Organic waste management at the retail sector: The case study of Central Grocery Market of Thessaloniki

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I hereby declare that the work submitted is mine and that where I have made use of another's work, I have attributed the source(s) according to the Regulations set in the Student's Handbook.

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Abstract

As the years pass by, the need to develop a sustainable world is even more urgent. A step towards this target is to adopt sustainable waste management methods as well as adopt methods to reduce the waste in a concept of circular economy. This study will examine the organic waste management in the retail sector. The food loss and waste, and especially the fruit and vegetable waste increases through the years. The fruit and vegetable waste occurs during the all the stages of the production, distribution and consumption. The absence of proper waste management causes many environmental impacts due to the production of GHG emmissions during the degradation. On the other hand, the implementation of sustainable organic waste management result to many benefits in both society and environment.

The bigger producer of this organic waste is the wholesale and the retail sector of fruit and vegetables. The grocery stores trade large volumes of fruits and vegetables and that for organic waste management should be adopted. This study will examine the fruit and vegetable waste that is produced in the Central Grocery Market of Thessaloniki. In addition, it will examine the waste management methods that are applied now and the actions that have been done towards food loss. For the aim of the study a survey and a number of interviews were contacted to the traders of the Central Grocery Market. The results will be precented and analyzed and efficient organic waste management for the retail sector will be proposed.

Keywords: FVW, waste managemet, retail sector

Revekka Skarli
31/10/2018

Preface

This thesis is submitted for the degree of Master of Science (MSc) in Environmental Management and Sustainability at the International Hellenic University.

This research herein was conducted under the supervision of Professor Giorgos Banias in the School of Economics, Business Administration & Legal Studies from July 2017 until October 2018.

To the best of my knowledge, this thesis is authentic, apart from where acknowledgements and references are referred to previous work.

I would like to express my deep appreciation to my supervisor Professor G. Banias for his guidance, full support and assistance throughout the thesis formation. The present thesis is the result of his valuable input, comments and directions.

Contents

1 Introduction

The last decades, nations worldwide have been working together to promote and adopt a sustainable development. Many definitions have been given to attribute the term of sustainable development. However, the definition that stands out and is more frequently quoted is the one of Brundtland Commission, “Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs”.

On September 25th, 2015 countries worked together and set the 2030 Agenda for Sustainable Development and agreed to adopt the 17 Sustainability Development Goals (Nations, 2015). Each goal has a specific target, but the goals and the targets are interrelated and need to be treated together in order to succeed.

The food loss and waste are a major problem globally, especially when 795 million people on earth are starving today, and the additional 2 billion people expected by 2050, according to the United Nations. The food loss and waste is a significant and very important issue which needs to be addressed immediately. Tackling this issue makes a significant contribution to addressing other targets of the Sustainability Development goals, such as combating hunger, strengthens the fight against climate change and increase incomes.

About 1.3 billion tones of food is lost or wasted globally, which equals to one third of the food produced, while in Europe the annual food waste is around 88 million tones, according to the European Commission. The distribution of food waste and loss, however, defers between industrialized countries and developing countries. The food loss in developing countries is over 40% and occurs after harvest and during processing, while in industrialized countries, the same amount of food loss occurs at retail and consumer level (Gustavsson, et al., 2011).

The technological progress offers solutions for sustainable organic waste management, such as composting and anaerobic digestion. Exploiting these opportunities, many benefits arise that affect the 3 pillars of sustainability, the economy, the society and the environment.

The aim of this study is to identify the volume of fruit and vegetable waste produced at the retail sector and more specifically at the central grocery market of Thessaloniki. In addition, this study aims to provide technical solutions for the organic waste treatment. To address the volume and the reasons of this impact, a survey was addressed at the owners of the grocery markets. The tool for this survey was a questionnaire which was structured in order to provide more specific results referring to the envi-

ronmental awareness and education, budget and cost issues and waste management treatments.

2 Literature Review

A brief review on the food loss, food waste and especially fruit and vegetable waste will be presented.

2.1 Food Loss and waste

Food waste is defined as any food, and inedible parts of food, removed from the food supply chain to be recovered or disposed (including composted, crops ploughed in/not harvested, anaerobic digestion, bio-energy production, co-generation, incineration, disposal to sewer, landfill or discarded to sea)" according to FUSIONS (Stenmarck, et al., 2016). Another important definition that should be introduced is for the food loss. "Food loss is defined as 'the decrease in quantity or quality of food'. Food waste is part of food loss and refers to discarding or alternative (non-food) use of food that is safe and nutritious for human consumption along the entire food supply chain, from primary production to end household consumer level" as defined by the Food and Agriculture Organization of the United Nations.

The food loss and waste can be categorized in two main types: vegetable commodities and products and animal commodities and products, according to the Food and Agricultural Organization of United Nations. For the aim of the study, only the fruit and vegetable commodities and products will be examined.

At this point of the study the terms fruit and vegetable should be separated and defined. A fruit is defined as "Edible parts of plants that contain the seeds and pulpy surrounding tissue; have a sweet or tart taste; generally consumed as breakfast beverages, breakfast and lunch side-dishes, snacks or desserts". A vegetable is defined as "Edible plant parts including stems and stalks, roots, tubers, bulbs, leaves, flowers and fruits; usually includes seaweed and sweet corn; may or may not include pulses or mushrooms; generally consumed raw or cooked with a main dish, in a mixed dish, as an appetizer or in a salad" (International Agency for Research on Cancer, 2003).

The fruit and vegetable waste (FVW) has been distinguished into five system boundaries (Gustavsson, et al., 2013):

- Agricultural production: At this stage, FVW occurs during harvest operation, due to spillage and mechanical damage.
- Post-harvest handling and storage: At the post-harvest stage and during the packaging of fruit and vegetables, a significant amount is thrown away due to

their impeccable appearance. Furthermore, loss also occurs during storage and transportation from the farm to the markets.

- Processing: Fruit and vegetable loss and waste also occurs due to their processing for another use, such as canning and juice production as well as during the processing.
- Distribution: A significant amount of FVW is produced during the distribution phase, mostly due to products that could not be sale and started to decompose.
- Consumption: This is the last stage where FVW occurs at households during consumption.

For the aim of the study, only the food waste during the distribution stage will be examined and analyzed.

2.1.1 Fruit and Vegetable Waste Worldwide

Tristram Stuart, a food waste campaigner, claims that "Cutting food waste is a delicious way of saving money, helping to feed the world and protect the plannet".According to the Fruit and Agricultural Organization of United Nation, the 45% of fruit and vegetables produced worldwide are converted to waste. It is a significant wastage rate as it is almost the half amount of the total production. It is indicatively mentioned that almost 3.7 trillion apples became organic waste this year. The table below shows the FVW produced worldwide for 2018 (Gustavsson, et al., 2011):

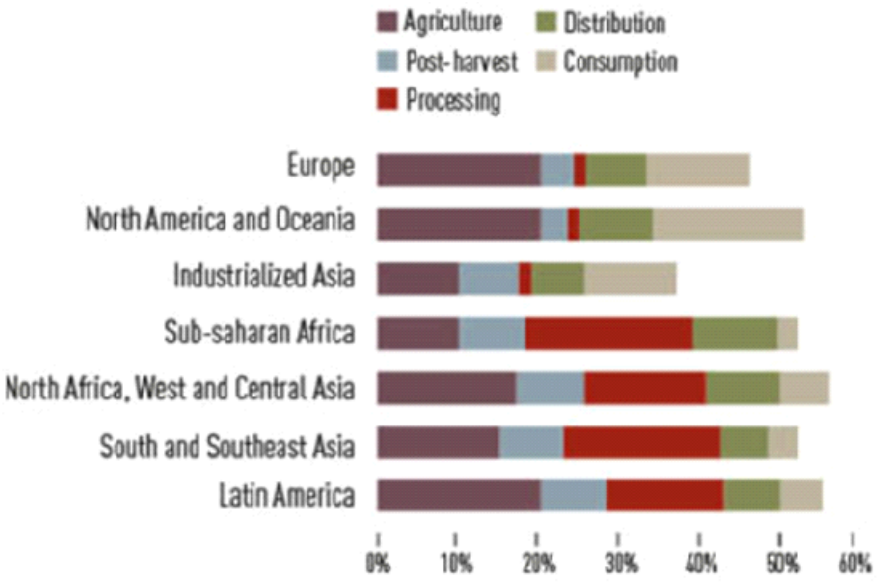

Figure 1: Fruit and vegetable waste worldwide for 2018, source: (Gustavsson, et al., 2011)

According to official data and research, it has been estimated that almost half of the fruit and vegetable production in US is converted to waste. A significant amount of organic food produced becomes waste after harvest mostly because the products do not meet the "appropriate" display conditions and their imperfection. The rest FVW is produced at the retail stores, from unsellable products and then during consumption (Goldenberg, 2016).

Another study that was held in UK provided records that almost two-fifths of the crop production becomes waste also because it looks "ugly". The imperfect sight of fruit and vegetables is a determining factor that affects their marketability. The "unacceptable" display products become animal's feed or thrown back to landfill. It is estimated that tis amount of FVW reaches the 40% of the UK's total production (Association, 2013).

A calculation based on USDA data and Statistics Canada in 2010, provided information about the FVW at the retail sector and at household in Canada. Almost 40% of the total food waste produced in retail stores and in homes was coming from fruit and vegetables (Rich & Felfel, 2015). This is a significant amount of food converted in waste through the supply chain.

India is another country with a significant FVW amount. India is the world's biggest country in fruit and vegetable production, according to the Worldbank (Desai, 2011). However, about 40% of the crops produced becomes waste due to lack of energy for cold storage and scarcity of food processing (Lee & Willis, 2010).

2.1.2 Fruit and vegetable waste at the retail sector

According to Parfitt, the estimation of food waste at the grocery retail sector is a difficult aspect, due to a number of variables that affect the accounting procedure. Such variables are the legislation on national and regional level, the available methodologies for the accounting administrative practices and corporate strategies (Parfitt, et al., 2010). The grocery retail sector has been categorized as the second largest producer of food waste, as it has been estimated by the WRAP (Waste and Resource Action Program) (Lee & Willis, 2010). The main causes that have been identified by WRAP are the dependence on demand on the season and the durability of the products.

However, in 2010, the food waste at the grocery retail sector in EU was estimated to be almost 4.4 million tones, which accounts for the 5% of the overall food waste in the European supply chain of food (Monier , et al., 2010). In addition, a USDA (Food and Agricultural Organisation of the United Nations, 2012) research in the same year showed that almost 6 billion pounds of fruit and 7 billion pounds of vegetables became a loss at the retail sector in US (Bentley & Kantor, 2018). In India, which produces 46 million tonnes of fruit, almost 72% becomes waste, from which the 23% is produced in the retail sector, due to lack of proper installations (Arivazhagan, et al., 2013).

Lebersorger and Schneider worked on a research on food loss at the retail level and the reasons for it. The categorization of the reasons was based on the frequency for all kinds of products that participated in the research. According to this categorization, about 89% of FVW was due to apparent flaws, such as color change, dents and over-ripe. The second most frequent reason was the lack of date label, which was responsible for almost 50% of FVW. Other reasons with lesser influence were the damaged packaging and the lack of part of the products (S.Lebersorger & F.Schneider, 2014).

Another research separates the in-store FVW into recorded and unrecorded waste. The recorded in-store waste results after the purchase from the supplier while the un-recorded in-store waste the purchased food that is not recorded as waste (Eriksson, 2012). In the first case, FVW is recorded on a daily basis and depend on date label and product deterioration. On the other hand, the two basic reasons for unrecorded waste were the retailer's incomplete recording or the incorrect recording (Eriksson, et al., 2012). However, if it was recorded it could either be categorized as pre-store waste or recorded in-store waste (Eriksson, 2012).

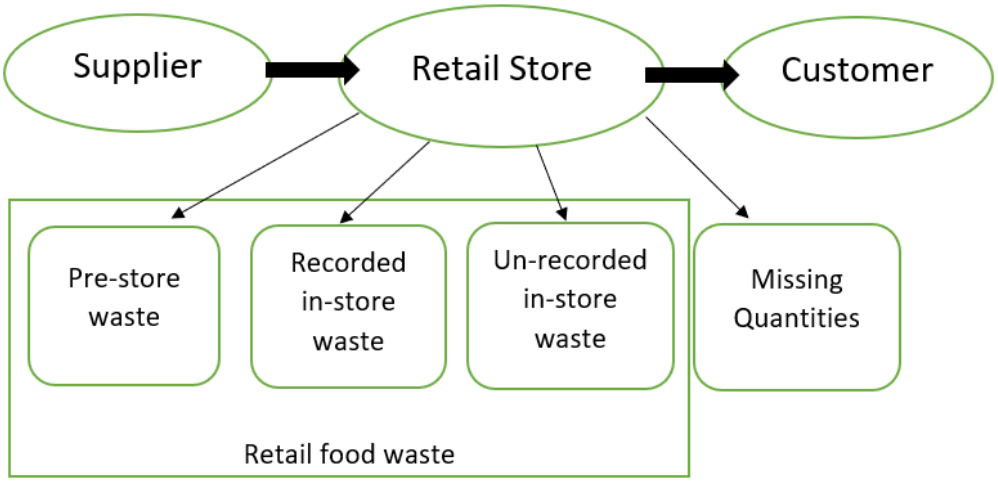

Figure 2: Separation of FVW at the retail sector

2.2 Waste Management

2.2.1 Legislation

The increase in population is inextricably linked to the increase of global pollution, as waste is an integral part of human activities (Rathi, 2006). The lanndfilling of waste poses environmental and health risks, as it produces higly polluting leachate and methane gas (Habib, et al., 2018). For this reason it is imperative to implement and adopt a legislative framework and quidlines for the proper management of the organic waste.

The 193 Member States of the United Nations have set the agenda with 17 Sustainable Development Goals. Among its objectives in the Goal 12 “Ensure sustainable consumption and production patterns” is included the “halve per capita global food waste at the retail sector and consumer level, and reduce food losses along production and supply chains by 2030” (FUSIONS, n.d.).

Figure 3: The Goal 12 of the Sustainable development Goals, source: United Nations

Landfilling is the easiest, less expensive and most widespread waste disposal method in the world. However, this way of managing organic waste hides many risks both for the environment and human health. One of the main threats from decomposing organic waste in landfills is the production of methane (CH4), which is one of the main greenhouse gas emissions. In 1995, the methane production from landfills was measured to count for the 3% of the total greenhouse gas emissions in the EU-15. Member States are obliged to a red1/action of landfilling of biodegradable municipal waste, up to 35% in comparison with the 1995 levels, according to Landfill Directive (1999/31/EC). This reduction should be achieved by 2016 for some countries, while other countries have to achieve this goal until 2020.

In the EU, the total amount of bio-waste is estimated at 76.5-102Mt from municipal waste that consist of food and garden waste, and about 37Mt from the food and drink industry according to the Green Paper on the management of bio-waste in the European Union {SEC(2008) 2936}.

The EU has established a priority order of waste management that should be applied from all Member States. The waste management hierarchy is provided in the table below.

Figure 4: The waste management hierarchy according to EU, source: EU Waste Framework Directive

For the efficiency of waste management operations, the EU defines the terms recycling and recovery in the Directive 2008/98/EC. The definitions of these terms are provided below, as they have been exactly defined in the Directive:

- "'recycling' means any recovery operation by which waste materials are reprocessed into products, materials or substances whether for the original or other purposes. It includes the reprocessing of organic material but does not include energy recovery and the reprocessing into materials that are to be used as fuels or for backfilling operations"

- "'recovery' means any operation the principal result of which is waste serving a useful purpose by replacing other materials which would otherwise have been used to fulfil a particular function, or waste being prepared to fulfil that function, in the plant or in the wider economy. Annex II sets out a non-exhaustive list of recovery operations"

An efficient bio-waste management can provide a number of benefits, such as reduction of GHG emissions, production of bio-gas and production of compost. The most popular and in-use disposal practices and technologies for organic waste treatment suggested by the European Union in the Green Paper are prevention at source, collection, landfilling, composting and anaerobic digestion.

In the waste management hierarchy, the landfilling is the last desired option. However, when it should be put in practice, account should be taken of the limitations and conditions that have been set at the EU Landfill Directive, to prevent environmental degradation due to methane and effluent production.

Composting and anaerobic digestion treatments are included in the recycling stream of the management hierarchy when used on land and for fertilizer production, or in the

pre-treatment procedure when used instead of landfilling or incineration. Furthermore, the anaerobic digestion process for energy production should be classified as energy recovery (Green Paper, EU).

Composting is the most in use and popular treatment of organic waste. It constitutes the 95% of the in use organic waste treatment operations. It provides a number of methods available to use and is mostly applicable for green waste and woody. On the other hand, anaerobic digestion is preferable for wet bio-waste treatment in controlled reactors, mostly for bio-gas production (Green Paper, EU). A more analytical research on composting and anaerobic digestion will be presented in next chapter.

2.2.2 Waste management Practices

As it has been mentioned before, FVW causes disposal and environmental issues, due to its high biodegradability, as it contributes to the production of GHG emissions, if not managed properly. The Food and Agriculture Organization of the United Nations has reported that 3.3 bilion tons of greenhouse gases are produced annually by food waste. It has also been estimated that almost two lac tons of energy resource that could be produced from fruit and vegetable waste is unexploited (Javaria, 2012). Until the recent past, FVW has been disposed into municipal waste streams, with no specification for energy recovery, but sent to landfills (Navirska & Kwasniewska, 2003).

The focus on waste management has become very important for the fruit and vegetable industries, due to the risk of climate change, the increasing costs of raw materials, as well as the increasing pressure of the stakeholders for more sustainable operations. A hierarchy guidance has been established in the late 1990s by the Environmental Protection Agency and the United States Department of Agricultural Food Composition Databases, providing the preferred practices for food waste and food recovery with the greatest value (Davis, 2014).

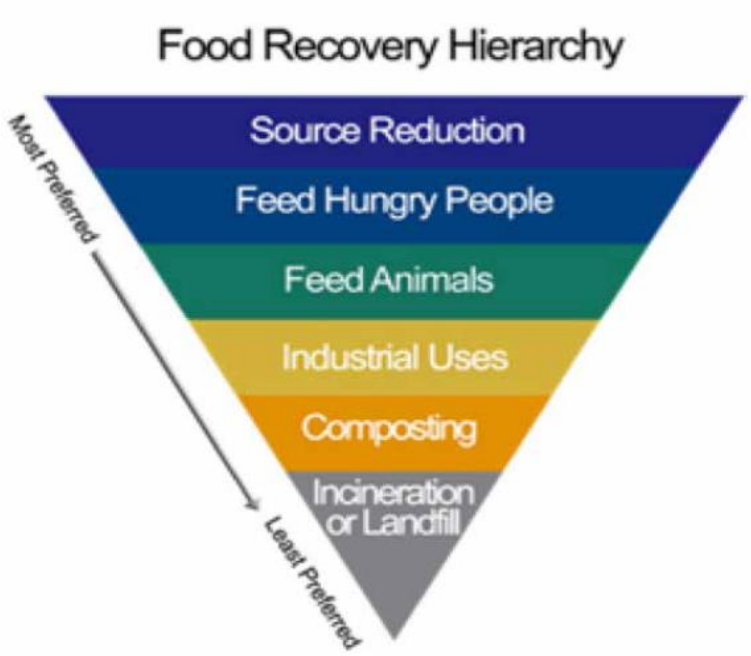

Figure 5: Food Reduction Hierarchy according to EPA, source: (Davis, 2014)

For the aim of the study, only the methods that are applicable for fruit and vegetable waste will be examined.

2.2.2.1 Donation

Feeding the hungry people is the most preferred possible option to treat FVW. A significant amount of food that becomes waste is edible and therefore the food donation could contribute to feeding local communities and to reduce the amount of organic waste send to landfills (Sustainable Foodservice, 2016). In 2015, the Global Food Banking Network saved 417 million kilos of edible food that would have send to landfills and donated to hungry people (Food Bank, 2016).

Food recovery programs and Food banks are the key partners for this waste management method. Companies, including manufactures and retailers, instead of disposing the edible food to waste, they could donate it to local food banks, who then redistribute it to partner charities for people in need (Broet & Diaz-Lonborg, 2018). A crucial parameter for this procedure is that the edible food that is donated should conform to strict food safety regulations. In addition, in 1996, the Bill Emerson Samaritan Food Donation Act was designed to encourage the donation of food and grocery as well as to restrict donors' liability to instances of gross negligence or international misconduct (Committee, 2000).

For grocery stores, the donation of fruit and vegetables has some difficulties. To begin with, not all of the products can be utilized due to their perishability (Hawkins, 2010). In addition, most of the grocery stores lack of proper facilities to maintain the products for too long, the time needed and the means to deliver to distribute the products to

food assistance providers. That for, they should corporate with external organizations to carry out the collection and distribution (Davis, 2014).

On the other hand, the benefits of this action are numerous. To begin with, companies and industries could gain potential tax benefits for donating food (EPA, n.d.). In addition , food donation decreases the disposal costs, and build a better image for the customers and the community (Davis, 2014). Moreover, this action decreases the amount of organic waste that is send to landfills and are responsible for the production of greenhouse gas emissions. Last but not least, food donation can address the Goal 2 "Zero Hunger" of the 17 Sustainable Development Goals.

2.2.2.2 Feed animals

The EPA's Food Recovery Hierarchy has categorized "Feeding Animals" as the third most preferred option for reducing organic waste. This alternative disposal method proposes a recycling of the organic waste through livestock as feed resources (EPA, 2018). Livestock constitutes a fast-growing agricultural sector with an increasing demand for livestock feeding products. According to FAO, world's needs for meet will rise 73% and for milk 58% in 2050. It has been reported that UK processes 660.000 tones of food waste as animal feed annually, with a worth of £110 million (WRAP, 2018).

Feeding animals with food waste is more practical and optimal to be applied in large industries, such as grocery stores (Alpert, et al., 2009). Alternate feed resources, such as fruits and vegetables, could meet both the needs for feed resources and the reduction of organic waste send to landfills (M. Wadhwa & M. P. S. Bakshi, 2013). This method of food waste reduction is economically favorable for both food industries and food animal industries. The food industries can decrease their disposal costs, and especially the costs of landfilling. On the other hand, farmers can decrease the costs of animal feed compared to traditional animal feed (SUSTAINABILITY, n.d.). An important parameter for this method is the safety control of the fruits and vegetables that are intended for animal feed. The pesticide residues that may contain can cause adverse effects on animal (Westendorf, 2000). The Harvard Food Law and Policy Clinic and the Food Recovery Project at the University of Arkansas, have written the guidance "Leftovers for Livestock: A Legal Guide for Using Excess Food as Animal Feed", which refers to regulations for animal feed from food waste (EPA, 2018). In addition, the Partnership for Food Protection National Workplan Workgroup proposes actions to address the gaps for this alternative method and build a stronger and properly structured network (Partnership for Food Protection National Workplan Workgroup, n.d.).

2.2.2.3 Composting

The nature of decomposition process divides composting in two categories, the anaerobic composting and the aerobic composting. The main deference occurs in the absence or not of oxygen during the process (Mirsa R.V., et al., 2003). the anaerobic

composting is commonly known as anaerobic digestion due to the acidic environment that is produced during the process. Therefore, the term “digestion” replaces the term “composting” to better describe the process (Center, n.d.). The composting and the anaerobic digestion are potential methods to improve the sustainability of waste management, by generating value-added products from reused organic waste. The composting is mostly used for the production of organic fertilizer as well as the production of heat. On the other hand, the anaerobic digestion is a sustainable process that leads to biogas production.

With regards to “Composting: the aerobic process”, a brief description of the method is presented. “Composting is a process of biological decomposition and stabilisation of organic substrates under conditions, which allow development of thermophilic temperatures as a result of biologically produced heat, with a final product sufficiently stable for storage and application on land without adverse environmental effects”, is a centralized definition for the aim and the procedure of this method (Vigneswaran S., et al., 2016). The method of compost of FVW is a potential option to reduce the quantity of waste that is send to landfill (Kumar, 2011).

It is an aerobic procedure with fast degradation that produces compost as soil amendment, with a small-scale investment. During the composting process, the microorganisms feed the organic matter, while consuming the oxygen in the pile (Nair & Delate, 2016). The main microorganisms involved are bacteria, fungi and actinomycetes. The pile goes through three temperature phases that are crucial for the efficiency of the process. The first temperature phase is the Mesophilic phase (20^{o}-40^{o}C), where the mesophilic bacteria break down the degradable compounds. The next temperature phase is called Thermophilic (40,6^{o}-65,6^{o}C), where fats and proteins break down by the thermophilic bacteria. In the same temperature phase, cellulose and hemicellulose also start breaking down by the cooperation of actinomycetes and thermophilic bacteria. In the sequel, the temperature decreases again to mesophilic temperatures and the curing phase begins. At that last phase, the most resistant compounds are attacked by actinomycetes and fungi. The final product is ready when the temperature of the pile exceeded by 10^{o}C the ambient temperature (Felton, 2015).

Composting contributes to promote a healthier agricultural system, as it produces organic fertilizer. In addition, it helps to reduce the methane and the formation of leachate in landfills (New Mexico Recycling Coalition, 2014). The sustainability of this method also lies on the low disposal cost, the production of organic fertilizer that can be profitable by selling it, as well as the production of heat, as a by-product of the procedure (Hawkins, 2010).

Although aerobic processes are proposed for FVW treatment, they have some limitations and difficulties in the procedure. Aerobic processes are not favoured treatments

for FVW due to their requirement of preparatory treatment for minimizing the organic loading rate (Landine R.C., et al., 2003).

Designs of pilot and commercial anaerobic digestion plants were introduced in the early 1990s. Since then, worldwide attention was received for the anaerobic digestion of organic waste (Karagiannidis A. & Perkoulidis G., 2008). The anaerobic digestion is a biological process that transform organic waste to energy rich compounds, such as biogas production. The term "anaerobic" indicates the absence of oxygen during the procedure, where the microorganisms break down the biodegradable materials (Sitorus, et al., 2013).

There are three types of anaerobic processes, that reflect the types of reactors used. The first one is the batch systems, where the reactor is fed once with the organic waste and the degradation stages are allowed to procced consecutively (Bouallagui H., et al., 2005). The other two types are the one-stage system and the two- stage system, which are preferred for fruit and vegetable waste. The main difference between them is the number of reactors used for the process. In the one-stage system the biological reactions proceed consecutively in a single reactor. On the other hand, the two-stage system requires two different reactors (Sitorus, et al., 2013).

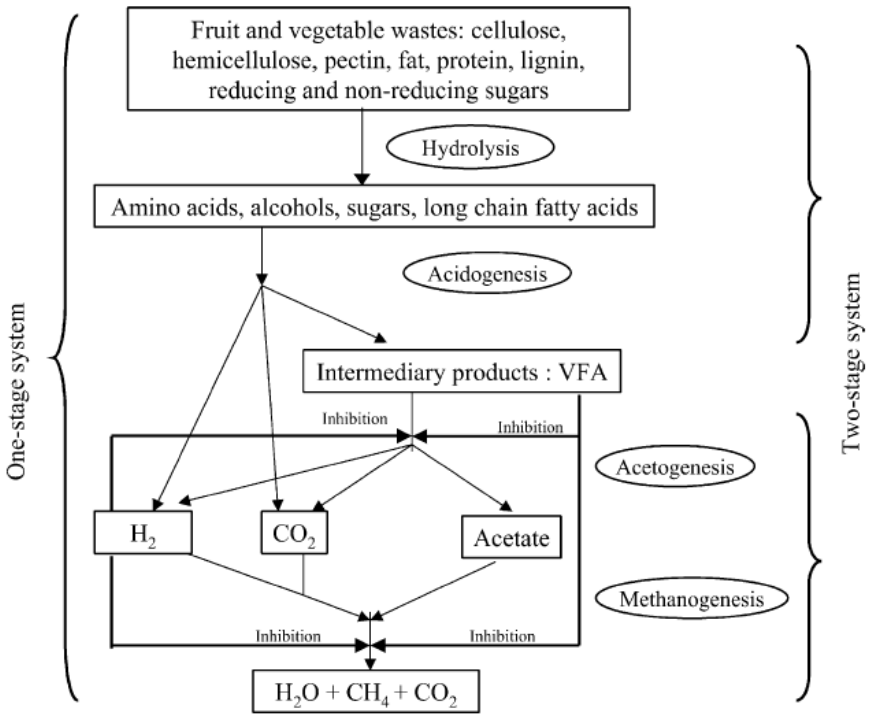

Figure 6: The anaerobic digestion procedure for FVW waste, source (Bouallagui H., et al., 2005)

Although the one-stage and two-stage anaerobic digestion are proposed as more suitable for FVW, studies provide evidence and results for anaerobic digestion treatments of FVW. They are summarized in the table below.

Process	Volume (L)	Loading rate (gVS/1day)	HRT (day)	VS Removal (%)	Methane yield (litre/gVS)	References
Batch System	10	1.06	47	65	0.16	(K. V. Rajeshwari, et al., 2001)
Batch System	5	0.9	32	58	0.26	(Bouallagui H, et al., 2004)
Continues one-stage CSTR	3	1.6	20	88	0.47	(Joan Mata-Alvarez, et al., 1992)
Continues one-stage CSTR	16	3.6	23	83	0.37	(Verrier D, et al., 1987)
Continues tubular reactor	18	2.8	20	76	0.45	(Bouallagui H, et al., n.d.)
Two-stage system: solid bed hydrolyser and UASB methaniser	100+25	6.8	2.5	94	0.35	(Rajeshwari KV, et al., 2001)
Two-stage system: ASBR hydrolyser and anaerobic filter	2.5+10	4.4	7+10	87.5	0.34	(Ruynal J, et al., 1998)
Two-stage system: CSTR hydrolyser and anaerobic filter methaniser	7 + 4	5.65	2+2.3	96	0.42	(Verrier D, et al., 1987)

Figure 7: The performance of different anaerobic processes for FVW

The anaerobic digestion procedure can be divided into the following basic steps:

Hydrolysis is the first step of the anaerobic digestion, in which the complex organic polymers are hydrolyzed into monomers. In the next step, called fermentation or acitogenesis, the monomers that have been produced are now degraded. The acetogenesis stage follows, where the convertion of fatty acids by the acetogenic bacteria , takes place. At the last step of the procedure, the methanogenesis, the methane producing bacteria complete the process by producing the methane gas (Nayono, 2010).

For the efficiency of the process, a number of factors must be taken into account. It has been reported that too high or too low temperatures affect negatively the microbial growth and therefore the energy production (Khalid, et al., 2011). A proper temperature rate for biogas production ranges between 35-37^{o}C, according to a research

(Briski F., et al., 2007). Another important factor for the anaerobic digestion is the Ph range. According to researchers, for methanogenesis, the Ph must range around 7.0 for an optimum process (Huber, et al., 1982). It has also been obtained that the performance of the anaerobic digestion depends on the moisture level of the contents. High moisture contents, with a humidity of 60-80%,a attribute to highest production rates, according to a research (Buallagui H., et al., 2003). Last but not least, critical role in anaerobic digestion plays the C/N ratio in the organic material. It has been suggested that the optimum C/N ratio for FVW ranges between 22-25, according to Guermond et al. and Lee et al (Guermoud N, et al., 2009) (Lee D.H., et al., 2009).

3 Research Objectives and Methodology

3.1 Methodology

The main focus of the waste management procedure in the grocery market is to ensure proper disposal of waste from activities performed by the grocery retailers in order to keep waste to a minimum level. Waste management is an essential tool for the profitability and green image enhancement if it is implemented at every level of grocery market's operations. Furthermore, it contributes to the regulatory risk minimization by integrating proven environmental practices. Present Thesis aims to investigate and respond the following research questions (RQ):

RQ1) What is the volume of fruit and vegetable waste produced at the retail sector?

RQ2) What are the waste management methods used?

RQ3) What are the optimum organic waste managements for the grocery retail sector?

This Thesis aims to respond to the aforementioned RQ through an extensive literature search and a qualitative study on an operational environment. This study will be based on a mixed method approach where questionnaires and interviews are used together in order to identify and collect useful information (Harris and Brown, 2010). Many researchers from various disciplines, outline the benefits of using interviews during their studies (Atkinson et al., 2004; Klemick et al., 2015; Pattison et al., 2015; James et al., 2016; Henrich et al., 2016; Middleton et al., 2016). Personal interviews can be categorized based on how open or close the questions are; the structured interviews, the semi-structured interviews and the unstructured interviews. The first category includes closed type questions with multiple choice answers. The second one includes questions with a mix of predefined and open answers, while the third category has only open questions that the interviewee can respond in whatever way they like (Burnay et al., 2014). For the needs of this thesis, the semi-structured interview survey was followed in order to identify and select the required responses of the grocery retailers with the usage of the appropriate questionnaires (Appendix I).

The collected data will be analysed and the findings will be presented in order to sufficient describe the current waste management performance of the grocery market located in Thessaloniki.

3.2 Questionnaire design

The questionnaire is an important tool for gathering information for a research. It is a practical way to collect data in a short time period and provides user anonymity. However, some disadvantages that occur from a questionnaire are the dishonesty of the respondents, the lack of conscientious responses and the difficulty to analyze some questions.

My questionnaire was contacted in the Central Grocery of Thessaloniki and designed aiming to collect data for the fruit and vegetable waste and its management methods applied on store. The questionnaire is categorized in four sections for better grouping, analysis and correlation of the responds. The first section refers to demographics to collect data for the location of the research, the number of stores participated in the research, the number of employees working, the average operating time of the stores and the main commodity in the market. The second section refers to the awareness of the waste as a problem within the store and the education of the owners and the employees on this issue. The next section aims to elicit information regarding the waste management strategy of the store, such as the disposal methods, the volume of organic waste and the existence of environmental management systems applied in the stores. The last section refers to budget and costs issues compared with the waste prevention and the applied waste policy. To collect all the above data, both quantitative and qualitative questions were contacted.

This survey was conducted in November 2017 and a number of 53 traders were interviewed through semi-structured questionnaire. Furthermore, an interview was conducted with a selected number of members of Central Grocery Market of Thessaloniki in order to better understand current and future waste management planned actions. Based on the result analysis, we attempted to draft the profile of the average trader of the Central Grocery market of Thessaloniki.

Of course, the study has faced a number of limitations. Even though we employed a total random sampling of questioned traders, we might have not been in position to have a totally 100% representative sampling. Other usual limitations also applied to our research, such as respondents were experiencing work overload and were negative on allocating time to respond to our questions, many definitions-terms were repeatedly explained to them to adverse knowledge limitations and lastly, they were reluctant to provide many details of their exact losses-financial benefits for their waste management related actions.

3.3 The case study of Central Grocery Market Of Thessaloniki

3.3.1 Installations

The Central Market Of Thessaloniki is an anonymous company, SA, that was established in 1966 as “Central Fruit and Vegetable Market of Thessaloniki” (KATH). However, in 1975 the KATH was established in new facilities that operate until now. The Greek Government is the only shareholder and it is supervised by the Ministry of Economy, Development & Tourism and the Ministry of Rural Development & Food .

The Central Market of Thessaloniki is the second largest in Greece and consist of the Central Grocery Market and the Central Meat Market. The company is intended to be the most beneficial, for the production and consumption, trade in fruit, vegetables and meat, by ensuring the quality and hygiene of the products traded. In addition, it confers on its premises favorable terms and conditions for the wholesale of fruit, vegetables and meat, and ensures the functioning of the free market and healthy competition for the benefit of both the producer and the final consumer. Furthermore, the Central Market Of Thessaloniki is active member of the World Union of Wholesale Markets (WUWM).

The installations of the Central Market of Thessaloniki are located on the 7th Km of the National Road Thessaloniki-Athens. The installations occupy a land area of 272 acres, of which 43 acres cover shelters, which include the Grocery Market with 280 stores distributed in 4 cores of 70 stores each, with a surface area of 60 m2 each, as well as the Creapark, with 24 stores of 165 m^2 each.

At the Central Market of Thessaloniki are also the First Imports – Exports, the 1st Chemical Service, The Veterinary Laboratory, the Agricultural Bank, office transports, accounting offices, stationery and packaging items as well as restaurants.

The amount of fruits and vegetables that are daily distributed are up to 600-800 tones, and approximately 600 tons of meat a weak. The number of incoming vehicles per day amounts to an average of 2000 vehicles (cars, agricultural vehicles trucks etc.) while the number of people working and visiting the market is close to 5000.

3.3.2 Actions towards fruit and vegetable waste

A specific action towards the adoption of circular economy and in the context of reducing food loss was organized by the company, called “Save the Food”. In December 2017, the 1st organized food rescue operation from recovered agri-food products from its traders took place in Thessaloniki. Non-tradable products were collected and 5000 portions of food were offered to vulnerable social groups with the cooperation of the Association Central Market Laureates of Thessaloniki, the Meat Merchandise Association and Of-living animals of Macedonia-Thrace-Thessaly, as well as collectives of the city. The action “Save the Food” was organized in keeping with Greece's commitments

and was drafted in accordance with the directives of Food and Agricultural Organization, FAO, and General Assembly of the United Nations. The main objective of this initiative was to inform and integrate consumers, state actors and businesses into the circular economy and recycling procedure. The ultimate goal of the administration of Central Market of Thessaloniki was that this action could be the trigger and lead the way to create a permanent structure for the management of non-marketable food.

The Central Market of Thessaloniki, aiming to address the issues of environmental protection, poverty and social exclusion, developed another action called "Supporting Social Enterprises in combating poverty and social exclusion", ("Social Plate"). The project is implemented between the cooperating countries Greece and Bulgaria under the program "INTERREG V-A Greece – Bulgaria 2014-2020" and started in April 2018. The main concept of this project is to reduce food loss, feed the weakest social groups and provide work to long-term unemployed. For the implementation of the action, the Central Market of Thessaloniki as a head and the International Institute of Education, Technopolis, founded the non- profit organization "Social Food Aid Urban Non-Profit Company". Non-tradable products are delivered daily by the trader's of KATH to the organic waste management office of the company. The products are separated into suitable for consumption and not, under the supervision of the quality control officer and then repackaged and redistributed, cooked or not, by social charges to vulnerable groups in our society. In the first four moths of operation of the program, 78.312,30kg of fruit and vegetables were handled, of which 43.506,50kg were offered to fellow citizens.

The aforementioned information was derived through a number of open interviews with the board members of KATH.

4 Research analysis

4.1 Trader's profile

The average KATH trader employees 2 persons and markets approximately 184 tons of fruits and vegetables per month. In the majority, the average trader considers waste generation as a significant social issue, even though, so far, they have not participated in any training regarding the environmental performance of the company and the waste management methods. In the majority, they dispose their waste in regular waste bins provided by the municipality and they are reluctant to employ a different method unless this derives financial efforts for their operation. Furthermore, they have not employed any environmental management system for the operation. The result is an amount of 1,2 tons of organic waste (fruits and vegetables) to be disposed in the municipality bins per month.

4.2 Interview outcome

A supplementary set of interviews were conducted with the board members of KATH. They were all in line, that KATH needs to enable the traders and provide the framework for a more efficient waste management. They recognize the communication and information gap and aim to address it through targeted and educational activities. Furthermore, they intend to strengthen future activities, mentioned in section 3.3.2 in order to minimize the environmental footprint and the total amount of KATH waste.

4.3 Descriptive statistics of the basis of the questionnaire

Based on the questionnaire presented in Append I we present some analysis of the questionnaire responses and interview results below.

1) How many stores do you own?

# of stores	Frequency	%
1	39	74%
2	11	21%
3	3	6%

Figure 8: The average number of stores for each trader

The majority of the traders participated in this research own 1 store, representing 74% of the total respondents. Only a small percentage own more than 2 stores, which holds the 6% of the responses.

2) How may employees are working in the store?

# of employees	Frequency	%
0	4	8%
1	21	40%
2	13	25%
3	13	25%
4	1	2%
5	0	0%
6	1	2%

Figure 9: The average number of employees

Most of the traders employee 1 person, representing the 40% of the total respondents. However, half of the respondents prefer to employee 2 or 3 persons in their store. The number of employees depends mainly on the volume of the fruits and vegetables that each store trades. This determines and the “size” of the store.

3) How many years is the store operating?

Although the new installations have been established since 1975, the respondents of the questionnaire seem to operate their stores for 11 years on average.

4) *What do you mostly trade?*

Type of product	Frequency	%
BOTH	26	49%
VEGETABLES	22	42%
FRUITS	5	9%

Figure 10: The anerage type of tradable product

Most of the traders prefer to market both fruits and vegetables, and only 5 of them prefer to have as a primary product only fruits.

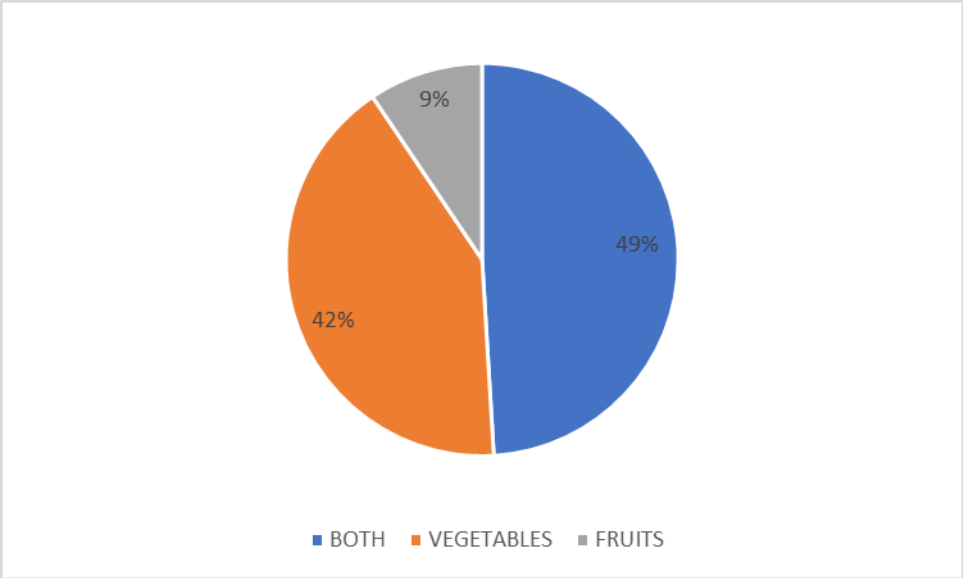

Figure 11: The average type of tradable product in a pie

This means that the 49% of the traders market both fruits and vegetables, 42% only vegetables and only 9% market just fruits.

5) *What is your main fruit or vegetable for trade?*

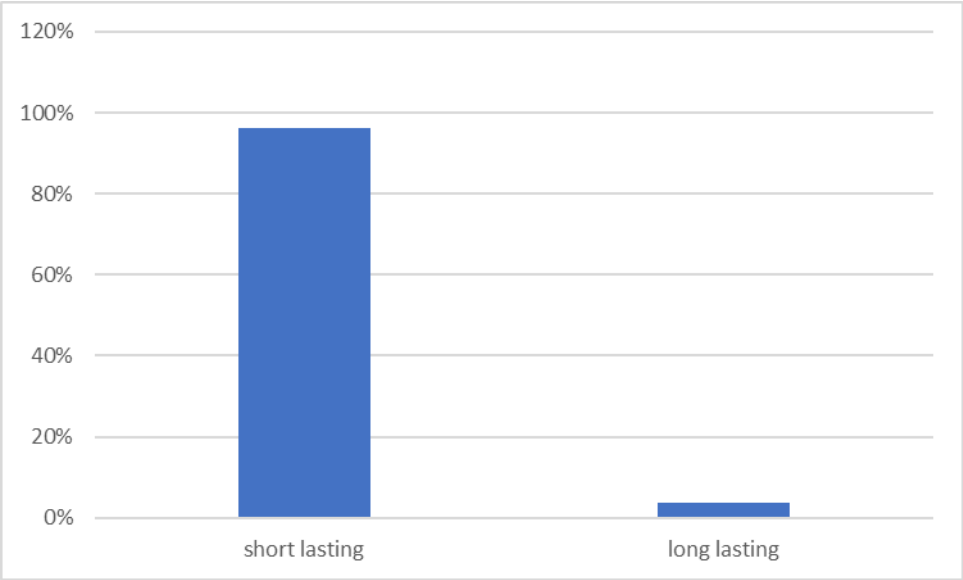

Figure 12: The percentage of short-lasting and long lasting products

A significant percentage of the fruit and vegetables that are being trade are short lasting which lead to high amount of food waste generated more often.

6) *Do you consider waste generation as a significant social issue of the community?*

Significance	Frequency	%
1	0	0%
2	1	2%
3	17	32%
4	19	36%
5	16	30%

Figure 13: The responses regarding the significance of waste

The majority of the respondents consider the waste generation as a significant social issue, while only 2% of the respondents believe that it does not affect the community. This results that the majority of the traders are aware of the waste generation problem which increases through the years, and needs to be addressed mainly in the big grocery markets which are the biggest producers of organic waste.

7) Has the owner or the staff participated in training/educational seminars with regards to the environmental performance of the company?

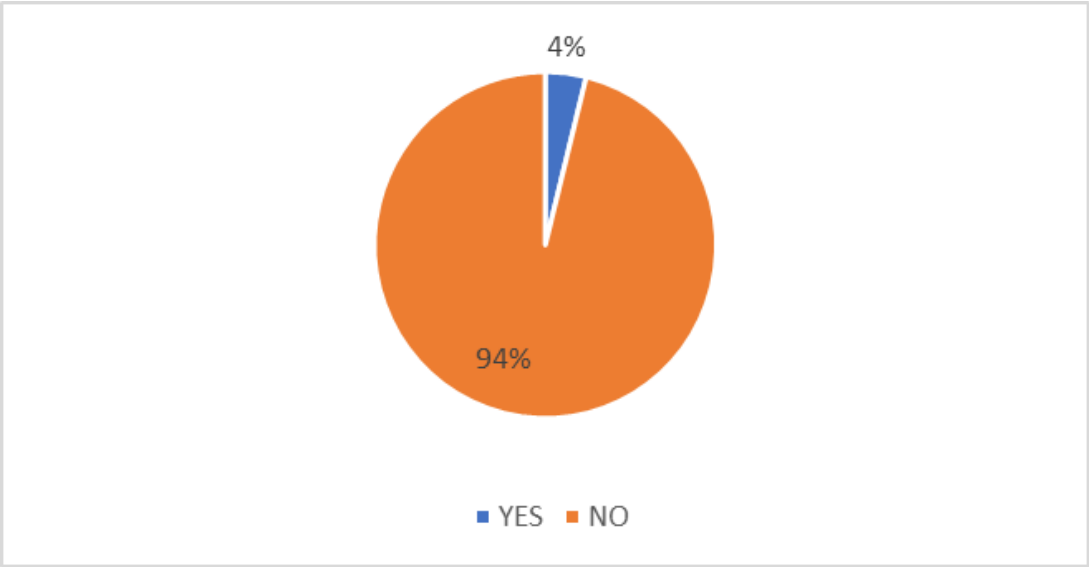

Figure 14: The responses regarding the question 7

Although respondents seem to be environmentally aware, the 94% of them have never participated in relevant training or educational activities.

8) *Has the owner or the staff participated in training/educational seminars with regards to waste management within the store?*

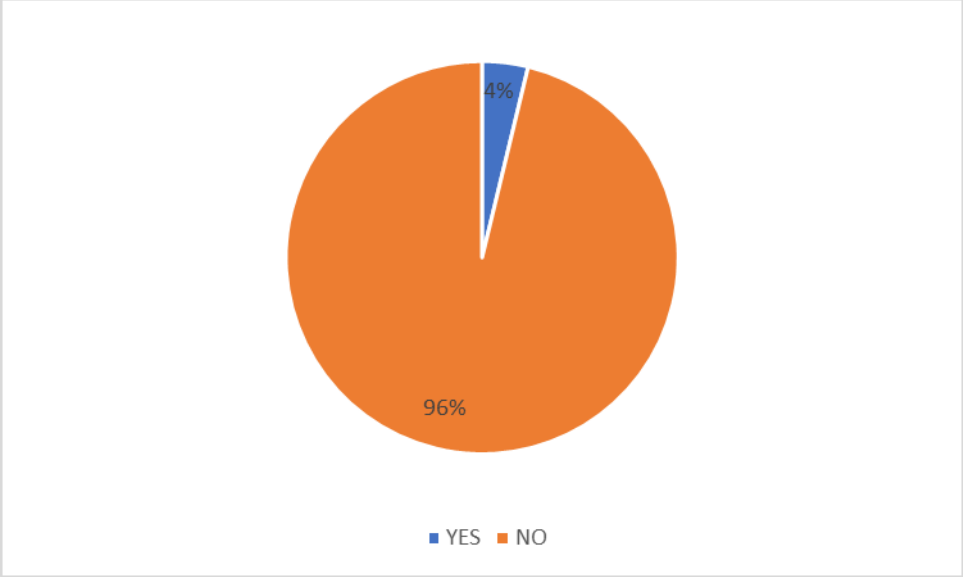

Figure 15: The responses regarding the question 8

In addition, only 4% of the respondents have participated in training/educational seminars with regards to waste management within the store. This result is significantly small regarding the question 6 which result to high environmental awareness.

9) *Is there any waste awareness campaign that the store is/has involved?*

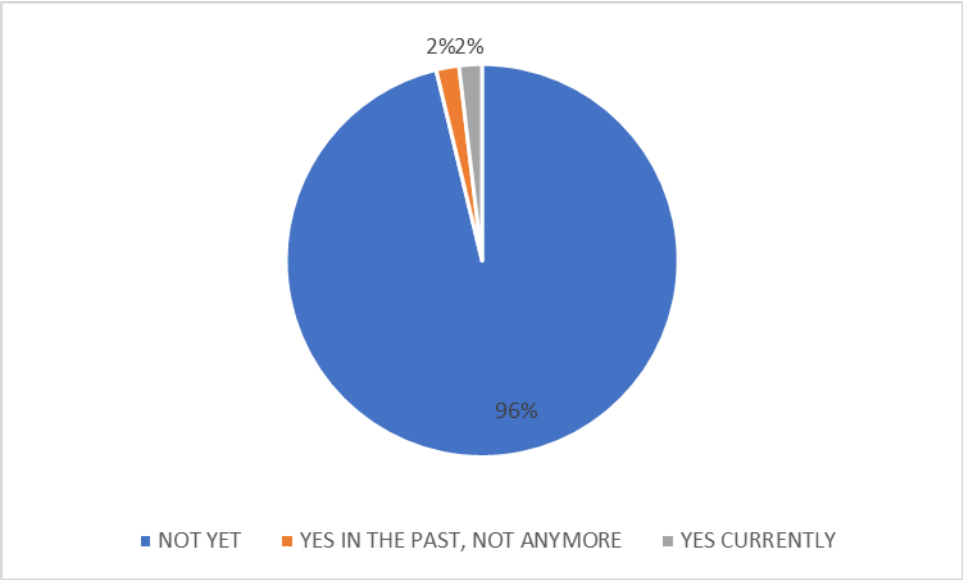

Figure 16: The responses regarding the involvement in waste awareness campaign

The overwhelming majority of the traders responded that they have not participated in any waste awareness campaign yet. As it has been mentioned before, in April 2018, a waste awareness campaigned started in KATH. However, although the questionnaire was held in November, none of the respondents answered "No but it is in the next year's plans". The reason for that was that they were not informed in time, but only when the campaign was ready to start.

10) What is your primary disposal method?

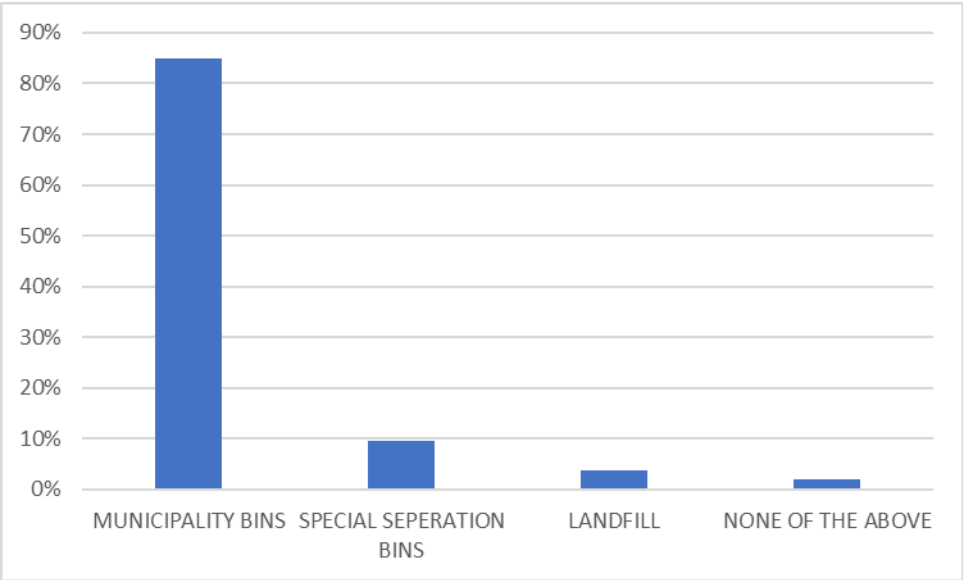

Figure 17: The disposal methods applied in KATH

The majority of the traders dispose their organic waste in the regular bins that are provided by the municipality. Only the 10% of the respondents use the special separation bins. The reason for that small percentage is that there are only two special separation bins provided in the market and are placed in the entrance and the exit of the area. Due to the big distances across the market area, the traders prefer the regular municipality bins that are easier to contact. Another outcome that must be pointed here is the very small percentage that produce no waste, as they claim, because they donate the fruits and vegetables that are no more tradable to charities, food banks and breeders for livestock.

11) How would you like to dispose your waste?

Method	Frequency	%
BETTER WASTE MANAGEMENT	13	25%
NO ACTION	32	60%
WASTE MNG COMPANY	3	6%
BETTER WASTE PLANING	1	2%
ORGANIC WASTE MANAGEMENT	1	2%
FOR BREEDERS	1	2%
CHARITY	1	2%
PROCUCTION\CONSUPTION	1	2%

Figure 18: Traders preference on disposal methods

The 60% of the respondents, which is the majority, proposed no action. The reason for that was that they are not informed for the available organic waste management methods and that for could not propose any action. As a result, the 25% proposed a better waste management of the organic waste, with no particular method or action. Only a few proposed specific actions, such as donation to charities and breeders for livestock.

12) Are any environmental management systems applied to the store?

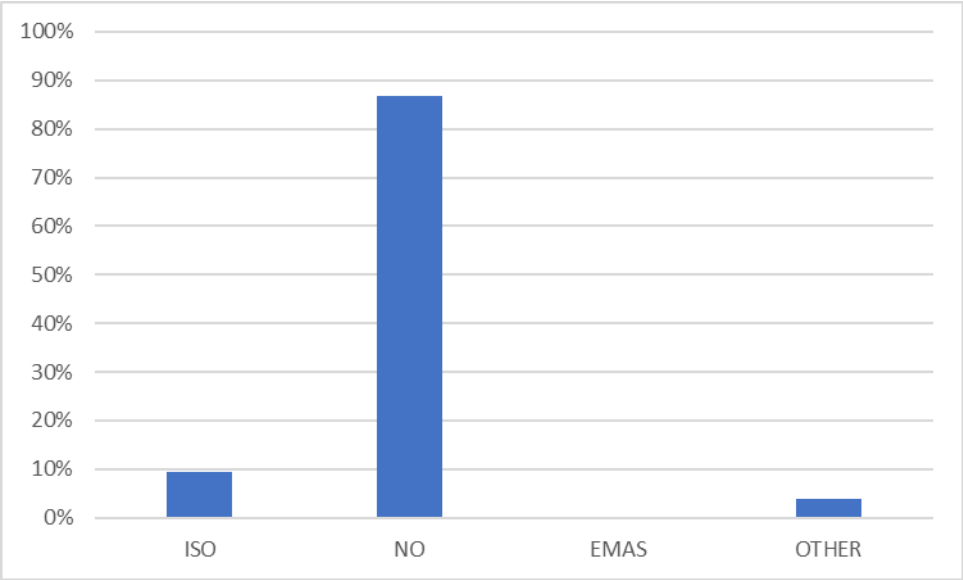

Figure 19: The existence of environmental management systems at KATH

A small percentage of traders only apply an environmental management system to their store. The reason for this is that the environmental management systems are not obligatory and traders have not adopted any of them.

13) *Could you please estimate the organic waste (tons) generated per month in store?*

On average, each operator creates about 1.2 tons of organic waste every month. This is an important amount of organic waste, especially if it is considered that the KATH is consisted of 280 grocery stores. The result is 336 tons of organic waste produced in KATH every month.

14) *Could you please estimate the volume (tons) of fruits and vegetables you trade per month?*

From the responses results that every operator in the KATH manages and markets 184 tons of fresh fruits and vegetables per month. Since KATH is the central grocery market for the western and northern Greece, this result is logical.

15) *Do you think that waste volume is increased during specific seasons of the year?*

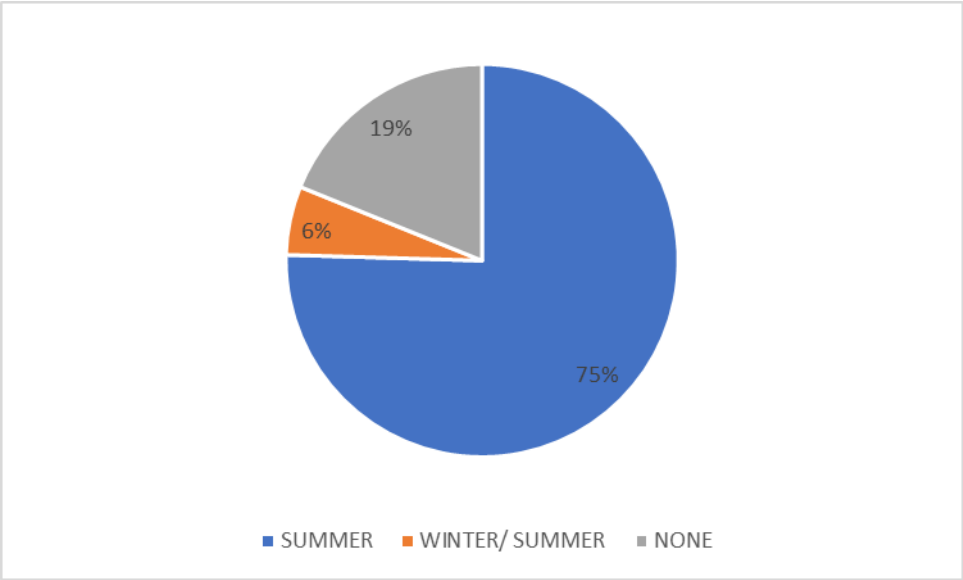

Figure 20: The responses regarding the question 15

The waste volume increases during the summers according to the responses of the 75% of the traders. The reason for this is the heat that is altering the products. Although the stores have installations with refrigerators for the maintenance of the products, the increased heat affect the lifetime of the fruits and vegetables. The 19% of the respondents claim that winter affects the lifetime of the products as much as the summer. The low winter temperatures have the effect of frosting the fruits and vegetables, with the result that a larger volume of non-tradable is produced.

16) *Do you think that waste management would lead to the avoidance of significant economic cost for the store?*

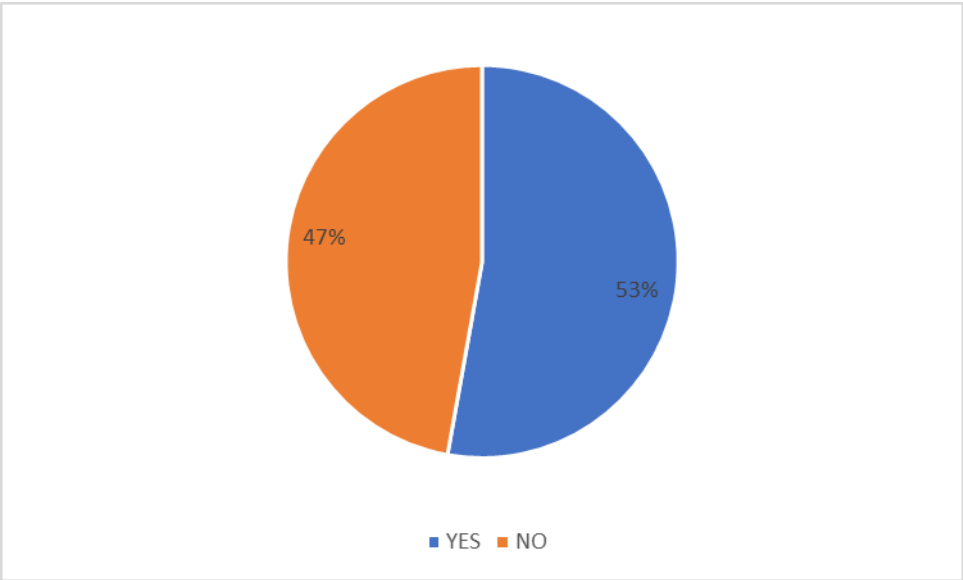

Figure 21: The responses regarding the question 16

Although there is a small defference between the results, the 53% of the respodents believe that a better waste management system could lead to the avoidance of significant costs for the store. The rest 43% that responded no was because they believe that

17) Would you consider to change your waste management method if this would result to the avoidance of economic cost for the store?

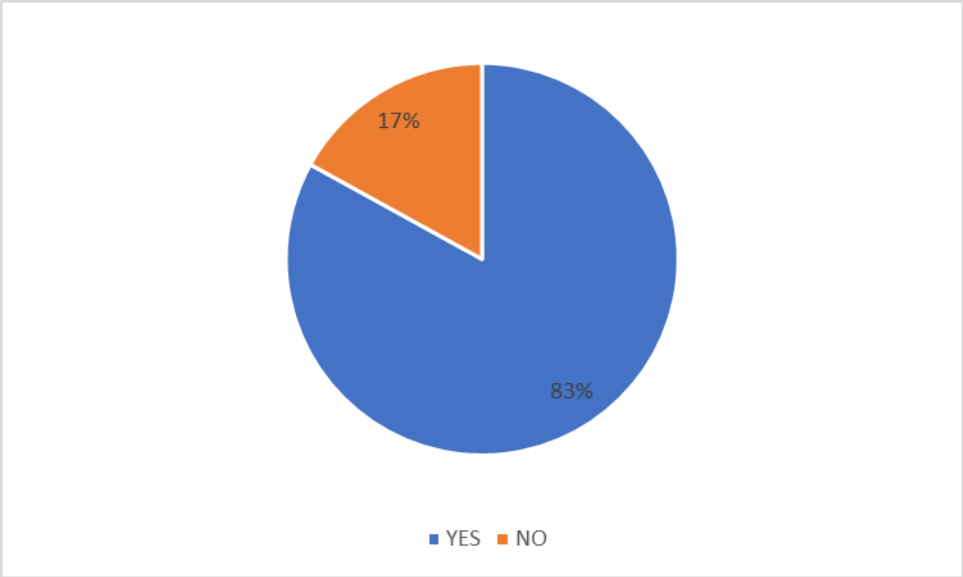

Figure 22: The responses regarding the question 17

The vast majority of the respodents are willing to change their wast emanagement method if this would result to the avoidance of economic cost for the store.

5 Conclusions

The scope of this Thesis was to identify and examine the volume of organic waste produced in KATH, the current waste management systems that are being applied (if any) and to format a suggestion for a more efficient waste management scheme for the daily operations of KATH.

We have identified that KATH and hosted traders are producing an extensive amount of waste and up-to-date they have not applied a concrete and holistic waste management approach apart from attempting to reduce the amount of food waste, by gathering and donating products that are close to their spoilage date to food banks. Although, they do showcase various levels of environmental awareness, and would be possible to adopt waste reduction and waste management schemes, they need to be persuaded of the advantages prior to its implementation. A leading factor that could steer the KATH and especially the traders towards more efficient waste reduction and waste management systems would be to highlight their direct and indirect “profit” ei-

ther in monetary or non-monetary values. In additional, educational and training seminars shall be performed in order to inform traders and KATH members of waste management techniques as well as to enable a more systemic and synergetic approach among members. Early KATH actions, gathering and donating fruits and vegetables to food banks could be the first step for a more holistic approach. An additional practice that could be implemented similarly to the food bank would be to gather the already semi-soiled or soiled products that could not be donated to food banks and sell them as a livestock food source. On the basis of the additional profit that such a scheme could deriver for the traders would make the adoption of this scheme easier. Furthermore, if KATH would wish to employ and invest in turning KATH waste into profit, they could decide to invest in composting technologies and centrally manage the collection, the processing and the market aspects of the derived agro-fertilisers.

Currently, KATH is planning to implement a number of additional actions and it might be useful to reassess the opinion and the actions of the traders within a two-year period time.

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7 Appendix I - Questionnaire

Research on organic waste management in the Central Grocery Market of Thessaloniki

Demographics

The following questions aim at gathering information about specific characteristics of each store

1. **How many stores do you own?**

- One
- Two
- More than two

2. **How many employees are working in the store?**

- One
- Two
- More than two

3. **How many years is the store operating?**

- ……

4. **What do you mostly trade?**

- Fruit
- Vegetables
- Both

5. **What do you mostly trade?**

- …….
- …….
- …….
- …….

Awareness

This section refers to the awareness of the waste as a problem within the store and if this is communicated among the staff members but also to the public.

6. **Do you consider waste generation as a significant social issue of the community?**

1 2 3 4 5
Less significant o o o o o Very significant

7. **Has the owner or the staff participated in training/educational seminars with regards to the environmental performance of the company?**

- Yes
- No

8. **Has the owner or the staff participated in training/educational seminars with regards to waste management within the store?**

- Yes
- No

9. **Is there any waste awareness campaign that the store is/has been involved?**

- Yes, currently
- No, not yet
- Yes, in the past but not any more
- No but it is in the next year's plans

Waste management

The following questions aim at eliciting information regarding the waste management strategy of the store

10. **How do you dispose your waste?**

- In the bins provided by the municipality
- There are special separation bins in site
- Landfilling
- There is a subcontracted company who deals with it

11. **How would you like to dispose your waste?**

- ……

12. Do you think that a part of the waste generated could be prevented with better planning?

- Yes
- No

If yes provide an example

……
……

13. Are Environmental Management Systems applied in the store?

- ISO
- EMAS
- Other
- No

14. Could you please estimate the organic waste (tons) generated per month?

- ……..

15. Could you please estimate the volume (tons) of fruit and vegetables you trade?

- ……

16. Do you think that waste volume is increased during specific seasons of the year?

- Winter
- Spring
- Summer
- Autumn

17. **Do you think that waste management would lead to the avoidance of significant economic cost issue for the store?**

- Yes
- No

18. **Would you consider to change your waste management method if this would result in the avoidance of economic cost for the store?**

- Yes
- No