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Developing the implementation of green warehousing at IKEA Finland

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Abstract

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Developing the implementation of green warehousing at IKEA Finland	**55 + 5**

Sustainability has become an increasingly important trend in supply chain management recently. The green warehouse, a crucial element in the sustainable supply chain, should be implemented strategically and efficiently.

The thesis aims to develop the implementation of green warehousing at IKEA Finland with three investigative questions (IQs). The research examines the IKEA's current warehouse sustainability with a focus on energy efficiency (IQ1), waste management (IQ2) and creates developing proposals for the IKEA's sustainable warehouse in the future (IQ3).

The introduction gives the reader an overview of the thesis topic including the background, the research question, key concepts and sustainability implementations in the case company IKEA. Subsequently, the theoretical framework represents the high-quality and most up-to-date literature, starting from a big picture of green supply chain management and green warehousing to various elements of advanced models in energy efficiency and waste management. The theory section concludes with presentations of future directions in green warehousing practices with renewable energy self-production and sustainable warehouse designs.

The research methods chapter includes three phases (P1, P2, and P3) and qualitative empirical research is the primary approach. Firstly, the desktop study phase (P1) reviews relevant literature on green warehousing implementation. The data collection phase (P2) aims to obtain information both from primary sources (four interviews with IKEA's Sustainability Leader, Logistics Manager, Goods-Flow Shift Leader and a warehouse employee) and secondary sources (IKEA Group Sustainability Reports). The final phase (P3) analyzes and interprets research results and matches the findings with theory literature to evaluate the current sustainability practices at IKEA's warehouses.

The research results demonstrate that the current implementations of energy efficiency (IQ1) and waste management (IQ2) at IKEA's warehouses are excellent. The case company has successfully applied the most innovative approaches to facilitate its green warehousing practices.

Regarding the model of a future warehouse, the researcher has formulated three developing proposals to improve the green warehouse at IKEA Finland (IQ3). The first developing proposal establishes a system of Key Performance Indicators (KPIs) in energy efficiency and waste management at IKEA's store level. The second proposal suggests IKEA to use two appropriate methods of gasification and anaerobic digestion to generate energy from biomass. Finally, the recommendations on redesigning IKEA's warehouses with more sustainable designs are the last development plan.

Keywords
Green supply chain management, green warehousing, energy efficiency, waste management, renewable energy, sustainable design.

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I would like to express my grateful thanks to my specialization teachers: Soile Kallinen, Eeva Aarnio, and Hanna Harilainen, who have taught me valuable knowledge in logistics and supply chain management to complete this thesis.

This research would not be completed without generous help from Tobias Lindberg, the representative of the commissioning company IKEA Finland Oy. Thank you for all your supports.

Lastly, this paper is dedicated to my parents, who have given me fantastic opportunities to experience this brilliant world.

Minh Luu.
Helsinki, May 2016.

1 Introduction

This chapter aims to give readers an overview of background information, the research question (RQ), investigative questions (IQs), benefits for stakeholders and international aspects. Several key concepts are also defined to help readers become familiar with the topic.

1.1 Background

"Sustainability is the key to our survival on this planet and will also determine success on all levels" (Arison 2009).

Doing business in the 21st century requires every management levels to possess an ecological mind to drive their businesses in a sustainable manner. Sustainability has become more important than ever with short-term business objectives as well as the long-term development of companies. Without a sustainable business strategy, the business performance and company's future are put in danger.

Green supply chain management and logistics deal with every logistics and supply chain activities to minimize their negative impacts on ecosystems and environment. One of these activities, warehousing logistics should be green and eco-friendly as possible. Implementing green warehousing strategy helps companies not only protect environment ethically and comply with local legislations actively but also cut costs of warehousing activities effectively.

IKEA is a global furniture manufacturer and retailer whose warehouses, distribution centers and department stores are located everywhere in the world. Possessing a massive international supply chain, IKEA needs to take into consideration about green logistics as a core business strategy of its value chain management. The thesis helps IKEA to enhance the efficacy of green warehousing at its warehouses in Finland. This purpose exactly suits IKEA's green policy and strategy, and the thesis is promising to generate realistic results to benefit its commissioning company IKEA.

For my professional career, writing a thesis about sustainability with a global company like IKEA is considerably beneficial for my logistics profession. This not only helps me deepen my knowledge and skills about green supply chain management but also trains me to develop project management practices, to boost research method skills and to grow in an international environment.

1.2 Research questions

This thesis aims to **"Develop the implementation of green warehousing at IKEA Finland".**

Research question (RQ) is that: **How can IKEA Finland develop green warehousing practices?** The research question is divided into investigative questions (IQs) as follows:

IQ 1. What are current practices to attain energy efficiency in IKEA's warehouse?
IQ 2. What are current practices to attain effective waste management in IKEA's warehouse?
IQ 3. What developing proposals can be made to develop green warehousing implementation in IKEA's warehouse?

Table 1 below presents the theoretical framework, research methods and results chapters for each investigative question.

Table 1. Overlay matrix

Investigative Questions (IQs)	Theoretical Framework	Research Methods	Results
IQ1: What are current practices to attain energy efficiency in IKEA's warehouse?	Method and strategy of energy efficiency in a warehouse. The focus is heating systems, lighting systems and mechanical handling equipment's energy consumption.	Desktop studies for relevant theories. Qualitative method: Interviewing warehouse's personnel to collect information and data.	Theory and model about methods and strategies of energy efficiency in warehousing (Chapter 2.3). Current energy efficiency practices in IKEA's warehouses. (Chapter 4.1.1)
IQ2: What are current practices to attain effective waste management in IKEA's warehouse?	The process of effective waste management in the warehouse.	Desktop studies for relevant theories. Qualitative method: Interviewing warehouse's personnel to collect information and data.	The process of effective waste management in the warehouse (Chapter 2.4). The current process of waste management in IKEA's warehouses. (Chapter 4.1.2)
IQ3: What developing proposals can be made to develop green warehousing implementation in IKEA's warehouse?	Best practices for energy efficiency and waste management in warehousing business. Future development plans for the green warehouse including green energy production and sustainable warehouse design.	Using all information and data collected to analyze all strengths and weaknesses of IKEA green warehousing practices.	Recommendations to boost current green warehousing practices in IKEA. Realistic developing proposals for IKEA's warehouse sustainability (Chapter 4.3)

1.3 Demarcation

This subchapter explains the scope of the thesis. In figure 1, the researcher illustrates the focused subjects of this topic and what matters are excluded from this study.

Figure 1. Green warehousing thesis demarcation

The thesis is planned to write about the sustainability of supply chain management and green logistics, which are enormous and complex fields. In logistics chain, inbound logistics is delivering, transporting and storing goods into a business (usually storage takes place in the warehouse). On the other hand, outbound logistics is storing, delivering goods out of a business (usually retailers or customers). (Ingram 2015.) Between inbound and outbound logistics, the internal warehouse plays an important role in goods storage, packaging, inventory management, and order fulfilment before products are delivered to customers. Regarding ecological aspects, sustainability can be implemented in all inbound, central warehouse, and outbound logistics activities. (Chand 2015.)

Within the scope of this bachelor thesis, the topic is narrowed down to focus on the sustainability in the central warehouse (green warehousing) (Figure 1). Three main aspects are researched including energy efficiency, waste management, and future development of the green warehouse. There will be no green implementation of inbound nor outbound logistics mentioned in the thesis.

1.4 International Aspect

IKEA is an international company that operates all over the world. The implementation of green warehousing is done in whole cooperation level. Therefore, the thesis author can

see the whole picture of green logistics policies in global IKEA. Furthermore, writing a thesis with IKEA and working with people from different backgrounds help the researcher develop international experience and multicultural knowledge.

1.5 Benefits

Firstly, the green warehousing implementation at IKEA will be revised. The improving suggestions will be given to logistics director as references to improve relevant practices. This helps IKEA have a clear direction of how to establish a better green implementation to its warehouses of department stores. Applying these implementations helps IKEA not only become more sustainable company but also save costs of warehousing activities.

In addition, writing this thesis is obviously a great opportunity for me to study, learn and practice in an international environment. I believe that at the end of thesis writing process, I will acquire new knowledge and skills that are necessary for my future career.

1.6 Key Concepts

In this section, the definitions of main concepts mentioned through the thesis are represented as follows:

Green Supply Chain Management: “is integrating environmental thinking in supply chain management, including product design, material sourcing, and selection, manufacturing processes, delivery of the final product to the customers and end-of-life management of the product after its useful life” (Srivastava 2007, 54-55).

Green warehousing: “approaches to reducing the environmental impact of warehousing at a level that an individual firm or warehouse manager could responsibly take” (Baker & Marchant 2015, 194).

Energy efficiency: “is a way of managing and restraining the growth in energy consumption. Something is more energy efficient if it delivers more services for the same energy input, or the same services for less energy input” (International Energy Agency 2015).

Waste management: “is the precise name for the collection, transportation, disposal or recycling and monitoring of waste” (Waste Management Resources 2009).

Renewable energy: "is energy which can be obtained from natural resources that can be constantly replenished, including bioenergy, geothermal energy, hydropower, ocean energy, solar energy, and wind energy" (Australian Renewable Energy Agency).

Sustainable design: "seeks to reduce negative impacts on the environment, and the health and comfort of building occupants, thereby improving building performance. The basic objectives of sustainability are to reduce consumption of non-renewable resources, minimize waste, and create healthy, productive environments" (U.S General Service Administration 2015).

1.7 Commissioning party

IKEA is a global designer, manufacturer, and retailer of furniture and home equipment. Founded in 1948 in Sweden, the company has headquartered in Leiden, Netherlands and operated in 47 countries with 328 stores worldwide. IKEA employs about 155,000 employees and has strong partnerships with 978 suppliers from 50 countries in the world. In 2015, IKEA welcomed nearly 771 million visitors to the store and 1.9 billion visitors to online shop. The total sales in the fiscal year 2015 were 31.9 billion euros (EUR), in which 3.5 million EUR made up net profits. (IKEA Group Sustainability Report 2015, 4-6.)

The first IKEA store in Finland was established in 1996 in Espoo. At the moment, IKEA Finland has five department stores which are located in Espoo, Vantaa, Tampere, Raisio, and Kuopio (IKEA Finland Website).

Sustainability is considered as central to IKEA's business. The company's sustainable development has been focusing on ethical governance, environmental protection, and human resource policy. In the supply chain aspect, IKEA has developed a global network of suppliers who are sustainable in renewable energy, waste management, and energy consumption. (IKEA Group Sustainability Report 2015, 7-10.)

IKEA has gained significant achievements in the sustainability of green supply chain management and operations. From the financial year 2010, 133 million euros has been saved by energy efficiency implementation in warehouses and department stores (IKEA Group Sustainability Report 2015, 39). The company has the ambition to self-produce up to 100% of energy consumed in whole operations by 2020. Since 2009, 1.5 billion EUR has been invested in wind and solar power and 600 million EUR has been announced for new investments in coming years. (IKEA Group Sustainability Report 2015, 37.) Undoubtedly, IKEA is one of the leading companies in sustainability in the business world.

2 Theoretical framework

This chapter presents relevant theory, concepts, and models required to conduct the study of developing green warehouse practices at IKEA Finland. The theory framework is studied accordingly to the figure 2.

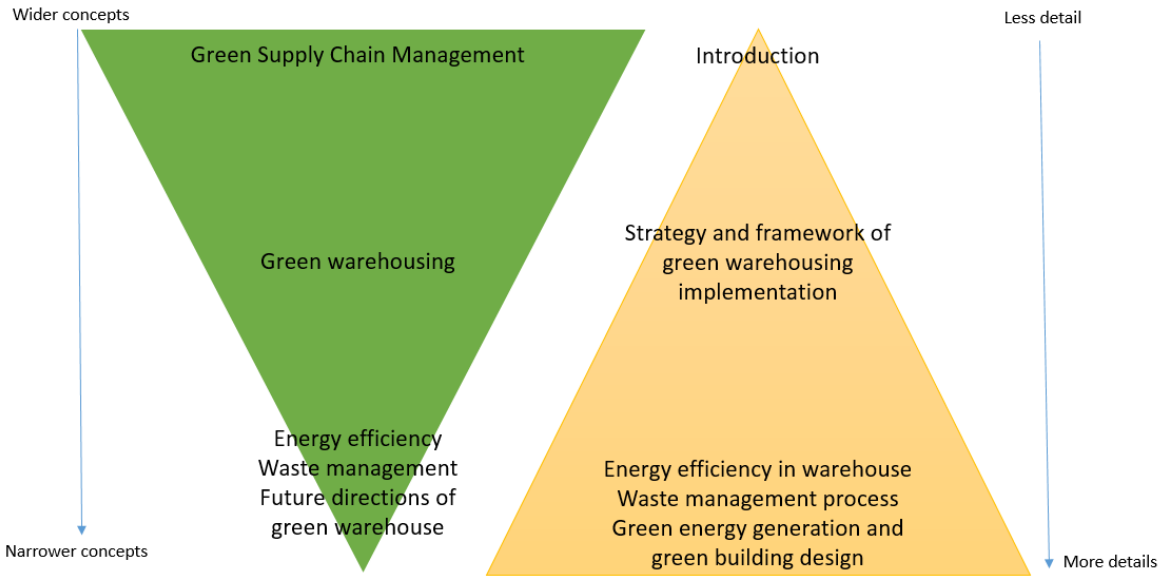

Figure 2. The conceptual structure of the theoretical framework.

The literature review starts with a big picture of green supply chain management in modern business in a nutshell, which mentions definitions, benefits, and decision-making approaches for green supply chain management. Subsequently, the thesis author discusses briefly key facts and general 3-stage framework of green warehouse implementation.

The later substantial content of theoretical framework includes in-depth theory and models on methods and strategies to develop green warehouse implementation. This section consists of various topics including energy efficiency, waste management, green energy self-production and sustainable design into warehouse buildings.

2.1 Green supply chain management

Green supply chain management is the integration of environmental management and supply chain management, which attempts to minimize products or services' negative impacts on the environment (Klassen & Johnson 2004). To be specific, green supply chain management deals with material reuse and recycle, energy consumption, waste management, and this process involves all members/organizations in every stage of design, sourcing, manufacturing, and delivery products/services to end-customers (Srivastava 2007, 54-55).

The question is that **why green supply chain management is so necessary for business strategy nowadays?** The simple answer is that companies are tremendously beneficial from these sustainable practices (Figure 3).

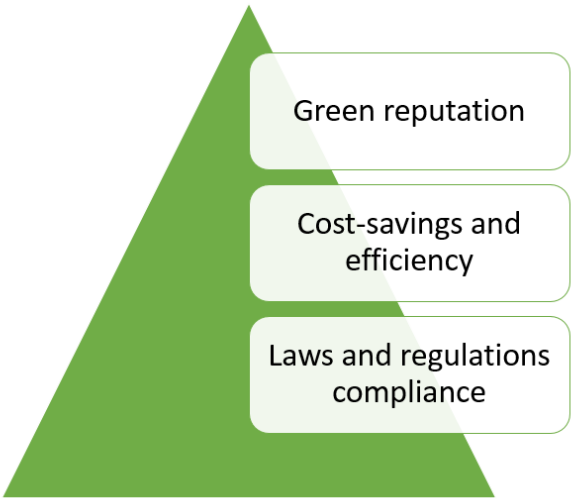

Figure 3. Benefits of green supply chain management (Adapted from Emmett & Sood 2010).

The first reason companies implement green business strategy is to comply with environmental regulations. Every national authority sets specific rules to protect and preserve environmental ecosystems in local countries. Violation of these laws usually results in significant fines from state and even legal lawsuits at environmental court. In addition, there are many of ecological standards and certifications which are recognized and operated globally. Acquiring these standards and certifications are significant advantages for international firms to enter new target markets. A good example is the certification ISO-14000 of environmental management from International Organization for Standardization (ISO 14000). (Emmett & Sood 2010.)

Cost savings and efficiency enhancement is another important root of green supply chain management. With the implementation of sustainable logistics strategies, companies reduce the energy consumption and water usage. Enterprises also have designed more environmental-friendly materials and attempted to recycle and reuse used products for different purposes instead of disposal. In other words, the companies aim to generate similar productivity and quality with fewer resources and less expenditure. (Emmett & Sood 2010.)

Lastly, implementation of green supply chain management is an excellent and innovative approach to enhancing firms' reputations. Nowadays green marketing is a very popular way for businesses to attract customers who are interested in the environment and also would like to participate in these green practices. A world-class sustainable company usually gains high reputations and trust from suppliers, business partners, and especially investors. In brief, green reputation is a considerable advantage that companies can deploy to develop businesses in a sustainable manner. (Emmett & Sood 2010.)

In general, management levels usually find it challenging to implement green practices because applications of sustainability bring significant advantages only when they come with an affordable investment. Therefore, **a systematic approach to decision-making is essential in green supply chain management** (Figure 4).

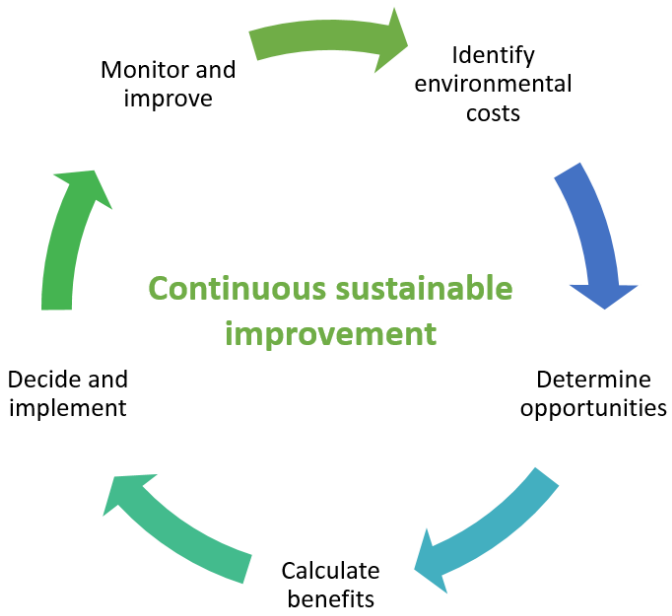

Figure 4. The framework for decision making in green supply chain management (Adapted from United State Environmental Protection Agency 2014, 12-13).

In the first step, sustainable managers identify from where significant environmental costs come. Then opportunities of savings costs from environmental costs are determined. Next, using quantitative methods, managers calculate and analyze the costs involved in proposed alternatives. The managers will have to decide on the proposed lists what environmental solutions will be implemented to generate maximum benefits for companies. During this process, monitoring and improving are essential to developing an overall result of green implementation. To sum up, this systematic approach helps companies identify, decide and focus on the greatest beneficial ecological applications as well as an emphasis on the continuous process of improvement in green supply chain management. (United State Environmental Protection Agency 2014, 12-13.)

Within the scope of this study, the thesis author examines the sustainability in warehouses in the following sections.

2.2 Green warehousing

The Supply Chain Decarbonisation Report (World Economic Forum 2009, 4) estimated that the human is responsible for 50,000 megatonnes of carbon dioxide generated annually, in which approximately 2,800 megatonnes of CO_2 results from logistics and transport industry. Warehousing activities contributed about 10.7% (300 mega-tonnes CO_2) of the total logistics emissions (World Economic Forum 2009, 4).

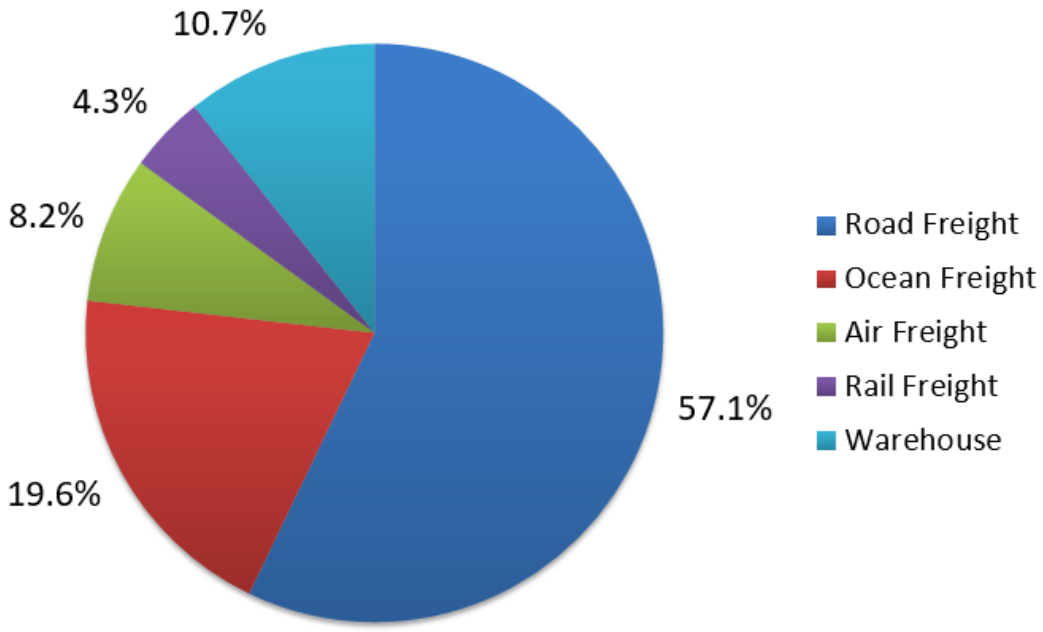

Figure 5. CO2 emission in logistics and transportation industry (Adapted from World Economic Forum 2009, 4).

As can be seen from figure 5, the contribution of warehousing activities to CO_2 emission is considerable and should be taken into account to reduce this footprint as possible. However, implementation of the green warehouse is a challenging mission which requires a well-structured strategy and clear future direction. In the following discussion, the framework of three stages of green warehouse implementation is presented (Figure 6).

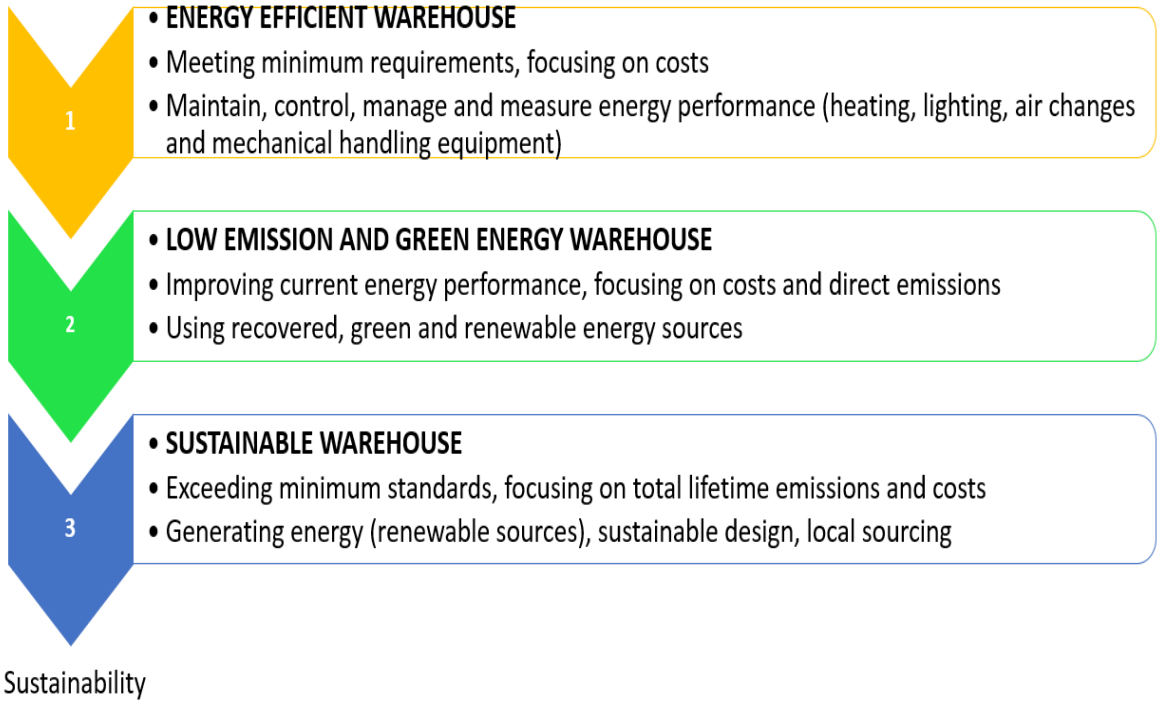

Figure 6. Three stages of green warehouse implementation towards sustainability (Adapted from Baker & Marchant 2015, 201).

According to Baker and Marchant (2015, 200-201), the framework towards sustainability of a warehouse consists of three stages. In the first stage, the simplest level of a green warehouse is an energy efficiency building with minimum requirements. This implementation focuses on the internal factors of the green warehouse such as heating, lighting, air changes and mechanical handling equipment. The energy efficient warehouse also has a measurement method to estimate and manage the energy consumption within the building. (Baker & Marchant 2015, 201).

The next stage is to establish a low-emission and green energy warehouse. Energy consumption and green practices are not only accurately measured but also continuously improved during the warehouse's operations. In addition, the building is expected to consume renewable and green sources of energy to lower carbon emissions. (Baker & Marchant 2015, 201).

In the most advanced stage of green implementation, a sustainable warehouse exceeds environmental requirements and performs beyond existing standards. The warehouse managers focus on total lifetime emissions concerning macro level for environment and ecology. The warehouse can self-produce energy from renewable sources such as solar panels, winds turbines, and biomass. At this stage, the warehouse becomes a truly green component of the sustainable supply chain. (Baker & Marchant 2015, 201).

In the next section, the thesis author will discuss how to implement and develop green warehouses in details by presenting diverse environmental-friendly aspects of a sustainable warehouse.

2.3 Energy efficiency in warehouse

Certainly, every warehouse needs to consume energy to perform daily business activities. With an effective implementation of energy management systems, the warehouse managers can help companies save up to 20% of energy bills with only a marginal capital investment. The largest consumption of energy in warehouse comes from heating and light systems, and this significant consumption can be reduced by energy saving practices and efficiency equipment. Indeed, the saving costs gained by efficient energy facilities and equipment usually greatly outweigh purchasing costs of these high-efficiency resources. (Huston 2013.)

The initiatives and actions which help to increase warehouses' energy efficiency regarding temperature, lighting systems, and mechanical handling equipment are presented as follows:

2.3.1 Warehousing temperature

Depending on nature of warehouses' functions and storage, local weather, design as well as in-house activities, every warehouse has different requirements of temperature to maintain. In real life, the primary sources of energy for heating/cooling systems in warehouse come from gas, fuel energy, and electricity. Noticeably, Baker and Marchant (2015, 203) pointed out that reducing inside warehouse temperature leads to a considerable reduction in energy consumption; for example 1 Celsius degree is decreased, 10% energy will be saved. Therefore, warehouse managers need to decide the optimal temperature in each area in the warehouse critically to cheapen monthly energy bills.

In addition, separate warehouse's areas with different activities should have different temperatures. In other words, local zones have a local temperature, which ranges from 10 to 19 Celsius degrees concerning areas' activities (Table 2).

Table 2. Satisfactory temperature in different warehouse zones (Carbon Trust 2002, in Baker & Marchant 2015, 203.)

Warehouse zones and activities	Satisfactory temperature
Bulk storage areas	10°C
Physical activities, unloading/loading gates	13°C
Picking areas, inspection sites	19°C

Furthermore, ventilation is another consideration in warehouse temperature maintenance. Ventilation is mandatory in the warehouse to exchange in-house air with the outside for retaining suitable work and storage atmosphere. According to Carbon Trust guideline (2002, in Baker & Marchant 2015, 203-204), there are many effective ways to facilitate energy efficiency with ventilation systems:

- Building a sufficient number of doors in the warehouse with wise design. Location of doors in a warehouse with the U-Shape design is far better than opposite design in maintaining temperature.
- Opening doors only when needed. Using fast-acting doors in highly active areas of loading and unloading gates.
- Isolating the picking, dispatching zones that required higher temperature from other cooler zones in the warehouse.

Finally, warehousing temperature optimization is easily done with an electronically automated tracking and managing systems. The choices of what types of heating/cooling systems are also vitally important in this case. These environmental-friendly initiatives, fortunately, will offset the costs of investing efficient temperature systems before long (Huston 2013).

2.3.2 Warehouse lighting systems

It is straightforward to maintain appropriate light levels to save energy and reduce costs in the warehouse. The warehouse manager might need to consult engineers to know about the amount of lights required in certain areas. In addition, choosing efficient and suitable light equipment also helps to enhance energy efficiency. (Baker & Marchant 2015, 206.) Table 3 suggests several highly-efficient lamp types in warehouse and offices.

Table 3. Suitable lamp types by activity zones (Adapted from Carbon Trust 2007, in Baker & Marchant 2015, 206.)

	Offices	Factories	External areas
Suitable lamp types	Triphosphorous tubular fluorescent, compact fluorescent, low voltage tungsten halogen.	Triphosphorous tubular fluorescent, high-pressure sodium, metal halide, inductive, emergency directional LED.	High-pressure sodium, metal halide.

As can be seen in Table 3, using the recommended lamp types for different zones in the warehouse is an easy but effective method to save energy. These recommendations are based on the capability of illumination of each lamp types and required level of light in each warehouse' areas. (Baker & Marchant 2015, 206.) Significantly, there is a considerable increase in LED (lighting-emitting diodes) usage in buildings and warehouses nowadays. Huggins (2014) indicated that LED systems can provide a far longer product life as well as up to 65-85% energy savings. Therefore, choosing a modern lighting technology as LED systems tremendously helps company's budget in long-term.

Saving energy with light systems also can be done by several following tips. There is a strict rule of turning on lights only when they are needed. The warehouse should be installed by automated sensor movement or timer to control switching on/off light systems. It is also important to maintain cleanliness and prevent lights from dust. More importantly, increasing usage of natural lights by opening more transparent glass skylights and windows saves energy and creates a more comfortable working environment for warehouse employees. (Richards & Riding 2015, 362).

2.3.3 Mechanical handling equipment

Counterbalance forklift truck supplied by electricity is a good environmental approach for warehouse's handling equipment and is one of the most popular choices of forklifts nowadays. Electric forklifts do not directly generate carbon dioxide and then improve internal air quality. (Richards & Riding 2015, 373.) With the usage of electric forklifts, regular charging is required, and it is possible to avoid overcharging by the automatic smart charger.

With external activities requiring a high level of power, diesel fuel or liquefied petroleum gas (LPG) usually more flexible and mobile than electric forklift (Baker & Marchant 2015, 207). However, these types of forklifts, of course, generate emissions to the environment.

Recently, Toyota launched the world's first diesel-electric hybrid forklifts which reduce 50% of fuel consumption, 45% of emission but perform at the equivalent power of traditional diesel forklifts (Toyota 2009).

2.3.4 Energy auditing

According to Baker and Marchant (2015, 211), an energy audit is a useful approach to measuring current energy consumption from which evaluate and improve efficiency. This method is conducted in three steps (Figure 7).

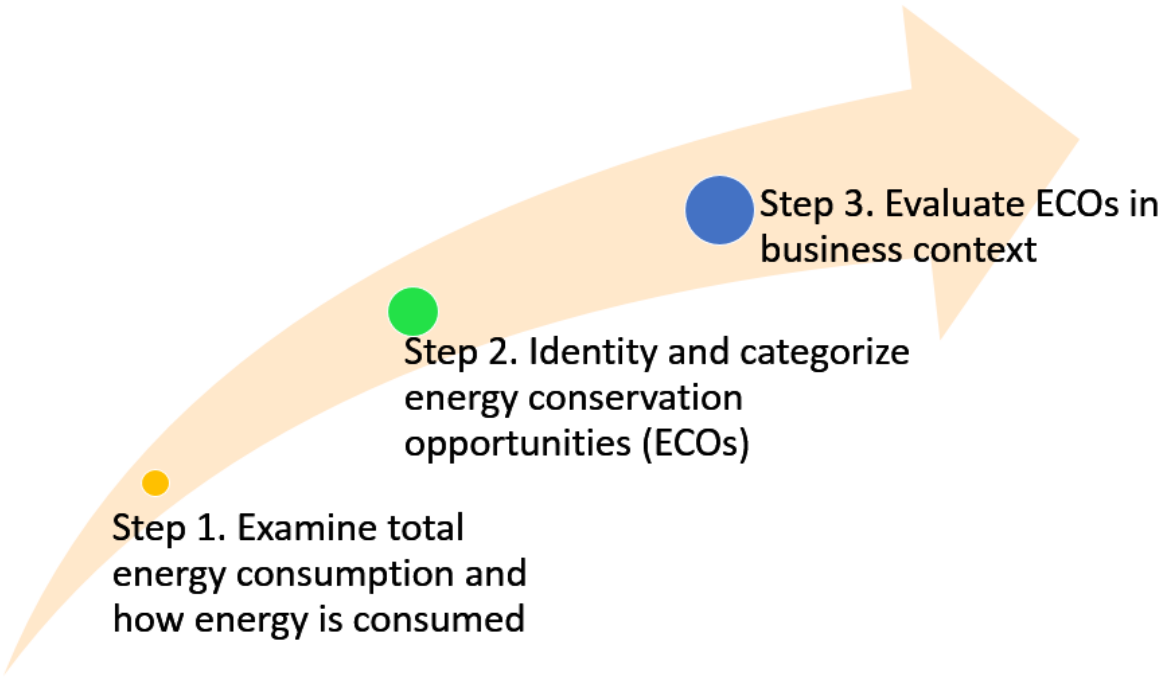

Figure 7. Energy auditing in a warehouse (Adapted from Baker & Marchant 2015, 211)

First of all, in step 1 total energy consumption in a warehouse can be established from previous electricity or gas bills. The estimated amount of energy consumed from each equipment/facility can be calculated through specifications from the manufacturer or other electric measurement devices. In step 2, every possibility of saving energy is explored. More importantly, these energy conservation opportunities (ECOs) need to be categorized accordingly to required capital investment. In the last step 3, ECOs are assessed with the risk of investment and return on investment before being approved or denied. (Baker & Marchant 2015, 211.)

Energy auditing is a strategic process to improve sustainability in a warehouse. This approach helps companies develop continuously and make wise decisions on sustainable investments. (Baker & Marchant 2015, 211.)

2.4 Effective management of waste

Waste generation is an inevitable consequence of daily warehousing activities. Management of waste is an important duty in a sustainable warehouse. An appropriate strategy and implementation of waste management help companies save costs by reusing recyclable materials, comply with local environmental regulations and make workplace clean, fresh and comfortable. (Redox 2005, 1.) The following information illustrates types of waste in warehouse and effective waste management implementation.

2.4.1 Types of waste in a warehouse

According to Redox (2005, 1-3), waste in a warehouse can be generated by either normal daily basis (typical waste) or irregular/unusual activities and damage (atypical waste) (Table 4).

Table 4. Types of waste in a warehouse (Redox 2005, 1-3).

	Characteristics and examples
Typical waste	All kinds of waste that are generated by daily business activities of the warehouse. These wastes are usually a non-liquid and solid waste. The amount of these wastes are predictably estimated and usually are stored in bins before being transferred to third-party to process. Examples: plastic bags, packaging cardboards, office papers, wooden materials, etc.
Atypical waste	This type of waste comes from unusual activities such as mistakes or damage in material handling, storage or replenishment process. The kinds of atypical waste are much complex; they could be liquid, non-liquid, metals, chemicals, and hazardous materials. Examples: Acid solutions, nickel, lead compounds, glass, iron, coppers, etc.

According to the table 4, waste separation is, of course, an essential part of effective waste management implementation.

2.4.2 Effective waste management process

The Carlsberg (2013) Waste Management Plan pointed out the waste hierarchy management in the practical process (Figure 8). This approach prioritizes to manage waste in the

most effective method possible (reduce) than other alternatives before the least effective way (disposal).

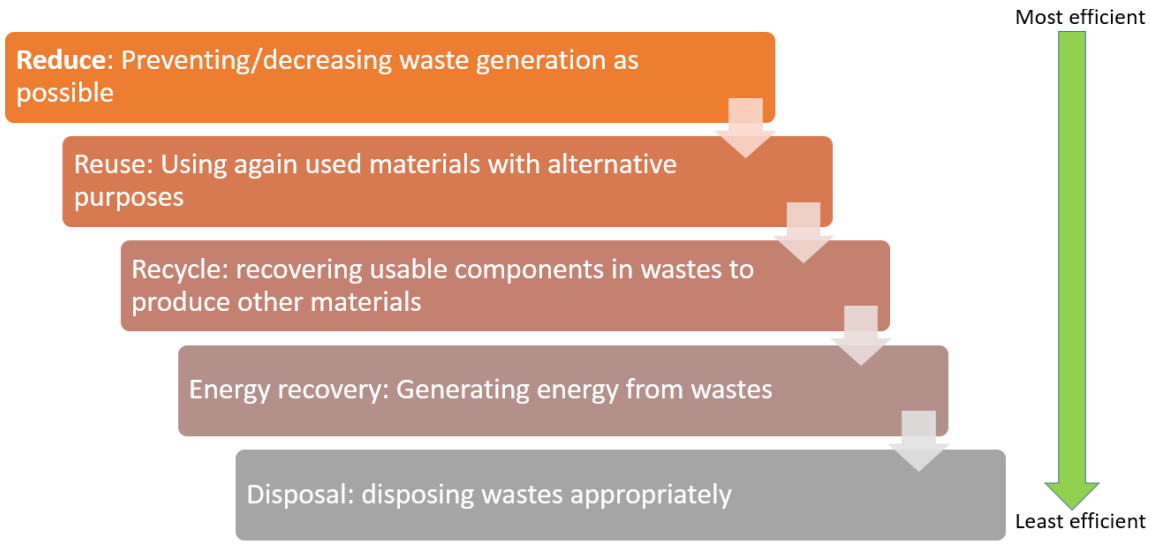

Figure 8. Waste hierarchy management (Adapted from Carlsberg 2013).

Minimizing the waste generation is the most environmental-friendly solution but a straight-forward task. Inside the warehouse, products should be carefully monitored to prevent expiration, contamination or damage. Material handling of component, equipment and products should be done in suitable method to avoid damage. The amount of waste also can be diminished by using efficient packaging materials from sustainable suppliers. (Carlsberg 2013.)

In addition, warehouse employees need attempt to reuse used materials in a creative way. For example: using the reverse side of office papers again, or using a good package to wrap new products. There is also another way to recycle wastes by using usable components with other purposes in industry. Furthermore, generating bioenergy from wastes could be an innovative solution for waste management. (Carlsberg 2013.)

Finally, if none of above method applicable, disposing wastes will be the last choice with the least level of efficiency. Waste disposal in an appropriate manner requires professionals and expensive investment in resources. This task usually is conducted by third-party, the waste processing firms. (Carlsberg 2013.)

2.5 Future directions of green warehousing

Nowadays, there has been countless examples of sustainability business practices around the world, also in green warehousing implementation. It is likely that most of the sustainable initiatives usually focus on present resources but refrain from future proposals to further sustainable prospects. Enterprises can look to future and plan for the forthcoming outlook of sustainability.

This section will discuss two of most promising methods of future green warehouse: energy self-production and sustainable building design.

2.5.1 Green energy generation

A modern sustainable warehouse in future can self-produce partial or nearly full energy needed by using renewable energy sources. This is considered to be a perfect approach to cut off emissions and greenhouse gas as well as save energy costs. Several most modern, clean sources of energy are solar, biomass, and the wind. (Richards & Riding 2015, 367.)

However, due to the extensive capital investment required, self-production of energy in warehouse nowadays is just an exceedingly environmental-friendly method but not a cost-efficient approach yet. Therefore, choosing an affordable way to self-produce energy is a daunting task for sustainability managers. Solar panels are a very expensive investment and usually requires about 15-20 years of payback. Nevertheless, electricity wind turbines have much fewer prices, and their return on investment are generally within five years. In any case, sustainability investment requires a large fund from companies before managements make a green decision. (Baker & Marchant 2015, 213.)

The investment of energy self-production is realistic if governments concern sufficiently and provide necessary incentives as well as enforce compulsory regulations. For example, many local governments in the UK require some local businesses to produce themselves at least 10% of energy consumed from clean sources of energy. Apparently, authority power plays a vital role in green energy generation. (Richards & Riding 2015, 367.)

2.5.2 Sustainable warehouse design

The highest level of warehouse sustainability is eco-friendly designs into buildings. Undoubtedly, the sustainability of warehouse can be most effective managed if initially the building has been designed and established ecologically.

Baker and Marchant (2015, 218-220) mentioned a number of green practices through examples of several green warehouses around the world; these sustainable designs are represented in Table 5.

Table 5. Sustainable ideas for warehouse designs (Baker & Marchant 2015, 218-220.)

Eco-Design practices	Examples of building applied the design
▪ Increasing the airtightness in the buildings to reduce heat loss. ▪ Establishing kinetic plates in the gateway to recover energy when vehicles arrive and leave the warehouse. ▪ Using biomass energy to supply for lighting and heating purpose. ▪ Recovering and managing rainwater by an innovative roof design	Gazeley Logistics Properties, Newcastle-under-Lyme, UK.
▪ Equipping with six industrial-scale wind turbines and 4,000 solar panels, producing sufficient energy for yearly need. ▪ Using sleep mode conveyor system, solar hot water, high-efficiency lights.	Nike Logistics Centre in Shanghai, China. Nike European Distribution Centre in Laakdal, Belgium (see figure 9)
▪ Building the warehouse under 2.5 meter into the ground. Insulation and ground temperature effect helps maintain sufficient temperature without any heating/cooling systems ▪ Installing photovoltaic panels to generate energy	AS/RS facility for Alnatura in Lorsch, Germany.

The thesis author has chosen some illustrations for sustainable designs in the warehouse. One of the good examples is that Nike European Distribution Centre (figure 9) located in Laakdal, Belgium has established an ecological logistics campus for European supply chain. In addition to thousands of solar panels, six wind turbines have a generation capacity of 9 MW. These premises are built with sustainable designs that help to increase energy efficiency and reduce carbon emissions. (Nike.com 2015)

Figure 9. Nike's European Distribution Centre in Laakdal, Belgium (Nike.com)

Figure 10. Amazon's mega fulfilment centre at Peterborough, UK (White, A. 2014).

In addition, figure 10 is a picture which was captured in a giant fulfilment and distribution centre of Amazon UK in Peterborough, England. The building has been established by thousands of skylights to reduce electricity consumption in lighting systems. Furthermore, the distribution centre is operating 24/7, and the conveyor systems are equipped with automatic sensors and highly energy efficiency operators. (White, A. 2014.)

2.6 Summary of the theoretical framework

The theoretical framework presented relevant theory and literature that served the research purposes. The chapter started with definitions of large concepts in green supply chain management which was defined as the integration of environmental management and supply chain management (Klassen & Johnson 2004). Three main benefits of sustainable supply chain management have been discussed, including law and regulations compliance, cost-savings and efficiency, and green reputation (Emmett & Sood 2010).

In addition, the topic was demarcated to the green warehouse that is the main focus of this study. The researcher illustrated three stages towards sustainability of the warehouse: energy efficient, low emission and green energy warehouse, and sustainable warehouse. In the most advanced stage, the genuinely sustainable warehouse is emission-free and able to self-produce sufficiently energy it consumes from renewable sources. (Baker and Marchant 2015, 201.)

One of the focus of theoretical framework is energy efficiency in the warehouse. The thesis author reviewed from high-quality literature to research advanced models and techniques in energy efficiency. This section examined the systems of lighting, heating and mechanical handling equipment in the warehouse with various initiatives to enhance efficiency in energy consumption. (Huston 2013; Baker and Marchant 2015, 203-211; Toyota 2009, & Richards & Riding 2015, 373.)

Furthermore, the thesis writer continued to discuss effective management of waste in the warehouse. The various types of wastes were summarized in table 4 with detail characteristics and examples. Subsequently, a hierarchical waste management process was illustrated in figure 8, where to reduce, reuse and recycle are priorities whereas disposal is the last option. (Carlsberg 2013; Redox 2005, 1-3.)

Regarding the future model of the sustainable warehouse, the last sections of theoretical framework discussed the possibility of self-production energy in modern warehouses from renewable sources (typically solar and wind power). The theory chapter concluded by

presentations of sustainable designs in several excellently ecological warehouses across the world. (Baker & Marchant 2015, 213-220; Richards & Riding 2015, 367.)

To sum up, the theoretical framework has reviewed properly necessary literature for the intended purposes of the research.

3 Research Methods

This chapter intends to indicate the methodology used to conduct this study. The qualitative research method and interview framework are presented in the following sections.

3.1 Qualitative research

Qualitative research has been the primary approach in this study. The reason thesis author has chosen qualitative method because the study needed to understand insight strategies of the sustainability of the case company. Qualitative research could provide a detailed description of the current situation of green warehousing practices at IKEA Finland. (Cooper & Schindler 2013, 144-148.)

The researcher aimed to understand the sustainability practices at IKEA's warehouses and to interpret the findings according to the theoretical framework. By conducting several interviews with IKEA's personnel, thesis author could evaluate in-depth and details the sustainable implementations, from which would suggest developing proposals. Moreover, this study needed to obtain information and data from a small size of reliable informant group. The interviewees were required to have deep understandings about targeted phenomenon. The smaller size of the sample also made the data collection process faster but deeper for the researcher. In short, qualitative research was the most appropriate method for this study. (Cooper & Schindler 2013, 147.)

On the other hand, the thesis author argued that quantitative method was not a suitable method to conduct and serve the purposes of this study. The research of the sustainability strategy in IKEA's warehouse was not measurable and cannot be quantified. The research did not require information from a large size of the sample. The targets of the research were sustainable strategies and practices in contextual information rather than numerical data. After data collection, research findings did not require any statistical or mathematical methods to analyse. Therefore, quantitative empirical research was not an applicable approach in this thesis. (Burns & Bush 2010; Cooper & Schindler 2013, 147.)

The research plan has been carefully designed with three phases (P1, P2, and P3) of desktop study, data collection, data analysis and recommendations (Figure 11). This empirical method enabled thesis author to have a clear direction of research and to produce a higher quality of research outcome. Furthermore, this research design ensured an easily understandable capability from the readers so that another person could conduct research with similar methods and conditions and provide constant results compared to the original research (Cooper & Schindler 2013, 260).

The details of empirical research method in this study have been visualized in Figure 11.

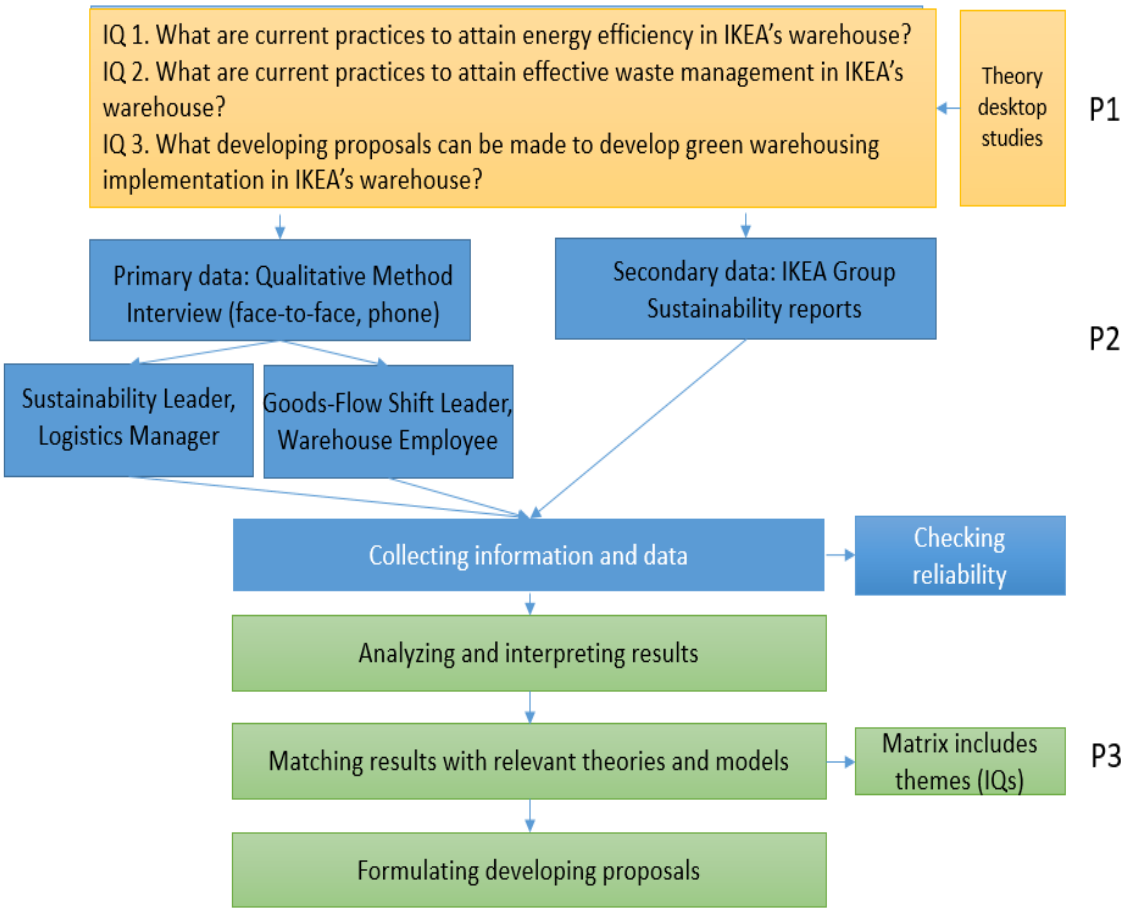

Figure 11. Research method

Phase 1 (P1) – **Desktop study**: Before any data collection process, the relevant theory has been studied in-depth. The theoretical literature has come from a big picture of sustainability in supply chain management, then the emphasis on methods and strategies of green warehouse practices. The theory framework has been up-to-date with the most recent advanced methods and techniques in the sustainability field.

Phase 2 (P2) – **Data collection**: Data has been obtained from both sources of primary and secondary information. Qualitative research has been conducted to acquire primary data. There were four interviews with the IKEA's sustainability leader, logistics managers, goods-flow shift leader and a warehouse employee. The interview questions were derived directly from interview framework (see next section). The qualitative method has been implemented with a high level of research ethics, validity, and reliability.

Phase 3 (P3): **Data analysis and recommendations**: All relevant information and data have been analyzed and interpreted. The research findings were summarized in a matrix table to match with theory literature which had been theorized in advance. Subsequently, the thesis author has created developing proposals for the case company.

3.2 Interviews as qualitative research methodology

The thesis author used interviews as the primary technique to obtain data in the qualitative research. Four interviewees were currently working in IKEA with different positions from the management level to a warehouse worker. This approach helped the researcher to evaluate the level of communication about sustainability within IKEA and to determine whether the sustainable strategy has been well communicated across the hierarchical structure in the company. (Cooper & Schindler 2013, 152-156.)

During the data collection process, the researcher was aware of responsibilities of an interviewer. Before the interviews, the thesis author had to consult relevant information from literature and establish well-structured interview frameworks. The qualitative interview frameworks were directly derived from the theoretical framework which has been reviewed in the previous chapter. The interview framework covered every aspect mentioned in investigative questions (IQs), this approach enabled a straightforward, categorized and theory-supported analysis in the later stage of the research. (Cooper & Schindler 2013, 153.)

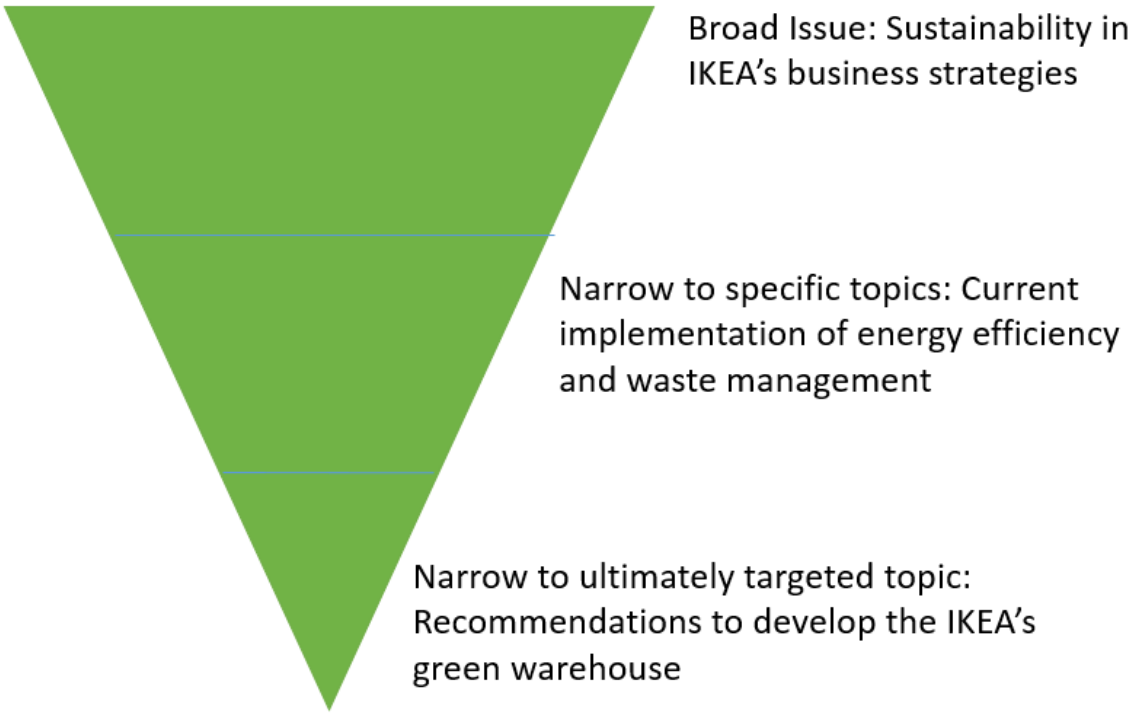

Figure 12. The interview question hierarchy (Adapted from Cooper & Schindler 2013, 154)

As illustrated in figure 12, the interview frameworks have been designed hierarchically. The interview frameworks consist of thematic categories, main and additional questions. The interviews started with a broad issue of how sustainability has been important to IKEA's business strategies. This introduction put interviewees at ease and gave them understanding that they actually had a great contribution to the research process. Subsequently, the interview topics were more specific to targeted goals of the interviewer (current green practices and interviewees' opinions of future developments). During the interviews, the interviewer attempted to make comfortable environments with the respondents. The researcher has also led the discussion, recommended topics and questions as well as controlled the content and speed of the interviews. (Cooper & Schindler 2013, 153-155.)

There are differences in what kinds of questions used during the interviews with different respondents (see detail questions in appendices 1, 2 and 3). With the management level (Sustainability Leader and Logistics Manager), the thesis author focused more on IKEA's warehouse sustainability strategies and management issue (planning, guideline, monitoring). On the other hand, the questions with the Goods-Flow Shift Leader and the warehouse employee referred more about the actual implementation of the green warehouse. This question designs enables the suitability with understanding and actual roles of interviewees in the case company, from which the thesis author could obtain more accurate information and data. (Cooper & Schindler 2013, 153-155.)

More importantly, all the interviewees understood well the questions and were encouraged to talk openly with the interviewer. The data was acquired by both face-to-face and phone interviews. The actual time of interviews ranged from 20 – 35 minutes. Furthermore, the selection of interviewees has been made carefully. At the management level, IKEA's Sustainability Leader and Logistics Manager have been in charge persons who have had responsibilities of sustainability of IKEA's warehouse. Two of these respondents also have been taking part in daily warehouse activities and had a deep understanding or desirable phenomenon. At the middle management level and staff, the Goods-Flow Shift Leader and the warehouse employee have been personnel to implement green warehousing practices. They understood clearly how sustainable practices has been implementing at IKEA's warehouses. Finally, the length of experience of interviewees is considerable; for example, the experience of working in IKEA of the Sustainability Leader is eight years, and the Goods-Flow Shift Leader is four years. (Cooper & Schindler 2013, 155-156; IKEA's Sustainability Leader, Logistics Manager 8 April 2016; Goods-Flow Shift Leader 12 April 2016 & Warehouse employee 11 April 2016).

There was only an obstacle with the position of the interviewer as an external person. The interviewees could not provide information on specific financial savings gained from sustainable implementations to the interviewer (IKEA's Sustainability Leader 8 April 2016).

(See the details of interview frameworks with the IKEA's Sustainability Leader, Logistics Manager, Goods-Flow Shift Leader and a warehouse employee in appendices 1, 2 and 3).

3.3 Reliability and validity of the research

Cooper and Schindler (2013, 257) stated that reliability and validity are two important characteristics of a credible study. Firstly, the reliability of the research means that if another person replicates the research with similar methods, samples, and conditions, the results will be consistent (Burns & Bush 2010). In addition, validity means that the research outcome accurately represents what the research intended to measure (Cooper & Schindler 2013, 257). During this study, the thesis author has emphasized on a high level of reliability and validity of the research; therefore, these requirements are satisfied.

About data collection process, the researcher has collected information in a comprehensive and accurate method. With attention to primary data, the thesis writer has interviewed four people, who were IKEA's personnel and very familiar with the topic (warehouse responsibility). The questions used in these interviews were derived from investigative questions and literature review. The interviews focused on the main content of matter and necessary information to understand insight data of green warehousing implementations at IKEA Finland. The informants were honest and reliable to provide the most accurate information. In addition, the secondary information was obtained from the internet-published version of IKEA Global Group Sustainability Report 2015 with correct references from the pdf document. Therefore, the contents of the interviews sufficiently represent the universe of relevant, desirable targeted topics, which means the study has content validity (Cooper & Schindler 2013, 257). Moreover, the thesis author has recognized the high similarity among the answers of different interviewees on the same phenomenon. In other words, this proved that the research has obtained internal consistency in reliability aspect. (Cooper & Schindler 2013, 261.)

Regarding the data analysis and interpretation, all information were recorded and analyzed carefully and correctly without bias. The results have been compared and matched with the theoretical framework to evaluate the current practices of the green warehouse at IKEA Finland. The theories and models have been well studied from the high-quality literature of green logistics and supply chain management. The comparison

was conducted in precise and careful manner. Finally, the developing proposals were formulated based on current level of the green warehouse at the case company and the future model of a sustainable warehouse. Every suggestion were constructive and realistic. In brief, the intended purposes of the study have been accomplished, or the research had internal validity (Cooper & Schindler 2013, 257).

To conclude, with a high level of research skills and ethic during the thesis process, the reliability and validity of this study have been achieved, and the research outcome is trustworthy for other future research.

4 Findings and discussion

This chapter aims to represent the research results followed by discussion from the thesis author. The research process has been conducted successfully according to the research method design. All investigative questions are answered comprehensively, and the thesis author is able to create developing proposals for case company.

The research results will be organized in two level of analysis to answer three stated investigative questions. The first level of analysis, the thesis author merely represents key findings from the research process with some degree of discussion. Moreover, in the second level analysis, these results will be compared with the most up-to-date literature which has been theorized in the theoretical framework in order to evaluate the case company implementation with most current advanced practices at present.

4.1 Current practices of green warehouse implementation

In general, sustainability plays a critical role in the IKEA's business strategy. The company has been actively investing in sustainable business operations and renewable energy. IKEA's commitment is to use scientific and technological innovations to transform from a low-carbon enterprise to a completely sustainable business with emission-free desires.

During the interview with IKEA's personnel, at the management level, both Logistics Manager and Sustainability Leader stated that sustainability had always been one of most focused areas in the company's business operation. The Logistics Manager indicated the ultimate ambitions of IKEA to create better lives for human in the world with a green planet. The sustainability of IKEA also helps to preserve ecosystems and tackle with climate change as well as limited exhausting natural resources. (Logistics Manager, Sustainability Leader 8 April 2016.)

Furthermore, being sustainable is a perfect way to reduce operational costs and increase profits. In fact, 133 million EUR has been saved from energy efficiency program within IKEA global operations since 2010 (IKEA Group Sustainability Report 2015, 39). In addition, one of most significant successes that makes IKEA proud of its green strategy is getting customers involved in sustainable practices when purchasing and using IKEA's products with sustainable design and functionality. Apparently, a sustainable company will gain preferences from customers, and at affordable price levels, customers also can possess sustainable products and take part in the war to combat climate change. This is a win-win situation for both IKEA and its customers, according to the Sustainability Leader (8 April 2016). In addition, all four interviewees expressed the great satisfactions to have

careers with a company which actively participates in environmental protection and sustainability.

Overall, the thesis author can recognize the importance of sustainable business strategy and efforts from IKEA to drive its business towards sustainability. In the following sections, the researcher examines the green warehouse practices at IKEA Finland as the scope of this thesis.

At the IKEA's stores in Finland, green operations and green warehousing activities gain particular attentions from management levels. Every employee in the company is aware of the importance of green operation in business strategy. Because of the distinctive nature of business models in IKEA's operations, warehouses are not only premises for storing products, receiving incoming shipments but also a shopping site for the customers. Therefore, green warehouse implementations at IKEA's warehouses are mainly designed to match their particular functionality. In the following sup-chapters, the implementation of energy efficiency and waste management at IKEA's warehouses in Finland will be described and discussed as a result of the research process.

4.1.1 Energy efficiency

Investigative question 1: **What are current practices to attain energy efficiency in IKEA's warehouse?**

Energy efficiency is one of the most important features of green warehousing implementation at IKEA Finland. Saving energy by installing high-efficiency equipment at stores and using renewable energy by purchasing green energy or self-producing energy from natural sources are mainly strategic approaches of the company towards efficient energy consumption. First of all, research findings of current practices of energy efficiency are presented as follows:

Given heating systems, in Finland IKEA's stores are heated by water which circulates the buildings, which is a great green initiative to save energy. The warehouses and buildings are usually segregated by different zones based on different functions. Each zone has own temperature level to be suitable for activities carried out in the zone. Particularly, the warehouse at IKEA stores is a shopping place for customers. Therefore, the temperature in warehouses is maintained accordingly to customers' point of view in order to ensure customers to have a pleasant atmosphere to shop in the stores. Lastly, energy-efficiency ventilation systems help to maintain fresh air changes internal warehouses and save elec-

tricity consumption by nearly 25% in average statistical data (IKEA Group Sustainability Report 2015, 39).

With attention to lighting systems, nowadays LED lights have been fully installed at every area of the stores in Finland. The lighting level is maintained at appropriate standards which depend on the degree of natural light among weathers and functions of illuminated areas. Moreover, the company has been equipped automatic sensor controllers for lighting systems under buildings, which enables the lights to be turned on only when necessary. These practices certainly are a sustainable manner to increase energy efficiency in IKEA's warehouses. As a result, one of the noticeable examples is that IKEA Vantaa Finland has gradually reduced its energy consumption by 5.5% and simultaneously saved 20,000 EUR in the fiscal year 2015 (IKEA Group Sustainability Report 2015, 39). Another aspect of the green warehouse is that mechanical handling equipment at the stores is powered fully by electricity and generate no emissions. This enables to reduce the carbon footprint of the company from exhausted energy usage and improve internal air quality within the warehouses. (IKEA's Logistics Manager 8 April 2016.)

Implementation of the green warehouse is most effective only when these practices come along with a systematic measurement approach. At IKEA, there is a holistic method to measure and audit the energy efficiency. At the country level, sustainable managers collect data of energy consumption from local stores and report the global managers during the fiscal year. This data will be deployed as a measurement scale of energy efficiency implementation in the company, from which set realistic targets for next year as well as continuously improve green energy practices. (IKEA's Sustainability Leader 8 April 2016.)

Significantly, IKEA has been conducting significant initiatives and actions to produce green energy for its operations. The company's target by 2020 will be able to produce as much as the energy it consumes for whole store chains, industries, and distribution centers in global. Particularly in Finland's market, the company plans to put a wild farm with wild-turbines in usage from 2017 to supply electricity for IKEA's operations. (IKEA's Sustainability Leader 8 April 2016.)

In the second level analysis, the thesis author will match research findings with the theoretical framework to assess the case company's practices (Table 6).

Table 6. IKEA's energy efficiency implementation with relevant theory framework.

IKEA's energy efficiency practices	Explaining and supporting results by matching with relevant theories	Theoretical framework and references
Heating systems by water with appropriate temperatures. The warehouse is segregated with different zones and different temperature. Energy-efficient ventilation systems	Saving energy and electricity. Reducing energy consumption in zones requiring a lower temperature. Facilitate air changes and save energy of heating systems.	*Chapter 2.3.1* Huston 2013. Baker & Marchant 2015, 203. Carbon Trust 2002.
Installing fully LED light systems in every store. Equipping automatic sensor controllers for lighting systems.	Saving energy and longer product life-cycle. Lights on only when needed	*Chapter 2.3.2* Carbon Trust 2007. Huggins 2014. Richards & Riding 2015, 362.
Mechanical handling equipment is powered fully by electricity	Reduce carbon footprint and improve internal air quality.	*Chapter 2.3.3* Richards & Riding 2015, 373.
A holistic approach to measure and audit energy efficiency.	Measurement for coming year targets and continuous improvement	*Chapter 2.3.4* Baker & Marchant 2015, 211.
Self-production of green energy (Wild-turbine farm in Kemi)	Reducing costs of energy, using renewable energy sources, reduce CO_2 emissions. Less dependent on energy prices	*Chapter 2.5.1* Richards & Riding 2015, 367. Baker & Marchant 2015, 213.

With illustration of table 6, most of the energy efficiency practices of IKEA at present are well supported by updated relevant theories and models which thesis author discussed in Theoretical Framework (Chapter 2). This demonstrates that IKEA's energy efficiency implementation in the warehouse is proficient with many applications of modern and advanced techniques as well as strategies. There is the only aspect of sustainable building design (chapter 2.5.2) has not been mentioned in IKEA's energy strategy, which could be a great element for developing proposals.

In summary, the current practices to attain energy efficiency at IKEA's warehouse are well-done and successful. The company possesses a holistic approach to enhance the level of efficiency in energy consumption. The implementation tackles with nearly every aspect of energy efficiency with the most up-to-date technologies and innovations. Energy efficiency at IKEA's warehouses contributes significantly to the company's success in green operations.

4.1.2 Waste management

Investigative question 2: **What are current practices to attain effective waste management in IKEA's warehouse?**

At IKEA's warehouse, waste has always been managed in the most ecological methods possible. While at global data, 88.9% of waste were recycled or energy recovered in the fiscal year 2015, this figure of IKEA's Espoo store in Finland was notably nearly 100% in the same period (IKEA Group Sustainability Report 2015, 36; IKEA's Sustainability Leader 8 April 2016).

In the first-level analysis, regard of typical waste from daily business activities, the company attempts to reduce these wastes by using less packaging but more recyclable papers, packages, and pallets. Moreover, all incoming materials and waste are separated in a proper manner such as wooden, plastic or cardboard. The priority for waste management process always aims to reuse, recycle or energy recover as much as possible. Disposal waste must be the last choice when no other alternatives applicable. (IKEA's Sustainability Leader 8 April 2016.)

On the other hand, atypical wastes which are generated by irregular basis or damage will be processed by recovery unit. The recovery unit will repackage damaged products or boxes, or reuse every usable component in damaged products as spare materials to repair other items in future. This program also identifies and deals with the main reasons for product damage to avoid future losses in the warehouse. In the fiscal year 2015, IKEA

global operation has reduced 4.2% of damaged products pre-sale. (IKEA Group Sustainability Report 2015, 46.)

While waste management process at IKEA's warehouse is implemented effectively, there is an existing limitation. The product ranges of IKEA's store are usually massive; therefore, the number of waste types generated from a warehouse is vast. IKEA can separate wastes better with more different kinds of waste for easier recycling. However, the third-party waste management companies, who are in charge of collecting and recycling wastes from warehouses, offer limited choices of waste types including paper, plastic, metal and wooden. There are also other kinds of waste, for example, glass, which is put all together as mixed waste before being recycled. (IKEA's Sustainability Leader 8 April 2016.)

The suggestions for IKEA's waste management process are using more recycling packages and cardboard pallets, reducing damaged products by increasing material handling care with items, contacting with new alternative third-party partners to facilitate waste separation and process. Furthermore, IKEA might need to come up with more creative initiatives to manage waste efficiently (See detail the developing proposal 2 of using biomass to generate energy in chapter 4.3.2).

The next stage is to compare IKEA's current practices of waste management with advanced theories as second-level analysis to assess the company's implementation (Table 7).

Table 7. IKEA's waste management process with relevant theory framework

IKEA's waste management practices	Explaining and supporting results by matching with relevant theories	Theoretical framework and references
Waste separation	Easier recycling process	*Chapter 2.4.1* Redox 2005, 1-3.
Reducing daily activity wastes Recycling, reusing waste as much as possible Disposing waste is the last choice	Minimizing amount of waste Waste management hierarchy	*Chapter 2.4.2* Carlsberg 2013
Repackage damaged products Reuse every usable component	Increasing recycling ability of waste management process.	*Chapter 2.4.2* Carlsberg 2013
Identify and deal with the root of product damage	Avoid future losses, damage and reduce the amount of waste.	Carlsberg 2013

As can be seen from table 7, most of the aspects of IKEA's waste management process are matched with relevant theories from Theoretical Framework (chapter 2). This proves the excellence and effectiveness of the IKEA's waste management approach. The company has successfully used a very well-structured method to manage warehouse wastes and these practices comply with most advanced techniques of waste management at present as what theoretical framework has shown.

To sum up, IKEA has effectively managed wastes in a sustainable manner. There is only an existing limitation resulting from third-party, which can be an aspect of recommendation to resolve this shortcoming for the case company.

4.1.3 Green warehouse under internal communication

There is always a difference in understanding business strategies from top management levels to middle-management personnel and employees. With the commissioning company IKEA, a question is how effectively green warehousing strategies are communicated throughout the workforce. To examine, the thesis author has obtained information of IKEA's sustainability from four interviewees who have different positions in the hierarchical

organization. This approach enables the researcher to assess how well sustainability at IKEA is communicated within the company (Figure 13).

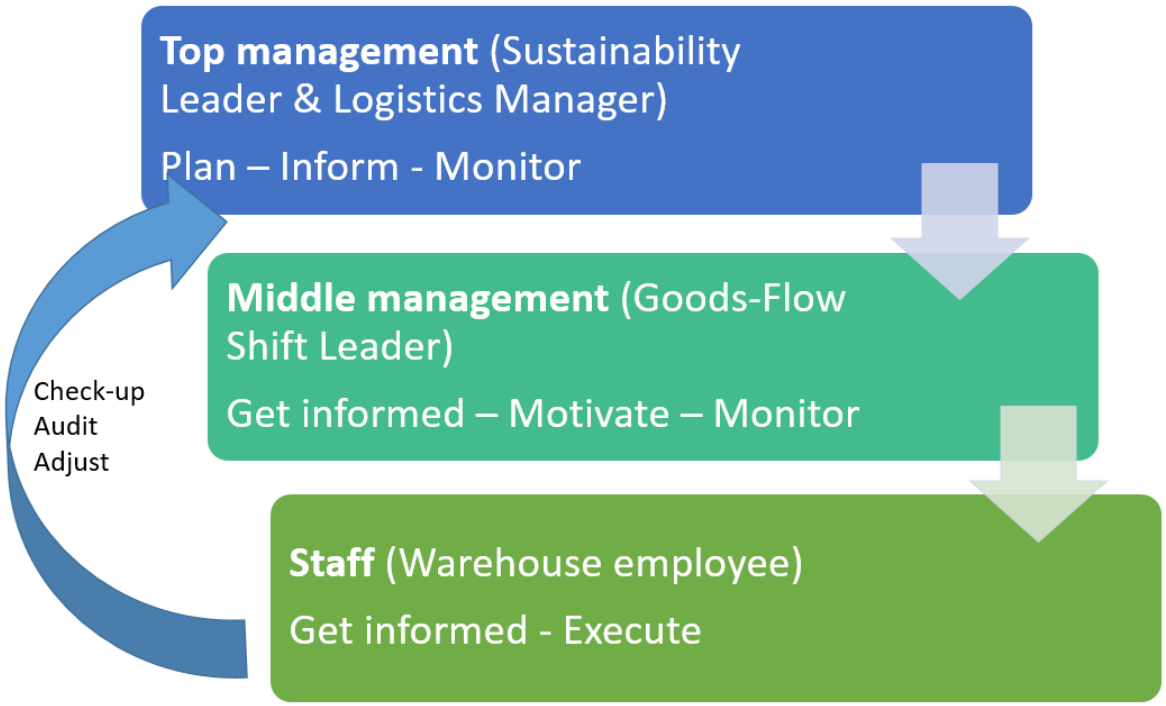

Figure 13. Internal communication and implementation of IKEA's green warehouse (Thesis author's own illustration).

At the top management level, IKEA's Sustainability Leader and Logistics Manager (8 April 2016) attempt to implement green warehouse in IKEA's stores by planning sustainable strategies according to IKEA Group Strategy, informing to warehouse employees and monitoring the sustainable warehousing executives. The Sustainability Leader also aims to communicate with staff the importance of working in a sustainable company. In addition to internal communication, the Sustainability Leader and Logistics Manager continuously check-up, monitor and adjust necessary changes in green implementation at IKEA's warehouses. (IKEA's Sustainability Leader and Logistics Manager 8 April 2016.)

At the middle management level, the IKEA's Good-Flow Shift Leader (12 April 2016) pointed out the necessaries of training and following-ups with new and current employees about the warehouse sustainability. The Good-Flow Shift Leader has always motivated his team members to comply with green practices such as waste management, recycling materials or energy efficiency during work shifts. (IKEA's Good-Flow Shift Leader 12 April 2016.)

As a typical logistics worker, the IKEA's warehouse employee (11 April 2016) said that he had an exquisite understanding of IKEA's warehouse sustainability. The company intends to inform sustainable strategies to employees by various methods: posters and leaflets, television videos of sustainability at cafeterias, motivation, and explanation during regular work shifts. There are also available guidelines of waste management and energy efficiency for employees who need to acquire further information. More importantly, the warehouse employee has actively complied with sustainable practices at the warehouse, and he proudly got employed by an environmentally-friendly company. (IKEA's warehouse employee 11 April 2016.)

In short, sustainability strategy at the warehouse has been highly effectively communicated within the organization. At every different position levels, IKEA's personnel has a good understanding of sustainability roles and hold significant responsibilities to execute these practices. Implementing an effective sustainability strategy requires increasing level of collaboration among companies' members and effective communication is a must, this has been well performed at IKEA Finland.

4.2 IKEA's green warehouse in three stages towards sustainability

This sub-chapters will place IKEA's current green warehouse implementation into a framework of three stages towards sustainability (Chapter 2.2 Green warehousing) indicated by Baker and Marchant (2015, 201). In an evaluation, the research results show that IKEA has been excellent in the first stage, conducting significant efforts in the second stage but enormous tasks required to reach the highest stage (Figure 14).

At the first stage of the green warehouse, IKEA is undoubtedly world-class in energy efficiency. The company has implemented various methods to save, maintain, control and audit energy as well as manage wastes. The company has gradually been moving to the second stage of a low emission and green energy warehouse. IKEA has actively attempted to reduce CO2 emissions and had initiatives to generate energy from clean, renewable sources in very near future. This on-going development is substantially positive attribution to the IKEA's sustainability success. (Baker & Marchant 2015, 201.)

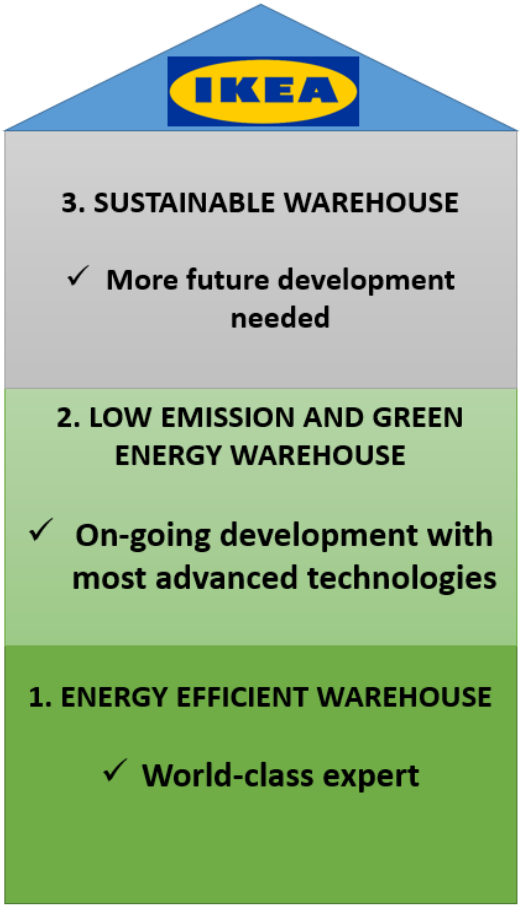

Figure 14. IKEA's green warehouse in the framework of three stages towards sustainability (Adapted from Baker & Marchant 2015, 201 and applied to IKEA's case).

In the most advanced stage, a sustainable warehouse is the future model of sustainability in warehousing logistics field. This revolutionary model requires the warehouse to produce and supply total amount of needed energy by itself, exceeding environmental standards and most important, having completely sustainable designs into warehouse buildings. It is still a long-term development with tremendous efforts required before IKEA can proceed to transform its warehouse to a modern truly sustainable warehouse. In the next part, the developing proposals by the thesis author are presented to help IKEA proceed to the most advanced stage of the green warehouse. (Baker & Marchant 2015, 201).

4.3 Developing proposals

In this sub-chapter, the thesis author points out developing proposals to facilitate the green warehouse at IKEA Finland. These proposals are valuable for IKEA's warehouse sustainability in further developments.

Investigative Question 3: **What developing proposals can be made to develop green warehousing implementation in IKEA's warehouse?**

4.3.1 Developing proposal 1: Establishing a system of Key Performance Indicators in energy efficiency and waste management at the store level

The IKEA Group Sustainability Report (2015, 36-51) provides various numbers and figures of target indicators and performance data of IKEA's sustainability in the worldwide scale. Those data are collected from all stores and distribution centres across the world before being reported in the global report. At the store level, however, the IKEA's warehouses still lack independent Key Performance Indicators (KPIs), specifically in energy efficiency and waste management (IKEA's Sustainability Leader 8 April 2016). In this developing proposal, the researcher establishes a KPIs' system at the IKEA store level in term of energy efficiency and waste management.

Hrebicek (2008) defined Key Performance Indicators (KPIs) as quantifiable metrics that help to measure enterprises' performances in achieving their objectives and goals. A company cannot improve something that is not measured. Every company needs feedbacks for continuous improvements. KPIs play a role of feedbacks in organization systems. In the particular case of IKEA's warehouse sustainability, a system of KPIs in energy efficiency and waste management is very necessary to measure, monitor and develop these green practices. Based on KPIs, the management levels understand the current situation of green practices at the store level and create appropriate development plans with realistic future targets. (Chae 2009.) The question is that: How can IKEA's stores select a set of effective KPIs in energy efficiency and waste management?

Wrong (2011) argued that choosing right KPIs is the key to the success. There is an enormous number of KPIs that can be applied in business's sustainability. An effective selection of KPIs must be the most important measurements that the managers desire to get insights. Moreover, KPIs need to be measurable, unambiguous, and these metrics should connect with core business strategies of organizations. This enhances creditability of KPIs with and managers and facilitates continuous development in the future (Wrong 2011.) Furthermore, the recommendations of selecting Environmental Performance Indi-

cators by European Commission (2003, 10-11) suggested that a good set of KPIs in sustainability allowed straightforward comparison. The KPIs should be compared among years to evaluate improvements in companies' sustainability over a period. The metrics also enable comparisons with other firms in same industries, national and regional levels. (European Commission 2003, 10-11.)

According to Chae (2009), the establishment of KPIs has a principle: "The less is better". The companies are recommended to focus on a few very key metrics with two hierarchical layers of KPIs: primary and secondary. The primary KPIs are several most important metrics that have the most effects the companies' performances and these KPIs are regularly monitored by managers. Meanwhile, the secondary KPIs are potential indicators which explain reasons why primary metrics are low or high. (Chae 2009.)

In addition, a study conducted by the Erasmus University of Rotterdam and Shareholder Support Group in 2012 suggests that the investors are likely to pay more attention to sustainability KPIs that especially are related to increases in the company's profits and cost savings (Mertens, Maas, Strootman & Meliefste 2012, 40-41). In particular, within the environmental KPIs category, several indicators such as reductions in greenhouse emissions, savings on energy due to efficiency improvements, the total weight of waste and disposal methods and percentages of materials recycled are most popular and important KPIs for businesses (Mertens, Maas, Strootman & Meliefste 2012, 21).

With above mentioned justifications and extensive references of Sustainability Reporting Guidelines from Global Reporting Initiative (2015, 52-63), the thesis writer formulates a system of KPIs including primary and secondary metrics for IKEA's store energy efficiency and waste management. The researcher chooses only a few most important indicators because it is recommended for IKEA to focus on essential KPIs at the store level before any other less important measurements (Table 8).

Table 8. A system of Key Performance Indicators of energy efficiency and waste management at IKEA's stores (Adapted from Global Reporting Initiative 2015, 52-63).

	Primary metrics	Secondary metrics
Energy efficiency	Reduction of energy consumption. Reductions in energy requirements of products and services.	Energy consumption within the organization. Energy Intensity.
Waste management	Total weight of waste by type and disposal method. Percentage of materials used that are recycled input materials.	Materials used by weight or volume.

(See Appendixes 4 and 5 for detail explanations of these KPIs from Sustainability Reporting Guidelines of Global Reporting Initiative).

The thesis writer recommends IKEA at the store level to have six KPIs in energy efficiency and waste management (Table 8). In most priority, the primary KPIs reflect the direct benefits of implementation of green practices at the warehouses. In actual practice, if the stores' manager can estimate equivalent with a specific amount of money saved, these KPIs are highly valuable for investors (Mertens, Maas, Strootman & Meliefste 2012, 40-41). In addition, the secondary KPIs are less important but still need to measure accurately to support explanations of the increase/decrease of primary KPIs (Chae 2009).

To sum up, emphasis on the several most essential key performance indicators of energy efficiency and waste management helps IKEA to measure, monitor and develop its green implementation. Even though the thesis author has been suggested these KPIs, the metric system at the IKEA's store should be considered by a group of key people, not an individual (Wrong 2011).

4.3.2 Developing proposal 2: Using biomass to produce renewable energy at IKEA's stores

The IKEA's Group Sustainability Report indicated that the company set an ambitious goal to produce 100% renewable energy to supply sufficiently entire IKEA's global operations by 2020 (IKEA's Group Sustainability Report 2015, 36). Regarding solar energy, the IKEA's Logistics Manager (8 April 2016) argued that because of a low number of sunlight

hours yearly, using solar panels in Finland is cost effective. Instead, the company decided to establish a wild farm in Kemi to produce electricity from wind turbines. Due to the scope of this study and the fact that IKEA has already researched on the potential of solar energy and invested in wild power, this thesis will not discuss further these clean sources of energy.

In this developing proposal, the researcher discusses an innovative approach to generating energy from biomass at IKEA's stores. In short, biomass is defined as biological materials such as wooden, agricultural wastes, energy crops and manure (Veringa 2009, 4-5).

The IKEA's Group Sustainability Report (2015, 46) estimated that IKEA's industry in the fiscal year 2015 has been generated approximately 1,054,968 tonnes of wooden wastes and also a large amount of bio-waste from IKEA's kitchen (not specified in the report). Nevertheless, there is no evidence (mentioned in the IKEA's Group Sustainability Report 2015) shows that IKEA has planned to implement bio-energy production. The thesis author justifiably claims that IKEA has a considerable potential to use biomass to produce energy. In the following sections, the researcher examines the applicable methods and techniques of using biomass to generate energy and suggests the most appropriate approach to applying at IKEA's stores. The table 9 below represents main definitions of several most popular methods to generate energy from biomass.

Table 9. The popular methods to generate energy from biomass(U.S. Department of Energy 2011).

	Brief definitions
Combustion	The most popular process that combusted biomass into other usable sources of energy.
Pyrolysis	Biomass is heated rapidly without oxygen.
Gasification	Biomass is heated in a controlled amount of oxygen to produce synthesis gas.
Anaerobic digestion	In the absence of oxygen, biomass is decomposed by bacteria.

Although combustion is the easiest method to process dry biomass such as wooden wastes, this process generates CO_2 emission. The efficiency of this approach is around 20%, which is relatively lower than other methods. The main reason for this inefficiency is

that a significant amount of heat is lost during burning process. The efficiency of this method can increase by using a combined heat and power system to reduce heat loss (efficiency up to 80%). (U.S. Department of Energy 2011.)

Regarding pyrolysis process, water, charcoal, oil, hydrogen, CH_4, CO, and CO_2 are products of this method. The main end-products of pyrolysis process is charcoal which is not suitable to produce electricity because of inefficiency and carbon emissions. (Painter, S.) In the next method, figure 15 illustrates a typical process of gasification created by Alter NRG Corporation.

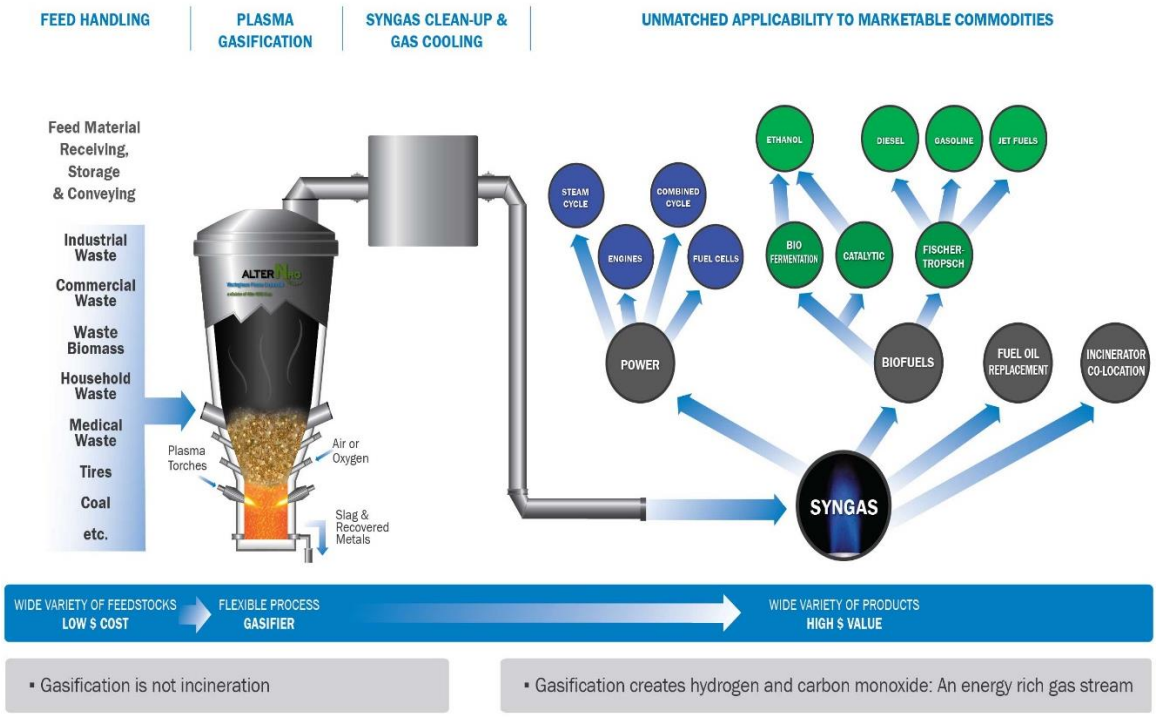

Figure 15. Gasification process (Alter NRG Corporation).

In gasification process, various materials of feedstocks can be processed (feed handling) by manually or automatically. The biomass is heated to high temperature rather than being burned (Plasma gasification). This process produces synthesis gas which contains some undesirable components that are cleaned up in next step. The final product of this process is clean syngas that is usable for energy purposes, for example, electricity production by gas-powered turbines. (Alter NRG Corporation.)

The final alternative to produce energy from biomass is anaerobic digestion. This process generates biogas from the decomposition process of wastes by bacteria. This method is relatively easy and inexpensive to implement. It is also especially suitable with organic

wastes such as food wastes. The desirable end-product of anaerobic digestion is methane (CH4), which is a clean energy for other purposes. (Ashden Biogas.)

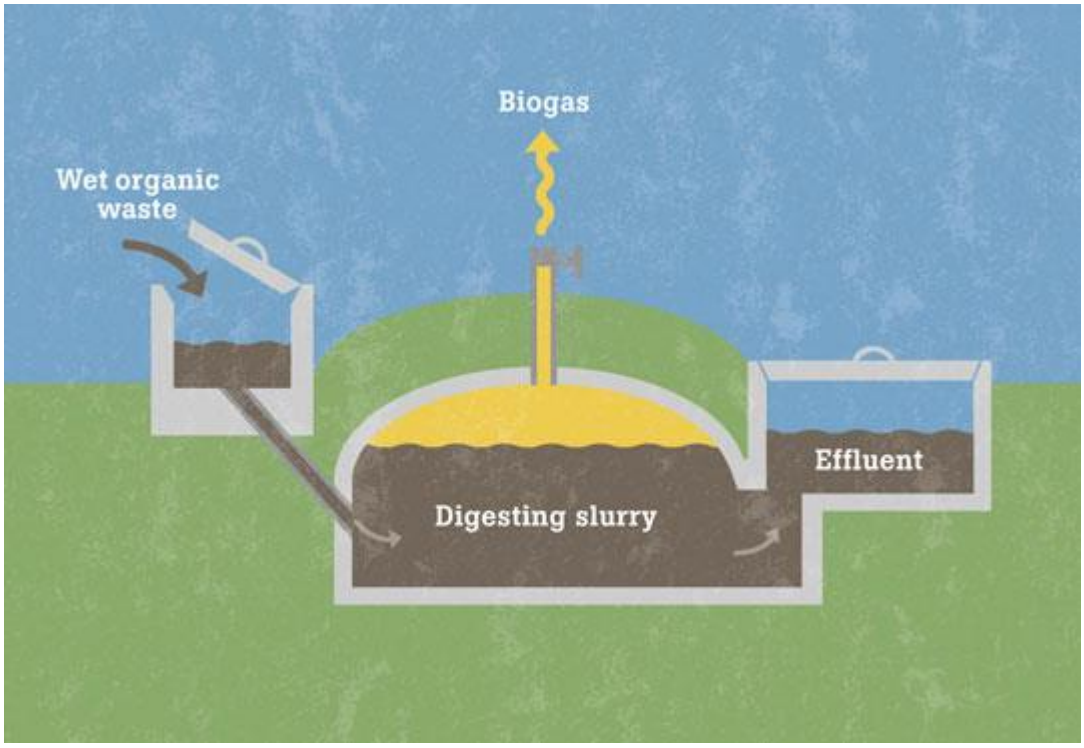

Figure 16. Anaerobic digestion (Ashden Biogas)

Figure 16 presents a model of producing biogas with anaerobic digestion. The system requires a large container (slurry) for the mixture of decomposing organic wastes. A biogas plant needs some methane-producing bacteria firstly; then the bacteria will reproduce and keep the process going later. The biogas is produced and taken from the system to use for energy purposes. The effluent matter after process should be discharged properly or used as organic fertilizers. (Ashden Biogas.)

In conclusion, gasification, and anaerobic digestion are two methods which generate fewer emission to produce energy from biomass (compared to direct combustion and pyrolysis). While gasification is suitable with dry matters such as wooden wastes (U.S. Department of Energy 2011), anaerobic digestion works best with organic feedstocks such as food wastes (Ashden Biogas). Wooden and foods wastes are available in IKEA's store, which means no costs needed for biomass materials. Hence, the researcher recommends IKEA to use gasification and anaerobic digestion as alternatives to produce energy from biomass. These applications help IKEA have a better waste management system and reduce costs of materials to supply biomass energy production.

4.3.3 Developing proposal 3: Redesigning the warehouse's buildings with more sustainable designs

In this section, the thesis author discusses various elements in establishing the green warehouse with more sustainable designs.

First of all, establishing more skylights and transparent glass windows to increase the level of natural light during daytime to help save energy and to create a pleasant working environment. In addition, in further development, IKEA Finland can start investing in solar energy in the southern area of Finland, where the weather condition is more suitable for solar panels' operations.

Figure 17. IKEA Boston, USA (Source: http://www.ikea-usa.com/)

The picture in figure 17 captured the roof of IKEA in Boston area, in which the stores installed 1,248 solar panels. Annually, IKEA Boston can produce approximately 383,200 KWh from this emission-free system. (Leitman, S. 2014)

Secondly, improving the air changes and ventilation systems in the warehouse with smart design to minimize heat loss but maintain required level of fresh air inside warehouses. The thesis author has found an innovative and ecological system of smart ventilation in figure 18 from Brooklyn Warehouse, New York (Leahy, K. 2011).

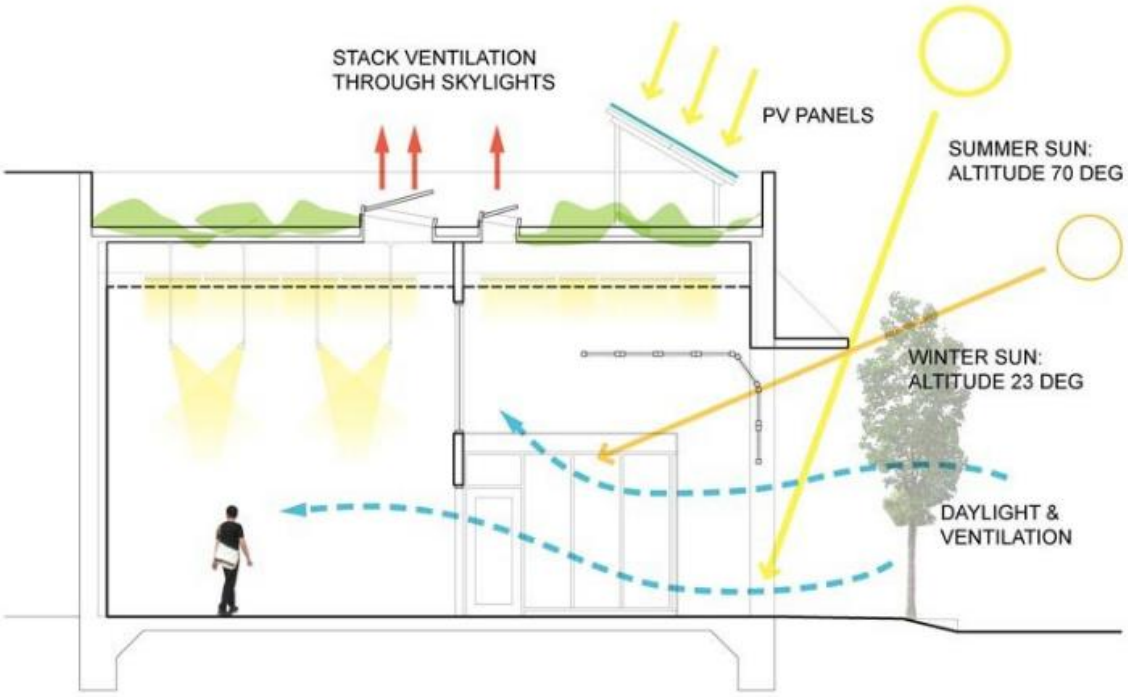

Figure 18. The smart ventilation system in Brooklyn Warehouse (Leahy, K. 2011).

The system in figure 18 includes the cool air flows (blue arrows) that get in the building through doors. The stack ventilation operates based on the principle of air buoyancy, which shows that warm air (red arrows) has upward movements. In this system, the ventilation is installed together with skylights to minimize the heat loss. (Leahy, K. 2011.)

Another initiative of sustainable design is that IKEA can use kinetic plates to harness energy from vehicles that depart or leave the store's gates (Figure 19). The system can produce energy from the weight of cars or buses which pass the gateway of the carpark. When the plates are pushed down, which generate the motions that run the electricity generators. The electricity is captured and used to supply energy to the stores. (Webecoist Momtastic.)

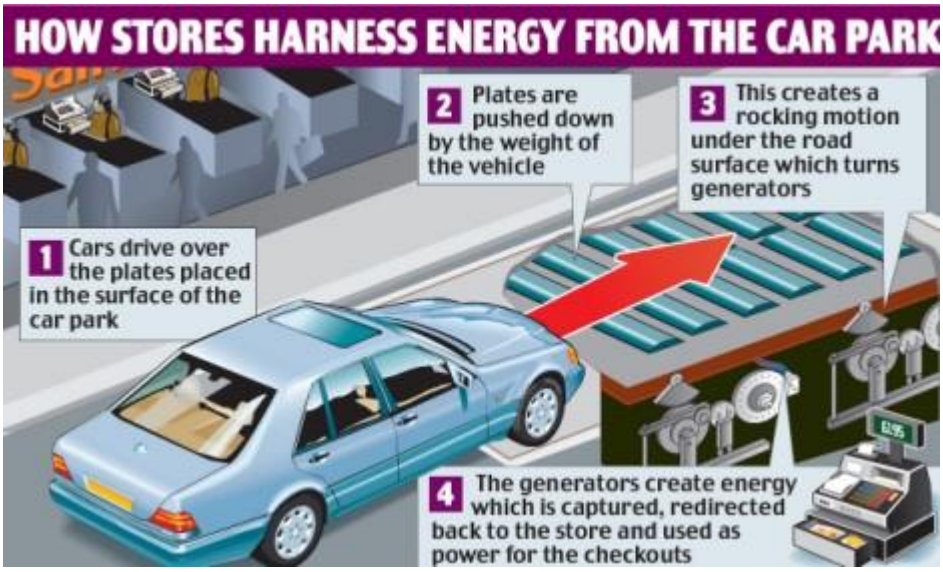

Figure 19. Kinetic plates in the car park (Webecoist Momtastic).

Overall, the above ideas of ecological designs for IKEA to develop the green warehouse are just a few to mention. The IKEA's warehouse can step up to the most advanced levels of the sustainable warehouse with sustainable designs into the buildings. This ecological transformation may take many years to complete, but that is worthy as the final target for green warehousing implementation.

To summarize this chapter, the thesis author recommends three developing proposals for IKEA to develop current green warehouse practices (main research question). Currently, a well-structured system of key performance indicators (KPIs) in energy efficiency and waste management is essential to measure, monitor and develop these sustainable practices. With the future perspectives, investing in green energy generation (solar, wind, biomass) and sustainable building design is two keys for IKEA to transform to the most advanced model of the sustainable warehouse.

5 Conclusion

5.1 Key results and recommendations

This research-oriented thesis has been completed successfully and answered the main research question and three investigative questions comprehensively. The key findings of this study are summarized as follows:

In the first investigative question (IQ1), **the current practices to attain energy efficiency at IKEA's warehouse are excellent**. The case company has successfully implemented various approaches to increase efficient energy consumption, including for example installing LED lights, equipping automatic sensor lighting controllers, applying appropriate temperature in different zones in the warehouse, using electrical forklifts, etc. In addition, the company has a holistic approach to measure and control energy performance. As a future green energy investment, the wild energy farm in Kemi has been established and expected to produce electricity starting from 2017. In brief, energy efficiency at IKEA goes beyond present standards and matches with most advanced models and strategies of energy efficiency in current theory literature. (See details in chapter 4.1.1)

In the second investigative question (IQ2), **current practices to attain waste management at IKEA's warehouse are successful and systematic**. IKEA aims to reduce waste generated from daily activities by using fewer packages but more recyclable materials. The company has an effective method to separate wastes and process them in the hierarchical waste management, where recycling, as well as reusing, are the priority and finally, disposing is the last option. However, there is a limitation when waste only can be separated into a few categories accordingly to what the third-party environmental company being able to process. IKEA actually can separate wastes better with many other categories, but no available waste-processing company in Finland can take responsibility to process new waste categories. The solution for this shortcoming is to continue contacting and finding new vendors for the waste process, even in neighboring countries. (See details in chapter 4.1.2)

In the final investigative question (IQ3), the thesis author has created **three developing proposals to develop the green warehouse at IKEA Finland**. The first developing proposal suggests a system of Key Performance Indicators (KPIs) in energy efficiency and waste management at IKEA's store level. This system of KPIs consists of the primary metrics (more important and having effects on profits) as well as the secondary metrics (explanations for the status of primary metrics). Moreover, the second improvement

proposal recommends IKEA to use biomass to generate energy. The two appropriate methods are gasification (wooden wastes) and anaerobic digestion (food wastes). Finally, the last development plan proposes initiatives on redesigning IKEA's warehouses with more sustainable designs including skylights, solar panels, smart ventilation and kinetic plates. (See details in chapter 4.3)

In conclusion, the current practices of energy efficiency and waste management at IKEA are splendid in a sustainable manner. The main research question: **How IKEA Finland can develop green warehousing practices is answered with a future direction to transform the current warehouse to the highest level of a sustainable store.** The topmost green warehouse has unprecedented ecological designs and can produce and supply energy as much as it consumes. At this stage, the warehouse becomes a genuinely sustainable element in IKEA's green supply chain.

5.2 Suggestions for further research

Sustainability is a fascinating aspect of future research in the academic business field. In green supply chain management, green warehouse plays a critical role in the sustainability of entire supply chain. In this sub-chapter, thesis author suggests several new directions for research on IKEA's green warehouse practices.

Based on the recommended key performance indicators (KPIs) created in this study (chapter 4.3.1), a quantitative research to measure KPIs in energy consumption and waste management data can be conducted. The study may need data from a period of time (for example in the last year). The numerical data can be analysed by statistical methods. The research outcome can provide insight data and figures of how many percentages of energy saved, or how many resources are preserved with lower carbon emissions. These measurements help managers to keep track on the situation of energy efficiency and waste management as well as to enable better decision-making process in the future.

Furthermore, a research-oriented thesis about green packaging and its effects on waste management in the warehouse is precious for case company IKEA. Last but not least, although IKEA has already implemented energy self-production and this study suggested to use biomass as an additional approach, there are always needs for continuous research on green energy sources to generate energy at IKEA's stores in the future.

5.3 Reflection on learning

The thesis process is one of most educational and effective periods of time for my individual learning experience during my bachelor degree. That is great to conduct research in my favorite field, sustainability in supply chain and logistics.

During thesis process, I have been learning many valuable skills and knowledge. First of all, I had opportunities to apply my knowledge and theories studied from Sustainable Logistics and Supply chain strategies into a business practice case.

Furthermore, I have been researching many advanced and most up-to-date, relevant literature, which considerably enriches my understanding about the green warehouse and green supply chain management. Lastly, I have practiced my English academic writing skills very effectively in thesis process.

The success of thesis writing process also comes along with practical practices. I had trained myself with skills in designing empirical research and developed my qualitative research skills. In addition, working with professional personnel from the case company IKEA was a great opportunity to improve my business professionalism.

There is only a limitation in my thesis process. Due to intensive studying and exam schedules, I had to extend the completion time of my thesis more than one month as planned. Fortunately, with individual efforts, helps from IKEA's representative and my thesis advisor, I have been able to complete my research successfully.

After all, I believe that thesis writing process has been an excellent method to enhance my logistics and supply chain expertise. This research is a baseline for me to enter new business career life as a supply chain professional.

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Appendices

Appendix 1. Interview framework with IKEA's Sustainability Leader and Logistics Manager

	Thematic Category/ Investigative questions	Main Questions	Additional Questions
1	Sustainability strategy and green warehouse practices.	What is the role of sustainability in IKEA's business strategy? Especially for green warehouse practices?	What are major benefits for IKEA when implementing sustainability?
			What are key achievements of green warehouse logistics at IKEA Espoo Finland?
2	Current practices to attain energy efficiency in IKEA's warehouse.	What is the framework/guideline for energy efficiency at IKEA Espoo Finland? (In term of saving energy with lighting, heating systems, and mechanical handling equipment)	How are IKEA's employees informed about these guidelines?
3	Current practices to attain effective waste management in IKEA's warehouse.	What is the waste management process at IKEA Espoo Finland? (Waste separation, process of managing waste)	What are advantages/disadvantages of the waste management process?
4	Recommendations to develop green warehousing implementation in IKEA's warehouse.	What are the methods of assessment/measurement green warehousing implementation at IKEA Espoo Finland?	
		What are the main limitations of green warehousing practices at IKEA's warehouse?	What are suggestions to tackle with these shortcomings?
		What are plans to develop green warehouse implementation?	

Appendix 2. Interview framework with IKEA's Goods-Flow Shift Leader

	Thematic Category/ Investigative questions	Main Questions	Additional Questions
1	Sustainability strategy and green warehouse practices.	What is your understanding of IKEA sustainability strategy?	How were you informed about IKEA's sustainability?
			What are key achievements of green warehouse logistics in your Replenishment team at IKEA Espoo Finland?
2	Current practices to attain energy efficiency in IKEA's warehouse.	What do you and your team usually do to increase energy efficiency at IKEA's warehouse? (according to IKEA's guideline)	How do you motivate your team members to comply with IKEA's warehouse sustainability?
3	Current practices to attain effective waste management in IKEA's warehouse.	What is the waste management process at IKEA Espoo Finland in a daily work situation? (Waste separation, process of managing waste)	What are advantages/disadvantages of the waste management process in your opinion?
4	Recommendations to develop green warehousing implementation in IKEA's warehouse.	What are your suggestions to develop IKEA's warehouse practices?	What are the main limitations of green warehousing practices at IKEA's warehouse?

Appendix 3. Interview framework with IKEA's warehouse employee

	Thematic Category/ Investigative questions	Main Questions	Additional Questions
1	Sustainability strategy and green warehouse practices.	What is your understanding of IKEA sustainability strategy?	How were you informed about IKEA's sustainability?
			Do you usually practice sustainability implementation at IKEA's warehouse as company's requirement?
2	Current practices to attain energy efficiency in IKEA's warehouse.	What do you usually do to increase energy efficiency at IKEA's warehouse? (according to IKEA's guideline)	How managers/supervisors promote sustainability of the warehouse?
3	Current practices to attain effective waste management in IKEA's warehouse.	What is the waste management process at IKEA Espoo Finland in a daily work situation? (Waste separation, process of managing waste)	What are advantages/disadvantages of the waste management process in your opinion?
4	Recommendations to develop green warehousing implementation in IKEA's warehouse.	What are your suggestions to develop IKEA's warehouse practices?	In your opinion, how is it important to promote sustainability at your workplace?

Appendix 4. Recommended KPIs in energy efficiency (Sustainability Reporting Guidelines of Global Reporting Initiative 2015, 53-54).

G4-EN6

REDUCTION OF ENERGY CONSUMPTION

a. Report the amount of reductions in energy consumption achieved as a direct result of conservation and efficiency initiatives, in joules or multiples.
b. Report the types of energy included in the reductions: fuel, electricity, heating, cooling, and steam.
c. Report the basis for calculating reductions in energy consumption such as base year or baseline, and the rationale for choosing it.
d. Report standards, methodologies, and assumptions used.

G4-EN7

REDUCTIONS IN ENERGY REQUIREMENTS OF PRODUCTS AND SERVICES

a. Report the reductions in the energy requirements of sold products and services achieved during the reporting period, in joules or multiples.
b. Report the basis for calculating reductions in energy consumption such as base year or baseline, and the rationale for choosing it.
c. Report standards, methodologies, and assumptions used.

G4-EN3

ENERGY CONSUMPTION WITHIN THE ORGANIZATION

a. Report total fuel consumption from non-renewable sources in joules or multiples, including fuel types used.
b. Report total fuel consumption from renewable fuel sources in joules or multiples, including fuel types used.
c. Report in joules, watt-hours or multiples, the total:
   - Electricity consumption
   - Heating consumption
   - Cooling consumption
   - Steam consumption
d. Report in joules, watt-hours or multiples, the total:
   - Electricity sold
   - Heating sold
   - Cooling sold
   - Steam sold
e. Report total energy consumption in joules or multiples.
f. Report standards, methodologies, and assumptions used.
g. Report the source of the conversion factors used.

Appendix 5. Recommended KPIs in waste management (Sustainability Reporting Guidelines of Global Reporting Initiative 2015, 52, 60).

G4-EN23

TOTAL WEIGHT OF WASTE BY TYPE AND DISPOSAL METHOD

a. Report the total weight of hazardous and non-hazardous waste, by the following disposal methods:
   - Reuse
   - Recycling
   - Composting
   - Recovery, including energy recovery
   - Incineration (mass burn)
   - Deep well injection
   - Landfill
   - On-site storage
   - Other (to be specified by the organization)

b. Report how the waste disposal method has been determined:
   - Disposed of directly by the organization or otherwise directly confirmed
   - Information provided by the waste disposal contractor
   - Organizational defaults of the waste disposal contractor

G4-EN1

MATERIALS USED BY WEIGHT OR VOLUME

a. Report the total weight or volume of materials that are used to produce and package the organization's primary products and services during the reporting period, by:
   - Non-renewable materials used
   - Renewable materials used

G4-EN2

PERCENTAGE OF MATERIALS USED THAT ARE RECYCLED INPUT MATERIALS

a. Report the percentage of recycled input materials used to manufacture the organization's primary products and services.