkimus käsitteli lääkintälaitteiden valmistajan näkökulmaa ja sitä miten he voisivat huomioida ympäristöystävällisyyden.

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I thought this day would never come; I am finally done with my Master's thesis. The project has been long and challenging, but also instructive and interesting. Writing thesis made me definitely challenge myself and that is why completion feels amazing.

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Even though I am really excited and cannot wait for all the new challenges, it is also a bit wistful to turn the new page and leave university times behind. When I arrived to Lappeenranta for the first time, I did not know how many amazing friends I would get and how memorable time we would spend together. We had a lot of fun, but we also supported each other with the studies and faced the challenges together. Applying for Lappeenranta University of Technology has been one of the greatest decisions in my life. I want to thank all my Lappeenranta friends and the University for this amazing and instructive journey.

Jenni Suuronen

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TERMS

Environmental sustainability: "Meeting the resource and services needs of current and future generations without compromising the health of the ecosystems that provide them" (Morelli, 2011, 5).

Medical device: Any instrument or other article that is intended to be used for human beings for the purpose of diagnosis, treatment et cetera (Council Directive 93/42/EEC).

Public procurement: Public procurement is related to a government's or public sector's acquisition of goods and services using public funding. The aim of public procurement is to spend taxpayers' money on the best value and offer a utility for large amount of taxpayers. (Uyarra & Flanagan, 2010; Parikka-Alhola & Nissinen, 2012).

Green public procurement (GPP): "A process whereby public authorities seek to procure goods, services and works with a reduced environmental impact throughout their life cycle when compared to goods, services and works with the same primary function that would otherwise be procured" (European Commission, 2015a). Green public procurement is a common concept used, when referring to environmentally sustainable public purchasing (Marron, 2003 etc.).

EU GPP criteria: A voluntary tool that contains criteria, which aim to support and encourage public authorities to take into account environmental aspects in procurement process (European Commission, 2015a).

EU GPP criteria for health care EEE: EU GPP criteria developed for electrical and electronic equipment (EEE) used in health care sector (European Comission, 2015d).

Environmental aspect: "An element of an organization's activities or products or services that can interact with the environment" (SFS-EN ISO 14001, 2004, 13).

Environmentally sustainable feature: In this study, environmentally sustainable feature refers to a feature of a medical device that reduces its negative impacts on environment.

1. Introduction

It is estimated that even a quarter of all human disease and death worldwide are caused by environmental factors such as air pollution, unsafe drinking water, climate change et cetera (Prüss-Üstün & Corvalán, 2006). The goal of health care sector is to prevent and treat diseases. At the same time health care sector actually contributes to the negative environmental factors. However, the awareness of health care sector's impact on the climate change is growing. (Roberts, Lawyer & ClientEarth, 2014)

In EU, there are in total approximately 15 000 hospitals. Together they generate enormous quantities of waste and have a significant impact on the natural resources due to their service delivery and consumed products. Furthermore, health care sector is one of the biggest producers of pollution. For example, in UK in 2011 even 25% of the pollution of the public sector belonged to health care. (Karliner & Guenther, 2011) Also health care sector's carbon footprint illustrates its significant impact on environment; its carbon footprint is comparable to international aviation and shipping. Within Europe the carbon footprint is at least 5% of total EU emissions. (LCB-HEALTHCARE Consortium, 2011) Health care sector and other authorities understand all the time better health care sector's impact on environmental problems. The sector has a lot of improvement potential and that is why health care sector is becoming one of the most important players in a global movement for environmental health. (Karliner & Guenther, 2011)

Purchasing of goods and services in hospitals has a significant role in the goal for greener health care sector. Hospitals procure and use plenty of disposable products as well as building materials and medical devices. These products and materials generate lot of waste and during operation they consume greatly water and energy. (HCWH Europe, 2014a) In Europe, approximately 10,4% of gross domestic product is spent on health care and about 7,50% is spent on medical technologies (MedTech Europe, 2014). Hospitals do not only have a great potential to adapt procurement procedures that support the environment, but they can also utilize their purchasing power. This way hospitals can promote and support environmental sustainability by investing in greener buildings as well as in greener purchasing of accessories and medical devices (Karliner & Guenther, 2011).

To improve and support more environmentally sustainable procurement in hospitals, European Commission has developed EU Green Public Procurement (GPP) criteria. Basically the criteria can be seen as guidelines, which aim to encourage public authorities to take into account environmental aspects in procurement decisions. (European Commission, 2015a) EU GPP criteria are a voluntary tool, but it has still the key role in EU's goals towards a more-resource efficient economy (European Commission, 2015b). EU GPP criteria have been developed for more than 20 different product groups and in November 2014 they were developed for electrical and electronic equipment (EEE) used in health care sector (European Comission, 2015d).

There are clear signs that environmental awareness is increasing in health care sector. This study will focus on understanding how the increasing environmental awareness effects on hospitals' purchasing of medical devices.

1.1. Research objectives

The purpose of this research is to study what is the role of environmental sustainability in health care sector and how it effects on the procurement of medical devices. First, this study will focus on examining the main environmental issues as well as motivators and barriers against green purchasing in public hospitals. After, the aim is to study what kind of an impact the environmental sustainability has on hospitals' purchasing of medical devices; how different environmentally sustainable features have been considered now and may the importance increase in the future?

Moreover, the purpose is to study which environmental aspects of medical devices may become the most significant in the future. One major challenge in the creation of the understanding is the novelty of the subject in health care sector, especially what comes to the green procurement of medical devices. Because of the novelty there is a lack of literature and previous research concerning the specific subject. Since quality and patient safety are especially highlighted features of medical devices, it is understandable that environmental aspects have not got that much attention before. Nevertheless, EU has recently developed green public procurement criteria for medical devices (EU GPP criteria for health care EEE) in order to support and offer guidelines for purchasers in hospitals. In this study, the criteria are going to be used as a framework in order to examine the most significant environmental aspects for medical devices.

In the end, the purpose is also to gain an understanding how the significance of the examined environmental sustainability of medical devices should be taken into consideration by a medical device manufacturer.

1.2. Research scope

This research focuses on the public health care sector in Finland. Even though the research is executed in Finland, the results may be, at least partly, generalized wider to Europe. Moreover, the focus is on identifying the key environmental issues caused by medical devices in order to understand what could be the most meaningful environmental aspects. In this study the term medical device refers to any instrument or other article that is intended to be used for human beings for the purpose of diagnosis, treatment et cetera (Council Directive 93/42/EEC). As the subject is new for health care sector and medical device industry, the EU GPP criteria for health care EEE will be used as a framework in the identification of the environmental aspects of medical devices.

To limit the scope of the topic, the research is made from the medical device supplier's point of view. In this context hospitals and the persons participating in the procurement process are determined as customers since they define the criteria for medical devices being purchased.

1.3. Research questions and problems

By understanding what could be the most significant environmental aspects of medical devices, the medical device supplier is able to identify the areas of focus. This way the company can also help to reduce its customers' negative environmental impacts.

As the objective of this research is to understand how a medical device supplier should take into consideration green aspects of medical devices, the following research questions have been addressed:

How a medical device supplier should take into consideration environmental sustainability in medical devices?

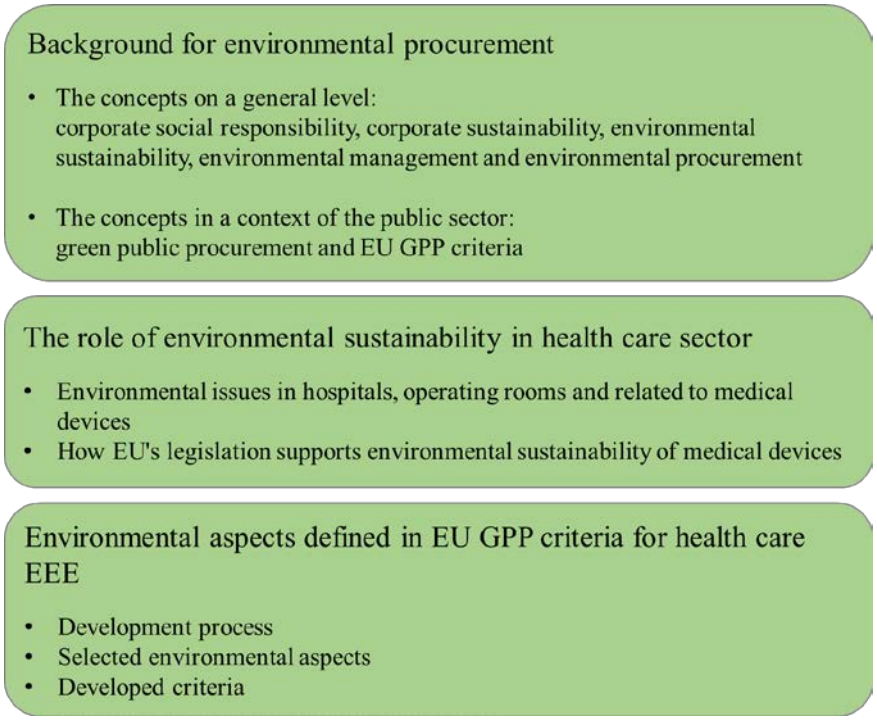
- *How the environmental sustainability is considered in the procurement of medical devices; at the moment and in the future?*
- *What could be the most significant environmentally sustainable features for medical devices?*
- *What is expected from the medical device supplier?*

1.4. The structure of the study

As the subject is relatively new for health care sector as well as for the medical device industry, there is not a lot of previous research made. That is why the identification of potential environmental aspects for medical devices mostly relies on the environmental aspects defined in EU GPP criteria for health care EEE. EU GPP criteria are also the main framework for the empirical research.

The theoretical part of this study has been divided into three themes; definitions of the concepts, the role of environmental sustainability in health care sector and the environmental aspects defined in EU GPP criteria for health care EEE. The Table 1 below summarizes the structure of the theoretical part and the different aspects that have been discussed.

Table 1 The structure of the theoretical part



After presenting the theoretical background for the thesis, the research methodology will be presented and also the validity and reliability of this thesis will be discussed. Finally, the results of the research will be presented and analyzed critically.

1.5. Literature review

There exists a gap within the research of green public procurement of medical devices. That is understandable since also EU GPP criteria are only recently developed for medical devices. However, the need for sustainability, which includes both social and ecological responsibility, has been noticed. For example, Walker & Brammer (2009) have studied sustainable public procurement in UK. In this study they also gave attention to health care sector and especially for the problems that prevent sustainability. According to their study the main barrier seems to be financial concerns. The concerns are based on the presumption that sustainable products are more expensive and the budgets are too tight for procuring them. In addition, sustainable products may not always be the best option from the patient care point of view, for example needles and swabs have to be disposable to ensure the safe use. (Walker & Brammer, 2009, 133, 136) Karlsson & Öhman (2005, 1071) pointed out the same kind of an issue in the health care sector; even though healthcare sector is a really water and energy intensive

sector, the most important values are patient and personnel safety and service quality, which are understandably leaving environmental aspects out of the discussion.

Many researchers agree that governments have the key role in improving the sustainable purchasing. First of all, governments are normally the biggest single purchasers in the countries, which mean they have a lot of purchasing power (Walker & Brammer, 2009, 128). For example in 2010 in Finland, public purchasing was approximately 19,4% of the GDP (TEM, 2015). With this power governments are able to simulate innovative activity among the companies (Aho et al. 2006).

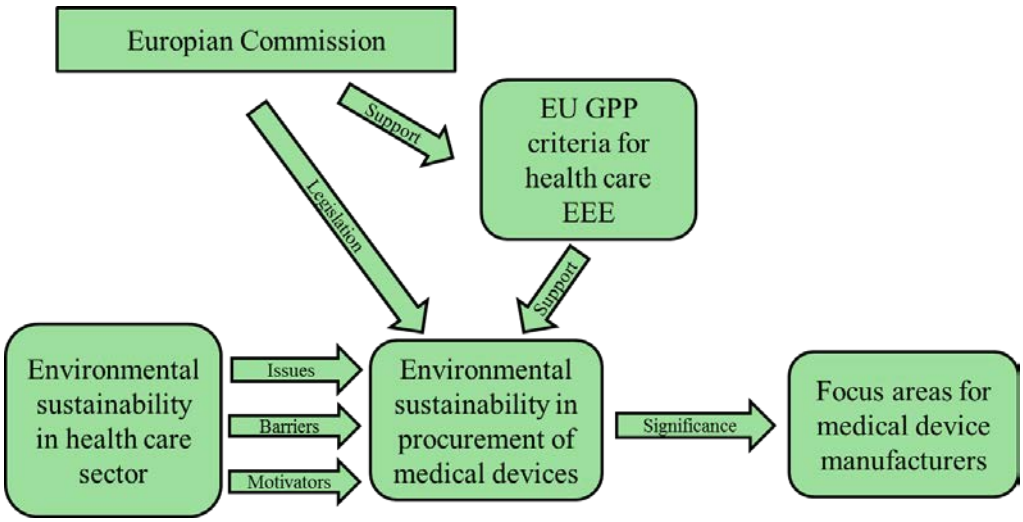
It is also widely agreed that the existing legislation has a significant impact on the sustainable operating. According to Brammer & Walker's study (2011, 471-472), sustainable procurement was widely implemented in those countries where also exist policy and legislation for it and generally the governmental practices are supportive for the sustainable procurement. Also Michelsen & de Boer (2009, 164) and Karlsson & Öhman (2005, 1071) call for the need for national standards and stronger environmental regulations in their studies.

1.6. Research framework

The research framework is presented in the Figure 1 below. The intention is to first describe the role of environmental sustainability in health care sector; in general, but also more specifically focusing on operating rooms and medical devices. European Commission's regulatory legislation and supportive guidance have a significant impact on public procurement. The theoretical part presents legislation that supports environmentally sustainable public procurement. EU GPP criteria are a voluntary tool that is created to support the implementation of green public procurement. These criteria will be presented and used later as a framework for the empirical research.

The empirical research will focus on defining the significance of green public procurement and the most significant green aspects of medical devices. Based on the theoretical and empirical part, the focus areas for medical device suppliers will be identified and presented.

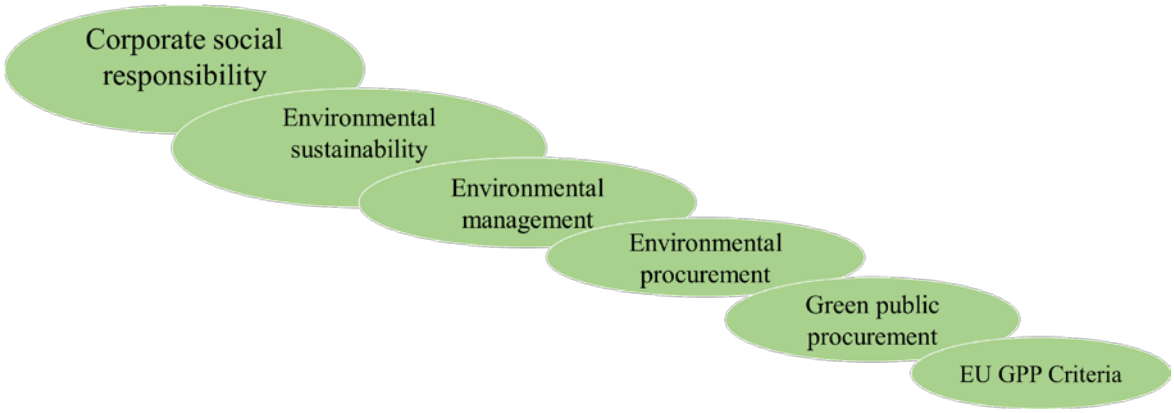
Figure 1 Research framework



2. Background and key concepts

In this section key concepts of this study are presented and discussed based on previous research. The aim is to provide a comprehensive picture of the subjects related to environmental sustainability in procurement. The key concepts are presented in the Figure 2 below. The discussion begins with the widest concept of corporate social sustainability followed by narrower concepts up to the concept of EU GPP criteria.

Figure 2 Key concepts



2.1. Corporate social responsibility and corporate sustainability

There are many definitions and models within researchers to describe the concept of corporate social responsibility (CSR) and corporate sustainability (CS). Nevertheless, the general definition of sustainability by WCED (World Commission on Environment and Development) is widely agreed within most of the researchers (Morelli, 2011; Marrewijk, 2003; Basiago, 1999). According to WCED (1987) sustainability is referred to the environmental and social aspects as well as to corporations and economic prosperity, which are highly linked to the concept of sustainable development. Sustainable development can be defined as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs'' (WCED, 1987, p. 43). Even though many of the definitions of CSR and CS are based on this general definition of sustainability, the difference and different aspects of CSR and CS are not unanimously agreed.

Marrewijk (2003) argued that in the past sustainability used to be associated to the environment and CSR to the social aspects. This observation can be seen from the models created in the past. Carroll (1978) argued that CSR can be defined through a view of social responsibility and what kind of expectations the society has towards the company. In the model the expectations are divided into four groups; economic, legal, ethical, and discretionary. Also Moon (2007) divides CSR in his model into these four groups, but he points out that CSR is not unambiguously generalized across companies, because their impacts on society are different. However, it can be noticed that these four groups do not highlight environmental aspects, but still Carroll's model gives a good picture of the concept of CSR.

In Carroll's model the economic responsibility of the company basically means that the company has to make profit by selling products and services that are wanted by the society. This assumption is essential for the existence of the company and that is why it is the base for all the other responsibilities. The legal responsibility instead refers to the society's requirement for the company to operate and achieve its economic targets within the legal framework. The economic and legal responsibilities are required of company by the society. The ethical responsibilities are not required, but they are expected of business by the society. They can be seen as responsibilities of the company

that go above the legal requirements. (Carroll, 1978) Moreover, ethical responsibilities consist of norms, standards, values and expectations that are desired by consumers, employees, shareholders and other stakeholders in order to ensure the fair and consistent operation of the firm. (Carroll, 2015) Discretionary responsibilities are voluntary activities, which are also not required, but more likely desired of the company by the society. The company itself has to be desired to run these activities. By participating in voluntary activities the company is not seen unethical per se. (Carroll, 1978; Carroll, 2015)

Marrewijk & Werre (2002) argued that the general and broad definition of sustainability or corporate sustainability is that it refers to the voluntary activities of the company that are aiming to include the social and environmental concerns in business operations and relationships with stakeholders. Also the concept of sustainability can be defined through different aspects. Kahn (1995) described the sustainability through three conceptual pillars: economic, social and environmental sustainability. Economic sustainability includes growth, development, and productivity as ways to support sustainable development. Social sustainability then includes the human factors such as equity, sharing, cultural identity and it is aiming to alleviate poverty. Finally, according to Kahn environmental sustainability includes the aspects of natural capital. Natural resources should not be wasted faster that they can be generated. It is important that the three pillars of sustainability are integrated. (Kahn, 1995; Basiago, 1999) Also Goodland and Daly (1996) divide sustainability into these three aspects, but they point out that the aspects should be analyzed separated since they follow different laws and methods.

Marrewijk (2003) describes the difference of CSR and CS as follows; CSR should be associated with the aspects of society, people and organizations such as transparency and sustainability reporting whereas CS with the value creation, environmental management, human resource management and so on. For both, it is in common that they refer to voluntary activities of companies and they demonstrate the social and environmental concerns of companies and their stakeholders. (Marrewijk, 2003)

Even some of the researchers prefer to keep a distinction between the concepts of CSR and CS, today the concepts are often considered synonyms (Marrewijk, 2003). Furthermore, the economic and legal responsibilities are still vital, but they are more

considered self-evident and assumptions of ethical and discretionary responsibilities are getting more highlighted (Carroll, 2015). Also the concepts of ethical and discretionary responsibilities are expanding. Carroll (2015) presents four major frameworks in his study that concern and describe the concepts of these assumptions; business ethics, stakeholder management, corporate citizenship and sustainability.

Business ethics (BE) refers to the fairness of the business operation that includes the policies, behaviors and actions of managers and employees in a commercial context. Business ethics can be seen as norms of what the company and managers should do and what they should not do. Nowadays strong business ethics are essential for the success of the company. The framework of stakeholder management (SM) emphasizes the responsibilities of the company towards its stakeholders. Stakeholders are different individuals and groups that have shares of the company or they are otherwise interested in the decisions and operations of it. The challenge for the company is to be able to create and maintain relationships with the different stakeholders in a way their different expectations can be met and balanced. Corporate citizenship (CC) is almost a synonym to the CSR, because the concept includes all its features. In this view, the company has the same responsibilities as the individual citizens have towards the responsibilities of CSR. In Carrol's model the concept of sustainability (SUS) especially highlights the environmental responsibilities in addition to the social responsibilities of the company. Recently SUS has become one of the most important responsibilities of the companies. (Carroll, 2015)

2.2. Environmental sustainability

Like mentioned earlier, environmental sustainability is associated with the natural capita (Kahn, 1995; Basiago, 1999). Morelli (2011) defines environmental sustainability through WCED's (1987) general definition of sustainability as follows: "meeting the resource and services needs of current and future generations without compromising the health of the ecosystems that provide them" (Morelli, 2011, 5). According to Goodland et al. (1996) there are many ways how companies can reduce the negative environmental impacts. Companies can change their structure of production and demand as well as support environmental protection by investments. Azapagic (2003) argues that one of the main drivers for companies to act sustainable has been legislation. For example, in EU the European Commission has created policies and legislation that

support sustainable development. However, another significant driver nowadays is that it is actually reasonable to be environmentally and socially responsible. It has started to be seen as a way to search for cost reductions, manage risks, develop innovative products, and have an impact on the fundamental change in culture and structure. (Azapagic, 2003) Also stakeholders such as companies are getting all the time more aware of environmental problems, which encourages companies to apply environmentally sustainable procedures and products (Min & Galle, 1997). In addition, it is recognized that the most talented people nowadays prefer to work in companies that are supporting and contributing to a better world by understanding that eco-efficiency reduces costs, improves reputation and gives opportunities for innovations. (Moon, 2007)

2.3. Environmental management and environmental procurement

In order to comply with legislation and stakeholders' requirements on environmental sustainability, many organizations have implemented environmental management strategies or they have undertaken environmental management systems. Klassen and McLaughlin (1996, 1199) define environmental management as "encompass(ing) all efforts to minimize the negative environmental impacts of the firm's products through their life cycle". Environmental management takes into account product technologies as well as production technologies in order to minimize the environmental impact of the whole operation. With the support of a strong environmental management organizations can achieve improved environmental performance. (Zsidisin & Siferd, 2001) According to Gupta (1995, 35) "an environmental management system prevent(s) adverse environmental effects and improve(s) environmental performance by institutionalizing various environmental programmes and practices such as initiating environment-related performance measures and developing green technologies, processes and products".

There are laws and regulations supporting the environmentally sustainable operation of organizations and this environmental legislation offer the base for environmentally sustainable activities (Walker, Sisto & McBain, 2008; Walker & Phillips, 2006). Nevertheless, organizations should go beyond and create a strategy and vision that considers environmental issues of the whole supply chain. Environmental initiatives can begin as operational initiatives such as reducing waste and emissions, but these goals

must grow and widen to consider the whole supply chain. It is not enough to only comply with the environmental legislation, if organizations aim to truly implement environmental management. (Walton, Handfield & Melnyk, 1998)

Environmental supply chain management can be defined as the set of organization's supply chain management actions, policies and relationships that response to negative environmental impacts. They will consider the whole supply chain of the product: design, acquisition, production, distribution, use, reuse, and disposal of the goods and services. (Zsidisin & Siferd, 2001) Traditionally, the purchase function has not had a significant role in the achievement of an organization's corporate goals and it has been regarded more as a support service (Green, Morton & New, 1998).

However, the purchasing function is started to be seen as a significant and central actor in the achievement of goals related to the environmental supply chain management (Green et al., 1998; Carter, Ellram & Ready, 1998; Min & Galle, 1997). This is because the environmental supply chain management should begin with a solid waste reduction and it cannot be successful without reducing the upstream waste sources that are associated with purchased materials, and components and their packing. (Min & Galle, 1997) In fact, packing material is the most common waste source disposed of in landfills. Anyhow, the role of purchasing has clearly increased and the term "environmental purchasing" has started to be used within researchers. Environmental purchasing can be seen as purchasing's actions taken in order to enhance recycling, reuse, and resource reduction as part of the supply chain management. (Carter et al., 1998) These purchasing's actions include purchasing of raw materials but as well the selection, evaluation and development of suppliers and their operations such as packing, distribution, recycling, reuse, resource reduction, and final disposal of their products (Zsidisin & Siferd, 2001).

Purchasing of raw materials and components is in the beginning of the supply chain and that is why the cooperation between purchasers and designers is agreed to be important in order to reduce solid waste (Walton et al., 1998; Zsidisin & Siferd, 2001). According to Walton et al. (1998) the cooperation between designers and purchasers enable substituting and selecting product materials in order to avoid hazardous materials. In addition, they argue that the cooperation would support to consider the whole life cycles of raw materials used in products.

Besides to the cooperation with R&D, sustainable supply practices play a central role in successful environmental purchasing (Walker & Phillips, 2006; Walton et al., 1998; Green et al., 1998). First, it is essential to search for alternative options and include sustainable criteria in supplier contracts. The criteria must ensure the supplier's compliance with environmental regulations, but also consider supplier's proactive process improvements. (Walker & Phillips, 2006; Walton et al., 1998) In addition, sustainable supply practices include the improvement of suppliers' processes. Purchasers should provide support and influence on suppliers' processes and also understand their core processes and materials. (Walton et al., 1998) Like mentioned earlier, packaging of the purchased material and components has a critical role in reducing the solid waste. Packaging represents even 30 percent of municipal solid waste and the amount is increasing. (Min & Galle, 1997) In order to reduce the packing material, suppliers must support buying organizations in this goal by considering the reduction of it in their inbound logistics processes (Walton et al., 1998).

Researchers argue that the main barrier against environmental purchasing is cost concerns (Walker et al., 2008; Min & Galle, 1997). Purchasing of green materials often means that the material is non-traditional and this may increase the material costs. The more specified criteria for the material may also mean that the amount of qualified suppliers is limited. In addition to these concerns, purchasers face the problem on how to protect the product and materials from shipping damage while reducing packing material. (Min & Galle, 1997) According to Green et al. (1998) one significant gap is that there is a lack of performance measures, which would evaluate the impact of environmental purchasing.

However, environmental purchasing has also been argued to have positive impacts on the organization's performance. In Klassen & McLaughlin's study (1996) positive environmental events and strong environmental performance were associated with significantly positive stock returns. In addition, Carter & Dresner (2001) argue that there is a link between the success of environmental projects, the quality of products and the performance of manufacture. The performance improvement achieved by greening the supply chain can occur as improved quality, the reduction of waste in design and selection process, the reduction of air emissions, improved resource

utilization, reduction of lead times, and in the end reduction of costs (Melnyk, Robert & Calantone, 2003; Rao & Holt, 2005).

In order to gain these positive impacts, it is not enough to be only compliant with the environmental regulation, but the organization must go beyond that. Organizations should understand the nature of resource productivity and adopt it. In addition, it is essential to innovate and with the help of these innovations create more recourse efficient processes and items. This way the company is able to achieve real competitive advantages. (Porter & Van de Linde, 1995) Also Carter & Dresner (2001) highlight the importance of proactive actions towards environmental regulation. Besides, they also highlight that companies should consider costs from a long-term and life-cycle based view in order to achieve performance improvements. Naturally, it is also significantly important that the management is committed to the environmentally sustainable practices in purchasing and supply chain management (Walton et al., 1998).

2.4. Green public procurement

Public procurement is related to a government's or public sector's acquisition of goods and services using public funding. The aim of public procurement is to spend taxpayers' money on the best value and offer a utility for large amount of taxpayers. (Uyarra & Flanagan, 2010; Parikka-Alhola & Nissinen, 2012). When referring to environmentally friendly public purchasing, a common concept used is green public procurement (GPP) (Marron, 2003; Testa, Annunziata, Iraldo & Frey,2014; Parikka-Alhola & Nissinen, 2012 etc.). According to European Commission, GPP can be defined as "a process whereby public authorities seek to procure goods, services and works with a reduced environmental impact throughout their life cycle when compared to goods, services and works with the same primary function that would otherwise be procured" (European Commission, 2015a).

The actions towards GPP usually begin with a general aim and goal to take into consideration environmental aspects, but later the general aim can widen to specific programs. In addition, the aim of GPP often is to positively impact on a large scale of environmental issues. The most common initiatives are the reduction of waste and increasing of energy efficiency, and also other issues like promoting the use of organic products, water conservation and decreasing of emissions of manufacturing. Moreover,

GPP's goal is not only to effect on governments' own behavior but also to influence the behavior of actors of markets. (Marron, 2003)

Government and public sector are significant players in the market due to their purchasing power. It is a general belief that governments should utilize this purchasing power by taking the responsibility of the climate change and also acting as an example by applying environmentally friendly purchasing habits. (Marron, 2003; Li & Geiser, 2005; Nikbakhsh, 2009) However, the largeness of public purchasing and the response of private sector to GPP effect on the efficiency of GPP policies. The effects depend on the issued markets and its features. GPP is more efficient when the public sector is a large purchaser of the products and the primary source of demand. Secondly, indirect effects of GPP on private sector should be analyzed carefully. By supporting the innovation of greener products and contributing suppliers to notice economic benefits of greener products, public sector can reduce the costs of purchasing green products and help the private sector to apply green purchasing as well. Nevertheless, GPP policies may also have a negative impact on private sector. This is due to government's actions that actually increase the prices of greener products and/or lowers prizes of less green products. (Marron, 2003)

According to Marron's study (2003) there are certain factors that describe and evaluate GPP policies. First, by applying GPP policies it is possible to reduce not only negative environmental impacts but also inefficiencies in public procurement. This situation can be described as a "win-win" and public authorities should be encouraged to search such opportunities. Sometimes GPP policies are designed to only improve environmental performance even though it causes more costs or reduces operational performance. This is a "win-lose" situation, where the increased costs has to be justified carefully by the gained environmental benefits.

In order to achieve the goals and benefits of GPP, governments must focus on the products with most relevant negative environmental impacts that are not covered by the existing regulatory (Marron, 2003). They should also identify the existing green equipment available in the markets, promote their GPP policies by reforming the processes and this way make an impact on the markets. One of the key actions towards successful GPP policies is to include green requirements in purchasing contracts and tenders. (Li & Geiser, 2005)

While identifying environmental impacts of products, the whole life cycle of the product should be taken into account, not just the design and production phase. The life cycle assessment (LCA) approach considers the environmental impacts from raw materials to end of life of the product. (Nikbakhsh, 2009) According to European Commission, LCA is a process for assessing the potential environmental impacts of products or services through their life cycle. LCA includes three key elements: identification of the environmental loads involved, such as the energy and raw materials consumed; evaluation of the potential environmental impacts of these loads and a definition of the possible options to reduce these environmental impacts. (European Commission, 2015d; European Commission 2015i)

After assessing the potential environmental impacts of the product or service, the costs can be evaluated by using Life cycle costing (LCC). It is a tool, which is based on financial valuation and evaluates the costs of the product through its whole life cycle. (European Commission, 2015j; Adell et al., 2011) LCC contains four main cost categories: investment, operation, maintenance and end-of-life disposal costs. Environmental LCC methodology takes into account also environmental costs. External environmental costs have to be measurable impacts, for example eutrophication is reported as grams of NOX and NH3. External environmental costs can be based on the LCA analysis. Life cycle costing enables costs to be calculated based on the whole life cycle of the product and not relying solely on the purchasing price. (European Commission, 2015j) By utilizing LCA and LCC it is possible to calculate and analyze the actual costs and benefits of the different opportunities and achieve a “win-win” situation (Marron, 2003).

There are still many barriers against the inclusion of environmental criteria into tenders and contracts. Recently made survey “The Uptake of Green Public Procurement in the EU27” (Renda et al. 2012) results that public authorities find it difficult to include green criteria in the procurement process; on a scale of 1 (not difficult) to 5 (difficult), the average level of perceived difficulty was 3.06. Nevertheless, according to Palmujoki, Parikka-Alhola & Ekroos’s study (2010) the consideration of environmental aspects in purchasing process is increasing. They examined how often environmental criteria have been applied in purchasing contracts in Finland and Sweden in 2005 and 2007. The results show that in Finland only 19% and in Sweden 42% of the contracts contained

environmental criteria in 2005, but in 2007, 33% of Finnish contracts and 66% of Swedish contracts contained environmental criteria.

However, there are some already recognized barriers that at least partly explain Renda's et al. finding of the difficulties to include environmental criteria. One of the most significant barriers is the assumption that green products are more expensive. Reason behind this assumption is that often the initial costs are actually higher for green products. But when looking at the overall costs, they usually decrease, because of the lower operating, maintenance or disposal costs. (European Commission, 2015h) This assumption can be seen also in the results of the study by Renda et al. (2012). According to the results, the most used criterion still is the purchasing cost, while LCC costing, which is considering the overall costs, is the least commonly used criterion.

Another significant barrier is a lack of knowledge, guidance and competence within public purchasers on how to set the environmental criteria (Palmujoki et al., 2010; Marron, 2003). Public authorities are also facing a lack of management support for applying environmental criteria (Bouwer et al., 2006). Senior officials within the public sector do not have enough information of the importance of GPP or the information is not spread for public purchasers. Related to this, there is also a need for systematic implementation and integration of GPP into management systems. (European Commission, 2015h) Spreading the information wider would also increase the cooperation between public purchasers and other actors such as environmental departments, which is a relative driver for successful GPP policies. (Marron, 2003)

In order to facilitate public authorities to implement GPP policies, European Commission has published a handbook "Buying green". The aim of the handbook is to explain the possibilities that EU has created to support GPP implementation by law. The handbook also contains practical and simple examples from different industries. (European Commission, 2011) However, besides this general guidance, European Commission has also developed EU GPP criteria to support the inclusion of environmental criteria in public tenders. The criteria are defined specifically for different product groups. (European Commission, 2015c)

2.5. EU GPP criteria

In 2008 European Commission decided to create EU GPP criteria. The purpose of the criteria is to offer clear, verifiable, justifiable and ambitious environmental criteria that have been developed based on life cycle analysis and scientific evidence for different products and services. The criteria are common within all EU Member States, which support EU-wide competition and lower the administrative burden to implement GPP (European Commission, 2015c). Moreover, EU's aim was to increase the awareness about legal possibilities to include green criteria in public tenders. The criteria are a voluntary tool for EU Member States, but the implementation is highly encouraged and suggested by EU (European Commission, 2015b).

So far GPP criteria have been developed for 20 product groups. The product groups have been selected based on analysis on how significant environmental impacts and possibilities for improvement, public expenditure, market availability and political sensitivity the group has. (European Commission, 2015c) The criteria define the key environmental aspects for the selected product groups. According to the ISO14001 standard an environmental aspect is "an element of an organization's activities or products or services that can interact with the environment" while an environmental impact is "any change to the environment, whether adverse or beneficial, wholly or partially resulting from an organization's environmental aspects" (SFS-EN ISO 14001, 2004, 13). By defining the key environmental aspects, the purpose is to support the purchasers to focus on the right matters. (European Commission, 2010)

In EU GPP criteria key environmental aspects are defined within the whole life cycle; from production and use phase to the end of life using life cycle assessment (LCA) and life cycle costing (LCC). In addition to the key environmental aspects, also the scope, technical characteristics, existing technologies, related legislation, market availability and cost considerations have been analyzed and defined for each selected product group. The development of GPP criteria is based on all these factors. (European Commission, 2010)

GPP criteria are still under progress and that is why there are no criteria for all product and service groups. (European Commission, 2015h)

EU has classified GPP's benefits into environmental, political, social and economic benefits. First of all, GPP criteria can be seen as EU's permission to take into consideration ecological aspects during the purchase process. (European Commission, 2010) According to the study by PwC (2009) two main reasons for green public procurement are a positive environmental impact of the purchase and the availability of green alternatives (PwC, 2009, 69). In addition, executing green procurement gives an example to private consumers and raises awareness of environmental issues. Acting as a leading example for markets, can be also seen as a political benefit. Executing green purchasing is a way to demonstrate the commitment of a public organization to environment and sustainability. (European Commission, 2010)

From the social point of view, GPP improves the quality of life by facilitating to establish high environmental performance standards for products and services (European Commission, 2010). For economics the most significant benefit is that GPP can be a driver for innovations and financial savings (European Comission, 2011). Public authorities' purchasing power creates great incentives for companies to innovate green products and technologies that have as low lifecycle costs as possible (European Commission, 2010). The study by PwC (2009) resulted that it is possible to achieve financial savings through the implementation of GPP policies, because in general GPP helps public authorities to cut costs. By using life cycle costing (LCC) method, the average financial impact of GPP was -1% (on average for 10 priority product groups/services, within the seven best performing Member States) in 2006 and 2007.

GPP is also a significant part of EU's environmental strategies. On 3 March 2010 European Commission launched the Europe 2020 Strategy: A European strategy for smart, sustainable and inclusive growth. (European Commission, 2015f) The environmental targets set in the strategy focus on climate change and energy sustainability: reducing greenhouse gas emissions 20% from the baseline of 1990, using 20% of energy from renewables and increasing energy efficiency by 20% (European Commission, 2015g). For achieving these targets, the strategy highlights GPP as one of the measures (European Commission, 2011) and the key role of public procurement as a leading example. Public procurement is not only giving a good example for the purchasers but also fostering markets to innovate greener products and services. (European Commission, 2015f)

3. Environmental sustainability in health care sector

After presenting the key concepts, this section discuss about environmental sustainability in health care sector. First, some key data of European and Finnish health care sectors is provided, followed by discussions about hospitals' and ORs' environmental issues. In the end of this section an overview of EU's legislation related to environmental sustainability of medical devices is presented.

3.1. Health care sector in Europe and in Finland

Health care sector is a major and significant sector in Europe. In total, European Union has approximately 15 000 hospitals. (Chevalier, Lévitan & Garel, 2009) The sector is a significant employer within European countries; in 2011 the sector employed about 23 million people, which is approximately 10,4% of the total employment. (Schulz, 2013) In Finland in 2010, health care sector employed 367 000 people, which was about 15% of Finland's total employment (Parantainen & Laine, 2010).

Most of the EU countries agree that public access to healthcare, at a reasonable cost for an individual as well as for the society, is a basic need. This is one of the values and principles of EU health system. By giving attention to the health care expenditure and financing in EU countries, it is possible to evaluate how the country responds to the challenge of offering a public access to quality healthcare. (Eurostat, 2015b) The expenditure rates also demonstrate the significant purchasing power of health care sector.

According to Eurostat (2015a) in 2012, EU countries' total public expenditure amounted in 49% of gross domestic product (GDP). Below, the Table 2 demonstrates that in 2012, the largest function was social protection, which accounted for 19,4% of GDP. After social protection, the second largest function was health care that accounted for 7,1% of GDP, which is 14,6% of the total expenditure of the governments.

Table 2 Government expenditure by function (Eurostat, 2015a)

% of GDP	2006	2007	2008	2009	2010	2011	2012
general public services	6.4	6.4	6.6	6.7	6.7	6.9	6.9
defence	1.5	1.4	1.5	1.5	1.5	1.5	1.4
public order and safety	1.8	1.8	1.8	1.9	1.9	1.8	1.8
economic affairs	4.2	4.0	4.6	4.9	5.1	4.4	4.6
environmental protection	0.8	0.8	0.8	0.9	0.9	0.8	0.8
housing and community amenities	0.9	0.9	0.9	1.0	0.8	0.7	0.7
health	6.6	6.5	6.8	7.4	7.3	7.1	7.2
recreation, culture and religion	1.1	1.1	1.1	1.2	1.1	1.1	1.1
education	5.0	4.9	5.0	5.3	5.3	5.1	5.0
social protection	17.5	17.1	17.5	19.5	19.4	19.1	19.4
total	45.6	44.9	46.5	50.3	50.0	48.5	49.0
% of total expenditure	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
general public services	13.9	14.2	14.1	13.4	13.4	14.1	14.1
defence	3.2	3.2	3.2	3.1	3.1	3.0	3.0
public order and safety	3.9	3.9	3.9	3.8	3.8	3.8	3.7
economic affairs	9.2	9.0	9.9	9.8	10.1	9.0	9.4
environmental protection	1.7	1.7	1.7	1.8	1.7	1.7	1.7
housing and community amenities	1.9	1.9	1.9	1.9	1.6	1.5	1.5
health	14.5	14.6	14.5	14.7	14.6	14.7	14.6
recreation, culture and religion	2.3	2.4	2.4	2.3	2.3	2.2	2.2
education	11.0	10.9	10.7	10.5	10.6	10.5	10.3
social protection	38.3	38.2	37.7	38.7	38.8	39.3	39.6

Governments' expenditure in health care varies between EU countries. The Table 3 below demonstrates that in 2012, the health care expenditure varied between 5,5% (Romania) to 11,8% (Netherlands) of GDP. In Finland the health care expenditure was 8,7% of GPD, which is equivalent to 16 661 Million EUR.

Table 3 Current healthcare expenditure in 2012 (Eurostat, 2015a)

	Million EUR	EUR per inhabitant	PPS per inhabitant	% of GDP
Belgium	40 947	3 691	3 270	10.9
Bulgaria (')	2 950	400	921	7.7
Czech Republic	11 346	1 080	1 592	7.4
Denmark	*25 979*	*4 655*	*3 209*	*10.6*
Germany	290 422	3 548	3 530	10.9
Estonia	1 011	763	1 080	5.8
Ireland	:	:	:	:
Greece	17 708	1 592	1 791	9.2
Spain	94 267	2 013	2 132	9.2
France	226 776	3 473	3 175	11.2
Croatia	3 076	719	1 085	7.0
Italy	:	:	:	:
Cyprus	*1 287*	*1 492*	*1 679*	*7.3*
Latvia (²)	1 077	508	798	6.0
Lithuania	2 097	698	1 193	6.4
Luxembourg	2 905	5 535	4 056	6.8
Hungary	7 491	754	1 370	7.7
Malta	:	:	:	:
Netherlands	70 515	4 215	3 788	11.8
Austria	31 960	3 801	3 452	10.4
Poland	24 145	627	1 179	6.3
Portugal (')	*16 537*	*1 566*	*1 844*	*9.7*
Romania	7 185	358	735	5.5
Slovenia (')	3 090	1 505	1 772	8.6
Slovakia (')	5 239	971	1 454	7.6
Finland	16 661	3 085	2 514	8.7
Sweden	36 971	3 899	2 868	9.1
United Kingdom	:	:	:	:

Since this study focuses on the public purchasing of medical devices, it would have been interesting to get information about the public expenditure especially on medical devices, but that information was not available. Nevertheless, Eurostat's (2015b) statistics of health care expenditure by provider offer information about the total health care expenditure share of retail sale and producers of medical goods, which contain also medical devices. The share of 2012 health care expenditure was ranging between 15% and 35%. In Finland, 17,3% of the total health care expenditure belonged to retail sale and producers of medical goods.

3.2. Environmental issues in hospitals

Health care sector's role in environmental issues has become more known due to the increased environmental awareness, more strict environmental regulations and the need for cutting costs of public expenditure (Karlsson & Öhman, 2005). Such as other public actors, also hospitals have a responsibility to act as an example in activities against climate change. The responsibility is even more highlighted, when the complex and major environmental impacts of health care sector are considered; hospitals have an extensive carbon footprint but also complex waste streams containing for example, infectious, hazardous, radioactive and solid waste. (Cosford, 2009; Zimmer & McKinley, 2008) The overall goal of health care sector is to improve human health, but often the personnel and CEOs of hospitals do not consider the impacts of their own waste and emissions on human health. However, the most significant motivators to reduce pollution and waste have been concerns about personnel's and patients' health as well as hazardous waste regulations and cots. (Zimmer & McKinley, 2008)

In order to prevent the climate change, hospitals should reduce their carbon footprint and first of all start by measuring it. It is essential to have a wide view on the issue; instead of measuring only energy use, hospitals should also consider transport, procurement, waste and building design. (Cosford, 2009) Especially waste management plays a central role and many of the hospitals' environmental issues are related to the waste generation and disposal methods. In addition, it is essential that hospitals do not only reduce the amount of waste but also the toxicity of the waste, which has directly negative impacts on human health. Disposal of hospital's waste and products results pollutants such as mercury and dioxin that are greatly adverse for human health.

Because of the large amount of solid and toxic waste, healthcare sector is responsible for the generation of these adverse pollutants. (Kaiser, Eagan & Shaner, 2001)

The impacts of hospital waste disposal on human health and environment are often indirect since the waste does not contain immediate hazards. These indirect impacts cause also indirect costs. That is why analyzing the life cycle of the product is useful for hospitals, because it takes into account all the environmental impacts that occur during the life-cycle. It is a way to observe indirect impacts and costs caused not only by the disposal but also manufacturing, distribution and use of the product. (Kaiser et al., 2001)

Therefore, primary tasks for hospitals to reduce negative environmental impacts include consideration of waste disposal methods and also implementation of green procurement that contains an environmental screening of the products. This screening can be done by utilizing the life cycle assessment and including environmental criteria into purchasing processes. (Kaiser et al., 2001) In order to take into account environmental aspects in purchasing, purchasers need precise information about the environmental aspects of specific products within the whole supply chain. In addition, the scoring used in the purchasing process should be improved and define the relative significance of environmental criteria. (Oruezabala & Rico, 2012)

However, there are many barriers against the implementation of environmental procurement in health care sector. The prioritization and main values in health care are patient and personnel safety, quality and clinical performance, which are so important that they often reduce and postpone the efforts towards reducing negative environmental impacts. (Karlsson & Öhman, 2005; Walker & Brammer, 2009) Nevertheless, as mentioned earlier, negative environmental impacts caused by health care sector have also often negative impacts on human health, which is against health care sector’s general goals (Zimmer & McKinley, 2008). The lack of possibilities to prioritize environmental issues is also related to the strict budgets, the perception that more environmental friendly products are more expensive and lack of the amount of personnel, especially environmentally aware personnel. In some cases hospitals do not have enough time and resources to concentrate on environmental issues. In addition, a general and significant problem is the lack of knowledge of environmental impacts of medical products. This issue hinders the implementation of green procurement policies

in public hospitals. (Kaiser et al., 2001; Zimmer & McKinley, 2008; Walker & Brammer, 2009)

Even though operating rooms (OR) represent relatively small physical area in hospitals, the waste they generate is about 20-33% of all waste produced in hospitals (Kagoma, Stall, Rubinstein & Naudie, 2012; ref. Goldberg, Vekeman, Torjman et al., 1996; Tieszen & Gruenberg, 1992). ORs are also consuming greatly energy, because of the circulation, humidity, lightning and temperature requirements (Kagoma et al., 2012). Moreover, the use of anesthetic gases significantly contributes to the global warming (Kagoma et al., 2012; McGain, Story, Kayak, Kashima & McAlister, 2012b).

The amount and costs of hospital waste produced in operating rooms is increasing. According to McGain, Mossenson & Story (2012a) anesthesiologists' attitudes towards recycling play a central role in improving the recycling in OR. Their study results that anesthesiologists find recycling in OR important, but still only 1 out of 9 respondents agreed that they recycle in their ORs. There occurs three main barriers towards OR recycling; insufficient facilities for recycling, insufficient information and know-how, and staff attitudes. By contrast, costs, lack of time, lack of space, and safety issues were found to be insignificant barriers. In order to increase OR recycling greater support from hospital administration is needed. (McGain et al., 2012a)

Plastic packaging is one major source of OR waste; surgical products are often double-wrapped and packaged in big containers (Kagoma et al., 2012) and another major source is single-use equipment (McGain et al., 2012a). It is estimated that even 80% of OR waste is produced before the actual surgery (Kagoma et al., 2012; ref. Donaldson, 2000). Even though recycling in the OR is important, even more important is to reduce packaging and single-use equipment (McGain et al., 2012a).

In addition to the amount of waste, another significant environmental issue is the use of anesthetic gases. The global warming potential (GWP) of anesthetic gases is even 2000 times that of carbon dioxide (Kagoma et al., 2012, Doyle, Byrick, Filipovic et al., ref. Canadian Centre for Pollution Prevention, 2005). For example, during one working day the amount of N2O or desflurane (anesthetic gases) one anesthesiologist administrates produces an amount of CO2 that is comparable to more than 1000km of car driving (McGain et al., 2012b; Ryan & Nielsen, 2010; Ishizawa, 2011). McGain et al. (2012b)

have made a list of recommendations on how to improve environmental sustainability of anesthesia practices. First, they recommend the use of low flow anesthesia, which does not contribute only to the emission reduction, but also reduces purchase costs of anesthetic agents. In addition, turning off or assessing a “stand-by” mode in anesthesia machines and monitors would possibly contribute in energy and cost savings. Also reduction of waste is important, for example by reducing package material. All these actions require cooperation with suppliers.

Above all, hospitals must ensure the patient safety and quality of care. Nevertheless, the current technology development can enable the consideration of greener practices without compromising safety or quality. Nowadays there are different technology and material alternatives available, which would improve the sustainable practices in OR and should be considered, when police-makers are searching for strategies to save money. (Kagoma et al., 2012)

3.3. Best practices

There are some good examples and pioneers on a field of green hospitals. The phenomenon is constantly growing; hospitals do not only want to heal the patients but also support the healthy living environment. And of course, the other benefits gained at the same time such as cost savings and increased patient safety are one significant driver. For now most of the best practices in hospitals focus on reducing the energy consumption and other negative environmental impacts of the hospital buildings and facilities. For example, Hospital General Dr Agosthino Neto in Guantanamo in Cuba achieved a 21% reduction in energy use by renewing air conditioners, refrigerators, the electrical system and boilers, whereas hospitals in São Paulo in Brazil have achieved a significant energy consumption reduction of 25% by installing compact fluorescent lights and improving light circuits. (WHO & HCWH, 2009)

However, the environmentally sustainable procurement has been noticed as well. Within the hospitals worldwide there are pioneers and single projects that stand out. The best practices of green procurement presented in this section are focused on reducing the use of hazard chemicals and materials, decreasing energy consumption and improving recycling.

Some of the pioneers from Europe are the city of Vienna in Austria and especially the Karolinska Solna University Hospital in Sweden. Vienna has been running an environmental program “ÖkoKauf Wien” for 15 years. The program requests all the public authorities, including hospitals, to implement ecological criteria into the procurement process. (HWCH, 2014) In this program, the most significant advancement in the health care sector has been the development of the WIDES database, which ensures the procurement of safe and ecological disinfectants in Viennese hospitals (HCWH, 2015).

At the moment Karolinska Solna University Hospital is under constructions and it will be taken into use at the end of 2016 (New Karolinska Solna, 2013). The mission for the new hospital is to emphasize remarkably environmental sustainability. The main principle is “the patient always first” attitude, but at the same time there is a significant focus on environmental sustainability and energy efficiency. Their goal is to become the world’s leader in the area of environmentally friendly hospitals. (New Karolinska Solna, 2013; New Karolinska Solna, 2011) Environmental aspects have been considered in constructions and also during the operational life, for example in materials, by using renewable energy and fuel and recapturing of NO2. The hospital is also ISO 14001 certified. (New Karolinska Solna, 2011)

Furthermore, environmental aspects are taken into account in the purchasing of medical devices. Karolinska Solna buys its medical equipment as a service and the relationship with the supplier is highly comprehensive. The contract includes procurement, installation, maintaining, repairing, upgrading, replacing of medical equipment as well as training. In addition, the supplier is obligated to do research and innovate in order to improve the quality and environmental aspects such as energy efficiency and patient safety. When medical equipment has to be purchased from other suppliers, the suppliers must support the mission of the hospital; quality and environmental sustainability. (Earley, 2014)

Without a doubt, Karolinska Solna hospital is the pioneer of green hospitals within Europe. Another noteworthy health care provider is Kaiser Permanente located in USA. They have in total 10 million members in eight states and they also provide nonprofit health plans. (Kaiser Permanente, 2015a) Such as Karolinska Solna, Kaiser Permanente is focusing on sustainability in the health care. They have won several awards for their

achievements and they can be called the industry leader in promotion of environmental sustainability. In Kaiser Permanente they have accomplished many projects of purchasing of medical equipment related for example, to the reduction of the use of harmful chemicals and materials and elimination of waste by re-using and recycling. (Kaiser Permanente, 2015b)

The recyclability and the ability to re-use the equipment have been taken into consideration in many projects. In the projects the supplier is required to trade-in the old medical equipment for new ones. (Kaiser Permanente, 2011a; Kaiser Permanente, 2011b; Kaiser Permanente, 2011c) For example, in one of the projects ran by a hospital in Northern California, the supplier traded-in and recycled old ultrasound devices for the new ones that needed to be more environmentally sustainable. The new equipment was smaller, so they required less chemicals and material inputs for manufacturing. In the end, Kaiser Permanente saved in total $130,550 by end of the year and was able to recycle 3.7 tons of electronic equipment. (Kaiser Permanente, 2011a) In addition to the recyclability the more environmental design has been noticed. In one of the projects in Kaiser Permanente the supplier was required to provide external defibrillators that met clinical but also environmental requirements. Finally, the equipment needed 33% less raw material due to the smaller size, was soldered without lead, was compliance with EU regulation on hazardous substances, the packing material was non-bleached and it caused less hazardous waste, because of the sustained support for existing equipment and long-lasting battery. Kaiser Permanent saved 9% of costs during the first year. (Kaiser Permanente, 2009)

There are not that many hospitals in the world that emphasize the environmental sustainability as much as the hospitals presented above. However, the best practices are a sign that environmental sustainability is becoming more important.

3.4. Overview of EU legislation

This chapter will present how EU legislation on public procurement supports the consideration of environmental sustainability. Furthermore, the chapter will present legislation that applies to medical device manufacturers and aims to protect the nature such as Ecodesign directive, and chemicals and electric waste legislation.

3.4.1. Public procurement legislation

The need for specific environmental aspects in purchasing directives has been noticed already in 2004. That year the Council and the European Parliament started to simplify and modernize the existing European legislation on public procurement and as a result they adopted two new public procurement directives (Directive 2004/18/EC and Directive 2004/17/EC). These new directives contain a mention of the possibility of including environmental aspects in award criteria. Nevertheless, that also required better and more detailed information on how and what kind of green criteria could be included into public tenders. Furthermore, this offered an opportunity for Green Public Procurement (GPP) criteria to be developed. (European Commission, 2015a) In 2008 the Commission decided to create Green Public Procurement (GPP) criteria as a voluntary tool to support public purchasers (European Commission, 2015b). The goal of GPP is to offer guidelines of greener purchasing for public purchasers and give guidelines on how GPP can simulate innovation in environmental technologies, products and services (European Commission, 2015b).

The development of GPP criteria has been a significant step towards more environmentally sustainable public procurement. Nevertheless, the publication of EU's 2020 Climate and Energy Package in 2007 has had a significant influence as well, and it contributes to the implementation of GPP criteria. The Package has three key targets: 20% cut in greenhouse gas emissions (from 1990 levels), 20% of EU energy from renewables and 20% improvement in energy efficiency. These targets were set in order to achieve the climate and energy targets set for the year 2020 and they have been enacted in legislation since 2009. (European Commission, 2015k) This new legislation has an impact on the public procurement directives, which have been revised in 2014. The new directives still do not require public purchasers to implement environmentally sustainable purchasing procedures. However, they resolve many of the legal uncertainties that have been delaying the implementation of sustainable procurement as well as the implementation of GPP criteria. (HCWH Europe, 2014b)

European Commission revised the public procurement directives by Directive 2014/24/EU on public procurement, Directive 2014/25/EU on procurement by entities operating in the water, energy, transport and postal services sectors and Directive 2014/23/EU on the award of concession contracts. The due date for transposing the

directives into national laws is before April 2016. Even though these directives are not included in the 2020 Climate and Energy package, they contribute with its targets. (Roberts et al., 2014; HCWH Europe, 2014b) It is still optional for the public authority whether to implement green criteria or not. Nevertheless, the directives are giving now better legal support and ensuring that public authorities can utilize the public procurement better in order to achieve climate and energy targets. (HCWH Europe, 2014b)

The new public procurement directive sets three different ways how to choose the "most economically advantageous tender": lowest price, lowest cost and best price-quality ratio (BPQR). Two latter options are allowing the consideration of environmental criteria as well. Lowest cost includes the price, but also other costs such as operating, service and disposing costs of the product. The costs of environmental externalities can be included as well and most likely in this case a life cycle method is used for the cost calculation. The best price quality ratio instead, allows a pubic authority to set own award criteria. They can include environmental and social criteria as long as they are linked to the subject matter of the contract. In addition, a big improvement is that this directive now allows certification and labelling to be included into technical specifications or award criteria. (HCWH Europe, 2014b)

3.4.2. Ecodesign Directive

Another improvement due to the 2020 Climate and Energy Package are the new standards established in order to enhance the procurement of high energy-efficiency products. These standards are established under the Ecodesign Directive (2009/125/EU) and they are contributing with GPP criteria as well. At the moment, there are some preliminary plans to include medical imaging equipment into the Ecodesign Directive. (Roberts et al., 2014)

The EU Ecodesign Directive is a standard that obliges manufacturers of energy-using products to improve the energy-efficiency and to reduce the negative environmental impacts throughout the life cycle of the products. The design base has a significant influence on the energy efficiency of the product and by the expression "ecodesign" it is meant that there has to be a greater focus on life time energy use and other environmental aspects already during the design base. The Directive includes obligatory

performance criteria which must be met in order to legally bring the product to the market. (Eceee, 2015a)

The Directive does not straight away come into force for all energy-using product groups. The product groups will be selected after an extensive product study that examines if the implementing measures can be considered or not. If the study results that the product group is relevant, the Commission will give a proposal based on the discussions of the definition, implementing measures, the efficiency of the market monitoring mechanisms and the estimation of voluntary agreements within the context of the Directive. Then, after drafting and outlining impact assessments, the final proposal will be developed and sent to voting. In the end, the Commission adapts the implementing measure and most likely it takes direct legal effect in all Member States. (Eceee, 2015b)

As mentioned before, the process for including medical imaging equipment into the Directive is on progress. The product study has been completed and the process is now on the stage where the Commission is discussing about the proposal. The challenge is that the products within the group are complex and they need to be considered separately. The purpose is to target one modality per year. (Eceee, 2015c)

3.4.3. WEEE Directive

WEEE stands for Waste of electrical and electronic equipment. The aim of WEEE (Directive 2012/19/EU) is to decrease the amount of waste electrical and electronic equipment and foster recycling, reusing and other kind of ways to utilize the waste instead of the final treatment. The directive is applied for all of the electrical and electronic products such as medical devices. (Tukes, 2014a)

The first version of WEEE (Directive 2002/96/EC) entered into force in February 2003 (European Commission, 2015l) and all the equipment put on the market after August 2005 were required to be marked with a separate collection label. The label is a crossed-out wheeled bin. In addition, the equipment has to have a mark that indicates the equipment's producer. (Tukes, 2014a) The mark in the equipment allows the consumers to return their WEEE free of charge (European Commission, 2015l). The recast of WEEE Directive became effective in February 2014, which specified the subject more detailed (European Commission, 2015l).

In Finland, the Directive has been executed into national legislation by the Waste Act (646/2011) (Tukes, 2014a). The Pirkanmaa Centre for Economic Development, Transport and the Environment is responsible for the requirements of producer responsibility. It means that the producers of EEE (electrical and electronic equipment) are responsible for organizing the recycling and waste management of the products they put on the market. Furthermore, they are also liable of the costs of the waste management. In order to comply with this requirement, the easiest way for companies is to join a producer organization. The producer organization takes care of the waste management. In return, the company pays compensation to the organization. The amount depends on the contract. (ELKER LTD, 2015)

3.4.4. RoHS Directive

The RoHS, Restriction of Hazardous Substances, is EU's directive that restricts the use and orders to substitute by safer alternatives the heavy metals such as cadmium, lead, mercury, hexavalent chromium, polybrominated biphenyls (PBB) and polybrominated diphenyl ethers (PBDE) in electrical and electronic equipment (Tukes, 2014b; European Commission, 2015m). The aim of this Directive is to save the environment and reduce the amount of hazardous waste as well as protect human health (Tukes, 2014b).

In July 2006, the Directive (2002/95/EC) entered into force for the first group of electrical and electronic equipment, which did not yet include medical devices. The recast of the Directive (2011/65/EU) also applied for the rest of the electrical and electronic equipment groups. The directive set the transition periods for the new products; for medical devices the restrictions on hazardous substances applied from 22 July 2014. After that date it was not allowed to place on the market medical devices that contain hazardous substances listed above. (Tukes, 2013)

The new Directive also defined the conformity assessment procedure for manufacturers. The manufacturer must have internal production control that ensures the fulfillment of the obligations and confirms that the product meets the requirements of RoHS. The technical documentation of the equipment must determine the conformity. After the manufacturer has affirmed that the product meets the RoHS requirements, the manufacturer shall draw up and sign the EU Declaration of Conformity and can then use

the CE marking on its products. (Tukes, 2013) The CE marking informs that the product is in conformity with the EU requirements that apply to it (Tukes, 2012).

3.4.5. REACH Regulation

The REACH stands for Registration, Evaluation, Authorization and Restriction of Chemicals. The regulation is binding regulation by European Union and it is directly applicable in all Member States. (Tukes, 2014c) The purpose is to protect human health and environment from the risks of chemicals as well as to improve the competitiveness of the EU chemicals industry. Furthermore, the target is to encourage using alternative methods for the hazard assessment of substances and reduce the number of tests on animals. REACH entered into force on 1 June 2007. (ECHA, 2015a)

Many of the companies in EU are impacted by REACH, because the regulation applies to all chemical substances, also substances in mixtures and articles that are manufactured or imported. REACH increases the responsibility of companies to provide proofs of chemicals safety; basically it transferred the responsibility from the authorities to the companies. (Tukes, 2014c) In order to comply with the regulation, companies have to register all substances manufactured or imported to EU, when the quantity is over one ton per year. Companies register the substances in the REACH database managed by the ECHA (European Chemicals Agency). The registration requires identifying and managing the risks of the substances the companies manufacture or sell in the EU. The safe use of the substance needs to be demonstrated to ECHA. Companies need to communicate the risk management measures to the users as well. If companies are not able to provide proof of the risk management, the use of the substance can be limited. The goal is that in the long run, the most hazardous substances will be substituted with more harmless substances. The registrations will be done in three phases by the year 2018. (ECHA, 2015a)

If a substance may have serious effects on human health or the environment and there is a need for more careful risk analyzing, a Member State or ECHA at the request of the European Commission can propose a substance to be included into a Candidate List of Substances of Very High Concern (SVHC). If a substance is included in the Candidate List, it creates legal obligations of information provisions to companies who are manufacturing, importing or using such substances, whether on their own, in

preparations or in articles. (ECHA, 2015b; Tukes, 2014c) The companies must provide proper information on the safe use of the article to the recipient and also to the end-user, if they request and the article contains the issued substitute a concentration of 0.1% by weight (Tukes, 2014c).

3.5. EU GPP Criteria for Health Care EEE

There are multiple significant reasons why European Commission decided to develop GPP criteria for health care electrical and electronic equipment (EEE). The reasons are related to the energy consumption, the size and demands of the markets as well as the level of technological development. Based on all these factors, health care EEE is a relevant product group for GPP criteria. (Dalenstam et al., 2014)

Medical equipment is a very energy intensive product sector. It causes more than 15% of the total energy consumption of hospital buildings and it is the third largest electricity consumer in hospitals, just after lightning and ventilation. (The Swedish Energy Agency, 2008) According to EPTA's (2007) article "Guidelines for energy efficiency in hospitals", the life cycle-cost analysis in purchasing is playing a significant role when reducing the energy consumption in hospitals. (EPTA, 2007)

Another reason why health care EEE is a significant product sector is that the industry is huge and growing continuously. Public authorities spend approximately €2 trillion a year on medical equipment, which is roughly 17 % of the EU's gross domestic product (European Commission, 2010). According to EUCOMED (2015), the market size in Europe is approximately €100 billion and the sector directly employs around 575,000 people. Furthermore, medical technology companies reinvest approximately 8% of sales into product research and developing. These investments and skills have made Europe a hub of excellence for innovation in medical technology. This has also an impact on the industry size, which is growing more than 4 % a year. (EUCOMED, 2015)

The markets for medical equipment are expected to grow even more in the future. First of all, the population is growing and ageing, because of the higher survival rates (Dalenstam et al., 2014). In addition, according to COCIR's report (2014), the installed base of the medical equipment in Europe is the oldest it has ever been. This means that countries need to invest in health care soon. All these factors are giving a sign that it is

time to innovate and right time to publish GPP criteria to support the innovation and purchasing of greener medical equipment (Dalenstam et al., 2014).

The Swedish Environmental Management Council (SEMCO) is the main author developing EU Green Public Procurement (GPP) criteria for medical devices. The project has two phases; last November the criteria were developed for health care medical devices and in the next phase the preliminary plan is to develop criteria for consumables (sanitary absorbent products excluded). During the project, SEMCO had meetings with the EU Stakeholder Ad Hoc Working Group (AHWG), stakeholders and Swedish experts to gather as much knowledge as possible to develop reports and the criteria. (Dalenstam et al., 2014)

The project started by delivering two versions of preliminary reports. These reports were modified and developed after meetings with AHWG, stakeholders and experts. Based on the reports, SEMCO created Technical background report (Dalenstam et al., 2014) and draft GPP criteria. Technical background report includes the description of the project; project plan, selection of scope, stakeholders, general information on the subject, key environmental aspects, criteria development process and proposal for core and comprehensive criteria. After discussions with other stakeholders and experts, and when the proposed criteria were verified by third party verification, SEMCO created a final report and GPP criteria. (Dalenstam et al., 2014)

3.5.1. Environmental aspects

The development of environmental aspects is based on life cycle analysis (LCA). LCA analysis for health care EEE do not usually include identification of hazardous substances, but the process of developing EU GPP criteria is requiring the identification. That is why also the assessment and risk analyses of hazardous chemicals have been made for health care EEE. The analyses of chemicals are based on the information of classification, volumes, upcoming legislation, scientific journals and information on hazards and risks during production, use and end-of-life. (Dalenstam et al., 2014)

Because of the nature of health care EEE, patient safety aspects are always more important than any other aspects. While developing GPP criteria, it was secured that there are no conflicts with patient safety and GPP criteria. (Dalenstam et al., 2014)

Based on the life cycle analyses and the analyses of the chemicals, the following key environmental aspects were included in the criteria: energy consumption, water consumption, gas consumption, and use of refrigerants in medical freezers, use of materials and content of hazardous chemicals (Dalenstam et al., 2014).

Energy consumption is the most significant environmental aspect for health care EEE. Reducing energy consumption of medical devices has significant positive impact on reducing GHG emissions and air pollution. (Dalenstam et al., 2014) In EU GPP criteria, energy consumption has been taken into consideration through five approaches: purchasing of energy efficient equipment and equipment with low power mode that are supplied with green performance management instructions and a metering device and ensuring the appropriate and energy efficient functioning of the equipment through a needs' assessment and the provisions of training on energy efficiency. (European Commission, 2014)

The criteria for *water consumption* were developed because of the possible water savings in the standby mode. Another significant reason was that for calculating water consumption, it is possible to use the same model as for energy performance. This decreases the effort of filling this criterion as well. (Dalenstam et al., 2014; European Commission, 2014)

To reduce GHG emissions caused by medical devices, *gas consumption* was included in significant environmental aspects as well (Dalenstam et al., 2014). Keeping the gas consumption low is not only an advantage for environment but also for economy and health of employees and patients. However, it is really important that the low gas consumption does not cause any danger or risk for the patient. (Dalenstam et al., 2014; European Commission, 2014)

Refrigerants are used in medical freezers to cool the space. Especially the most commonly used refrigerants, halogenated alkanes, are distinctly harmful for ozone layer and they contribute to global climate change. (Brown & Domanski, 2014) Global warming potential (GWP) has been created to describe and measure how harmful a chemical is for ozone layer. The global warming potential (GWP) "represents how much a given mass of a chemical contributes to global warming over a given time period compared to the same mass of carbon dioxide" (EPA, 2014). To reduce these

negative impacts on environment, purchasing medical freezers containing refrigerants with low GWP, is one approach in GPP Criteria (European Commission, 2014).

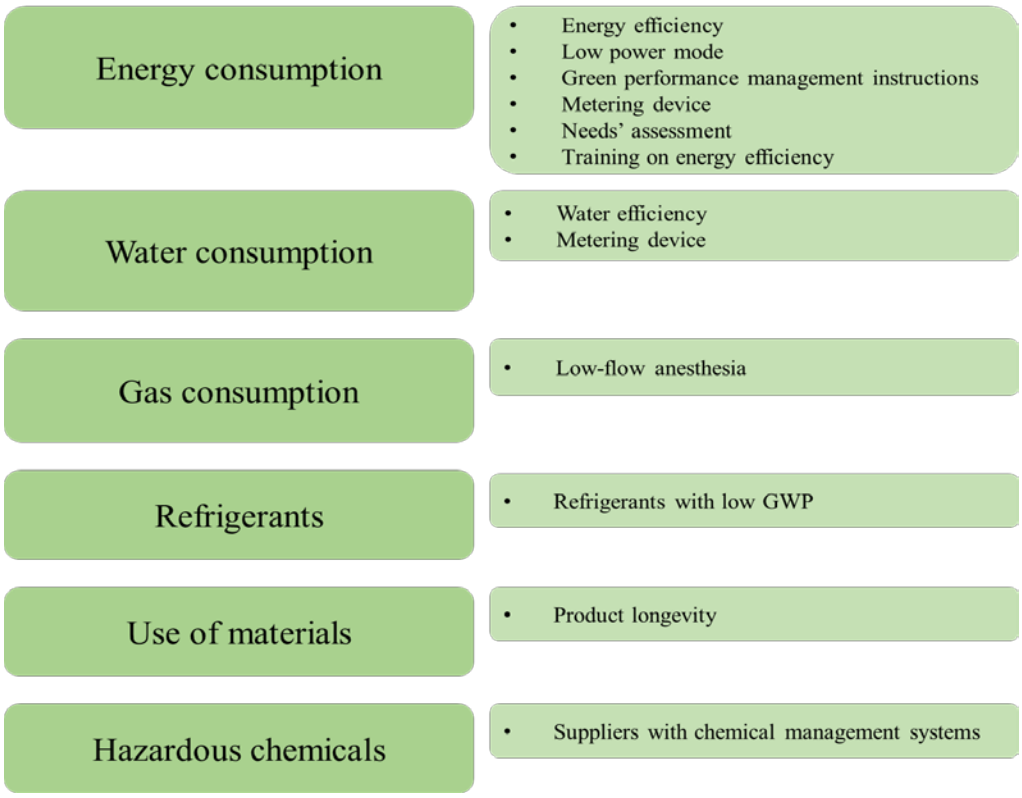
Stakeholders decided to focus on ecological design and possibilities for refurbishment while developing the criterion regarding *use of materials* and scarcity of resources. That is because it is too difficult and complicated to develop criteria regarding composition of materials for all different equipment. (Dalenstam et al., 2014) In GPP criteria the use of materials is taken into account by requiring the longevity of the equipment. The longevity is ensured by offering repair or replacement of the product to make the life of the equipment as long as possible and to prevent the replacement with new equipment because of the lack of spare parts. (European Commission, 2014; Dalenstam et al., 2014)

Even though life cycle analysis resulted that chemicals are not one of the most significant environmental aspects for Health care EEE, there are other strong reasons why chemicals are included into GPP Criteria. Medical devices can contain hazardous substances and actually only little is known how different chemical cocktails effect on humans and the environment. In addition of the lack of precise information, another reason was a concern that some companies do not know enough about the obligations regarding the information of chemicals. Voluntary instruments, like GPP, are needed to achieve national goals such as The Swedish Chemical Agency's goal on a Non-Toxic Environment by 2020. (Dalenstam et al., 2014) Based on these reasons, content of hazardous chemicals is included in the GPP Criteria by requiring a supplier to have chemicals management systems (European Commission, 2014).

3.5.2. Criteria

The criteria proposed in EU GPP criteria for health care EEE are defined based on the most significant environmental aspects (European Commission, 2014). In this section each of the criterion will be presented. Figure 3 below demonstrates the connection between the most significant environmental aspects and GPP criteria.

Figure 3 Environmental aspects and related criteria



According to life cycle analysis, improving the energy efficiency of health care EEE is the most effective tool in order to reduce environmental impacts during the lifetime. In order to determine the most energy efficient equipment, it is important to have well defined energy performance measuring methods. This ensures that the energy efficiency of tenderers' equipment is measured in the same way and the results can be compared in equal terms. (Dalenstam et al., 2014) To be able to define proper energy measuring methods, the medical equipment has been divided into six categories; CT, hemodialysis equipment, MRI, medical sterilizers, disinfectors and a category that consist all the rest. Descriptions of the measuring methods for all of these categories are included into the GPP criteria. (European Commission, 2014)

The requirement of purchasing low power mode equipment has been considered as a relevant energy performance criterion. In order to ensure the patient safety, it was discussed especially carefully during the discussion. The criterion of automatic low power mode has been developed for medical sterilizers, CT, MRI, ECG diagnostic and ultrasound. (Dalenstam et al., 2014) The requirement is that the equipment can be configured to go automatically into a standby or off mode after a stated period of

inactivity. In addition, it is advantageous if the required start-up time is short and the needed effort is small between the changes of different modes. (European Commission, 2014)

The use of the equipment is one important and significant environmental aspect in order to minimize the environmental impacts as much as possible. Therefore, one of the GPP requirements for suppliers is that they need to provide user instructions for green performance management for medical devices. (Dalenstam et al., 2014) This manual has to be available in a written or digital form with the equipment. The minimum requirements of the content of the manual are defined in GPP Criteria; it has to include instructions on how to minimize the environmental impacts during the whole life cycle and how to minimize consumption of energy, water, consumable materials/ parts and emissions. The instructions have to include also recommendations on the proper maintenance and instructions about the spare parts that can be replaced and how to clean the machine. (European Commission, 2014)

To reduce the impact of user habits alternations, the equipment is recommended to be purchased with a metering device. The metering device should follow and register electricity, water and/or gas usage depending, which of them are relevant for the equipment. It is advantageous, if the acquired data can be sent directly to a central point of data gathering. The evaluation of the data might highlight some user habits that actually increase the energy consumption. (Dalenstam et al., 2014; European Commission, 2014)

Because energy consumption is a significant environmental aspect for health care EEE, the proper and energy efficient functioning of the equipment is guaranteed through a needs' assessment and training on energy efficiency. The training shall include information how to adjust and fine-tune the equipment's electricity using parameters in a way the energy consumption is minimized. By proper adjusting and fine-tuning, it is possible to achieve remarkable energy savings. (Dalenstam et al., 2014)

The purpose of the needs' analysis is to gather information on the specific user routines, activities and environment related to the equipment purchased under the contract (Dalenstam et al., 2014). The information may include for example frequency of use, type of examinations etc. The information enables the adjustment of the parameters in a

way the user prefers. Based on the information the user can also decide if a customized energy efficiency optimization should be applied. The needs' assessment shall be accomplished upon installation and also in up-coming preventive maintenance. (European Commission, 2014).

The criterion concerning water efficiency is applied to dialysis and disinfectant equipment since their water consumption is remarkable. According to the study by Agar (2010), dialysis consumes approximately 500 liters water per patient. However, available market data shows that even 28% of this consumption could be reduced, which means that there exists clear possibilities for improvement. (Dalenstam et al., 2014; ref. Agar, 2010) To calculate the water consumption of the equipment, the same model with some modifications can be used as for calculating the energy performance. (Dalenstam et al., 2014)

According to the EU GPP criteria, low flow stands for "a flow rate that gives adequate O2 and agent to the patient with a good response time to changes; maximum 2 liters per minute in clinical studies" (European Commission, 2014, 22), while normally the flow is 4-5 liters per minute. Anesthesia equipment that are used for long and medium term treatment should be supplied with back pressure compensated low-flow function of maximum 2 liters. Furthermore, it is advantageous, if the anesthesia equipment are equipped with an automatic low flow function or provided with a guiding user interface for achieving low flow. (European Commission, 2014)

As discussed earlier, refrigerants that are used in medical freezers, may have high GWP (Global Warming Potential). However, equipment containing refrigerants with low GWP are available on the market. That is why the requirement to purchase medical freezers containing refrigerants with low GWP is included into the criteria. (European Commission, 2014)

According to the GPP criteria, repair and replacement of the equipment has to be covered by warranty. The tenderer must ensure that there are original or equivalent spare parts available for the expected service life. The expected service life is at least for five years over warranty. (European Commission, 2014)

The supplier shall have a chemicals management system. The system has to dedicate resources and ensure the necessary expertise. The supplier has to also confirm that they

have documented routines and instructions that ensure the awareness of the content of chemicals in the equipment, which have been included into the Candidate List of Substances of Very High Concern (SVHC) identified under the REACH regulation. In addition, the supplier must describe monitoring, following-up and resources allocated for chemicals management. (European Commission, 2014)

The purpose of this criterion is to ensure that the supplier informs its customers (authorities in hospitals) on the updates of the Candidate List of Substances of Very High Concern regarding the products being sold to hospitals. (Dalenstam et al., 2014) The authorities in hospitals have to be notified within 5 years following the delivery of the product and the notifications has to be made within 6 months after the publication of updates. In addition, the supplier has to provide the results of the risk management file review when informing on updates. (European Commission, 2014)

4. Research methodology

This study began with creating a preunderstanding of the research topic by examination of previous research in the literature review. The theory framework of this study consist a discussion of key concepts of green public procurement and an introduction to EU GPP criteria. The aim of the theory framework is to widen the understanding of the subject and create a base for the empirical research.

The understanding of the subject also led to an understanding what kind of a research method would best fit with this study. The aim of the empirical research is to provide a diverse understanding of the specific, multidimensional topic, which requires an open-ended approach to the research method. This chapter presents research methodology for empirical research.

4.1. Research method

Usually, research methods are divided into qualitative and quantitative methods. In qualitative method, the data is often presented in a verbal or visual form. The aim of the data is to be theoretically representative. (Uusitalo, 1991, 79) This means that only relatively small amount of cases are being examined, but the examination is profound (Eskola & Suoranta, 1998, 18) and the emphasis is on understanding the different aspects of the actors and situations (Hirsjärvi & Hurme 2008, 22). In quantitative

method, the data is often presented in a numerical form (Uusitalo, 1991,79-80). The aim of the method is to examine predictability, generalization and causal connection (Hirsjärvi et al., 2008, 22). The main difference between qualitative and quantitative methods is that a qualitative research aims to develop a theory, whereas a quantitative research aims to test a theory (Uusitalo 1991,81). However, some of the researchers state that these two methods should not be separated that strictly and the confrontation has been used mainly for purposes of illustration. (Eskola et al., 1998, 10; Hirsjärvi et al., 2008, 21).

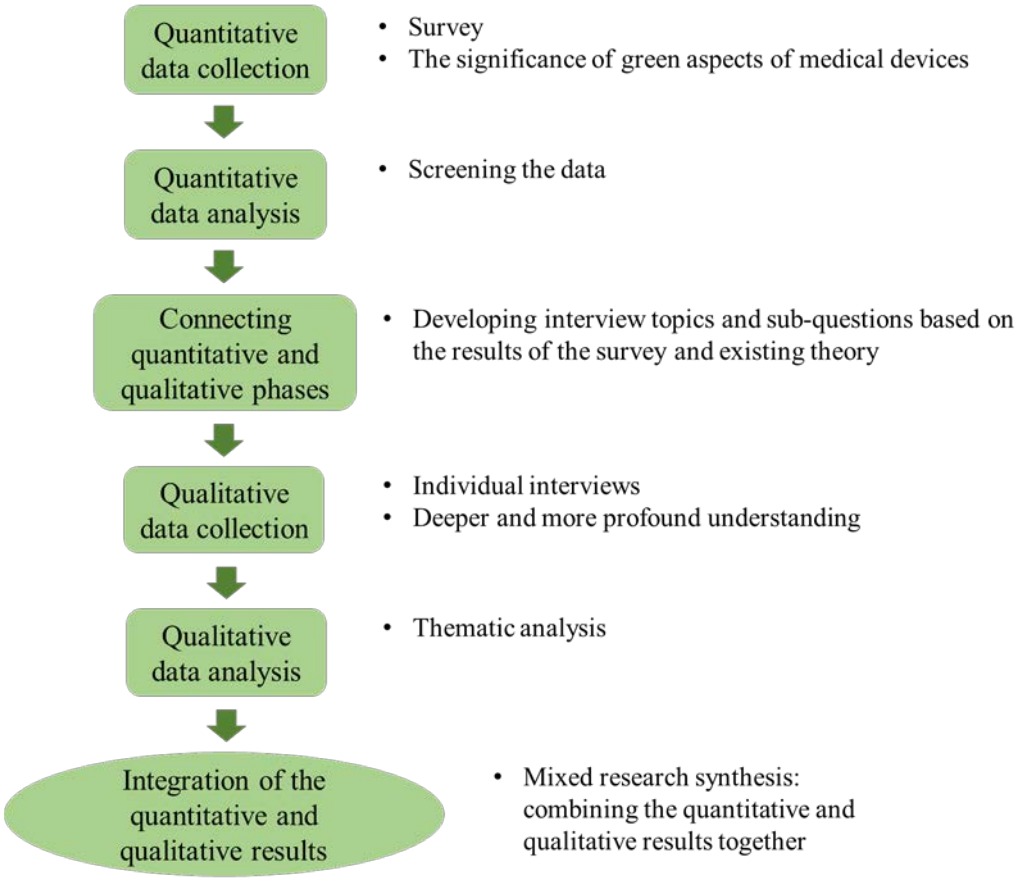
A mixed method is a research method that includes at least one quantitative method and one qualitative method (Caracelli & Greene, 1993). The mixed method approach was selected for this study, because it allows the analysing of diverse types of data and so provides a profound understanding of the subject. In this study, the empirical research includes features from both qualitative and quantitative research approaches and the mixed method approach is used for a complementary purpose. That is used when the quantitative and qualitative data are overlapping, but they are examining different facets of the phenomenon. The aim is to clarify, enhance and illustrate the results from one method type with the results from the other method type. (Caracelli et. al, 1993) To generalize the results, the studies normally begin with a survey, and after the results are detailed and explained with interviews (Creswell, 2014).

4.2. Research design

As the mixed method approach was selected, the aim of the research process is to connect quantitative and qualitative phases and integrate the results of both phases. The priority of quantitative and qualitative approach should be determined in studies that include both quantitative and qualitative approaches (Ivankova, Creswell & Stick, 2006). In this study, the priority is determined by the purpose of this study and research questions. Even though the priority is often given to the approach being the first phase of the research process (Ivankova et al., 2006), in this study the priority is given to the qualitative approach that is carried out by interviews. This choice was influenced by the aim of this study to provide a profound and diverse understanding how a medical device manufacturer should consider environmental sustainability in medical devices.

The aim of the first, quantitative, phase was to identify the significance of different environmentally sustainable features of medical devices. The qualitative phase of the study focused on interpreting the results of the quantitative phase and to deepen the understanding of the phenomenon with more diverse answers. The research process in this study is adapted from Ivankova et al. (2006) and presented in the Figure 4 below.

Figure 4 Research design adopted from Ivankova et al. (2006)



4.3. Data collection

The data collection for the empirical research includes both, qualitative and quantitative data. In this study, the quantitative data is collected with a survey. The survey data is not as accurate and valid as it should be, but rather gives a good general picture. The qualitative data is needed to ensure the more detailed and profound understanding. It is collected with interviews made for procurement specialists in Finnish public hospitals.

The quantitative data collection was made by a survey. The main purpose was to gather a general picture of the subject and an estimation how the significance of environmentally sustainable features of medical devices will change in the next five years. Furthermore, the purpose was to use the results of the survey as a background for the interviews. The survey was built with GE Survey Tool. It consist 24 multiple-choice questions and space for free comments in the end. The questions in the survey were divided into three themes: background information about the respondents, environmental sustainability in the purchasing process and environmentally sustainable features of medical devices. Because the survey was allocated for Finnish respondents, the language was Finnish. The survey is presented in the Appendix 1 and the response request email in the Appendix 2.

The survey was sent to 89 recipients in June 2015. The quantity consist 40 procurement specialists, 28 clinicians and 21 medical technicians from Finnish public hospitals. In public procurement processes procurement specialists make the final decisions. Nevertheless, clinicians and medical technicians often define the needs and requirements for the equipment being procured. In order to get as comprehensive results as possible, the survey was sent to people working in these three functions. Finally, 19 surveys were received in total; six from procurement specialists, seven from clinicians and six from medical technicians. The response rate for the survey was 21%. Out of the received surveys, all of them were usable for the analyses.

There exists a variety of different research interview forms. In a structured interview the interview is standardized in order to minimize the differences between interviews. The opposite is a totally unstructured interview; the interviewer has planned beforehand only the main question and the interview is supposed to continue as a conversation. (Bryman, 2016) In this study, the aim of the interviews is to get a profound and diverse understanding of the specific subject. For this purpose the best interview form is a semi-structured interview, which is a mix of structured and unstructured interview forms.

In a semi-structured interview form, the researcher formulates an interview guide that includes questions or topics to be asked in an interview. In order to achieve the diversity of the answers, it is crucial that the questions are not too specific and they allow the flexibility in the conduct of the interviews. The aim of the questions is to keep the conversation around the defined subjects of the study. (Bryman, 2016) Since the

research problem of this study is multidimensional, an informal conversation that is led to interested topics relevant for the research is selected to be the best interview form for this study.

In this study, the interviews were held for three purchasing specialists from different Finnish health care districts. The specialists for the interviews were selected on a basis of their job description. They all work in a field of purchasing of medical devices in hospitals. These selected purchasing specialists have decision making power in purchasing process and they all have an extensive view on the process with valuable opinions. Since the interviewees' identity will not be revealed, interviewees are named as Interviewee 1, 2 and 3. Interviewee 1 is a head of procurement. Her field consist all the equipment and furniture of the health care district. Interviewee 2 is also a head of procurement in a field of equipment. In her role, the special focus is on the procurement of medical devices. Interviewee 3 is a procurement specialist in a field of medical devices and accessories.

The interviews were executed in Finnish. They included four themes: environmental sustainability in purchasing, conceptions against environmentally sustainable purchasing, the future and questions specifying the survey results. All themes included sub questions in order to get more precise answers. The themes and sub-questions were same in all of the interviews, but the form and order of the questions changed according to the situation. As well, there were some questions that all of the interviewees did not answer due to the lack of information. The framework of the interviews is presented both in Finnish and English in the Appendix 3. Later, the themes of the interviews are a framework for the analyses of the results.

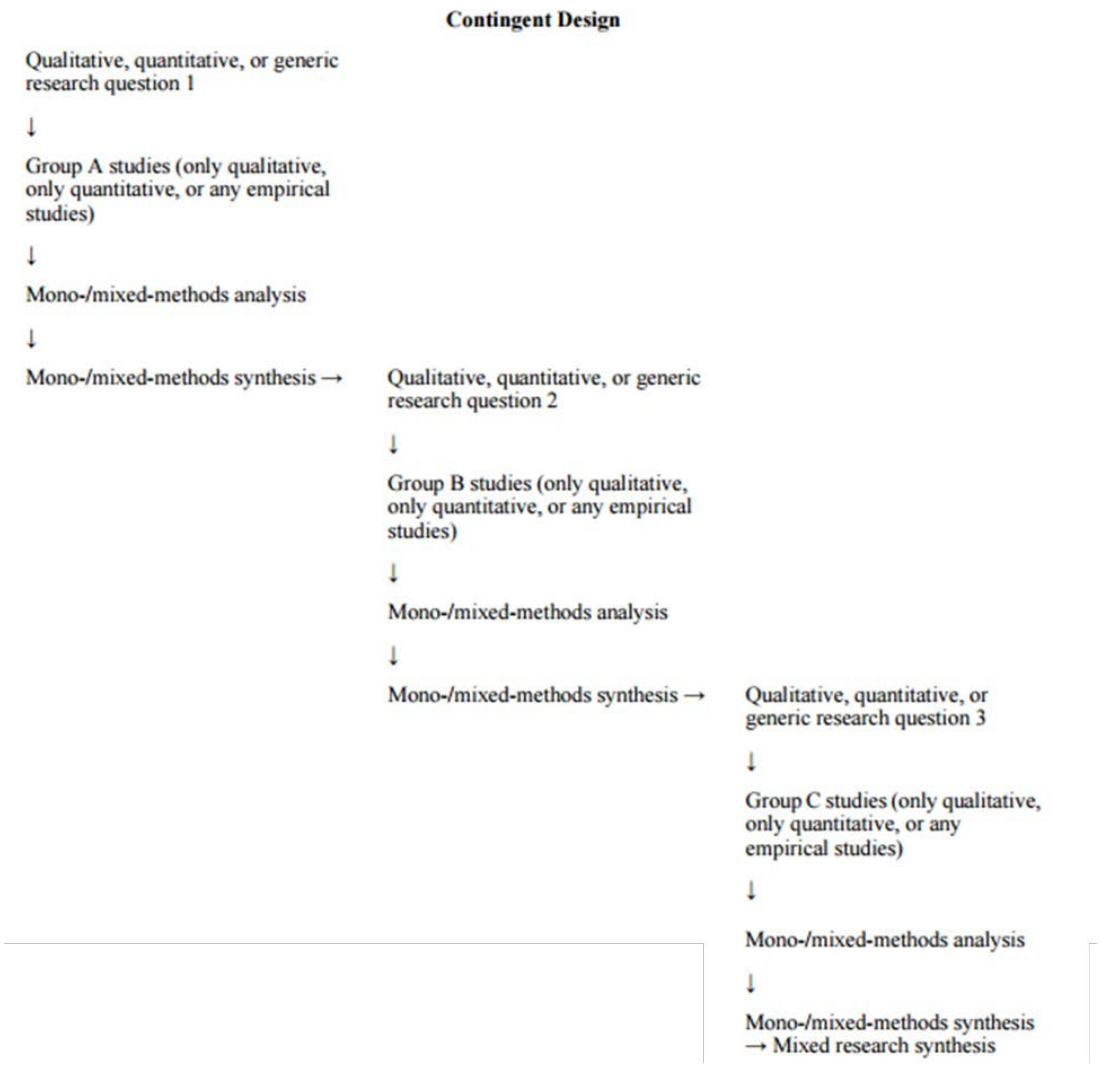
4.4. Data analysis

The research design of this study is based on the mixed method approach. It requires that the results generated by quantitative and qualitative research needs to be resolved and brought together. Sandelowski, Voils & Barroso (2006, 1) use the term mixed research synthesis for "the type of systematic review aimed at the integration of results from both qualitative and quantitative studies in a shared domain of empirical research". In the mixed research synthesis the focus is on combining the data or results for

reporting. In their study, Sandelowski et al. (2006) present three designs for mixed research synthesis: the segregated, integrated, and contingent designs.

In this study, the contingent design is utilized. Contingent design can be determined as "the cycle of research synthesis studies conducted to answer questions raised by previous syntheses" (Sandelowski et al., 2006, 9). This means that the results of the first research have an impact on the planning and execution of the next research. The studies conducted can be either quantitative or qualitative and the results can be analyzed with quantitative or qualitative methods. After, the aim is to produce quantitative and qualitative research synthesis that will be combined into a theoretical or narrative rendering of findings. (Sandelowski et al., 2006) Below, the Figure 5 demonstrates the idea of the contingent design.

Figure 5 Contingent design (Sandelowski et al., 2006, 14-15)



In this study, the quantitative research (survey) was conducted first. As mentioned, the aim of the survey was to identify the significance of green aspects of medical devices. The survey results were analysed by creating frequency tables and graphical analysis. In addition to the theory of the subject, also the results of the survey were considered when planning the interview guide and its themes and sub-questions. The aim was to deepen the understanding of the survey results by getting more comprehensive answers with interviews. The interviews were recorded and transcribed for analysis. First, the interviews were analysed one by one, and after the results were combined. Finally, the results generated from the survey and interviews were combined together and analysed. The combined results of the empirical research are presented in the Chapter 7.

4.5. Validity and reliability of the study

Validity describes how well a research and its results measure the specific subject the researcher planned to measure (Eriksson & Kovalainen, 2008). This means how well the theoretical and empirical methods are connected to each other (Uusitalo 1991, 86). In order to achieve a profound understanding of the subject and to increase the validity of the research, multiple sources of evidence should be used (Yin, 2003). In order to increase the validity of this research, the researcher familiarized herself carefully with the previous research before planning the empirical study. This increases the basic understanding of the subject. Furthermore, the data is collected from multiple sources with surveys and interviews, which also increases the validity and ensures the profound understanding of the subject.

Reliability refers to the demonstration that the study and its operations can be repeated, with the same results (Yin, 2003). This means that the researcher should offer enough information how the study has been conducted and how the results have been analysed (Koskinen, Alasuutari & Peltonen, 2005). In this study, reliability is ensured by offering information about the research methodology in this chapter. However, according to Eskola et al. (1998, 211) in qualitative research also the researcher and his/her actions and decisions determine the reliability of the study. The researcher should make observations objectively and according to the purposes of the study. However, it is essential that the subjectivity of the researcher has been considered while evaluating the reliability of the study. (Eskola et al., 1998, 210). In order to minimize the effects of

researcher’s subjectivity this study has been made as carefully and consistently as possible without letting presumptions effect on the research process.

During the analysis of the survey and interview results, some issues that may have on impact on the validity and reliability of this study occurred. First issue is related to the response options of the survey. As one respondent mentioned, options like “I do not know” or “I do not participate in the procurement of these devices” would have been needed for the questions about the significance of different green aspects of medical devices. Because all the respondents did not have experience of the procurement of all different kinds of devices concerned in the survey, some of the answers might not be based on accurate information, but more on the best guess. The second is issue is related to the analysis of the interviews. As mentioned earlier, the interviews were held in Finnish. Because this study is executed in English, the interview answers needed to be translated into English as well. The translation was done especially carefully to ensure that the answers do not change because of the translation. However, the translation might have caused some differences in linguistic nuances of the answers.

5. Empirical research: results and analysis

The empirical research is divided into quantitative (survey) and qualitative (interviews) parts as presented in the previous chapter. The aim of this chapter is to present the results from the survey and from the interviews. First, the results of the survey will be presented and analyzed, and after the results of the interviews will be presented and analyzed. The results of the survey and the interviews are combined together in Chapter 7.

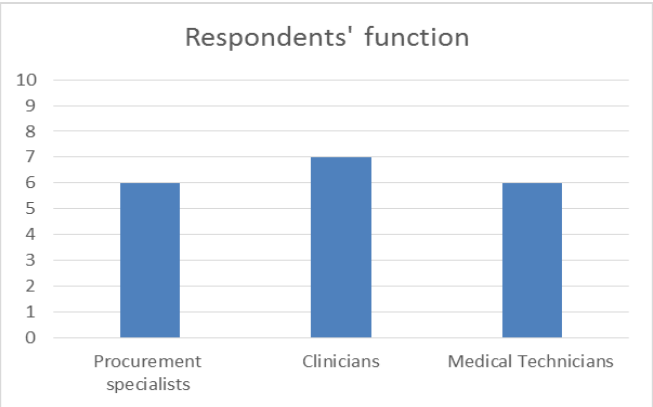
5.1. Results from the survey

The questions in the survey were divided into three themes: background information about the respondents, environmental sustainability in the purchasing process and environmentally sustainable features of medical devices. The results of the survey will be presented next based on these themes.

5.1.1. Background information about the respondents

Altogether 19 respondents participated in the survey. As presented in the Figure 6 below, among the respondents 6 (32%) were procurement specialists, 7 (36%) were clinicians and 6 (32%) were medical technicians. Since the respondents are evenly representing different functions, differences in opinions are equally taken into consideration and the results are diverse.

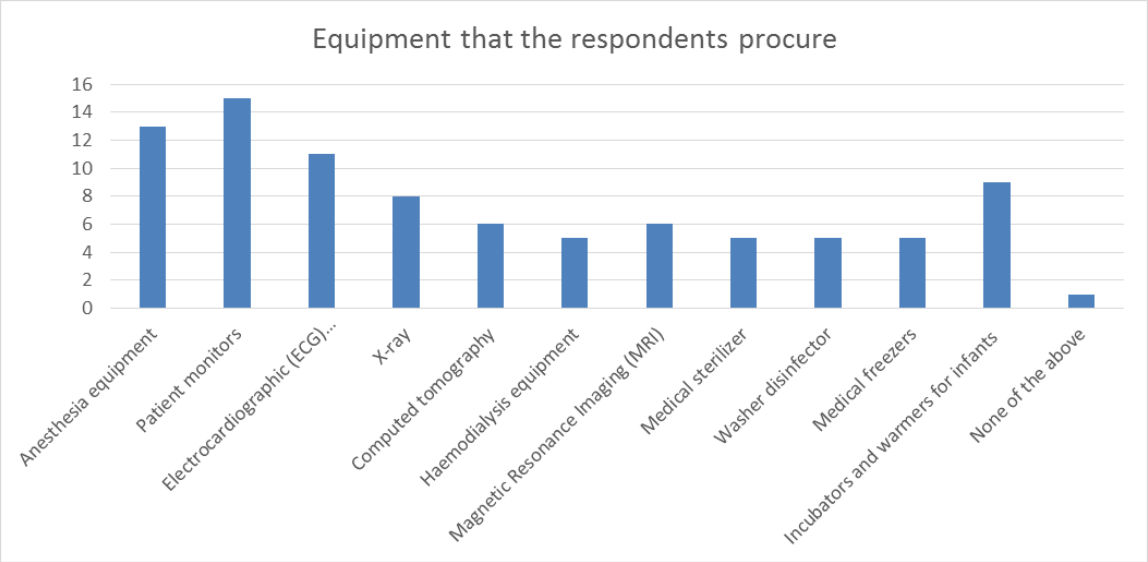
Figure 6 Respondents' function



The respondents were asked to define the equipment of which procurement they are involved. The equipment listed in the survey represented the equipment that are included in the EU GPP criteria for medical devices. Most of the respondents are

involved in the procurement of anesthesia equipment, patient monitors and ECG equipment as described in the Figure 7 below. However, all the types of equipment are represented, which ensures the diversity of the results.

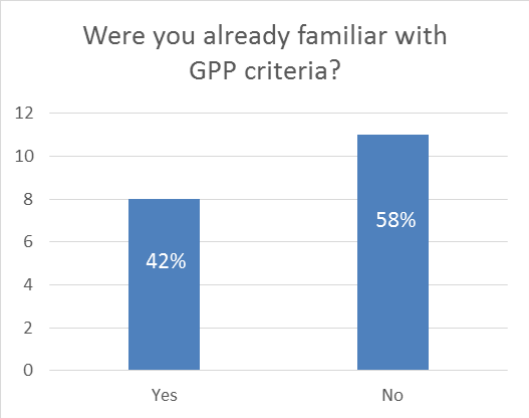
Figure 7 Equipment that the respondents procure



5.1.2. Environmental sustainability in the purchasing process

Because EU GPP criteria for medical devices is in a big role in this research, it was essential to examine the respondents' knowledge rate concerning it. The definition for the criteria was given in the beginning of the survey, but the respondents were asked if EU GPP criteria was familiar for them already. The results are presented in the Figure 8 below; 42% of the respondents were familiar with the criteria and correspondingly 58% were not familiar with it.

Figure 8 Respondents' familiarity with EU GPP criteria



In order to examine the environmental sustainability in the purchasing process, the respondents were asked if environmental sustainability is considered in the procurement process and what benefits can be achieved by environmental sustainable procurement. Almost half of the respondents do not consider environmental sustainability in the procurement process, whereas 26% consider it occasionally and 26% consider it always (Table 4). The survey results that the most significant benefits of environmentally sustainable procurement are conservation of nature, encouraging suppliers to consider environmental aspects in innovation and positive impact on image (Table 5). Moreover, even 79% of the respondents believe that environmentally sustainable procurement leads to cost savings in a long term (Table 6).

Table 4 Environmental sustainability in the procurement process

Is environmental sustainability considered in the procurement process?	**Amount of responses**	**Percent**
Yes	5	26 %
Occasionally	9	48 %
No	5	26 %

Table 5 Benefits of environmental sustainable procurement

What benefits can be achieved by environmental sustainable procurement?	Amount of responses	Percent
Conservation of nature	18	95 %
Encouraging suppliers to consider environmental aspects in innovation	16	84 %
Positive impact on image	14	74 %
Leading by example	11	58 %
Cost savings	11	58 %
None of the above	0	0 %

Table 6 Environmental sustainable procurement and long term cost savings

Do you think that environmentally sustainable procurement will lead to cost savings in a long term?	Amount of responses	Percent
Yes	15	79 %
No	4	21 %

Only 16% of the respondents make the procurement decision solely based on life cycle costs (LCC) and 26% make the decision based on acquisition price. However, most of the respondents (58%) consider both LCC and acquisition price. The respondents were also asked to determine which factors they include into the LCC calculations. All respondents include acquisition price, and almost all of them include also service and spare part costs. Electricity, water and end-of-life costs are included far less often. The Table 7 below demonstrate the results related to the use of LCC.

Table 7 Use of life cycle costing

Which one has a greater impact on the procurement decision; acquisition price or life cycle costs?	Amount of responses	Percent
Acquisition price	5	26 %
Both are considered	11	58 %
Life cycle costs	3	16 %

Which of the following are included in the life cycle cost calculation?	Amount of responses	Percent
Acquisition price	19	100 %
Service costs	18	95 %
Costs of spare parts	17	89 %
Electricisty costs during the use phase	5	26 %
Water costs during the use phase	5	26 %
End-of-life (recycling) costs	4	21 %

5.1.3. Environmentally sustainable features of medical devices

The purpose of this part of the survey was to examine the significance of different environmentally sustainable features of medical devices. The significance was examined by asking the respondents to define how often the feature in question is included as a requirement into a tender at the moment. In addition, the respondents were asked to estimate how often the feature is included into a tender after five years in order to understand which features will become more significant. The features asked in the survey are based on the EU GPP criteria for health care EEE that were discussed earlier in the Chapter 3.5.2.

Before presenting the results of the single features, it is interesting to take a look at the big picture on how the significance of the environmentally sustainable features will change after five years. According to the results, each of the features asked in the survey will be included more often in a tender after five years. In other words, the significance of environmentally sustainable features of medical devices seems to increase in the future. Below, Figure 9 (at the moment) and Figure 10 (after five years) offer a clear demonstration about the change in the significance of the features. As can be seen from the Figure 10, each of the features are estimated to be included in a tender clearly more often compared to the Figure 9. The numbers on a horizontal plane represent the questions in the survey (Appendix 1).

Figure 9 How often the feature is included in a tender at the moment**?**

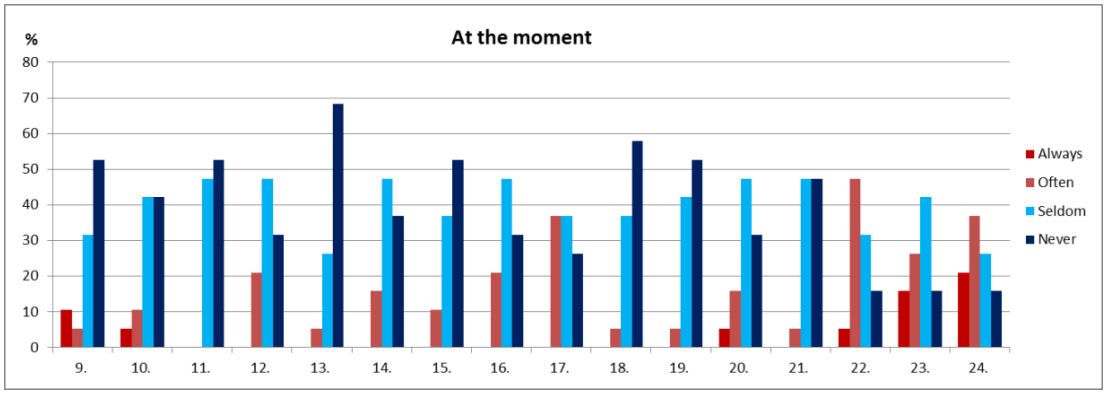
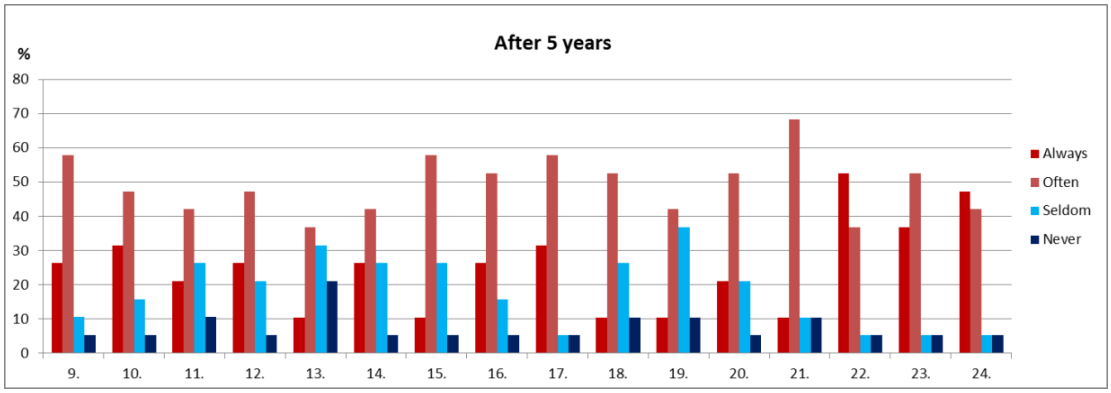


Figure 10 How often the feature will be included in a tender after five years?

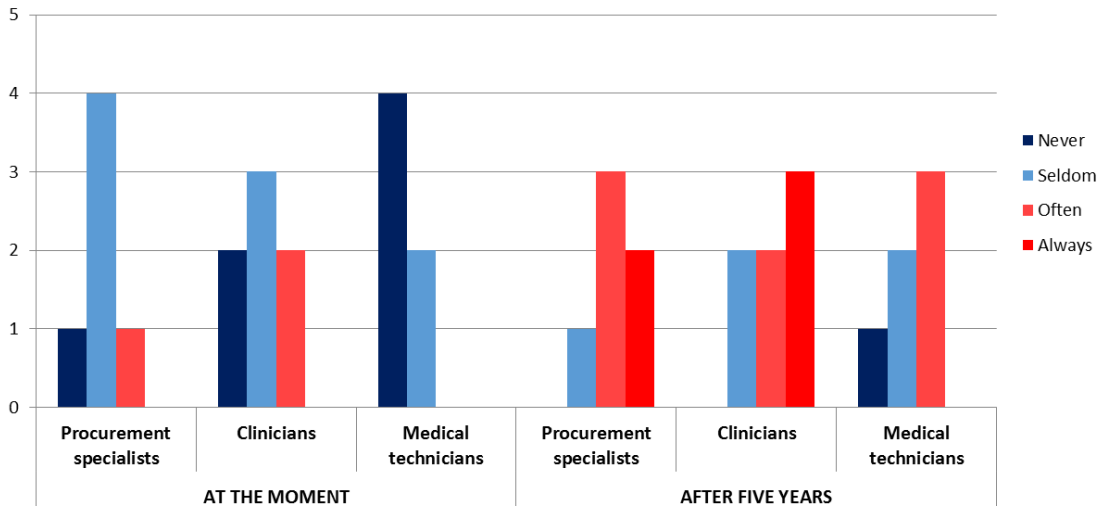


Energy consumption was considered in the questions 10, 11 and 13-18 of the survey (Appendix 1). As can be seen from the Table 8, 16% of the respondents reported that low electricity consumption (question 14) is already at the moment often a requirement in a tender. However, the significance will increase; even 69% of the respondents estimated that after five years low electricity consumption will be a requirement in a tender always or often. There are some differences between the results gathered from people representing different functions. Figure 11 below, presents that results from procurement specialists and clinicians are more positive than results from medical technicians. This trend appeared almost in every question. Related to the low electricity consumption, the supplier should also be able to offer report and results of the measurement practices of the electricity consumption (question 15). The results of this question were really similar with the results of the question related to low electricity consumption.

Table 8 Low electricity consumption (question 14)

Is low electricity consumption a requirement in a tender?	At the moment	After five years
Never	37 %	5 %
Seldom	47 %	26 %
Often	16 %	43 %
Always	0 %	26 %

Figure 11 Low electricity consumption: results by functions (question 14)

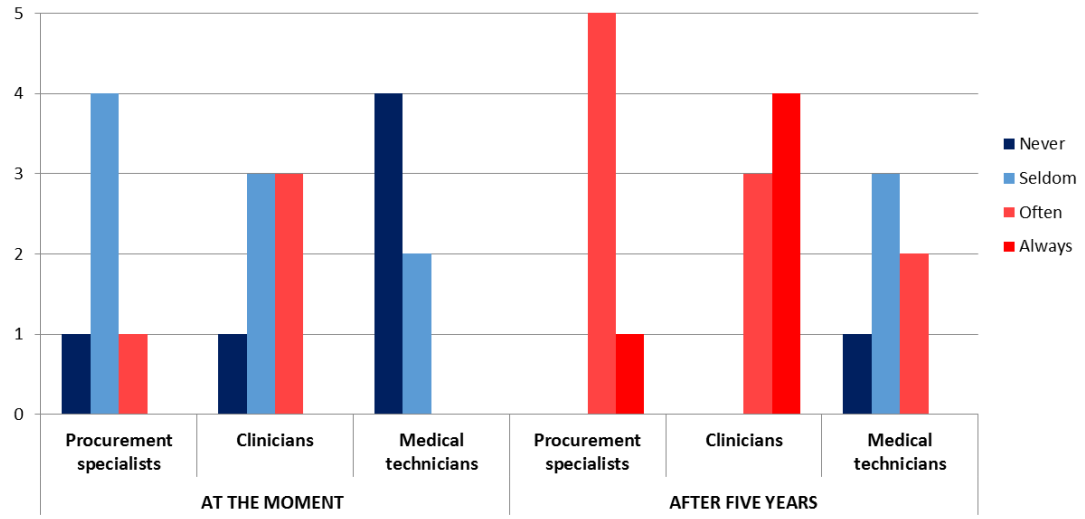


One of the requirements related to the energy consumption is an automatic low power mode (question 16). According to the results, the automatic low power mode in medical devices is at the moment and is going to be slightly more significant feature than the low electricity consumption. To be more precise, 21% of the respondent report that the automatic low power mode is already often a requirement in a tender and even 79% estimate that it will be a requirement in a tender often or always after five years (Table 9). The respondents from different functions had different opinions about the automatic low power mode. Figure 12 presents the results by functions. The automatic low power mode seems to be more significant for clinicians, whereas procurement specialists and especially medical technicians are more cautious with their answers. As the low power mode seems to become a significant feature in the future, it will be also important that the device has a short time between start-up to full functionality (question 17); even 90% of the respondents estimate that it will be a requirement in a tender after five years.

Table 9 An automatic low power mode (question 16)

Is an automatic low power mode a requirement in a tender?	At the moment	After five years
Never	32 %	5 %
Seldom	47 %	16 %
Often	21 %	53 %
Always	0 %	26 %

Figure 12 An automatic low power mode: results by functions (question 16)



The respondents were asked if an electricity metering device is or will be a required feature for medical devices (question 18). Only 5% of the respondents report that the electricity metering device is a requirement at the moment. However, the significance increases again in the future; 63% of the respondents estimates it to be a requirement after five years. Still the features discussed above seems to be and become slightly more significant than the electricity metering device.

A training on electricity efficiency optimization of the medical device (question 11), a needs assessment of the user (question 13) and instructions on green performance optimization (question 10) were discussed in the survey. As Table 10 and Table 11 demonstrate, training or needs assessment cannot be considered significant at the moment. Especially the significance of the training will increase in the future; in total 63% report that it will be a requirement after five years. The needs assessment (frequency of use, type of examinations etc.) has not been estimated to become that significant since only 47% of the respondents estimate it to be a requirement in the future. Nevertheless, a guide with instruction on green performance optimization

(electricity and water consumption, use of consumable parts and emissions minimization etc.) is estimated to be significant in the future. As can be seen from the Table 12 below, 79% of the respondents estimate it will be included in a tender after five years.

Table 10 Training on electricity use optimization (question 11)

Is a training on electricity use optimization a requirement?	At the moment	After five years
Never	53 %	11 %
Seldom	47 %	26 %
Often	0 %	42 %
Always	0 %	21 %

Table 11 Needs assessment of the user (question 13)

Is a needs assessment of a medical device user a requirement?	At the moment	After five years
Never	69 %	21 %
Seldom	26 %	32 %
Often	5 %	37 %
Always	0 %	10 %

Table 12 Instruction on green performance optimization (question 10)

Is a guide with instructions how to maximize the green perfomance of the medical device a requirement?	At the moment	After five years
Never	42 %	5 %
Seldom	42 %	16 %
Often	11 %	47 %
Always	5 %	32 %

The next topic is water consumption. At the moment, low water consumption (question 21) of the medical device is not a significant requirement in a tender. As Table 13 below presents, most of the respondents include low water consumption into a tender only seldom or never. However, the significance will increase since 78% estimate that it will be included into tenders often or always in the future. According to these results, low water consumption will be even more significant than low electricity consumption that was discussed earlier (Table 8). The respondents were also asked to define if the water consumption metering device is a requirement in a tender (question 19). According to the results presented in the Table 14 below, the water consumption metering device is

not at the moment and is not going to be a s significant feature than the other features discussed in this study. Only 53% of the respondents estimate that it will be a requirement in the future.

Table 13 Low water consumption (question 21)

Is a low water consumption a requirement in a tender?	At the moment	After five years
Never	47 %	11 %
Seldom	47 %	11 %
Often	6 %	67 %
Always	0 %	11 %

Table 14 Water consumption metering device (question 19)

Is a water consumption metering device a requirement in a tender?	At the moment	After five years
Never	53 %	10 %
Seldom	42 %	37 %
Often	5 %	43 %
Always	0 %	10 %

The results of this study demonstrate the increasing significance of low Gas consumption, which is a relatively significant requirement already at the moment. The respondents were asked if an automatic (question 23) or a manual (question 24) low flow function in the medical device is a requirement in a tender. Already at the moment 42% of the respondents consider that the automatic low flow function is a requirement in a tender often or always and even 58% consider that the manual low flow function is a requirement in a tender at the moment, which can be seen from the Table 15 and Table 16. When comparing the results by functions (Figure 13) it is interesting that none of the procurement specialists report that the automatic low flow function is often or always a requirement in a tender at the moment. However, in the future the significance will be remarkable since even 90% of the respondents report that the automatic or manual low flow function will be a requirement in a tender after five years.

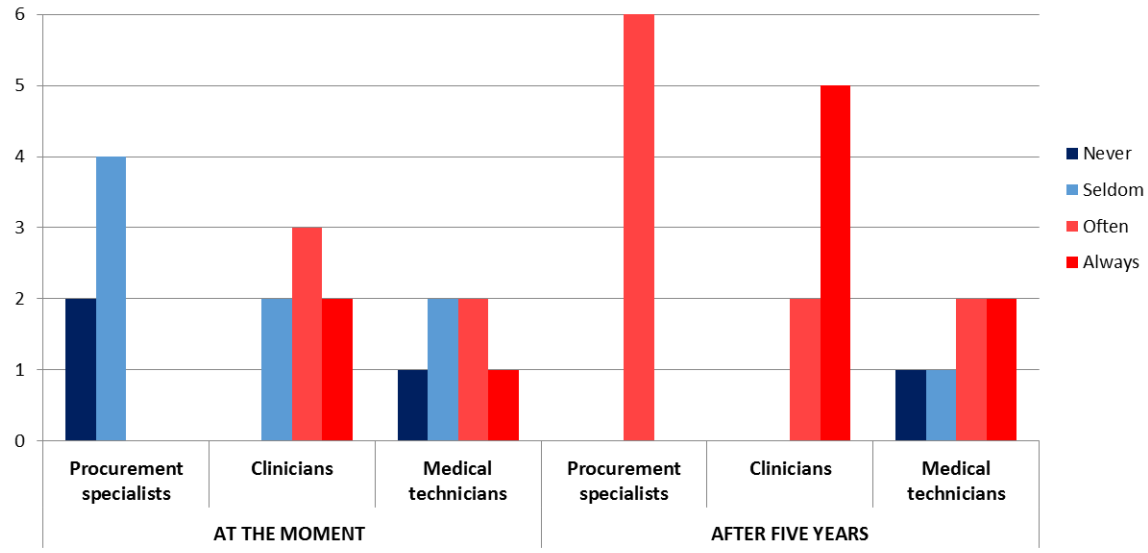
Table 15 Automatic low flow function (question 23)

Is an automatic low flow function a requirement in a tender?	At the moment	After five years
Never	16 %	5 %
Seldom	42 %	5 %
Often	26 %	53 %
Always	16 %	37 %

Table 16 Manual low flow function (question 24)

Is a manual low flow function a requirement in a tender?	At the moment	After five years
Never	16 %	5 %
Seldom	26 %	5 %
Often	37 %	43 %
Always	21 %	47 %

Figure 13 Automatic low flow function: results by functions (question 23)



As the significance of low gas consumption is remarkable, also the significance of a gas metering device (question 20) is more significant than electricity or water metering devices. As can be seen from the Table 17 below, 21% of the respondents consider that the gas metering device is a requirement in a tender at the moment. Again, the significance is estimated to increase in the future; 74% of the respondents report the gas metering device will be a requirement in a tender after five years.

Table 17 Gas metering device (question 20)

Is a gas flow metering device a requirement in a tender?	At the moment	After five years
Never	32 %	5 %
Seldom	47 %	21 %
Often	16 %	53 %
Always	5 %	21 %

Such as low gas consumption also the use of refrigerants with low global warming potential (GWP) is a significant factor. Like the Table 18 presents, already at the moment almost 50% of the respondents require often that refrigerants used in medical freezers have a low GWP (causes less harm for the ozone layer). Even 90% estimate that after five refrigerants with low GWP will be required often or always in a tender.

Table 18 Refrigerants with low global warming potential (question 22)

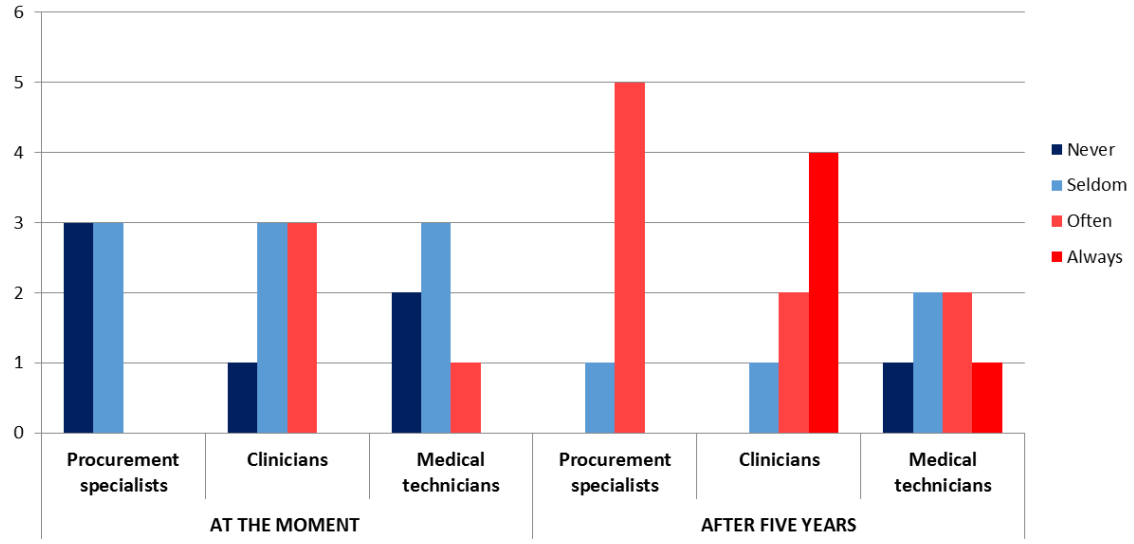
Refrigerants in medical freezers have a low global warming potential (GWP) is a requirement in a tender	At the moment	After five years
Never	16 %	5 %
Seldom	32 %	5 %
Often	47 %	37 %
Always	5 %	53 %

Product longevity was one topic in the survey. The aim was to understand if the product longevity is significant from the environmental sustainability point of view. For that reason, the respondents were asked if the product longevity is a requirement in a tender in order to reduce the burden on the environment (question 12). According to the results presented in the Table 19 below, at the moment 21% of the respondents report that the product longevity is often a requirement in a tender, which is a rather good result. However, when looking at the results by functions (Figure 14), none of the procurement specialists consider that at the moment the product longevity is often a requirement in a tender. And again, the significance seems to increase; 74% of the respondents estimate that the product longevity will be often or always a requirement in a tender after five years.

Table 19 Product longevity (question 12)

Product longevity is a requirement in a tender in order to reduce the burden on the environment	At the moment	After five years
Never	32 %	5 %
Seldom	47 %	21 %
Often	21 %	48 %
Always	0 %	26 %

Figure 14 Product longevity: results by functions (question 12)



Finally, the last topic are hazardous chemicals. The respondents needed to define if it is a requirement in a tender that the supplier informs the hospital on the updates of the Candidate List of Substances of Very High Concern (SVHC –list) regarding the medical device being sold to the hospital (question 9). As can be seen from the Table 20 below, this is not a significant requirement at the moment since only 15% of the respondents consider that it is often or always a requirement in a tender. The significance of all the asked factors will grow, but especially this one. According to the results, even 85% of the respondents estimate that the information on the updates of the SVHC-list will be a requirement after five years.

Table 20 Hazardous chemicals (question 9)

The supplier offers information on the updates of the Candidate List of Substances of Very High Concern regarding the medical device is a requirement in a tender.	At the moment	After five years
Never	53 %	5 %
Seldom	32 %	10 %
Often	5 %	58 %
Always	10 %	27 %

In the end of the survey, the respondents had a possibility to give comments. One respondent wrote about the need for more information and training about green procurement in hospitals. He/she continued that all companies should commit to the green practices, because otherwise some of the suppliers might consider green criteria as a possibility to make a complaint about the competitive tendering. This issue was included in the framework of the interview and it will be discussed more detailed later. Another respondent wrote that five years might be too short period of time, because in Finland water and electricity are cheaper than elsewhere in Europe. Nevertheless, within 10 years there could be a bigger change in the implementation of the green procurement. One respondent asked this kind of discussion for disposable accessories as well. Finally, in one comment the survey response options were criticized since the options did not include options such as “don’t know” or “does not apply to devices I deal with”. According to this comment, it is hard to answer to the questions, if you have not been involved in a procurement processes that deal with the asked devices and features. This is a good comment and is taken into consideration in the chapter 5.5. Validity and reliability of the study.

5.1.4. Summary of the significance of the different environmentally sustainable features of medical devices

According to this study, only few of the asked environmentally sustainable features of medical devices can be considered to be rather significant already at the moment. Nevertheless, in the future the significance of all the asked features will more or less increase. The Table 21 below demonstrates the summary of the significance of different features. The features have been placed in order according to the estimated significance

after five years (the column on the right) in a way that the most significant feature is at the top of the list.

As can be seen from the results presented in the Table 21, the five most significant features after five years will be an automatic and manual low flow function, short and automated start-up to full functionality, use of refrigerants with low GWP and updates of the of the Candidate List of Substances of Very High Concern (SVHC –list) regarding the medical device being sold to the hospital. Instead the least significant features will be the needs assessment and water metering device.

Table 21 Summary of the significance of environmentally sustainable features of medical devices

Environmentally sustainable features	Is the feature often or always a requirement in a tender…	
	…at the moment	…after five years
Automatic low flow function	42 %	90 %
Manual low flow function	58 %	90 %
Short and automated start-up to full functionality	37 %	90 %
Refrigerants with a low global warming potential (GWP)	52 %	90 %
Hazardous chemicals: Updates of the Candidate List of Substances of Very High Concern	15 %	85 %
Automatic low power mode	21 %	79 %
Instructions for green perfomance optimization	16 %	79 %
Low water consumption	6 %	78 %
Gas flow metering device	21 %	74 %
Product longevity	21 %	74 %
Low electricity consumption	16 %	69 %
Report of measurement practices of the electricity consumption	11 %	69 %
Elecrticity metering device	5 %	63 %
Training on electricity use optimization	0 %	63 %
Water consumption metering device	5 %	53 %
Needs assessment	5 %	47 %

5.2. Results from the interviews

The interview consist four themes: environmental sustainability in the procurement, conceptions against environmentally sustainable procurement, the future and the questions specifying the survey results. Besides these themes, the organization of the procurement process was discussed in the beginning of each interview. The results will be presented next based on these themes.

5.2.1. Background: How the procurement process is organized

In order to understand the procurement process of medical devices, the interviewees were asked to describe the procurement process and the actors or functions that are involved. The answers from the interviewees varied to some extent. In Interviewee 1's hospital the procurement has been divided into service acquisitions, accessory acquisitions and device and equipment acquisitions that consist basically everything that does not belong to accessories. Furthermore, the device and equipment acquisitions are divided into acquisitions under 10 000 euros and investment acquisitions over 10 000 euros. Investment acquisitions are planned yearly based on a certain budget reserved for them. Medical devices (over 10 000e) and construction projects are examples of investment acquisitions. According to Interviewee 1 procurement specialists are involved in the whole procurement process; from the planning with the user (clinician) to the approval of the purchase order and invoices. Collaborators in the procurement process are the actors who are experts with the issued medical device and medical technicians from the relevant field. Needs regarding the medical device being procured rise from medical technicians and clinicians with whom procurement specialists collaborate considerably.

Also in Interviewee 2's hospital procurement has been divided into acquisitions emphasizing accessories and acquisitions emphasizing accessories and medical devices of special health care. Interviewee 2 stated that the work of procurement specialists consist contract management and management of the competitive tendering process. Procurement specialists aim to gather certain devices into general agreements, simplify the procurement process and they also listen carefully the needs of clinicians in order to serve their internal customers in the hospital. According to Interviewee 2, the initiative

to procure a certain medical device, rises usually from clinicians who make a proposal as well as the technical specifications for the acquisition. Also other functions may need agreements for certain things. Sometimes the initiative rises from procurement specialists, for example if a large group of devices should put under an agreement in order to simplify the procurement process.

According to Interviewee 3, the procurement process depends on the case. However, the actor from the hospital ward, who knows the most about the device being procured is always involved in the procurement process. He/she is normally the one, who uses the device, knows the operational environment and knows the requirements for the device. Interviewee 3 states that also a person from the service organization (medical technician) is involved, if needed. And of course, a procurement specialist is always involved in the procurement process. This is the usual cooperation group, but sometimes for example an IT consultant is needed. Interviewee 3 highlights the increasing role of IT; the devices are no longer only manual, but instead one has to be able to manage the software of the device as well. Nowadays, the personnel has to be trained to know the new and changed environment. This is a challenge also, when the requirements for procured medical devices are being defined; one has to know the device in order to know what the device needs and what exist in the markets.

5.2.2. Environmental sustainability in the procurement of medical devices

The purpose of this theme was to understand how environmental aspects are considered in the purchasing of medical devices at the moment. All interviewees stated that environmental aspects are considered more in the purchasing of other equipment (washing machines et cetera) than medical devices. However, according to Interviewee 3, recycling and disposal of the medical devices are aspects that are sometimes considered in the procurement process. In addition, the longevity of the device is ensured by requiring certain warranty period. Like Interviewee 3 mentions, when the required longevity of the device is so long that it excludes “disposable devices” from the tendering process, it is also good for the environment and of course essential from the quality point of view.

Even though environmental aspects are not considered significantly in the procurement of medical devices, Interviewees 1 and 3 state that life cycle costs are taken into account

in the procurement decision. When asking about the factors that are included into the calculation on life cycle costs, Interviewee 1 states that environmental factors are considered more in the procurement of other equipment than medical devices. However, Interviewee 1 continued that in addition to the acquisition price, service and maintenance costs (including spare parts) during the life cycle are considered for medical devices as well. Interviewee 3 highlights the importance of life cycle costing. Life cycle costs are calculated for seven years for each device that is being procured since the acquisition price is not the whole truth. According to Interviewee 3, the calculation of life cycle costs consist acquisition price, accessories needed during the use, service and maintenance and the most expensive spare parts (how many are needed and how often they need to be changed). Requirements are defined for all these factors. However, Interviewee 3 highlights also the functionality of the medical device. It is a significant factor, which is considered throughout the procurement process. When asking about the electricity or water costs, Interviewee 3 states that these kind of factors are included into lice cycle costs, if they are meaningful. However, when talking about medical devices that kind of factors rarely have a significant value, but the decision is rather based on the overall functionality. Table 22 below summarizes interviewees' answers.

Table 22 Costs that are taken into consideration in the procurement of medical devices

Interviewee	Acquisition price	Service and maintenance	Spare parts	Accessories	Electricity costs	Water costs	Recycle / disposal costs
Interviewee 1	x	x	x				
Interviewee 2	x						
Interviewee 3	x	x	x	x	(if meaningful)	(if meaningful)	

As discussed earlier, EU GPP criteria for health care EEE is developed in order to support the public purchasers to consider environmental aspects in the procurement. The familiarity of the criteria was discussed in each interview, but all interviewees agreed that EU GPP criteria for health care EEE is not generally known within public purchasers. However, Interviewee 3 stated that even though the criteria is not generally known, the increased public conversation about environmental sustainability adds pressure on the public procurement as well.

5.2.3. Perceptions of environmentally sustainable procurement

The aim of this theme was to find out what kind of perceptions of environmentally sustainable procurement there are within public purchasers. First, the interviewees were asked to describe what they think is the general attitude towards environmentally sustainable procurement. According to the interviewees, the attitude towards environmental sustainability in procurement seems to be somewhat positive, but it is still not the priority one or the most current topic in conversations. Like Interviewee 1 mentioned; the attitude towards the idea is positive, but in practice the patient care always comes first.

The perceptions of quality and price of environmentally sustainable solutions were discussed in the interviews and the opinions varied between the interviewees. Interviewee 1 thought that there are no conflicts with the quality, but the products are expected to be more expensive. Interviewee 2 has a totally opposite opinion. She does not consider the products to be more expensive, but instead she is concerned if more environmentally sustainable products have enough power to maintain the desired level of performance. Interviewee 3 does not see any conflicts with quality; instead she thought the quality might be even better, because the product has been designed more carefully. In addition, she considers that environmentally sustainable solutions do not necessarily cost more than other products.

All of the interviewees agreed that cost savings in the long run could be one of the benefits that can be achieved by environmentally sustainable solutions. According to the answers, the cost savings could be achieved due to the lower energy consumption and Interviewee 3 mentioned also the lower gas consumption. However, all of the interviewees seemed to be also unsure about how much it is actually possible to save energy and is it really significant in the end. For example, Interviewee 1 did not know how much the energy consumption varies between different kind of medical devices, but assumed that imagining equipment consume a lot of energy and there could be a lot of saving potential. On the other hand, interviewee 2 highlights that cost savings is not a target in the purchasing of medical devices. First of all, they are searching for quality and a good and trustworthy supplier.

In addition to cost savings, Interviewee 2 and 3 mention the decrease of scarcity of natural resources and materials as one of the benefits gained by more environmentally sustainable solutions. Interviewee 2 states that recycling of old medical devices is one important practice in their hospital. When procuring new medical devices, medical technicians will inspect the condition of the old ones. The ones that are still usable will be transferred to other departments. In addition, Interviewee 3 stated that the user safety would increase as well, when harmful chemicals are used less and less and the production materials have been selected more carefully.

The interviews resulted that one significant barrier against considering environmentally sustainable features in medical devices is the highlighted importance of high quality and safety of the patient care as well as the requirements related to the functionality. These aspects are the priority one and do not usually leave space for environmental sustainability. Like Interviewee 2 mentioned, medical devices are so critical that they may not be the first object, when looking for ways to save nature. Interviewee 3 emphasizes the functionality; ease of use and time saving. As an example, she mentions the stand-by feature and questions its significance and impact on functionality. The feature saves energy, but it takes time, when the device restarts. The lost time may be critical, when the patient waits on the operating table.

According to the interviews, another barrier is the lack of knowledge. Like discussed earlier, Interviewee 1 states that the price of environmentally sustainable medical devices is assumed to be higher than for products without environmentally sustainable features. She considers that it is because of the lack of facts and information. In addition, Interviewee 1 mentions that many people have the attitude that environmental sustainability is more like a nonsense mindset that does not help to achieve anything concrete. This attitude is also due to the lack of information. Interviewee 3 instead highlights the lack of documented, measurable, fact based and understandable information about environmentally sustainable features of medical devices. At the moment, it is hard to know how much environmentally sustainable features really add value to the procured device and what impact the feature has on the functionality.

Interviewee 2 also emphasized the lack of information about the environmentally sustainable features, but also the lack of market knowledge. She brings out that a public contracting entity always has a fear that if some exact numerical values are put in

absolute requirements, suddenly there is only one supplier left, whose device meets the requirements. It is not legal for public purchasers to set requirements that block all but one supplier or device, because then the competitive tendering is discriminatory. Public purchasers should have more information about the market availability of environmentally sustainable features in order to set certain environmentally sustainable requirements. In addition, Interviewee 2 mentions that the lack of knowledge about the environmentally sustainable features leads to the difficulty to set weighted values for the requirements.

Related to the issue of setting the requirement, in the survey one respondent pointed out the following issue: at the moment, environmentally sustainable requirements are seen as a possibility to make a complaint about the competitive tendering. According to the interviewees this is not a general opinion. According to Interviewee 1, any requirement may increase the possibility of complaints, especially if the requirements are not unambiguous. However, like other interviewees she does not consider that this issue is a general opinion about environmentally sustainable requirements.

The interviewees were also asked what could be the key to overcome the barriers. All of the interviewees agreed that increase in information and knowledge would be the first step. Interviewee 2 mentioned a need for a third party that would spread knowledge, motivate and support public purchasers in green procurement. At the moment, the increase of knowledge about environmental sustainability depends only (and too much) on the activity of public purchasers themselves. Interviewee 3 highlights the important role of suppliers in spreading the information. The supplier should know the device properly and offer information about its environmentally sustainable features; what is the value and does the feature really save nature without lowering the level of functionality. According to Interviewee 3, the information must be documented, understandable, and verifiable and based on facts. In addition, she considers that it would be good, if the proofs got from suppliers could be based on a standard or some other common measurements or values. Then the proofs would not be only described by the suppliers themselves and the proofs from different suppliers would be measurable and comparable with each other.

5.2.4. The future of environmental sustainability of medical devices

First of all, the interviewees were asked how they see the future of environmentally sustainable procurement of medical devices. All of the interviewees agreed that the significance of environmentally sustainable features will increase. Interviewee 2 believes that five years is a good timeline and after, the situation will be different. Environmental sustainability will be included into a tender's requirements some way. Alternatively, green aspects may be part of the contract made with a supplier. Interviewee 1 believes that EU GPP criteria for health care EEE could be utilized as well in the future. In addition, she thinks that only seldom the acquisition price will be the main requirement. Instead, the overall economy will be the base for the decision. Furthermore, Interviewee 1 believes that the acquisition price of the medical device can be higher, if the life cycle costs can be proved to be lower.

The interviewees were not entirely sure what could be the first product group, in which environmentally sustainable features are considered. Interviewee 1 and 2 considered that it will be a product group that consumes a lot of electricity. According to Interviewee 2, first product group could be large imagining equipment. She thinks that electricity consumption could be considered in the operating costs of the device or it could be an advantage; the lower the electricity consumption is, the more the supplier will benefit from it.

The interviewees were also asked what could be the most significant environmentally sustainable feature in medical devices. Interviewee 1 was not sure, but assumed that a feature that is related to electricity consumption could be significant. She adds that also the requirement related to the supplier's chemical management system (in EU GPP criteria for health care EEE) will be significant. Interviewee 2 states that features, which can be easily compared and presented as numerical values are electricity, gas and water consumption. However, she does not know if these features are more significant than for example instructions or training on environmentally sustainable use.

Interviewees 2 and 3 stated also the training and instructions on how to use the device in a most optimal way to reduce the consumptions, may lead to real savings. They both highlight that it is important it does not lead to the issue that the use of the device

becomes more complicated, instead the use should become all the time easier. Interviewee 2 mentions that a stand by –function could be one way to achieve savings in electricity consumption, especially concerning the devices that present a large amount of all of the devices in hospitals. Nevertheless, like mentioned earlier Interviewee 3 is concerned if the device does not return quickly enough back to the full functionality.

Interviewees gave also opinions on what they expect from the suppliers' side related to the environmental sustainability in medical devices. According to the interviews, the answer was clear: suppliers should also share information on how environmental sustainability has been taken into account in their medical devices. Interviewee 2 states that this would also raise public purchasers' interest towards environmentally sustainable features and possibly lead to a concrete advantage.

Interviewee 3 highlights the importance of the longevity of the medical device. The updates should be available in a way that it does not require the hospital to change the whole device or a large amount of components. In addition, she highlights the importance of product support and service. Furthermore, Interviewee 3 points out that not only the device but also its components should have a long service life. This requires good sub-contractor management from the supplier, who should also have strict requirements for the longevity of the components. Finally, Interviewee 3 states that user training is essential at every stage. The personnel should be trained to use and set the settings of the device in the most optimal way; in a way it saves time and environment, but also prevents mistakes and problems.

6. Discussions and conclusions

This chapter focuses on the discussion of the main contributions of this study. First, in the empirical contribution the research problem and sub-questions will be answered based on the empirical research findings. After, the findings will be reflected to theoretical background that was presented in chapters 2, 3 and 4. Finally, some managerial implications as well as the limitations and suggestions for future research will be presented.

6.1. Empirical contribution

The aim of this study was to understand how a medical device supplier should consider environmental sustainability in its medical devices. This research problem was examined by studying the role of environmental sustainability of public procurement of medical devices and what could be the most significant environmentally sustainable features of medical devices. Furthermore, the aim was to understand public purchasers' expectations for a medical device supplier.

The study focused on the following research problem and sub-questions:

How a medical device supplier should take into consideration environmental sustainability in medical devices?

- *How the environmental sustainability is considered in the procurement of medical devices; at the moment and in the future?*
- *What could be the most significant environmentally sustainable features for medical devices?*
- *What is expected from the medical device supplier?*

The empirical research was conducted by surveys and interviews held for procurement of public hospitals. Next chapters present the main contributions of the empirical research.

6.1.1. The increasing significance of green public procurement of medical devices

The empirical research results that environmental sustainability is not yet significantly considered in the public procurement of medical devices. According to the survey

findings, only 26% of the respondents consider environmental sustainability in the procurement process at the moment. Also interviews resulted that for now environmental sustainability is considered more within other products than medical devices. However, sometimes aspects such as recycling and disposal are considered as well as the longevity of the medical device. In order to support public purchasers with green procurement, EU has developed EU GPP criteria for health care EEE. Nevertheless, according to the interview results, the criteria are not well-known within public purchasers. The survey results were more positive; even 42% of the respondents were familiar with the criteria.

According to this research, life cycle costs are considered in most of the procurement processes of medical devices. The survey resulted that 16% make the procurement decision based on solely on life cycle costs and 58% make the decision based on both, life cycle costs and acquisition price. Surveys and interviews both resulted that acquisition price, service and spare part costs are included into the calculations of life cycle costs. Only few of the respondents include also electricity, water or disposal costs.

However, the significance of environmental sustainability, life cycle costs as well as EU GPP criteria for health care EEE seem to increase in the future. The survey results that the significance of all the asked environmentally sustainable features of medical devices will increase after five years (Figure 10 and Figure 11). Also the interviews resulted that environmental sustainability will be included into tenders some way and EU GPP criteria might be utilized as well. Additionally, environmental sustainability might be included into the contract. Furthermore, in the future only seldom the procurement decision will be based solely on the acquisition price, but more on the overall life cycle costs. Might be that the acquisition price can be even higher, if life cycle costs can be proved to be lower.

The findings indicate that conservation of nature and natural resources, encouraging suppliers to consider environmental aspects in innovation and positive impact on image are the main benefits of green public procurement. In addition, environmentally sustainable procurement is believed to result in lower costs in a long term. According to the interviews, also the user safety can be improved, when less harmful chemicals and materials are used. Price and quality of more environmentally sustainable medical devices were argued for and against. One opinion is that environmental sustainability

does not have an impact on the price, and can even result in improved quality due to the investment on product development. Nevertheless, the price of environmentally sustainable medical devices was also believed to be higher and there were concerns how the environmental sustainability impacts on the functionality of the device.

The main barriers against green public procurement of medical devices are the highlighted importance of quality and safety of the patient care, requirements for the functionality as well as the lack of knowledge. According to the results, ensuring the quality, safety and the best functionality of the device does not leave space or time for environmental sustainability. Instead, the lack of knowledge about environmentally sustainable products may lead to wrong assumptions such as higher price or negative impact on functionality or quality. It is also difficult for public purchasers to determine the real value of environmentally sustainable features without the accurate knowledge and facts. In addition, this leads to the difficulty to define the requirements for the tender. The findings indicate that there is a lack of knowledge about the markets. For public purchasers it is essential that the requirements they set for suppliers are not discriminatory. If they set requirements related to environmental sustainability, they need to know that there are more than one supplier who can meet the requirements. Public purchasers would need more information about the environmental sustainability of the medical devices at the market in order to set non-discriminatory requirements.

According to the results, it is clear that the key to overcome the barriers is the increase in information and knowledge about environmental sustainability of medical devices and green procurement practices. There would be a need for a third party that would spread information, motivate and support public purchasers with green procurement practices. In addition, suppliers could share more information about the environmental sustainability of their devices. It is highlighted that the information is documented, fact-based and understandable. In order to ensure the comparability of the documented facts, there is also a need for a common standard or other common measurements or values that the suppliers could utilize in the measurement process.

6.1.2. The most significant environmentally sustainable features of medical devices

Especially the survey focused on examining the significance of different environmentally sustainable features of medical devices. As mentioned earlier, the

survey resulted that all of the asked environmentally sustainable features seem to become clearly more significant after five years (Figure 10 and Figure 11). At the moment, only few of the features are rather significant. These features are manual and automatic low flow function and the use of refrigerants with a low global warming potential (GWP).

According to the survey findings, automatic and manual low flow function and the use of refrigerants with low GWP will be one of the most significant features also in the future. In addition, automatic low power mode and the fast recovery as well as supplier's chemicals management system that ensures the accurate updates of the Candidate List of Substances of Very High Concern will become significant. Besides to these, the significance of instructions for green performance management of the medical device will increase as well.

The interviews resulted that the most significant features could be the ones that are easily comparable and can be presented as numerical values, such as electricity, water and gas consumption. However, the interviewees had different opinions about the stand by –function (low power mode). It could be a relevant way to achieve electricity savings, but on the other hand the recovery time is a concern. In addition, training and instructions about the most optimal way to use the medical device were highlighted. An appropriate and comprehensive training would also minimize user errors. Nevertheless, it is essential that the functionality is maintained and the use of the device does not become more complicated due to the environmentally sustainable features. Interview findings indicated that the first product group, in which the environmental aspects will be especially considered could be medical devices that consume the most electricity; one example is large imaging equipment.

6.1.3. Expectations for a medical device supplier

Since the lack of information and knowledge was identified as a barrier against green procurement practices, this study also results that it is highly desired that medical device suppliers would share information about environmental sustainability of their medical devices. As mentioned earlier, the information shall be documented, based on measured facts and understandable. Sharing the information would increase the general interest against environmentally sustainable features, but also possibly result in a concrete

advantage for the supplier. However, it is greatly emphasized that environmental sustainability should never overrun the aspects of quality, patient safety and functionality, and the value of the environmentally sustainable features must be described and proved. One essential way to share information, is a comprehensive user training. Due to the training it would be possible to save environment and time, but also prevent mistakes and errors.

Besides to the marketing, the longevity of the medical device and its components were emphasized. According to the findings, it is essential that the updates for the device do not require the hospital to change the whole device or a great amount of components. Also a functioning and fast product support and service should be ensured. What comes to components, the sub-contractor management plays an important role. The supplier should secure the good quality and longevity of the components by appropriate requirements for its suppliers.

6.2. Theoretical contribution

The findings of this study contribute to previous studies, but also provide some interesting additions. As mentioned, there exist a research gap and lack of empirical evidence about green public procurement of medical devices. These findings should offer a valuable view to this specific subject.

It is widely agreed that the awareness of health care sector's impact on climate change is growing (Roberts et al., 2014; Karliner & Guenther, 2011; Karlsson & Öhman, 2005) and that public procurement has a significant role in the goal to reduce the negative environmental impacts (HCWH Europe, 2014a; Karliner & Guenther, 2011; Kaiser et al., 2001). This study also resulted that public purchasers are interested in the green public procurement of medical devices and it will become more significant part of the procurement process in the future. Also Palmujoki et al. (2010) argue that environmental aspects will be taken into consideration in public procurement increasingly. This argument of increasing significance of green public procurement is supported by the current and upcoming EU legislation and support, which was discussed in the chapter 3.5. One great example is the development of EU GPP criteria for health care EEE, which is meant to support the green public procurement of medical devices.

This study resulted that motivators for green public procurement are conservation of nature and natural resources, encouraging suppliers to consider environmental aspects in innovation, positive impact on image and cost savings in the long run. Also the safety was considered to be improved by more environmentally sustainable devices. These motivators have been identified in the previous literature as well (European Commission, 2011; Zimmer & McKinley, 2008). However, acting as an example has been identified to be one motivator for public purchasers (European Commission, 2010), but it did not stand out in this study.

The barriers against green public procurement of medical devices identified in this study reflect well on the previous research. Also Karlsson & Öhman (2005) and Walker & Brammer (2009) found that the prioritizing of the main values of patient and personnel safety, quality and clinical performance often reduce or postpone the efforts for green public procurement. Moreover, such like in this study the perception that green products are more expensive and the lack of knowledge of environmental impacts of medical products were identified to be barriers against green public procurement (Kaiser et al., 2001; Zimmer & McKinsley, 2008; Walker & Brammer, 2009). This is supported by Renda's et al. (2012) study, which resulted that public authorities find it difficult to include environmentally sustainable requirements in the procurement process. Kaiser et al. (2001) and Zimmer & McKinsley (2008) argue that the lack of knowledge is caused by strict budgets that leads to a lack of personnel, especially environmentally aware personnel. This argument was not discussed in this study. However, a need for a third party, who would support public purchasers in implementing green public procurement was recognized.

Kagoma et al. (2012) argued that use of anaesthetic gases and electricity consumption are significant environmental issues in hospitals' operating rooms. This argument supports the findings of this study; automatic and manual low flow function, automatic low power mode and instructions for green performance were found to be one of the most significant environmentally sustainable features of medical devices. However, the fast recovery from low power mode to full functionality was highlighted in order to maintain the good level of clinical performance. Since low electricity consumption was identified as a significant feature, large imaging equipment was seen as a relevant and first product group for green public procurement. The increasing significance of low

electricity consumption of imaging equipment is supported by EU's upcoming legislation as well; there are preliminary plans to include medical imaging equipment into Ecodesign directive, which would require suppliers to focus more on the electricity consumption (Roberts et al., 2014).

An interesting finding of this study is the highlighted role of the medical device supplier, which has not been discussed previously in the research. According to this study, the medical device supplier should also market environmental sustainability of their devices and this way share information to public purchasers. As long as the marketing is based on facts and measured documentation and does not hinder patient safety or clinical performance, it can be even an advantage for the supplier in the competitive tendering process. In previous literature only the roles of EU, governments and hospital management have been highlighted in order to support public purchasers.

6.3. Managerial implications

The research results provide some useful managerial recommendations since green public procurement of medical devices is a relatively new subject of study. These managerial recommendations that are supported by empirical data from Finnish public hospitals may add value for medical device suppliers, who want to support their customers to solve their environmental issues.

First of all, the results indicate that environmental sustainability will be increasingly considered in the public procurement of medical devices. Since the interest towards environmental sustainability is increasing within public authorities, also medical device suppliers should begin to focus on environmental sustainability of their devices and operation. It is reasonable to assume that environmental sustainability is one relevant field of focus for medical device suppliers.

The empirical data of this study provides some suggestions what steps the medical device manufacturer could take in order to best support public hospitals to solve their environmental issues. As was found, gas and electricity consumption as well as the use of refrigerants and the importance of chemical management system will become the most significant environmentally sustainable features of medical devices. This finding indicates that one relevant way to consider environmental sustainability in the medical devices, is to focus on these areas. In addition, it was strongly highlighted that medical

device suppliers should also market and share information about environmental sustainability. The marketing has to be based on documented and reliable facts and also proof the value of the issued feature; not only for the environment, but for clinical performance as well. Finally, it was found that environmental sustainability of medical devices can and most likely will bring concrete benefits for a medical device supplier.

Besides to public purchasers, the pressure to consider environmental sustainability comes also from EU. At the moment, it is voluntary for public purchasers whether to consider environmental sustainability in the purchasing or not. However, EU is offering all the time more support, such as by developing the EU GPP criteria for health care EEE and the Buying Green! Handbook. It is recommended that also medical device suppliers would give attention to these guidelines since they provide some clues of the public authorities' needs. However, medical device suppliers should also give attention to the upcoming legislation. A good example is EU's Ecodesign directive since EU already has preliminary plans to include medical imaging equipment into the directive. This directive is allocated directly to manufacturers.

6.4. Limitations and suggestions for future research

The most significant limitations of this study are related to the geographical demarcation and sample population. This research was limited to examine green public procurement of medical devices only within Finnish public hospitals. This geographical demarcation limits generalizing the research results wider to other countries, although a common assumption, especially about EU countries, could be established. In addition, the interviews were held only for public hospitals' procurement specialists. As the survey results indicated, procurement specialists, clinicians and medical technicians' opinions varied relatively lot. If the interviews would have held also for clinicians and medical technicians, the empirical data would present more comprehensive results.

With regard to the presented limitations, a suggestion for future research is to examine green public procurement of medical devices in other EU countries as well in order to achieve more comprehensive results. Since medical device suppliers sell devices all over the world, would be also interesting to gather an understanding how significant environmental sustainability of medical devices is in the countries outside EU, where EU's legislation and support for green public procurement do not apply. Since this

study examined the opinions of clinicians and medical technicians only by the survey, another suggestion is to examine more comprehensively their opinions. The results would possibly provide valuable information about environmental sustainability of medical devices from the users' point of view and further support medical device suppliers in the product development and design.

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Appendix 1

Ymparistoa saastavat julkiset hankinnat

Taustatiedot

*** 1. Mista yksikosta olet?**

- Hankintayksikosta
- Kliinisesta yksikosta
- Laakintatekniikka
- Muu

*** 2. Minka laitteiden hankinnassa olet mukana? Voit valita useampia vaihtoehtoja.**

- Anestesiakoneet
- Potilasmonitorit
- EKG-laitteet
- Rontgenlaitteet
- Tietokonetomografialaitteet
- Hemodialyysilaitteet
- MRI-laitteet
- Sterilointilaitteet
- Desinfioivat huuhtelu- ja pesulaitteet
- Laboratoriojaakaapit ja -pakastimet
- Keskoskaapit ja vastasyntyneen virvoittelupoydat
- Ei mikaan ylla mainituista

Ympariston huomiointi hankinnoissa

*** 3. GPP (Green Public Procurement) on minulle tuttu entuudestaan**

- Kylla
- Ei

*** 4. Huomioidaanko ymparistoystavallisyys hankintapaatoksissa?**

- Kylla
- Satunnaisesti
- Ei

*** 5. Vaikuttaako ostopaatokseen enemman hankintahinta vai tuotteen elinkaaren aikaiset kustannukset?**

- Hankintahinta
- Molemmat otetaan huomioon
- Elinkaarikustannukset

* **6. Mitka seuraavista otetaan huomioon elinkaarikustannuksia laskettaessa? Voit valita useita vaihtoehtoja.**

- [x] Hankintakustannukset
- [ ] Kaytonaikaiset sahkokulut
- [ ] Kaytonaikaiset vesikulut
- [ ] Huoltokustannukset
- [ ] Varaosakustannukset
- [ ] Jate-/kierratyskustannukset tai jalleenmyyntihinta

* **7. Uskon, etta vihreat hankinnat johtavat myos kustannussaastoihin pitkalla aikavalilla**

- (•) Kylla
- ( ) Ei

* **8. Mita etuja voidaan mielestasi saavuttaa ymparistoa saastavilla julkisilla hankinnoilla? Voit valita useita vaihtoehtoja.**

- [ ] Ymparistön saastaminen
- [ ] Toimimme esimerkkina muille
- [ ] Positiivinen vaikutus imagoon
- [ ] Kustannussaastot
- [ ] Kannustamme toimittajia huomioimaan ymparistotekijat innovoinnissa
- [ ] Ei mikaan yllamainituista

Laitteen ominaisuudet

Vastaa kysymyksiin 9-24 sen mukaan, miten usein kysytty tekija on vaatimuksena toimittajalle/laitteelle osana hankintamenettelya.

Vastaa ensin, mika tilanne on talla hetkella ja arvioi sitten, mihin suuntaan vaatimuksia on mahdollisesti kehitetty noin 5 vuoden kuluttua.

* **9. Toimittaja toimittaa listauksen laitteen kemikaaleista, jotka kuuluvat Candidate List of Substances of Very High Concern (SVHC)-listaan ja pitaa listan ajantasalla vah. 5 vuoden ajan.**

	Aina vaatimuksena hankintamenettelyssa	Usein vaatimuksena hankintamenettelyssa	Harvoin vaatimuksena hankintamenettelyssa	Ei ole koskaan vaatimuksena hankintamenettelyssa
Talla hetkella	( )	( )	( )	( )
n. 5 vuoden kuluttua	( )	( )	( )	( )

* **10. Toimittajan toimittamassa kaytto-oppaassa ohjeistetaan sahkon- ja vedenkulutuksen, kertakayttoisten osien seka paastojen vahentamiseen.**

	Aina vaatimuksena hankintamenettelyssa	Usein vaatimuksena hankintamenettelyssa	Harvoin vaatimuksena hankintamenettelyssa	Ei ole koskaan vaatimuksena hankintamenettelyssa
Talla hetkella	( )	( )	( )	( )
n. 5 vuoden kuluttua	( )	( )	( )	( )

* **11. Toimittaja tarjoaa koulutusta laitteen sahkonkulutuksen optimoinnista**

	Aina vaatimuksena hankintamenettelyssa	Usein vaatimuksena hankintamenettelyssa	Harvoin vaatimuksena hankintamenettelyssa	Ei ole koskaan vaatimuksena hankintamenettelyssa
Talla hetkella				
n. 5 vuoden kuluttua				

* **12. Laite on suunniteltu pitkaikaiseksi niin, etta vahennetaan ymparistön kuormittumista**

	Aina vaatimuksena hankintamenettelyssa	Usein vaatimuksena hankintamenettelyssa	Harvoin vaatimuksena hankintamenettelyssa	Ei ole koskaan vaatimuksena hankintamenettelyssa
Talla hetkella				
n. 5 vuoden kuluttua				

* **13. Toimittaja tekee asiakkaalle tarveanalyysin sahkonkulutuksen optimoimiseksi**

	Aina vaatimuksena hankintamenettelyssa	Usein vaatimuksena hankintamenettelyssa	Harvoin vaatimuksena hankintamenettelyssa	Ei ole koskaan vaatimuksena hankintamenettelyssa
Talla hetkella				
n. 5 vuoden kuluttua				

* **14. Laitteessa on mahdollisimman matala sahkonkulutus**

	Aina vaatimuksena hankintamenettelyssa	Usein vaatimuksena hankintamenettelyssa	Harvoin vaatimuksena hankintamenettelyssa	Ei ole koskaan vaatimuksena hankintamenettelyssa
Talla hetkella				
n. 5 vuoden kuluttua				

* **15. Toimittajalla on antaa raportti/kuvaus sahkonkulutuksen testauskaytannoista seka saaduista tuloksista**

	Aina vaatimuksena hankintamenettelyssa	Usein vaatimuksena hankintamenettelyssa	Harvoin vaatimuksena hankintamenettelyssa	Ei ole koskaan vaatimuksena hankintamenettelyssa
Talla hetkella				
n. 5 vuoden kuluttua				

* 16. Laite on mahdollista ohjelmoida automaattiseen virransaastotilaan, kun sita ei ole kaytetty vahaan aikaan

	Aina vaatimuksena hankintamenettelyssa	Usein vaatimuksena hankintamenettelyssa	Harvoin vaatimuksena hankintamenettelyssa	Ei ole koskaan vaatimuksena hankintamenettelyssa
Talla hetkella				
n. 5 vuoden kuluttua				

* 17. Laite palautuu virransaastotilasta taydelle teholle nopeasti

	Aina vaatimuksena hankintamenettelyssa	Usein vaatimuksena hankintamenettelyssa	Harvoin vaatimuksena hankintamenettelyssa	Ei ole koskaan vaatimuksena hankintamenettelyssa
Talla hetkella				
n. 5 vuoden kuluttua				

* 18. Laitteessa on sisaanrakennettuna tai siihen voi liittaa mittauslaitteiston, joka mittaa sahkonkulutusta

	Aina vaatimuksena hankintamenettelyssa	Usein vaatimuksena hankintamenettelyssa	Harvoin vaatimuksena hankintamenettelyssa	Ei ole koskaan vaatimuksena hankintamenettelyssa
Talla hetkella				
n. 5 vuoden kuluttua				

* 19. Laitteessa on sisaanrakennettuna tai siihen voi liittaa mittauslaitteiston, joka mittaa vedenkulutusta

	Aina vaatimuksena hankintamenettelyssa	Usein vaatimuksena hankintamenettelyssa	Harvoin vaatimuksena hankintamenettelyssa	Ei ole koskaan vaatimuksena hankintamenettelyssa
Talla hetkella				
n. 5 vuoden kuluttua				

* 20. Laitteessa on sisaanrakennettuna tai siihen voi liittaa mittauslaitteiston, joka mittaa kaasuvirtausta

	Aina vaatimuksena hankintamenettelyssa	Usein vaatimuksena hankintamenettelyssa	Harvoin vaatimuksena hankintamenettelyssa	Ei ole koskaan vaatimuksena hankintamenettelyssa
Talla hetkella				
n. 5 vuoden kuluttua				

* **21. Laitteissa on mahdollisimman matala vedenkulutus**

	Aina vaatimuksena hankintamenettelyssa	Usein vaatimuksena hankintamenettelyssa	Harvoin vaatimuksena hankintamenettelyssa	Ei ole koskaan vaatimuksena hankintamenettelyssa
Talla hetkella	○	○	○	○
n. 5 vuoden kuluttua	○	○	○	○

* **22. Laboratorion kylmalaitteissa (jaakaapit, pakastimet) kaytetaan kylma-ainetta, joka sisaltaa mahdollisimman vahan otsonikerrosta ohentavia aineita**

	Aina vaatimuksena hankintamenettelyssa	Usein vaatimuksena hankintamenettelyssa	Harvoin vaatimuksena hankintamenettelyssa	Ei ole koskaan vaatimuksena hankintamenettelyssa
Talla hetkella	○	○	○	○
n. 5 vuoden kuluttua	○	○	○	○

* **23. Anestesialaitteessa on automaattinen matalavirtaus-toiminto**

	Aina vaatimuksena hankintamenettelyssa	Usein vaatimuksena hankintamenettelyssa	Harvoin vaatimuksena hankintamenettelyssa	Ei ole koskaan vaatimuksena hankintamenettelyssa
Talla hetkella	○	○	○	○
n. 5 vuoden kuluttua	○	○	○	○

* **24. Anestesialaitteessa on manuaalinen matalavirtaus-toiminto, jonka optimaaliseen kayttoon on selkeat kaytto-ohjeet**

	Aina vaatimuksena hankintamenettelyssa	Usein vaatimuksena hankintamenettelyssa	Harvoin vaatimuksena hankintamenettelyssa	Ei ole koskaan vaatimuksena hankintamenettelyssa
Talla hetkella	○	○	○	○
n. 5 vuoden kuluttua	○	○	○	○

Onko sinulla muuta kommentoitavaa aiheesta? Alla on tilaa vapaille kommenteille.

Kiitos vastauksistasi! Paina viela Submit -nappainta, jotta vastaukset tallentuvat jarjestelmaamme.

Submit Cancel

Appendix 2

Hyvä vastaanottaja

Opiskelen Lappeenrannan teknillisessä yliopistossa kauppatieteitä ja työskentelen harjoittelijana GE Healthcare Finland Oy:lla. Olen parhaillani tekemässä tutkintooni liittyvää pro gradu -tutkielmaa siitä, kuinka EU:n kriteeristö ”Green Public Procurement (GPP)” vaikuttaa julkisten sairaaloiden hankintoihin. GPP on vapaaehtoinen kriteeristö, jonka tarkoituksena on tarjota ohjeita ja kannustaa julkisia hankkijoita hankkimaan tuotteita, jotka aiheuttavat ympäristölle haittaa vähemmän verrattuna muihin markinnoilla oleviin vaihtoehtoisiin tuotteisiin.

Toivoisin, että osallistuisitte tähän kyselyyn ja tukisitte tutkimukseni onnistumista. Kyselyyn vastaamiseen kuluu noin 5-10 minuuttia. Kyselyn vastaukset käsitellään luottamuksellisesti eikä kyselyyn vastanneiden henkilöllisyys paljastu missään vaiheessa. Vastaaminen tapahtuu alla olevan linkin kautta. Kyselyssä on yhteensä 24 kysymystä. Vastattuasi kaikkiin kysymyksiin muistathan painaa SUBMIT-näppäintä, jotta vastauksesi tallentuvat järjestelmäämme. Vastausaikaa on 5.7. asti.

Kyselyssä ei valitettavasti ole lainkaan ääkkösiä, sillä kyselyn rakentamiseen käytetty työkalu ei tunnista niitä. Pahoittelut, mikäli tämä aiheuttaa hämmennystä.

Tässä linkki kyselyyn:
https://supportcentral.ge.com/esurvey/GE_survey/takeSurvey.html?form_id=1844674
4073709621463

Mikäli teillä on jotain kysyttävää kyselyä koskien, voitte olla yhteydessä minuun joko sähköpostilla: jenni.suuronen@ge.com tai puhelimitse p. 040 7462478

Kiitos jo etukäteen yhteistyöstä!

Ystävällisin terveisin,
Jenni Suuronen
EHS Intern
GE Healthcare Finland Oy

Appendix 3

Haastattelurunko / The framework of the interviews

TEEMA: Ympäristöystävällisyys hankinnoissa

Theme: Environmental sustainability in purchasing

1. Tunnetaanko GPP-kriteeristö yleisesti?

   Are GPP criteria known generally?
2. Miten ympäristöystävällisyys ilmenee hankinnoissa?

   How environmental sustainability is taken into account in purchasing?
3. Miten tämän tyyppiset hankinnat on organisoitu?

   How the purchasing of medical devices is organized?

TEEMA: Ympäristöä säästäviin hankintoihin kohdistuvat käsitykset

Theme: Conceptions against environmentally sustainable purchasing

4. Miten ympäristöä säästäviin hankintoihin suhtaudutaan?

   What is the general attitude towards environmentally sustainable purchasing?
5. Mitä etuja voidaan saavuttaa?

   What benefits can be achieved?
6. Mitä esteitä?

   What barriers there are?
7. Mikä olisi avain kohti ympäristöä säästäviä hankintoja? Miten esille tulleet esteet voitaisiin kumota?

   What could be the key to overcome the barriers?

TEEMA: Tulevaisuus

Theme: The future

8. Millainen kehitys ympäristöä säästävillä hankinnoilla mielestäsi on nähtävissä?

   How does the future look like for environmentally sustainable purchasing?
9. Mikä voisi olla mahdollisesti ensimmäinen tuoteryhmä, johon GPP:tä sovelletaan?

   What could be the first product group for implementing GPP criteria?
10. Mitkä ovat mielestäsi keskeisimmät GPP-kriteerit?

    Which are the most crucial GPP criteria?
11. Tuoko GPP:n kriteerien täyttyminen lisäarvoa laitteelle? Kuinka monta prosenttia arvioisit, että kriteerit täyttävän laitteen hinta voisi nousta?

In your opinion, does it bring added value for a medical device if it does fill GPP criteria? How much you estimate the price could possibly increase?

12. Mitä toivot laitevalmistajien puolelta ympäristöystävällisyyden suhteen?
    What it comes to environmentally friendly purchasing, what do you expect from the medical device manufacturer?

TEEMA: Kyselyn vastauksia tarkentavat kysymykset

Theme: Questions specifying the survey results

13. Vaikuttaako tuotteen hankintapäätökseen enemmän hankintahinta vai elinkaaren aikaiset kustannukset?
    Which one has a bigger influence on a final purchase decision; purchase price or life-cycle costs?
14. Onko toimittajan kemikaalien hallinta ja siihen liittyvä dokumentaatio kriittinen tekijä hankintapäätöstä tehtäessä?
    Are the supplier's chemicals management system and its documentation a critical factor when making the final purchase decision?
15. Kyselyssä yksi vastaajista otti esille seuraavan ongelman: ”Vihreät kriteerit nähdään mahdollisuutena riitauttaa kilpailutus”. Onko tämä mielestäsi yleinen näkemys?
    In the survey one respondent adduced the following issue: "Green criteria are seen as a possibility to make a complaint about the competitive tendering". Do you think this is a general opinion?