Understanding waste management practices in the commercial food service sector

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ABSTRACT

Long working hours, the increased participation of women in the labour force, the growing middle class, as well as the convenience offered by restaurants have greatly accelerated the growth of the commercial food service sector across the world. This is also true for South Africa where eating outside of the home has become more prevalent. South African food consumption patterns show a rise in the consumption of food outside home while consumption of home cooked meals is decreasing. The expansion of the commercial food service sector comes with an increase in the amount of waste generated by the sector, adding to the high volumes of waste that municipalities are grappling with. Municipal efforts towards diversion of waste from landfill tend to focus more on household waste, while waste coming from restaurants receives less attention. As a result, most of the waste generated in restaurants is disposed at the landfills as mixed waste.

The aim of the study was to understand waste management practices in the commercial food service sector to identify opportunities for waste reduction and recovery of resources through source separation. The study was conducted in twenty restaurants of two malls located in eThekwini metropolitan municipality. A triangulation approach, which involved the use of both qualitative and quantitative research methods in one study, was adopted to understand waste management practices in the commercial food service sector. A waste characterisation study was conducted to understand waste composition and generation rates of restaurants; observations were used to uncover waste management practices in the restaurants while semi-structured interviews were used to understand sources and reasons for waste generation.

Based on the waste characterisation results, waste generation rates estimated indicate that 10.25 tonnes is generated by Mall1 restaurants and 9.41 tonnes by Mall2 restaurants annually. More than 74% of waste generated by the sampled restaurants can be recovered through recycling (paper, plastics, glass and tins) and composting/anaerobic digestion (food waste). Food waste accounted for close to 50% of restaurant waste that was sorted in both Mall1 and Mall2. Restaurant managers cited poor stock rotation, over-purchasing of stock, negligence from the staff members, placing wrong orders, preparation of excessive amount of food, dissatisfaction with the taste of food and people ordering more food than they can eat as the main reasons for food waste generation. The results also showed that restaurant waste cooking oil ranged between 500ml to 150 litres per week. Currently, waste from restaurants is handled by the same service provider contracted by the management of both shopping malls. Unsorted waste from the restaurants is collected and sorted for recycling while residual waste is taken for landfilling.

The composition of waste and current waste management practices by restaurants in both malls highlight the need for improved waste management practices. With the expected growth in the restaurant industry, improved waste management practices at the source of generation, which appreciate waste as a resource and encourage diversion of waste away from landfill is required. This may include implementation of source separation schemes to enhance recycling and ensure diversion of clean recyclables. Waste prevention and reduction through reducing material wastage and green purchasing should be given greater priority as dictated by the waste hierarchy. Food waste can be reduced by providing training to restaurant staff members, procurement of food that is needed in the business, carefully checking ingredients during receiving of goods, practicing FIFO method, improving communication between staff member and customers during order taking, giving surplus food to staff members and also measuring food waste.

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List of Abbreviations

CSIR	Council for Scientific and Industrial Research
CSR	Corporate Social Responsibility
DEA	Department of Environmental Affairs
DSW	Durban Solid Waste
DST	Department of Science and Technology
EPA	Environmental Protection Agency
EIU	Economist Intelligence Unit
2Es	Energy and Efficiency
FIFO	First In First Out
FSC	Food Supply Chain
FW	Food Waste
GNI	Gross National Income
GRA	Green Restaurant Association
GDP	Gross Domestic Product
IWMP	Integrated Waste Management Plan
NAFTC	Netherlands Agro Food and Technology Centres
NRA	National Restaurant Association
NOWCS	National Organic Waste Composting Strategy
3Rs	Reduce, Re-use and Recycle
REC	Research Ethics Committees
SOP	Standard Operation Procedure
SSS	Source Separation Scheme
RSA	Republic of South Africa

CHAPTER 1: INTRODUCTION

1.1 Background

Environmental protection is widely acknowledged as a key principle in a business's operation. Heightened concern about environmental protection started as early as 1960 in response to environmental impacts of industrial and economic growth (Paterson and Kotzé, 2009; Ismail, Kassim and Zahari, 2010). Ever since then there has been an emphasis on businesses to change from a profit focused business approach to a more integrated business approach which supports adoption of green practices (Tan, Muzafar, Tan and Choon, 2017). Hospitality scholars often conceptualize green practices under the framework of corporate social responsibilities (CSR) (Ismail *et al.*, 2010; Kwok, Huang and Hu, 2016). CSR is a company's voluntary commitment to environmentally friendly activities to reduce social and environmental effects that result from the operation of the business (Choi and Parsa, 2007; Ismail *et al.*, 2010). The inherent goal of CSR is to encourage businesses to add value to the society through inclusion of the concept as a core business activity instead of treating it as a separate consideration (Choi and Parsa, 2007).

The restaurant industry is one of the industries that have realized the need to engage in environmentally friendly practices and contribute towards sustainable development (Choi and Parsa, 2007; DiPietro, Gregory and Jackson*,* 2013; Jang, Chung and Kim, 2015; Kwok *et al.*, 2016). Although there is increasing concern about the environment among restaurants, there has been little evidence of genuine long-term commitment (Faulkner, Carlisle and Viney, 2005). Adoption of green practices within the restaurant industry has tended to be slower compared to other components of the hospitality industry (DiPietro *et al.*, 2013). This is particularly true in the developing countries where economic and social equity issues are considered more important than environmental issues (Kasim and Ismail, 2012). When investigating drivers and barriers towards implementation of environmentally friendly practices in restaurants, Kasim and Ismail (2012) pointed out that top managers are usually disinclined to invest in environmentally friendly practices mainly because adoption of environmentally friendly practices is believed to impact negatively on the performance of the business instead of creating sustainable and competitive future gain (Faulkner *et al.*, 2005). The view is that adoption of green practices deviates the business from the primary objective of generating profit, controlling costs, creating efficient production and maintaining markets which many businesses live by. However, there are restaurants that have adopted environmentally friendly practices. McDonalds is the mostly cited restaurant group when it comes to adoption of green practices (Wang, 2012; Kasim and Ismail, 2012; DiPietro *et al.*, 2013; Ismail *et al.*, 2010; Jang, Kim and Bonn, 2011). The green practices

implemented by this company include energy efficiency and innovation, sustainable packaging, waste management and also green building design (Kasim and Ismail, 2012).

Several studies indicate that the restaurant operations evidently have a major effect on the environment through use of natural resources and waste generation (Davies and Konisky, 2000; Revell and Blackburn, 2007; Tibon, 2012; Kasim and Ismial, 2012). When investigating the influence of green restaurant decision making, Teng, Wu and Huang (2014) reported that the restaurants result in adverse environmental impacts through overconsumption of natural resources and pollution. The restaurant industry is one of the most water and energy intensive industries with energy usage almost five times more per square foot than any other type of commercial building (Jauhari, 2014). Energy sources used for the operations of restaurants includes electricity, fossil fuels and certain types of vehicle fuel. Most of this energy gets consumed during preparation of the food and ventilation. For example, in the United Kingdom the restaurant industry is estimated to contribute about 60% of carbon emissions per year (Revell and Blackburn, 2007). Water plays a crucial role in the restaurant sector for undertaking activities such as food preparation, dish washing, laundry and sanitation (VanSchenkhof, 2011; Jauhari, 2014). In California about 6% of the total water usage in the commercial and industrial sectors takes place in kitchens with restaurants being the largest user in this sector (Jauhari, 2014). Overconsumption of resources and the resultant pollution usually highlight the need for improvement (Chavan, 2005). Given that the industry is expecting to see considerable rates of growth in the near future, it is beyond doubt that implementation of environmental practices is crucial in the restaurant industry and that the industry needs to ensure that the environment is protected, the carbon footprint reduced and harm to ecosystems avoided (Omidiani and HashemiHezaveh, 2016).

Waste production and disposal is one of the most visible and obvious consequence of restaurant operations. Researchers in the hospitality industry have explored "environmentally friendly" or "green practices" in the restaurant industry from different standpoints (Choi and Parsa, 2007; Ismail *et al.*, 2010; Jang *et al.*, 2011; Chou, Chen and Wang, 2012; Tibon, 2012; Wang, 2012; Ismial and Kasim, 2012; DiPietro *et al.*, 2013; Wang, Chen, Lee and Tsai, 2013; Teng *et al.*, 2014; Hilario, 2014; Jang *et al.*, 2015; Chen, Cheng and Hsu, 2015; Kwok *et al.,* 2016; Tan *et al.*, 2017). Kwok *et al.*, (2016) has looked at the green attributes of restaurants with the aim of identifying the important attributes of green practices from a consumer perspective and also to understand how these attributes influence consumer's behavioural intensions. Wang (2012) explored the importance and the impacts of green practices in a restaurant. Hilario (2014) investigated responsiveness of fast-food chain managers towards the implementation of green practices in restaurants. However, there has been limited research specifically looking at waste management.

This topic tends to be overlooked in the hospitality literature and is usually submerged in the literature discussing environmental management (including all aspects of the environment such as water and energy use) and often does not include much on the waste management aspect of the environment.

Nonetheless, restaurant waste is categorised as commercial waste, which also includes waste that comes from streets, public areas and also institutions (Shekdar, 2009). In developing countries, commercial waste is the second largest amount of waste (10–30%) after households (55–80%) which generate the bulk of the municipal waste (Miezah, Obiri-Danso, Kadar, Fei-Baffoe, and Mensah, 2015). The local authorities are usually the ones that are responsible for the management of this service (Zhu, Asnani, Zurbrugg, Anapolsky and Mani, 2008). In South Africa, Section 156 (1) (a) of the South African Constitution in conjunction with schedule 5-part B of the constitution places solid waste disposal, refuse dumps and refuse removal as the sole responsibility of the local government (RSA, 1996).

Municipal solid waste management has proven to be a challenge, especially in many developing countries. In these countries, waste management is usually characterized by inefficient collection services, littering, illegal dumping, and informal waste picking at the landfills (Ogawa, 2000 in Manaf, Samah and Zukki, 2009). The problem of solid waste management is common in many rapidly growing cities or towns due to increased waste generation. Increased waste generation has been linked to rapid urbanisation, economic development, high living standards, ever increasing population growth, geographic location, and administrative systems (Wang and Nie, 2001). Approximately 1.3 billion tonnes of municipal solid waste is generated per year globally and projections show that this amount of waste is expected to rise to 2.2 billion tonnes by 2025 (World Bank / Hoornweg and Bhada-Tata, 2012). Exacerbating the issue of increased waste generation is the limited space available to landfill the waste that is produced on a daily basis. The threat posed to the natural ecosystem and human health by the ever increasing waste generation, as well as lack of land for new landfills that are in close proximity to the points of generation, is a concern.

Thus, sustainable waste management options are necessary in the restaurant industry. This will help reduce waste generation and also encourage diversion of waste away from landfill thereby alleviate the problem faced by the municipalities. Sustainable waste management options within the restaurant industry will also lead to other benefits such as reduced waste disposal costs, improved business image as well as health and safety benefits (Pirani and Arafat, 2016).

1.2 Problem statement

The hospitality sector is experiencing significant growth across the world (Pirani and Arafat, 2014). For example, Japan's food service industry recorded sales of R 3.99 trillion (1JPY = 0.12 ZAR) in 2016 (Otsuka, 2017). In India the restaurant sector is valued at R 60.05 billion (1USD = 13.47 ZAR) and is expected to grow to R 1009. 88 billion (1 USD = 13.47 ZAR) by 2021, with an annual growth rate of 10 percent (Sood and Mishra, 2016). The South African food service sector is not an exception, this has been highlighted in a study on "Expansion Opportunities in South Africa's Competitive Fast Food Market" which showed that South Africa is expected to see significant growth between the year 2015 and 2018 (BMI, 2015). The expansion of the food service sector consequently comes with an increase in the amount of waste generated by the sector, adding to the high volumes of waste that municipalities are grappling with. Theoretically, the food service sector generates a significant amount of packaging, organic food waste and waste cooking oil. Unfortunately, the majority of waste produced in the restaurants is disposed at the landfills as mixed waste, which consequently imposes pressure on the landfills. Despite the considerable amount and the reported high recyclability of waste generated by the commercial food service sector, municipal efforts towards diversion of waste from the landfill tend to focus more on household waste while neglecting the relative small amount coming from restaurants (Tatàno, Caramiello, Paolini and Tripolone, 2017). According to Tatàno *et al.,* (2017), a comprehensive perspective of sustainable and integrated management should consider all waste, not only limited to the majority that is generated by households but also considering the non-negligible contributions of commercial and institutional waste, which includes restaurants as a significant waste generation source. The reported composition of waste generated in the commercial food service sector presents an opportunity for diversion of waste away from landfill through recycling. Understanding the nature and the volume of the fractions comprising the waste stream will assist in knowing the volume and fractions of waste that can be separated at source to enhance recycling and potentially divert waste from landfills.

Also, the commercial food service sector together with other sectors including all types of accommodation (bed and breakfast accommodation, hotels and guest lodges), transport as well as tour and travel agencies form an important part of the tourism sector. Tourist's expenditure on food services is approximated to 20%, making it the third-biggest revenue stream in the tourism industry after transport and accommodation (Kasim and Ismail, 2012). Given that tourism directly depends on the environment, a disregard for environmental protection by each component of the sector is self-destructive (Chou *et al.,* 2012). Therefore, it is crucial for all components of the sector (including restaurants) to contribute to environmental protection in order to ensure that the sector remains viable.

Disposal of commercial and household organic waste (including food waste) has been identified as one of the major gaps in the eThekwini Metropolitan Municipality (IWMP, 2016). Food waste is a problematic waste stream because of its socio-economic and environmental implications. Approximately 10.2 million tonnes of food waste is generated in South Africa (Nahman and de Lange, 2013). About 5% of this waste is estimated to occur at the consumption stage of the food supply chain (Nahman and de Lange, 2013). The food service sector contributes to food wastage that occurs at the consumption stage. As one of the countries that are food insecure at household level (Altman, Hart and Jacobs, 2009), food waste prevention and minimisation in South Africa is of critical importance.

Furthermore, South Africa is considering a landfill ban on disposal of organic waste (DEA, 2013). Therefore, diversion of food waste through prevention, minimisation and composting/anaerobic digestion will require an understanding of the food service sector waste management practices as well as the reasons and drivers for these practices. In line with this reasoning, landfills in some South African cities such as the City of Johannesburg are fast reaching their full design capacity (Letlape and Gumbo, 2016). With continuous landfilling of waste, the availability of landfill airspace has become a concern suggesting alternative waste management options. Landfill space is currently not a concern in eThekwini municipality, however the closure of the Bissar landfill is an indication that the municipality might experience the same problem if actions to conserve the available landfill space are not taken.

1.3   Scope of the study

The scope of the study focused on providing insight into waste management in the commercial food service sector. Understanding waste management practices will assist in identifying potential opportunities for reducing and recovering resources through source separation. To reduce and recover waste within the commercial food service sector, there is a need for detailed research to identify basic problems such as how much is wasted, what is wasted and when wastage occurs. Therefore, this study aims to comprehensively investigate questions regarding waste management practices, types of materials generated, activities that produce waste, disposal practices as well as the reasons and drivers for these practices.

The study specifically focuses on twenty restaurants located in two malls (ten restaurants each mall) of eThekwini Metropolitan Municipality. The sample size was determined prior to the commencement of the research based on the timeframe of the study, resources available, as well as on the aim of the study. Out of the twenty restaurants that agreed to participate in the study, thirteen restaurants participated in the waste characterisation study, while seventeen restaurants participated in the interviews. The purpose of the study was to gain an in-depth understanding of

waste management practices of the sampled restaurants, with no aim of generalising the findings. Therefore, the findings of the study cannot be generalised to a wider population based on this study alone. However, good waste management practices identified in the study may be used in other restaurants or in other similar operations.

1.4 Aims and objectives

The aim of the study is to understand waste management practices in the commercial food service sector to identify opportunities for waste reduction and recovering resources through source separation. The study also aims to widen academic knowledge on commercial food service sector waste in a South African context. To achieve the aim of the study the following objectives were investigated:

1. Quantification and characterisation of the composition of restaurant waste;
2. Identifying sources of restaurant waste;
3. Determining attitudes towards reducing, re-using and recycling of waste;
4. Evaluating waste management practices at the restaurants;
5. Identifying opportunities for waste reduction and recovering of resources; and
6. Formulating recommendations for improved waste management in restaurants.

1.5 Research questions

The following research questions form the core of this research in addressing the objectives:

- What is the amount of waste generated by restaurants?

- What is the composition of the waste generated by restaurants?

- What is the potential recycling rate of waste generated by restaurants?

- How do restaurants manage their waste?

- What can be done to improve waste management in restaurants?

1.6 Research Methodology

A triangulation method which involves the use of both qualitative and quantitative research methods was adopted to fulfil the aims and objectives of the study. Data was collected by means of a literature review, observations, semi-structured interviews, as well as by a waste characterisation study. The literature review included waste management in South Africa, commercial food service industry as well as waste generation in the commercial food service industry including food waste, packaging waste and waste cooking oil. Semi-structured interviews

and observations were used to identify activities that produce waste, disposal practices as well as the reasons and drivers for these practices while a waste characterisation study was used to quantify the waste generated and the percentage by weight contribution of each waste category generated by restaurants. Figure 1-1 shows the research methodology that was adopted in the dissertation.

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  │   5 & 6      │  │characterization│  │Semi-structured interviews│ │  3, 4, 5 & 6 │
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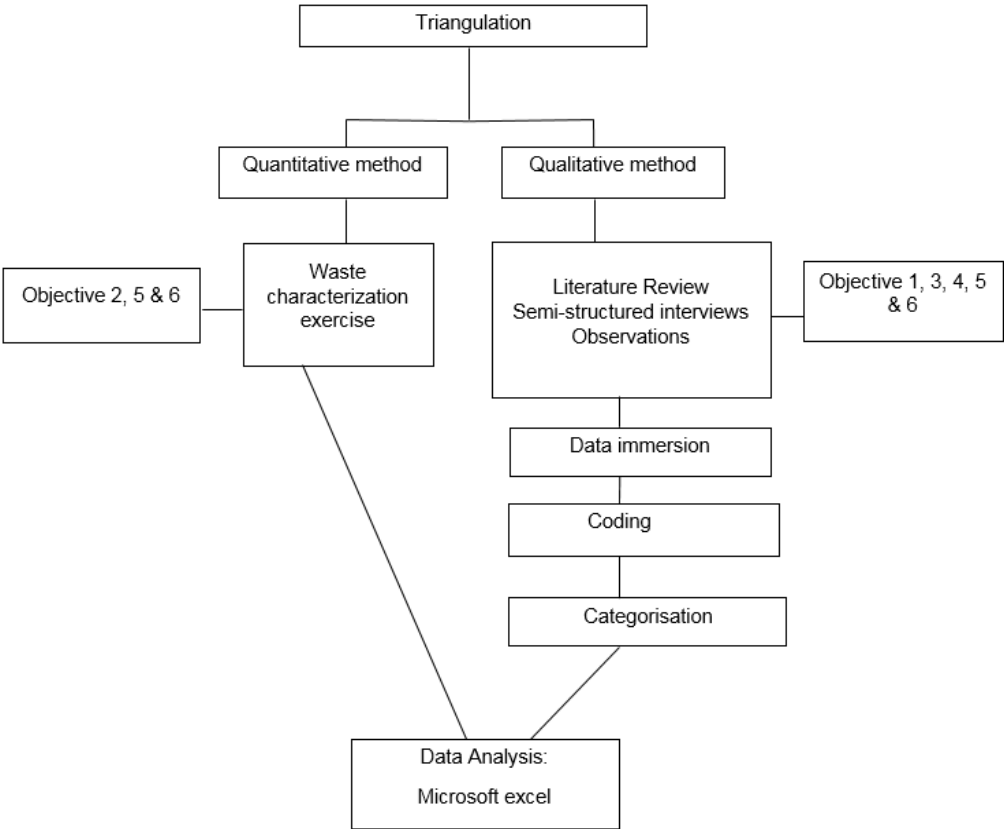
Figure 1-1: Research methodology adopted in the study

1.7   Limitations of the study

There were some limitations encountered during the research. As it is the case in all research studies involving human participants, one of the requirements of conducting this study was to obtain an ethical clearance. Delays in ethical clearance approval was one major challenge that was encountered during the study. Consequently, this resulted to time delays thereby hampering the progress of the studies as it was not possible to commence with data collection. Due to time delays, the initially planned sample size of thirty restaurants from three malls (10 restaurants each mall) was reduced to twenty restaurants from two malls to ensure completion within the timeframe of the study. This reduced sample size is, however, still regarded as appropriate for this study.

Another obstacle that was encountered during the study was the recruitment and ensuring that the restaurants fully participate in the study, as the success of the research was dependent on the participation of the restaurants. One of the roles of the participants in the study was to use green plastic bags which were provided by the researcher to capture waste generated. On the day of distribution some restaurants indicated that they still needed to get permission from the owner of the restaurants even though they had agreed to use the plastic bags when they were recruited while some took the plastic bags and never used them. This resulted to an overall participation rate of 65% in terms of waste characterisation (seventeen out of the twenty restaurants which were initially identified). Mistrust as to the nature of the study might have been one of the reasons that restaurants were hesitant and or did not fully participate in the study. Some restaurant managers admitted that they thought that the research was conducted to inform decision making for increasing waste service fees as there has been an increase in electricity and water fees.

During the literature review, it was difficult to find literature on waste management in the commercial food service sector in a South African context. A comprehensive research on waste management in the commercial service sector has never been done and therefore there was generally no background information. This did not only result in lack of rich background to the study, but it also highlighted the importance of the study in bridging the gap in the literature. Also, during the interviews, some of the restaurants were closed due to renovation and that caused further delays to the study.

Generally, waste characterisation studies should be undertaken over a period of one week to provide a reasonable representation of the real situation (Dahlen and Lagerkvist, 2008). However, in this study waste characterisation was carried out in two days (one day during the week and one day over the weekend). Waste characterisation included only waste that was disposed in the plastic bag and did not include waste materials that were separated at source such as corrugated cardboards and aluminium cans. Thus collection of waste samples might have had an influence on the findings of the study particularly on the amount of waste generation and composition as well as the degree of variability of waste materials. Also, during sample collection for waste characterisation, the researcher relied on the restaurant staff in ensuring that all and only waste generated on the sampling day was put in the green plastic bags that they were provided with (green plastic bags).

1.8   Outline of the chapters

This section of the dissertation presents and describes the chapters of the study and highlights various topics that are covered. This dissertation comprises five chapters. **Chapter one** is the

introductory chapter which provides a background to waste management in the commercial food service sector. The problem statement, limitations of the study and the overarching aims and objectives are presented in this chapter. **Chapter two** of this study reviews literature on South African commercial food service sector, waste management trends in South Africa, waste management in the food service sector, green restaurants and the main waste materials (food waste, packaging waste and waste cooking oil) generated by the restaurants. C**hapter three** describes the study area together with the research methods employed including observations, waste characterisation and interviews. **Chapter four** presents the results and discussion. **Chapter five** draws conclusions from the findings and provides recommendations on how the restaurants can improve their waste management practices. Figure 1- 2 shows outline of the chapters.

Chapter 1
- Background to the study and problem statement
- Aims and objectives of the study
- Limitations of the study

Chapter 2
- Review of previous literature on waste managent in the commercial service sector

Chapter 3
- Describes research design, instruments employed and data analysis
- Description of the study area

Chapter 4
- Interpretation of the results and discussion

Chapter 5
- Conclusion and Recommendations

Figure 1-2: Outline of chapters

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

Improving waste management and diverting waste away from landfill have been recognised as a key priorities in South Africa. The internationally accepted waste management hierarchy adopted by South Africa acknowledges waste avoidance as the most favoured and important approach towards sustainable waste management. Where waste cannot be avoided, the hierarchy recommends waste reduction, re-use, recycling, recovery and landfilling as the last option. The National Waste Management strategy (DEA, 2012) also promotes diversion of waste from landfill through minimisation, re-use, recycling and recovery. Targets set under the National strategy include diverting 25% of recyclable material from landfill and also introduction of source separation programmes in metropolitan municipalities, secondary and large cities by 2016 (DEA, 2011).

However, in spite of the good policy in South Africa, landfilling continues to be the common practice of waste management. The latest baseline study shows that approximately 90.1% of total waste generated in South Africa was landfilled in 2011 (DEA, 2012). According to Trois and Simelane (2010) municipal solid waste that is landfilled in South Africa contains more than 40% of organic waste and more than 40% of recyclable waste. Landfilling takes up landfill space and also more valuable land space. Additionally, landfilling is one of the contributors of climate change (Rahman, Shams and Mahmud, 2010). Food waste disposed at the landfills decomposes and releases methane gas thereby contributes to climate change. For example, disposal of organic waste (including food waste) is estimated to contribute 4.3% to South Africa's greenhouse gas emissions (Oelofse and Nahman, 2013). Landfilling also means that resources that could have been otherwise recovered and returned to the value chain, are lost.

To bridge the gap between policy and implementation, a more strategic approach focusing on diversion of waste from landfills is required. Kuniyal, Jain and Shannigrahi (1998, p. 300) suggests "*involvement and participation of each individual or participatory group for complete segregation at source, proper collection, transportation and environmentally sustainable disposal along with sustainable practices of reuse and recycling"*. Waste generators or service users have been regarded as one of the most important stakeholders that play a pivotal role in shaping the waste management system and these may include households, civil organisations, commercial and industrial sectors. Guerrero, Maas and Hogland (2013) also highlight the importance of identifying the stakeholders and understanding the role they have to play in the structure to establish an efficient and effective system.

The commercial food service sector is one of the stakeholders which contribute to commercial waste production. This industry is reported to produce a significant amount of packaging and organic food waste (Davies and Konisky, 2000). Unfortunately, most of this waste ends up in landfills. For example, in India, about 75 percent of the 600 000 tonnes of glass that is produced by restaurants, cafes, bars and hotels every year is not recycled, it ends up in landfills (Singh, Kaushik, Soni and Lamba, 2014). The reported composition (significant amount of packaging and food waste) of the waste generated in restaurants shows that there is an opportunity to manage restaurant waste in a sustainable manner that will support waste prevention and diversion of waste away from the landfills. However, to manage waste in a sustainable manner there is a need to understand waste management practices of restaurants in terms of the volume of waste generated, composition of waste as well as the reasons and drivers for these practices.

2.2   Solid waste management in South Africa

Historically, waste management has been approached from a point of collection and disposal. This waste management approach simply involved a process by which waste is collected from the point of generation and taken away from the people to the landfill (Lincoln, 2011). It is apparent that this approach to waste management is one of the fundamental reasons for the overweighing burden placed on municipalities today. Because section 156 (1) (a) of the South African Constitution in conjunction with schedule 5, part B of the constitution places solid waste disposal, refuse removal and refuse dumps as the sole responsibility of the local government (RSA, 1996); municipalities are faced with a challenge of managing high volumes of waste. Exacerbating the issue of increased waste generation is the limited space available to landfill in some municipalities. At the same time constructing a new landfill can be challenging due to lack of suitable land in close proximity to the point of waste generation (Oelofse and Nahman, 2013).

2.2.1   Waste generation in South Africa

It is estimated that South Africa generated about 108 million tonnes of waste in 2011. The waste generated comprised of 59 million tonnes of general waste, 1 million tonnes of hazardous waste and 48 million tonnes of unclassified waste (DEA, 2012). General waste which forms the bulk of waste generated in South Africa is mainly composed of non-recyclable municipal waste (35%), construction and demolition waste (20%) followed by mainline recyclables (including paper, plastics, glass and tyres) (19%), organic waste (13%) and metals (13%) (DEA, 2012). The composition of the general waste presents a potential for diversion of 65% of waste generated from landfill. However, landfilling remains the main waste management option in South Africa. A national baseline study reported that about 90% of waste generated was disposed of to landfill in 2011 while only 10% was diverted away from the landfill through recycling (DEA, 2012).

2.2.2 Diversion of waste from landfilling

Ideally, diversion of waste from landfills should follow the waste hierarchy through implementation of waste reduction strategies at source, re-use, recycling and finally recovery as the last option. However, attention paid towards diversion of waste from landfills in South Africa has rather focused on material recycling. Waste diversion in South Africa is encouraged by a strong legislative framework. The National Waste Management Strategy promotes diversion of waste from landfill through minimisation, re-use, recycling and recovery. Targets set under the National strategy include diverting 25% of recyclable material from landfill and to initiate source separation programmes in metropolitan municipalities, secondary and large cities by 2016 (DEA, 2011). In line with the government's aim to divert waste to recycling and recover energy from residual waste (DST, 2012), diversion of waste from landfill has focused more on material recovery.

This has been evident in the National Waste Sector Survey for 2012 (DST, 2013) which showed that material recycling is the mostly used treatment technology by both formal private waste handlers and municipalities when compared to other technology options (including thermal, chemical, biological, mechanical) (see Figure 2-1). Another notable finding from the study is the transition of the private waste handlers towards the use of technology options that divert waste from landfill while municipalities remain heavily reliant on landfilling (see Figure 2- 2).
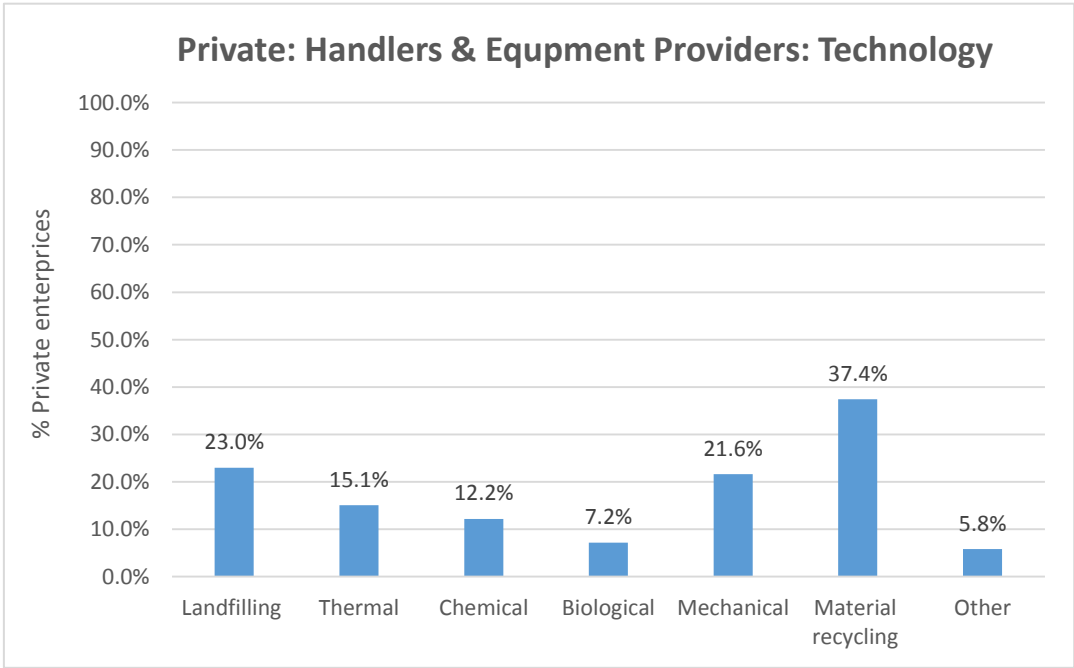
Figure 2-1: Technology options used by private companies (Adapted from: DST, 2013)
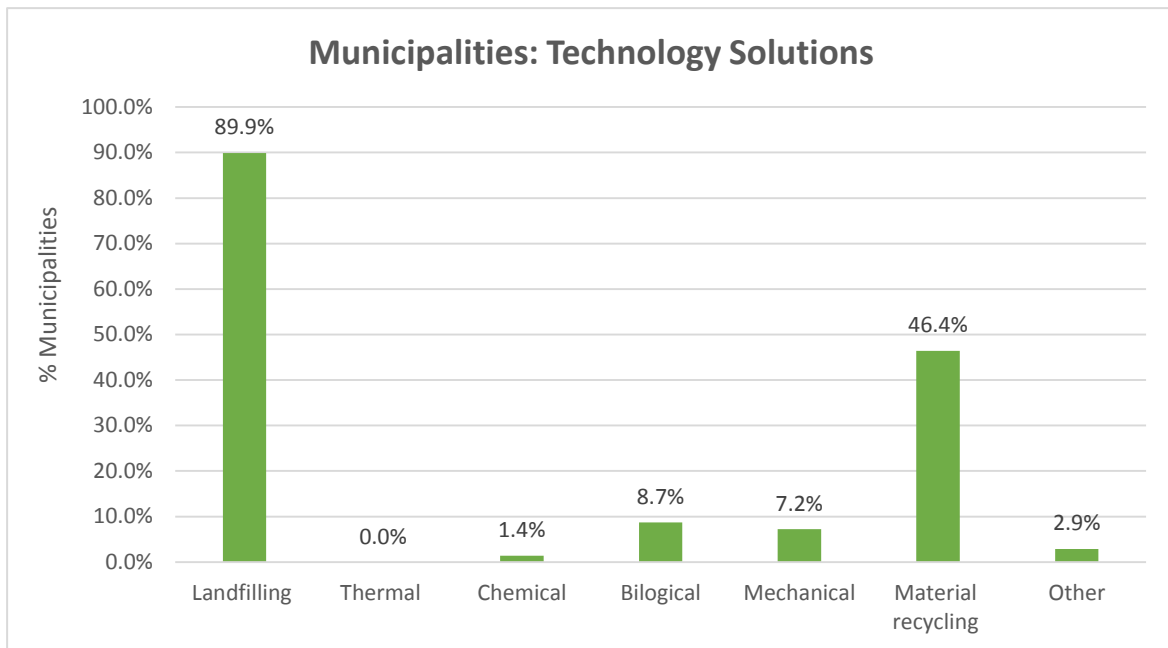
Figure 2-2: Waste management technology used by private waste handlers and municipalities (Adapted from: DST, 2013)

The collection of recyclable material in South Africa is mainly conducted by the informal waste pickers and the packaging/recycling industry. Approximately 85.000 waste pickers survive by reclaiming re-usable and recyclable waste from streets and landfills (Van den Berg, 2014). In 2004, waste pickers diverted about 16 to 24 tonnes per picker per annum and are estimated to have saved municipalities between R309.2 and R748.8 million in landfill airspace (Godfrey, Strydom and Phukubye, 2016).

A similar trend has been observed in international countries where material recovery and incineration with energy recovery have been the most favoured options used to divert waste (Mazzanti, Montini and Zoboli, 2008). Figure 2-3 shows waste management options used in different European countries and the rate at which these are used in each country. Countries such as the Netherlands, Denmark, Sweden and Belgium have been successful in minimising the amount of waste going to the landfills and this has been achieved mostly through material recovery and incineration with energy recovery (Mazzanti *et al.*, 2008). On the other hand, countries such as the United Kingdom, Poland and Greece remain heavily reliant on landfilling with low rates of material recovery.
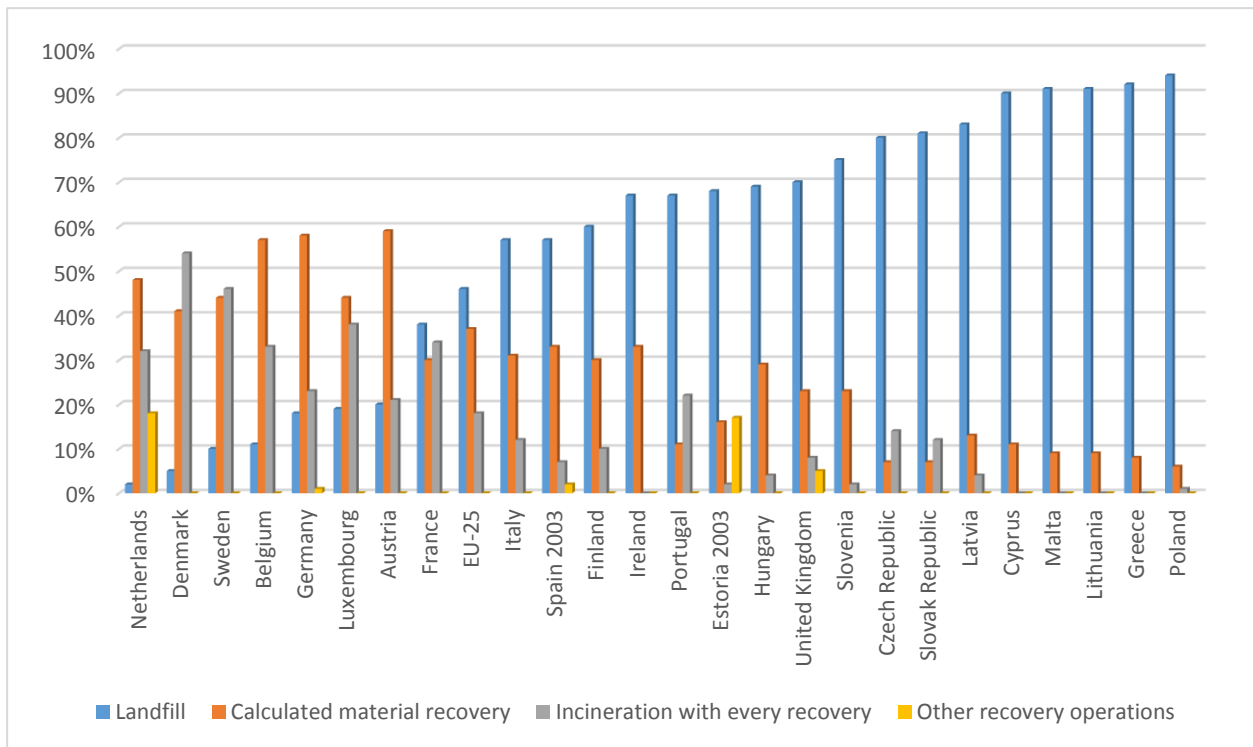
Figure 2-3: Approaches to waste management in Europe (Adapted from: Mazzanti, Montini and Zoboli, 2008)

2.2.3 The importance of waste source separation

Source separation refers to the separation of waste into different categories at the point and time waste is generated (Yang, Li, and Fu, 2011). There are numerous benefits associated with source separation which benefit various stakeholders including, compost producers, municipalities, farmers, recycling industries, and other waste management stakeholders (Bennagen, Nepomuceno and Covar, 2002). One of which is the role the activity plays in closing the loop of materials as it enhances recycling while reducing negative impacts of solid waste and the need for extraction of natural resources (Nguyen, Zhu and Le, 2015). Continuous supply of source separated waste to composting facilities and other recycling industries results in production of new products and compost to return humus and nutrients to the soil. At the same time, it reduces disposal costs, waste collection costs, environmental impacts from the extraction of natural resources, leachate and landfill gas emissions through reduced disposal of organic waste in landfills (Bennagen *et al.*, 2002).

There has been rapidly evolving research on factors influencing participation and non-participation in source separation schemes (Hornik, Cherian and Madansky 1995; Hage, Söderholm and Berglund, 2009; Sidique, Lupi and Joshi, 2010; Saphores and Nixon, 2014; Miliute-Plepiene, Hage, Plepys and Reipas, 2016). This topic has been explored in a variety of

contexts including situational, socio-technical systems, individual behavioural determinants and interactions between them. Yet, despite the contributions of these studies to understanding the factors that influence recycling behaviour, an essential underlying question remains unanswered: *what are the factors that influence recycling behaviour*? Hornik *et al.,* (1995) reports that the literature fails to develop a coherent and successful recycling research stream mainly because of the lack of substantive ties between many disciplines that have conducted research in this space. The literature depicts a complex picture covering a wide variety of factors that influence recycling which makes it exceedingly difficult to identify a consistent set of results (Thomas and Sharp, 2013). Sidique *et al.,* (2010) found distance, convenience, recycling infrastructure and social pressure as the most important drivers of recycling behaviour. Comparing tools to change recycling behaviour, Timlett and Williams (2008) found that providing feedback to households on their sorting performance as the most effective, when compared to door stepping and offering incentives. Thomas and Sharp (2013) looked at normalisation of source separation and suggested use of innovative and unique communication and education awareness strategies to ensure that households understand waste source separation in terms of what materials to sort, how to sort the materials and why it is important for them to separate their waste. Other authors identified convenience as a key determinant of recycling behaviour (Saphores and Nixon, 2014; Miliute-Plepiene *et al.,* 2016), while Hage *et al.,* (2009) found norms and economic motivation as the drivers of recycling behaviour.

Both developing and developed countries have been establishing strategies to realise the benefits offered by separating waste at source. Source separation schemes differ from region to region and may take different forms of collection including kerbside collection, drop-off and buy-back collection system (Rousta, Bolton, Lundin and Dahlén, 2015). However, the actual segregating responsibility lies significantly with the waste generator who remains key to the success of the source separation scheme (Yang *et al.*, 2011). While there are countries such as Japan where source separation has become a normal activity from which lessons can be drawn (Zhang and Wen, 2014), getting people to participate is still a challenge in many regions. Thomas and Sharp (2013) report that recycling is not a normal activity for everyone hence even with provision of infrastructure, and education and awareness campaigns, some people do not participate or fully participate in source separation. This is common in cities of developing countries where source separation programmes that have been implemented for decades yet they are still at pilot stage (Nguyen *et al.*, 2015). South Africa is one of the countries where source separation is not a normal activity. Assessing household recycling behaviour in large urban areas as well as small towns and rural areas, Strydom and Godfrey (2016) found that only 7.2% households showed dedicated recycling in large urban areas while only 2.6% was found in small towns and rural areas in 2015. The low levels of recycling behaviour in South Africa indicate a need for improvement through the

use of different instruments that are unique to the South African situation. Restaurant recycling behaviour in a South African context is currently unknown. However, the low levels of household recycling behaviour may be a reflection of the status of source separation in restaurants. Research on the link between recycling behaviour at work and home shows that people that recycle at home are more likely to recycle at work (Marans and Lee, 1993; Tudor, Barr and Gilg, 2007).

2.3 Review of the commercial food service sector in South Africa

The food service sector is a sector that offers food and beverages, which may be eaten inside or outside of the establishment and or institution. Edwards (2013) identifies two ways of classifying the food service sector. This sector can be grouped into commercial, profit or private sector and institutional/welfare, public or cost sector (see Figure 2- 4). Ntloedibe (2014) also classifies the South African food service sector into commercial and institutional/service sectors. The commercial food service sector includes hotels, all types of restaurants (restaurants, fast food restaurants and buffet type restaurants) and clubs while the institutional service sector includes transport services, health (public and private hospitals), educational institutions, and prisons (Ntloedibe, 2014). Alternatively, the food service sector can be classified based on the business rationale. This classification method considers whether the provision of food is the primary goal or a complimentary service (see Figure 2- 4). Hence, an organisation whose primary goal is to provide food is categorised as profit or commercial sector while in an organisation where the food is offered as complimentary service to the primary business goal is referred to as public or institutional sector.
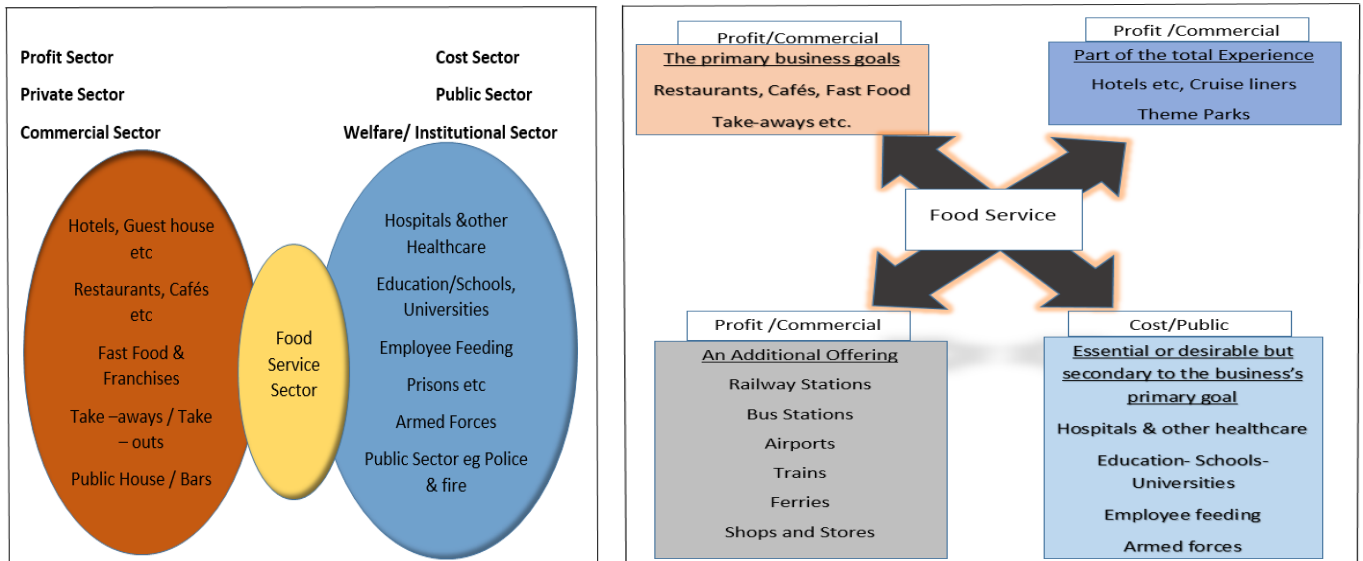
Figure 2-4: Classification by dividing the sector into two groups (left) and classification based on the rationale of the business (Adapted from: Edwards, 2013)

The South African food service sector has experienced tremendous growth over the past years, with fast food restaurants, full service restaurants and coffee shops being the main contributors to the growth of the industry (Ntloedibe, 2014). Within the commercial food service sector, the fast food service sector is expected to continue to rise for the next three years with a rate of 7% per capita consumption (BMI, 2015). The growth in the commercial food service sector is influenced by the growing trend of eating out of home in South Africa. The culture of eating out of home is driven by changing lifestyles, growing wealth, convenience and accessibility of fast food (Osman, 2007). The wealthy consumers and the growing middle class are the ones that tend to eat out more than the less wealthy. However, there has been an interesting observation among the low socio-economic group of spending on selected luxury items within their constrained budget (Vermeulen and Bienabe, 2007). A recent study on consumption of fast food among young adult consumers in Johannesburg, South Africa reported that over 50% from all socio-economic groups had fast food at least once a week or more while the frequency of eating fast food was found to be high among the low socio-economic group when compared to middle and high socio-economic groups (Van Zyl, Steyn and Marais, 2010). Given the high frequency of eating out among the less wealthy, and that the growing middle class which constitutes the largest population group is transitioning into wealthier consumer group over time, the commercial food service sector is still yet to continue to grow.

Additionally, commercial food service sector forms a vital component of the tourism sector. When people tour they enjoy eating traditional or local food of the country or region (Ntloedibe, 2014). In 2004, major tourist destinations, including Cape Town, Johannesburg and Durban experienced

a massive rise in tourist's arrivals which resulted in an increase in sales for outlets aimed at catering for tourists.

2.4   Green restaurants

The restaurant industry is increasingly acknowledging its environmental impact and the need to be environmentally responsible (Wang *et al.*, 2013). Importance of environmental protection within the food-service industry has been demonstrated by the growth of green restaurants research (Wang *et al*, 2013). This topic has been explored from different aspects including economic benefits of implementing green practices, development of green management standards, consumers' perceptions and intentions to visit green restaurants. "Green restaurant" is a label given to restaurants that perform environmentally friendly activities. Chen *et al.,* (2015) defines a green restaurant as a restaurant that offers a selection of green food menu options that use locally grown food, as well as one that implements green practices. Hence, the operation and management of these businesses is characterized by implementation of 3Rs (reduce, re-use, recycle) and 2 Es (energy and efficiency). These restaurants place great emphasis on continuous procedural modifications to reduce the environmental and social problems that arise directly or indirectly from their operations while still generating profit and meeting consumer's demand.

Adoption of green practices in restaurants should be aimed at reversing the environmental and social problems that result directly or indirectly from their operations (Hilario, 2014), through reducing the use of non-recyclable products, harmful chemical products and also reducing over-use of resources. Evidence from the literature on adoption of green restaurants suggests that while environmental benefits should be the main reason for adoption of green practices, it is not the case in reality. Restaurants engage in green practices for various reasons. Legal compliance is one of the reasons why businesses adopt green practices, to avoid cost and legal punishments associated with non-compliance (Chou *et al.*, 2012). For example, Wang *et al.,* (2013) reports that in Taiwan, implementation of green practices in the food and beverage industry is only encouraged by laws or government policies. Conducting a study on reasons for going green in serviced accommodation establishments, Tzschentke, Kirk and Lynch (2004) found cost saving on the operation costs as the main reason for adoption of green practices in their study. They report that rising waste disposal charges, energy and water through the introduction of metres and taxes such as landfill tax and climate change levy were frequently mentioned as the reason why the restaurants implement green practices. Thus, incorporation of water, energy, raw material measures and waste minimisation strategies enables the companies to maximise profit at the lowest operational costs. In line with this reasoning Tzschentke *et al.,* (2004) reports that most of the establishment's commonly implemented green practices that benefited the businesses financially. Chou's *et al.*, *(*2012) finding when they conducted a study on green practices in the

restaurant industry from an innovation adoption perspective in Taiwan shares Tzschentke' *et al.*, (2004) argument that adoption of green practices in restaurants is more influenced by financial gains from implementing those practices rather than from benefiting the environment. Adoption of green practices for creating an improved image, and a competitive advantage over other competitors is another reason for implementation of green practices. For example, restaurant owners in the United States of America (USA) adopt green practices for their business with the purpose of improving their image (Hilario, 2014).

Going green or adopting green practices is not regulated by any law, however businesses voluntarily adopt these practices or use going green as a self-regulation for economic benefits and sustainability of the natural environment. In countries such as the United States of America, green practices are promoted by non-governmental organisations such as Green Restaurant Association (GRA) and National Restaurant Association (NRA). These non-governmental organisations offer cost-effective and convenient techniques for restaurants to become environmentally friendly (Hilario, 2014) by encouraging adoption of environmental policies in the restaurants and providing training for restaurant employees around green practices. For example, the GRA offers three types of certification options for existing restaurants, new buildings, and events. Within each certificate there are standards which guide the restaurants in terms of what environmental aspects to focus on and those guidelines may include (a) Building materials and sustainable furnishings (only apply to new builds); (b) Use of non-toxic products; (c) Water conservation and efficiency; (d) Pollution prevention; (e) Purchasing organic, sustainable and local foods; (f) Composting and recycling (g) Energy efficiency and conservation (Hilario, 2014).

As indicated above, there are multiple green practices that can be employed by businesses. Among the green practices mentioned above, waste minimisation, recycling and composting, green food as well as energy and water efficiency appear to be the most common green practises. Wang (2012) identifies green practices that can be implemented by restaurants as outlined in the following sub-sections.

2.4.1   Waste minimisation, recycling and composting

Food waste forms the bulk of waste generated in the commercial food sector when measured in weight while packaging forms the bulk of the waste when measured in volume (Davies and Konisky, 2000). Packaging and food waste can be reduced through adoption of waste minimisation strategies by restaurants. For food waste this may include reducing food over-purchasing, adjusting menus to reduce frequently uneaten food, training staff to reduce preparation waste and improper cooking, storing food properly to reduce spoilage and also repurposing leftover food (United States Environmental Protection Agency, 2014). Packaging

waste on the other hand can be reduced by purchasing items in bulk, using reusable service ware and using packaging that is recyclable (United States Environmental Protection Agency. 2014).

Better source separation of resources such as glass, plastic, metal, cardboard, and aluminum is also important to improve the potential for recycling and increase the value as resource, if the waste is clean. On the other hand, biological treatment (including composting and anaerobic digestion) of food waste generated in the commercial food service sector could help reduce the amount of waste that goes to the landfill and the resulting environmental impacts of food waste at landfills.

2.4.2 Energy and water-efficient equipment

Energy and water efficient equipment can be any equipment that consumes less energy and saves water. An example of energy efficient equipment could be the use of fluorescent light bulbs as they last longer and save energy. For example, Starbucks which is one of the green restaurants in the United States of America uses water efficient equipment and also uses energy-efficient lighting in seating areas (Wang, 2012).

2.4.3 Green food

Green food is basically the use of organically and locally produced food. More specifically green food is considered to include food that is grown with no use of pesticides, chemical fertilizers and other chemical inputs. With the increasing health consciousness among consumers, organic food has become a criterion for selecting a restaurant. Kwok *et al.*, (2016) reports that green food tends to appeal more on customers that are concerned with healthy food that is low in carbohydrates, fat or calories. Investigating the influence of introducing green food on the frequency of patronizing in a restaurant, Vieregge, Scanlon and Huss (2007) found that about 67% of participants appreciate locally grown products, and 70.9% would visit the restaurant more frequently if locally-grown food is offered.

Evidence suggest that implementation of green practices impact positively on a business. According Llach, Perramon, Alonso-Almeida and Bagur-Femenías (2013) green practices in restaurants bring economic benefits. Implementation and adoption of green practices can also attract a new category of customer, further satisfy existing customers, improve a restaurant's image, and thus ensure a better overall position for the company in the market. A study conducted by Dutta, Umashankar, Choi and Parsa (2008) in India and the United States revealed that consumers are always willing to pay more for green practices. Implementation and adoption of the green practices does not only influence the consumer's behavior but also influences the manager's willingness to increase the price for green practices.

2.5 Review of waste management in the commercial food service sector

The commercial food service sector (i.e. full service restaurants, fast food outlets, hotels, cafeterias and bars) generates a significant amount of wasted food, packaging waste (Davies and Konisky, 2000) as well as waste cooking oil (Zein, Wazner, and Meylan, 2008). Food waste as reported by Majid and Howee (2007) makes up the bulk of the waste generated (up to 70% by weight). Packaging is reported to consist of paper, cans, plastics (i.e. bottles/bags), and glass. In terms of volume, packaging forms the bulk of the waste when compared to food waste (Majid and Howee, 2007).

Davies and Konisky (2000) identify three ways in which the food and beverage industry impacts on the environment, namely upstream, downstream and direct environmental impacts. Upstream environmental impacts refer to the environmental impacts that occur in the production, manufacturing and transportation stage of products that are used in the restaurants. These may include pollution produced by farm land supplying food outlets, manufacturers and suppliers. Direct environment impacts on the other hand are the environmental impacts that occur as a result of providing the services in the food outlets. These environmental impacts may include impacts of waste generated from the restaurants, energy consumption and also air emission. The third category of environmental impacts in a food and beverage industry is down-stream impacts which relate to the relationship between the service companies, consumers and suppliers and also how the service companies can influence a change in environmental behaviour of consumers and suppliers through education and awareness.

2.6 Review of food waste

The following sub-sections provide an overview of food waste in the context of this study.

2.6.1 Definitions of food waste

There is no universally accepted definition of food waste. Food waste definitions vary greatly depending on the region or research. Below are five different definitions of food waste:

I.   A common definition is the one provided by Gustavsson, Cederberg, Sonesson, van Otterdijk and Meybeck (2011) which defines food waste or loss as loss of food that was meant for human consumption, excluding the inedible parts. This includes the food that is intentionally used as feed or bioenergy. According to Gustavsson, *et al.,* (2011) food waste occurs at the last stages of the food supply chain (retail and consumer level) while food that is lost in the early stages of food supply chain is referred to as food loss (post-harvest and processing stages).

II. In contrary to Gustavsson's *et al.,* (2011) definition is Bond, Meacham, Bhunnoo and Benton's (2013) definition which includes waste or loss of both edible, inedible food (vegetable peelings, meat carcasses and teabags) as well as food of personal preference (possibly avoidable). Possibly avoidable food may include items such as bread crusts which some people choose not to eat and potato skins which can be eaten when food is prepared in certain ways. According to Bond *et al.,* (2013) this definition is useful as it considers food waste infrastructure requirements that can be employed (for example composting or anaerobic digestion) to divert biodegradable food waste from the landfill.

III. Food waste may also be broadly defined as waste or by-product that occurs in different stages of the food supply chain (from production, processing, distribution until consumption) (Okazaki, Turn and Flachsbart, 2008).

IV. Similar to Okazaki's *et al.,* (2008) definition, Tielens and Candel, (2014) define food waste as food that gets wasted in the food supply chain, irrespective of the stage of the food supply chain at which it occurs.

V. Ostergren, Gustavsson, Bos-Brouwers, Timmermans, Hansen, Moller, Anderson, O'Connor, Soethoudt, Quested and Easteal (2014) define food waste as all the food that exits somewhere along the Food Supply Chain (FSC) for recovery or disposal. For example, this may include food used for bio-energy production, composting as well as food that is not harvested.

In this dissertation, Tielens and Candel's (2014) definition which defines food waste as all the food that gets wasted along the food supply chain, irrespective of the stage of the food supply chain at which it occurs was used.

2.6.2 Food waste in developing and developed countries

There are disparities in the amount of food waste generated between developing and developed countries. The difference is not necessarily on the total amount of food waste generated but on the stages at which it occurs. Developed countries waste about 40% of their food at retail and consumer level (Gustavsson *et al.*, 2011). A study conducted by Ventour (2008) found that United Kingdom (UK) household waste about 6.7 million tonnes of food every year. Approximately 21.7 million tonnes of food is purchased by the UK households and about one-third of that food does not get consumed. Food waste at the end of the FSC may be largely due to a variety of factors including high retail grading standards, poor stock rotation, affordability, attitudes, behaviours, date labelling, discarding leftovers as well as poor meal planning and cooking abilities (Bond *et al.*, 2013).

Developing countries on the other hand experience great loss of their food in the early stages of the FSC. Hence, food waste in developing countries has been linked to poor harvesting technologies, poor storage and transport facilities (Lundqvist, de Fraiture and Molden, 2008). Gustavsson's *et al.,* (2011) report on global food losses and food waste indicates that more than 40% of the food losses occur at post-harvest and processing levels and much less is wasted at the end of the FSC. China and India are the main contributors of food waste generation in developing countries. China is estimated to generate about 195 million tonnes of food waste annually (Thi, Kumar and Lin, 2015), with storage waste contributing the most food lost at post-harvest stage (Liu, 2013).

According to Parfitt, Barthel and Macnaughton (2010) there is a huge gap in the understanding of food waste in transitional economies. Evidence from the literature shows that distribution of food waste generation in the FSC may not be the same as reported by Gustavsson *et al.,* (2011) in developing countries. The literature highlights various factors influencing food waste generation that were not considered in the global food losses which are likely to change the reported distribution of food waste within the FSC, particularly in transitional countries. Factors such as technological developments, dietary shift, urbanisation and socio-economic development were not considered on the global food losses and food waste study due to limited and lack of reliable data used to benchmark the study. Data used to estimate post-harvest food waste dates back to 1970's and 1980's and does not take into consideration the changes in the FSC as well as the global changes (Baxter, 2016). This is particularly true for the transitional countries such as Brazil, Russia, India, China and South Africa which undergo rapid socio-economic development. Transition countries refer to those countries undergoing a shift from central planning towards free markets and high national income status (Bond *et al.*, 2013). These countries experience rapid population growth, urbanisation, rising incomes, dietary shift as well as huge advances in agricultural technologies which may have great influence on the amount of food waste generated in those regions.

Technology plays a pivotal role in reducing the amount of food that gets lost in pre-consumer stages of the FSC. This was observed in a study conducted by Economist Intelligence Unit (EIU) (2014) which showed a strong relationship between food loss and technology when correlated. Technological developments over the past twenty years are likely to have reduced pre-consumer food waste in developing countries, especially in transitional countries. Baxter (2016) reports that as countries progress in terms of development, the infrastructure used for production improves. This results in a decrease in the amount of food waste occurring at production stages and an increase in the late stages of the food supply chain. While food waste at consumption stage has been a concern in developed countries, transitional countries are starting to follow the same trend as developed countries where they waste a considerable volume of food at consumption stage.

For example, consumption food waste is already a concern in China where food waste generated at consumption level (more than 50 Mt of grain) is greater than food that is lost at production stage (35 Mt) annually (Liu, 2013). Another notable trend is that restaurants in China generate more food waste than households, indicating high frequency of eating out.

Rising incomes in developing countries is likely to have increased post-harvest food waste over the past years. Thi *et al.,* (2015) estimated the status of food waste generation in developing countries based on the Gross National Income (GNI). The study revealed that food waste generation in developing countries increases with the increasing GNI which is a similar trend seen in developed economies. According to Thi *et al.,* (2015) economic growth along with urbanisation and population growth in developing countries will increase food waste generation. Also, the movement of people away from primary sources of food to urban areas in transitioning economies is likely to further increase food waste generation (Parfitt *et al.,* 2010). High population size and income in urban areas comes along with high food quality consumer demands and aesthetics standards (Liu, 2013). Therefore, meeting high food quality consumer demand may involve discarding food that does not meet the consumer demands even if it is still good and fit for consumption.

Rising income, growing affluence and escalating urbanisation in transitional countries has resulted in nutritional transition from traditional staple food to more nutritious and healthy organic food and meat. Given that vegetables and fruits account for highest food waste (Timmermans, Ambuko, Belik and Huang*,* 2014), food waste generation will potentially increase in those regions.

2.6.3   Food waste in South Africa

There is generally little primary data in terms of the amount of food waste produced in South Africa. This is partly due to a lack of waste data reporting, lack of accurate data as well as few waste characterisation studies conducted at both national and municipal level (DEA, 2012). In the National baseline study food waste is submerged under organic waste (which may also include garden waste) and does not specifically provide quantification of food waste. As such, food waste quantities in South Africa were calculated by applying percentages of food wastage in Sub-Saharan Africa (Oelofse and Nahman, 2013). The percentages of food wastage in Sub-Saharan Africa were taken from a study conducted by Gustavsson *et al.,* (2011) on Global Food Losses and Food Waste study.

Approximately 10.2 million tonnes of food waste is generated in South Africa (Oelofse, 2015). As it is the case in developing countries, South Africa loses a great amount of its food in the early stages of the FSC. Figure 2-5 shows, respectively food wasted in South Africa at different stages of the food supply chain. It can be seen that food waste decreases as it moves from production

to consumer stage, with great amount being lost at pre-consumer stages while less food gets wasted at consumption stage. However, there is no significant difference in food lost between the pre-consumer stages. In contrary to Nahman and De Lange's (2013) FSC breakdown, Notten, Bole-Rentel and Rambaran (2014) reports that South Africa is likely to have a different food waste breakdown in the FSC. They point out that the more sophisticated distribution networks and infrastructure reduces wastage in pre-consumer stages while the affluence among consumers is likely to increase food waste at consumption stage.
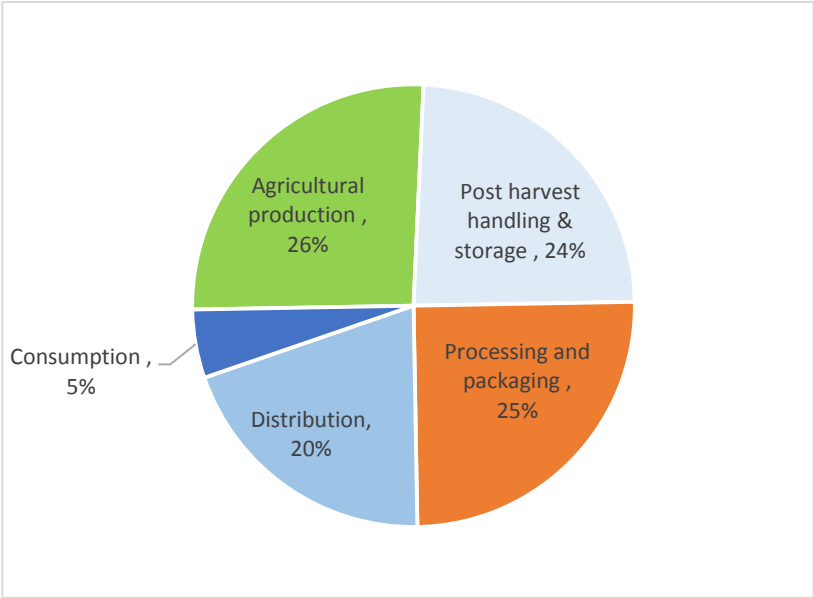
Figure 2-5: Food waste along the food supply chain in South Africa (Adapted from: Nahman and de Lange, 2013)

Unfortunately, landfilling remains the common way of managing waste in South Africa. Quantitative amount of food waste disposed at the landfills at a national level is not available however; the National baseline study reports that approximately 1.97 million tonnes of organic waste was disposed at the landfill in 2012 (DEA, 2012). Consequently, disposal of organic waste (including food waste) is estimated to account for 4.3% of South Africa's greenhouse gas emissions (Oelofse and Nahman, 2013).

Although the scale of food waste's adverse socio-economic and environmental effects are becoming more visible in South Africa, there is no legislation that specifically regulates food waste. Like other waste streams, food waste is controlled by legislation that is relevant to waste management. However, South Africa has made some strides in encouraging diversion of organic waste from landfill through development of the National Organic Waste Composting Strategy (NOWCS). The Department of Environmental Affairs acknowledges that composting is not the only nor the most favoured option for managing organic waste (DEA, 2013), but it is a strategy

that responds to the goals set under the National Environmental Management: Waste Act (Act 59 of 2008) to "divert 25% of recyclables away from landfill for re-use, recycling, and recovery" (DEA, 2013). In line with this reasoning, South Africa is considering a landfill ban on disposal of organic waste (DEA, 2013).

Food recovery hierarchy sensibly dictates prevention of food waste, diversion to hungry people and then to animals, processing to recover useful components, and finally disposal where the above is not an option (United States Environmental Protection Agency, 2010). Availability of sophisticated distribution networks and infrastructure in South Africa reduces the amount of food that is lost in pre-consumer stages of the FSC (Notten *et al*, 2014). South Africa is also one of the countries with Netherlands Agro Food and Technology Centres (NAFTC) aimed at representing the Dutch agro-food business in emerging markets and facilitating business development. This is a very important initiative as it allows joint creation of solutions by companies, knowledge institutes and the government to contribute towards reduction of food waste (Tielens and Candel, 2014).

2.6.4 Socio-economic and environmental impacts of food waste

There is a diversity of social, economic and environmental impacts of food waste. Firstly, disposal of food waste at the landfill site contributes to climate change. When food is disposed at the landfill site it decomposes and releases methane, a greenhouse gas more effective at trapping heat in the atmosphere than carbon dioxide. For example, the disposal of organic waste (including food waste) is estimated to contribute 4.3% to South Africa's greenhouse gas emissions (Oelofse and Nahman, 2013). In addition, greenhouse gases are released during production (especially meat production), transportation, processing and storage of food (Nahman, De Lange, Oelofse and Godfrey, 2012).

Secondly, food waste also implies that the potential valuable resources that were used throughout the supply chain to produce food that eventually ends up in the landfill are also lost. Because the food system depends on the natural system and also on other agricultural inputs; when food is wasted or lost water, land, energy, resources used to produce, process, store, distribute food are also lost. Betz, Buchli, Göbel, and Müller (2015) reports that adverse impacts of food waste are greater at the later stages of the FSC than at the farming stage due to the input of more resources used to prepare the food ready for consumption. This is one main reason why the reduction of food waste at the end of the value added chain (including the food service industry) is of major importance.

The implications of food waste also include the cost of production, loss of revenue due to unsold products at retail level, cost of disposal at landfill and agricultural inputs. Edible food waste is estimated to cost South Africa about R61.5-billion a year (Nahman and de Lange, 2013). In the United States the cost of food waste at household level is estimated between R19453.84 to

R32423.07 (1USD =14.24 ZAR) per year (Leib, Gunders, Ferro, Nielsen, Nosek and Qu, 2013) while the cost of food waste in the United Kingdom is estimated to R 189.4- billion (1GBP = 18.56 ZAR) per year (Ventour, 2008).

Lastly, from a social point of view food waste prevention is perceived to be an important element to consider towards improving food security (Gustavsson *et al.,* 2011; Searchinger, Hanson, Ranganathan, Lipinski, Waite, Winterbottom, Dinshaw and Heimlich, 2013; Parry, Bleazard and Okawa, 2015). The notion is that reduction in food wasted will have a positive impact on food insecurity. It is estimated that a reduction of food waste and loss by 50% in 2050 could bridge the gap (by 20%) between calories required and those available (Searchinger *et al.*, 2013). However, the perceived link between waste and food security has been challenged by Tielens and Candel (2014) in a study that focused on the relation between food security and food waste reduction. The study reports that the assumption that reduction of food waste automatically contributes to food security, particularly for poor consumers, is not evident. The argument is that, although a reduction in food waste or loss would have a positive impact on the overall availability of nutrients to individuals, evidence to show how and to what extent such reductions in the developed countries would increase the availability and access to those nutrients for low-income countries is still lacking. Timmermans *et al.*, (2014) also reports that there is no evidence of the perceived direct link between global food waste and the extent of global food insecurity. They report that reductions in food waste in the developed countries will not essentially lead to increased availability and supply in food-insecure countries. Additionally, causes of hunger and malnutrition are complex in nature and may not be solved by addressing food waste and food availability issues (Timmermans *et al.*, 2014).

2.6.5   Food waste from the restaurants

There is a large body of literature on food waste generation in the food service sector [Darlington, Staikos and Rahimifard *(*2009); Marthinsen, Kaysen and Kirkevaag (2012); Silvennoinen, Katajajuuri, Hartikainen, Jalkanen, Koivupuro and Reinikainen (2012); Pirani and Arafat (2014); Katajajuuri, Silvennoinen, Hartikainen, Heikkila and Reinikainen (2014); Muller (2015); Betz *et al.*, (2015)]. Studies that have been done on food waste from the food service sector mainly focus on the quantification and composition of food waste generated, drivers of food waste as well as food waste minimisation options. Food waste forms the bulk of waste generated in the food service sector when measured by weight (Davies and Konisky, 2000). A study on food waste volume and composition within the food service industry revealed that about 75000–140000 tonnes of edible food are wasted annually in the Finnish food industry. When combined, food services, retailers and the food industry generate about 250000-320000 tonnes of food waste annually (Silvennoinen *et al.*, 2012).

Betz *et al.*, (2015) identifies four stages at which food waste in a food service sector occurs and these include storage losses, preparation losses, serving losses and plate waste. Storage losses occur during storage, before and after the food has been prepared including food that gets discarded because it has reached its expiry date or loss of food due to poor storage. Preparation losses occur during preparation of food and cooking, for example burnt food. Serving losses is the food that gets thrown away because it remained from the buffet and serving bowls while plate waste refers to food that does not get eaten by the consumers.

Plate waste has been studied by Wrap (2012) with the main aim of understanding out of home consumer food waste. Reasons for leaving food on the plate that were highlighted in the study include "portion being too big", health reasons (customers being weight conscious) and also food not meeting consumer's expectations. The study also highlighted that there are consumers who think that it is normal to leave food at the end of a meal. Approximately three-fifths of the consumers indicated that they were not concerned by leaving food at the end of their meal. Once food is left over after a meal, restaurant operators have no choice but to dispose of the food as restaurant waste, unless the customer takes the food for later consumption (Kantor, Lipton, Manchester and Oliveira, 1997).

The amount and composition of food waste generated in the food service sector is greatly influenced by the type of restaurant and the way it operates the business. Buffets menus are reported to waste more food when compared to a la carte menus (Silvennoinen *et al.*, 2012). High food wastage in buffet menus can be due to mismanagement of kitchen processes, difficulty in projecting customer demand, human error during food preparation as well legislation (how long a buffet should be left out). Vegetables and chips are more likely to be left after a meal, followed by meat, salad, potatoes, fat, bones and bread while rice, sauces, drinks, part of sandwich bread and fish is less likely to be left over after a meal (Giorgi, 2013).

2.7   Review of packaging/ packaging waste

The following sub-sections provide an outline of packaging waste as it relates to this study.

2.7.1   Function of packaging

The function of food packaging is to preserve and contain food in a way that meets industry standards and consumer needs and maintains food safety (Marsh and Bugusu, 2007). It is also used as a communication tool between the manufacturer, retailers and consumers. Information on how to store the product and its shelf-life is communicated through the use of packaging (Jindal, 2010). Manufacturers/retailers also use packaging for advertising products (Jindal, 2010).

2.7.2 Packaging waste generation and its environmental impacts

The need to dispose and manage high volumes of packaging waste after using the content, places packaging waste in bad light in public discussions (Opara and Mditshwa, 2013). This is because environmental impacts of packaging are only based on the packaging itself (Williams, Wikström, and Löfgren, 2008). Svanes, Vold, Møller, Pettersen, Larsen and Hanssen (2010) draws attention to the need for a shift towards a systematic and holistic approach when assessing environmental impacts of packaging. This means that environmental impacts must not only cover the impacts of the packaging when it has reached its end of use but must also cover the ability to fulfil the requirements of packaging which may include prevention of product loss. Nevertheless, packaging waste has increased greatly in recent years. According to Jindal (2010, p. 1088) "consumption and production of waste from packaging for consumer products arguably has surpassed the fine line between necessary and excess packaging". This is due to the type of packaging material used for marketing or advertising as well as the growing over-reliance on packaging which results in increased environmental impacts. Environmental impacts of packaging occur throughout its life cycle, from its production until it reaches its end-use. The impacts of packaging are believed to be more during material extraction and final product manufacturing (Council on Environment and Water, 2011). When not recycled, disposal of packaging waste puts pressure on the landfills.

Often left out when identifying environmental impacts of the packaging system is the impact of packaging on food waste. Food waste in relation to packaging occurs at retail and consumption stage. A study conducted by Williams, Wikström, Otterbring, Löfgren and Gustafsson (2012) reported that about 20 to 25% of the food waste can be related to packaging. The main packaging related causes of food waste that were identified in the study included 'too big packages', 'packages that are difficult to empty' as well as a 'use-by and best-before dates'.

2.7.3 The role of packaging in reducing food waste

Consensus exists that improved packaging reduces postharvest food waste (Kerry, O'grady and Hogan, 2006; Williams *et al.*, 2012; Opara and Mditshwa, 2013; Verghese, Lewis, Lockrey and Williams, 2013). Verghese *et al.*, (2013) outlines different ways through which packaging can be used to minimize food waste as it moves from the farm until it reaches the consumers and these include:

I.   Adoption of improved packaging such as active and intelligent packaging. Intelligent packaging refers to packaging that monitors the quality of food. This type of packaging informs the consumer, manufacturer and retailer about the changes in the quality of food (Kerry *et al.*, 2006). Active packaging on the other hand is packaging that protects food

from external conditions such as oxygen and excessive moisture which may speed up the spoilage process. Self-adhesive oxygen absorbing labels is one of the examples of active packaging used for cooked meats, especially hams (Kerry *et al.*, 2006). Exposure of food to oxygen results to deterioration of quality attributes such as nutrients and color (Opara and Mditshwa, 2013). Therefore, self-adhesive oxygen absorbing labels maintain and extend the shelf life of food.

II. Alleviating confusion on 'use by' and 'best before' dates among manufacturers, retailers and consumers. Confusion and concerns about health risks in relation to 'use by and 'best before' dates' results to food being wasted whilst still good and perfectly fit for consumption.

III. Increased use of retail ready packaging to minimize damage as a result of double handling, at the same time ensuring protection of the product contained as well as recoverability of packaging when it reaches its end of use.

IV. A transition towards pre-packed and processed foods can also assist in reducing food waste by extending the shelf life of food products.

2.7.4 Packaging waste from Commercial Food Service Sector

Packaging waste from the commercial food service sector is mainly composed of transport packaging such as corrugated cardboard boxes (Aarnio and Hamalainen, 2008). Commercial food service sector packaging waste also comprise of paper, glass, metals and plastic (Davies and Konisky, 2000). This is demonstrated by a study that was conducted by Majid and Howee (2007) on sustainable solid waste management for island resorts which revealed that packaging waste amounts to 21.5 % of the total waste generated (5.77% paper, 1.56% timber, 8.06% cans, 5.07% plastics (Bottles/bags) and 2.68% glass). Figure 2-6 below shows the flow of waste packaging from the packaging industry until it reaches the service companies.
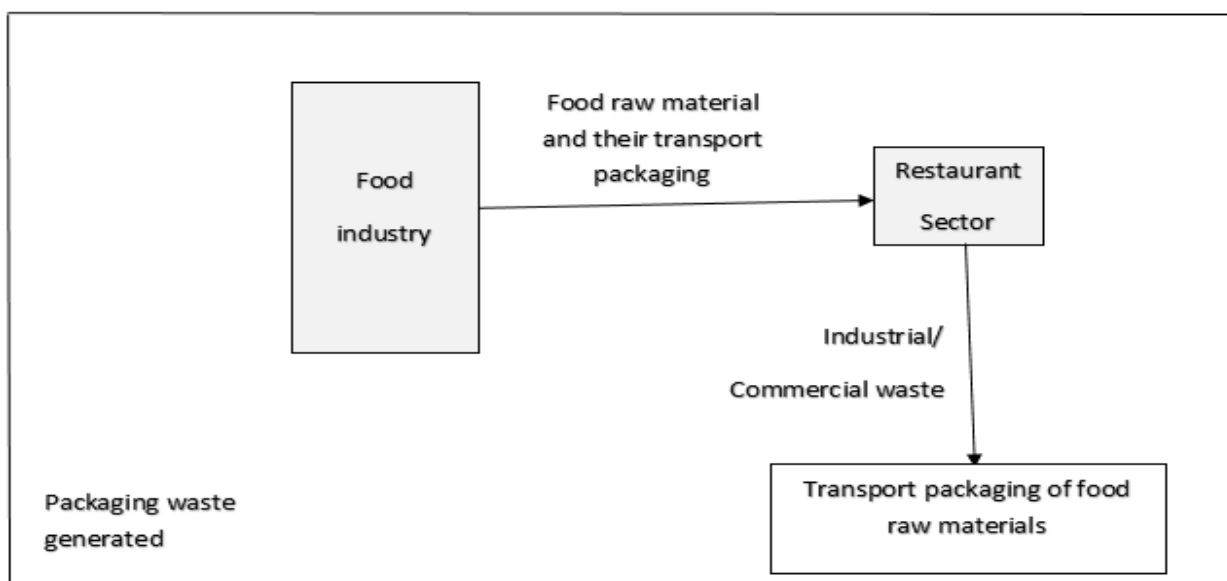
Figure 2- 6: Packaging waste in the food industry (Adapted from: Aarnio and Hamalainen, 2008. p., 613)

Although packaging from restaurants constitutes a relatively small amount of the total restaurant waste, poor management of packaging waste can result to detrimental environmental impacts. Packaging from fast food establishments often ends up as litter when consumers ate the food.

2.8   Waste cooking oil

Unlike other components of waste generated in the commercial food service sector, waste cooking oil from a waste management point of view, is not well documented. Literature on waste cooking oil makes reference to poor disposal of waste. Waste cooking oil appears in renewable energy studies, particularly studies focusing on production of bio-diesel from waste cooking oil. Waste cooking oil simply refers to cooking oil that has been used during food preparation. The food service sector uses a large amount of cooking oil for a number of purposes including deep frying; stir frying and shallow frying (Zein *et al.*, 2008). China is reported to be a large producer of cooking oil, with an estimate of 500 million tons of waste cooking oil generated annually (Zhang, Mortimer and Wang*,* 2012).

Generally, in public restaurants, frying is conducted in the same oil for several days (Kulkarni and Dalai, 2006. p., 2902). This has been demonstrated in China where the amount of waste cooking oil reutilised is estimated between 200 and 300 million tons (Zhang *et al.*, 2012). In South Africa waste cooking oil is used as animal feed or consumed by the poor people (City of Cape Town, 2011). This poses serious health risks to both animal and human health. A study conducted by Anelich, Kock, Roux, Botha, Bezuidenhout, Coetzee, Venter, (2001) on the quality of used frying fats in South Africa revealed that 11.7% of the fast food outlets were over-using the cooking oil

and that consumption of this oil can cause cancer. The study also revealed that in some instances waste cooking oil was disposed by distributing it to staff members or was sold to the poor at a reduced price. This is a critical point of concern especially in a country that is already savaged by HIV/AIDS.

Poor disposal of cooking oil does not only impact on people but also on the environment. Waste cooking oil is also reportedly disposed down drains and this results in sewer system blockages and contamination of water bodies. This affects rivers, lakes, seas and underground water (Castellanelli and Mello, 2007).

2.9   Conclusion

The South African food service sector is growing at an exponential rate. The expansion of the food service sector consequently comes with an increase in the amount of waste generated by the sector. Theoretically, the food service sector generates a significant amount of packaging, organic food waste and waste cooking oil. Unfortunately, most of the waste produced in the restaurants is disposed at the landfills as mixed waste. This consequently imposes pressure on the landfills. The reported composition of waste generated in the commercial food service sector presents an opportunity for diversion of waste away from landfill through recycling.

CHAPTER 3: RESEARCH METHODOLOGY

This chapter presents the research design adopted in the study including sampling strategy, data collection methods as well as how the participants of the study were protected during data collection and publication of the information.

3.1   Research design

There are two main research approaches that are used to do research, namely quantitative and qualitative approaches. Whether a researcher chooses to use qualitative or quantitative research largely depends on the research problem and what the researcher aims to achieve (Petty, Thomson and Stew, 2012). Qualitative research originates from sociology, psychology and anthropology, basically social science that focuses on how people behave, their experiences and their take on social phenomena. This approach is defined as "an emergent, inductive, interpretive and naturalistic approach to the study of people, cases, phenomena, social situations and processes in their natural settings in order to reveal in descriptive terms the meanings that people attach to their experiences of the world" (Yilmaz, 2013. p., 312). It is grounded on the belief that reality is socially constructed and holistic with greater emphasis placed on gaining deeper understanding of the lived experiences of people when they interact with each other and the wider social system. To gain access to the lived experiences and the meaning attached to those experiences, the investigator has to interact directly with the participants, where the researcher becomes an instrument (Yilmaz, 2013) while the topic of interest is typically the participant's experience. Hence, Yilmaz (2013) reports that a qualitative research is heavily dependent on the interaction between the participant and the investigator. Another important characteristic of qualitative research is that it involves the use of words to gain in-depth understanding of the phenomena.

Conversely, quantitative research method stems from the natural sciences (Fekede, 2011) and has been embraced by a lot of researchers including biologists, geologists and physicists who are interested in exploring things that can be observed and measured (Antwi and Hamza, 2015). This research approach is rooted in positivism which places great emphasis on objectivity, replicability, and generalizability (Harwell, 2011; Williams, 2007). Positivists hold that reality exist independently of social construction and that it can be measured. The assumption is based on the notion that the "*social world external to individual cognition is a real world made up of hard, tangible and relatively immutable structures*" (Li, 2016. p., 74). Embedded in this approach is the perspective that, valid knowledge is obtained through observations and measurements without the investigator's thinking and logical reasoning. In essence, quantitative researchers are

expected to be detached from the researched by controlling any possible researcher's influence on the research. A popular identifier of quantitative research is the use of standardised scientific methods (Williams, 2007), to generate numerical data including occurrences, volumes, or the size of the associations between entities (Pietkiewicz and Smith, 2012; Gelo, Braakmann and Benetka, 2008). Hence Williams (2007) states that quantitative research is suitable for research requiring numerical data.

A triangulation approach, which involves the use of both qualitative and quantitative research methods in one study, was adopted to understand waste management practices in the commercial food service sector. In social sciences, triangulation was first introduced by Campbell and Fisk in 1959 when they looked at convergent and discriminant validation by the multitrait-multimethod matrix (Yeasmin and Rahman, 2012). This method has gained enormous recognition among scholars and researchers especially in the field of social research (Yeasmin and Rahman, 2012). According to Adami and Kiger (2005) triangulation is the use of more than one method in studying the same phenomena. This research method is applauded for giving rich and comprehensive data while allowing the researchers to be confident with their results (Thurmond, 2001). The assumption is that using more than one method in one study neutralises the flaws of one method with the strengths of the other method (Thurmond, 2001). Yeasmin and Rahman (2012) also add that triangulation brings about the creation of innovative methods of exploring a phenomenon to balance with the traditional data collection methods.

Yeasmin and Rahman (2012) identify various ways through which one can use triangulation including (a) using two or more theoretical positions when interpreting data (theoretical triangulation), (b) using multiple investigators instead of one (investigator triangulation), (c) retrieving data from various sources to form one body of data (data triangulation) and lastly (d) using two or more data collection method (methodological triangulation). Methodological triangulation can be further categorised into within-method and across method (Bekhet and Zauszniewski, 2012). Within-method refers to the use of different methods from the same paradigm (quantitative or qualitative) while across method refers to use of different methods from both qualitative and quantitative paradigm (Bekhet and Zauszniewski, 2012).

This study adopted 'across methodological triangulation'. As mentioned above, this type of triangulation involves the use of quantitative and qualitative research methods. Quantitative and qualitative research approaches in this study played different but complementary roles, with one method playing a role that could not played by the other. This study was built on the belief that there are multiple realities and that those realities can be gained through interacting with the participants of the study while at the same time recognising that a quantitative element would bring valuable data to capture a complete picture of what was studied.

The rationale for using a triangulation approach in this research was to understand waste management practices in the commercial food service sector. Adoption of triangulation in this study was influenced by the research objectives which contain a combination of qualitative and quantitative elements. Ponce and Pagán-Maldonado (2015) found that environmental problems are very complex in nature and that unpacking or understanding their complexity requires more than one research approach. Halcomb and Andrew (2005) reiterated that the complexity of the modern human phenomena necessitates the use of multiple methods to fully understand it. Integrating qualitative and quantitative approaches in one study allows for recognition of multiple realities (Yeasmin and Rahman, 2012), while reducing the weaknesses associated with using a single research approach. Consequently, the methods and materials used in this study were selected to fulfil the specific objectives of the study. Table 1 below shows the link between the objectives of the study and the data collection techniques that were used in the study.

Table 3- 1: Link between objectives of the study and data collection methods

Objectives	Data collection methods	Research approaches
Investigate waste management practices at the restaurants	Semi-structured interviews & observations	Qualitative method
Quantification and characterisation of restaurant waste	Waste characterisation exercise	Quantitative method
Investigate attitude towards reducing, re-using and recycling of waste	Semi-structured interviews & observations	Qualitative method
Identifying sources of restaurant waste	Semi-structured interviews & observations	Qualitative method
Identify opportunities for waste reduction and recovering of resources	Semi-structured interviews, observations, waste characterisation exercise & literature review	Qualitative and quantitative methods
Provide recommendations for improved waste management in restaurants	Semi-structured interviews, observations, waste characterisation exercise & literature review	Qualitative and quantitative methods

Halcomb and Andrew (2005) identify two purposes of using triangulation including validating findings and completeness purposes. Initially, triangulation in social sciences was adopted to validate findings, mainly because it is exceedingly difficult to validate findings through replication

as is the case in natural sciences. Human behaviour is greatly influenced by the setting in which it occurs (Atieno, 2009). Hence, social research occurs in a natural, 'real life' situation which always presents particular and unique characteristics, thereby making it impossible to generate the same findings in a second setting, or even in the same setting at a different point in time. As a result, triangulation has been used to increase confidence in the accuracy of the results (Carter, Bryant-Lukosius, Dicenso, Blythe and Neville, 2014). Triangulation for completeness is another purpose of triangulation that was seen to develop in the literature over the past years. Halcomb and Andrew (2005) describe triangulation for completeness purposes as the use of more than one method to gain an in-depth understanding of the phenomena under study. In this study the investigator opted for triangulation for completeness purposes as it is useful for researching less explored or unexplored research problems (Hussein, 2015; Yeasmin and Rahman, 2012). Waste management practices in restaurants in a South African context is largely unexplored, similar studies have been done in the UK.

The triangulation approach was also considered appropriate to capture objective and subjective elements of the study. Qualitative methods captured experiences and opinions of mall and restaurant managers on waste management practices, the reasons and drivers for these practices which could not be captured through the use of a structured quantitative approach. Through the use of a qualitative research approach the researcher has not only captured the experiences and opinions but has gone beyond to determine the underlying factors influencing the practices. Also, based on the gaps presented in the literature on waste management practices in the commercial food service sector in a South African context, using qualitative methods was beneficial in providing insights into waste management practices that were not known, which is in line to Klassen, Creswell, Clark, Smith and Meissner's (2012) contention that qualitative methods allow for identification of previous processes, explanations of why and how phenomena occur and a range of effects (Klassen *et al.*, 2012. p. 378). Quantitative research methods on the other hand were used to quantify the percentages of waste categories and fractions generated by restaurants and also to determine the composition of waste they generate. This objective of the study was particularly suited to be captured using quantitative research as it involved collection of numerical data. Through the use of quantitative methods it was possible to objectively determine the composition (percentages by weight) of waste generated by restaurants which could not be done using qualitative research methods. Sharma and McBean (2007) reports that an understanding of the quantities of each waste fraction within a waste stream is necessary for planning solid waste management programs. In this study, this information assisted in identifying potential ways of diverting waste away from landfills to more sustainable waste management options.

In essence triangulation enabled the investigator to generate empirical data about the volume and composition of waste produced in mall restaurants while at the same time contributing to a deeper understanding of waste management practices gained through restaurant and mall manager's experiences.

3.2 Description of the study area

The study was conducted in eThekwini Metropolitan Municipality in KwaZulu Natal. Waste management services in this area are rendered by Durban Solid Waste (DSW). The DSW provides collection service to 33 616 industrial and commercial customers, 421 329 informal households as well as 524 582 formal households. eThekwini Metropolitan Municipality is one of the municipalities that run source separation projects with over 800 000 households participating in the programmes (eThekwini Municipality, undated). In addition, the municipality has four landfills namely; Bisasar, Mariannhill, Lovu and Buffelsdraai landfill. Disposal of household and commercial waste has been discontinued at Bisasar landfill due to lack of air space while Mariannhill is expected to reach its full capacity in 3 years' time. Landfilling airspace is currently not a concern in Lovu (25 years life span) and Buffeldraai (65 years life span). However, diversion of waste disposal from Bisasar to other landfills will decrease the lifespan of the receiving landfills. Conducting the study in this area will provide background information for expansion of source separation initiative to commercial food service sector. In line with this reasoning, South Africa is considering a landfill ban on disposal of organic waste (DEA, 2013), therefore it is crucial for restaurants to develop or improve organic waste management practices ahead of the organic landfill ban.

3.3 Sampling

It is often almost impossible to cover the whole population of interest when conducting research. As a result, researchers have a task of identifying a sub-set of the population that represents the wider population of interest. Defined as a *"portion, piece, or segment that is representative of a whole"* (Onwuegbuzie and Collin, 2007. p. 378), sampling largely depends on the research question, research design and also on the time, money and resources available to the researcher. Careful selection of the participants and the ability to balance time and resources is therefore important to ensure good sampling and subsequent good quality findings of the study (Onwuegbuzie and Collins, 2007). Shorten and Moorley (2014) state that good sampling strengthens a study while saving time, money and resources. To ensure good sampling, Devers and Frankel (2000) suggest development of a sampling frame which is done by identifying the criteria for selecting sites, identifying participants that will provide rich information and also ensuring that those participants participate in the study.

There are two sampling methods that could be used in research and these include probability and non-probability sampling methods. Probability sampling refers to the selection of participants through the use of a random sampling strategy where each person from the wider population has an equal chance of participating in the study (Teddlie and Yu, 2007). Non-probability on the other hand refers to purposive selection of the participants that will provide rich information to the study (Teddlie and Yu, 2007). Unlike probability sampling which aims for representativeness, non-probability sampling is particularly concerned with in-depth understanding of the phenomena of interest (Teddlie and Yu, 2007). As previously stated, this study aimed to gain an in-depth understanding of waste management practices in the commercial food service sector and therefore non-probability sampling methods were employed.

3.3.1   Selection of the study site

The study selected twenty restaurants located in two shopping malls (10 restaurants per mall) located in the eThekwini Metropolitan Municipality in KwaZulu-Natal. A convenience sampling strategy which has been widely adopted by other researchers including Bernard and Mildred, (2015); Asuamah, Kumi and Kwarteng, (2012); and Nyarai, Willard, Moses and Ngenzile, (2016) was used to select the study sites. The selection of malls was based on their availability, geographical proximity and the number of restaurants listed as tenants. Malls that are in close proximity to the Council for Scientific and Industrial Research (CSIR) Durban offices with ten or more different restaurants including cafés, bars, cafeterias, fast food restaurants and a la carte type restaurants were selected.

3.3.2   Selection of the restaurants

Mall restaurants were selected because they are located close to one another which made it easy for the researcher to move from one restaurant to another between interviews as opposed to street restaurants which may be far apart from each other. Also malls have spacious waste storage areas which provided ample space for the waste characterisation part of the study.

3.3.3   Selection of the participants

Participants in the study were selected based on their positions in the organisation in which they are employed. Restaurant managers and mall management staff members were purposively selected to be the participants of the study. As stated by Anderson (2010), purposive sampling selects participants that provide rich information. Restaurants managers and mall management members were selected because of their knowledge about the business operations as well as their position as managers which put them in a better position to know waste related issues within

the businesses in terms of waste generation and how it is managed. In cases where the managers were not available, interviews were conducted with a staff member nominated by the manager.

3.3.4   Sample size

A sample size is the number of participants that are included in a study. Qualitative research is associated with small samples when compared to quantitative research which uses bigger sample sizes with the aim of generalising the results. Anderson (2010) reports that the reason for selection of small samples sizes in qualitative research is because qualitative research aims for in-depth understanding of a phenomena. However, Onwuegbuzie and Collins (2007) caution that, associating qualitative research to small sample sizes and quantitative to bigger sample sizes may be misleading. They argue that in qualitative research, there are studies that require big sample sizes while it may be appropriate to use small sample sizes in some studies. A sample size of twenty restaurants selected from two shopping malls (10 restaurants per mall) was purposively selected to participate in the study. The sample size was determined prior to the commencement of the research based on the timeframe of the study, resources available as well as on the aim of the study. The restaurants included cafes, fast food restaurants and full service restaurants. Different types of restaurants were included to ensure relevance to the wider population, given that waste generated in restaurants is influenced by the type of restaurant.

3.4   Data collection methods

Data was collected by means of a literature review, observations and semi-structured interviews, as well as by a waste characterisation study. Details of the data collection methods are provided in this section of the dissertation.

3.4.1   Literature review

The study commenced with a desktop review of academic reports, journal papers and books. The literature highlights issues around waste management in South Africa, commercial food service industry as well as waste generation in the commercial food service industry including food waste, packaging waste and waste cooking oil.

3.4.2   Waste characterisation study

Waste characterisation is a method used to identify the composition and quantify the amount of waste generated (Martinho, Silveira and Branco, 2008). Understanding the nature and the magnitude of the waste types comprising the waste stream is very important in informing alternative technology choices, baseline to monitor progress towards diversion and recycling targets and also to inform waste collection systems (Oelofse, Muswema and Koen, 2016). A

waste characterisation exercise was conducted as part of the study to gather information that will guide restaurant's waste diversion programs and initiatives. The waste components that were investigated included packaging and food waste which are reported to be the main waste components generated in restaurants. Also, since the study was aimed at gathering information to identify opportunities for diversion of waste from landfill through source separation, the waste categories were recommended with this general aim in mind. Given that the amount of waste generated by the restaurants varies depending on the day of the week (waste generation is high during the weekends compared to weekdays), a waste characterisation of each restaurant waste was carried over two days (one day during the week and one day during a weekend) to capture variation in waste generation.

3.4.2.1 Waste characterisation pilot study conducted

A pilot study was conducted in two restaurants (a fast food restaurant and a full-service restaurant). The primary aim of conducting a pilot study was to pre-test the data collection tools that were going to be used during the main waste characterisation. This included identifying, problems, gaps and faults that were going to compromise the success of the main waste characterisation study and also to revise the techniques based on the findings of the pilot study. The following are the specific objectives for conducting the pilot study:

- To test if it was possible to isolate waste generated by each sampled restaurant, given that the restaurants share a temporary waste storage area.

- To inform the data collection sheet that was going to be used to record waste categories and fractions generated by restaurants.

- To test if it was possible to capture waste generated only on the day of sampling

- To estimate time and resources that will be required for the main study. These included time required for undertaking waste characterisation of each restaurant, number of plastic bags to be distributed to restaurants and other instruments needed for waste characterisation etc.

- To test the efficiency of the equipment used during waste characterisation (eg. scale, PPE).

The pilot study showed that it was possible to isolate waste generated by each sampled restaurant through the use of green plastic bags marked with unique codes, without disrupting the restaurant and mall's operation. However, there seemed to be lack of understanding on how the green bags should be used and what they are used for. As indicated above the plan was to capture only

waste generated on the sampling day, but during the waste characterisation till slips from the day before sampling were found, indicating that some of the waste that was collect might have been left over from the previous day. Also, because waste generated before distribution of plastic bags was put inside the green plastic bag with the bin liner (black plastic bag), during disposal of waste the staff members admitted that they took their normal bin liner (black bag) and left the green bag as a bin liner (see Figure 3-1). As a result, some of the waste generated in that restaurant on the sampling day was not captured as it was not possible to spot the bags at the waste area.

Figure 3-1: Restaurants that had already disposed waste when the green plastic bags were distributed

Another notable observation from the pilot study was that corrugated cardboard gets separated at source and stored at the temporary waste area while one of the restaurants separated aluminium cans at source (see Figure 3-2). In terms of the efficiency of equipment, heavy duty gloves that were used during sorting were not flexible to allow weighting and writing. Through conducting the pilot study, the researcher identified other waste categories that were not included on the data collection sheet. A summary of the findings and corrective actions that were implemented based on the pilot study is provided in Table 3- 2.

Figure 3-2: Source separation of aluminium cans by a restaurant

Table 3-2: Summary of the waste characterisation pilot study result and how the challenges were addressed

Challenges/gaps/faults	How the challenges/gaps/faults were addressed
We did not capture all of the waste that was generated by one of the restaurants for the day of sampling. The reason for this was because when we handed the plastic bags on the day of sampling there was already waste in the bin (in a clear plastic bag) and the restaurants staff was instructed to put the clear plastic bags inside the green plastic bag. During disposal of waste, the restaurant staff admitted to take the clear plastic bag and left the green bag as a bin liner, hence it was not possible to identify the plastic bag at the waste area.	This was addressed through better communication with the restaurants on how to use the plastic bags.
Corrugated cardboard was not captured because it gets separated at source and /or at temporary storage area	That was noted
One of the restaurants separate aluminium cans at source	During the actual waste characterisation study, restaurants were asked whether they separate their waste at source or not. All the restaurants that participated in the actual waste characterisation did not separate waste their at source
Till slips from the previous day of sampling were found during the waste characterisation indicating that there is a possibility that the waste collected was not only generated on the day of sampling.	This was addressed through better communication with the restaurant managers and during the sampling day they were reminded to empty the bins if there was waste left over from the previous day
PPE (heavy duty gloves) were not flexible to allow weighting and writing	Heavy duty gloves were replaced with garden gloves

3.4.2.2   Collection of waste and sorting

Site visits to both the malls and to the restaurants prior to the waste characterisation study were done to familiarise the researcher with the waste flows from the restaurants to the waste areas of the mall. This allowed the researchers to gather information and also to design potential ways for collecting the waste sample in a manner that did not disrupt the operations of the mall and restaurants. The proposed plan of sample collection was to isolate waste arising from the sampled restaurants from waste coming from other shops (therefore the coded bright green bags) and also to isolate waste from each restaurant among sampled restaurants. This was done by assigning unique codes to the sampled restaurants. Green plastic bags marked with respective unique codes were distributed to the restaurants to use as bin liners a day before waste sampling day. It was then explained to the restaurant staff members when to use the plastic bags. On the sampling day, the restaurants were revisited before they opened to check if the plastic bags were placed in the bins and also to check if there was no waste that was left over from the previous day so as to ensure that only waste accumulated on the sampling day was captured. Waste accumulated on the sampling day was then collected to the waste area as usual, where the green bags were separated from black and clear plastic bags that are normally used by shops. Green plastic bags were further grouped under similar codes (multiple bags from the same restaurant) and those plastic bags that were not used by restaurants were later requested back to ensure that there was no green bag missing. In the waste areas of the mall, the plastic bags from each restaurant were counted and weighted with a calibrated digital scale with an accuracy of two decimal places. Each bag was then opened and the content deposited on to a sorting table and waste was then separated into 21 predetermined waste categories (Table 3-4). Waste collection and sorting is illustrated in Figure 3- 5. However, during presentation of the results only the nine main categories (glass, porcelain, paper and cardboard, non-recyclable material, metal, plastic, food waste, hazardous waste and other) were regarded sufficient to address the aim of the study in terms of assessing recycling potential of restaurant waste, which is in line with Chang and Davila's (2008) assertion that classification of the waste categories depends on the purpose of its application. Waste characterisation was carried out at the central waste area of the mall and personal protective equipment (steel toe boots, overalls and gloves) was worn at all times (see Figure 3-3).

Figure 3-3: PPE worn during sorting

To provide guidance and to ensure consistency in the sorting procedure in both malls, waste categories shown in Table 3- 4 were used during sorting. The waste categories covered waste material that is likely to be generated in restaurants. These included mostly packaging waste from transport packaging, packaging of ingredients and sales packaging of products (glass, cardboard, metals, and plastic), food waste (inedible food waste generated during preparation, food left on a customer's plate), broken porcelain, fused fluorescent light bulbs (hazardous waste) and "other" waste to provide a category for waste not catered for elsewhere.

Table 3-3: Waste categories used when sorting

General waste Categories	Fractions/Description
Glass	Glass bottles, glass cups etc.
Porcelain	
Paper and Cardboard- All recyclable Paper and Cardboard	All white Office Paper
	Common mix paper
	Cardboard
	Tetra Pak
Non-recyclable paper	Badly soiled, tissue paper, wax paper, laminated etc.
Metal: ferrous and non-ferrous	Ferrous metals: metal cutlery
	Non-Ferrous metals : beverage or coke can, tin foil etc.
Plastic- All recyclable plastics	HDPE drink bottles – i.e. Milk bottles
	PET drink bottles – i.e. 2 litre or 1 litre beverage bottles
	Polypropylene – i.e. PET bottle caps etc.
	Polystyrene
	LD - Clear Plastic
	LD - Mix Plastic
	LD - Stretch i.e. cling wrap
	All non-recyclable or not identified plastics
Food waste	Avoidable food waste- burnt food, leftover food etc.
	Un-avoidable food waste-bones, peels, egg shells etc.
Hazardous waste	Cleaning chemicals/ medical care waste, fluorescent light bulbs
Other	

Table 3-4: Illustration of waste collection and sorting

Step 1: Distribution of green plastic bags marked with unique codes and explaining to the restaurant managers when to use the plastic bags.	
Step 2: Revisiting restaurants to check if the plastic bags were placed in the bins.	
Step 3: Collection of waste from temporary waste area.	
Step 4: Grouping of green plastic bags under similar codes.	

Step 5: Depositing the content from each green plastic bag on to a sorting table.	
Step 6: Sorting of waste into clear plastic bags.	
Step 7: Weighing of sorted waste categories with a digital scale.	
Step 8: Recording of the waste quantities into the waste spread sheet.	

As indicated earlier, twenty restaurants were recruited to participate in the study (ten restaurants each from two shopping malls). Sampling was carried out twice in each restaurant, once during a week day (Tuesday) and once during a weekend day (Saturday) given that the amount of waste

generated by the restaurants varies by days of the week (waste generation is high during the weekends compared to weekdays). To fully participate in the study, the restaurants were required to use green plastic bags for the collection of waste during both sampling days (week and weekend day). Restaurants that did not participate on both sampling days were excluded from the characterisation study. From the twenty restaurants, at least thirteen restaurants fully participated (six in Mall1 and seven in Mall2). The restaurants included cafes, fast food restaurants and full service restaurants.

3.4.3 Semi-structured interviews

Another data collection method that was employed in the study is semi-structured interviews. Petty *et al.,* (2012) define semi-structured interview method as the interaction between the participant and the researcher through the use of predetermined questions as a guideline to the interview. This method has been used in various disciplines particularly in social science where the researchers are interested in understanding human behavior, attitudes, values, beliefs, and motives. The strength of this method is that it is a 'free' interview style where the interview becomes a conversation between the researcher and the participant (Miles and Gilbert, 2005). Depending on the flow of the conversation, the interview guide may not be executed as it is, however, it is the responsibility of the researcher to ensure that all pre-determined questions or topics are covered. Miles and Gilbert (2005) report that the extent to which a semi-structured interview should be structured depends on the research question and the data analysis method. Complex research questions require use of less structured format while simple research requires a good structure.

A semi-structured interview method was selected because of its flexibility as it allowed the participants to provide their perspective of reality and the diversity of their experiences in their own words compared to standardised questionnaires which do not allow the participants to elaborate. These interviews enabled the researcher to collect rich and in-depth data by prompting and probing deeper to the phenomena of interest (Stukey, 2013). Miles and Gilbert (2005) report that semi-structured interviews also allow a researcher to identify contradictions from the information and to address the contradictions by asking the participant to explain more on the contradicting responses. The interviews were recorded and transcribed for purpose of data analysis.

3.4.3.1 Interview pilot study conducted

The cornerstone to successful interviews is conducting a pilot study and this involves a process of selecting a representative population of the sampled population to test a questionnaire or an

interview guide. Majid, Othman, Mohamad, Lim and Yusof (2017) report that pilot studies are essential as they prepare researchers for the actual interviews and also allow researchers to identify errors and modify the interview guide or questionnaire to ensure that the questions are drafted to answer the main aim of the study. Prior to the actual interviews, a pilot study with two restaurants was conducted, transcribed and analysed. Specific objectives of conducting pilot interviews included the length of the interview, relevance of the questions, logical sequence and also to check if the questions were clear and easy to understand. Findings from the pilot study showed that the interviewees understood the questions and interviews were completed within the pre-determined time frame (30-60 minutes). It was also identified that there are questions that are overlapping which were addressed accordingly.

3.4.3.2 Semi structured interviews conducted

As mentioned earlier, twenty restaurants were selected to participate in the study.   Out of the twenty selected restaurants, seventeen restaurants participated in the interviews (85% participation rate). The restaurants included ten full-service restaurants, four cafes and three fast food restaurants. Semi-structured interviews where therefore conducted with two mall management staff members and seventeen restaurant staff members (ten in Mall1 and seven in Mall2). Table 2 shows the demographics of the restaurant staff members interviewed. A majority of the participants were managers; three participants were supervisors while one participant was a baker. From the restaurant staff members, about 39% had a tertiary qualification while the majority of the participants had matric. Participants in this study were mainly man (59%) and between the age of 20 to 29 years (53%) and 30 to 39 (41%). Sixty-five percent of the participants had less than five years' experience, 23% had five to ten years while 21% had more than 10 years of experience.

Table 3-5: Demographics of staff members

Variables	Frequency	Percentage
Gender		
Female	7	41
Male	10	59
Age		
20-29	9	53
30-39	7	41
40-49	1	6
Level of education		
Matric	10	59
Post matric certificate	2	12
Tertiary	5	29
Position		
Supervisor	3	18
Baker	1	6
Manager	13	76
Experience		
<5 years	11	65
5-10 years	4	23
More than 10 years	2	12

3.5 Observation

Defined as *"observing and measuring the world around you, including observations of people and other measurable events"* (Driscoll, 2011. p.,154), observation was also selected to collect data in this study. Data in observation is captured through the use of various instruments such as field notes, photographs (pictures), audio-tape and video-tape. Once actions or experiences are captured the researcher has the task of developing a theoretical framework to help give meaning to the actions observed (Petty *et al.*, 2012).

Driscoll (2011) points out two types of observations that may be used when observing people including participant observation and unobtrusive observation. In participant observation the researcher interacts with the participants and becomes involved in the given activity or situation being studied. On the other hand, in unobtrusive observation the researcher captures events, actions and experiences without being involved. In this research, unobtrusive observation was used to take note of the activities that generate waste in restaurants and their waste management practices. Also observing waste flow from restaurant kitchen until it gets to the waste area assisted during planning of waste collection for the waste characterisation study. This data was captured through the use of pictures and field notes. Data captured from the observations assisted in validating some of the information obtained through interviews. Ritchie and Lewis (2003) reports that visual observations are useful in gathering information about phenomena where non-verbal communications are likely to be important as it allows experiences, events and actions to be 'seen' through the eyes of the researcher, often without any construction on the part of those involved. Petty *et al.*, (2012) however cautions that the presence of an observer may result in a change in behaviour thereby resulting in inaccurate data.

3.6 Ethical consideration

Ethical consideration is very important when dealing with human participants. Research ethics involve requirements that a researcher works under from the beginning of the study until the results of the study are presented. These requirements are implemented to protect the participant's dignity when the study is conducted until the information is published (Fouka and Mantzorou, 2011). Ethical clearance for this study was obtained from the CSIR and North West University Research Ethics Committees (REC). Therefore, the study followed the ethical guidelines provided by the CSIR REC as well the North West University REC to protect the dignity of the participants and to ensure that the research is conducted in an ethical manner.

To protect the dignity of the participants and to ensure that the research is conducted in an ethical manner, permission to conduct this research was obtained from the top management of both

malls. Informed consent of mall managers and all restaurant staff members that participated in the study was then obtained. Before obtaining consent, all the participants of the research were guaranteed confidentiality and they were adequately informed about what the study entails and how they are expected to participate in the study, their voluntary participation as well as the right to withdraw from the study at any time. All the participants signed a consent form. A recording device was used to capture data during the interviews after consent for recording was obtained from the participants.

3.7   Data analysis

Data analysis is a step-by step process of organising and classifying data collected in a study. This exercise enables the researchers to make sense out of large volumes of data collected in a study and to draw conclusions (Bengtsson, 2016). In this study qualitative and quantitative data was analysed separately.

Qualitative data was analysed inductively. This involved analysing data through detailed examination of transcripts and observations to generate codes and categories. As it was the aim of the study to present the views of the participants, there was no predetermined structure of data analysis, codes and categories emerged from the raw data. This allowed the researcher to present the mall and restaurant manager's account of experiences which is very important as it prevents loss of valuable information due to the use of predetermined structure of analysis. Additionally, inductive qualitative analysis was appropriate for this study as it is used for less explored studies (Burnard, Gill, Stewart, Treasure, Chadwick, 2008).

Qualitative data analysis commenced with **data immersion** (first stage of qualitative data analysis processes) which involved repeated reading of transcripts and observations to get a sense of what the data looks like. Data immersion encourages generation of ideas about the potential ways through which the data can be analysed (Green, Willis, Hughes, Small, Welch, Gibbs and Daly, 2007). However, it also often goes further than this, and lays a foundation connecting disjointed units of data into a clearer picture of the issue under study. After immersing with the data, relations, similarities and dissimilarities were closely examined to organize data with similar ideas in a stage called **coding**. According to Green *et al.,* (2007) coding is a qualitative data analysis method used to reduce data while not losing the meaning through examining and organizing the information obtained during data collection. There are two fundamental approaches to coding including emergent coding and priori coding. Priori coding refers to the use of predetermined codes to organise similar aspects of the data while emergent coding refers to codes that emerge from the raw data (Blair, 2015). Emergent coding is more in line with the aim of the study (to ensure that the *data represents participants*' contributions to the study while generating rich and

comprehensive picture of what is investigated) and therefore was considered appropriate. The concepts or phrases were coded line-by-line manually. Each descriptive label of the concepts or phrases was explained to ensure that they are consistently applied. The codes were used to generate frequencies of responses as well as between them using Microsoft Excel. Coding was followed by categorisation of data which refers to the collection of similar idea under one category (Morse, 2008). This allowed the researcher to describe and determine the characteristics of each category and also to compare and contrast the codes within each category. An example of how the codes and categories were developed is showed in Figure 3-4 below.
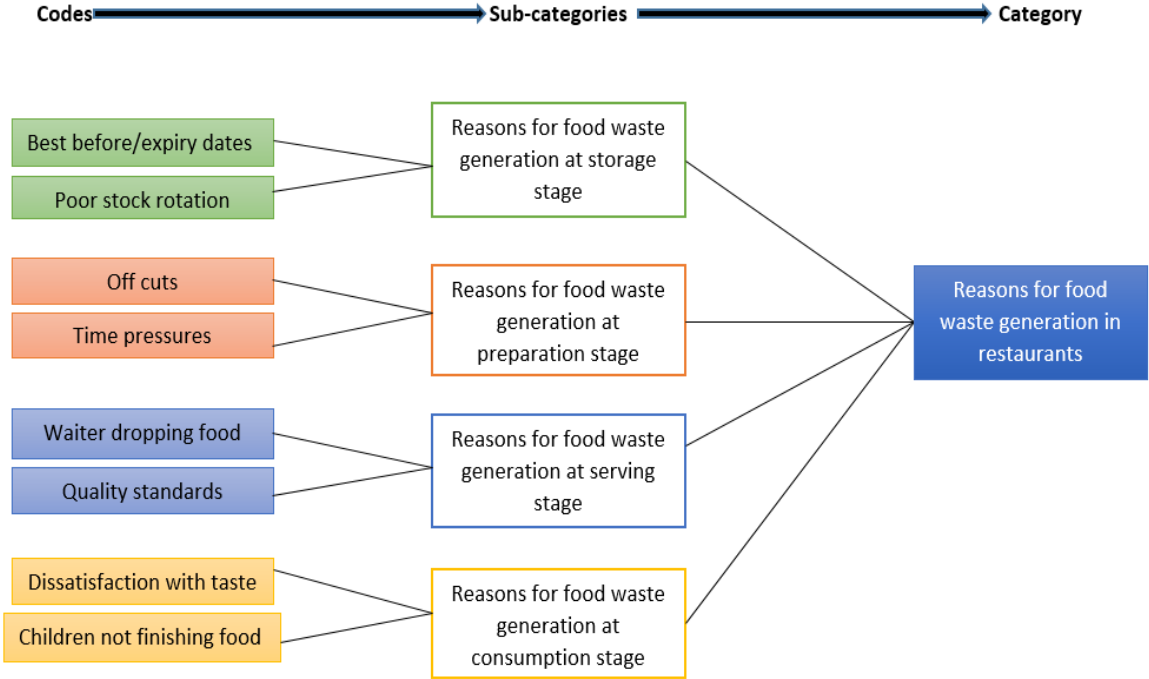
Figure 3- 4: An example of how the codes and categories were developed

The primary aim of collecting quantitative data was to generate a statistically sound description of the amount, composition and characteristics of waste generated by sampled mall restaurants in order to identify potential ways of diverting waste from landfills. Waste characterisation data was analysed by weight in percentages. The percentages of different waste fractions were entered on Microsoft Excel to generate bar graphs, line graphs, and pie charts.

3.8   Conclusion

A combination of qualitative and quantitative research approaches was used to understand waste management practices of restaurants. The use of qualitative and quantitative research approach was informed by the objectives of the study. Qualitative approach enabled the researcher to gain in-depth understanding of the waste management practices, sources and reasons for food waste,

existing measure used for reduction of food waste and quantities of waste cooking oil generated in the restaurants. Quantitative research method on the other hand was used to quantify the percentages of waste categories and fractions generated by restaurants and also to determine the composition of waste they generate.

CHAPTER 4: RESULTS AND DISCUSSION

This chapter presents the results and discussion of the study. Firstly, this chapter presents composition and waste generation rates of restaurants. This is followed by sources and reasons for food waste generation as well as existing measures used to prevent food waste in the restaurants. A descriptive account of waste management practices of restaurants including waste storage, collection and disposal. Finally, generation rates and disposal of waste cooking oil by restaurants is presented.

4.1 Waste characterisation results

This section provides the results of the waste characterisation component of the study. Waste composition and generation rates of the malls are presented separately.

4.1.1 Waste composition

To determine waste composition of the sampled restaurants, a total of **799.35kg** of waste from two malls was sorted and the weight of each waste category was recorded. Waste produced on the sampling days were accumulated and sorted the following day similar to the procedure outlined in Dahlen and Lagerkvist's (2008) time limitation procedure. Dahlen and Lagerkvist' (2008) report that a waste sample should be sorted within two days of collection to avoid chemical and physical changes to the sample. In Mall1, 135.10kg of waste was sorted for a week day sample, and 252.95kg for a weekend sample while 148.05kg for a weekday sample, and 263.25kg for a weekend sample was sorted in Mall2. The total waste available for sorting into fractions during the week in both malls was comparably smaller than the total waste available for sorting during the weekend, suggesting that restaurants generate more waste during the weekend than during the week. Table 4- 1 shows total kilograms of waste sorted from different types of restaurants in Mall1 and Mall2.

Table 4-1: Kilograms of waste sorted from different types of restaurants

Mall	Restaurant type	Number of Restaurants	Total waste sorted (Kg) week sample	Total waste sorted (%) week sample	Total waste sorted (Kg) weekend sample	Total waste sorted (%) weekend sample
Mall1	Fast food Restaurant	1	15.50	5.47	19.60	3.80
Mall1	Full service Restaurant	5	119.60	42.24	233.35	45.21
Mall2	Café	3	22.55	7.96	69.50	13.46
Mall2	Fast food Restaurant	2	17.05	6.02	26.70	5.17
Mall2	Full service Restaurant	2	108.45	38.30	167.05	32.36
Grand Total		13	283.15	100	516.20	100

Overall waste composition of restaurants was derived from combining waste sorted during the week and waste sorted during the weekend from each restaurant. Due to the small sample size, average of each fraction from all the restaurants was then calculated to get an objective view of the general composition of the waste as percentages by weight. Figure 4- 1 shows the waste composition of Mall1 when waste sorted during the week and weekend is combined.

From Figure 4- 1, it is clear that food waste is the major fraction (by weight) generated by restaurants in Mall 1, accounting for 47.74% of the total waste from the sampled restaurants. Similarly, food waste was also the highest waste category (by weight) in Mall2, contributing about 49.66% of the total waste sorted (see Figure 4- 2). These findings are consistent with previous studies where food waste formed the bulk of waste generated in restaurants (Hogan, Cunningham and Finn, 2004; Majid and Hwee, 2007; Tatano, Caramiello, Paolini and Tripolone, 2017). The percentages of the food waste component from the above cited studies ranged from 36.81% to 71.73%. When conducting a study in three restaurants (full service restaurant, a restaurant located in a shopping centre and a canteen) in the Republic of Ireland, Europe, Hogan *et al.,* (2004) reported 36.81% of food waste. Tatano *et al.,* (2017) found 28.2% of food waste when they conducted their study in a fast casual restaurant in Italy, while Majid and Hwee (2007) found an alarming 71.73% of food waste when they conducted a waste characterisation study in 10 restaurants with size ranging from seven to sixty tables in Malaysia. Comparison of the food waste

component with other restaurant waste characterisation studies such as those of Dangi, Pretz, Urynowicz, Gerow and Reddy (2011), Alfagi, Purnaweni and Setiani (2015) and Oliveira, de Moura and Cunha (2016) was not possible due to different terminology or rather categorisation of the food component. Unlike Majid and Hwee (2007) who fractionated the organic component into food and garden waste, those studies only had organic waste as one category, with no clear definition of what it means. In this regard, it was not possible to compare the food waste component to those studies as it was not clear as to whether the organic waste category contained only food waste or all waste materials that fall into the organic waste category such as wood waste, garden waste and food waste. Dahlen and Lagerkvist (2008) criticize the use of the term "organic waste" and reports that the use of the term as used by these authors is wrong as it is used to classify only food waste and garden waste and yet there are other organic waste materials such as paper. Derqui, Fayos and Fernandez (2016) and Lebersorger and Schneider (2011) also indicate that different classification methods make comparing findings difficult. Lebersorger and Schneider (2011) point out that a lack of substantial information including the definition of food waste categories, the exact classification of individual food items and the consideration of food packaging as reasons for incomparable data. The different methodology or classification of food waste clearly illustrates a challenge in terms of comparing and applying data and in turn highlights the need for a uniform method of classifying food waste in order to produce data that can be compared and applied. Oelofse *et al.,* (2016) recommend accurate and detailed recording of the sampling methodology.
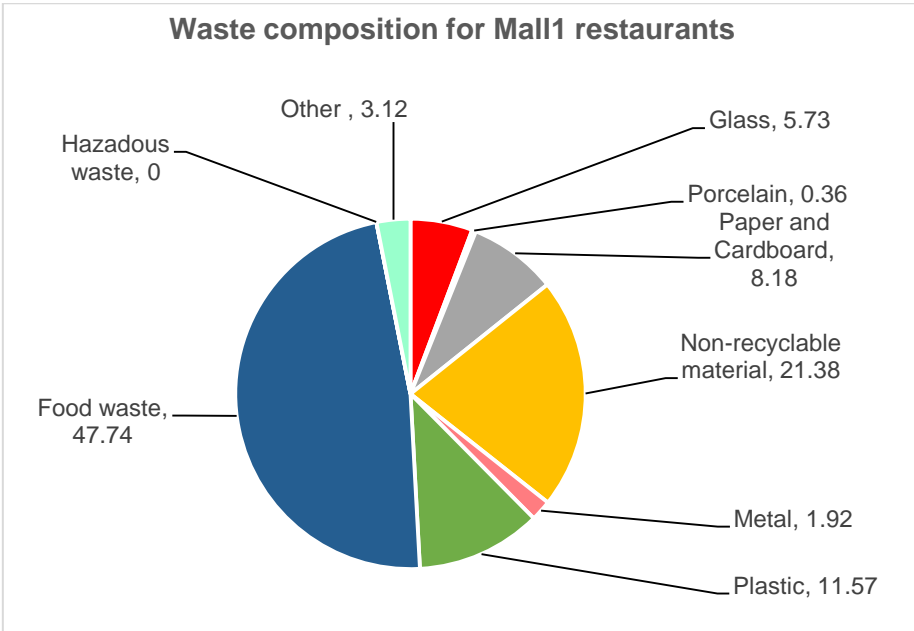
Figure 4-1: Waste percentage composition for mall1 restaurants
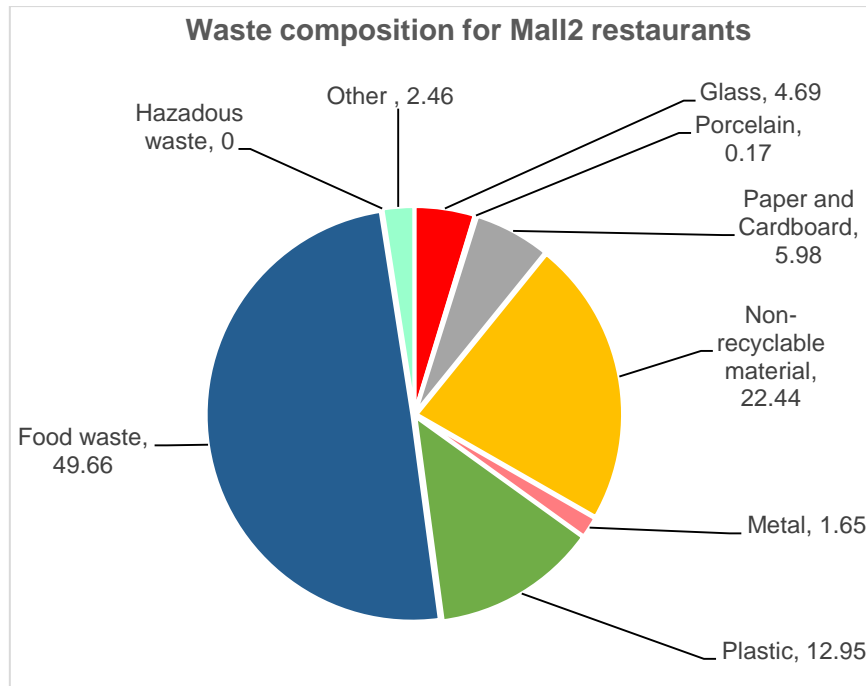
Figure 4-2: Waste percentage composition for mall2 restaurants

In contrast to the findings of restaurant waste composition presented in Figure 4- 1 and 4- 2, a waste characterisation study by Austin Resource Recovery (2012) found cardboard as the greatest quantity of waste contributing 26% of the total waste generated in quick service (also known as fast food) restaurants. Although the high amount of cardboard as compared to food waste in the Austin Resource Recovery's (2012) study may have resulted from various factors including efficient staff members, restaurant practices and policies, proper food stock management, menu style as well as type of restaurant, it is not unexpected that quick service restaurants may produce more cardboard than food waste when measured by weight. Generally, quick service restaurants are characterised by limited menu options, provision of standardised ingredients, partially prepared food, limited seats and food prepared for take away (Austin Resource Recovery, 2012). Standardizing and limiting menu items reduces food waste generated during preparation stages (Tatano *et al.*, 2017) while plate waste and packaging waste may be reduced by the take away type of service where the food and its packaging is taken away and disposed out of the premises of the restaurant (Aarnio and Hamalainen, 2008). Another possible explanation to differences between the findings presented in Figure 4-1 and 4- 2 and those of Austin Resource Recovery (2012) could be the fact that Mall1 and Mall2 have cages for source separation of corrugated cardboard (see Figure 4- 3) while the study only included waste destined for disposal. As a result, most of the cardboard that was found during sorting was food contact cardboard packaging (see Figure 4- 3).

Figure 4-3: Shows contaminated food contact cardboard packaging (left) found during sorting and clean source separated corrugated cardboard (right)

As shown in Table 4-4, food waste generated from Mall1 consisted of 26.71% avoidable waste and 21.03% non-avoidable waste. In Mall2 (see Table 4- 5) the food waste component was made up of 31.73% avoidable waste while 17.93% was non-avoidable. This can be equated to 55.95% avoidable food and 44.05% non-avoidable food in Mall1 and 63.89% avoidable food and 36.11% non-avoidable food in Mall2 (Figure 4- 4). The amount of non-avoidable food waste found in the study appears to differ markedly from the 19% and maximum of 21% reported by Ventour (2008) and Betz *et al.,* (2015) respectively. This may be due to different classification methods used when measuring food waste. Investigating the magnitude and the potential for reduction of food waste in the Swiss food service industry, Betz *et al.,* (2015) used the same classification method as the one used in this study. However, they did not indicate in which category the possibly avoidable fraction of food was characterised under, which could have great impact on the results as the possibly avoidable fraction also presents a considerable share amount of food waste. For example, in Ventour's (2008) study the possibly avoidable fraction of food waste was almost the same as the un-avoidable fraction at 20% and 19% respectively. Ventour (2008) classified the food waste component into avoidable, un-avoidable, and possibly avoidable food waste. However, the results found by Papargyropoulou, Wright, Lozano, Steinberger, Padfield and Ujang

(2016) at 44% of non-avoidable waste were close to the results found in Mall2 (36.11%) and almost the same as those found in Mall1 (44.05%).
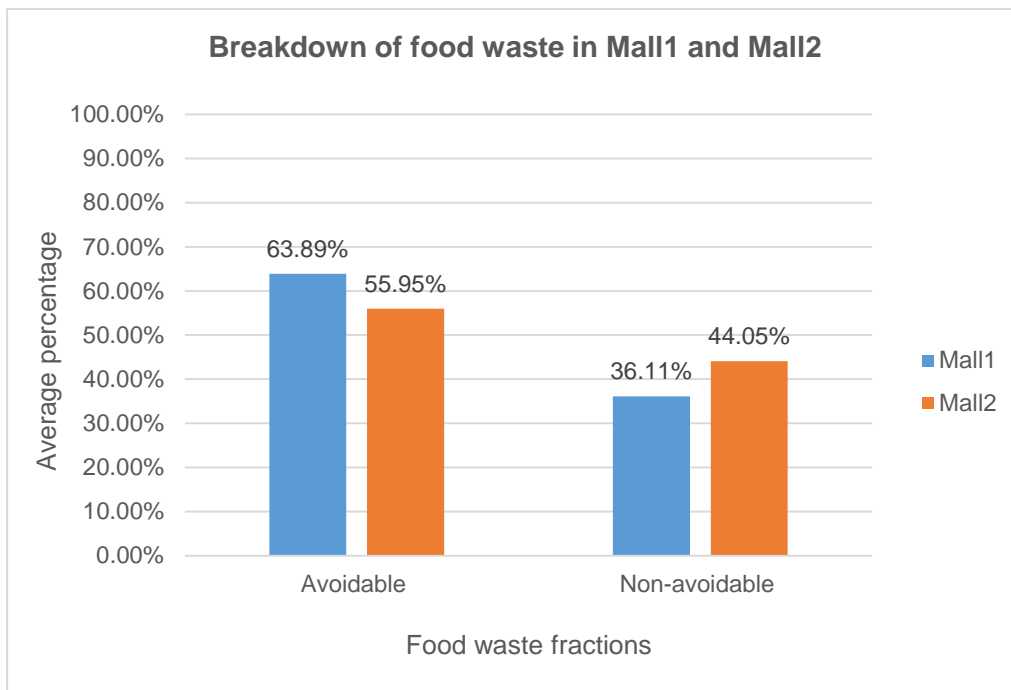
Figure 4-4: Break down of food waste component in Mall and Mall2

The second predominant waste material found in both Mall1 and Mall2 was non-recyclable material. Non-recyclable material consisted of non-recyclable paper (mostly food soiled tissue paper), non-recyclable plastic and other single use non-recyclable beverage containers such as coffee cups. The amount of non-recyclable material found in Mall1 and Mall2 was almost the same with 21.38% of the total sorted in Mall1 and 22.44% in Mall2. The considerable amount of non-recyclable waste can be attributed to the utilisation of single use paper napkins in the kitchens, tissues, individual condiment packets and other food packaging plastic that falls under the non-recyclable waste category.

In Mall1 non-recycle material was followed by plastic (11.57%), paper and cardboard (8.18%), glass (5.73%), other material (3.12%), metal (1.92%), porcelain (0.36%) respectively. Similarly, non-recyclable waste in Mall2 was followed by plastic (12.95%), paper and cardboard (5.98%), glass (4.69%), other material (2.46%), metal (1.65%) and porcelain (0.17%). In contrary to the composition of mainline recyclables (paper and cardboard, glass and metal) found in Mall1 and 2 (see Figure 4- 5), most of the studies found paper and cardboard to be the largest packaging components (Majid and Hwee, 2007; VanWaning, 2010 cited in Pirani and Arafat, 2014; and Davies and Konisky, 200) while Tatano *et al.,* (2017) found glass as the largest component. This may be attributed to the source separation of corrugated cardboards as indicated earlier. Hazardous waste was absent in both Mall1 and Mall2 restaurants which concurs with other

studies (Dangi *et al.*, 2011; Austin Resource Recovery, 2012). In total, the mainline recyclable material including metal, paper and cardboard, glass and plastic presented 27.40% in Mall1 and 25.27% in Mall2. These figures suggest a greater potential for recovery through recycling. The considerable amount of mainline recyclables found in both malls appear to be close to the total percentages of recyclable material found by Majid and Hwee (2007) at 21.5%.
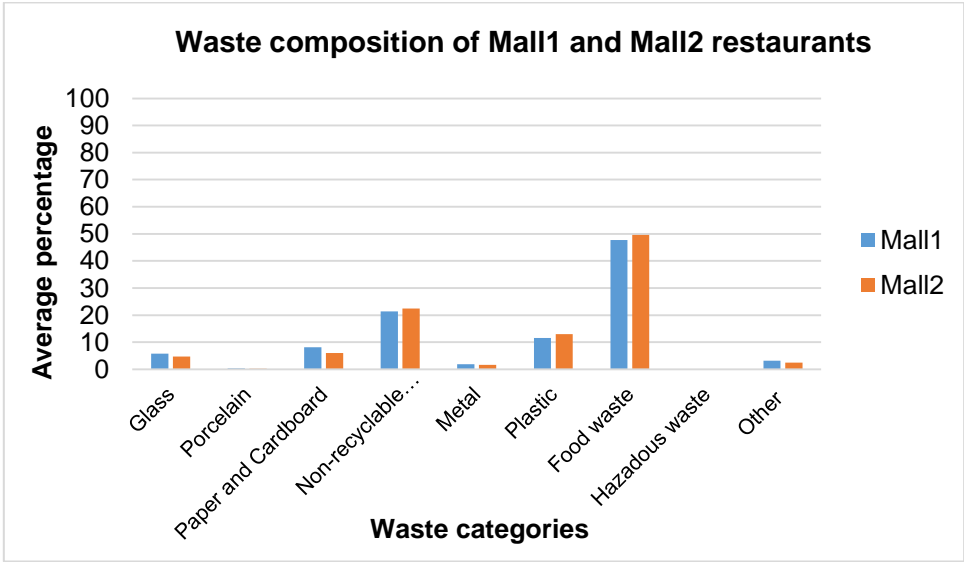
Figure 4-5: Waste percentage composition for Mall1 and Mall2 restaurants

The week day and weekend day sample were combined for a direct comparison in both malls. There was no large variation in percentage composition of waste sorted during the week and the weekend day in both Mall1 and Mall 2 in most of the waste categories (see figure 4- 6 and 4- 7). As expected, food waste represented the major component during the week and weekend day in both Mall1 and Mall2. However, the difference is that more food waste was disposed during the weekend in Mall1 while more food was disposed during the week in Mall2. Given that weekends are popular times for visiting the restaurants, one would have expected food waste generation in Mall2 to be more during the weekend day than weekday. But it is not the case, which indicates a need for a study to be conducted over a period of time to ensure that the results were not because of unusual circumstances. In Mall1 non-recyclable material and plastic were also more during the week while other waste categories (glass, paper and cardboard, metal and other) were higher over the weekend than during the week (see figure 4- 6). In Mall2, only food waste and plastic were higher during the weekday than over the weekend while other waste materials were higher during the weekend (see figure 4- 7). While there may have been some differences between week and weekend days in waste composition, it is interesting to see that the percentage composition

of the waste categories sorted during the week and weekend day were more or less the same in both Mall1 and Mall2.
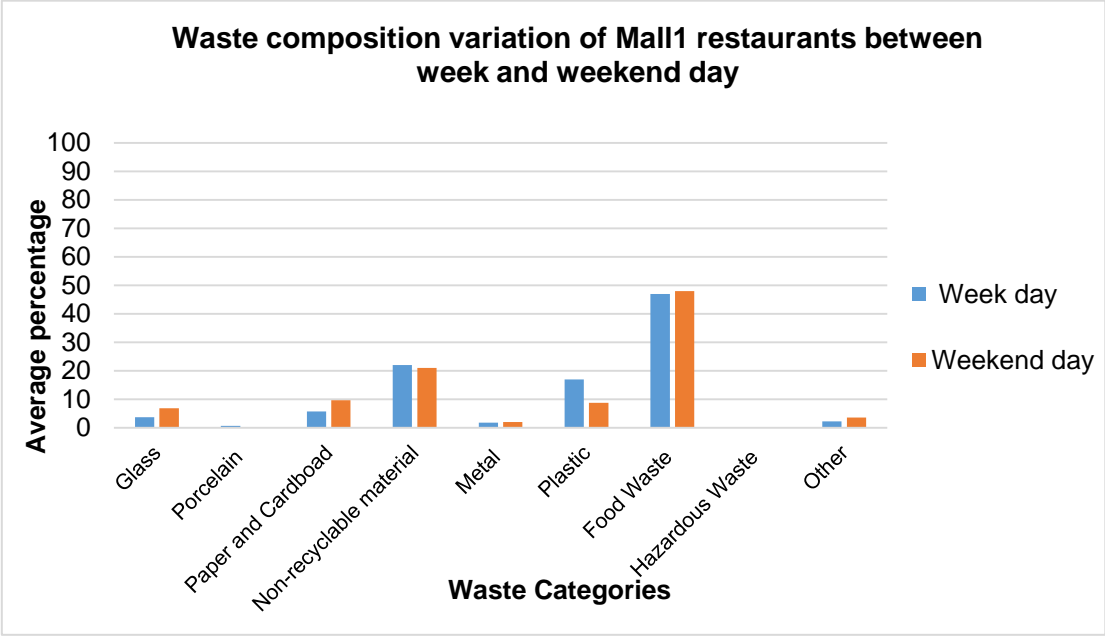
Figure 4- 6: Composition variation of Mall 1 restaurants between week and weekend day
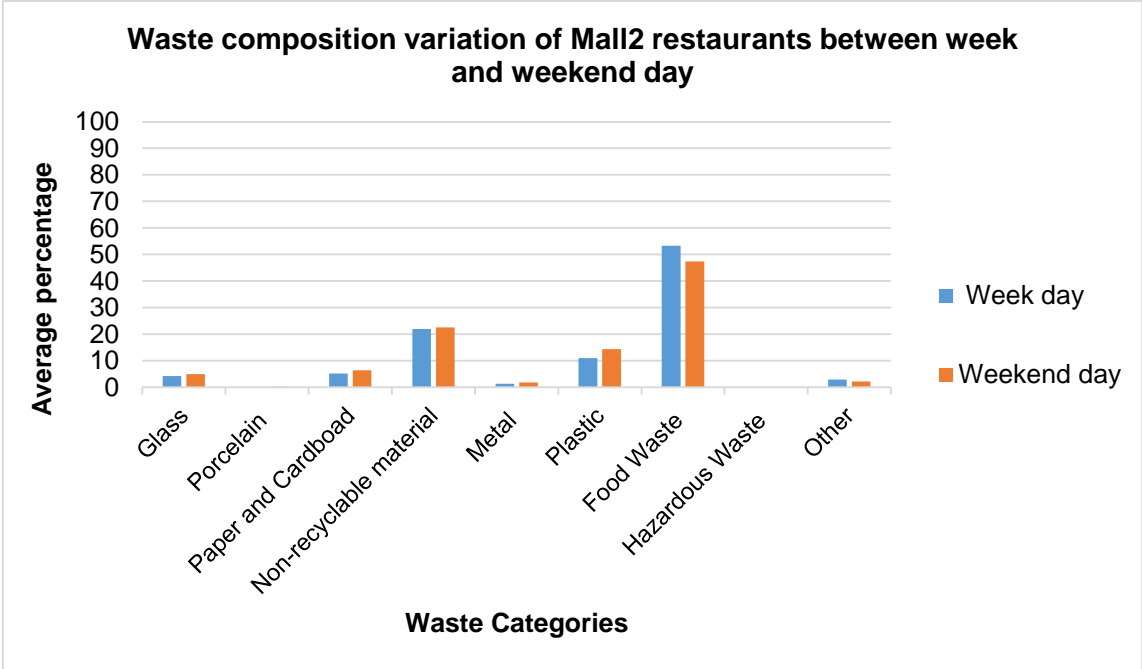
Figure 4- 7: Composition variation of Mall2 restaurants between week and weekend day

To confirm whether the differences identified in the percentage composition of waste generated during the week and weekend day is large enough to be statistically different, a Mann-Whitney test was applied in both Mall1 and Mall2. A critical values of U at p. <0.05 for a two-tailed test was used. To be significant the U Statistic must be equal to or less than the critical value. The results shown in Table 4-2 indicate that there were no statistical significant differences between week and weekend in MALL1 in most of the waste categories. Significant difference was found in plastic. Plastic category included HDPE, PET, Polypropylene, Polystyrene, and LD - Mix Plastic and mostly LD - Clear Plastic. The difference in the presence of plastic between week and weekend may be explained by the fact that restaurants receive their stock during the week and therefore more waste during the week may have resulted from transport plastic packaging. There was no statistical significant difference found in all the waste categories in Mall2.

Table 4-2: Mann-Whitney U test results for the comparison of waste sorted from Mall1 restaurants between week and weekend sample

Critical value	U statistic	Interpretation	Main waste category
5	12	No statistically significant difference	Glass
5	16	No statistically significant difference	Porcelain
5	16	No statistically significant difference	Paper and Cardboard
5	17	No statistically significant difference	Non-recyclable material
5	13	No statistically significant difference	Metal
5	0	Statistically significant difference found	Plastic
5	14	No statistically significant difference	Food Waste
5	18	No statistically significant difference	Hazardous Waste
5	16	No statistically significant difference	Other

Table 4- 3: Mann-Whitney U test results for the comparison of waste sorted from Mall2 restaurants between week and weekend sample

Critical value	U Statistic	Interpretation	Waste fraction
8	17.5	No statistically significant difference	Glass
8	22	No statistically significant difference	Paper and cardboard
8	24	No statistically significant difference	Non-recyclable material
8	17.5	No statistically significant difference	Metal
8	17	No statistically significant difference	Plastic
8	22	No statistically significant difference	Food waste
8	24.5	No statistically significant difference	Hazardous waste
8	23	No statistically significant difference	Other

Table 4- 4: Average waste composition and standard deviation across detailed categories in Mall1

General waste Categories	Fractions/Description	Average percentage	Standard deviation
Glass	Glass bottles, glasses cups etc	5.73%	2.09
Porcelain	Porcelain	0.36%	0.41
Paper and Cardboard- All recyclable Paper and Cardboard	All white Office Paper	0.68%	0.20
	Common mix	2.91%	3.04
	Cardboard	3.93%	3.47
	Tetra Pak	0.64%	0.43
Non-recyclable paper	Badly soiled, tissue paper, wax paper, laminated etc.	19.64%	15.67
Metal: ferrous and non-ferrous	Ferrous metals: metal cutlery	0.44%	0.28
	Non-Ferrous metals : beverage or coke can, tin foil etc	1.48%	1.02
Plastic- All recyclable plastics	HDPE drink bottles – i.e. Milk bottles	1.19%	0.47
	PET drink bottles – i.e. 2 litre or 1 litre beverage bottles	1.61%	0.79
	Polypropylene – i.e. PET bottle caps etc	0.48%	0.32
	Polystyrene	0.43%	0.32
	LD - Clear Plastic)	5.25%	2.52
	LD - Mix Plastic)	2.62%	1.26
	LD - Stretch i.e. cling wrap	0.00%	0
	All non-recyclable or not identified plastics	1.74%	0.60
Food waste	Avoidable food waste- burnt food, leftover food etc	26.71%	5.99
	Un-avoidable food waste-bones, peels, egg shells etc	21.03%	15.58
Hazardous waste	Cleaning chemicals/ medical care waste	0.00%	0
Other		3.12%	1.95
Total		100.00%	56.42

Table 4- 5: Average waste composition and standard deviation across detailed categories in Mall2

General waste Categories	Fractions/Description	Average percentage	Standard deviation
Glass	Glass bottles, glasses cups etc	4.69%	6.95
Porcelain	**Porcelain**	0.17%	0.17
Paper and Cardboard- All recyclable Paper and Cardboard	All white Office Paper	0.87%	0.51
	Common mix	1.08%	0.43
	Cardboard	3.55%	2.27
	Tetra Pak	0.49%	0.21
Non-recyclable paper	Badly soiled, tissue paper, wax paper, laminated etc.	19.78%	13.32
Metal: ferrous and non-ferrous	Ferrous metals: metal cutlery	0.51%	0.37
	Non-Ferrous metals : beverage or coke can, tin foil etc	1.13%	0.96
Plastic- All recyclable plastics	HDPE drink bottles – i.e. Milk bottles	1.96%	1.17
	PET drink bottles – i.e. 2 litre or 1 litre beverage bottles	2.23%	1.19
	Polypropylene – i.e. PET bottle caps etc	0.55%	0.47
	Polystyrene	0.62%	0.50
	LD - Clear Plastic)	3.80%	2.49
	LD - Mix Plastic)	3.79%	2.03
	LD - Stretch i.e. cling wrap	0	0
	All non-recyclable or not identified plastics	2.66%	1.50
Food waste	Avoidable food waste- burnt food, leftover food etc	31.73%	20.76
	Un-avoidable food waste-bones, peels, egg shells etc	17.93%	12.65
Hazardous waste	Cleaning chemicals/ medical care waste	0	0
Other		2.46%	1.10
Total		100.00%	69.08

A closer consideration of waste composition by type of restaurant is represented in Figure 4- 8 and 4- 9. As expected, waste generated by Mall1 restaurants was dominated by food waste (see Figure 4-8). Surprisingly, the fast food restaurant contributed more food waste (51.37%) than the full service restaurants (47.39%). Higher food waste percentage in a fast food restaurant when compared to full-service restaurants was unexpected given that fast food restaurants are characterised by limited menu options, provision of standardised ingredients, partially prepared food, limited seats and food prepared for take away while full service restaurants offer a variety of meals that are eaten in the premises of the restaurants. This finding is contradictory to Silvennoinen's *et al.*, (2012) study which showed that full restaurants waste more food than fast food restaurants. In their study, fast food restaurants discarded about 7% of all food served while full service restaurant contributed 19% of all food served. This finding also contradict with Hollins (2013) who found full service restaurants to generate more food waste than fast food restaurants. In Hollins's study (2013) full service restaurants wasted about 23% of the total amount of food purchased while fast food restaurants only wasted 8%. However, the amount of food waste found in fast food restaurants confirms a finding by Kuczeruk (2011) in Elmedulan Jr, Apat and Matunog (2014) who found that food waste contributed more than 50% of waste coming from fast food restaurants. Plastic was the second predominant waste category in fast food restaurant at 23.31% while 10.41% of plastic was found in full service restaurants making non-recyclable material the second predominant waste stream in full service restaurants. Low levels of metal and other waste categories were present in both fast food and full service restaurants. Glass material was absent in fast food restaurant waste while 6.29 % of glass was found in the waste from full service restaurants. Kuczeruk (2011) in Elmedulan Jr *et al.,* (2014) also found minimal amount (0.6%) of glass in the waste from a fast food restaurant.
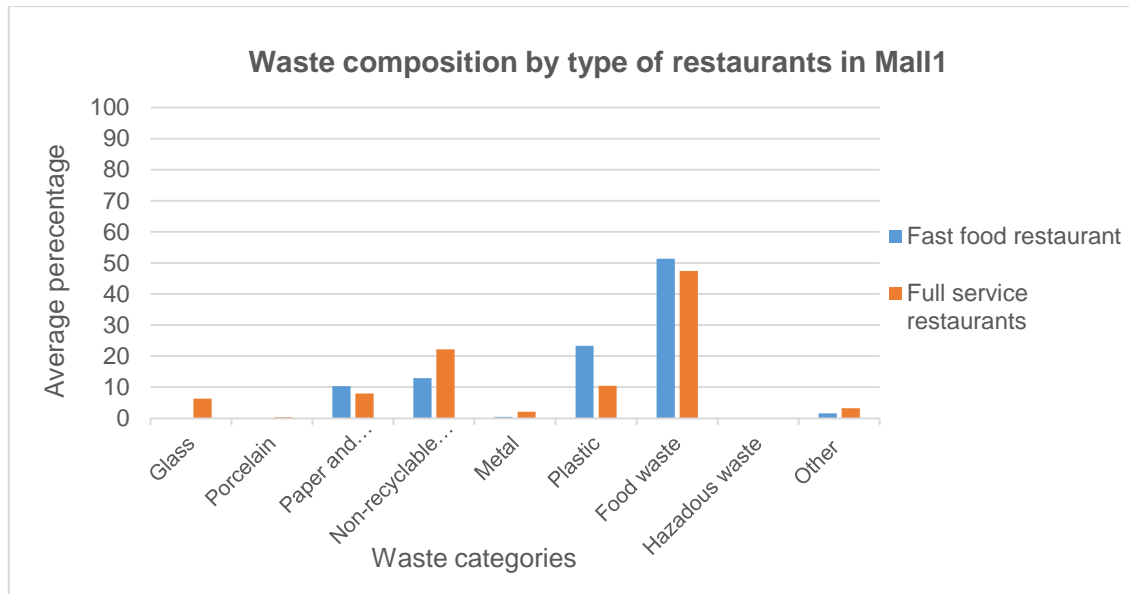
Figure 4- 8: Waste composition by type of restaurant in Mall1

As expected, food waste contributed the most in all types of restaurants in Mall2. Comparatively fast food restaurants had the highest food waste percentage (57.49%) as compared to full service restaurants (48.97%) and cafes (47.47%). This finding contradicts the finding of Silvennoinen *et al.*, (2012) who found food waste by type of restaurant as follows: cafes (19%), full service restaurants (18%) and fast food restaurants (7%). Although the estimated food waste by type of restaurant found in this study does not concur with Silvennoinen's *et al.*, (2012) finding, it is interesting to note that the food waste percentage found in cafes and full service restaurants was almost the same in both studies. Non-recyclable waste also seemed to make a considerable contribution in all types of restaurants in Mall2, forming the second predominant waste category. The amount of non-recyclable waste was almost the same in full-service restaurants and cafes at 23.72% and 22.27% respectively, while it contributed 14.17% of the total amount of waste in fast food restaurants. This indicates a need for restaurants to use re-usable utensils and products packaged in recyclable material. Pirani and Arafat (2014) suggested green purchasing as one of the strategies that can be used to reduce waste in the restaurant hence green products often result to reduced waste generation as they are not packaging-intensive and the packaging that they do have is recyclable. Demand for recyclable and re-usable utensils will not only result in improved waste management in the restaurants but will also result in a shift towards production of re-usable and recyclable material from their suppliers. Davies and Konisky (2000) report that while it is important for restaurants to reduce their direct environmental impacts including energy use, an opportunity to also improve upstream environmental impacts exists. They report that the restaurants are the ones that make a decision about what to sell to the customers, as well as where to source the ingredients, and so they have the authority to expand the decision to include environmental aspect such as use of recyclable packaging in their products and use of organic

ingredients. Conducting a study on food waste in the food service sector, Derqui *et al.*, (2016) also touched on the need for restaurants to put pressure on their suppliers to adopt environmentally sustainable practices in order for them to operate in a sustainable manner. Plastic waste also formed a considerable fraction of the total waste. The percentage of plastic was high in cafes and almost the same in fast food restaurants and full service restaurants. Plastic material in a restaurant comes from packaging for ingredients that are used to prepare meals, PET and plastic cups to serve beverages as well as disposable cutlery for takeaways. Low levels of metal were found in all the types of restaurants, presenting less than 2% of the total waste. Previous research on restaurant waste has shown metal to contribute less than 9% of the total waste (Hogan *et al.*, 2004; Majid and Hwee, 2007; Dangi *et al.*, 2011; Austin Resource Recovery, 2012; Tatano *et al.*, 2017; Oliveira, Rodrigues, Lopes and Dias-Ferreira, undated). Full service restaurants had the highest percentage of glass in Mall2 while only 0.65% of glass was found in cafes. Absence of glass in a fast food restaurant could be explained by the fact that fast food restaurants only serve non-alcoholic beverages in tins, plastic bottles and paper cups. On the other hand, depending on the restaurant, full service restaurants also serve alcoholic beverages in bottles. This finding concurs with Austin Resource Recovery's (2012) finding where there was no glass material found when they conducted a waste characterisation in a fast food restaurant.
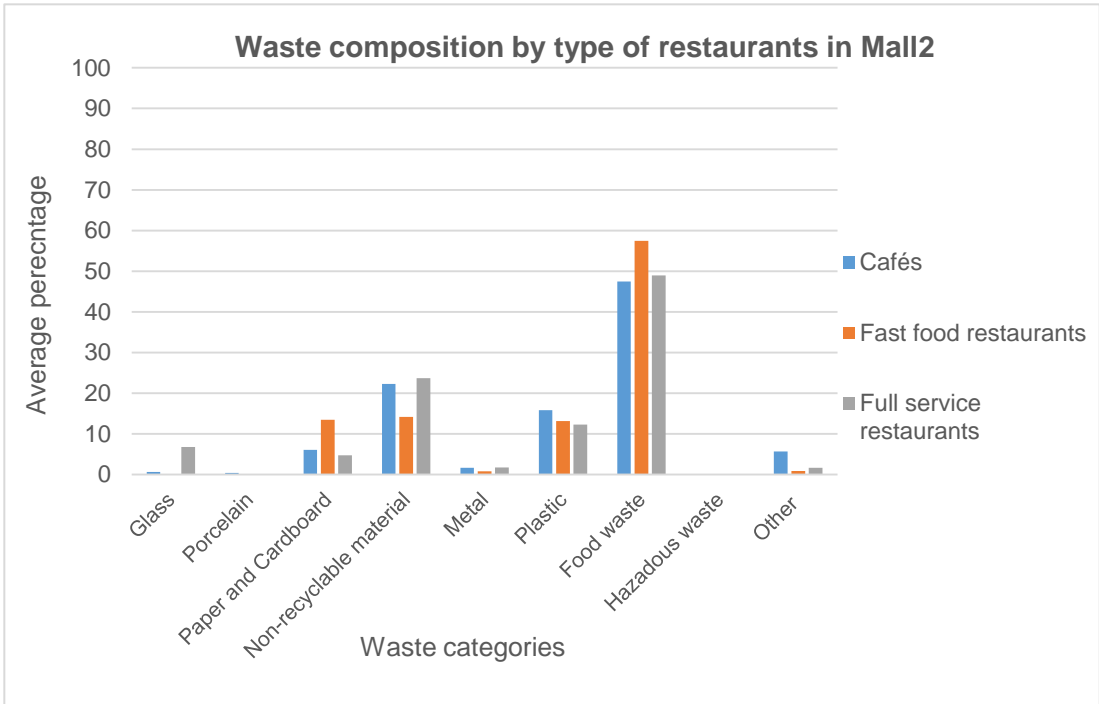
Figure 4- 9: Waste composition by type of restaurants in Mall2

Through the waste characterisation it was possible to calculate theoretical recovery potential of the waste generated by the restaurants. This was done by adding the waste composition

percentages of the mainline recyclable material (paper, plastics, glass and tins) and food waste. Overall potential recovery rate in Mall1 was found to be 75.14% and 74.93% in Mall2. In parallel with the potential recovery rate of Mall1 and Mall2, potential recycling rate by restaurant is represented in Figure 4- 10 and 4-11. The results showed that most of waste generated in the restaurants could be recycled. This finding indeed confirms previous research which also found that most of the waste generated in restaurants can be recovered through composting of food waste and recycling of recyclable material (metal, plastic, glass, paper and cardboard) (Nielsen (2004) in Kasim and Ismail 2012; Majid and Hwee, 2007; Austin Resource Recovery, 2012). Comparatively, the fast food restaurant had the highest recycling potential rate (85.47%) followed by full service restaurants (74.12%) in Mall1. The highest recycling potential rate in Mall2 was found in fast food restaurants (82.92%) followed by full service restaurants (74.54%) and cafes (71.65%). The theoretical recovery potential of waste generated by Mall1 and Mall2 restaurants is less than the 95% potential recycling rate reported by Nielsen (2004) in Kasim and Ismail (2012). Currently, waste from restaurants is handled by the same service provider contracted by the management of both shopping malls. Unsorted waste from the restaurants is collected and sorted for recycling while residual waste is taken for landfilling. Waste source separation in the restaurants could assist in ensuring recovery of clean recyclables.
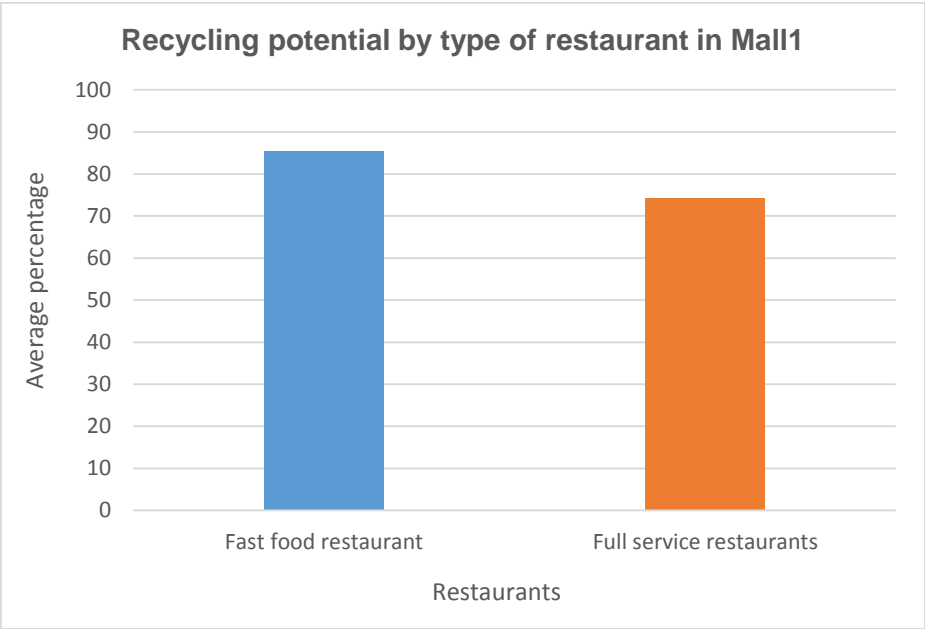
Figure 4- 10: Recycling potential rate by type of restaurant in Mall1
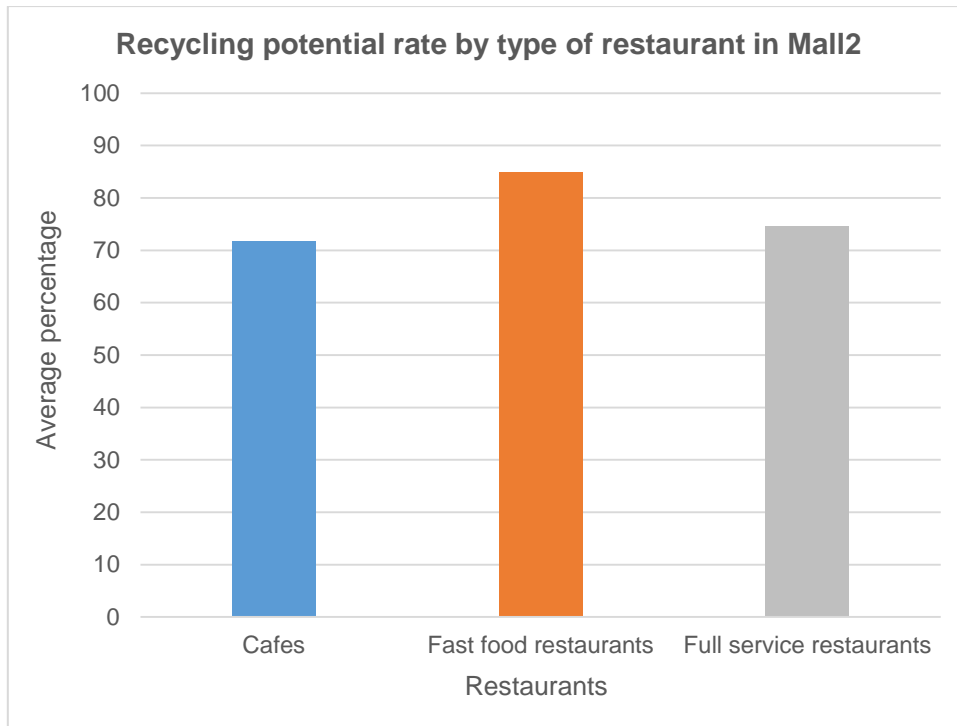
Figure 4- 11: Recycling potential rate by type of restaurant in Mall2

4.1.2   Waste generation quantities

Due to a lack of data on the number of customers and number of meals served in the restaurants on the sampling days, only average waste generated during two sampling days was calculated. On average, the sampled restaurants in Mall1 disposed 22.52 kg on a week day and 42.25 kg by weight on a weekend day during the quantification period. In Mall2 the restaurants generated an average of 21.15 kg on a weekday and 37.61 kg on a weekend day. This was derived from calculating the average of the total waste generated by restaurants during the week day and weekend day. Average waste generated by sampled restaurants in both malls during the week day and weekend day is higher than restaurant waste generation of 10.98 kg/day reported by Ilyas, Ilyas, Ahmad and Nawaz (2017) which so gives an idea of how much room for improvement there is. Assuming that waste generation from the restaurants is constant and that restaurants open 7 days per week, from these results we can deduce that Mall1 restaurants generate an average of 197.10 kg per week and 180.97 kg in Mall2. The results translate to an annual waste generation of 10.25 tonnes in Mall1 and 9.41 tonnes in Mall2.

4.2   Sources of food waste in the restaurants

The previous section revealed that food waste forms the majority of waste generated in restaurants. High food waste in the restaurants highlights a need for better management of the food. In order to reduce food waste, it is important to have a clear understanding of the sources

of food waste in restaurants. Food waste contributions in different stages was obtained from the restaurant managers' perspective. The participants were asked to score food waste contributions of each stage from a scale of 1 to 5, 5 being the highest amount and 1 being the smallest amount. In accordance with Betz *et al.,* (2015), food waste was categorised into four stages including storage, preparation, serving and plate waste. Storage waste included food that was lost during storage (in refrigerators and dry storage areas). Preparation waste included all the food that was thrown away during cooking stages such as incorrectly prepared food, burnt food and inedible portions. Serving waste included all the food that was correctly prepared but not sold (for example waiters dropping food and wrong orders). Plate waste on the other hand included all the food that was left by customers on their plates.
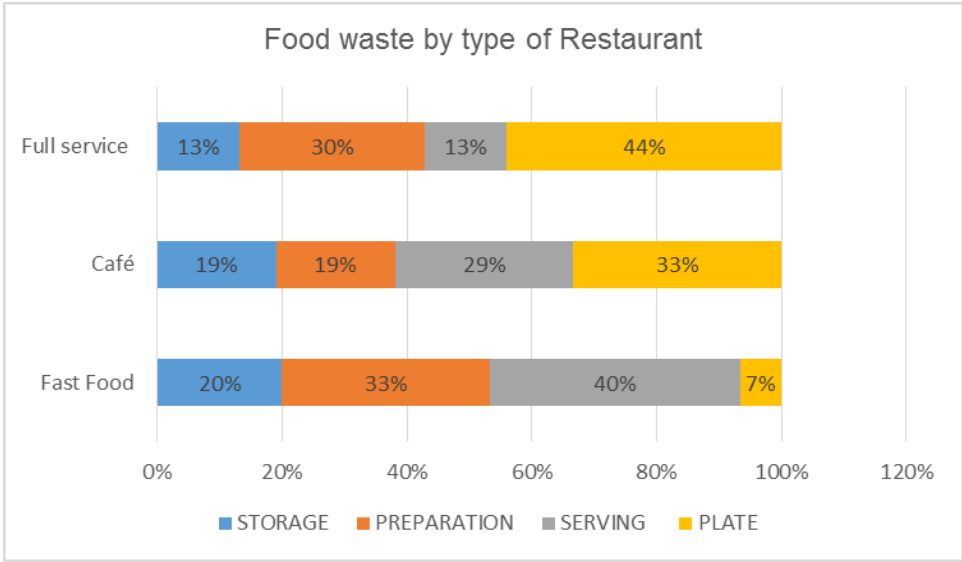
Figure 4- 12: Comparing percentage of food waste in different stages of the service by type of restaurant

The results showed that contribution of food waste along the food chain differed from all three types of restaurants. It was established that the distribution of food waste throughout the service greatly depends on the business model, the types of ingredients used as well as the types of products used. What was evident, however, was that food waste is more prevalent in the pre-consumer stages of the service. In total pre-consumer food waste was 56% in full service restaurants, 67% in cafes and 93% in fast food restaurants (see Figure 4-12). In full service restaurants, pre-consumer food waste consisted of 13% storage waste, 30% preparation waste and 13% serving waste. High preparation waste in full service restaurants may be due to a number of reasons including generation of inedible parts as a result of using food that is not pre-prepared and ready to cook. Some of the food that is wasted at preparation stages may include items that are accidentally spilled on the kitchen floor, fluids, food that is wasted during potato peeling, roots from leafy vegetables, bones, improper preparation as well as small pieces of

meats. According to Papargyropoulou *et al.,* (2016) unavoidable food waste constitutes about 74% of the total waste generated at preparation stages. This however may vary depending on the type of food used during preparation. Figure 4- 13 shows inedible food waste generated during preparation stages.

Tatano *et al.,* (2017) suggests use of pre-prepared (or semi-manufactured) ingredients with minimal on-site preparation to reduce preparation waste. This however does not necessarily avoid generation of food waste altogether but rather shifts it to the suppliers. (Wrap, 2013). In cafes, serving waste presented the highest share of food arising from pre-consumer stages while storage and preparation waste were the same at 19%. The reason for high serving waste in cafes relates to the fact that most of their meals are made out of bakery products which are baked at the beginning of the day. Thus, difficulty in estimating the customer demand may result to food being wasted. Fast food restaurants on the other hand reported 40% serving waste, 33% preparation waste and 20% storage waste. High serving waste may be an indication of poor customer demand in the fast food restaurants. As reported by Drewitt (2013), fast food restaurants offer quick counter service which requires some of the food to be prepared before orders. Thus, food is cooked before it is ordered and stored in a warmer. Therefore, overestimating the number of customers that may visit a restaurant as well as their consumption needs may result in preparation of food that does not get sold. In parallel to poor forecasting of the demand, is the use of margin of error used during planning. Nguyen (2018) reports that some restaurants do not want to tell their customers that they cannot fulfil an order, as a result, they end up preparing more than they actually need. This was demonstrated in a study conducted by, Papargyropoulou *et al.,* (2016) who revealed that restaurants prepared 30% more food than what was required by the reservations. It was quite surprising to see that preparation waste in fast food restaurants contributed 33% of the total food waste. This percentage of preparation waste is even higher than in full service restaurants (30%) which are reported to prepare most of their food from scratch (for example, peeling of vegetables and deboning of meat). However, the amount of preparation waste from fast food restaurants found by Silvennoinen *et al.,* (2012) (29%) is close to the amount of preparation waste found in this study. Storage waste also contributed a fair share of the total food waste generated in restaurants with contribution of 13% in full service restaurants, 19% in cafes and 20% in fast food restaurants. In contrary to these findings, Betz's *et al.,* (2015) found storage waste to be less than 5%.

Figure 4- 13: Inedible food waste from preparation stage

Plate waste was the highest category in full service restaurants (44%) and cafes (33%) while plate waste contributed the least food waste in the fast food restaurants (7%). It was not surprising to find higher percentages of plate waste in full service restaurants and cafes than in fast food restaurants. In full service restaurants and cafes, food is mostly consumed in the premises of the restaurants while fast food restaurants provide limited sitting and offer food for takeaway. Out of three fast food restaurants that were interviewed, two restaurants did not have seats at all. Customers either took their food as a takeaway or used the food court sitting, hence the low percentage of plate waste in fast food restaurants. Although the style of service in full service restaurants and cafes may have undoubtedly contributed to high percentage of plate waste, the high percentage of food waste could also be influenced by portion sizes. Pujan (2016) reports that restaurants offer big portion sizes such as family size portions to attract the customers. Big portion sizes as a cause of plate waste has also been cited by a number of authors who suggested provision of smaller portion sizes (Betz *et al.*, 2015; Heikkilä, Reinikainen, Katajajuuri, Silvennoinen and Hartikainen *et al.*, 2016; Pujan, 2016; Sakaguchi, Pak and Potts, 2018). Investigating the effect of reducing portion size on food intake and plate waste, Freedman and Brochado (2010) found that provision of smaller portion sizes resulted in reduced plate waste.

Scoring food waste from different sources allowed the researcher to identify areas that could be targeted with food waste reduction measures. Stages of the service that recorded more than 25% of food waste in all the restaurants were identified as stages where great attention should be placed when addressing food waste in each type of restaurant. To reduce food waste, the results of the study suggest that full service restaurants should place more attention in preparation and plate waste in full service restaurants, serving and plate waste in cafes and preparation and

serving stages in fast food restaurant. However, these results should be interpreted with caution, as it is possible that some of the participants were not able to score accurately. A more objective measure of restaurant food waste from different stages of the supply chain is recommended.

4.3 Reasons for food waste generation from each stage of the restaurant service

Reasons for food waste generation were obtained from the restaurants manager perspective by asking them to list top three reasons for food waste generation in each stage.

4.3.1 Storage waste

As shown in Table 4-6, poor stock rotation, malfunction of the refrigerators, over-purchasing of stock, poor storage of ingredients were identified as the primary reasons for food waste generation in the restaurants. Other reasons for food waste generation included products reaching expiry dates/best before dates (12%), damage on ingredients packaging (9%), products packed on a wrong compartment (3%), breaking the frozen cycle of the ingredients (3%), improper labelling of the ingredients at storage (3%) and poor hygiene levels (3%). Figure 4-14 shows an example of food waste from storage stage.

Figure 4- 14: Edible food waste from storage stage

A key recommendation for reducing food waste at the storage stage is practising proper stock rotation. Stock rotation is very important as it makes managers and staff members aware of the products they have in stock, how long the product should be kept and which ones should be used first. The commonly used method of doing stock rotation is the FIFO (First In First Out) method. This method involves continuous re-arrangement of the ingredients during storage where new products are placed behind so that old products are used first. As part of stock rotation, Pujan (2016) suggest that all ingredients are checked carefully to identify rotten or damaged products

and also to check if the food is stored under the correct temperature. Over-purchasing of stock on the other hand can be addressed by reviewing stock purchasing procedures and training staff to ensure that the food is used before it reaches its expiry date (Wrap, 2013).

4.3.2 Preparation waste

The results showed that a lot of food waste (edible portion) occurs as a result of human error during the preparation stages. Out of six reasons for food waste generation identified by the restaurant managers, only two reasons were not related to human error (malfunction of the fridge in the preparation section and offcuts). Offcuts as one of the reasons for food waste generation was mentioned by only one restaurant staff member could mean that they do not repurpose their ingredients in their restaurant. In terms of frequency percentage, the top three reasons for food waste generation were negligence from the staff members (42%) (burning and dropping food were the frequently mentioned examples), incorrectly prepared food /not following the recipe (23%) and improper portioning/ measuring of food (12%). Other reasons included malfunction of the fridge in the preparation section (8%), staff not following the standard operating procedure (SOP) (8%) and offcuts (4%). These findings seem to point to a possible need for improvement of the staff performance. One of the most obvious strategies that can be used to reduce food waste during preparation stage is training of the staff members. Continuous training and acknowledgement of staff is necessary to ensure efficiency in the staff members and consequently reduced food waste as a result of proper handling of food. (Ferreira, Liz Martins and Rocha, 2013; Pirani and Arafat, 2014; Betz *et al.*, 2015; Pujan, 2016). Training is recommended to clarify problems and highlight potential for avoiding food waste (Betz *et al.*, 2015). Using different training methods increases the effectiveness of the training (United States Environmental Protection Agency, 2014) and this can be achieved through the use of seminars, posters, symposium and the use of billboards (Elmedulan Jr *et al.*, 2014).

4.3.3 Serving waste

Placing a wrong order is one of the four causes of serving waste that were revealed during the interviews. Papargyropoulou *et al.,* (2016) also found wrong order taking as one of the causes of food waste and attributed it to poor coordination and communication between the different departments (sales department, kitchen and waiting staff) in charge of bookings. This was reported to be more common in cases where the initial order was changed (Papargyropoulou *et al.,* (2016). According Nguyen (2018) miscommunication among restaurant staff members may occur as a result of cultural gaps, physical layout of the operation or language and also because of limited time.

The interviews revealed another contributing factor to serving waste as preparation of excessive amounts of food. Preparation of excessive amounts of food can be attributed to poor forecast of customer demand. Previous research shows that kitchen operators sometimes have difficulties in estimating the number of customers that might visit their restaurant and also meals that may be purchased (Derqui *et al.*, 2016; Nguyen, 2018). Estimating demand is very important as it helps in predicting the number of customers that may visit the restaurant and consequently the amount of food that needs to be prepared for that day. Restaurant managers use predictive and logical systems to estimate the demand by considering a variety of internal and external factors. Internal factors may include previous sales and past clients while external factors may include pay days, public holidays, weather and events close to the restaurants. Although restaurants interviewed in this study did not mention customer demand forecasting as one of the reasons for food waste generation, the research revealed that different forecasting practices exist in the restaurant industry, with some companies using a tool while others use logic. Most of the managers indicated to use logic to estimate the demand while only one manager reported to use a tool. The restaurant manager reported that the benefit of using the tool is that it does not allow the restaurant to prepare more food but allows them to prepare less food and thus encourages food waste reduction. Wrap (2011) reports that although forecast error can be reduced through the use of tools, the forecast error cannot be eliminated. Accurate forecast is key to reducing pre-consumer food waste and the resultant costs to the business as it is ensured that the prepared food has an end customer. Nguyen (2018) suggests studying the customer's preferences and other factors.

Another possible reason for preparation of excessive amounts of food may be the used margin of error during planning. Evidence suggests that restaurants prepare more food than their estimated demand (Ferreira *et al.,* 2013; Papargyropoulou *et al.*, 2016; Nguyen, 2018; Derqui *et al.*, 2016). While investigating food waste management in the hospitality sector, Nguyen (2018) revealed that overproduction is regarded as a risk management strategy. This is because restaurants do not want to take the risk of running out of food, hence they generate more food in case more people visit their restaurants (Nguyen, 2018). However, more often than not the excessive amount of food ends up as waste. This is a significant finding as it suggests a low level of educational awareness surrounding food waste reduction and profitability. Overproduction wastes constitute significant cost to the company as materials and resources in manufacturing are wasted given that the finished (prepared) product no-longer has an end customer (Darlington *et al.*, 2009). Papargyropoulou *et al.*, (2016) conducting a study of food waste generation and prevention in the hospitality industry revealed that restaurants prepared 30% more food than what is required. When questioned on the use of margin of error, about 15 restaurants that were interviewed in this study reported to prepare food to meet the demand while two restaurants

declared to prepare more food so that they do not run out. One of the restaurant managers that admitted to prepare more food than their demand reported that they increase their food quantities by 10%.

Other causes of food waste generation during the serving stages included waiters dropping food (24%) which could indicate a need for training of staff members. Restaurant managers also identified customers ordering something that they do not know (14%) as one of the drivers of food waste.

Restaurant manager: "*There are dishes that are sent back by customers. This happens when the customer's orders something that they do not know and when the order arrives they do not want the food, so they send it back. This mostly happens with eggs where a customer orders a sunny side up egg, which is a very raw egg. When they get the order they say it's very raw, I can't eat this, they send it back. In this case, the eggs are taken back to the kitchen for more cooking but if the product can't be fixed it becomes waste to the restaurant*".

4.3.4 Plate waste

In terms of plate waste, there are four drivers of food waste that were identified by the restaurant managers. The first reason for plate waste generation was dissatisfaction with the taste of food. Dissatisfaction with the taste of food as a driver of plate waster was also cited by Juvan, Grün, and Dolnicar (2018). Customers usually have an expectation of how the food should taste like when they visit a restaurant. When the expectations are not met, the food is sent back to the kitchen through complaints. For example, this may occur when they are not happy with the taste of certain ingredients, condiments, or the quality of the served food (Nguyen, 2018). Consequently, this leaves the restaurant staff with no choice but to dispose the food as it cannot be served or eaten by someone else. The second reason was customers leaving food because they are full which may be attributed to provision of big portion sizes. The third reason for plate waste generation was people ordering more than they can eat. A similar observation was made in Papargyropoulou's *et al.,* 2016 study. They revealed a significant driver of food waste relating to customer's cultural belief by providing an example of a leader of the family ordering more food than the family can eat to show that he can provide for the family. The fourth reason was children not finishing food. According to Neff, Spiker and Truant (2015) children waste more food than adults. It was also interesting to note Niaki, Moore, Chen and Cullen (2017) finding which revealed that food wastage behaviour differs among children. In this study Niaki's *et al.*, (2017) investigated food waste generation by elementary school students with the aim of assessing if there was a difference in food waste generation between grades. They categorised the grades into pre-school to grade 1, grade 2 to grade 3 and grade 4 to grade 5. The results showed that pre-school to grade 1 category wasted more waste food than grade 2 to grade 3 and grade 4 to grade 5

categories. A lot of restaurants have meals tailored for children (Duursma, Vrenegoor and Kobus, 2016). However, woman and elderly who are reported to eat less food than men do not order portion sizes tailored for them (Duursma *et al.*, 2016). These findings are very important as they show that standardised meals served in restaurants do not meet the appetite of every customer.

Although plate waste is consumer-related food waste, strategies to reduce it can be employed by both restaurants and consumers. However, Derqui *et al.*, (2016) reports that most of the managers regard plate waste minimisation as a responsibility of the customer and not responsibility of the restaurants. This is mainly because food left on the plate is paid for and does not impact on the financial performance of the restaurant. (Derqui *et al.,* 2016). Thus, restaurant staff members are encouraged to reduce food waste occurring in the kitchen to maximise profit (Wrap, 2013). However, they lack economic driver to reduce plate waste, because the more consumers order, the more the profit they make (Wrap, 2013).

Ensuring provision of good quality service is one of the strategies that can be used by restaurants to reduce plate waste. Investigating generation and collection of restaurant waste in Italy, Tatano *et al.*, (2017) revealed that restaurants use fresh locally grown food with good quality to avoid waste as a result of poor quality and taste. Wrap (2013) suggests customisation of portion sizes and use of various prices based on the portion sizes. To ensure correct portioning, Duursma *et al.,* (2016) suggested use of calibrated measuring tools such as cups and serving spoons. Other strategies documented in the literature include the use of small serving plates and the offer versus serve food provisioning method. Offer versus serve method is a food provisioning method where the customers are given an opportunity to choose what they want. This method can help reduce wastage of side dishes and accompaniments which are often left uneaten by customers in the restaurants. On the other hand, customers can also play a crucial role in plate waste reduction by ordering food that meets their appetite and also by taking their food as 'doggy bag' for later use (Principato, 2018). Table 4- 6 shows the frequency percentage of the reasons why food is wasted at each stage of the restaurant service.

Table 4-6: Reasons for food waste generation from each category

SOURCES AND REASONS FOR FOOD WASTE GENERATION	Frequency	Frequency (%)
STORAGE WASTE		
Poor stock rotation	6	18%
Poor storage of ingredients	5	15%
Over purchasing of stock	5	15%
Damage on ingredient's packaging	3	9%
Malfunction of the fridge	6	18%
Products packed on a wrong compartment	1	3%
Breaking the frozen cycle of the ingredients	1	3%
Improper labelling of the ingredients at storage	1	3%
Products reaching expiry dates/best before dates	4	12%
Poor hygiene levels	1	3%
	33	100%
PREPARATION WASTE		
Incorrectly prepared food /not following the recipe	6	23%
Negligence from the staff members	11	42%
Malfunction of the fridge in the preparation section	2	8%
Time pressures in the kitchen	1	4%
Improper portioning/ measuring of food	3	12%
Staff not following the SOP	2	8%
offcuts	1	4%
Total	26	100%
SERVING WASTE		
Waiters placing a wrong order	7	33%
Overproduction of food	6	29%
Waiters dropping food	5	24%
Customers ordering something that they do not know	3	14%
Total	21	100%
PLATE WASTE		
Dissatisfaction with the taste of food	4	36%
People order more food than they can eat	2	18%
Customers leaving food because they are full	4	36%
Children not finishing food	1	9%
Total	11	100%

Figure 4-15 shows reasons why food is wasted in each stage of the restaurant service and as well as the stages at which each restaurant needs to place greater attention when addressing food waste. Stages at which each type of restaurant needs to place great attention are coloured with red (Stages of the service that recorded more than 25% of food waste) while green was used to indicate low food wastage.
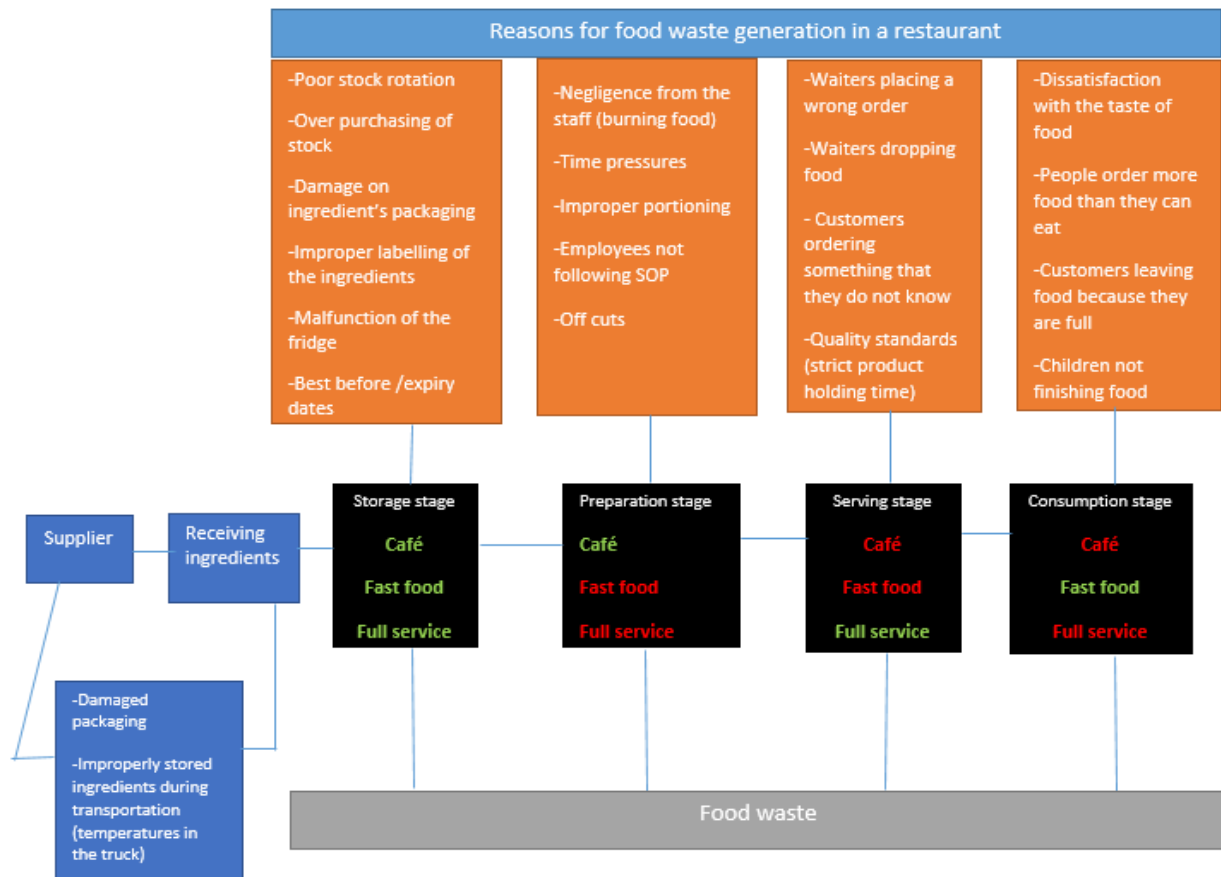
Figure 4- 15: Stages at which food waste occurs and the reasons for food waste generation

4.4 Other reasons for food waste generation

Beyond the direct reasons for food waste generation that were identified by the participants, standard operation procedure is also one of the reasons for food waste generation that were uncovered in the study. Each and every business processes, procedures, policies and standards put in place to ensure that a business runs smoothly, to which employees of a company are expected to adhere to. Hence employee behaviours are greatly influenced by their organisation processes, procedures, policies and standards. How restaurant employees forecast their customer demand and decide on the amount of food to prepare, how they handle the food during storage and preparation and what they do with the food when it has been rejected by a customer or when it has been left on the plate is governed by business processes, procedures, policies and standards. One factor arising from legislation which results to food waste production highlighted by a number of authors in the literature is time limitation in terms of how long the food must be kept before sale (Heikkilä *et al.*, 2016; Papargyropoulou *et al.*, 2016). Conducting a study on elements affecting food waste in the food service sector, Heikkilä *et al.*, (2016) found time limitations in terms of how long prepared food should be stored before sale as one of the causes of food waste generation. When restaurants were asked if they have time limitations on how long

the food must be stored before sale, all the respondents indicated that there are procedures that determine how long prepared food should be kept before it is sold. They reported that different ingredients have got different holding times. For example, ingredients such as rice, cakes and muffins can be kept for a day while products like sushi, burger patties and pizza dough can only be kept for few hours.

Restaurant manager: "*This restaurant is a franchise and we do everything according to the standard of operation, there are rules and regulations, time frames for finished product, how long a finished product should be kept in a fridge. There is something called preparation date, where you write the time you prepared the food, how long it should be kept in the fridge and when it should be disposed. Salads is an example of food that has time limitation. According to the hygiene standards it should not be kept for longer than the specified time. We have to maintain the time to ensure food safety. California roll sushi is supposed to be on display for only four hours, and you see it's still ok, it can be consumed but according to the standard operation you can't serve it to the customers. Also creamy garlic source, is very sensitive. Salads as well because when you keep the salad for a long time it starts showing a different colour*".

4.5   Most wasted food commodities in the restaurants

The main types of food wasted by restaurants were also investigated. Figure 4-15 shows the percentage of each type of food that restaurants throughout the service, in order of frequency. Vegetables, bread, meat and dough were the main types of food wasted in the restaurants. This finding corroborates Chisnall' (2018) who found vegetables to be the most wasted food commodities. Fruit, flour, garnish, salads and calamari were the least wasted food commodities. When combined, carbohydrate foods make up the most frequently wasted food. This finding concurs with Hollins's (2013) study. Hollins (2013) found carbohydrates food such as bread, pasta and rice as the most wasted food commodities in the restaurants when conducting a study on waste in the UK hospitality and food service sector. In wrap's study food commodities like vegetables and fruit and meat were the least wasted.
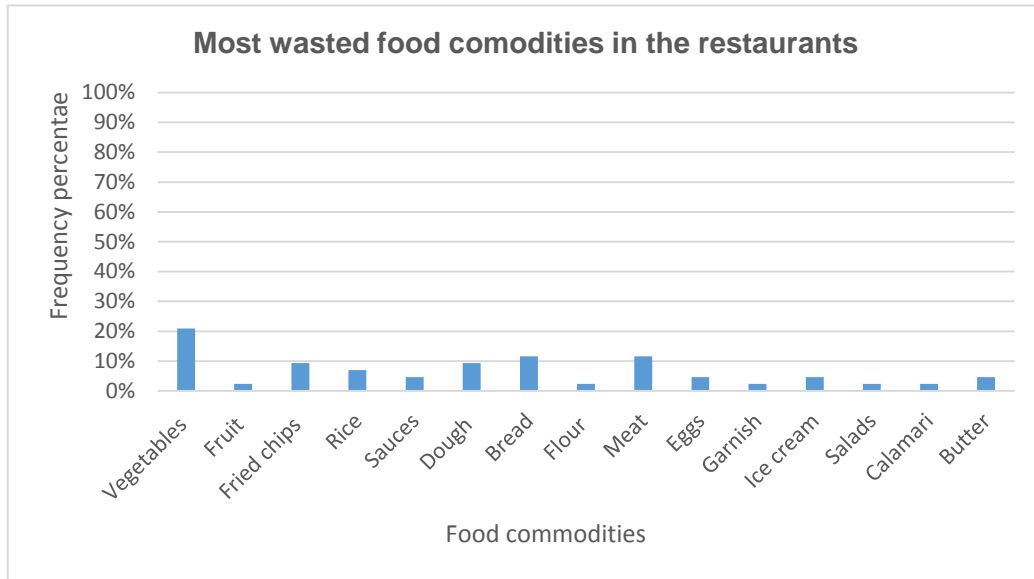
Figure 4- 16: Most waste food commodities in the restaurants

4.6   Existing measures used to reduce food waste

Generation of food waste, regardless of whether it is generated in pre-consumer stages or post-consumer stages of the restaurant service constitutes one of the largest environmental threats. It is beyond doubt that reduction of food waste is critical for sustainable management of food. Having investigated the amount, causes and sources of food waste, it was imperative for the researcher to look at restaurant practices and processes to identify existing measures used to reduce food waste as well as their food waste disposal practices. In order to reduce food waste, the food recovery hierarchy sensibly dictates prevention of food waste, diversion to hungry people and then to animals, processing to recover useful components, and finally disposal where the above is not an option (see figure 4- 16). Thus the main aim of this section was to identify measures used to prevent and re-use food from the time food is purchased until it is disposed.

Food Recovery Hierachy

Source Reduction
Reduce the volume of surplus food generated

Feed Hungry people
Donate extra food to food banks, soup kitchens and shelters

Feed Animals
Divert food scraps to animal feeds

Industrial Uses
Provide waste oils rendering and fuel conversion and food scraps for digestion to recover

Composting
Create a nutrient-rich soil amendment

Landfil/incineration
Last resort to disposal

Figure 4-17: Food waste hierarchy (Adapted from: United States Environmental Protection Agency, 2010.p.,3)

The interviews revealed a number of measures that are used to reduce food waste in the restaurants, one of which relates to purchasing of ingredients. When purchasing ingredients some of the respondents indicated that they only purchase the ingredients that are needed in their businesses. This is very important as excessive amount of ingredients increases the risk of spoilage at storage stages of the service. Ensuring procurement of only ingredients that are needed in the restaurants does not only prevent waste generation but also prevents financial loss as a result of buying food that ends up as waste. According to Hollins (2013) Restaurants loose more money when they buy ingredients that they do not need. Food costs in the restaurants is estimated to range from 28% to 35% of sales (ReFED, 2018).

Restaurant manager: "*We try and monitor food wastage from the time stock is brought in. We limit the amount of stock that we bring in. If it's not a busy period, you know that having a lot stock in your fridge is a waste. So rather limit your stock and try to be productive with the amount of stock that you have*".

Restaurant manager: "*I always tell my boss not to order too much, you'd rather have products sold out than to waste. It's better to tell the customers that a certain item is sold and suggest something else*"

In line with purchasing of ingredients, another food waste prevention measure that was identified in the study was the use of good quality ingredients. The majority of restaurants (franchises) reported that they only get their ingredients from head office. The head office sources ingredients from authorised suppliers. All the ingredients are checked for quality before they are distributed to the restaurants. One of the respondents reported that because they are a franchise, food purchased from their brand has to taste the same no matter where the restaurant is. A common reason given for only getting ingredients from the head office was to ensure that the ingredients they use are of good quality. Tatano *et al.* (2017) has also cited the use of good quality food as one of the measures for reducing food waste. Some of the restaurants reported that they are allowed to buy certain ingredients directly from suppliers, however, the supplier has to be approved by the head office. For example, one of the respondents reported that "*We are authorized to buy fish from local fisherman, but I don't believe in buying from local fisherman because the fish might be contaminated. So I buy my products straight from the head office because everything that comes from head office is tested, and standardised".* This example does not only show how concerned the restaurant manager is when it comes to the quality of food, but it also illustrates reluctance to buy locally produced food although several studies have shown a growing consumer interest in local foods (Vieregge, *et al.,* 2007; Jang *et al.*, 2011; Chou *et al.,* 2012). From an environmental perspective, buying locally produced food reduces the distance that the food has to travel from the producer to the end-user as well as other environmental impacts associated with transporting food such as energy use and emission of carbon dioxide (Wang, 2012; Jang *et al.*, 2011).

Upon arrival of the stock, the respondents reported that the stock is checked to ensure that the order is correct and that the food is in good condition upon receipt. When the food is not in a good condition, they send it back to the head office or to the supplier. Examples given on the stock that is returned back to the head office or to the supplier included broken burger patties, opened or damaged packaging of the product, broken chicken pieces and tomatoes that are too ripe. The respondents indicated that they have procedures that they follow when checking their products. For example, with vegetables they check if they are dry (because if there is any liquid they get spoiled very quickly), if the stock was stored in correct temperatures during transportation, hygiene in the trucks as well as best before and expiry dates. With the best before and expiry dates a person responsible for receiving stock checks if the dates on the primary packaging correspond with the dates on the secondary packaging. Careful checking of stock that the restaurants receive plays an important role in reducing food waste by rejecting poor quality products and products that have a greater risk of spoilage. However, this does to prevent food waste altogether, as rejected products become waste to the head office or the suppliers. Accepted products are then taken to different storage areas. All the restaurants reported to use

the FIFO method which is a commonly used storage method where new products are kept behind so that the new products are used first.

Another strategy used to prevent food waste that was identified in the study is the provision training to staff members. The interviews revealed that restaurants use different training methods such as on the job training, contracting service providers to provide training and distribution of a leaflet containing everything about the store. Training as a critical measure for food waste reduction has been cited by a number of authors (United States Environmental Protection Agency, 2014; Betz *et al.*, 2015; Canali, Amani, Aramyan, Gheoldus, Moates, Östergren, Silvennoinen, Waldron and Vittuari, 2016; Nguyen, 2018). Providing training helps improve the performance of the employees. For example, one of the restaurants reported that training and experience in their restaurant is very important as they prepare pizzas from open fire which may be difficult compared to preparation with the use of calibrated stoves. To improve the performance of the staff members, one of the restaurant mangers reported that every morning they have sessions called "fire up" where they talk about the challenges that they encountered the previous day and address those problems before they start a new day.

The type of food used during preparation has an influence on the amount of waste generated. Use of pre-prepared or precut food reduces the amount of food waste generated during preparation stages such as inedible portions of food and also incorrectly portioned food (Tatano *et al.*, 2017). The majority of fast food restaurants reported to use pre-prepared food while most of the full service restaurants reported to prepare their food from scratch. Some cafes prepared their food on site while others reported to get most of their products ready to sell.

Measuring the amount of waste generated in the restaurant is acknowledged as an important step towards reducing food waste (United States Environmental Protection Agency, 2014). When asked if they measure the amount of food waste they generate, all the participants reported that they measure the amount of food waste they generate by recording the type of product and the stage at which it was generated. One of the participants also stated that they are limited to waste R100 and below a day. Once the restaurant exceeds the limit, the manager investigates the sources of the food waste, the reason why it was wasted and the person responsible for wasting the food. This is very important as it shows the staff members how important food waste reduction is. Restaurant manager: "*We have a waste sheet allocated to record all the waste we throw away, then we try and minimised our waste because waste is not good for your profit? We identify the reasons why food is wasted and we address those. It could be training needed, on the waiters and production staff. For example, if you waste an item then you go write it down, you write I wasted a quarter chicken, it was burnt, this staff member was involved and this is how it was sorted. Even if a staff member throws away a wasted item we find it when we are doing a bin*

check and then we follow up on that and discipline the staff member. However, before I discipline a staff member I ask myself questions as a manager, that did I train the person, does she have the correct equipment to do the job and if these were not done call the staff member teach the staff member instead of demotivating her /him. But if the staff member continues then we give a staff member a warning".

However, when probed deeper on measuring of food waste, all the respondents admitted that they only measure food waste that occurs at the pre-consumer stages. A majority of the restaurants indicated that they are not concerned with waste that comes from the table. Lack of concern in plate waste generation was also evident in the way one of the restaurants classified food waste. He stated that waste food waste occurring in pre-consumer stages is classified as waste while food occurring at the consumption stage is classified as left overs. This clearly shows that food waste is classified based on its financial implication on the business.

Restaurant manager: *"I am not concerned about any kind of waste from the table, I am concerned about food that gets wasted before it reaches the table because that is where I might lose my profit. Anything that comes from the table is classified as left overs and we have got nothing to do with left overs".*

The example provided above supports Derqui's *et al*., (2016) earlier finding that most of the restaurant managers do not regard plate waste minimisation as their responsibility, mainly because it does not affect the economic performance of the restaurant. While the findings point to high levels of concern on food waste generation in the pre-consumer stages of the services among restaurant managers, there were only three respondents that reported to repurpose their ingredients. One the respondents reported that they have in-house specials which incorporate the use of off-cuts. The respondents were then asked about surplus food management. About 59% of the participants reported that they give their surplus food to staff members while 41% of the participants admitted to dispose food waste.   Respondents cited poor quality of the food and liability concerns regarding food safety as the reason why they do not give surplus food to the staff members or donate it.

Restaurant manager: "*Once the food passes the times limitation according to the procedure. It's not good for human consumption. That is why we do not give it to staff members. It's very risky to give the food to people because it is a procedure, we use processed food, so there is a reason why they say it should be used within an hour. I am going to be liable for anything that happens, if I give the food to the people".*

Another initiative that was used to reduce food waste was the use of incentive. One of the managers reported that they get incentivised for good performance in their business and reducing

pre-consumer food waste is one of the areas that are considered. Incentives have been proven to be effective in increasing recycling rates (Iyer and Kashyap, 2007; Yau, 2010; Li, Huang and Harder, 2017)   and have been recommended as one of the strategies that can be used to reduce food waste in the restaurants (United States Environmental Protection Agency, 2010). Conducting a study to evaluate the effectiveness of incentives in encouraging food waste diversion, Li *et al.,* (2017) found that the use of incentives scheme had a great impact on food waste diversion. Timlett and William, (2008) however caution that people are less likely to continue recycling when the incentive has been withdrawn. Oke (2015) adds on to report that while the use of   financial incentives may have great impact in encouraging participation or increase in recycling rate, it has limited to no impact in instigating a the recycling behaviour.

4.7   Waste management in the restaurants

This section provides a general overview of waste management practices employed by the restaurants from waste generation until waste is disposed as un-wanted material. The available disposal methods are presented and analysed, while possible interventions to improve the overall management of wastes are discussed on the basis of the existing infrastructure.   Waste management practices were uncovered through observation and were later confirmed in the interviews with centre management. In Mall1 interviews were conducted with a waste manager and in Mall2 interviews were conducted with an operational manager.

Currently, waste from restaurants is handled by the same service provider contracted by the management of both shopping malls. The mall uses a combination of a cage and recycling bins to store waste coming from the shops (see Figure 4-17). Cages and bins placed in different collection points in the mall (temporary waste area) are shared by shops and from there waste is collected to the waste area where it is sorted. Waste from each collection point is collected three times a day. Information about what and how to separate waste is communicated through the use of posters in Mall2 (see figure 4- 7). The posters were only plagued in restaurant kitchen doors as they were believed to be the main generators of food waste.

Figure 4- 18: Cage for corrugated cardboard (left) and a poster (right)

Despite the provision of recycling bins and use of posters to guide participants on how to sort, participation among mall shops has not been efficient. Direct observations on disposal practices in the malls showed that corrugated cardboard is the only waste material that is correctly separated. As shown in Figure 4- 18, other waste material such as food waste and packaging waste were disposed as mixed waste. This indeed highlights a need for improved education and awareness. Information based instruments play an important role in encouraging source separation (Keramitsoglou and Tsagarakis, 2013). Education awareness campaigns have been conducted through the use of different interventions including the use of leaflets, websites, handbooks, newspapers, door stepping and stickers (Zhuang, Wu and Wang, 2008). Evaluating the effectiveness of sticker prompts for encouraging household food waste recycling behaviour, Shearer, Gatersleben, Morse, Smyth and Hunt (2017) found the visual prompts, in the form of a green refuse bin sticker, to be effective in increasing food waste recycling. Door stepping resulted to an increase in the amount of food waste diversion when Dai, Gordon, Ye, Xu, Lin, Robinson, Woodard and Harder (2015) evaluated the effectiveness of door stepping over a period of two weeks. Door stepping is reported to be effective compared to distribution of leaflets and education awareness through the use of a telephone (Gerber and Green, 2000). According to Timlett and Williams (2008) door stepping works best in areas where the population is difficult to reach. A survey by Mee, Clewes, Phillips and Read (2004) found leaflets to be the most preferred method of communication compared to newspapers and personalised letters when they conducted a study on effective implementation of a marketing communications strategy for kerbside recycling.

Figure 4-19: Lack of source separation in the malls

Specific focus on restaurant disposal practices showed that source separation of waste in most of the restaurants is limited to currugated cardboard. From the 17 restaurant staff members that were interviewed, only 18% of the restaurants claimed to separate their waste at source. When probed, one of the respondants reported that source separation is part of their procedure. They have different colour coded bins in different sections for food waste and all dry waste. Incoporation of source separation on a restaurant's procedure is very important more particularly for restaurants that be long to franchises. Franchise groups have strict set of rules to which restaurants have to adhere to and those rules are ussually the same throughout the world. Thus, rules set by franchises may act as a barrier towards implementation of source separation (an external activity) in restaurants that belong to franchises compared to individually owned restaurants where the owners have idependence and the authority to make changes in the business when ever they want to.

Another respondent directcly associated their source separation practices with the concern for environment which supports earlier research (Akil, Johar and Siong, 2015; Bom, Belbase and Bibriven Lila, 2017; Akil, Foziah and Ho, 2017) that source separation is likely to be influenced by environmental conciousness. For example about 80% of the respondents indicated that environmental concern was the major motivation for their waste segretaion practices when Bom *et al.,* (2017) conducted a survey on public perceptions and practices of solid waste in USA.

About 64% of the respondents reported that they do not separate their waste at source while 18% reported that they sometimes separate their waste. Low percentage of partcicpation in source

separation among restaurants concides with the contention reported by Thomas and Sharp (2013) that provision of infrstructure and education awareness is not enough to encourage source separation, more particularly in developing countries. A similar observation was made by other authors who found that restaurants do not practice source separation, their waste often ends up in landfills (Henningsson, Hyde, Smith, and Campbell, 2004; Darlington *et al.,* 2009; Singh *et al.,* 2014).

This conclusion somewhat conflicts with Elmedulan Jr's *et al.,* (2014) finding which showed that more than 50% of fast food restaurants practiced waste separation. In their study, high source separation in restaurants was achieved by manadating source separation. To ensure compliance, the restaurants were required to incoporate source separation and waste reduction of waste as the SOP (Elmedulan Jr *et al.,*2014). Mandatory source separation of waste is reported to be more effective than voluntary schemes (Kasim, 2007; Cheung Chi-fai Research Office, 2017). Inclussion of recycling as part of the business policy shows the business is serious about source separation and also ensures that resources to support the programme will be provided when needed (Snarr and Pezza, 2000).

Table 4- 7 presents the results on the reasons given for not separating waste at source in the restaurants. In order of frequency, the restaurant managers cited lack of recycling bins and time as the major reasons for not separating waste. About 24% of the respondents cited lack of time as one of the reasons for not separating waste. Some of the restaurants that reported to sort waste, admitted not to sort waste when it's busy. Tatano *et al.,* (2017) also found a co-relation between source separation and peak time of serving meals where source separation was found to be low during peak time of serving food. Lack of source separation during busy periods may be due to the fact that source separation is viewed as an external activity and therefore activities that are part of the business become a priority during those periods. In line with the business activities one of the respondents reported that: *It's not part of the procedure, so it's not the important thing in the business because it does not benefit the business* [restaurant manager]. Lack of time was closely followed by lack of separate bins for sorting waste. Lack of space was another reason given for not separating waste. For example, one of the restaurants even reported that *if we were to separate our waste it would mean that we would have over 30 bins because we have bins in different sections.* Other reasons for lack of source separation included lack of knowledge, laziness and that they are new in the business.

Table 4-7: Reasons for not separating waste

Reasons for not separating waste at source	Frequency (%)
Time pressures	24%
I don't know	10%
There is no space	14%
It's not part of the brand/procedure	10%
I don't get anything, why should I do it	5%
I don't have knowledge about source separation	10%
We don't have recycling bins in the kitchen	19%
Laziness	5%
We have just taken over the business	5%

Considering the responses of the restaurant staff members, it is not likely that they will improve their waste disposal practices without interventions to address the identified reasons for not sorting waste. The above information can be used as a starting point towards redesigning the Malls' source separation scheme into a user focused scheme. Keramitsoglou and Tsagarakis (2013) identify provision of a user focused source separation scheme as one of the most important strategies towards implementation of a successful source separation scheme. Conducting a study on public participation in designing a recycling scheme towards maximum public acceptance Keramitsoglou and Tsagarakis (2013) highlighted the importance of consulting the end-users of the source separation scheme during planning and decision making as opposed to the top-down approach where municipalities implement source separation schemes without consulting the people for which the source separation scheme is intended for. The authors explored questions relating to the type of waste materials that the end-users would like to use, the number of plastic bags that would be required for the collection of recyclables, collection method as well as market based instruments that can be employed to motivate participation.

The restaurant managers were then asked to suggest possible solutions that would improve their participation in the source separation scheme. The main solutions for improved source separation were identified as education awareness, financial incentives, provision of bins and inclusion of

source separation in the SOP. As shown in Figure 4-20, about 36% of the respondents reported that they would separate their waste if they were to be provided with bins. One of the respondents however admitted that their restaurant can only separate waste generated in pre-consumption stages as post consumption waste is disposed by customers in bins placed in the sitting area. Recycling bins in the malls were available in the temporary waste area as shown in Figure 4- 18. However, it is apparent from the results of the study that lack of recycling bins in the restaurant kitchens acted as a barrier towards source separation. Provision of recycling infrastructure is recognised as one of the factors necessary to encourage participation in source separation (Xu, Ling, Lu and Shen, 2017). According to Timlett and Williams (2008) provision of recycling bins enables and influences recycling behaviour in most cases, even for individuals with no past recycling behaviour. Provision of recycling as one of the factors that instigate recycling behaviour was demonstrated in Bernstad's (2014) study when she assessed the effect providing containers for separation of food. The study revealed that provision of containers resulted to increased recycling rate and participation.

The frequency analyses shows that education awareness was the second highest proposed solution. Continuous provision of education awareness is necessary for improved source separation more particularly in malls where tenants change time and again. Information about the source separation scheme can be shared through the use of leaflets, letters and door to door campaigns to ensure that all the tenants are adequately informed about the source separation scheme.

Financial incentive is another solution that was proposed to improve source separation. The restaurants managers' report that incentives for participating and separating correctly would encourage staff members to participate in the recycling scheme. These findings concur with Babazadeh, Nadrian, Mosaferi and Allahverdipour's (2018) finding which revealed that people expect to be rewarded for participating in source separation.

The last solution proposed was inclusion of source separation in the SOP. This proposition is very important as it will encourage the restaurants to treat source separation as a core business activity instead of treating it as an external activity. Inclusion of source separation in the SOP was shown to be effective in Elmedulan Jr's *et al.*, (2014) study which showed that more than 50% of fast food restaurants practiced waste separation.
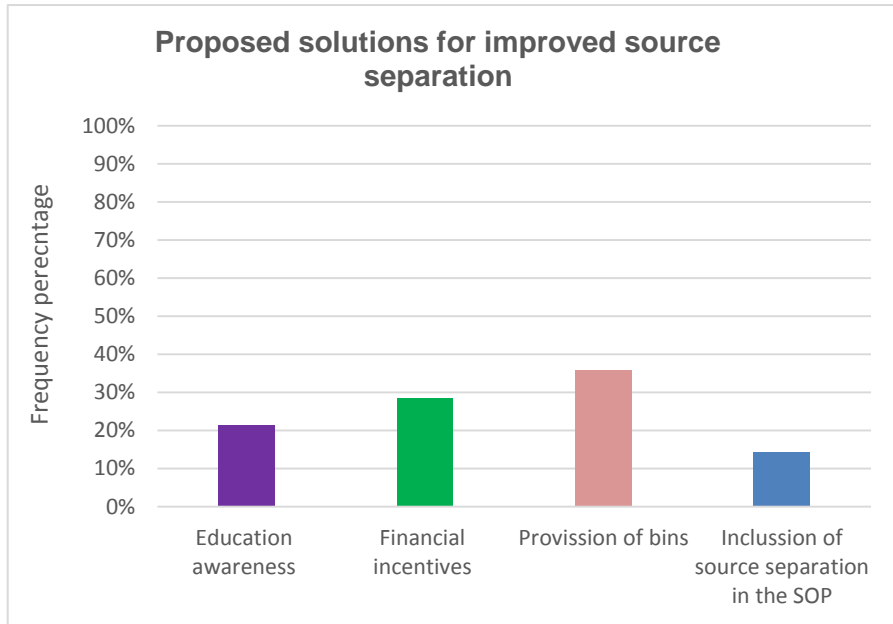
Figure 4- 20: Proposed solutions for improved source separation

Currently, unsorted waste from the restaurants is collected and sorted at the waste area. Materials such as plastic, glass and metal are taken for recycling. In Mall1 food waste is taken to a company that re-uses the food while Mall2 does onsite composting. Information on the quantities generated, recycled and landfilled was provided by Mall1. However, because the information did not contain waste quantities from individual shops, it was not included in the study. Figure 4- 19 shows waste flow from the point of generation until it is sent for landfilling.
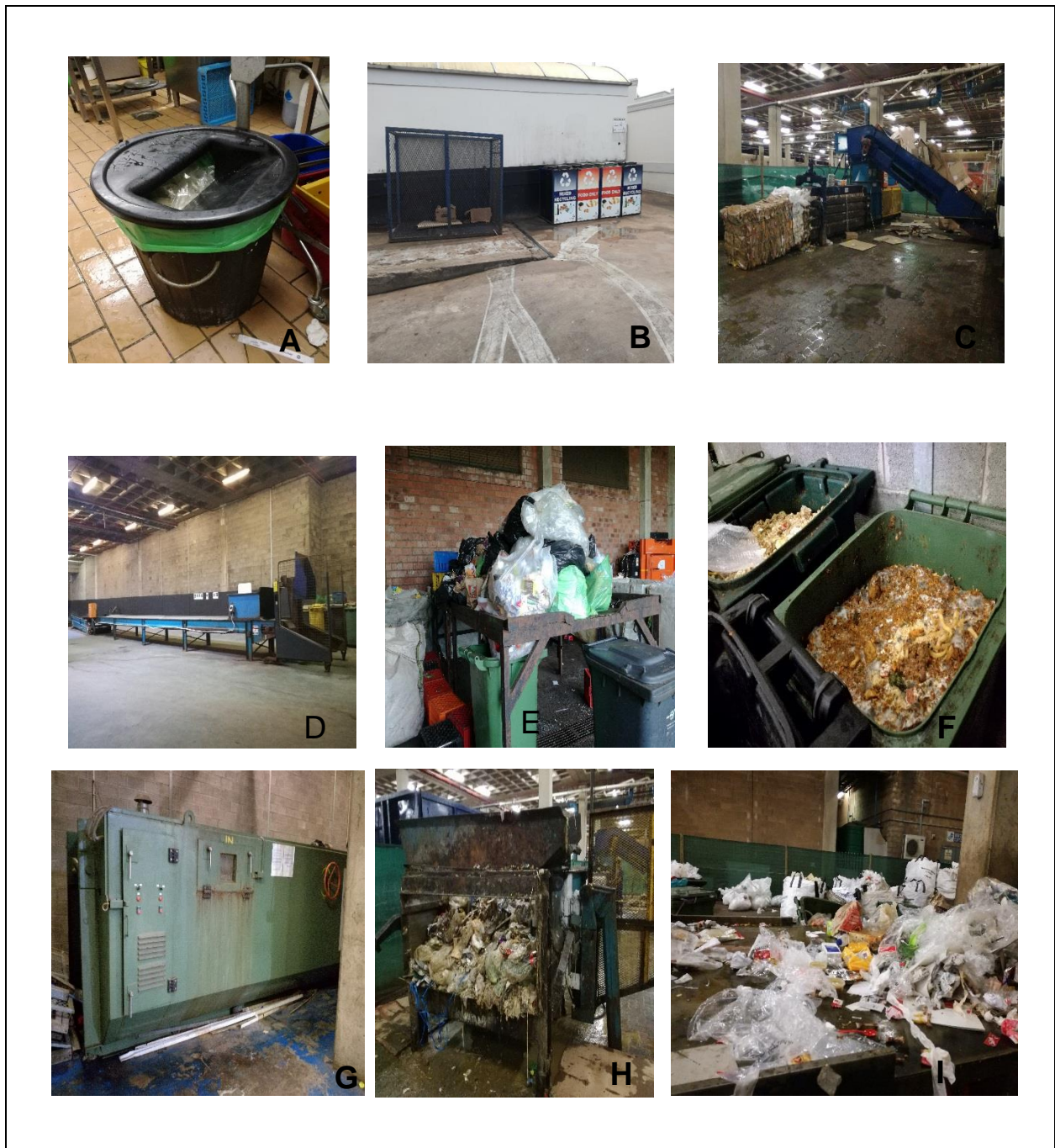
Figure 4- 21:Waste management of restaurant waste: A-waste bin in the restaurant kitchen, B-Temporary waste area (recycling bins and cage for cardboard), C-Cardboard baled for recycling, D-conveyer belt for sorting, E-sorting table, F-food waste sorted for composting, G-Composting machine, H-compaction of residual waste for landfilling, I-Recyclables in bulk bags

4.8   Conclusion

Overall findings of this chapter indicate a need for more improved waste management practices of the restaurants. The main areas that call for action are low source separation participation and

most importantly minimal efforts towards reducing waste in restaurants. Joseph (2006) reports that provision of infrastructure alone cannot solve the waste problem and that participation of all key stakeholders is necessary for improved waste management. Figure 4- 22, shows key stakeholders and some of the roles that they can play to improve waste management of restaurant waste. Cooperation by these stakeholders can be achieved through provision of household education awareness on waste management by the government. Given that people that separate their waste at home are more likely to separate it at work (Marans and Lee, 1993; Tudor *et al*, 2007), it is likely that household education about waste avoidance, reduction and recycling may have an influence on how the malls, customers, restaurants and suppliers manage their waste. The malls can contribute by providing continuous education awareness about the source separation scheme (SSS). Restaurant head office can contribute by introducing customised portion sizes and incorporating source separation as part of the standard operating procedure while restaurants can ensure efficiency in the staff members, use of re-usable utensils and separate waste at source. Offering ingredients packaged with recyclable material by suppliers would enhance recycling of restaurant waste while customers can reduce food waste by ordering food that meets their appetite and taking 'doggy bags' for later use.
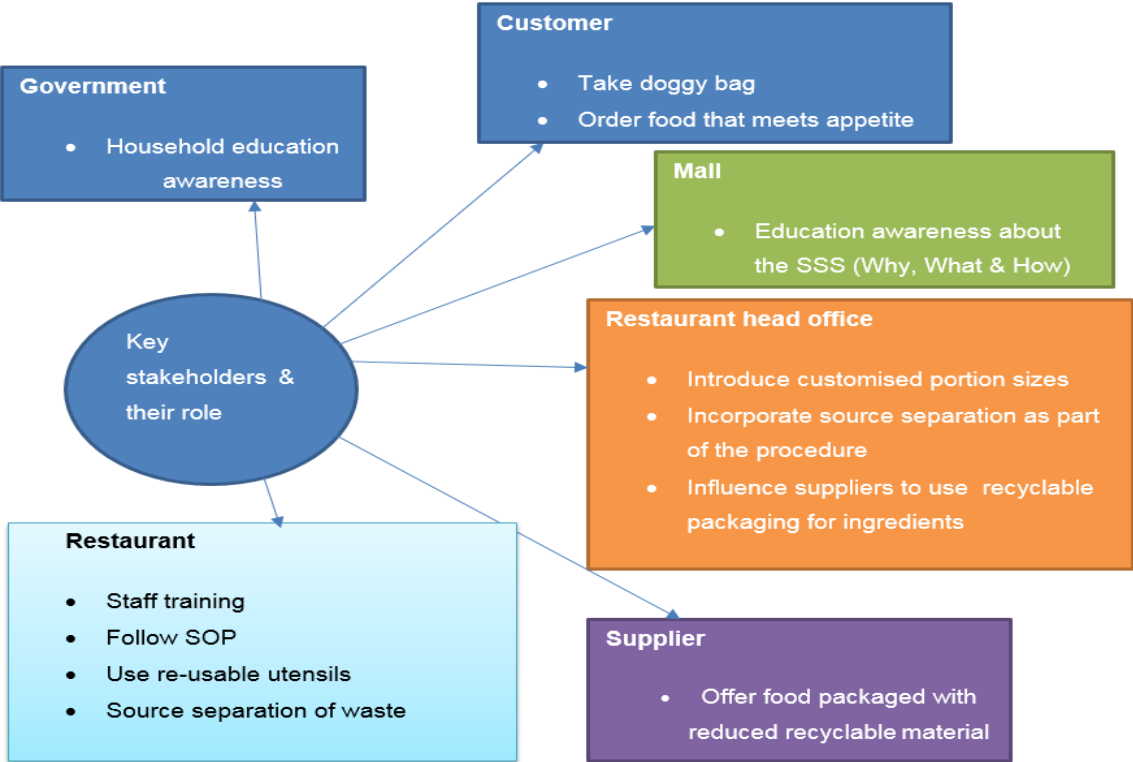

Figure 4-22: Key stakeholders and their role in improving restaurant waste management

4.9   Waste cooking oil generation and disposal practices

Waste cooking oil, also known as used cooking oil is used during preparation of food. Due to its nature and the way it is disposed it was not possible to capture waste cooking oil data during the waste characterisation. Waste cooking oil data regarding generation and disposal practices was obtained through the interviews. As indicated previously cooking oil is used for a number of purposes including deep frying; stir frying and shallow frying (Zein *et al.*, 2008). Repeated heating of cooking oil results in deterioration in its quality and consequently disposal of it. When the participants were asked about how they determine that the cooking oil needs to be changed, about 69% of the respondents indicated to use cooking oil tester strips, 23% look at the colour of the oil while 8% of the respondents used a tea cup test (if you can't see the bottom of the cup, the oil needs to be changed).

In terms of waste cooking oil output, the results revealed that restaurants generate a lot of waste cooking oil with generation ranging between 500ml to 150 litres per week. Average waste cooking oil generation by type of restaurant is shown in figure 4- 20. As shown in figure 4- 20 the amount of waste cooking oil generation varied across restaurants with more waste cooking oil being produced in full service restaurants (63 litres/week) followed by fast food restaurants (53 litres/week). There was no waste cooking oil generated in cafes. Difference in the amount of waste cooking oil across restaurants may be due to different cooking methods as well as the ingredients used. For example, absence of waste cooking oil in cafes may be due to the fact that cafes offer bakery products with ingredients that may require shallow frying such as eggs, sausages and schnitzels as opposed to fast food restaurants and full service restaurants which deep fry ingredients such as meat and chips. The amount of waste cooking oil from fast food restaurants (53 litres per week) found in this study somewhat contradicts with findings of Ramuedzisi (2016). Conducting a study on challenges in recycling used cooking oil in Polokwane, South Africa, Ramuedzisi (2016) found that fast food restaurants generate an average of 640 litres per month which can be translated to 160 litres per week. The amount found in Ramuedzisi's study (2016) is higher than the average waste cooking oil found in fast food restaurants.
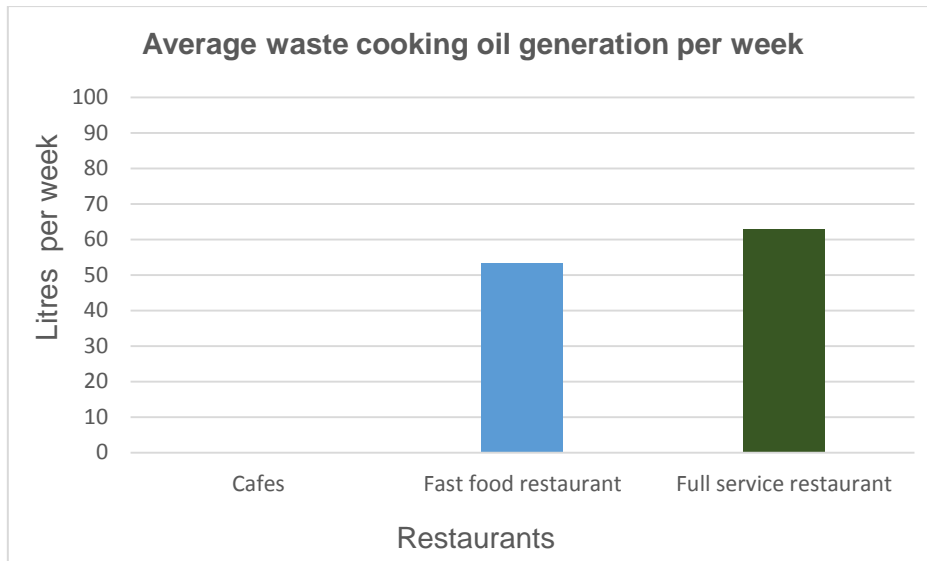
Figure 4- 23: Average waste cooking generation per week

The restaurant staff members were then asked about their waste cooking disposal practices. The results showed that the restaurants had good waste cooking oil management practices with almost all the staff members indicating to sell their waste cooking oil to a company that recycles it to biodiesel. Only one restaurant member admitted that they distribute their waste cooking oil to staff members. This finding concurs with previous research which reports that restaurants dispose their used cooking oil by distributing it to the staff member (Anelich *et al.*, 2001; Ramuedzisi, 2016). This is a concern given that using waste cooking oil can pose serious health hazards (Anelich *et al.*, 2001).

CHAPTER 5: CONCLUSSION AND RECOMMENDATIONS

5.1 General conclusion and recommendations

This chapter draws conclusions on the findings of the study and provide recommendations. The aim of the study was to understand waste management practices in the commercial food service sector to identify opportunities for waste reduction and recovering resources through source separation.

Waste characterisation studies in Mall1 and Mall2 revealed that more than 74% of waste generated by the sampled restaurants has the potential to be diverted from landfill through recycling (this includes paper, plastics, glass and tins) and composting/anaerobic digestion (food waste), while all of the waste generated is currently being disposed as mixed waste. Potential recycling rate by type of restaurant in Mall1 ranged from 74.12% to 85.47% and 71.65% to 84.92% for Mall2. Food waste accounted for close to 50% of waste that was sorted in both Mall1 and Mall2. Food waste generated from Mall1 consisted of 26.71% avoidable waste and 21.03% non-avoidable waste. In Mall2 the food waste component was made up of 30.55% avoidable waste while 19.07% was non-avoidable These figures demonstrate how significant food waste is as a component of the restaurant waste and also highlights the need for diversion of waste through composting or anaerobic digestion. Also, South Africa is considering a landfill ban on disposal of organic waste (DEA, 2013), therefore it is crucial for restaurants to develop or improve organic waste management programs ahead of the organic disposal ban. When combined, mainline recyclables, presented 27.40% in Mall1 and 25.27% in Mall2, suggesting a greater potential for recovery through recycling. Another notable observation in the study was the considerable amount of non-recyclable waste owing to the use of single use of paper napkins, non-recyclable food packaging, waxed disposable cups and other single use materials. With the expected growth in the restaurant industry, improved waste management practices at the source of generation is required. Waste generation estimates indicated that 10.25 tonnes is generated in Mall1 and 9.41 tonnes in Mall2. Possible waste minimisation options for each waste fraction was sourced from the literature and are provided in table 5- 1 below.

Table 5- 1: Possible waste minimisation options

General waste Categories	Fractions/Description	Waste minimisation options of each waste fraction	References
Glass	Glass bottles, glass cups etc.	• Using dispensers and re-usable glasses for beverages in full service restaurants	Wrap, undated
Porcelain		• Providing training to the staff members	Pirani and Arafat, 2014
Paper and Cardboard- All recyclable Paper and Cardboard	All white Office Paper	• Printing and copying double sided • Source separation and segregation of white office paper which cannot be avoided	Pirani and Arafat, 2014
	Common mix	• Printing and copying double sided	Singh *et al.*, 2014
	Cardboard	• Encouraging the suppliers to use re-usable totes and crates for transportation of ingredients	Verghese *et al.*, 2013; Singh *et al.*, 2014; United States Environmental Protection Agency, 2014
	Tetra Pak	• Buying in bulk containers	United States Environmental Protection Agency, 2014
Non-recyclable paper	Badly soiled, tissue paper, wax paper, laminated etc.	• Using products that come in less packaging, and also more recyclable packaging	Singh *et al.*, 2014
Metal: ferrous and non-ferrous	Ferrous metals: metal cutlery	• Using dispensers and re-usable glasses for beverages in full service restaurants	Wrap, undated
	Non-Ferrous metals : beverage or coke can, tin foil etc.	• Donating old kitchen utensils/table ware	Singh *et al.*, 2014
Plastic- All recyclable plastics	HDPE drink bottles – i.e. Milk bottles	• Buying HDPE packaged food in larger bulk packaging	United States Environmental Protection Agency, 2014; Singh *et al.*, 2014
	PET drink bottles – i.e. 2 litre or 1 litre beverage bottles	• Using dispensers and re-usable glasses for beverages in full service restaurants • Buying in bulk	Wrap, undated; Singh *et al.*, 2014
	Polypropylene – i.e. PET bottle caps etc.	• Using dispensers and re-usable glasses for beverages • Buying in bulk	Singh *et al.*, 2014; Wrap, undated
	Polystyrene	• Avoiding over packaged products	Singh *et al.*, 2014; United States Environmental Protection Agency, 2014
	LD - Clear Plastic	• Avoiding over packaged products	Singh *et al.*, 2014; United States Environmental Protection Agency, 2014
	LD - Mix Plastic	• Avoiding over packaged products	Singh *et al.*, 2014; United States Environmental Protection Agency, 2014

General waste Categories	Fractions/Description	Waste minimisation options of each waste fraction	References
	LD - Stretch i.e. cling wrap	• Avoiding over packaged products	Singh *et al.*, 2014; United States Environmental Protection Agency, 2014
	All non-recyclable or not identified plastics	• Purchase of products with recyclable packaging • Using dispensers or refillable containers for condiments • Preventing the use of straws • Use condiment dispensers instead of individual packets	Pirani and Arafat, 2014; United States Environmental Protection Agency, 2014
Food waste	Avoidable food waste- burnt food, leftover food etc.	• Accurate customer demand forecasting • Staff training • Incentivising staff members for reducing food waste • Careful menu planning • Encouraging customer to take doggy bags • Storing food properly • Donating leftover food • Educating customers about food waste	Silvennoinen *et al.*, 2012; Pirani and Arafat, 2016; Betz *et al.*, 2015;United States Environmental Protection Agency, 2014
	Un-avoidable food waste- bones, peels, egg shells etc.	• Buying ready to cook food	Tatano *et al.,* 2017

Given that food waste contributes close to 50% of the total waste generated by mall restaurants, identifying the sources of food waste as well as why food is wasted in the restaurants was paramount. The interviews revealed that causes of food waste in a restaurants are complex and vary from stage to stage of the supply chain. as shown in figure 5-1, poor stock rotation, over-purchasing of stock, negligence from the staff members, placing wrong orders, preparation of excessive amount of food, dissatisfaction with the taste of food and people ordering more food than they can eat were identified as the main reasons for food waste generation.

During interviews the participants of the study were requested to score the amount of food wasted in each stage to identify areas where great attention should be placed when addressing food waste. There was a clear difference in the distribution of food waste along the supply chain from restaurant to restaurant. This study identified that a lot of food waste occurs during pre-consumer's stages of the service in all the restaurants. Although food waste was found to be prevalent in the pre-consumer stages in all the restaurants, post-consumption waste also formed a considerable portion of food waste with waste percentage of 44% in full service restaurants and 33% in cafes. To reduce food waste, the results of the study suggest that full service restaurants

should place more attention in preparation and plate waste, serving and plate waste in cafes as well as preparation and serving stages in fast food restaurants. There are many strategies that can be used to reduce food waste from the above mentioned stages. According to the food waste recovery hierarchy preventing food waste from occurring is more important than re-using or recycling it. Food waste education awareness among customers and restaurant staff members certainly has major role to play in reducing food waste. These education awareness campaigns should not only focus on the impacts, but also on how the food is grown and the amount of resources that need to be used in order for a product to be ready for consumption. Lack of knowledge on how the food is produced due to the movement of people away from the sources of food has been cited as one of the reasons why it's easy for people to waste food (Parfitt *et al.,* 2010). A number of strategies that can be employed to educate customers and restaurant staff members such as door to door campaigns, websites, handbooks, newspapers, door stepping and stickers have been highlighted through this research. In line with education awareness and training of staff members it is crucial to ensure proper handling of food, when the stock comes in until it is served to the customers. Training may include information to improve practising FIFO method, storing the food correctly, portioning food correctly, and better communication between restaurant staff during order taking as well proper preparation of the food. Rewards can also be used to encourage staff to reduce food waste (2015). An effective manager is also crucial in reducing food waste in a restaurant and managing people is one of the many aspects of management. In a restaurant a manager can reduce food by continually monitoring and evaluating staff's performance and also by ensuring that the staff members follow the SOP. It is also the manager's responsibility to ensure that each and every employee's work performance meets the expected standard. Suggestions of how to tackle food waste at each of these stages are provided by Betz *et al.*, (2015).

Although food waste was found to be the highest proportion of waste generated in all the restaurants, this research showed that the restaurants have a positive attitude towards reduction of food waste. Strategies used to reduce food waste were identified as procurement of food that is needed in the business, carefully checking of ingredients during receiving of goods, practicing FIFO method, giving surplus food to staff members and also measuring pre-consumer food waste. From the interviews, it was clear that the restaurant staff members understood the economic impacts of food waste in their restaurant. What seemed to be lacking is knowledge on environmental and social impacts of food waste as the majority of the participants admitted that they are not concerned about plate waste as it did not impact on the economic impact of the business. This point to a need for extensive education awareness on the issue of food waste and its implications.

Waste cooking oil is another waste component that was studied. The results showed that waste cooking oil generation ranged from 500ml to 150 litres per week. There was a clear difference in waste cooking oil by type of restaurant with full service restaurants contributing more waste cooking oil, followed by fast food restaurants while no waste cooking oil was found in cafes. The results showed that the restaurants had good waste cooking oil disposal management practices with almost of all the restaurant staff members reporting to sell their cooking oil to a company that converts it to biodiesel.

In terms of waste management, waste from restaurants is handled by the same service provider contracted by the management of both shopping malls. The mall uses a combination of a cage and a two bin system, one bin for organic waste and one bin for recyclable materials such as metal, plastic, glass. Although the mall runs a source separation, the results revealed that a majority of the restaurants do not separate their waste at source. Only separation of cardboard was efficient. Reasons given for not separating waste included lack of time, lack of recycling bins, lack of space, lack of knowledge about source separation, recycling is not part of the brand/procedure. The participants proposed education awareness, financial incentives, provision of bins and inclusion of source separation in the SOP as the key solution to low source separation participation. This type of information will be of great importance to the mall in terms of improving participation in the source separation scheme as it provides basis for development of user focused source separation scheme. The current source separation scheme can be improved by educating the restaurants about how to separate waste, what to separate and why it is necessary for them to separate waste.   Careful redesigning of the source separation scheme through a comprehensive sorting process that begins in the restaurant kitchens and continues to the waste area for further separation is necessary in both malls. Provision of recycling bins in the restaurant kitchen might be effective in increasing participation, as bright coloured bins act as a signal of a social norm or reminder to separate waste (Aschemann-Witzel, de Hooge, Amani, Bech-Larsen and Oostindjer, 2015). Additionally, use of one bin with different compartments can be used to address the issue of space identified by the participants of the study. Another area for improvement in the malls relates to the bins provided for separating waste. There was no bin for residual waste, as indicated earlier, the malls use a cage for corrugated cardboard and two bins for food waste and recyclable. This collection method can create confusion when the participants of the recycling scheme want to dispose non-recyclable waste, as there is no bin for that waste category.

Given that the industry is expecting to see considerable rates of growth in the near future, there is no doubt that improved waste management practices are crucial in the restaurants. It is evident

that more could be done to encourage diversion of waste and most importantly reduction of waste generation. Table 5- 2 presents a summary of findings against the objectives of the study

Table 5-2: Summary of key findings

Objectives	Key findings
Quantification and characterisation of the composition of restaurant waste	✓ More than 74% of waste generated by the sampled restaurants could be recovered through recycling (paper, plastics, glass and tins) and composting/anaerobic digestion (food waste) ✓ There was no significant difference in the composition of waste generated between the week and the weekend in Mall1 while only plastic was found to be significant in Mall2 ✓ Food waste accounted close to 50% of the total waste sorted in both malls ✓ Food waste generation by type of restaurant showed that fast food restaurants generate more food waste than full service restaurants in Mall1. Similarly, in Mall2 fast food restaurants had the highest food waste percentage followed by full service restaurants and cafes ✓ There was no hazardous waste found in both malls ✓ There was a considerable amount of non-recyclable waste ✓ Restaurants generated an average of 197.10 kg in Mall1 and 180.97 kg in Mall2 per week ✓ Based on the waste characterisation, annual waste generation was estimated to 10.25 tonnes in Mall1 and 9.41 tonnes in Mall2 ✓ The results showed that waste cooking oil generation ranged from 500ml to 150 litres per week
Sources of restaurant waste	✓ Main sources of food waste were identified as storage, preparation, serving and plate waste. The results showed that food waste is more prevalent in the pre-consumer stages of the service in all the restaurants ✓ Waste cooking oil was generated during the preparation of food
Attitudes towards reducing, re-using	✓ Efforts towards reducing waste were limited to pre-consumer food waste. Strategies used to minimise food waste generation in pre-consumer stages included providing training to restaurant staff

and recycling of waste	members, procurement of food that is needed in the business, carefully checking of ingredients during receiving of goods, practicing FIFO method ✓ Only corrugated waste was sorted at source, other waste materials were disposed as mixed waste
Waste management practices at the restaurants	✓ Waste from restaurants is handled by the same service provider contracted by the management of both shopping malls ✓ The malls have recycling bins for source separation at the temporary waste area ✓ Unsorted waste from the restaurants is collected and sorted at the waste area for recycling and composting ✓ The restaurants had good waste cooking oil disposal management practices (they sell their cooking oil to a company that converts it to biodiesel).
Opportunities for waste reduction and recovering of resources	✓ 74% of waste generated by the sampled restaurants can be recovered through recycling (paper, plastics, glass and tins) and composting/anaerobic digestion (food waste) ✓ Reduction of plate waste, non-recyclable waste and packaging waste
Recommendations for improved waste management in restaurants	✓ Reduce amount of waste generated ✓ Buying products packaged in recyclable material to enhance recycling ✓ Redesigning source separation scheme through a comprehensive sorting process that begins in the restaurant kitchens and continues to the waste area for further separation is necessary in both malls

5.2 Recommendations for future research

To improve waste management practices in the restaurants, the limitations and conclusions drawn from this dissertation indicated the following areas as recommendations for future research.

•This dissertation focused on twenty restaurants of two malls located in eThekwini Metropolitan Municipality. It is recommended that future research should seek to investigate a representative sample of restaurants.

•Reasons for plate waste generation in this dissertation were gathered from a manager's perspective. Examination of reasons for plate waste generation from a customer's perspective in a South African context is an important area of potential research as this aspect is gaining attention in United Kingdom. Understanding current customer's food wasting behaviour is required to reduce plate waste. This may include investigations about food waste awareness, how consumers understand food within the context of everyday lives and also how their food waste behaviour differs at home and in restaurants. Also, food waste contributions in different stages of the food supply chain was obtained from the restaurant managers' perspective. It is recommended that future research should consider a more objective measure of restaurant food waste from different stages of the supply chain.

•Time limitations in terms of how long the food must be kept before sale is one of the reasons for food waste that were uncovered in the study. Further research to what the time limitations mean, how they are determined and even more importantly whether they relate to food safety or quality is required. A clear understanding of what time limitations mean will help in identifying potential ways through which the food can be recovered.

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ANNEXURES

ANNEXURE 1: RESTAURANT STAFF MEMBERS' INTERVIEW GUIDE

1. General Information

Restaurant manager …………………………………………………………Date……………………………………………..

Contact number …………………………………………………...Email address…………………………………………..

Name of the Mall ……………………………..................Restaurant Name……………………………………………..

Type of restaurant ☐ a la carte type restaurant ☐ Buffet type restaurant ☐ Fast food restaurant

☐ Full-service restaurant ☐ Café ☐ Other

If other, specify……..

What is the average number of meals served per day?...

2. Purchasing of raw material

☐

Where do you source your raw materials? ....

Do you buy your raw material? ☐ In bulk ☐ One by one

Which type of food do you buy? ☐ Pre-cut ☐ Uncut ☐ both pre-cut and uncut

Do you buy ☐ Frozen? ☐ Fresh

Do you consider waste minimization when purchasing food?

Are there any products that you have substituted to reduce the amount of waste you generate?

3. Waste generation

Do you track the waste you generate? ☐ Yes ☐ No

How much waste do you generate per week? ....

Have you made efforts to reduce the amount of waste you generate? ☐ Yes ☐ No

If yes, please specify……

Where does most of your packaging waste come from? ....

List top three reasons why food is discarded at these stages of the service in the table below

Storage losses	1.
	2.
	3.
Preparation losses	1.
	2.
	3.
Serving losses	1.
	2.
	3.

From a scale of 1 to 5 (5 being the highest amount of food waste) how would you score food waste coming from the stages listed below

Storage	
Preparation	
Serving	
Plate waste	

Which food commodities are wasted the most? ....

Are there any strategies put in place to prevent and or reduce food waste?...

4. Waste management

Who provides waste collection services for your restaurant? ☐ Private waste handler ☐ Municipality

What is the collection frequency? ☐ Every day ☐ One a week ☐ Other

Do you separate your waste at source? ☐ YES ☐ No

If yes, what is the amount of waste you send for recycling per week/month? …………………………………………………

Which recyclable material do you send for recycling? ....

Who collects your recyclable material? ....

Who encouraged you to separate your waste? ☐ Company policy ☐ Private waste handler

☐ Municipality ☐ Voluntary participated ☐ Other

Other, please specify……..

What do you do with your left over food? ☐ Donate ☐ Give staff members ☐ Dispose as food waste

☐ Other

Other, please specify……..

If you dispose your left over food, do you have any reason for not donating the food?

What do you do with your food waste? ☐ Landfill ☐ Compost ☐ Macerate ☐ donate for animals

Other, specify………..

What is the average amount of waste cooking oil you generate per week/month?

How do you dispose your waste cooking oil?

Do you have questions?

Is there any other information related to waste management that you feel we should take note of?

Thank you for your time!

ANNEXURE 2: MALL MANAGERS' INTERVIEW GUIDE

1. General Information

Mall manager …………………………………………………………….Date………………………………………………………

Contact number ……………………………………………………......Email address…………………………………………

Name of the Mall …………………………………………………No of restaurants……………………………………………

2. Waste Management

Is the mall responsible for the waste generated by all the businesses? ……………………………………………………

Who provides waste collection services for the mall?

What is the collection frequency? ☐ Every day ☐ One a week ☐ Other

If other, specify………..

How much waste does the mall generate per month?

Do you track waste generated by each business?

If yes, what is an average amount of waste restaurants generates per month? ……………………………………………

Do you recycle your waste?

If yes, (a) Do you receive source separated waste from the businesses? ……………………………………………….

(b) What is the amount of waste you send for recycling per month? ……………………………………………

(c) Which waste material is targeted for recycling? ……………………………………………………………

(d) Who collects your recyclable material? ……………………………………………………………………

(e) Is recycling part of the policy? ………………………………………………………………………………

Does the mall have waste management policy? *(please share if available)*………………………………………………

Which waste management policies are imposed on the restaurants? ……………………………………………………

Are there any businesses that do not comply with the waste management policies? ....

How do resolve non-compliance? ……

Do you have questions?

Is there any other information related to waste management that you feel we should take note of?

Thank you for your time!