# EVALUATING FROZEN FOOD WASTE WITHIN PRE-RETAIL LEVELS IN A FOOD MANUFACTURING COMPANY IN KWAZULU-NATAL

By

**RIKASHA SHAMLALL**

Submitted in accordance with the requirements for the degree.

**Doctor of Philosophy**

In the subject

**Environmental Management**

To the

DEPARTMENT OF ENVIRONMENTAL SCIENCES

In the

COLLEGE OF AGRICULTURE AND ENVIRONMENTAL SCIENCES

UNIVERSITY OF SOUTH AFRICA

Student Number: 36408468

SUPERVISOR: Prof L Leonard

January 2024

**ACKNOWLEDGEMENT**

I wish to express my profound gratitude to the following individuals and institutions for their immense assistance in completing this study:

This study is dedicated to my mother.

Thank you, Mom, for your support, motivation, and for believing in me, I would not have done it without you.

I am most grateful to my supervisor, Prof L Leonard, for his time, encouragement, and commitment towards the completion of my studies.

Thank you to Etienne Thiebaut and Mark Clayton, for all the help and assistance within the food manufacturing industry.

Thank you to the management team of RCL Foods for the assistance provided during the research.

Thank you to all the participating employees and the food manufacturing company for their time and valuable input.

Above all, thank you to the Almighty God for the ability and all the strength.

**SUMMARY**

The generation of food waste is a pervasive issue within all tiers of the food supply and value chain, resulting in an annual loss of approximately 1.3 billion metric tons, encompassing a substantial 30% of global food production. Food wastage spans the primary production phase, food retail establishments and continues through to the food consumption phase within households. In recent years, there has been a significant surge in global attention directed towards the issue of food loss and waste.

The aim of this study is to conduct an in-depth investigation into the generation of waste associated with frozen and chilled food products within the supply and value chain of a prominent food manufacturing company situated in KwaZulu-Natal Province, South Africa. The study objectives were to investigate the (i) reasons and drivers behind food waste generation of frozen and chilled food products in the supply and value chain of a food manufacturing company; (ii) explore the socio-economic and environmental impacts of frozen and chilled food waste generation in the company, (iii) understand consumer perceptions on chilled and frozen food waste generation in relation to their buying habits and patterns and, (iv) to critically analyse the national policy and regulatory framework on frozen and chilled food waste management in the food retail sector and make policy recommendations for sustainable chilled and frozen food waste management in the supply and value chain. The use of the triple bottom line theory aligns with the needs of the study as it gives insights into the need for appropriate reduction of food waste for the environmental, social, and economic growth of a country.

Interviews, questionnaires, an online Four Eyes survey, and observational techniques were employed to gather primary data. To select a representative sample of retail stores where frozen and chilled are sold, the Fisherman's online Qualtrics calculator was utilized. Respondents for this study were drawn from a diverse pool, including policymakers, walk-in customers, retail outlet employees, and environmental scientists. The analysis of secondary data procured from the manufacturing company was conducted using Microsoft Power BI. Quantitative data were processed using the Statistical Package for Social Sciences (SPSS) to compute mean values. Qualitative data, in contrast, were analysed and assigned codes before being collated within themes, creating clusters of related information, patterns, and key concepts. Themes

were ranked based on their significance and relevance to the research objectives, guiding subsequent in-depth discussions and analysis. The organized qualitative data served as the foundation for interpretative discussion, enabling insights and connections and drawing of study conclusions. Additionally, geographical information data, in conjunction with the 202 indicators pertaining to retail store sites, underwent integration within Geographic Information Systems (GIS) software. This integrated approach facilitated the production of visual maps, which served to visually represent the spatial distribution and pertinent attributes associated with these retail stores where frozen food is sold.

Research findings underscored that suboptimal handling practices significantly contribute to the generation of waste within the frozen and chilled food domain. Furthermore, it became evident that there exists a paucity of concrete food waste regulatory policies aimed at mitigating the issue of waste generation specifically within the frozen and chilled food sector. The implications of this study are intended to serve as a valuable resource for governmental entities and stakeholders operating within both the supply and value chains. By shedding light on the challenges and deficiencies surrounding frozen and chilled food waste, these findings can inform strategic decision-making and policy development aimed at fostering more sustainable practices in this critical sector of the food industry.

**Keywords: Food, Waste, Frozen, Chilled, Mitigation, Retailers, Supply, Chain, Social, Economic, Environmental, Drivers, Reasons, Policy, Regulation**

**TABLE OF CONTENTS**

**LIST OF FIGURES**

## LIST OF TABLES

## LIST OF ABBREVIATIONS

| | |
|---|---|
| CGCSA | Consumer Goods Council of South Africa |
| FAO | Food and Agriculture Organisation |
| FLW | Food loss and waste |
| FMC | Food Manufacturing Company |
| FSC | Food Supply Chain |
| FTF | Freezer to Fryer |
| FW | Food Waste |
| FUSIONS | Food Use for Social Innovation by Optimising Waste Prevention Strategies |
| GHG | Greenhouse Gas |
| HLPE | High-Level Panel of Experts |
| IDAFLW | International Day of Awareness of Food Loss and Waste |
| IQF | Individual Quick Freezing |
| KZN | KwaZulu-Natal |
| NEMWA | National Environmental Management Waste Act (59 of 2008) |
| NWMS | National Waste Management Strategy |
| OSA | On-shelf availability |
| OECD | Organisation for Economic Co-Operation and Development |
| SAFL | Southern Africa Food Lab |
| SAP | System Applications and Products |
| SDG | South Africa Adopted Sustainable Development Goals |
| UN | United Nations |
| USDA | United States Department of Agriculture |
| WRAP | Waste Research and Action Programme |
| WWF | Worldwide Fund for Nature |

## LIST OF DEFINITIONS

**Food Loss:** refers to the decrease in the quantity or quality of food intended for human consumption that occurs during the production, postharvest, and processing stages of the food supply chain.

**Food Waste**: Food waste refers to the discarding or loss of edible food, occurring at various stages of the food supply chain, from production and processing to distribution and consumption.

**Supply Chain:** A supply chain is a network of interconnected entities and activities involved in the creation and distribution of goods or services from the point of origin to the end consumer.

**Value Chain:** A value chain is a series of activities that organizations undertake to create and deliver a product or service to the end consumer.

# CHAPTER 1: INTRODUCTION

## 1.1. Background

Food waste generation, particularly chilled and frozen food waste, in modern society continues to increase and remains a major challenge at every stage of the food supply chain and value chain, from the primary production phase in farms to the retailers, consumers, restaurants, and others (Beullens & Ghiami, 2022; Pimentel et al., 2022; Buisman et al., 2019). Policy makers and academics are showing increased attention to food waste, both general foods as well as frozen and chilled food. Such interest is due to the adverse repercussions of food waste that include environmental degradation, societal concerns, and economic implications (Gustavsson et al., 2011; Pirani & Arafat, 2016; Goggins & Rau, 2015). However, there are limited details of the drivers responsible for food waste throughout the food supply chain (İlkin et al., 2023), as global research tends to focus mainly on household and retail food waste, and it is important to fill knowledge gaps in order to inform national and local waste management policy (Marrucci et al., 2020; Ariyani & Ririh, 2020; Martin-Rios et al., 2022).

Gaps in the literature concerning the generation of waste in frozen and chilled food stem from two primary factors: firstly, the relatively recent recognition of the significance of food waste, specifically within the chilled and frozen food category; and secondly, the evolving approaches undertaken in food waste research such as the use lifecycle analysis to assess the environmental impact of food waste, the use of advanced in technology, such as sensors, RFID (Radio-Frequency Identification), and IoT (Internet of Things) devices, are being employed to track and manage food throughout the supply chain and the use of Data analytics and machine learning algorithms that are used to analyse large datasets related to food production, distribution, and consumption. These technologies help identify patterns, predict potential waste, and optimize supply chain processes (Garrone et al., 2018, Cerulean, 2020, Wallace, 2023). With the exception of a small but growing number of researchers from other disciplines such as supply chain management, sociology, and anthropology and even business management, food waste has been studied largely from an engineering and technological perspective (Cohen, et al., 2018, Cerulean, 2020, Wallace, 2023, Khanam, 2021).

Sub-Saharan Africa and North Africa are responsible for producing approximately 100 to 130 million tons of food waste per year (Sheahan & Barrett, 2017). If this amount of food had been well-managed, it would be of great service to so many people who experience food insecurity. The food waste includes cereals, tubers, roots, pulses, vegetables, meat, seafood, milk and eggs. In sub-Saharan Africa, post-harvest losses encompass a more significant amount of food waste, which reflects the potential harvested food items leaving the field of the farmer before feeding the people. It means that both the efforts and money invested in food production are being wasted (Makanjuola et al., 2020). In Nigeria, approximately 123 million metric tons of food are wasted even before reaching the market. The extent of food losses and waste is relatively higher in developed nations, where food items are still suitable for human consumption (Paul & Gilliland, 2017). There is a potential in the broken food security value chain in Africa as an opportunity to deduct food loss and food waste across all stages of food production (Paul & Gilliland, 2017).

Household food waste is an important topic to be addressed as the world's population is increasing along with concerns for food security. According to a recent report, in South Africa, 10 kg per capita per year of food is wasted (Beega, 2021). In Nigeria, it is 189 kg. South Africa is noteworthy because of the wide range of domestic waste produced (Hermanussen & Loy, 2023). Due to food waste, many people are unable to satisfy their hunger and requirement for nutrition. In nations where citizens can afford more, they are likely to throw away more food (WWF, 2023). South Africa is a middle-income nation but, in terms of food loss and food waste, the nation is competing with developing and developed nations around the world and is responsible for significant food waste. (Joardder & Masud, 2019).

Undoubtedly, the issue of food waste has attained global prominence, as underscored by the Sustainable Development Goal 12.3, which sets forth the imperative of halving the per capita global food waste at the retail and consumer stages by 2030, while concurrently mitigating food losses throughout the production and supply chains, encompassing post-harvest losses (Food and Agriculture Organization of the United

Nations (FAO), 2020; De Neve & Sachs, 2020). The wastage of food can be aptly characterized as an interdisciplinary predicament, encompassing a spectrum of concerns that traverse the domains of socioeconomic, environmental, and ethical considerations (Payne, 2014).

Food security and control are, therefore, matters of great importance for consumers and it is necessary to maintain the stability of the quality characteristics of food during its production, distribution, storage, and commercialization (Franco & Cicatiello, 2021). Consumer reliability on frozen and chilled food, especially related to aspects of the supply chain, is of high priority for all involved in the production, commercialization, logistics and distribution of foods (Ahmed et al., 2021; Lagorio & Pinto, 2021). In this context, it is evident that stringent controls pertaining to hygiene and product temperature assume paramount significance. The principle of the refrigerated preservation of foods is to reduce and maintain the temperature of the food such that it significantly reduces the rate at which detrimental changes occur in the food (Martindale & Schiebel, 2017; Świechowski et al., 2022). These measures are indispensable in preserving the integrity of food items and mitigating the risk of spoilage and subsequent disposal, particularly within the realms of dairy, meat, and vegetable products (Nicosia et al., 2022, de Gorter et al., 2023; Ganeson et al., 2023). Foods subjected to inadequate storage temperatures may undergo alterations in their intrinsic characteristics, potentially posing health risks to consumers. Additionally, such improper storage conditions can shorten the product's shelf life, contributing towards substantial economic losses (Molina et al., 2023; Wastes, 2023).

#### 1.1.1. Global overview of frozen and chilled food waste generation

According to the Food and Agriculture Organization of the United Nations (2023), an estimated 1.3 billion tons of food is wasted globally each year, projected as one third of all food produced for human consumption. Expectedly, most of this waste occurs in developed nations (Benyam et al., 2021). For instance, per capita food waste by consumers, not including the production process, in Europe and North America is around 95-115 kg per year, compared to just 6-11 kg in sub-Saharan Africa (SSA) and South/South-East Asia regions.

The comprehensive report of the United Nations (2021) elucidates the intricate dynamics of food waste within the global food supply chain, revealing that approximately 14% of the food produced is lost during the transition from harvesting to retail, indicating that 17% of the total food production is squandered during the consumption phase. This consumption-related loss further divides into 11% occurring in households, 5% in the food service sector, and 2% in the retail industry (United Nations, 2021; Food and Agriculture Organisation, 2023). It is noteworthy that household per capita food waste generation appears to be broadly similar across country income groups, suggesting that action on food waste is equally relevant in high, upper-middle, and lower-middle income countries (United Nations Environmental Program, 2022; de Gorter et al., 2023; Molina et al., 2023). Such empirical data underscores not only conspicuous global disparities in food waste but also the diverse sources contributing to this pervasive issue, highlighting the importance of addressing this concern on a global scale (İlkin et al., 2023; Wegren, 2023).

Despite the estimates derived from The Food Waste Report (2021), there is a lack of clear and collective understanding about how much food is wasted by consumers in and outside of homes, and where and why it occurs, especially within the chilled and frozen food sector and, hence, the report relies on confidence indicators to substantiate estimates (United Nations, 2021; FAO, 2023). From an ethical perspective, the issue of chilled and frozen food waste presents a conundrum that demands immediate attention and introspection. At its core, this predicament underscores a profound moral dilemma: the squandering of precious resources that could otherwise serve as vital nutrition sources for an ever-expanding global populace (FAO, 2023; Sharma et al., 2023). This concern is further compounded by the disconcerting reality that millions of individuals across the globe continue to endure starvation and/or malnourishment, even as a substantial proportion of available food ends up as wastage rather than alleviating their dire circumstances (Harvey et al., 2020; Olio, 2023). Indeed, the statistic that one-quarter of the discarded foodstuffs could, theoretically, ameliorate the plight of the undernourished is a stark indictment of the ethical transgressions intrinsic to the issue at hand (Olio, 2023).

Food waste, whether chilled or frozen, poses ethical concerns due to its depletion of resources and nutrient supplies. Conversely, amidst millions facing starvation or malnutrition, a significant portion of the discarded food could potentially alleviate their plight (Olio, 2020). Globally, approximately one-third of food produced for human consumption, totalling around 1.3 billion tons annually and valued at approximately US$1 trillion, is lost or wasted (Tkáč et al., 2022). The sheer magnitude of unconsumed food resources could feasibly sustain over two billion people, more than twice the number of individuals grappling with undernourishment worldwide (Tkáč et al., 2022; World Food Programme (WFP), 2022). Remarkably, if wasted food constituted a nation, it would stand as the third-largest contributor to carbon dioxide emissions globally, trailing only the United States and China (WFP, 2022). Paradoxically, affluent nations' consumer waste nearly mirrors the entire net food production of sub-Saharan Africa each year, further manifesting in the distribution of food losses, with developing countries witnessing 40% of losses occurring post-harvest and during processing, while industrialized nations contend with more than 40% of losses transpiring at the retail and consumer levels (WFP, 2022). Recognizing the paramount significance of mitigating food waste, the United Nations has positioned its reduction by half by 2030 as a top priority referring to Sustainable Development Goal 12 (United Nations, 2021; Waste, 2023).

Approximately 24% of the fresh water used in crop production, 23% of cropland area and fertilizers, and 368 mils metric tons are wasted every year due to food losses (Joardder & Masud, 2019). The global economic cost of food waste, particularly chilled and frozen or loss in terms of financial, social, and environmental perspectives is approximated to be about $1 trillion per year, in addition to environmental costs and social costs that are approximated to be $700 billion and $900 billion respectively (Amicarelli et al., 2021). Of the reported food waste and food loss costs, about $680 billion are lost in developed countries while about $310 billion food waste is generated in developing countries (Welch et al., 2021). According to Tonini et al. (2018) and Mosna et al. (2021), the cost of food waste and food loss in Europe alone is estimated at $170 billion every year. European Union countries are committed to reducing food waste by 50% (amount of wasted food per capita) by 2030 (European Commission). Reducing food waste is considered an essential factor in ensuring food security at a global level, as it will allow the use of limited resources for other purposes, reduce environmental risks, and avoid financial losses (Priefer et al., 2016).

Of the total frozen food produced for human consumption, an estimated 14% is lost through natural and logistical factors, food losses between harvest and retail are driven by a complex interplay of natural factors encompassing pest and disease infestations, adverse weather conditions, spoilage due to inherent perishability, and the critical timing of harvesting, while logistical factors contribute significantly, with inefficient harvesting methods, inadequate storage/cold-storage facilities, transportation challenges, market dynamics, and consumer behaviours all playing pivotal roles (FAO, 2020). The significant wastage of food, accounting for approximately 17% of the total food available to consumers (UNEP, 2021), costing the global economy an estimated $936 billion a year (FAO, 2014), is attributed to a combination of systemic and behavioural factors across various sectors of the food supply chain.

At the household level, consumer behaviours play a crucial role in food waste, encompassing over-purchasing, poor meal planning, misinterpretation of expiration dates, and a general lack of awareness regarding the environmental and ethical consequences of food disposal. In retail and restaurant sectors, practices like excessive stock ordering, stringent aesthetic standards for produce, and portion sizes that exceed consumer capacity contribute to food being discarded. The lack of effective refrigeration is a leading contributor to this challenge, directly resulting in the loss of 526 million tons of food production, or 12 per cent of the global total, in 2017 (International Institute of Refrigeration [IIF/IIR], 2021). This is enough to feed an estimated 1 billion people in a world where currently 811 million people are hungry and 3 billion are unable to afford a healthy diet (FAO, 2023). Food production will need to increase significantly to feed the expected human population of 9.7 billion by 2050 (United Nations, 2019). According to the FAO (2023), food and agricultural exports grew 3.2 per cent between 2019 and 2020, an increase of nearly $52 billion, with developing countries accounting for around 40 per cent of this rise. In 2021, the value of global agricultural trade was expected to increase 8 per cent, to $137 billion which would imply growth in chilled and frozen food production and waste generation. Currently being piloted in Cambodia and Indonesia by the global cool coalition, is the methodology charts a holistic but modular process that includes cooling comprehensively (including various sectors such as agricultural cold chain, and end uses) and considers access to cooling for all  United Nations Environmental Program (2022).

### 1.1.2. Frozen and chilled food waste generation trends in selected developed countries.

Frozen food waste generation remains a challenge in developed countries (van der Werf & Gilliland, 2017), notably the United States of America, Canada, United Kingdom, Australia, and Germany. Ishangulyyev et al. (2019) monitored waste in the wholesale and retail industry and established that food waste in the retail sector is projected at around 500 thousand tons for 2019, which represents about 1.5 % of food turnover globally. Orr & Schmidt (2021) segregated food assortment into five product groups: (1) fruit and vegetables, (2) dairy products and convenience, (3) bread and bakery products, (4) meat, fish and poultry, and (5) other food products (frozen foods, beverages, dry goods) informing to the categorical challenges of frozen and chilled food waste generation of approximately 290 thousand tons annually.  According to the FAO (2023), data collected for the United Kingdom indicates 14.3 million tons of food wastage annually, reporting that the UK is the most wasteful of the EU's member nations (Chen et al., 2020). Roughly 70% of the United Kingdom's food moved through the cold chain (Facchini et al., 2018) placing it at a better position to reduce waste, however more food ended up spoilt and wasted despite global hunger indicators and commitment to Sustainable Development Goal 12 (United Nations, 2021; Tkáč et al., 2022; FAO, 2023; Cole-Hamilton, 2023).

Similar findings were made in 2022 when the National Zero Waste Council in Canada studied home food waste and discovered that 39% of the frozen and chilled food items that people threw away included 63% of the food that could have been consumed. For the average Canadian household that amounts to 140 kilograms of wasted food per year – at a cost of more than $1,300 per year. For Canada as a whole, that amounts to almost 2.3 million tons of edible food wasted each year, costing Canadians in excess of $20 billion. All types of food are wasted, but in Canada the most prominently wasted foods by weight are vegetables and fruits (30%) and dairy (9%) (National Zero Waste Council, 2022). The above shows the magnitude of the problem of fast-moving consumer goods which are part of chilled and frozen foods in the supply and value chain, spoilt and discarded.According to the United States Environmental Protection Agency (EPA, 2018), while millions of people globally go to bed hungry, the United States discards more food than any other country in the world - nearly 60 million tons annually. That is estimated to be almost 40% of the entire US food supply and equates to 148 kilograms of waste per person (Chauhan et al., 2021). The amount of food wasted in America has an approximate value of nearly $218 billion – the equivalent of 130 billion meals (Pimentel et al., 2022). Sadly, nearly 35 million people across the United States live with food insecurity and 10 million of them are children (United States Department of Agriculture (USDA), 2018). Food wastage frequently arises as a consequence of inadequate temperature control measures (Wangsa et al., 2023). Particularly pronounced vulnerabilities pertain to perishable food items during their transit and handling phases, wherein the transition between mobile and stationary refrigeration facilities can give rise to significant temperature oscillations (Ramanathan et al., 2023; Wangsa et al., 2023). Elgarahy et al., (2023) indicated that fluctuations occur notably between refrigerated trucks and trailers, loading docks, and storage facilities.

According to a report by the Australian Government Department of Agriculture (2020), food waste is often due to poor temperature management. The greatest risks for perishable foods occur during transportation and handling between mobile and stationary refrigeration points when there are sometimes significant temperature variations between truck or trailer, and/or loading docks and storage facilities. Estimates of food waste attributable to breaks and deficiencies in the cold food chain are provided for the first time in January 2022 by the Food and Agriculture Organization. According to preliminary and conservative estimates put the cost of food waste within the cold food chain in Australia at $3.8 billion at farm gate values comprising (Brodribb & McCann, 2020, de Lange & Nahman, 2015, Nodali Ndraha et al., 2020):

- 25% (1,930,000 tons) of annual production of fruit and vegetables worth $3 billion.
- 3.5% of annual production of meat (155,000 tons) worth $670 million.
- seafood (8,500 tons) worth $90 million.
- 1% (90,000 tons) of annual dairy production valued at $70 million.

Thus, it can be said that food waste is one of the most significant problems and has serious financial ramifications.

### 1.1.3. Frozen and chilled food waste generation trends in selected developing countries and in South Africa.

Chilled and frozen food loss is mainly high in the developing world, even though it is not as much as in the first world countries. The reason for this is that while developing countries are home to nearly 80% of the world's harvested cropland, they refrigerate only around 20% of the perishable food they produce (compared with 60% in developed countries) (Dupont et al., 2020) This implies that there are relatively few storage facilities to preserve chilled and frozen food in developing countries. In India, post-harvest losses for some crops exceed 40%, and only around 4% of the country's food moves through the cold chain (Facchini et al., 2018). Brazil is one of the world leaders of food waste. According to Empresa Brasileira de Pesquisa Agropecuária, Embrapa or Brazilian Company of Agriculture Research (2019), around 40 000 tons of foods are wasted every day in the country, an amount that could feed 19 million people. Data show nearly 50% of the food wasted is lost in factories, during processing procedures or while being transported, 30% is lost in supply centres, 10% during the harvest and 10% in households. Part of the cause is spoiling of vegetables and perishable goods before they reached the consumer (Alegbeleye et al., 2022). Africa remains a persistent challenge for food waste according to the Food and Agriculture Organization (FAO, 2020) where 470 million people experience food insecurity. This further increases the urgency of this challenge to identify innovative and integrated solutions to food wastage and food insecurity by bringing together many levers of change to reduce the burden on the poor and vulnerable people hit hardest by this challenge.

In sub-Saharan Africa, post-harvest food losses are estimated to be worth US $4 billion per year or enough to feed at least 48 million individuals with the total quantitative food loss in sub-Saharan Africa estimated at 37% post-harvest, or 100 million metric tons per year. If Africa loses 50% (FAO, 2018) of its total production to perishable goods as dairy, meat, fruits, and vegetables it implies that about US $2 billion of chilled and frozen food products goes to waste. For grains alone, the value of post-harvest losses is estimated to equate to approximately US$ 4 billion per annum (African Union Commission, 2018). According to the World Bank (2019), a rapidly growing population and changing diets in sub-Saharan Africa (SSA) are driving food consumption and imposing significant demands on the continent's water, land, and energy needs. Out of a population of one billion, 60% live in rural areas, and around 578 million are moderately or severely food insecure. Climate change threatens to undermine the ability of agricultural food systems to adapt and increase in the face of long-term stresses and climate variability. Food losses vary per commodity type, as shown by losses being highest for fruits and vegetables, at around 50% (FAO, 2020).

Establishing robust food cold chains could help address many of the challenges associated with food loss. By one estimate, developing countries could save 144 million tons of food annually if they reached the same level of cold food chain infrastructure in terms of refrigeration equipment, as in developed countries (Dupont et al., 2020). This implies that Africa still generates less than enough power to sustain its cold chains which lead to more food losses and waste particularly for frozen and chilled foods. Figure 1.1 below shows the overall post-harvest loss of food for sub-Saharan Africa relative to other regions of the globe. This figure indicates that the sub-Saharan African post-harvest loss dominates all other regions with 95% food loss, with South and Southeast Asia at 87% and North America and Oceania preventing the most losses. Figure 1.2 shows food loss waste by crop in Sub-Saharan Africa.

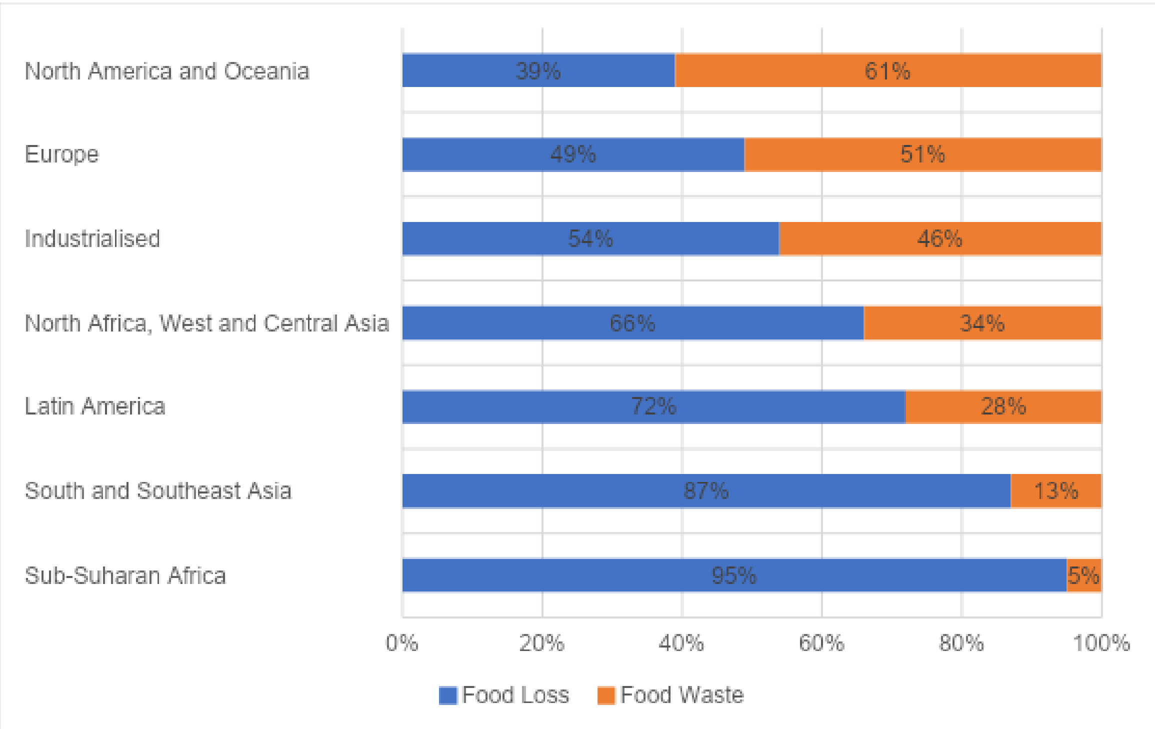



**Figure 1.1:** Post-harvest food loss for sub-Saharan Africa relative to other regions of the globe. Source: World Bank Report (2015)

Sub-Saharan Africa incurs a 50% loss in fruits and vegetables from production to consumption. A study conducted by Lipinski et al. (2013) indicated that the largest food loss, particularly chilled and frozen foods, accounted for approximately 50% of total production, is seen in sub-Saharan Africa from the production, handling, and storage stages (Oelofse et al., 2021).

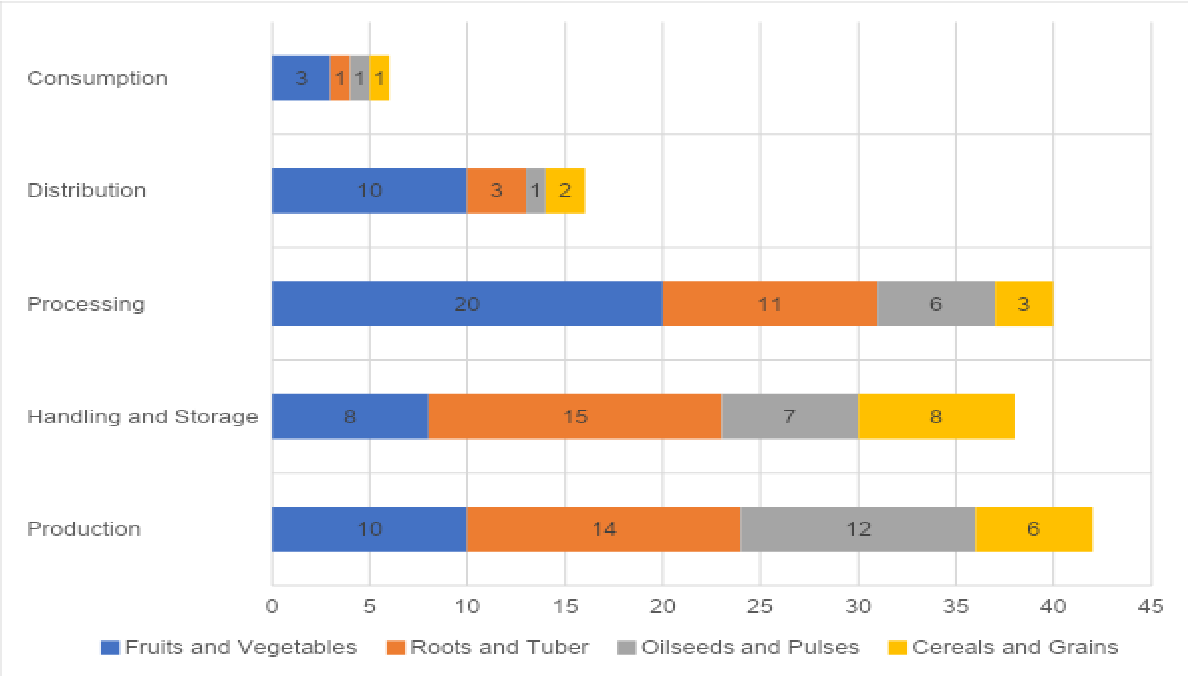



**Figure 1.2:** Food loss and waste by crop in sub-Saharan Africa. Source: World Bank Report (2015)

According to the World Food Program (WFP, 2018), Rwanda loses and wastes 40% of total production each year of which 30% constitutes chilled and frozen foods. These losses represent 12% of Rwanda's annual GDP. According to the NDC Policy Intervention strategy of the Malabo Declaration of Rwanda which aims at reducing post-harvest losses by 50% in 2025 in attaining SDG 12.3, such losses are attributed to climate variability, poor harvest and post-harvest techniques, inadequate storage, processing, connectivity, and energy access. The minimal cooling and refrigeration and low awareness of food waste particularly chilled and frozen foods waste generation. In Rwanda, only 5% of a company in the food and agriculture sector have refrigerated trucks, and only 9% have a cold room to store fresh produce (Binda et al., 2022, World Bank, 2020).

Together with Kenya, Rwanda are part of the Africa Centre of Excellence for Sustainable Cooling and Cold chain (ACES) which is aimed at creating a world-leading collaboration among governments, academic, industry, communities and non-governmental organizations that accelerates sustainable solutions to market to simultaneously address two urgent and interconnected global development challenges: food loss and access to sustainable cold chain and cooling (UNEP, 2020). Inspira Farms in Rwanda, under the project Solar Cold Storage and Processing, commissioned 10 modular, solar-powered food processing and refrigerated storage facilities in six districts across four of the five provinces of Rwanda (FAO, 2020). Each facility has a total area of 150 square metres, including cold storage, a processing area, an aggregation area, and administrative and hygiene spaces (Peters, 2020). Facilities run completely off-grid and in compliance with food safety standards (Toma et al., 2020). The main impact of the system is the increased availability and access to cold storage for fresh produce. In Rwanda, the cold rooms are expected to be used for fresh vegetables and fruits as well as for flowers. The installed facilities provide access to the cold chain for more than 100,000 smallholder farmers. Additionally, the availability of cold storage has prompted farmers to produce high-value crops for both local and export markets (Pandey, 2021).

An estimated two thirds of fruit and vegetable products, 40% of root crops and 21% of grain are lost in Zimbabwe annually (Kuhlmann & Agutu, 2020). Of this, grain to the value of around US$ 200 million is lost to food waste due to a lack of storage and processing options. According to the FAO (2018), most of these losses are experienced between harvest and the point-of-sale and are ascribed to a lack of cold chain facilities for perishables, unreliable and inadequate storage, and insufficient agro-processing skills among smallholder farming communities. A recent study published by the Global Food Donation Policy Atlas (GFDPA) (2020) suggested that in Ghana, as much as 3, 2 million tons of food are wasted or lost throughout the supply and value chain. This has triggered the Africa Continental Free Trade Area (AfCFTA) (African Union, 2022) International Chamber of Commerce to spearhead an initiative to enhance supply chain processes amongst members to enhance AfCFTA's forecasted USD $450 billion annual contribution to Africa's gross domestic product by 2035. The food waste issue is an emerging concern that has gone unnoticed for many years in Mauritius. However, out of a total food production of 2,419,685 tons including imports, 5281 tons of frozen and chilled food products are wasted annually, which is approximately 1.73% (Government of Mauritius, 2016).

This signifies the magnitude of the challenge of chilled and frozen food wastage. There are various regional initiatives in Africa to reduce chilled and frozen food waste generation that focus on energy-efficient and climate-friendly cooling. These form part of global initiatives to reduce frozen and chilled food waste (United Nations Environmental Program, 2022). African regions benefitting from these initiatives include East Africa countries involved in the United for Efficiency Project (U4E), Southern African Development Community (SADC) countries, Ghana, Senegal, and Rwanda (United Nations Environmental Program, 2022). The World Bank, FAO Investment Center and Rabobank are working together on developing “The Cool Move” (Muposhi & Dhurup, 2021). This seeks to increase high-quality (first-mile) cold chain accessibility and use in rural areas in emerging markets in an economically viable way, combined with suitable finance solutions and investments. The Cool Move aims at an integrated value chain approach that strives to professionalize the whole value chain by bringing all the stakeholders to an equal level of competitiveness. According to the World Bank (2021), its objectives include: reduction of post-harvest losses by improving access to the cold chain for smallholders, thereby improving food security and food safety solutions for cold chain and other agro logistics to enhance the quality of frozen and chilled foods.

#### 1.1.4. Republic of South Africa frozen and chilled food waste trends

In South Africa, nearly 10.3 million tons of food is wasted annually, constituting a third of the 31 million tons of food produced annually - and costing the country over $7.5 billion yearly (de Lange & Nahman, 2015). Similarly, a report by the Council for Scientific and Industrial Research (CSIR) approximated the cost of food waste and food loss in South Africa at R61.5 billion (about $7.5 billion) every year (World Wildlife Fund, 2017). With the devaluation of the rand currency, this value continues to grow. South Africa loses up to 37% of meat, fish, diary and vegetable products, such a loss would constitute roughly US $2,77 of chilled and frozen foods. There is a lack of statistical data on frozen and chilled food waste, and loss at primary production level is challenging because of the agricultural sector’s heterogeneity and the relative lack of research when compared to other stages in the food supply chain.

The study by Oelofse et al. (2021) also indicated that up to 27-37% of meat, fish and dairy products are lost as waste in the retail supply chain, with the distribution stage accounting for between 7% and 15% of the loss. According to the Food Loss and Waste Initiative report (Freight Surveillance International, 2022), the South African government is a signatory to the United Nations Sustainable Development Goals Target 12.3 that aims to reduce food waste by 50% by 2030. This implies that South Africa needs to reduce almost 25% of chilled and frozen food waste generation to meet the set SDG targets. The figures reported for the significant amount of food wasted in South Africa bring into focus the almost 2.5 million adults and 600 thousand children who are experiencing hunger almost every day (Spaull & Tomlinson, 2021).

While it may be tempting to increase food production in order to address food security challenges in the world, such a solution will only come at a high cost by putting pressure on the scarce natural resources of land and water (Dou & Toth, 2021, Gunders, 2021). As a result, there is growing urgency to develop systems-wide approaches and efforts to minimise food waste across the food supply chain (Hawkes & Ruel, 2018). Consequently, the quantitation of food waste and loss has become a valuable tool used by governments and international bodies to draw the attention of the various stakeholders to the proper use of food resources in the face of persisting food insecurity challenges (Berry, 2020).

Sustainability discussions around the world have recently concentrated on reducing food waste, particularly involving chilled and frozen foods, because of the associated negative social, financial, and environmental effects (de Bruin et al., 2021). Averaging the value chain for all commodity groups, Table 1.1 indicates that the total quantity of food waste across the value chain in South Africa amounts to 10 332 770 tons. Of this figure, 5,166,385 tons constitute chilled and frozen food waste, as per the 50% loss estimates suggested by Oelofse et al. (2021). This number represents the average food losses and waste incurred per annum, based on the average food supply over the period 2014-2018. This equates to 34.3% of local production, and 45.4% of the available food supply in South Africa that enters the food value chain in the country being lost or wasted across the different stages of the value chain (Nahman & de Lange, 2013).

According to Oelofse and Muswema (2018), an estimated 43.5% of all fruit and vegetables produced are directed for processing. Therefore, this percentage of the output from the post-harvest handling and storage stage is assumed to enter the processing stage of the value chain. Total food losses stand at an overall national average of 10 332.77 tons. As 22 783.84 tons of food enters the value chain, this implies that nearly half of the food produced is lost along the supply and value chain.

**Table 1.1:** Average annual food supply in South Africa. Source: FAOSTAT (2021) as cited in the CSIR Technical Report on Food Waste (2021)

| | Annual food supply for South Africa ('000 t) | | | | | |
|---|---|---|---|---|---|---|
| | **2014** | **2015** | **2016** | **2017** | **2018** | **Average** |
| Cereals | 10 194.00 | 9 858.00 | 10 319.00 | 10 523.00 | 10 434.00 | 10 265.60 |
| Roots and tubers | 1 778.00 | 1 789.00 | 1 808.00 | 1 841.00 | 1 874.00 | 1 818.00 |
| Oilseed and pulses | 273.00 | 415.00 | 228.00 | 301.00 | 304.00 | 304.20 |
| Fruit and vegetables | 3 955.00 | 4 075.00 | 3 484.00 | 3 536.00 | 3 602.00 | 3 730.40 |
| Meat | 3 467.00 | 3 508.00 | 3 642.00 | 3 563.00 | 3 704.00 | 3 576.80 |
| Fish and seafood | 389.39 | 361.67 | 347.14 | 366.99 | 366.99 | 366.44 |
| Milk | 2 564.00 | 2 683.00 | 2 700.00 | 2 785.00 | 2 880.00 | 2 722.40 |
| **Total** | **22 620.39** | **22 689.67** | **22 518.14** | **22 915.99** | **23 164.99** | **22 783.84** |

An estimated loss of 50% of the total food production is attributed to chilled and frozen foods (Oelofse et al., 2021) while Muswema (2018) estimated that only 43.5% waste is generated from processing the harvest while 37% of chilled and frozen foods goes to waste referred in Table 1.2.

**Table 1.2:** Quantities of food waste (in thousands of tons) at each stage of the value chain for South Africa. Source: FAOSTAT (2021) as cited in CSIR Technical Report on Food Waste (2021)

| Commodity group | Agricultural production | Post-harvest handling & storage | Processing & Packaging | Distribution (Incl. Retail) | Consumption |
|---|---|---|---|---|---|
| Cereals | [1] 1 | [2] 5.8 | [3] 36.5 | 2 | [4] 14.5 |
| Roots and tubers | [5] 10 | [6] 9.8 | [7] 9 | [8] 2.3 | [9] 1.5 |
| Oil seeds and pulses | [10] 1 | [11] 38.4 | [12] 60 | 2 | [13] 17 |
| Fruit and veg | [14] 9 | [15] 18.3 | [16] 31.6 | [17] 5.5 | [18] 20.5 |
| Meat | [19] 6.03 | [20] 5.22 | [21] <1 | 7 | [22] 10 |
| Fish and seafood | [23] 0.75 | [24] 0.44 | [25] 31.1 | [26] 7 | 2 |
| Milk | [27] 1 | [28] 12 | [29] 3 | [30] 3.4 | [31] 14 |

Note: The percentages indicated in red have remained unchanged from the previous estimate due to unavailability of local South Africa estimates.

Table 1.3 reflects the estimates of losses incurred at different stages in the South African food value chain (Oelofse & Nahman, 2013; Nahman & de Lange, 2013). To the 26% of food loss entering the production stage of the value chain is added losses that occur post-harvest handling and storage, processing, distribution and consumption, at levels of 26%, 27%, 17% and 4%, respectively (Oelofse & Nahman, 2013). Similar figures were estimated by Nahman and de Lange (2013), who indicated a loss of 26% in the production stage, a slight decline compared to the figures estimated by Oelofse and Nahman (2013) of 2% to 24% in the post-harvest and 25% for processing stages, with an increase in losses to 20% in the distribution stage and consumption losses at 5%.

Thus, table 1.3 suggests that, with the exception at the consumption stage, chilled and frozen food losses average around 25% for each stage of the supply and value chain.

**Table 1.3:** Percentage loss at every stage of the value chain. Source: CSIR technical Report on Food Waste (2021)

| **Stage in the Value chain** | **Oelofse & Nahman (2013)** | **Nahman & de Lange (2013)** |
|---|---|---|
| Production | 26 | 26 |
| Post-harvest handling and storage | 26 | 24 |
| Processing | 27 | 25 |
| Distribution | 17 | 20 |
| Consumption | 4 | 5 |

1.1.5. National policy and regulatory framework on food waste generation in South Africa

A policy and regulatory framework refer to a set of rules, guidelines, laws, and regulations established by government bodies or other governing entities to govern and guide behaviour in a specific domain or sector. It provides a structured approach to addressing societal, economic, or environmental issues and aims to achieve desired outcomes or objectives through the implementation of rules and policies. According to the Food and Agricultural Organisation, food loss and waste involving particularly chilled and frozen food currently represents a pressing challenge in the design of sustainable food systems to mitigate chilled and frozen food waste generation (Zhong et al., 2017). There is no legislation in South Africa that regulates food waste per se. Yet the perception of the food industry is that it is highly regulated, often leading to still usable products being condemned (Kushner, 2017). Food waste is controlled by legislation that includes waste or waste management in general. This legislation is enforced by environmental health practitioners, the Department of Water and Sanitation and the Department of Environmental Affairs (DEA, 2017). Policies, legislation and regulations that would govern the management of food loss and waste include the following: The National Environmental Management: Waste Act 59 of 2008 and the National Environmental Management; Waste Amendment Act 26 of 2014 (National Environmental Management: Waste Act, 2009, Trubetskaya et al., 2022).

Both these Acts stipulate controls for the management and recording of waste, including the issuing of licences (Ramukhwatho et al., 2018). Most importantly for the purposes of food loss and waste, it requires municipalities to develop integrated waste management plans (Franco & Cicatiello, 2021). The corresponding National Environmental Management Act 107 of 1998, under which the above two Acts reside, specifically outlines some principles relating to waste, noting that waste should be avoided or, where it cannot be avoided altogether, should be minimised, reused, or recycled wherever possible (Bellemare et al., 2017). The Act also includes a citizen dimension, noting that any person must take reasonable measures to avoid pollution and/or degradation of the environment.

The government's goal to reduce waste sent to landfills by 25% by 2016 is outlined in the National Waste Management Strategy (NWMS). NWMS 2020, an update and revision of NWMS 2011, aids the informal sector, waste pickers, and vulnerable populations in the circular economy. It is in line with and responsive to the Sustainable Development Goals of Agenda 2030. Compared to the eight overarching goals of the NWMS 2011, the NWMS 2020 has nine (National Waste Management Strategy, 2020). Potential measures to reduce waste are also cited, with goal 1 being the most relevant to the reduction and diversion of food waste from landfill through promoting the minimisation, reuse, recycling, and recovery of waste (Sheahan & Barrett, 2017). The strategy also provides for the designation of waste management officers to co-ordinate waste management activities within and across the different levels of government to ensure implementation of the food regulations under the Foodstuffs, Cosmetics and Disinfectants Act 54 of 1972 and the Health Act 63 of 1977 (Jenkin et al., 2017).

It is these regulations that are perceived to influence food waste rather than the environmental laws. Given the environmental, social, and economic cost of disposing of food, the legal obligations of waste disposal would suggest that the role of the government at all levels is vital for co-ordinating, implementing, incentivising, and monitoring the minimisation and diversion of food loss and waste from landfill (Ayeleru et al., 2017). There is growing pressure for companies to reduce chilled and frozen food waste due to consumer pressure for responsibly sourced products. Likewise, it is increasingly important for retail outfits to manage inventory to avoid frozen and chilled food waste and stock high-quality products with long shelf lives to differentiate themselves from competitors (de Bruin et al., 2021). Both public discussion and scientific research are becoming increasingly interested in food waste in South Africa because of the lasting impacts that are only getting clearer as more research is conducted. The growing list of research and publications on food waste in the last six to seven years is evidence of the growing concern and recognition of the urgency of the need to address the problem of food waste in South Africa (Dzumbunu, 2017; Cronjé, 2018; Marx-Pienaar et al., 2018; O'Donnell et al., 2018; Mathee, 2020; Marais et al., 2021; Oelofse et al., 2021; Dlomo, 2021; Jere et al., 2021).

### 1.2. Problem Statement

In South Africa, there is a lack of statistical data on frozen and chilled food waste, and loss at primary production level is challenging because of the agricultural sector's heterogeneity and the relative lack of research when compared to other stages in the food supply chain. South Africa is a water-scarce country, the poverty levels are strikingly high, and considering the staggering amount of food that is being lost and wasted every year, the impact on food security and the economy is appalling. What exacerbates the situation is that much of the frozen and chilled food losses and waste are occurring on processed food and therefore causing further economic strain (Stanciu et al., 2022). According to the latest study by Ahmed et al. (2021), almost 68% of South Africa's food losses and waste occur before the food even reaches the consumers. Of these food losses and waste, almost 50% occur during the processing and packaging phase of the supply chain, while 6% occur in the distribution phase. Additionally, estimations by Oelofse et al. (2021), show that the food waste ratio in the different stages of the FSC differs between the different food classes. For instance, out of the total of fish and fresh vegetable waste across the value chain, most of the waste is generated in the processing and packaging stage while meat shows a high volume of waste generated in the distribution phase (including the retail phase).

Food waste generation in South Africa are contra to sustainability. As per the findings of the triple bottom line theory, people, planet, and profit are the key determinants of sustainability (Oelofse et al., 2021). The Triple Bottom Line (TBL) theory is a business framework that goes beyond traditional financial metrics to assess an organization's performance and impact on three dimensions: economic, social, and environment (Bahraini, 2021). In this regard, the higher generation of food waste can have significant implications across all the three domains of sustainability. The triple bottom line theory has clearly indicated the fact that the three dimensions that have been mentioned in the case of the theory are largely interlinked. These entities tend to impact one another and therefore, degradations in one can have negative implications on the others. In this regard, the study that has been facilitated here has looked into the food waste generation of KwaZulu-Natal, a region of South Africa. The main problem that has been studied here is to identify the main sources of generation of food waste at pre-retail levels in KwaZulu-Natal and the impacts that this is having on the overall growth and development of the region and the economic and social scenarios that prevail in the region. An understanding of the most important issues that are currently being faced in the region of KwaZulu-Natal (KZN) can assist in drawing an appropriate analysis of the prevailing conditions. Implementing the most suitable regions can contribute to a decrease in food waste in the area (Raak et al., 2017).

However, a proper analysis of the main issues leading to such problems is an essential area and has been conducted in the present study. The main reasons for food waste generation have been provided here, and this can be seen as a crucial requirement for facilitating a future roadmap that can have better overall implications. The use of such strategies has been facilitated to engender a better understanding of the issues that are being faced in KZN and then portray its overall significance for the region and the country as a whole. However, one area that was considered is the lack of adequate literature pertaining to the overall understanding of waste generation at the retail level and especially for the specific area of KZN (Cronje et al., 2018; Marais et al., 2021; Mathee, 2020; Oelofse et al., 2021). Therefore, primary research was necessary to ensure better outcomes and foster an overall improvement (Dlomo, 2021; Dzumbunu, 2017; Jere et al., 2021; Marx-Pienaar et al., 2019; O'Donnell et al., 2018).

Some studies looking into food waste in retail used a case study approach to look at specific instances of food waste in the retail industry of the country as a whole and the KZN region in particular (Dlomo, 2021). Other studies used larger sample sizes but focused mainly on qualitative work and limited quantitative data (Jere et al., 2021) while others focused on cases in specific sectors such as the hotel and catering industry (Dzumbunu, 2017; Jere et al., 2021; Marais et al., 2021). Some of the local research on food waste production and interventions in the retail industry focussed on specific waste types causing waste management problems (Dlomo, 2021).

Currently, there is very limited information about the KZN area in the existing literature. Studies have used the partial approach, where the analysis of the data focuses on certain aspects of a given level and is not investigated in its entirety. For instance, the retail industry is only part of the distribution phase, and therefore does not cover frozen and chilled food waste generation in the distribution phase in its entirety. The proposed research took place at one of the largest food manufacturing companies (FMC) in South Africa that processes and supplies frozen and chilled products to a wide base of retailers and wholesalers around the country. The city has four landfills: the Bisasar landfill, the Mariannhill landfill, the Buffelsdraai landfill, and the Lovu landfill. About 1.4 million tons of general waste, including food waste, are dumped in these landfills annually. Due to site rehabilitation needs, the Bisasar landfill only accepts separate yard waste, construction debris, and covering materials. Since the Bisasar landfill was downsized, more tons of waste had to be dumped at the Mariannhill landfill, giving the Mariannhill Landfill Conservation Facility just over a year to operate. There are 70 years and 35 years of landfill safety at Buffelsdraai and Lovu, respectively. The lifespan of these landfills will be shortened by the pressure from the volumes of waste that should be accommodated by the closed landfills (Moodley et al., 2019).

The FMC from which data for this research was collected supplies its products to a total of 3865 retail stores within the coastal and inland regions of South Africa, while 422 stores are found in KwaZulu-Natal (Figure 3.2). The FMC is a leading South African food manufacturer employing over 21 000 people, producing a wide range of branded and private label food products which are distributed through their own route-to-market supply chain specialist. The name of the company is not provided according to an NDA agreement, but the company has been operating since 1960 with operations all over Africa. There are 422 stores in KwaZulu-Natal Province trading in four different trademarks (Table 1.4).

**Table 1.4:** Split of sample stores by retailer size and total food waste. Source: Researcher (2023)

| Retailer | Number of stores | Number of products | Tons of food waste |
|---|---|---|---|
| Retailer A - Ranked 1 (Largest) | 127 | 1670 | 1953.23 |
| Retailer B - Ranked 2 (Medium) | 33 | 1219 | 216.37 |
| Retailer C - Ranked 3 (Medium) | 26 | 941 | 218.33 |
| Retailer D - Ranked 4 (Small) | 16 | 640 | 115.09 |
| **Total** | **202** | **2123** | **2503.03** |

There is a need to gain an understanding of food waste produced in the distribution phase of the supply chain, the categorisation of different waste products, and the scale of the problem. Details of these factors can be determined by engaging with the retailers and suppliers, and working outwards to the management of waste, as well as to point out some of the barriers and opportunities for managing food waste more sustainably as a resource within and beyond the present system. Focusing on a comprehensive micro-study of a supermarket store in the complex environment of change factors and inhibitors can investigate broader systems and processes that affect food waste management and progressive integration.

In the restaurants of KZN, food waste is a huge cost to bear, and it has to be managed and controlled. Several critics have identified that the US still disposed of a startling amount of excess food (Buzby et al., 2014, Hall-Phillips & Shah, 2017, US EPA, 2015). There are several reasons for food waste. One is business practice and the other is customer behaviour (Sucheran & Olanrewaju, 2021). In multiple restaurants of KZN, food waste and losses can take place from a wide variety of sources including food being spoiled or being out of date. On the other hand, food waste can take place during the preparation stage, for example, a restaurant can find a significant amount of food spoiled due to incorrect portion size, pest attack, or hygiene problems.

The management of restaurants is largely responsible for dealing with food waste; however, it is also the responsibility of customers. In order for restaurants to be more environmentally friendly, it is crucial that they include sustainable offerings to customers (Sucheran & Olanrewaju, 2021). The fundamental measure that should be instituted is to avoid excessive purchase of stock from suppliers. Apart from that, donating food to hungry people, feeding animals, and composting are other alternatives for reducing food waste (Harduth et al., 2017).

Food waste generation is also a concern for waste management across cities and rural areas in South Africa. As the urban population grows, people find it a challenge to import food from rural areas. Agriculture in urban areas not only presents an opportunity to explore the means of sustainable food production but also to manage organic food waste in cities (Menyuka et al., 2020). In cities, organic waste is taken to a landfill area for disposal thereby contributing to environmental challenges. In rural areas, people use recycling methods which reduce environmental impacts but are unable to address the problem of food waste. However, this is due to the waste collection services may be less frequent or non-existent in rural areas. Lack of regular waste collection can result in improper disposal methods, including open dumping or burning, rather than recycling or composting. Food waste is found to be the most prevalent waste stream generated by informal traders. A census in the Durban metropolitan area showed that informal traders mainly comprised women and half of them sold food (Sahathu, 2021). Food waste is problematic in landfill areas as they are responsible for generating greenhouse gases. Food waste is edible and produced for human consumption but when discarded may be consumed by pets or other animals. Food waste is an important waste stream generated mainly in urban areas (de Bruin et al., 2021).

## 1.3. Aim and Objectives

### 1.3.1. Research Aim

What are the drivers of food waste generation in the supply and value chain of a food manufacturing company for frozen and chilled food products, and what are the socio-economic, environmental, and consumer perception impacts associated with this waste. Additionally, how does the national policy and regulation framework influence frozen and chilled food waste management, and what policy recommendations can be made for sustainable waste management in the supply and value chain.

### 1.3.2. Study objectives

The study objectives are:

1. To investigate the reasons and drivers behind food waste generation of frozen and chilled food products in the supply and value chain of a food manufacturing company.
2. To investigate the socio-economic and environmental impacts of frozen and chilled food waste generation on the supply chain and value chain.
3. To investigate consumer perceptions on chilled and frozen food waste generation in the supply and value chain in relation to their buying habits and patterns.
4. To critically analyse the national policy and regulation framework on frozen and chilled food waste management in the food retail sector and make policy recommendations for sustainable food waste management in the supply and value chain.

### 1.3.3. Research Questions

1. What are the reasons and drivers behind frozen and chilled food waste in the food supply and value chain of FMC?
2. How does frozen and chilled food waste generation impact society, the economy, and the environment in relation to food manufacturing sustainability goals in FMC's supply and value chain?
3. What are the perceptions of consumers on frozen and chilled food waste generation in relation to their buying habits and patterns in the food supply and value chain of a FMC?
4. What are the merits and demerits of national policy and regulation frameworks in mitigating frozen and chilled food waste generation by a FMC in South Africa, and how do they contrast with those from other developing and developed countries?

## 1.4. Theoretical framework

The use of an appropriate theoretical framework is extremely important as it can guide a study towards increased success. In the opinions of Wikurendra et al. (2022), ensuring the use of appropriate theories to guide a study can help in generating overall improvement and can allow better results for the study as well. The present study made use of the Triple Bottom Line theory as the basis of the overall study and as a source of information for the study as well. Chapter 2 of this thesis provides details of this Theory. The appropriate use of the Theory promotes a better understanding of the long-term impacts that food waste generation can have on the overall region of KZN. Therefore, the application of the theory in the appropriate manner proved beneficial as it assisted in generating key outcomes.

The Triple Bottom Line Theory is extensively used to understand key facets of sustainability and so can help in showing the current relevance of sustainability for businesses and individuals to promote improved levels of sustainability (Wilkie et al., 2015, Bhattacharya et al., 2022). In addition, it highlights the impacts that sustainability has on the overall practices associated with the business as well and with societies and individuals. In addition, the Theory can be crucial in understanding the implications that food waste in the region of KZN can have on society and the country as a whole (Woolley et al. 2022). However, due to lack of existing literature particularly about food waste pertaining to stored and cold food and pre-retail levels and especially in the case of the KZN region, a broader literature source was used.

Nevertheless, the Theory here has been employed to ensure a better understanding of the implications of food waste in the region. The Triple Bottom Line Theory clearly indicates 3 key areas associated with sustainability (Writer, 2022). These three areas include people, planet, and profit. Ensuring all three aspects can be a beneficial way of fostering improvement in sustainability. However, food waste and the negligence of individuals have largely compromised levels of sustainability in the region. This can be seen as a critical issue when extrapolated to the country as a whole, given the fact that it can result in a decline in the positive results generated for South Africans. The three areas associated with the theory are largely interlinked with one another and a reduction or a lack in one area can impact the others (Xue et al., 2017). For example, in the case of food wastage, there is a high chance that the profits of the organisations and the society and the people as well are largely negatively impacted.

An increase in food wastage can lead to a scarcity of food, which can be seen as a critical issue for people. Therefore, food wastage, which is a part of the planet aspect of the Triple Bottom Line Theory, can impact the people aspect as well (Yaddanapudi & Yaddanapudi, 2019). The people aspect of the theory represents the social area and society as a whole. Changes in the planet aspect affect the people aspect and, in turn, the theory can be beneficial in understanding major issues faced by business. Likewise, wastage of food correlates overall with levels of hunger and malnutrition that might increase in the society or in the region of KZN. The understanding that has been generated from the use of the Triple Bottom Line Theory clearly indicates the need to analyse the main reasons for food wastage (Bahraini, 2021). This can be seen as a major reason behind the conducting of such a comprehensive study using primary as well as secondary research data analysis (Bhattacharya et al., 2022). Apart from this, there is a need to understand that increased in food wastage negatively impacts the economy of the region (Kayikci et al., 2022). The present study indicated that a rise in food wastage can generate poverty and hunger. This shows the overall interlinkages between the three domains of the Triple Bottom Line Theory. Thus, with a decline in the planet aspect, the profit aspect is also largely impacted to have significant consequences for the region of KZN in particular, and the entire of South Africa in general.

Therefore, the use of the Triple Bottom Line Theory in this study was extremely beneficial in better understanding the key issues that can be faced due to food waste in the region. The major implications of food waste and the critical concerns that must be considered have been critically outlined in the study with reference to the Triple Bottom Line Theory (Yoobic, 2021). The Theory has served as a starting point and basis for research throughout the study. With an understanding of the Theory, the researcher correctly understood the strategies that can be used to mitigate food waste. Besides, this can be seen as the rationale of the study, as it is an important area to understand the major implications of food waste generation. The reason behind such a high amount of food waste generation in the region can be seen as a major help in forming effective strategies that can be beneficial in this regard (Zanoni & Zavanella, 2012).

## 1.5. Motivation/Justification of the study

South Africa, as with most developing countries, is lagging behind other nations concerning waste management, and more so for the management of chilled and frozen food waste. Although South African-based research on frozen and chilled food waste and its quantitation were reported as early as 2013 by the CSIR (Oelofse & Nahman, 2013), the country lags behind the industrialised world in the implementation of intervention measures to curb chilled and frozen food waste. This is partly because of the existence of many knowledge gaps concerning the food waste inventory in the country and it is therefore challenging to implement any realistic interventions (UNEP, 2021). Being a signatory to the UN's SDGs, this position needs to be addressed urgently to achieve the SDG 12,3 of cutting food waste by 50% by the year 2030 (World Bank, 2018). Food waste management requires an in-depth analysis of data from various sources, including multidimensional and multi-activity approaches, to better understand the causes and select the most appropriate solution that is backed by evidence (FAO, 2021).

The food industry in South Africa has unfortunately not prioritized frozen and chilled food waste management yet, since it is not considered its core function (Harding et al., 2015). It should be noted, however, that sustainable food production and consumption is particularly important for South Africa because of its food security vulnerability due to a growing population and limited resources, which will become grave at some point if not addressed. The choice of how to dispose of food waste in South Africa is currently determined by personal factors, such as cost and hygiene, and to a limited extent, regulated for certain classes of waste. However, without any specific definition or legislation about food waste in South Africa, waste generators are not legally obliged to manage it sustainably, and therefore will more likely continue to use the cheapest method available. This discussion highlights gaps in most of the investigations into food waste in South Africa, as seen in Table 1.5.

**Table 1.5:** Recent studies related to chilled and frozen food waste generation.

| | | |
|---|---|---|
| 1 | UNEP and FAO, (2022). | Sustainable Food Cold Chains: Opportunities, Challenges and the Way Forward. Nairobi, UNEP and Rome, FAO |
| 2 | UNEP (2021). | UNEP Food Waste Index Report 2021 |
| 3 | WWW, 2017 | Food Loss & Waste in Farming, South Africa |
| 4 | Consumer Goods Council of South Africa, Food Safety Initiative | Food Loss and Waste Initiative 2018-2020 Report |
| 5 | FAO (2022). | FAO. 2022. World Food and Agriculture – Statistical Yearbook 2022. Rome. https://doi.org/10.4060/cc2211en |
| 6 | James, S. J., & James, C.(2010) | The food cold-chain and climate change. Food Research International. |
| 7 | Stephen J. James and Christian James | Chilling and freezing of foods; Food Refrigeration and Process Engineering Research Centre, The Grimsby Institute, Grimsby, UK |
| 8 | Pedretti, E. F., Duca, D., Ballarini, M., Boakye-Yiadom, K. A., Ilari, A. (2023). | Environmental impact assessment of producing frozen spinach in central Italy, Resources, Environment and Sustainability, 12, 100110 |
| 9 | Ögel, İ. Y., Ecer, F., & Özgöz, A. A., (2023) | Identifying the leading retailer-based food waste causes in different perishable fast-moving consumer goods' categories: application of the F-LBWA methodology. Environmental Science and Pollution Research, 30(12), 32656–32672, |
| 10 | Ramanathan, U., Ramanathan, R., Adefisan, A., ...Cama-Moncunill, X., Samriya, G. (2022). | Adapting digital technologies to reduce food waste and improve operational efficiency of a frozen food company - the case of Yumchop Foods in the UK, Sustainability, 14(24), 16614 |

| | | |
|---|---|---|
| 11 | Marchi, B., Zanoni, S. (2022). | Cold chain energy analysis for sustainable food and beverage supply, Sustainability, 14(18), 11137 |
| 12 | Ríos-Fuentes, B., Rivas-García, P., Estrada-Baltazar, A., ...Miranda-López, R., Botello-Álvarez, J. E. (2022). | Life cycle assessment of frozen broccoli processing: Environmental mitigation scenarios. Sustainable Production and Consumption, 32, 27–34 |

Notwithstanding the quantitative data describing food loss and waste at the processing, packaging and distribution stages of the supply chain that were provided in a study by Oelofse et al. (2021), no prior study in South Africa has examined data in the whole distribution phase of the supply chain. Kliaugaitė and Kruopienė (2017), highlighted the same issue with data quality for food waste produced by the grocery retail sector in South Africa, which has gaps in the data and information due to resistance to sharing the data. The comprehensive food waste study by Oelofse et al. (2021) was based on approximations, which have some limitations in revealing the actual picture of frozen and chilled food waste at the different stages of the supply and value chain. In general, retailers and other big companies do not reveal that kind of information to people outside their organisations due to commercial sensitivity and privacy issues. Hence, limited work is available that comprehensively indicates food waste in the processing and packaging, and the distribution phase of the supply chain (Kliaugaitė & Kruopienė, 2017).

Freezing of foods is generally one of the most valuable solutions to reducing food waste, both at the retail and consumer levels. According to the American Frozen Foods Institute (AFFI), up to 47% reduction in food waste can be achieved by the distribution of frozen foods compared to non-frozen foods (AFFI, 2021). Preliminary research has shown that of these tons of frozen food waste being generated, over 70% of it is meat and dairy products. Such waste is generally regarded as having a much greater negative environmental impact than vegetable waste (Costello et al., 2016). No other local research has investigated at these discussed problems in the FSC.

The purpose of this study is therefore to investigate chilled and frozen food waste generation in the distribution phase of the supply chain of a major food manufacturer and distributor in South Africa using big data analytics. As has already been highlighted, food waste at this stage of the supply chain is generally substantial and therefore most worrying. However, to be able to address this problem adequately, the food waste problem must first be accurately described to introduce effective waste reduction measures. This research provides a comprehensive picture of food waste in the distribution phase based on primary data over five years from a major supplier of chilled and frozen foods to and from thousands of retailers around the country. The thesis provides information that can be used to recommend possible frozen and chilled food waste reduction measures and possibly drive policy changes aimed at mitigating food waste generation.

In South Africa, the problem of food waste is a developing one that interests a range of stakeholders including the government, business, and non-governmental organisations. This is because of the gaps in policy regulating the sector and challenges it faces. There is no specific food waste management legislation in South Africa; rather, food waste is managed along with other types of waste as defined by the National Environmental Management Waste Act (NEMWA) (Act 59 of 2008). However, the country has shown that it recognizes the challenges related to food waste and has an interest in addressing the issue. In 2015, South Africa adopted the 2030 Sustainable Development Goals (SDG 12.3). The seventeen Global Development Goals are interconnected, and their aims are to eradicate poverty, safeguard the environment, and guarantee that everyone lives in peace and prosperity. The current study contributes valuable insights that enrich the existing body of knowledge. Firstly, it illustrates the importance of using a mixed method approach in gathering data and investigating the impact of frozen and chilled foods waste generation, in view of its drivers, social, ethical, economic and environmental aspects. This research further explores the impact of the policy and legal framework to address issues of frozen and chilled food waste generation. What is special about this research is that in seeks to segregate its investigation and targets only chilled and frozen foods in KwaZulu-Natal, South Africa, research describing aspects of frozen and chilled waste generation has not been published before.

In many cases, researchers investigated food waste in general, and they did not segregate their research based on type of food waste commodity. In addition, few international research publications are available on the subject of chilled and frozen food waste generation. Thus, this approach will provide a new perspective in the study of food waste generation. Its insights dovetail broader issues as social issues, economic issues, environmental issues, policy framework, consumer perceptions, drivers of chilled and frozen food waste generation.

### 1.6. Research Design

The design of the study is a mixed approach (Singleton & Straits, 2018) meaning that research methods used were both qualitative and quantitative (Ormrod et al., 2020). Research design, also called a research strategy, is a plan to answer a set of questions (McCombes, 2019). The study used desk review to retrieve online data from the manufacturing company SAP Intranet system. Questionnaires with constructed statements were also used for both individual interview for quantitative data and individual in-depth interviews for qualitative data (Mohajan, 2021). Furthermore, an online Four Eyes survey was used to collect data. Thus, the study generated four data sets for analysis and the data was sourced from respondents, the SAP Intranet system and the Four Eyes online survey. These data sets are intertwined to dovetail and generate a strong, rich content analysis.

### 1.7. Data sources and tools

A variety of tools and techniques as well as methods to organize complex work schemes are necessary for data acquisition, management, and interpretation (Magnuson & Dixon, 2020) Data sources were varied, including online data sources and repositories such as the UNISA student portal, Scopus, Wikipedia, books, World Bank reports, national food waste reports, United Nations reports, notes from field work and observations. Mensah & Goderre (2017) further suggested that information is the collection, aggregation, analysis, and presentation of data that provides understanding. Data sources ranged from publications, books and journals to the SAP Intranet system of the food manufacturing company.

This study respondents included employees, policymakers, consumers, and environmental scientists who contributed to sourcing of data. The tools used were questionnaires for individual interview and in-depth individual interviews. An online survey - the Four Eyes - was also used as an instrument to collect data. The focus area for the research was in KwaZulu-Natal (KZN) province. KwaZulu-Natal is located in the southeast part of the country with an area of around 92,100 km2 (35,600 sq. mi). It has a long coast of the Indian Ocean and borders three countries, Mozambique, Eswatini and Lesotho (Figure 1.3). The capital of the province is Pietermaritzburg, and the largest city is Durban.

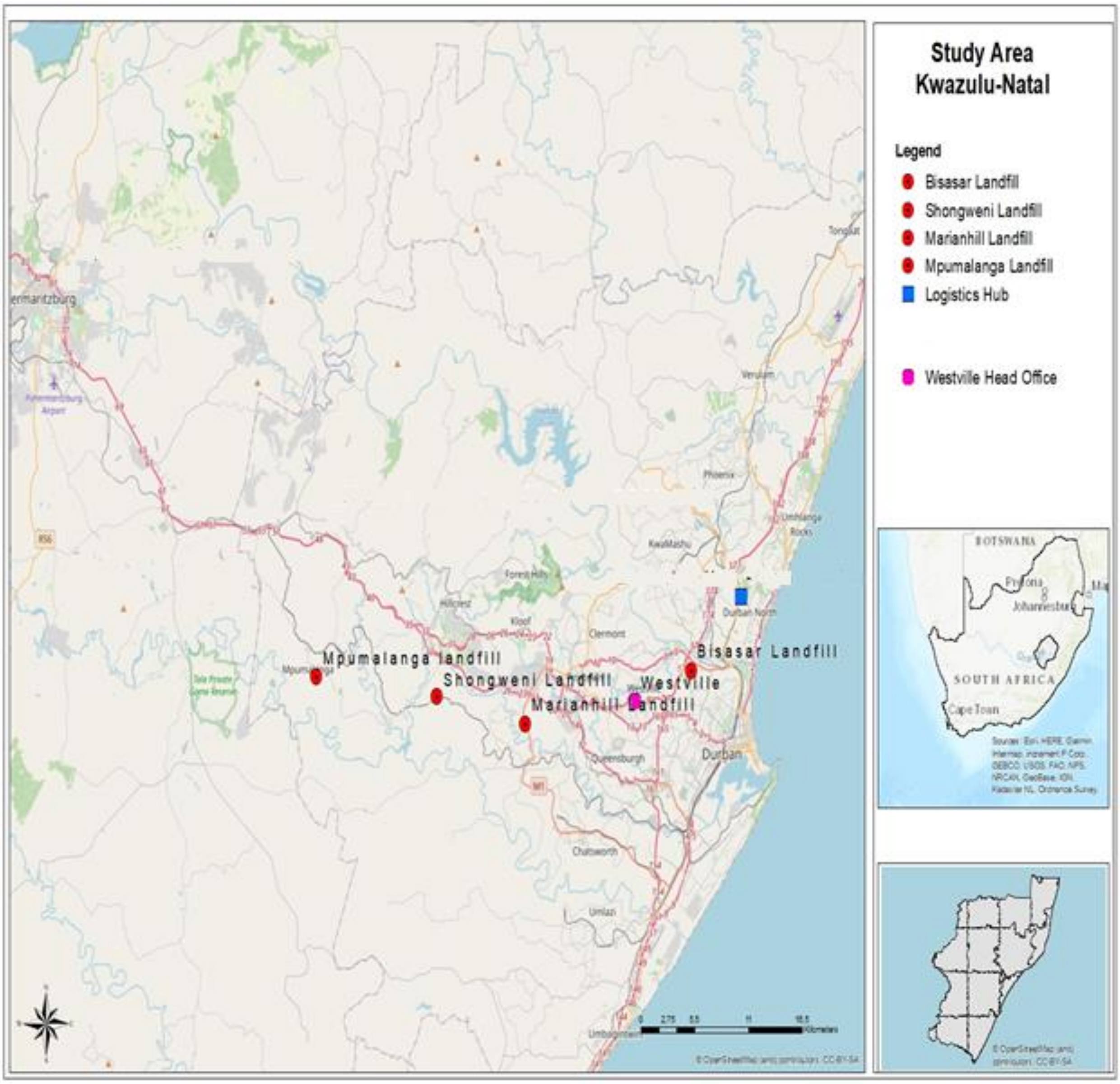



**Figure 1.3:** Study Area - KwaZulu-Natal. Source: Generated by the researcher with ArcGIS

## 1.8. Data Analysis

Quantitative data were analysed using the Statistical Package for Social Sciences Statistics (IBM SPSS). Descriptive statistics were used. Data were analysed from the manufacturing company intranet system (SAP), observations and the Four Eyes online survey software using Power Business Intelligence Microsoft software. Power BI allowed for visualizations of data. Qualitative data from interviews and questionnaires was analysed qualitatively through coding narratives according to discrete themes and ranking them on continuous dimensions (Hoyle et al., 2017). Data were coded and classified under categories which helped the researcher identify emerging themes (Leedy & Ormrod, 2019).

As the overall research has made use of both primary and secondary data, the use of data triangulation was applied as well. As per Ormrod et al. (2020), data triangulation can be considered to be an area that is generally employed in the case of secondary data only, as was the case in the present study. Therefore, the employing of triangulation of data is an essential area of research. The overall generation of the study here has allowed better insights into the chosen area. However, an appropriate use of triangulation was crucial in considering multiple kinds of data and various sources of data for analysis. Further, there is a need to understand that the primary data that is being used in the study have been compared with the secondary data that has been employed in terms of triangulation and this has enhanced the overall outcomes of the study in the long run as well.

## 1.9. Scope and limitations of the study

### 1.9.1. Scope of the study

There are various types of chilled and frozen food wastage occurring in the Republic of South Africa particularly KwaZulu-Natal impacting in many ways socially, economically, and environmentally. This study however focused on a major food manufacturing company (FMC) and 202 retail outlets it supplies in KwaZulu-Natal province to obtain secondary data from document review and through the SAP intranet system of the Food Manufacturing Company. It further focused on perceptions of walk-in customers, employees of the retail outlets, environmental scientists, and policymakers. The theoretical framework in the study is important for the research because it is relevant to food wastage and its impact on stakeholders such as people and environment.

### 1.9.2. Limitations of the Study

The study was limited to KwaZulu-Natal Province, South Africa. Study respondents were employees of a major food manufacturing company FMC, employees of the retail outlets, environmental scientists, policymakers, and walk-in customers. It further focused on 202 retail outlets supplied by FMC to obtain secondary data from document review and through the SAP intranet system of the Food Manufacturing Company. Resources such as time and funding for data collection were a restriction. The mixed method approach and procedures of data collection were used to ensure that this limitation was overcome. The limitation of this study is that it only used the Triple Bottom Line Theory as theoretical framework, which quantifying and measuring social and environmental impacts in a standardized way can be challenging and there is a lack of globally standardized metrics and reporting frameworks. This makes it difficult to compare the sustainability performance of companies across industries and regions.

### 1.9.3. Delimitations of Study

This study is delimited to KwaZulu-Natal province, South Africa. It does not encompass other provinces or regions within the country. The research is limited to frozen and chilled foods available within the KwaZulu-Natal market. It excludes other types of food products such as fresh produce, canned goods, and dry goods. The study examines frozen and chilled foods in KwaZulu-Natal within a specific timeframe, from July 2017 – June 2022. Historical data beyond this timeframe is not included. The investigation focuses on frozen and chilled foods available through retail outlets, supermarkets, and distribution channels operating within KwaZulu-Natal. It does not extend to wholesale markets or direct-to-consumer sales.

### 1.10. Significance of the study

It was anticipated that the findings of the study will identify the types of challenges encountered giving rise to food waste generation in general and frozen and chilled waste in particular. This is where strategies of equipping food manufactures, and retailers will be derived. The results of the study are further expected to provide information that will help raise awareness to policy makers and government about the plight of food waste generation, frozen and chilled foods in particular. Associated with the socioeconomic and environmental impacts surrounding frozen and chilled food waste generation, policy makers and the government will be better positioned to dovetail policies aimed at providing a balance in the waste management ecosystem, recycling, reusing, and mitigating wastage to create sustainable livelihoods positively impacting to socio-economic deprivation of the South Africans and the KwaZulu-Natal Province in particular. This study will use the Triple Bottom Line Theory to underpin literature review.

### 1.11. Ethical Considerations

The participants' consent was obtained via their signing an informed consent form that described the purpose of the study and confirmed the anonymity of the respondents (Henning et al., 2019). Permission to conduct the study was sought from the both the Ethics committee at UNISA and the food manufacturing company. Data collected online through the Four Eye required the consent of participants. Questionnaires were serialised and anonymised to protect the identity of respondents (Nachmias et al., 2016). Company information was masked according to a non-disclosure agreement. (NDA) that is a legally binding contract that establishes a confidential relationship between the researcher and the other signatories of the NDA.

### 1.12. Structure of the thesis

This study is organised into eight (8) chapters.

Chapter 1 introduces the study with the background of food waste and its challenges globally and in South Africa. The chapter further plans out the objectives of the study, research aim and the motivation for this research.

Chapter 2 details the literature review on food waste highlighting food waste terminology. The problem of food waste globally and nationally is highlighted from previous research. The impacts and drivers of food waste is also emphasised which is overlaid with consumer perceptions on food waste in the retail sector.

Chapter 3 characterises the research methodology concentrating on the following elements: study area, data collection methods by objective and data analysis techniques.

Chapters 4, 5 and 6 present the research results as split between quantitative, qualitative and desk research, respectively. Results are further split by each objective set with visuals and tables to add to the discussion and findings.

Chapter 7 presents the discussion of the findings from a comparative review with literature review. Economic and environmental impacts are discussed in line with the drivers for food waste in the retail sector.

Chapter 8 is based on the final conclusions based on the objectives of the study and comments from the researcher with recommendation for future research.

Chapter 2 reviews the published research on food waste both internationally and domestically in the retail and cold chain sectors. Studies on food waste already conducted, theoretical underpinnings, and governance will be the main areas of focus. A literature review is provided to address the stated objectives and to outline the study's context.

### 1.13. Chapter Summary

This section introduces the study by summarizing the global and South African contexts of food waste. It emphasizes the importance of the issue and its impacts on the environment, society, and economy. The chapter outlines the study's goals, which include understanding food waste management in South Africa, identifying causes, and proposing solutions. The research aims to contribute to sustainable food practices and address food waste challenges in the country. It also discusses the motivations behind the study and establishes clear boundaries for the research.

# CHAPTER 2: LITERATURE REVIEW

## 2.1. Introduction

This section contains the literature review covering literature on food loss and food waste in an FSC, and the policies and practices used to mitigate food waste and loss locally, in South Africa and globally. The key concepts such as the FSC, food loss, food waste, and food wastage are discussed. Food waste in South Africa, the drivers and impacts of food waste, food waste policies and governance in South Africa and around the world are also presented with two broad sections of the study which is the conceptual and theoretical framework.

## 2.2. Overview of food waste generation

Food loss and food waste are often used interchangeably in scientific literature, to refer to materials that are intended for human consumption that are subsequently discharged, lost, degraded, or contaminated along the FSC (Girotto et al., 2015). The two issues have become some of the most important sustainability challenges being faced by modern society and affecting all countries from the developed to poor countries and influenced by the level of income, urbanization, and economic growth (Ishangulyyev et al., 2019). Given the threat of rising food waste and loss on a global scale, understanding the extent of food waste and loss, and the identification of sustainable solutions for all contributors to the food supply chains has become especially important (Gaiani & Fonseca, 2020).

The discharge, loss, degradation, or contamination of food material occurs along the entire FSC from the agricultural production phase in the field to the final consumption phase in the household (van der Werf & Gilliland, 2017). Given its wide-ranging implications, food waste and loss have been receiving increased attention in the past decade, especially after the 2007–2008 food crisis which rekindled the debate surrounding the global availability of food and its impact on achieving a sustainable future. While several studies have evaluated the quantities of wasted or lost food, the application of the results for comparative analysis and development of intervention measures was limited in some cases because of the difficulty in conceptualising the terms “food waste” and “food loss”, which have been used interchangeably in several studies (Gustavsson et al., 2011; Oelofse et al., 2013; Oelofse, 2019; Szymkowiak et al., 2022). The terminology for food waste is a little bit more complex than what is portrayed by the term. Additionally, the use of the term “food wastage” in literature which is defined as “any food lost by deterioration or waste” seems to encompass both food loss and food waste, therefore adding another layer of complexity. Consequently, before expanding on the discussions on food waste and loss as employed in this study, it is important to define these terms and provide their meanings as used in this research.

Buzby et al. (2014) stated that food waste is a component of food loss that occurs when edible food goes unconsumed. According to this definition, food loss is defined as “the amount of edible food, postharvest, that is available for human consumption but is not consumed for any reason such as cooking loss and natural shrinkage (e.g., moisture loss); loss from mould, pests, or inadequate climate control; and plate waste”. According to Szulecka et al. (2019, p. 257), food waste can be observed at different stages of the supply value chain and “can be edible and non-edible, avoidable, possibly avoidable and unavoidable.”

The Food Use for Social Innovation by Optimising Waste Prevention Strategies EU (FUSIONS EU) Project defined food waste using a definition that expands beyond the description by Buzby et al. (2014). While there is an emphasis on the edible part of the food in the definition by Buzby et al. (2014), according to Östergren et al. (2014), the FUSIONS EU definition of food waste as any food, including the inedible parts of food that is removed from the FSC to be disposed or recovered.

The FAO attempted to harmonise and systematise the definitions of these two terms through a definitional framework that categorised food loss and food waste differently depending on where in the value chain the food is wasted or lost. The FSC and its distribution channels in the supply and value chain are illustrated in Figure 2.1 below, which also depicts the various system boundaries and important components of the supply chain (Gustavsson et al., 2011; Helmold, 2022).

**Primary Production:** This consists of agricultural production and post-harvest handling and storage. At this stage, food is lost in the field, during harvesting or in abattoirs, storage or during transportation to processing plants.

**Processing and Packaging:** This is where the food is processed and packed before being sent to the consumers. The inedible part of the food is removed, and also food not meeting specifications is eliminated, therefore making up the bulk of the food wastage in this stage (Parfitt et al., 2021).

**Distribution:** The distribution phase includes the transportation of processed food to the market, and the processes in the market system, such as the wholesale and retail sectors. The bulk of the waste in this stage includes packaging damage or spoilage, damage during transport or non-appropriate transport systems, expired food, prepared food wastes and inedible food preparation waste (Helmold, 2022).

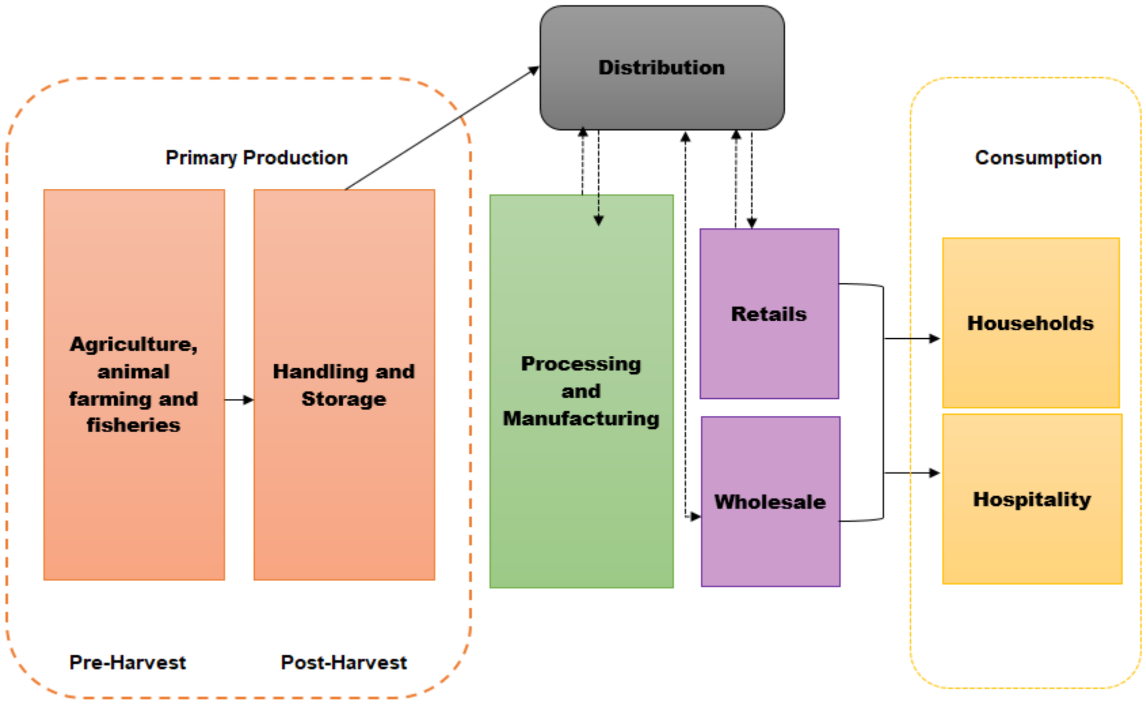



**Figure 2.1:** Five main phases and respective role-players within distribution channels of the food supply chain. Source: Helmold (2022)

**Consumption:** This includes waste in the household and in the hospitality industry. The generation of food waste at this level includes food that is discarded due to quality issues or spoiled, leftovers or inedible preparation food wastes and is influenced by several interconnected factors such as the socio-demographic characters of the household, consumption behaviour and food patterns (Alvarez et al., 2020).

Based on this FSC model, and according to the FAO (2014) definition, food waste refers to the waste or loss at the consumer level and in retail stores as illustrated in Figure 2.1. On the other hand, when food is wasted or lost during the production, storage, processing, and distribution phases of the supply chain, it is referred to as food loss (FAO, 2014). However, this definition also presents other challenges since the losses in the distribution phase are classified as food loss (FAO, 2014), as opposed to the conceptual models by Ishangulyyev et al. (2019) and van der Werf and Gilliland (2017), where the distribution phase is part of food waste category. In other studies, however, several authors examining food waste reported on food waste which is inclusive of both what is referred to as food losses and food waste (Gustavsson et al., 2011; Oelofse et al., 2013; Oelofse, 2019; Szymkowiak et al., 2022) as defined in the FAO report (FAO, 2014). Also as is highlighted in the FSC in Figure 2.1, retail is part of the distribution phase of the food items and is therefore sometimes quantified and reported together with wastage from the whole of the distribution phase, which would mean classifying what is regarded as food loss and food waste according to the FAO definition (Oelofse et al., 2013; Oelofse, 2019). For instance, a definition by Szymkowiak et al. (2022) suggested that food waste includes any food disposed of by the FSC, including food production, distribution, and consumption.

Irrespective of the differences in terminology, both food loss and food waste refer to "decreased food volume" in the supply chain which has severe impacts on food security around the world (Møller et al., 2014). This study is situated in the distribution phase of the FSC. Its definition of food waste is consistent with a definition by Dora et al. (2021) who highlighted that food losses mainly occur in the upstream supply chain such as during production, post-harvesting, and processing while food waste occurs when food that was originally produced for human consumption is either removed wastefully or is not consumed by humans. This includes food wasted during transportation after the processing stage. It should be noted, however, that while the study classifies all the losses in the distribution phase as being part of food waste in the FSC, the data used in this study are limited to those reported by the distributor which consists mainly of food returns from the retailers, which is food labelled as store damages, expired food, damage during transportation, spoilage, and others. Food waste in the company's depot before shipment is not included in the study.

As indicated in Table 1.1, the average supply of food in tonnage in the Republic of South Africa between 2014 and 2018 was 22 620.39 in 2014, 22 268.67 in 2015, 22 518.14 in 2016, 22 915.99 in 2017 and 23 164.99 in 2018 with a total average of 22 783.84, with almost half of that supply going to waste as slightly above 10 332.77 tons (CSIR, 2021). This suggests that almost 45% of food waste generation occurs across the food supply and value chain and of the 10 332.77 tons of waste, this implies that 4,494.75 tons is chilled and frozen food waste (CSIR, 2021).

As indicated in Table 2.1, from 2014 to 2018, the averaged distribution and storage losses for cereals makes up 5,8% of waste, 18.3% for fruits and vegetables while meat, fish and seafood's recorded 0% losses. These are commodities within the frozen and chilled foods in the supply and value chain and this implies that losses are incurred at other stages of the supply and value chain (CSRI, 2021).

**Table 2.1:** Average annual losses during transport and storage in South Africa. Source: FAOSTAT (2021) as cited in CSIR Technical Report on Food Waste (2021)

| Losses during transport and storage ('000 tons) | | | | | | | |
|---|---|---|---|---|---|---|---|
| | **2014** | **2015** | **2016** | **2017** | **2018** | **Avg. loss (/000 tons)** | **Avg. loss (%)** |
| **Cereals** | 601 | 433 | 380 | 867 | 672 | 590,6 | 5,8 |
| **Roots and Tubers** | 170 | 188 | 163 | 186 | 187 | 178,8 | 9,8 |
| **Oilseed and Pulses** | 117 | 107 | 101 | 127 | 132 | 116,8 | 38,4 |
| **Fruit and Vegetables** | 674 | 709 | 650 | 690 | 688 | 682,2 | 18,3 |
| **Meat** | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Fish and Seafood** | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Milk** | 0 | 0 | 0 | 9 | 0 | 0 | 0 |

Meat, fish, seafood and milk do not record any losses during transportation and storage this is due to these products often undergo preservation methods such as refrigeration, freezing, or packaging techniques that extend their shelf life and maintain their quality during transport and storage. Also, Meat, fish, and milk are perishable products with high demand and quick turnover rates in store. This means that they are often transported and sold rapidly, reducing the likelihood of spoilage during storage (Gillespie, Pacheco, et al., 2023).

The retail sector arguably is committed to food rescue and donations, but consumers revert to feeding pets, home composting or disposal of the waste into the municipal bin (Ramakhwatho, 2016). Implementation of waste prevention strategies are contained in the Food Waste Prevention and Management Guideline for South Africa (DEFF, 2021; CSIR, 2021, Trento et al., 2021).

### 2.2.1. Environmental and Socioeconomic impacts of frozen and chilled food waste generation.

Food waste has multiple impacts including environmental, economic, and social. Of these various impacts, the environmental and economic impacts are the most significant because of their effect on the life of consumers. These are discussed in the sections below. Over and above the losses indicated in Table 2.1, frozen and chilled food waste or loss is associated with several significant economic, social, ethical, and environmental impacts due to the excessive consumption of natural resources and greenhouse gas (GHG) emissions, both driven by population growth and urbanisation (Oelofse, 2021).

#### 2.2.1.1. Environmental Impacts

According to the United Nations Environmental Program (UNEP) food waste index report from 2021 (UNEP, 2021), up to 10% of global GHG emissions are attributed to unconsumed food. Not unexpectedly, the carbon footprint of wasted food is reportedly 3.3 gigatons of $CO_2$ (Hudson & Messa, 2019). This is driven by the use of food waste disposal methods which contribute to the production of GHG emissions especially in developing and poor countries where most of the frozen and chilled food waste ends

up in landfills. The largest user of water resources is agriculture, which accounts for over 90% of the total water footprint (Aschemann-Witzel et al., 2015). Thus, water and energy costs mean that food waste is also very costly to the economy and the environment. Given that GHG are produced at every point in the chain of food production, the especially high GHG levels in the production, processing, and distribution phases result from the use of energy and the fact that a third of that food is wasted (Scholz et al., 2015). In addition to the production of GHG, food waste consumes 20% of freshwater, fertiliser, cropland, and landfill space (Buzby, 2022).
The global warming impact of avoidable food waste was quantified between 2000 and 3600 kg CO2-eq.t-1 (Tonini et al., 2018). For example, waste beef and pork emit 4% of carbon dioxide, making them one of the largest food categories contributing to environmental impacts (FAO, 2013). Direct or indirect emissions from food waste are affecting the environment food waste also has massive effects on the global economy. Food losses lead to four main impacts: land use, depletion of water resources, biodiversity loss, and climate change (Costello et al., 2016). Biodiversity is suffering from food wastage in the sense that the present number of losses within the whole production and distribution chains has led to a rise in land conversion to arable land due to deforestation, whereby there is a change in land use (FAO, 2013). This leads to further losses in wildlife, namely insects and mammals (FAO, 2013). Energy, fuel, and water used to grow food that might not be consumed also have an impact on food waste. The largest user of water resources and one that was namely agriculture, accounts for over 90% of the total water footprint. (Aschemann-Witzel et al., 2015). Gibson (2016) claims that the water footprint also includes virtual water, which is the water used for treatment, production, and consumption. Therefore, all forms of water, direct or indirect, are considered.

According to the FAO (2013), the only use of water in the production of food waste occurs during the agricultural process. The Ecological Footprint is a metric used to assess how a specific population's consumption has an impact on the environment. Nearly 1 billion, 400,000 hectares, or nearly 30% of the world's agricultural land, is taken up by food that is produced but not consumed (Hudson & Messa, 2015). Food waste also contributes to climate change. Whether there are food losses or not, food production uses fossil fuels across its supply chain, namely in mechanical harvesting and transportation activities. When food waste is sent to landfills, it contributes to greenhouse gas emissions. Food loss and waste have many negative economic and environmental impacts. Economically, they signify a wasted investment that can reduce farmers' incomes and increase consumers' expenses. Environmentally, food loss and waste impose a host of impacts, including greenhouse gas emissions and unproductively used water and land, which in turn can lead to diminished natural ecosystems and the services they provide (Djekic et al., 2019). Scherhaufer et al. (2018) analysed three major environmental potentials related to food waste throughout the entire food chain: GWP, AP and EP.

Their results show that the highest impacts occur in the production stage, pointing out, that the consumer stage comprising food consumption and food waste disposal contributes to up to 15% of overall environmental impacts (Scherhaufer et al., 2018). Food losses and food waste are huge environmental burdens. Lost and wasted food means a loss of all the resources needed to produce it, such as water, land, energy, and more. All wasted food generates between 8% and 10% of the world's total man-made greenhouse gas (GHG) emissions, which produce climate changes such as floods, droughts and heat. In comparison, the global aviation industry produces 2-3% of greenhouse gases. This use of natural resources drives up costs, drives up food prices, and is debilitating (Schneider & Eriksson, 2020).

In addition, the food cold chain has implications for the global climate and the environment. Thus, poor refrigeration resulting from leaks can contribute to carbon gas emissions. The International Institute of Refrigeration reports that emissions from food loss and waste due to lack of refrigeration totalled an estimated 1 gigaton of $CO_2$ in 2017. This is especially important given that, to achieve the ambitious Paris Agreement target of keeping the global temperature rise below 1.5°C, global $CO_2$ emissions will need to be reduced to net zero by mid-century (UNEP, 2021). Thus, international cooperation in this field is fundamental.

Mechanical refrigeration equipment uses electricity to operate. By one estimate, refrigeration in supermarkets accounts for up to 4% of the total electricity use in developed countries (Environmental Investigation Agency (EIA), 2021). Producing this electricity releases $CO_2$-equivalent emissions and contributes to global warming, especially if the electricity is generated from carbon-intensive fossil fuel sources (Liang et al., 2022). In total, around 80% of the greenhouse gas emissions from refrigeration, air-conditioning and heat pump systems is associated with indirect emissions from energy use, whereas the remaining 20% is associated with direct emissions from refrigerant use (Ozone Secretariat, 2021). Available data suggest that, altogether, food cold chain equipment contributed 261 million tons of $CO_2$-equivalent emissions in 2017 (International Institute of Refrigeration [IIF/IIR], 2021). If this is added to the emissions from food loss and waste due to a lack of refrigeration (an estimated 1,004 million tons of $CO_2$-equivalent), then the combined total greenhouse gas emissions associated with the global food cold chain total an estimated 1,265 million tons of $CO_2$-equivalent emissions, or around 4% of total global greenhouse gas emissions (International Institute of Refrigeration [IIF/IIR], 2021). However, more data are needed to accurately estimate greenhouse gas emissions from the food cold chain.

In transportation and logistics, many forms of road transport already emit high levels of airborne pollutants such as sulphur oxides, nitrogen oxides and particulate matter, often exceeding limits set by the World Health Organization. Refrigeration units add to this impact: by one estimate, a trailered transport refrigeration unit can emit 6 times as much nitrogen oxide and 29 times as much particulate matter as the modern Euro VI truck propulsion engine that pulls it (Dung et al., 2015). Yet regulations and standards for transport refrigeration units are often underdeveloped or not well applied (Lehtokunnas & Pyyhtinen, 2022).

In general, data on the wide-ranging environmental impacts of cold chain activities remain scarce. In particular, adoption of the Kigali Amendment provides a trigger to enhance global action on climate-friendly cold chains, as demonstrated at the 31st Meeting of the Parties of the Montreal Protocol on November 2019 where more than 80 parties voluntarily joined the Rome Declaration on the contribution of the Montreal Protocol to sustainable cold chain development for food waste reduction (WRI, 2019). The Declaration, launched as a joint initiative by Italy, the UNEP Ozone Secretariat and the FAO, aims to strengthen cooperation at all levels between relevant stakeholders to exchange knowledge and promote innovation of energy-efficient solutions and technologies (UNEP, 2021). Reducing non-$CO_2$ emissions, including refrigerants used in cold chain technologies, is key to achieving the Paris Agreement targets, as highlighted in the latest mitigation report from the Intergovernmental Panel on Climate Change (IPCC). Adherence to these agreements will mean a reduction in both cold and chilled food waste generation and carbon emissions.

As the global mean temperature continues to rise, projections point to increases in the intensity and frequency of heat extremes, including heatwaves (Scafetta, 2023). As of 2021, 110 both developed and developing countries have committed to reducing their cooling emissions in either their enhanced Nationally Determined Contributions (NDCs) or long-term climate plans under the Paris Agreement. This is up from only 6 countries that included cooling in their NDCs in 2015 (GCCA, 2022). The international community has also recognized the role of cold chains in food systems in the Rome Declaration on the Contribution of the Montreal Protocol to Food Loss Reduction through Sustainable Cold Chain Management, and in a 2019 UN Environment Assembly resolution (Ozone Secretariat, 2021). The Rome Declaration stresses the importance of pursuing national action and international cooperation to promote the development of the cold chain, including sustainable and environmentally friendly refrigeration to reduce food loss.

#### 2.2.1.2. Social Impacts

The generation of chilled and frozen food waste, particularly from a volume disposed point of view, is in stark contrast to the millions of South Africans and other people around the world who are suffering from chronic hunger. According to Martin-Rios et al. (2018), up to 842 million people are affected by severe food shortages globally. Food that contributes to food waste includes 45% of all fruits and vegetables, 35% of fish and seafood, 30% of cereals, 20% of dairy products and 20% of meat. This implies that even at the global level chilled and frozen waste accounts for nearly a half of the total food loss and waste - the figure for South Africa is estimated at 46.5%. This means that almost half of the global food that goes to waste is chilled and frozen (de Bruin et al., 2021).

Retailers provide a significant influence on the upstream and downstream handling of food because of their position in the food chain. The main types of frozen and chilled food waste at retail and distribution levels are recalled products, damaged food, spoilage, unsold stock, and short-dated products. Some of the main reasons for making an item unsellable include delays in delivery; overstocking so that a regular replenishment of stocks leads customers to choose the newest products; a poor demand forecast those results in overstocking; an expired shelf-life past the best-before date or use-by date, and visual defects or damage to the packaging (Lehtokunnas & Pyyhtinen, 2022; de Bruin et al., 2021).

Social impacts are consequences of an action or event, while environmental impacts pertain to the changes or effects on the natural environment caused by human activities. Both types of impacts are crucial considerations when evaluating the overall sustainability and consequences of various actions, policies, or events (Wang et al., 2020). The amount of food wasted globally does not justify the extent of food insecurity. An estimated 14 million people in South Africa go to bed hungry, and about 40% of the food that is produced is wasted (IOL Reporter, 2021). Despite the fact that South Africa's constitution guarantees access to food and adequate nutrition, food insecurity, hunger, and various forms of malnutrition continue to be problematic (WWF, 2019). In Africa, the malnutrition rate is around 20%, although significant progress has been made in the fight against hunger. This figure is alarming because it is significantly higher than the 10% global average (FAO, 2020). Food security would be improved by the food supply chain operating more efficiently and wasting less food. It is necessary to make efforts to comprehend the underlying causes of food waste in order to make this a reality (Irani et al., 2018). Sustainable food systems must also contend with the environment's changing climate. The effects of climate change will make it challenging to continue producing the same amount of food in the future. To feed a growing population by 2050, it is anticipated that global food production will double.
Concerns exist regarding South Africa's capacity to accommodate the country's anticipated 73 million population increase by 2050 (WWF, 2017).

Chilled and frozen food waste generation can be appreciated in terms of a significant socio-economic loss for various stakeholders, including producers, retailers, and consumers in the food supply and value chain. Included are financial losses in businesses, and household food insecurity and hunger affecting livelihoods and social subsistence and nutritional needs of vulnerable populations. The current production of food is sufficient to feed the world population twice (WFP, 2018). At the same time, roughly one in nine people worldwide suffer from hunger (FAO, 2018). It is clear that a profound change in the food system is needed to nourish the 800+ million people that suffer from undernourishment to ensure the health of the planet. The real cost of food waste is not only paid for by nature, but also by people. The social impact of malfunctioning food systems cannot be underestimated, particularly when over 30% of the worldwide production of food is wasted (World Bank, 2020) while at the same time one in nine people does not have access to sufficient nutritious food. The global population is expected to grow by 2.3 billion people by 2050 to a total of almost ten billion people. Thus, either food production should increase by 56% to feed all those people or can reduce our food waste and not have to increase our food production at all (Aragie et al., 2018). On the macro-level, plans are made to reach targets to reduce food waste and nudge consumers' behaviour in the right direction, such as streamlining expiration labels and eliminating the use of trays in cafeterias (Ranghanatan et al., 2018). Optimization of expiration labels and removal of trays in cafeterias have proven to be efficacious approaches for mitigating food waste. By furnishing lucid and uniform expiration labels that enhance consumers' comprehension of food freshness and safety, the aforementioned strategies facilitate a reduction in the premature disposal of food resulting from misinterpretation of date labels. The optimization of expiration date labelling serves to curtail unnecessary wastage and engender a propensity among consumers to utilize products prior to their designated expiration date (Stephan, 2021). As indicated in Figure 2.2, a big share of the waste, however, still happens on the micro-level - within households.

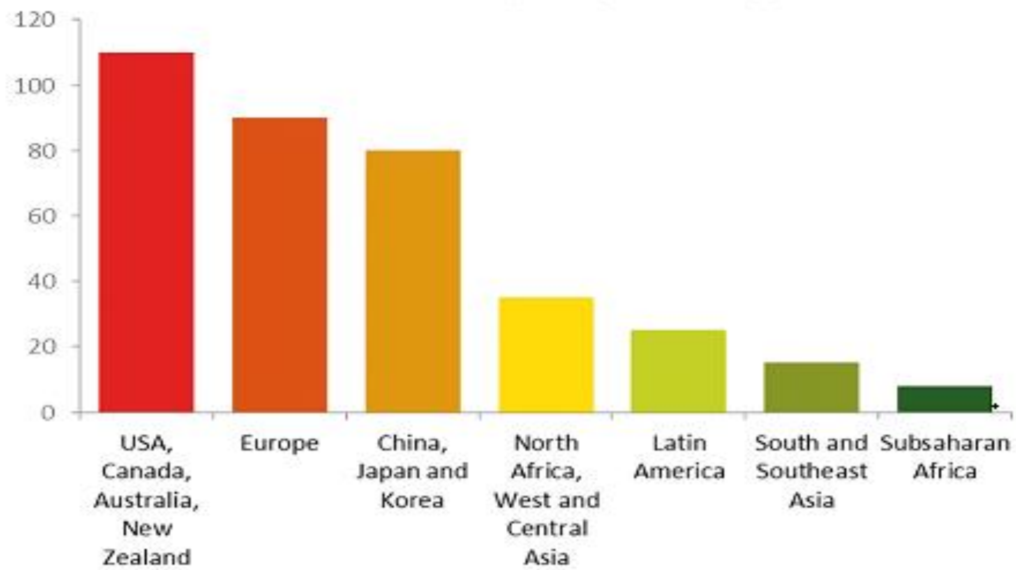



**Figure 2.2:** Relative food waste per country or region at the consumer level. Source: FAO (2017)

The information in Figure 2.2 for consumer food waste per capita are based on data from the report 'Global Food Losses and Food Waste' (FAO, 2017). Globally, consumer food waste amounts to roughly 350 million tons which equates to about 50 kgs per person or 10% of total food supply (Gustavsson et al., 2011). If such food was equitably distributed, the world would not have people going to bed without a meal. While food waste and poor nutrition are global issues, they hit close to home in South Africa. These trends signify that although Africa and particularly sub-Saharan Africa has huge amounts of food loss and waste, these losses are relatively low at the consumer level. This might be attributed to various reasons such as there being a relatively reduced food production in Africa compared to developed countries, reduced knowledge of processing and poor or inadequate storage facilities, accounting for an estimated total of 45% of food loss (Martin-Rios et al., 2018)

When viewing the state of nutrition in South Africa, 43.6% of South African children are deficient in Vitamin A, which leads to a weakened immune system and thereby increasing the prevalence of illness, disease and blindness while 10% of South African children suffer from iron deficiency anaemia, a condition that can leave children feeling tired and weak (Sanders, 2017). According to a report by the University of the Western Cape's School of Public Health indicated that on average IQs are being lowered because of this chronic under-nutrition, especially in early childhood. Adults who are on diets with inadequate nutrients are at higher risk of developing diabetes, heart disease and certain cancers (Sanders, 2017). As the South African diet continues to shift towards one that is higher in processed foods and lower in fruit and vegetables, malnutrition will increase as well (FAO, 2018). Thus, reducing food waste in South Africa can improve the health and well-being of South Africans.

#### 2.2.1.3. Economic Impacts

Food waste is not only bad for the environment, but it also costs consumers and businesses a loss of money and nutrients (Buzby et al., 2014). In the United States, people waste an average of more than 1,250 calories of food each day, which equates to more than 400 pounds of food per year (Spiker et al., 2017). This equates to an annual loss of up to USD 218 billion, or 1.3 % of the United States' gross domestic product (GDP) (Varese et al., 2022). The economic worth of wasted food is projected to be 9.2 % of household spending or $1,800 a year for a family of four (Varese et al., 2022). Food waste also adds to a rise in demand and food prices, making healthy food less accessible to those who are hungry. Based on the latest research, the majority of our diet consists of perishable foods, comprising dairy products, meat, fish, and fresh fruits and vegetables, which are known for their high nutrient content (Buzby et al., 2014).

In addition, the nutritional value of wasted food is estimated to be 33 grams of protein, 5.9 grams of dietary fiber, 1.7 micrograms of vitamin D, 286 milligrams of calcium, and 880 milligrams of potassium per person, each day (Spiker et al., 2017). This wasted food not only represents a loss of calories and vital nutrients that are necessary for sufficient nutrition but also reflects a rise in food prices and consumer expenses, reducing access to high-quality, nutritious foods and endangering global food security (Flanagan et al., 2019).

In 2012, food waste cost South Africa about R61.5 billion annually, or 2.1 percent of the country's GNP at the time (Nahman & de Lange, 2013). About the R1,191.00 worth of food that a middle-class person consumed in a month in 2010 (and assuming an inflation rate increase of 42.5% over the subsequent six years, from 2010 to 2016), for every 5% of food waste that is recovered, an additional 195 000 people can be fed each year (Nahman & de Lange, 2013). Real economic growth averaged just 1.1% over the last decade, compared to the average South African population growth rate of 1.5% over the same period (STATS SA, 2019). Reducing food waste would result in economic benefits such as lower disposal costs, reduced overhead, labour costs, and tax benefits from donating food. For example, food waste affects pricing policies in developed countries, leaving those on minimum incomes who cannot afford to spend more on food at the greatest risk. The food price is also largely linked to environmental causes (Schneider & Eriksson, 2020).

Finding the relationship between socioeconomic determinants and environmental degradation has wide implications for evaluation and formulation of policy design to improve environmental quality while the social factors responsible for environmental performance are required to be further explored (Tkáč et al., 2022). Part of the socioeconomic impact is economic loss where chilled and frozen food waste represents a significant economic loss for various stakeholders, including producers, retailers, and consumers (Dreyer et al., 2019). Wasted food translates into financial losses for businesses and households, impacting profitability and disposable income. The management and disposal of chilled and frozen food waste incur additional costs for businesses and municipalities. These costs include waste collection, transportation, landfill fees, and waste management infrastructure investments. Ultimately, these expenses can burden consumers and taxpayers (Aragie et al., 2018). Chilled and frozen food waste generation represents lost opportunities to address food insecurity and hunger (Berry, 2020). By reducing food waste particularly chilled and frozen generation, more resources could be directed towards meeting the nutritional needs of vulnerable populations. Part of the environmental impact, the decomposition of chilled and frozen food waste in landfills produces methane, a potent greenhouse gas that contributes to climate change. Additionally, the energy-intensive processes involved in food production, refrigeration, and transportation also contribute to carbon emissions and exacerbate climate change (Bessa et al., 2021). The disposal of chilled and frozen food waste requires waste management systems, such as landfills or incinerators, which can have negative environmental impacts. Improper disposal or inadequate waste management can lead to pollution of soil, water, and air, affecting ecosystems and human health. Addressing these socioeconomic and environmental impacts requires comprehensive strategies such as improved supply chain management, better inventory control, consumer education and awareness, innovative food waste reduction initiatives, investment in sustainable infrastructure, and policy interventions that promote responsible food consumption and waste management practices (Tkáč et al., 2022).

### 2.3. Global challenges and problems of frozen and chilled food waste generation

Globally, the demand for food has increased along with an increase in the population (Benyam et al., 2021). Unfortunately, with the rise in demand for food, food production has increased along with a concomitant increase in associated food waste so that almost one-third of all food produced for human consumption is lost or wasted each year (Beega, 2021). Food waste generation and chilled and frozen food waste in particular around the world brings into perspective some very serious issues that should be addressed:

- if food waste including chilled and frozen food waste is reduced, it increases food availability and boosts food security around the world especially given over 800 million facing hunger every day (Buzby, 2022).
- it draws attention to the significant loss of resources (natural and artificial) used in food production to end-stage consumption, which could be used to satisfy other needs (Gustavsson et al., 2011).
- frozen and chilled food waste has unfavourable externalities that influence the environment which includes GHG emission, fertiliser runoff, pesticide leaching, soil erosion, odours, larval infestation and water pollution from animal waste and leaching landfills, which can affect groundwater aquifers, streams, rivers, and coastal watersheds (Hudson & Messa, 2019).
- wasting perfectly good edible food is morally wrong (Hannah, 2019).

### 2.3.1. Developed vs. underdeveloped countries

According to van der Werf and Gilliland (2017), frozen and chilled food waste or loss is much more prevalent in developed countries where stringent food quality measures are in place. According to an analysis of worldwide food waste by Gustavsson et al. (2011), the authors noted that while the proportion of original output that is wasted is comparable in industrialized and developing nations, food waste per person in Europe and North America was far higher than in African countries south of the Sahara or in Southeast Asia (Figure 2.3). The study revealed that low-income nations encounter higher levels of early-stage food waste primarily due to inadequate infrastructure and technology, whereas industrialized nations tend to face greater late-stage food waste issues (Gustavsson et al., 2011; Scholz et al., 2015).

According to Rodrigues et al. (2021), the UK, which wastes 14.3 million tons of food annually, is the most wasteful of the EU's 27 member nations, according to EU-27 statistics that were released by the Independent in December 2015 (Ribeiro et al., 2022). In the UK alone, where 8.4 million people cannot afford a meal, approximately £13 billion worth of food is wasted annually (Rodrigues et al., 2021). Government and non-governmental organizations have committed to reducing food waste to lessen the environmental impacts associated with food production.

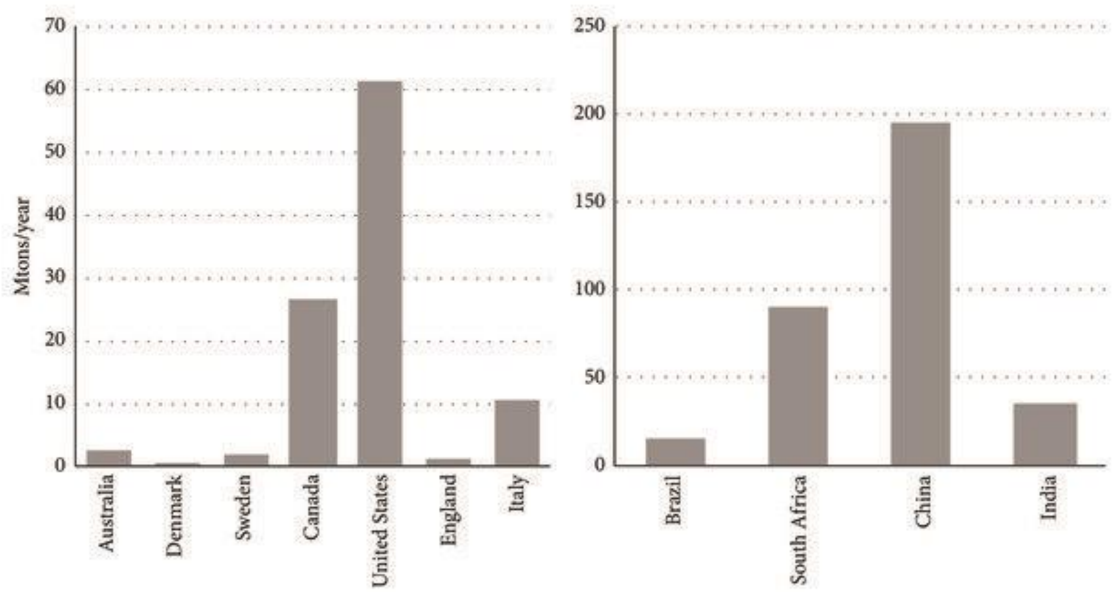



**Figure 2.3:** Worldwide generation of food waste in developed and developing countries (Paritosh et al., 2017)

These campaigns were created in response to growing worries about the industrialized food systems' high levels of waste, the anticipated significant increase in global food consumption, and the close connection between agricultural production and environmental effects (FAO, 2013).

## 2.4. Frozen and chilled food waste generation in South Africa

The magnitude of chilled and frozen food waste generated in the food supply chain of developing nations like South Africa and the factors contributing to it are little understood du Toit, 2018). The CSIR found that between 9 and 10 million tons of food were lost in South Africa every year representing 30% of South African agricultural production. This research concluded that most (95.9%) of the food losses in South Africa occurred before reaching the consumers (Figure 2.4). The study's estimates were based on the scant information available about SA's population, food production, and supply chain in 2007 (Oelofse & Nahman, 2013).


**Figure 2.4:** Food waste in South Africa. Source: Oelofse and Nahman (2013)

The latest study by the same authors (Oelofse et al., 2021) showed a much-increased contribution of food waste by consumers as indicated by the reduction from 95% reported in 2013 to almost 82% of food losses and waste occurring before the food even reached South African consumers. As highlighted earlier, nearly 50% of supply chain activities still take place in the processing and packaging stage, while only 6% take place in the distribution stage. Because of their market prices, meat and seafood accounted for up to 41% of all food waste costs therefore interventions should target all phases of the value chains for meat, fruit, and vegetables, with the focus on the processing and packaging phases (Nahman & de Lange, 2013).

According to estimates, by manufacturing food that is not consumed, South Africa wastes enough energy annually to power the city of Johannesburg for almost 16 weeks (WWF, 2023). Likewise, for South Africa, the world's 30th driest nation, the squandered embedded water associated with food production would fill almost 600 000 Olympic swimming pools. Nearly 90% of the garbage produced in South Africa is dumped in landfills, where the food waste contributes to the generation of methane gas and carbon dioxide. There is a potential to reverse the extreme food insecurity that large segments of the population experience if food loss and waste was successfully reduced (de Lange & Nahman, 2015). In 2017, the CSIR projected that food waste, or food unfit for human consumption, costs the South African economy more than R61 billion every year. Remarkably, this waste estimate represents 2.1% of the nation's Gross Domestic Product (Oelofse et al., 2019).

Table 2.2 compares the amount of food wasted globally to that wasted in South Africa. Food waste is mostly caused in underdeveloped nations like South Africa by financial, managerial, and technical constraints in harvesting practices, storage, and cooling facilities (exacerbated by challenging weather conditions), infrastructure, packaging, and marketing systems. In addition, a lack of backing from the government and limited government action are also one of the major problems driving food waste out of control in developing countries such as South Africa (Mateboho & Chenene, 2020). According to Dora et al. (2021), the level of food wastage in the food supply chain (FSC), and the overall contribution of the different phases of the FSC on the total quantity of food waste or loss is influenced by several factors including a lack of connectivity and coordination across tasks within the FSC, infrastructure limitations, climate and environmental factors, the grading for quality or safety standards as well as the customers' choices on which products to purchase and whether to consume or discard the food after purchase (Hodges et al., 2011).

In a developing country such as South Africa, the challenge of infrastructure limitations could be a major issue. According to an FAO report, developing countries such as South Africa are predicted to experience an increase in food waste due to anticipated changes in their food systems resulting from increased urbanization, supermarket chain development, and dietary and lifestyle modifications (FAO, 2013).

**Table 2.2:** Comparison of South African and global food wastage. Source: DEFF and CSIR (2021)

| Indicator | Global | South Africa |
|---|---|---|
| **Edible portion of food waste** | 1.3 billion tons per year | 10 million tons per year |
| **Consumer food waste** | 95–115 kg per person per year for Europe and North America. South/Southeast Asia and Sub-Saharan Africa = 6–11 kg per person per year. | Every week, households produce 6 kg on average. In Ekurhuleni, people dispose of 8 kg of food waste per person annually, compared to 12 kg per person in Johannesburg. |
| **Cost** | R37.57 trillion (1 USD = 14.45 ZAR) (Jain et al., 2018). Environmental effects such as pesticide exposure, water use, greenhouse gas emissions, biodiversity loss, and soil erosion account for about R14.45 trillion (1 USD = 14.45 ZAR) of this cost. | R75 billion, or 2.2 % of the country's GDP (de Lange & Nahman, 2015). The opportunity cost is R71.4 billion, of which R3.6 billion is for disposal and externalities (social and environmental costs). |
| **Climate Change** | 13.6% of the world's emissions from fuel combustion are represented by 4.4GT $CO_2$ Equivalents. There are 2.8–4.14 tons of $CO_2$ emission equivalents per ton of wasted food. | Food waste contributed about 0,04 Gigatons of $CO_2$ equivalents in 2010, or 7.6% of South Africa's overall greenhouse gas emissions. |
| **Water** | The blue water footprint of the world's food waste in 2007 exceeded a volume of 250 $km^3$ was. This exceeds the blue water footprint account for any nation at the national level. | The food that was wasted in South Africa in 2012 required 1.7 $km^3$ of water to produce. This is equivalent to 680,000 Olympic-sized swimming pools, |

## 2.5. Drivers of food waste in the food retail industry in South Africa.

Although the percentage of food waste at the retail level is only 5% of the total, there are several reasons why it is important to work on food waste in the retail industry. Retail stores collect products from different food manufacturers and suppliers and distribute them to consumers (Parfitt et al., 2021). Not all retailers produce the same amount of waste. Some studies have found that smaller stores have higher relative levels of waste than larger ones (Ali & Bharadwaj, 2014). Through this interaction between stakeholders and consumers upstream in the supply chain, retailers have immense potential to impact most of the FSC and reduce food waste (Cole-Hamilton, 2023).

As highlighted in Table 2.3, there are many causes of food waste at the retail phase, but three main sources can be identified (Teller et al., 2018):

- Consumer in-store behaviour and consumer demand.
- Store management, i.e., replenishment and assortment decisions.
- Product shelf life.

The bulk of food waste is generated in the retail industry for a variety of reasons including spoilage, breakage of refrigerators and freezers, use-by dates, and non-compliance with food standards, to name a few (WRAP, 2013). However, it could be argued that large supermarket chains support high-energy-demanding activities like industrial farming, overfishing, and global sourcing, which all harm the planetary boundaries, and thereby facilitate mass consumption and are indirectly related to the depletion of natural capital (Ramanathan et al., 2014). The indices of sustainability differ for each retailer, but among the biggest South African grocery shops, sourcing, $CO_2$ emissions, energy use, and food and packaging waste are all prominent (Ahi & Searcy, 2015). To offset food waste, shops offer discounts and sell food products to consumers before they expire and must be discarded. Food discounting, on the other hand, only makes up 0.75% of the revenue loss of 4% (Weber et al., 2011). In industrialized markets, food waste at retail establishments is a bigger concern than in underdeveloped countries.

In mature markets, consumers' demand for consistent availability and a wide range of options in retail outlets leads to excess supply and, as a result, increased food waste. There is a complex moral and social debate between consumers who demand choice and businesses who provide it, yet the environmental and economic consequences are far more quantifiable (Weber & Herrlein, 2012).

**Table 2.3:** Drivers of distribution food wastage. Source: DEFF and CSIR (2021)

| Driver | Cause | Result |
|---|---|---|
| **Distribution system** | Long distances travelled.<br>Sub-optimal logistics.<br>Uneven road surfaces.<br>Road accidents. | Reduced shelf life.<br>Product discard. |
| **Date labels** | Food not sold on time.<br>Food items not used in time.<br>Poor stock rotation in-store/depot. | Donations.<br>Discarded. |
| **Ordering systems** | Over delivery.<br>Over ordered. | Donations.<br>Discarded. |
| **Packaging** | Packaging failures. | Discarded. |
| **Product recalls** | Food safety concerns.<br>Compromised quality. | Condemnation. |
| **Quality specifications** | The product was rejected for being below quality. | Donations.<br>Discarded. |
| **Cold chain failures** | Fridges and freezers not operating at optimum temperatures.<br>Power outages.<br>Consumers moving stock out of the cold chain areas. | Condemnation. |
| **Retail over-stocking** | Company policies always require full shelves. | Donations.<br>Discarded. |
| **Failure to distribute edible surplus** | Reputational concerns.<br>Strict liability.<br>Logistical challenges for redistribution. | Condemnation.<br>Discarded. |

Retailers and wholesalers in the United Kingdom produce approximately 1.7 million tons of food waste each year. Due to the high expense and difficulty of distributing this food, more than half of it ends up in landfills. Retail stores, restaurants, and convenience stores in the United Kingdom waste 27 million tons of food each year amounting to €28.6 billion ($41.9 billion) in waste. Retailers are caught in a tricky situation as they do not want to incur the costs and social stigma associated with food waste, but they also want to keep their shelves stocked. An easy option would be to participate in food donation programs and give away any leftover food at the end of each day. Unfortunately, the expenditures involved, as well as the inspection that food must undergo before being resold or given away, make this very difficult for shops (Facchini et al., 2018).

Such plans also ignore the environmental consequences of excessive food production. Retailers, of course, want to alleviate the financial burden of food waste, but they also want to make the best social judgments possible (Beega, 2021). Retail establishments serve as a bridge between producers and customers and are strongly related to other FSC stages. For instance, Gustavsson et al. (2011) pointed out that the food losses in the agricultural stage are caused by quality criteria set by merchants.

Therefore, decisions made at the retail level may influence areas upstream or downstream in the FSC. Another factor to consider is high-quality food that is wasted at retail establishments (Scholz, 2013). According to Mena et al. (2014), the shelf life of products is increased and protected by packaging and, moreover, meat products need both primary and secondary packaging, so that the waste produced by these procedures needs to be disposed of properly to prevent bacterial contamination. Food waste is found along the whole supply chain, and the amount of food waste varies according to the kind of product and the conditions at each site. Generally speaking, roots and tubers, which are more robust and less prone to be broken during handling and transit, are less likely to be wasted than soft and green fruit and vegetables. Table 2.4 below provides the estimated waste percentages for each commodity group at each stage of the sub-Saharan African food supply chain. The amount of food waste that is considered edible across the entire supply chain in South Africa is estimated to be 10.2 million tonnes annually. This can be divided into several categories, including 20.7 million tonnes during agricultural production, 20.4 million tonnes during post-harvest handling and storage, 20.6 million tonnes during processing and packaging, 2 million tonnes during distribution, and 0.25% million tonnes during consumption compared to Table 1.2 indicated the quantities of food waste (in thousands of tons) at each stage of the value chain for South Africa.

**Table 2.4:** Estimated percentage waste by commodity group at each stage in the sub-Saharan African supply chain.  Source: DEFF and CSIR (2021)

| **Category Group** | **Agricultural Production** | **Post-harvest handling and storage** | **Processing and packaging** | **Distribution** | **Consumer** | **Total** |
|---|---|---|---|---|---|---|
| Cereals | 6.0% | 8.0% | 3.5% | 2.0% | 1.0% | 20.5% |
| Roots and Tubers | 14.0% | 18.0% | 15.0% | 5.0% | 2.0% | 54.0% |
| Oil seeds & Pulses | 12.0% | 8.0% | 8.0% | 2.0% | 1.0% | 31.0% |
| Fruits and Vegetables | 10.0% | 9.0% | 25.0% | **17.0%** | 5.0% | 66.0% |
| Meat | 15.0% | 0.7% | 5.0% | **7.0%** | 2.0% | 29.7% |
| Fish and Seafood | 5.7% | 6.0% | 9.0% | **15.0%** | 2.0% | 37.7% |
| Milk | 6.0% | 11.0% | 0.1% | **10.0%** | 0.1% | 27.2% |

With more sophisticated techniques used during harvesting and post-harvest processing and storage, there should be less waste in the early phases of the supply chain. However, the external considerations including road conditions, accessibility, and proximity can affect the distribution of waste. Wholesale markets, grocers, retailers, and fish markets are all part of the distribution stage of the supply chain. Within the South African context, this also includes street vendors and spaza shops (African Union Commission, 2018)

Factors that contribute to food waste include market economies, resource limitations, laws, cultural differences, supply chains, and consumer behaviour that is organized into policies, systems, and practices (Parfitt et al., 2021). Thus, numerous factors in the supply chain and management choices made in the supply chain can be linked to the causes of food waste. In addition, these authors point out that it is necessary to distinguish not only the level of food waste in the supply chain but also the food category. This is due to the fact that these foods contain various biomaterials with various rates of degradation and various nutritional qualities. Food waste and supply chain concerns must therefore differentiate between perishable and non-perishable foods. Mena et al. (2011) conducted a root cause analysis and identified three groups, namely: mega-trends, natural constraints, and management causes that drive food waste within the supply chain.

### 2.6. General structure influencing food waste generation

2.6.1. Megatrends influencing frozen food waste generation.

Megatrends are broad or sector-specific trends that have an effect on the food waste issue. Parfitt et al. (2010) refined global trends and identified three interconnected trends that give the factors influencing food waste a general structure. One of the most significant megatrends is sustainability. Consumers are becoming more aware of their impact on the environment and are demanding sustainable practices from companies. This means that companies must find ways to reduce their carbon footprint and minimize waste.

**Urbanization and Shrinking Agricultural Markets** – Expanded food supply chains are more necessary because of accelerating urbanization and population growth. Infrastructure upgrades for general transportation, roads, and marketing are necessary for the expansion of these food supply chains while minimizing food inflation (Oelofse & Nahman, 2013). Complex supply chains are impacting global food waste (Parfitt et al., 2010).

**Dietary changes** – Due to rising disposable incomes, dietary habits are shifting in various communities from starch-based staples to more varied diets. Consumption of perishable foods like the Top 11 fruits and vegetables may increase as a result of dietary changes (Oelofse & Nahman, 2013). Increased demand for fresh produce and a wider selection within this category can lead to higher store inventory levels and food waste (Gustavsson et al., 2011; Parfitt et al., 2010).

**Globalization of trade** – Increased food imports and exports could endanger domestic food production (Oelofse & Nahman, 2013). The complexity of the food supply chain is increasing as competition intensifies along with globalization of trade. These complex issues include increased transportation distances, longer food storage periods, and longer food shelf life, leading to food waste (Parfitt et al., 2010). Such factors can further be appreciated in global trade policies that regulate trade particularly between developed and underdeveloped countries (Soomro et al., 2021). Policies like the Economic Partnership Agreement (EPA) prioritize industries in favor of goods from industrialized countries in the North, which are often dumped into third-world countries. This practice has contributed to the decline of various sectors within industries such as agriculture, fisheries, and vegetable production, among others (van der Werf & Gilliland, 2017). Such factors lead to local produce stalling in preservation granaries leading them to spoil and being discarded. Other trade policies include the Generalised System of Preference where also developed countries will allow certain products at a stipulated quota and a fixed price to be imported into the world market and where the developed countries have a competitive advantage, they do not allow those goods to filter into their markets. Similarly, the Africa Growth and Opportunity Act follows the same pattern (Buthelezi, 2023).

2.6.2. Natural constraints influencing frozen food waste generation.

In general, the food supply chain and value chain both at the global and local level can be attributed to many factors. In the industrialised countries of the North, granaries of food go to waste while in the global South there are massive shortages in food supply. This has led to two separate worlds. A renowned scholar, Ul Haq stated that a poverty curtain descended across the face of the world making it two different worlds and two different planets. Former World Bank governor Robert McNamara calls it the North South divide. Regardless, the following variables have been found to be the main causes of food waste at the retail level of the food supply and value chain (Feyaerts et al., 2019):

**Food storage and display** - To produce the illusion of abundance, which is thought to boost sales, retailers frequently overcrowd product displays (Gunders, 2021). In order to meet their daily needs, retailers must also have a large selection of goods and enough inventory. Overstocking, overcutting, and inefficient inventory rotation are caused by a combination of the fear of running out of stock for sale and harsh penalties for lost sales (Gunders, 2021)

**Ready-made food** - Based on a worldwide trend of consumer convenience, convenience foods are becoming more and more popular. Although ready-to-eat foods are designed to use damaged or irregularly shaped products, they actually produce more scrap and waste as a result (Mena et al., 2011).

**Consumer expectations for flawless cosmetics** - Based on the quality of perishable foods, consumers frequently select certain retail establishments (Gunders, 2012). This trend forces retail groups to offer top-quality products with perfect shape, size and colour (Gustavsson et al., 2011). Due to this trend, most healthy foods are no longer produced solely for aesthetic purposes, which results in food waste at the supplier level of the food supply chain (Ahmed et al., 2021).

**Date Labels** - Food that has passed its expiration date must often be taken off the shelves in accordance with the law. “Best before” and "Use by" dates are suggested by manufacturers at the best times for consumption but are not necessarily regulated (Gunders, 2012). Many foods are safe to eat past their sell-by or use-by dates, leading to the premature selection of easy-to-eat foods (Gunders, 2012; Gustavsson et al., 2011; Mena et al., 2011). For the consumer, the placement of the date label and the actual date, as well as a larger font size that makes the text easier to read and find, can be crucial (Møller et al., 2014).

**Packing and packaging size** - Food supply chains set minimum order quantities based on box size to simplify product ordering and delivery. Inflexibility in cartons and unit sizes can result in certain stores ordering more than expected (Gunders, 2012). In addition, this author suggests that bulk packaging of goods gives consumers more options for household consumption, which transfers waste to final consumers.

**Discarded Product** - Gunders (2012) argued that food waste is more common at the end of promotions and the holiday season. High failure rates of newly launched products and packaging damaged during transportation can also lead to increased food waste (Abdel-Shafy & Mansour, 2018)

**Seasonality of produce** - Perishables are affected by the natural environment. Certain products grow during certain seasons. An environment that is both hot and muggy can shorten product shelf life and increase food waste throughout the supply chain (Gunders, 2012; Gustavsson et al., 2011; Mena et al., 2011).

**Forecasting difficulties and poor ordering** - Various forecasting methods are used in the food supply chain (Gunders, 2012). While other use more impromptu and ad hoc techniques, some retail groups forecast and plan orders using a scientific approach. Due to the complexity and inherent inaccuracy of product demand forecasting, forecasting and orders are significant contributors to food waste (Falatouri et al., 2022)

**Promotions and price** - According to published research, supply and demand fluctuations in the food supply chain can be influenced by pricing and promotional activities and mechanisms, which can result in food waste (Gunders, 2012). Accurate metrics and procedures are necessary for managing promotions – maximally thirteen. Promotions encourage customers to buy unusually large quantities of products, which increases domestic food waste. When purchasing in advance, there may be waste, particularly when the product has a limited shelf life (Le Borgne et al., 2018).

### 2.6.3. Management practices of frozen food waste

**Performance measurement and management** - According to research, administrators' main priorities are availability, cost, and efficiency (Gunders, 2012; Mena et al., 2011). All these variables have an impact on food waste, but the indicator itself is typically not a key performance indicator and may suffer at the expense of other performance indicators (Mena et al., 2011). Loannou et al., (2022) argued that measurement systems and rewards for supply chain managers encourage actions that lead to more effective supply chains.

**Quality management** - Strict quality control procedures used by retail groups can result in product rejections at distributors and points of sale and even full product recalls. These failures have a direct negative impact on the supply chain. Fruits and vegetables are a category of fresh foods that come in a wide range of quality. Although it is crucial to keep an eye on product quality, businesses often place a higher priority on rigid quality control procedures and rules than the waste they generate (Mena et al., 2011). Gunders (2012) calls for a reassessment of qualitative and aesthetic specifications and various quality assurance measures to minimize waste in the supply chain.

**Waste management policies** - While some members of the supply chain have well-defined waste management procedures and objectives, many do not have specific roles within the supply chain that focus on food waste (Mena et al., 2011). Data gathered indicate that various individuals and organizations within the supply chain manage waste in very different ways. If it is not monitored and measured throughout the supply chain, food waste may increase. From an economic standpoint as well as a viewpoint of food safety and sustainability, managing food waste is becoming more and more crucial for businesses (Fattibene et al., 2020). There needs to be a radical action plan to better manage food waste because the amount of food waste lost in supply chains has a significant financial and commercial impact. Managers can quantify the economic impact on revenue and emphasize the significance of the food waste problem by measuring the amount of food that is wasted (Aktas & Oledinma, 2017, Toma et al., 2020).

## 2.7. Consumer perceptions on food waste in South Africa

With an estimated 53%, the consumer in higher-income countries is the largest contributor to food waste in the entire food chain (Stenmarck et al., 2016). When one considers that much of this waste could be avoided, an urgent need to change consumer behaviour is evident. The factors that cause consumers to waste food are however more complex and are influenced by other variables. Fruit and vegetables account for 44% of food waste in South Africa (WWF, 2017). Hermsdorf et al. (2017) argued that lowering product quality standards in the retail sector can reduce food waste in consistence with findings by Oelofse, et al, (2020). Lowering product quality standards in the retail sector to reduce food waste can have both positive and negative implications. Lowering aesthetic or cosmetic standards for produce can lead to more items being accepted for sale, even if they have minor imperfections but on a negative effect of lowering quality standards may affect consumer perceptions and preferences (Ahmed et al., 2021). These quality standards for products are primarily based on visual appearance and consumers expect near perfection at full price. However, these perceptions need to change in order to reduce food waste. Surplus buying is another source of household food waste, exacerbated by promotions that encourage consumers to buy more than necessary to benefit from a discount (Oelofse et al., 2018). To minimize consumer food waste and maintain a positive brand perception, brands need to understand how consumers interpret retail food waste practices such as expiry dates and sales promotions (Hall-Phillips & Shah, 2017). Consumers expect brands to act responsibly and demonstrate meaningful purpose beyond profit (Beverland, 2021). Often food waste is a result of conflicting goals, such as convenience, taste, and saving money. Consumer food waste behaviour is determined by consumers':

- Motivation (including attitudes, awareness, and social norms related to food waste);
- Opportunity (including time availability, access to technology, and quality and quantity of food); and
- Ability (skills and knowledge) to control or change behaviour related to food waste.

Socio-demographic aspects such as age, gender, income and household size also correlate with food waste since they influence motivation, ability and/or opportunities, but play no causal role (Stenmarck et al., 2016). A study in Kimberley, South Africa, found that 43% of participants were very concerned when throwing away food, 18% were moderately concerned, 27% were mildly concerned and only 12% were not concerned (Cronje et al., 2018). In addition, these authors argued that the majority (89%) do not plan meals and 61% throw away food when they have prepared too much, with a correlation between these two aspects of consumer behaviour is evident. The lack of meal planning can contribute to over preparation, leading to excess food that is then thrown away (Cronje et al., 2018; Sharma & Joshi, 2019). Another study found that French consumers' attitudes towards promotions were more positive with a lower perceived likelihood of waste (Le Borgne et al., 2018).

Higher-income consumers waste more food due to over-buying and over-preparation, which reflects a desire to have more than too little when supporting the family while low-income consumers mostly waste due to special offers or poor storage (Oelofse et al., 2018). People may also misunderstand portion sizes or there are too many discrepancies between Woolworth's concept of a single portion and the desired image of a single portion (Roodhuyzen et al., 2017). The existence of such discrepancies may lead to consumer confusion, frustration, or a perception that the product packaging or information provided by Woolworths does not accurately represent what consumers consider an appropriate single portion. Addressing these discrepancies may involve clearer communication, transparent labelling, and potentially aligning with recognized standards for portion sizes to meet consumer expectations. However, social norms have a clear influence, busy lifestyles and the prevalence of unforeseen events also have a strong impact on the level of food waste. People who encounter unforeseen changes in their schedule more often tend to waste more food. It also shows that households with less food waste tend to have five household food management practices: planning food purchases and consumption, reducing impulse buying, keeping track of food supplies, accurately measuring food amounts when cooking, and using leftovers (Stenmarck et al., 2016).

### 2.8. Cold chain system for frozen foods

Due to this study being based on frozen and chilled products, the cold chain system requires understanding. A food cold chain is the integrated set of activities undertaken to ensure that perishable food products are kept at the optimal temperature throughout the supply chain, which stretches from freshly harvested produce to the final consumer. This requires a resilient network of temperature-controlled preconditioning, pack houses, processing plants, vehicles or containers, cold storage and wholesale/retail facilities. It also requires temperature control by end users. The cold chain can be categorised into 6 stages:

Harvesting – Deterioration of product integrity occurs from the moment of harvest. A positive step can be to harvest at the coolest time of day and use shade after harvest. Fish should be stored in ice. Milk must be cooled immediately after milking (GCCA, 2022).

Preconditioning - Products must be cooled to the optimum temperature, sorted and packaged. Products must be kept refrigerated while waiting for onward transport. Many products are cooked and processed, then chilled or frozen before further shipment (Ramanathan et al., 2014)

Transport - Various means of transport form the critical process that connects all stages of a cold chain (Moraes et al., 2021).

Bulk storage - Because products arrive in bulk (sometimes in multiple stages) at the warehouse, refrigeration is also required. These tiers also buffer inventory against demand and provide platforms for deconsolidation and last-mile delivery. Depending on the type of food product, storage at different temperature levels is required (Cole-Hamilton, 2023)

Retail - Refrigeration in point-of-sale equipment is required to keep products in a low-temperature environment before consumer purchase, both during temporary storage and during display (Burek & Nutter, 2020)

Domestic and food service - Products that require refrigeration should generally be stored in a refrigerator or freezer until consumed at home or, for catering establishments, cooked and served to customers. This also depends on consumer buying cycles and the local supply chain (Huang et al., 2021). The FMC in this study is made up of different types of cold functions with 19 cold storage and distribution facilities across SA, with 4 of these facilities in KZN. A breakdown of its functions is indicated in Figure 2.5.

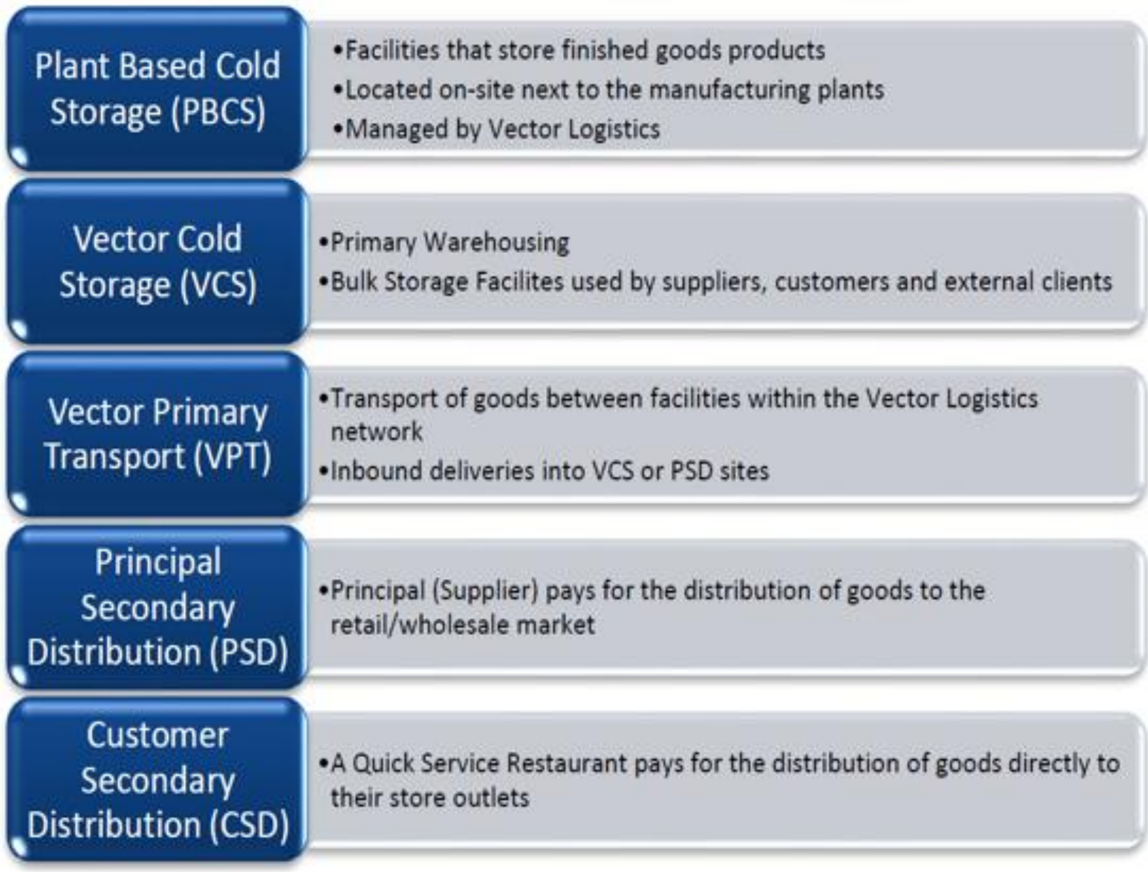



**Figure 2.5:** FMC Logistics Business Types. Source: Researcher (2023)

### 2.9. Zero waste grocery retail (ZWGR) within the frozen foods sector

Although a review of literature on the use of continuing education (CE) in the food retail industry revealed few academic publications, non-academic literature sources on Zero Waste Grocery Retailing (ZWGR) could be found (Ho & Chu, 2019). The ZWGR theory within the context of CE is not established, but the idea itself can be recognized as a subsystem within CE. The ZWGR idea is still in its infancy but is gradually gaining traction in developed economies. Table 2.6 is a comparison of ZWGR and traditional retail, built on the 4Ps.

**Table 2.5:** The 4Ps framework within ZWGR. Source: Ho & Chu, (2019)

| | |
|---|---|
| Product | Groceries are viewed as a temporary collection of energy because they require energy for production, transportation, release energy during consumption, and release energy during disposal (Tree Hugger, 2015). As a result, the focus is on reducing waste.<br>Quality: Since there are fewer brands, SKUs, and packaging options, quality is crucial for attracting new customers.<br>Bulk foods are offered for sale to customers who either bring their own food containers or rent them from the shop (Borromeo, 2014). |
| Price | List Price: Based on input (i.e. the energy required for production), life cycle (i.e. perishability and disposal) and weight or quantity (Ho, 2019)<br>Discounts: Aim to be cheaper than supermarkets due to the elimination of traditional packaging (biodegradable packaging, customers bring their food containers or rent them from the store and reuse them) and because efficient management of material flows (inventory and forecasting systems) is more important than maximizing sales. |
| Place | Online channel: Food delivery without packaging or using reusable packaging (e.g. wooden boxes, egg cartons, glass bottles)<br>Physical channel: In-store items are presented in bulk and are available packaging-free through the following methods: Bulk Grocery (refers to the purchase and sale of food and other household items in large quantities)<br>Shop visual: Due to the packaging-free nature of the goods, the shop is colourful and visually appealing.<br>Location: Most of the above examples are within walking distance of city centres and in areas with a segment of green consumers with higher disposable incomes (Borromeo, 2014). |
| Promotion | Adverts: Promoting the reuse of food containers, locally/sustainably produced items, community wellbeing and emphasizing the importance of food waste in becoming a resource again<br>Sales Promotion: Promotion of seasonal items with minimal environmental impact and various reuse reward schemes such as eco-points |

The latter system and its subsystems take on a fractal shape (Ho & Chu, 2019) and can be identified as a fractal process that replicates over time and space within the realm of the main fundamental principles that guide and limit its development. By adopting a fractal shape in the context of CE and business planning, a company aims to create a cohesive, sustainable, and self-replicating system that aligns with the principles of a circular economy. This approach contributes to long-term resilience, resource efficiency, and positive environmental impact. A ZWGR framework can be derived from the CE principles of waste avoidance, material cycles and recycling (Andrej Fidersek, 2015).

### 2.10. Waste Management in South Africa

It is often said that South Africa is 20–30 years behind other developed countries in the management of waste and the shift away from landfilling towards prevention, reuse, recycling, and recovery (Godfrey & Oelofse, 2017). Municipal solid waste (MSW) is classified into five broad categories (Table 2.6). A study by Godfrey et al. (2020) found that Europe has had a strong influence on the policy and legislation that has emerged in South Africa since the late 1990s (Godfrey & Oelofse, 2017). In South Africa, waste generated (90%) continues to be sent to landfills for disposal, the reliance on landfilling can be a historical practice that dates back several decades. If landfilling has been the primary method of waste disposal in the past, existing infrastructure and practices may be geared towards this approach.

In many countries around the world, sustainability and improvement of waste management services remain a significant challenge. The rising cost, limited revenue, and seeking alternative "fit for purpose" solutions continue to challenge municipalities in rendering an effective waste service (Kubanza & Simatele, 2019). Unless the challenges raised in this research for determining the correct waste disposal solutions can be addressed (Mannie & Bowers, 2014). There have been initiatives with larger businesses concerning recycling bins which are put in place in the store and can be used by the consumer to separate municipal solid waste (Abdel-Shafy & Mansour, 2018).

A study by Greenpeace International showed that at least 50% of unused packaging for goods was not recycled. The lack of recycling knowledge also results in large financial losses in the Fast-moving consumer goods (FMCG) sector within South Africa (Glushkov et al., 2021). South Africa’s implementation of waste management services is affected by the lack of planning and insufficient waste services (Godfrey & Oelofse, 2017).

**Table 2.6:** Five broad categories of Municipality Solid Waste. Source: SAWIS (2014)

| | |
|---|---|
| **Biodegradable Waste** | Food and kitchen waste, green waste and paper etc. |
| **Recyclable Materials** | Paper, glass, bottles, cans, metals, plastic etc. |
| **Inert Waste** | Construction and demolition waste, dirt, rock, debris etc. |
| **Composite Waste** | Waste clothing, polystyrene, waste plastic including toys etc. |
| **Domestic hazardous waste and toxic waste** | Medication, paints, chemicals, light bulbs, fluorescent tubes, spray cans, fertilizer and pesticides containers, batteries, shoes polish etc. |

Products are packed to be sold in retail and wholesale sectors. The transportation packaging is handled as industrial waste for food production which ends up at a store and disposed of from the store whilst the sales packaging of the food products ends up in households whereby it is collected and disposed of as household waste. Correct disposal of both sets of materials should be effected (Ferronato & Torretta, 2019). Products and materials produced must be manufactured in a manner whereby it minimizes waste or uses natural materials. This will reduce the toxicity of waste produced during and after production. Materials that can be reused must be utilized instead of disposed of incorrectly (Rinkesh, 2023). These materials can be reused for different purposes without making much change to the form or properties of the material. This increases the life span of the material that is produced. Companies are now placing sustainability as the key focus area of their publicly published CSR reports making them accountable for their actions (CSIR, 2021).

The National Waste Management Strategy (NWMS) had put forward goals to ensure that at least 25% of recyclable waste is reused instead of ending up at landfill sites (StatsSA, 2012). Where recycling occurs in South Africa, it is largely driven by the informal waste sector that is thought to collect 80% of glass, 90% of PET plastic, and most of the recovered paper into the recycling economy (Karadağ & Kundakcı, 2015). Recycling is a very important industry that sustained close to 55 000 jobs in 2015 (Karadağ & Kundakcı, 2015). Such an informal waste sector is critical as South Africa is seen to use between 30 to 50 kilograms of plastic per person per year, while most people do not even know that such waste is harming our oceans. Marine scientist

Caroline Reid provided insights into what plastic packaging waste is doing to our environment due to the lack of recycling within South Africa (Sgqolana, 2022). On the coastline of KwaZulu-Natal, an average of a million sea birds dies due to plastic waste, and the same fate is seen with other marine life. Waste such as plastic waste and food waste is stemmed from the manufacturing industry (Babayemi et al., 2019, Kasza et al., 2022).

The materials used for the packaging of consumer goods should be directed towards more recyclable or reusable materials. The biggest “trend” seen amongst fast-moving consumer goods (FMCG) companies is sustainability (CSR, 2007). South Africa has always worked towards improving, reasonable and sustainable waste management. Clarity and functional roles and responsibilities including international learning can point South Africa in the right direction to have a world-class waste management system that will reduce environmental impacts (Godfrey et al., 2020). In South Africa, the approach to waste management is of the highest priority, with practices designed to reduce waste before it enters the waste stream and to recover generated waste for recycling or composting.

Waste in South Africa is still being sent to landfill sites. The waste management hierarchy Given the reliance on landfilling, the remaining capacity (airspace) of existing landfills is an important consideration. The remaining landfill airspace (Figure 2.5) is located far away from densely populated urban areas, and the increase in the distance from the pickup point of the waste to the landfill results in the increased cost of rendering the waste collection service. (Municipality, 2016). According to the national list of license waste management activities (SAWIC, 2018), there are 111 licensed waste treatment facilities in South Africa, with 150 facilities registered on the SAWIS, and 62 report their activities. Most of the facilities are licensed for the treatment of waste, sewage, and wastewater (Chatterjee et al., 2015).

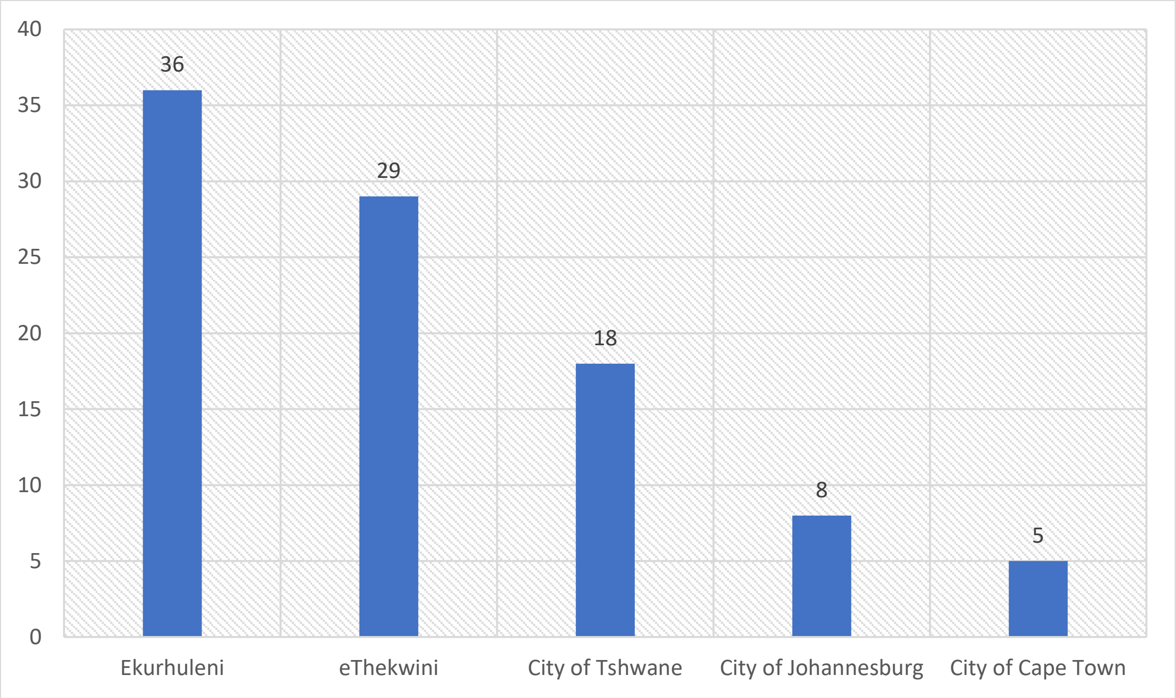



**Figure 2.6:** Estimated remaining landfill airspace in South Africa. Source: DEA (2018)

There are only four licensed composting facilities and a single licensed biogas installation Company in KwaZulu-Natal. In KwaZulu-Natal, eThekwini has access to 3 landfill sites which are La Mercy, located 35 km north of Durban, Bisasar Road, 7 km from the Durban CBD (Central Business District) and Mariannhill, located 20 km to the west of the CBD. Since 1997, the Mariannhill landfill, which has a 4.4 million $m^3$ capacity, is a full treatment plant for leachate and receives about 850 tons of solid waste a day (KZN Department of Transport, 2002). The life span for this landfill is estimated until 2024. Waste management in South Africa faces numerous challenges. The lack or absence of a recycling infrastructure that will enable the separation of waste at source and diversion of waste streams to material recovery within FMCG companies leads to mixed waste ending up at landfill disposal. For the South African waste sector, resource efficiency, waste prevention, and reduction of waste is ranked at the highest level (Moodley et al., 2019).

Corporate social responsibility (CSR) activities (Figure 2.6) are seen to mitigate risks, enhance reputation, and contribute positively to business results. The CSR strategy is to make a positive difference in business and the community and in FMCG companies. This can influence waste from the supply chain through to energy efficiency of distribution, to take this sector many steps forward in reducing future harm to the environment (Vaverková et al., 2018).


**Figure 2.7:** Corporate social responsibility (CSR) framework. Source: Ferronato et al. (2018)

Correct waste handling approaches are key to determining the quantities of waste that can be reused or recycled before disposal in the landfill. It is essential, then, to streamline the waste handling process to aid the recycling of waste within the FMCG Company (Tamvada, 2019). As highlighted in the Food Recovery Hierarchy (Figure 2.8), the best solution to deal with food waste is the prevention or reduction of surplus food generated by the source (USEPA, 2020). Source reduction has positive impacts on resource utilisation, including improved water and land use. Unfortunately, according to Woolley et al. (2016), the industry and retailers are not incentivized to manage the amounts they purchase since the purchase of more products equates to more profits for them. For instance, some of the suppliers pay back the retailers on the food that is returned to the supplier due to either expiry of the products, store damage and so forth, a practice that does not necessarily force the retailers to stop overstocking.

Preventing food waste in the distribution phase of the FSC can be achieved through proper inventory management, the use of proper food packaging, incentives, and other approaches (Soma, 2022). Inventory management is important as it provides a way of tracking food data for the food items that come in the retail store or restaurant from the suppliers, and also the food that goes out as sales or returned as food waste (Woolley et al., 2022). Good inventory management allows retailers to implement dynamic price changes according to stocks and sales forecasts, therefore reducing food waste. Amongst the most important factors affecting the sale of food, and therefore generation of food waste in the distribution phase include seasonal changes, events, and changes in market trends. When implemented properly, inventory management can help retailers and suppliers perform good sales forecasting using historical sales data analysis which can go a long way to address food waste source identification, which is important in the development of waste management interventions (Lukić, 2016).

### 2.11. Opportunities and challenges of the distribution phase

Food waste recycling can positively impact some sectors of the economy and create jobs while negatively impacting other sectors and activities (Harvey et al., 2020). The intersection of food loss and food waste is where the FSC distribution phase is located. Under this arrangement, food loss can be gathered for anaerobic digestion instead of being dumped in a landfill, and food waste can be brought back by the distribution vehicles for use as feedstock for AD or as a means of redistributing food to the underprivileged. While no one can guarantee benefits that are 100% attainable, it can design environmentally responsible and technologically feasible alternatives into increasingly complex scenarios to meet the various demands of planning for the future and daily living today. Examining a variety of factors to determine benefits and drawbacks greatly aids in the general understanding of the issues, which are related to food waste and the economy. The opportunities and difficulties addressed by the twelve “Review" articles are compiled in Table 2.7 as a starting point (UNEP & FAO, 2023).

**Table 2.7:** Opportunities and challenges addressed by review items. Source: Researcher (2023)

| # | Opportunities | Challenges |
|---|---|---|
| A | Anaerobic digestion (AD) converts waste into energy and simultaneously produces a digestate used as a bio-fertiliser. AD is an effective kind of treatment to avoid harmful impacts on human health and the environment (Avicenna et al., 2015) | Technical-operational, economic, and regulatory challenges have to be mutually addressed by decision-makers, researchers and end-users. Resources availability, financial issues and institutional competencies are crucial aspects for long-term feasibility (Avicenna et al., 2015) |
| B | Food recovery actions can be addressed as strategies for the restoration of a potentially lost value, addressing environmental, economic and social aspects(Baglioni et al., 2016) | The exact fraction of food that could be redistributed is hard to estimate (Franco & Cicatiello, 2021) |
| C | Carbon-rich waste conversion to polyhydroxyalkanoate (PHA) products offers new opportunities to reduce issues related to waste disposal, avoiding industry-generated environmental impacts and preserving food resources (Al-Rumaihi et al., 2020) | Different branches of scientific and academic areas should cooperate with industry to implement industrial-level techniques still at the laboratory level (Kotiranta et al., 2020). |
| D | Efficiency within the food supply chain can gain benefits from microbial protein and organic fertilisers (Ahi & Searcy, 2015). | Technological applications for the recovery of added value components from waste streams need to be broadly implemented (Joshi & Visvanathan, 2019). |
| E | The initial highly expensive investments for the implementation of bio refineries could be balanced by the minimal price of food waste, avoiding burdens and disposal costs (Jenkin, 2018). | Most of the presented techniques are only at the lab scale and only a few have been carried out at the pilot scale (Du Plessis, 2020). |
| F | Economic benefits could be achieved by using FW as biomass (Du Plessis, 2020) | Economic analyses (including the challenges and costs associated with collection and transportation operations) are impossible because FW bio refineries have not yet been implemented on an industrial scale (Kıran et al., 2015). |
| G | Bioconversion of FW to energy is economically viable. Additional improvements can result from further research (Kiran et al., 2014). | Preliminary feasibility studies must include collection and transportation costs (Gillespie et al., 2023). |

To define policies and strategies to address food waste issues in a way that also addresses environmental and financial constraints, there urgently needs to be a strong link between academia and policy. The majority of the processes under study still operate at the laboratory scale and scaling them up to an industrial scale will take considerable work (Aldaco et al., 2020). To determine where bio-economic advantages can be utilized in FW management and where additional work is required to address potential issues, an extensive analysis of opportunities and challenges was carried out. Technical, economic, and cultural factors discovered through the evaluated scientific work are taken into account in this work. Technical, among other things, refers to benefits and obstacles resulting from the technology, design, and technical capabilities involved. Economic, including cost-effectiveness, viability, and pricing issues. Stakeholder acceptance or rejection, regulations, and behaviour are primarily cultural (Blanc & Ottimofiore, 2021).

### 2.11.1. Opportunities

#### 2.11.1.1. Technological opportunities

Food waste is acknowledged as a focal point for addressing the world's waste issue. Food waste has historically been linked to sustainable food management (Girotto et al., 2015) and food redistribution (Kirby et al., 2017), as well as better management of the entire supply chain (Facchini et al., 2018), can be achieved by considering viable method for food waste reduction. For underdeveloped countries like sub-Saharan Africa and some of the newly industrializing countries (NICs) like South Africa, FW is an important source of clean energy (Ohnishi et al., 2018), displacing common and more hazardous energies such as coal, firewood, crop residues, etc. (Slorach et al., 2019), and the disposal of waste in an eco-friendlier manner at the same time. These include the generation of power through renewable energies such as biomass for cooking gas and electricity for lighting. Practices such as AD recovery (Breitenmoser et al., 2019) have significantly reduced $CO_2$ emissions and are also considering fuel substitution within the power grid (Slorach et al., 2019).

Food waste is also used for the production of macromolecules (Uçkun Kıran et al., 2015), the processing of carbon-rich materials by bacteria and the production and upgrading of value-added chemicals. It is also beneficial as a potential raw material.

Thus, FW may be important from a phosphorus recovery perspective to avoid rock mining for phosphorus used in agricultural, medical, construction, and industrial systems (Breitenmoser et al., 2019; Ohnishi et al., 2018; Sgarbossa & Russo, 2017; Uçkun Kıran et al., 2015). One technological opportunity example to tackle food waste is the development of smart refrigeration systems. These systems use sensors and data analytics to monitor and optimize temperature and humidity levels in refrigerators and food storage facilities. By maintaining optimal storage conditions, such systems can extend the shelf life of perishable foods and reduce spoilage, ultimately reducing food waste (Kirby et al., 2017). Advanced data analytics can be used to optimize supply chains and reduce food waste. By analysing data on demand patterns, shelf life, transportation routes, and storage conditions, companies can identify inefficiencies and make informed decisions to minimize waste. Predictive analytics can also help anticipate and prevent potential bottlenecks or spoilage risks, enabling proactive measures to be taken (Breitenmoser et al., 2019).

#### 2.11.1.2. Economic opportunities

In South Africa, annually, 10% of FW production is still surplus food suitable for consumption (Facchini et al., 2018). Initiatives for the redistribution and reuse of food can be seen as value recovery techniques (Ohnishi et al., 2018), and the by-products of FW processing can be returned to the economy and provide additional economic benefits such as digestate, a by-product of biogas production from anaerobic digestion - a system used as a fertilizer and soil conditioner (Verstraete et al., 2016). Various processes that require high-carbon materials as raw materials can reduce costs using FW. Energy production from fuel hydrogen follows this perspective and also avoids disposal costs (Sgarbossa & Russo, 2017).

As the issue of food waste gains more attention, there is an opportunity to provide consultancy services to businesses in various sectors, including restaurants, hotels, grocery stores, and food manufacturers. These consultancies can offer expertise in waste auditing, process optimization, supply chain management, and implementing strategies to reduce food waste (Ahi & Searcy, 2015). By helping businesses reduce waste and improve operational efficiency, these consultancies can create economic value while addressing the food waste problem. Companies can establish online platforms or apps that connect food businesses with surplus food to charities, food banks, or individuals in need. These platforms can provide economic opportunities by charging a commission or subscription fee to businesses for using their services. Additionally, they can generate revenue through partnerships, sponsorships, or targeted advertising. By facilitating the redistribution of surplus food, these platforms can create economic value while addressing food waste and food insecurity (Facchini et al., 2018).

### 2.11.2. Challenges

#### 2.11.2.1. Technological challenges

Food waste happens throughout the entire food supply chain, primarily for technical and infrastructure-related reasons (Facchini et al., 2018). Losses and FW are also impacted by technical constraints, spills, and contamination that can happen at process levels (Sgarbossa & Russo, 2017). Almost all of the reviewed literature concur that additional research and wide-scale application of solutions are required to significantly increase resource efficiency and decrease waste (Piccolella et al., 2019). Various food supply chain configurations can be implemented to reduce FW output flows and introduce new relationships between nodes currently in the supply chain in order to reclaim viable resources from the FW (Ohnishi et al., 2018). The impact of food production and processing may also be lessened if the food supply chain has self-sufficient energy sources (Sgarbossa & Russo, 2017). Better data are needed to assess potentially redistributable foods (Facchini et al., 2018). As the issue of food waste gains more attention, there is an opportunity to provide consultancy services to businesses in various sectors, including restaurants, hotels, grocery stores, and food manufacturers (Ayeleru et al., 2023).

These consultancies can offer expertise in waste auditing, process optimization, supply chain management, and implementing strategies to reduce food waste. By helping businesses reduce waste and improve operational efficiency, these consultancies can create economic value while addressing the food waste problem (Sgarbossa & Russo, 2017). Companies that specialize in data analytics can offer services to track and analyse food waste throughout the supply chain. By providing insights into patterns, trends, and areas of waste generation, these companies can help businesses optimize their operations, reduce waste, and cut costs. They can also develop predictive models that help identify potential waste hotspots, enabling proactive interventions. By harnessing the power of data, these analytics companies can provide economic benefits to businesses while addressing food waste challenges.

#### 2.11.2.2. Economic challenges

The low cost of fossil fuels, which increases production from raw materials, is a factor affecting the economic viability of the FW recovery sector. Products must be able to contend on a market to be used in the practical implementation of FW recovery (Verstraete et al., 2016). Furthermore, a broad economic analysis of bio-refineries has not yet been conducted, as actual bio-refineries have not been implemented (Kıran et al., 2015). Cost is also very important when generating electrical energy to assess overall benefits, and when considering collection and transportation of FW materials (Ohnishi et al., 2018). When it comes to farm-level food loss, economics is also crucial, particularly when it happens as a result of financial limitations in developing nations (Facchini et al., 2018). Implementing food waste reduction initiatives often requires upfront investments in technology, infrastructure, and training. For example, businesses may need to purchase new equipment or retrofit existing facilities to optimize food storage and handling. These initial costs can pose a significant economic challenge, particularly for small and medium-sized enterprises (SMEs) with limited financial resources (Kıran et al., 2015).

## 2.12. Governance and policy on food waste

According to Parfitt et al. (2021), when the FAO was created in 1945, reducing food loss was part of its mandate. However, strong emphasis on addressing this mandate was further bolstered in 2015 through the launch of Agenda 2030, for which most of the countries are signatories. Agenda 2030 includes the establishment of seventeen sustainable development goals (SDGs) to achieve economic growth, social integration, and environmental protection. Of these SDGs, 10 are closely linked to food sustainability and the 12th advocates for sustainable consumption and production patterns. SDG 12.3 specifically focuses on the reduction of food waste by 50% and therefore aiding in attaining climate change goals of decreasing GHG emissions by reducing food sourced GHGs (Lombardi & Costantino, 2021). Further, to the development of the SDG with a specific focus on food waste and food loss, the UN has developed and published a methodology for countries to monitor food waste in the supply chain and to track and report on the country's progress to the agreed SDGs (Chua, 2019). The European Union (EU) has also alluded to waste management in its mandate: the Waste Framework Directive 2008/98/EC in 2008 as a sustainable way for waste management by ranking waste prevention and management options in order of priority (Eriksson, 2015). It provided a pyramid of priorities for managing waste which acted as a blueprint for other member states in the EU to develop their country-specific programs.

However, this framework was not specific to food waste. This directive was updated in 2018 by incorporating food waste-specific directives, including food waste reduction targets (30% by 2025 and 50% by 2030) (Eriksson, 2015). The European Union Commission (the executive of EU that operates as a cabinet government) built on this regulation by including additional proposals and targets for each stage of the FSC in the "Farm to Fork Strategy" that is embedded in the European Green Deal. The United States Environmental Protection Agency (USEPA) developed the Food Recovery Hierarchy shown in Figure 2.8 below (USEPA, 2019), which agrees with the measures that were set by the EU in the Waste Framework Directive 2008/98/EC. However, the Food Recovery Hierarchy included one crucial difference from the Waste Framework Directive 2008/98/EC since it is more focused on food waste, and therefore goes further to separate the prevention stage into what can be viewed as two sublevels (Figure 2.8 below).

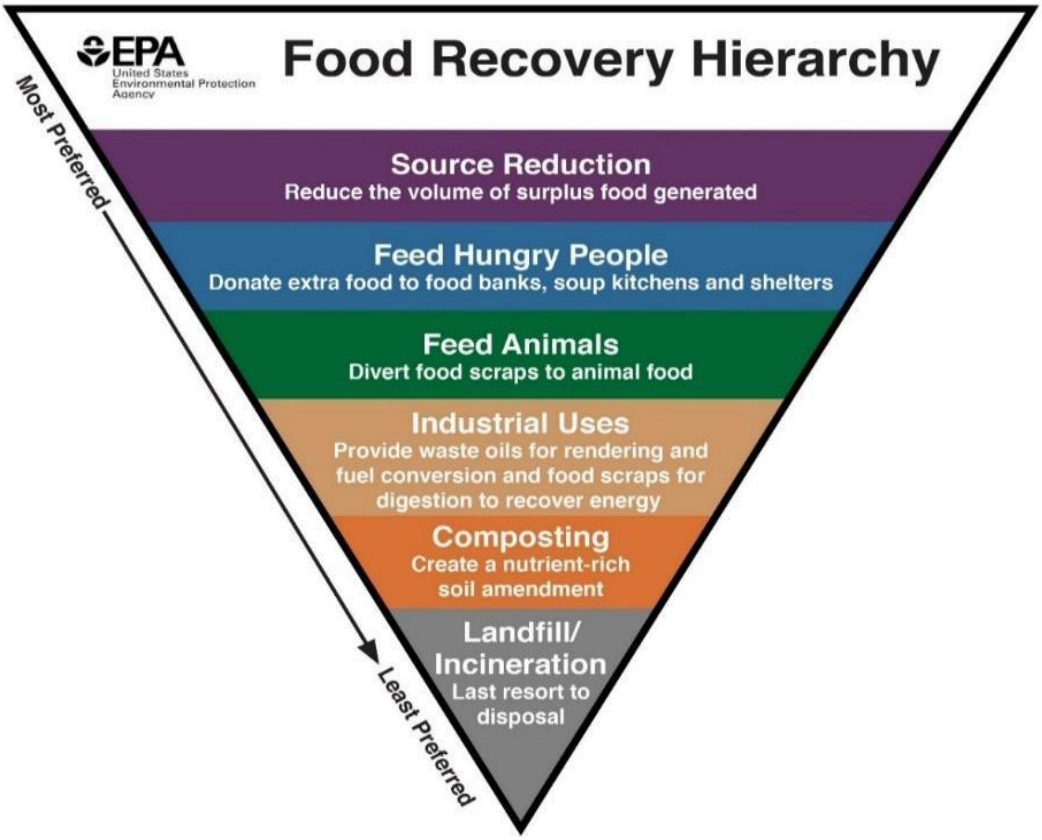



**Figure 2.8:** The EPA food recovery hierarchy. Source: US EPA (2015)

These separations set waste source reduction as the more preferred option and feeding hungry people as the less preferred sublevel. The United Kingdom (UK) developed their waste hierarchy as an EU member which came into effect in 2011, deriving from the Waste Framework Directive 2008/98/EC. The UK Waste Hierarchy guidelines went further to propose a waste management hierarchy specific to different waste types. The proposed guidance specific to food waste consisted of prevention at the top, followed by anaerobic digestion, compositing, and lastly disposal, which consists of landfilling or incineration (USEPA, 2019). The guidance was updated in 2021 into what is currently referred to as the “Statutory guidance: Food and drink waste hierarchy”. The updates are similar to the USEPA Food Recovery Hierarchy shown in Figure 2.8. There are notable differences in composting, which was broken into two sublevels, composting and land spreading, as well as the last levels which were broken into incineration for energy generation, incineration without generating energy, and lastly landfilling. Interest in food waste and its quantitation has not received sufficient attention from politicians, academics, and civil society activists in many societies around the world (Pandey, 2021).

However, this position has since changed in the last 10 years when interest began to grow as the true scale of problems associated with food waste became clearer. According to an FAO report (FAO, 2015), the annual estimates of global food loss and food waste show that fruits and vegetables are the most worrying with 40–50% of the food wasted and lost, while fish (35%), cereals (30%), oilseeds, and meat and dairy products (20%) also show considerable amounts of wastage. This distribution of food loss and waste statistics and the associated sources was also corroborated in South African studies by Oelofse et al. (2019), who showed similar trends in food waste distribution. Bessa et al. (2021) also highlighted the problem of fruits, vegetables, and cereals which reportedly accounts for as much as 70% of the total food wasted and lost, primarily throughout the FSC. What is more worrying, however, is that a significant amount of food waste produced, especially at the consumer level in households, retail and food service sectors, is avoidable and therefore can be reduced (Tonini et al., 2018).

However, while food waste may not be eliminated, the waste management challenges in developing and poor countries imply that much of the generated waste ends up in landfills which is problematic because of its impact on the environment (Dlomo, 2021). Studies have shown that food waste is detrimental to the environment as discussed in the previous section. It can be postulated that as a result of these challenges, implementing a food waste regulation would have positive impacts on food security, the environment and industries and could be one of the most rational paths to a sustainable future. However, mitigating food waste is a very complex issue, requiring diverse and well-tailored governance measures. The need to develop strategies to mitigate food loss and food waste in the manufacturing and processing, as well as the wholesale and retail sectors and the associated waste management challenges is widely acknowledged around the globe. In the last decade, several international, national and local initiatives were developed and implemented to address the food waste problem (Al-Obadi et al., 2022).

Retailers face a particular problem as their customer's value a variety of products including food items, thus encouraging more sales of these products which may end up as waste. If retailers fail to offer a wide selection of products, they may lose competitive advantage. But with growing public concern about the climate crisis, consumers are realizing how food waste and their shopping habits exacerbate the problem. Retailers can - and should - make meaningful changes to help limit food waste. Some initiatives used to implement expiration date tracking technology include training store employees on food waste issues, improving transparency and agility within the supply chain, and giving back to the community (Yoobic, 2021).

### 2.12.1. South African waste legislation

In South Africa, a main challenge is waste management, with robust service delivery and ensuring a clean and safe environment. Section 24 of the Bill of Rights gives all citizens the right to a clean environment (Constitution of South Africa 1996). South African waste management is governed by the principles of the White Paper on Integrated Pollution and Waste Management, the National Waste Management Strategy (NWMS), and the National Environmental Management: Waste Act 2008 Such legislation is indicated in Figure 2.9 (Muzenda, 2012).

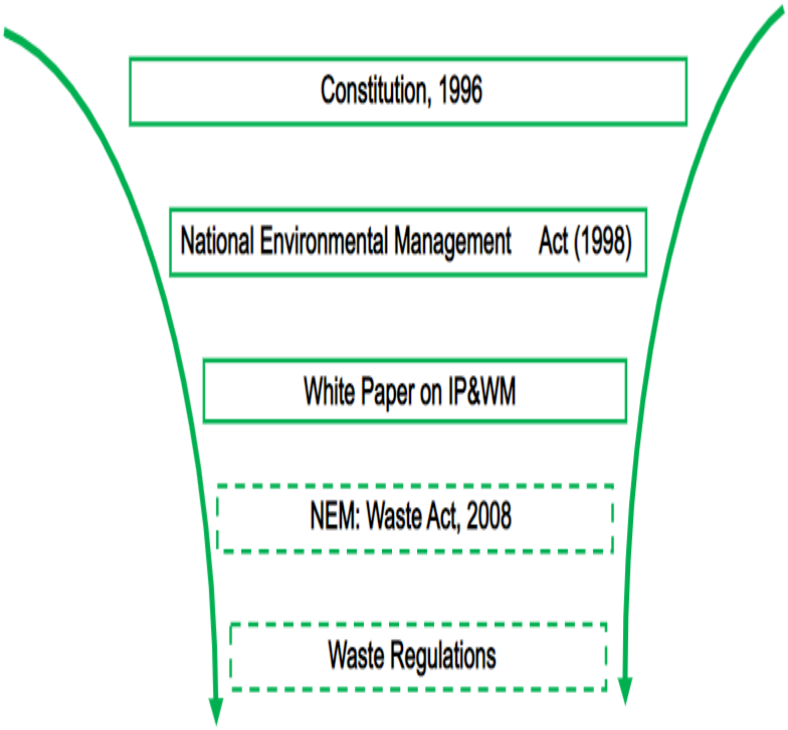



**Figure 2.9:** Legislative background. Source: Department of Environmental Affairs, (2017)

Thus, in South Africa, waste management is governed by legislation which includes but is not limited to:

2.13.1.1. National Environmental Management Act: Waste Act (Act 59 of 2008)
An Act to achieve the protection of human health and the environment and the prevention of pollution. The act also ensures that citizens receive waste services at affordable rates. The act also highlights the importance of the reuse of waste.

2.13.1.2. National Environmental Management Act 107 of 1998
This Act provided hazardous waste guidelines, and protection of the environment when hazardous waste is disposed of. The duties of the waste generators are outlined in section 16 of the NEMA.

2.13.1.3. National Waste Management Strategy (NWMS)
A worldwide provision of waste services according to the standards set out in the Waste Act. The initial goal of the NWMS is to ensure waste minimization, reuse, recycling, and recovery of waste (Waste Management Hierarchy – Figure 2.7).

The waste hierarchy is now collectively accepted as the model of waste minimization. As per National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008) described, “Waste Act”, any substance, material or object, that is unwanted, rejected, abandoned, discarded or disposed of, or that is intended or required to be discarded or disposed of, by the holder of that substance, material or object, whether or not such substance, material or object can be reused, recycled or recovered and includes all wastes as defined in Schedule 3 to this Act; or (b) any other substance, material or object that is not included in Schedule 3 that may be defined as a waste by the Minister by notice in the Gazette, but any waste or portion of waste, referred to in paragraphs (a) and (b), ceases to be a waste (NEMWA, 2014). The waste management hierarchy in South Africa, outlined by the National Waste Management Strategy, allows for waste prevention and minimization should be the first option before reuse, recycling, recovery, and disposal to be the treatment (DEA, 2019). The primary principles of the hierarchy are minimizing resource consumption and preventing environmental pollution - the two pillars of sustainability in the food manufacturing company. Processing, treatment, and disposal of waste takes place following the principles of environmental justice and unbiased access to environmental services as expressed in the NEMA.

In the hierarchy of waste management methods, the three R's (reduce, reuse, and recycle) are used as the guiding principles (Al-Obadi et al., 2022). A zero-waste economy is the goal of the hierarchy of waste management. Internationally, the waste management hierarchy has been used in addressing waste management issues and has been combined with waste management strategies, policies and legislation such as the South African National Environmental Management Act (No.107 of 1998); South African Waste Strategy (2012); United Kingdom Waste Regulations (2011); South Australia Zero Waste Strategy (2010); and the EU Waste Policy (1999). Through waste prevention and recycling, this hierarchy's primary goal is to ensure sustainable waste management. Utilizing waste as a resource and keeping it out of landfills is the goal of implementing the waste management hierarchy. The intention is to promote sustainability in waste management by moving away from filling waste with resources and toward using waste as a resource (DEA, 2019).

Important pieces of legislation that govern waste management and the environment in South Africa includes:

- National Water Act 36 of 1998
- Environmental Conservation Act 73 of 1989
- NEMA Waste Bill, which came into effect on 01 July 2009.
- National Health Act 61 of 2003

An understanding of the existing legislative areas that govern food waste and other related aspects can help in better identification of the crucial areas that must be adequately developed (Trubetskaya et al., 2022). All the acts and bills that have been outlined above have clearly indicated the fact that South Africa should develop appropriate legislation and laws that can help in improving and promoting better outcomes for the reduction in food waste within the country (South African Government, 2019).

All these laws and legislations can be seen to impact minimisation of wastage and can be beneficial in conserving the environment and ensuring better levels of sustainability (Department of Environmental Affairs, 2017). The levels of sustainability that can be associated with the country at present is significantly lower than global standards and therefore, there is a need for the country itself to come up with adequate measures to enhance the same (United Nations, 2022). Food waste management is a major area that can help in engendering betterment in this direction and therefore, it can be said that the overall outcomes of the sustainability area in South Africa is dependent on stringent policies and laws that have been facilitated here as well (Aktas & Oledinma, 2017).

The National Water Act of 1998 is dedicated to the generation of appropriate results when it comes to appropriate water management and controlling water pollution. The Act is clearly related to the conservation of water resources in the country and has been designed to ensure that there is a complete stop to any form of water pollution. However, it is closely related to the area of waste management and food waste management. According to Wilkie et al. (2015), food waste is one of the primary causes of water pollution globally. Besides, water pollution is critical and can impact the health and wellbeing of all individuals in the region of KZN and in the country as a whole. This means that conserving water is essential and for this, minimisation of food waste is key. Therefore, this is a major Act that allows better and stringent measures that can help in limiting food waste generation.

The Environmental Conservation Act 73 of 1989 on the other hand is directly linked with the aspect of waste management in South Africa. This Act is aimed at ensuring greater protection of the environment and ensures enhancements in the overall domain of improvement of the environment. As mentioned earlier, the overall area of food waste generation is one of the most detrimental areas that can impact the overall environment. In this regard, the use of correct strategies that can help in managing food waste that has such adverse implications on the environment is one area that can be easily availed from the act whereby addresses various aspects related to environmental protection, pollution control, and sustainable development (Writer, 2022).

Therefore, appropriate policies and frameworks are available, which have a powerful impact on the overall domain of food waste management and can be considered to be extremely beneficial. The Act has provisions for food waste management and ensuring minimisation of same.

The NEMA Waste Bill is another crucial piece of legislation that is directly linked with improving waste management. Integrated waste management, as highlighted in the NEMA Waste Act, advocates for a comprehensive approach encompassing waste reduction, recovery, reuse, recycling, and responsible disposal. The primary goal is to mitigate the detrimental impact of waste on the environment while endorsing sustainable methodologies. Within the legislative framework, environmentally friendly waste management practices are accorded utmost precedence in the hierarchy of strategies. Typically, this hierarchy encompasses recovery, treatment, recycling, reuse, reduction, avoidance, and as a last resort, disposal. Moreover, the NEMA Waste Act introduces the concept of Extended Producer Responsibility (EPR), which places the onus on manufacturers to effectively manage post-consumer waste throughout the entire lifecycle of their products. This incentivizes manufacturers to adopt environmentally conscious and sustainable product designs and packaging. To facilitate appropriate waste handling and disposal, the Act includes provisions for waste classification. Additionally, in order to ensure ethical waste management practices, the Act mandates the development and implementation of waste management plans by various stakeholders, including businesses and local governments (Wentzel, 2022).

The various processes and frameworks that can be employed in the case of waste management and especially food waste management have been effectively pointed out. It can be stated that the use of this Bill can be helpful in ensuring better policies that are dedicated to waste minimisation and management (Xue et al. 2017). In addition, this can help in facilitating net zero waste emission, which is a key requirement here. However, it is a hypothetical scenario and cannot be directly attained at present.

The National Health Act of 2003 is another landmark in the South African legal system which has indirect links with aspect of food waste and the need to appropriately manage same. The use of appropriate food waste management is strongly considered in the Act and the legal provisions are designed in a manner to minimise food wastage. Food wastage has severe social consequences (Yoobic, 2021) as it can cause hunger and malnutrition and therefore, significant implications on the health and wellbeing of any individual. Therefore, this Act ensures a framework that allows the generation of a structured and uniform health system, which can be beneficial in the long run and can help in engendering betterment as well. Besides, with the appropriate use of food waste management, consistent health enhancement can be facilitated, which means that the overall Act is indirectly linked to food waste management (Bulelwa, 2023).

#### 2.13.1.4. Polokwane Declaration on Waste Management

A Polokwane conference took place in 2001 which resulted in the formation of the Polokwane Declaration. The resolution was to reduce food waste by 50% by the year 2012 and achieve zero waste by the year 2022 and was intended to be a milestone. A 16-point working strategy was put into place (DEAT, 2001). The declaration also stresses the importance of public participation in the development of waste management strategies (Nyika et al., 2019).

The major goals of the declaration are to reduce the amount of waste generated, and to promote the protection of the environment and the health of citizens. It calls for the implementation of waste management strategies that are based on the principles of reduction, reuse, recycling, recovery, and finally disposal. The declaration also encourages local governments to develop integrated waste management systems that promote sustainability and resource conservation (DEFF, 2021). Furthermore, it calls for the implementation of waste management policies that are in line with international conventions and national legislation. As the intended objective was to cut down waste by 50% by 2012, it seems this waste management policy remained only on paper and was not enforced as we still have gross irregularities in the management of waste in South Africa (Nyika et al., 2019). This requires a review on how best these national policies can be implemented. (Ghafari, 2022).

### 2.12.2. South African food loss and waste voluntary agreement

Contrary to the positive policy direction in developed countries, in developing countries including those in sub-Saharan Africa and Southeast Asia, food waste is unfortunately not given the serious attention it deserves with limited interventions currently implemented to address the challenge (Phasha et al., 2020). The same is observed in the South African waste policy where food waste has unfortunately been ignored apart from the statutory duty of care in the NEMWA No. 107 of 1998 (National Environmental Management: Waste Act, 2009). Food waste is mentioned only briefly and has limited infrastructure and systems for managing it sustainably and is therefore largely ignored. In the absence of an overarching piece of legislation to address food waste and food loss in South Africa, the Consumer Goods Council of South Africa (CGCSA), in collaboration with the Department of Trade, Industry and Competition (DTIC) and the Department of Environmental Affairs (DEA) introduced the South African Food Loss and Waste Voluntary Agreement in 2020 (CGCSA, 2020). The voluntary agreement, which was co-funded by the European Union through the SA-EU Dialogue Facility was introduced as a measure in an effort to adhere to the UN's SDG to cut food waste by 50% by 2030, as highlighted in Figure 2.9 below. The voluntary agreement is a Launchpad for the development of food waste policy in South Africa (Creecy, 2023).

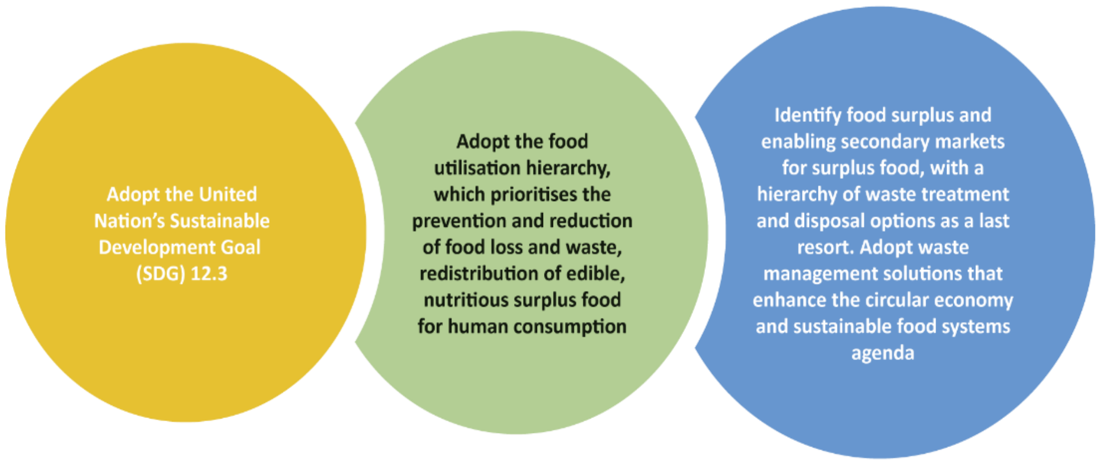



**Figure 2.10:** Vision for South African food loss and waste agreement. Source: CGCSA (2020)

The agreement requires food producers and retailers to measure and report food waste to establish and set baselines that will be used to track progress towards the collective vision aimed at reducing food waste by 50% by 2030 (CGCSA, 2020). The baselines would then be used to develop and finalise the national policy interventions aimed at addressing food waste in South Africa. This agreement targets food producers and retailers as they are in a unique position to influence changes to reduce part of the food waste produced each year since most of the food waste occurs in the supply chain before reaching the consumers (CGCSA, 2020). In addition to the South African Food Loss and Waste Voluntary Agreement and the NEMWA, the Western Cape's Organic Waste 2027 Landfill Restrictions is another piece of legislation implemented by the Western Cape government, aimed at eliminating organic waste from the landfills by 2027, therefore inducing a change in management of food waste in the country in support of the UN's SDGs (GreenCape, 2022).

There are four main drivers for designing food waste management strategies: (i) Raising awareness of the problem of food waste generation and the need to manage it effectively (ii) Ensuring national and international development goals (e.g., food waste). Management is directly linked to Sustainable Development Goal 12 (Responsible Consumption and Production), (iii) Considering the socio-cultural and economic imperatives of a particular country or region, and (iv) Recognizing the potential to convert food waste into or out of valuable products to gain energy (Thyberg & Tonjes, 2016).

The main criteria were to raise awareness among stakeholders in the food supply chain, which includes citizens, farmers, retailers, transporters, authorities, charities, marketers, etc. Secondly, market-based instruments such as financial support and tax breaks should also be considered in policy manufacturing. The regulatory aspect addresses food waste reduction through activities such as simple food standards, school meal reform, food donation and food stewardship. Alternatively, voluntary agreements have been made between national and local governments, food companies and non-governmental organizations to work together to minimize or capitalize on food waste. The reduction could also be achieved through citizen empowerment, job creation and cultural integration policies (Fattibene et al., 2020). With all these aspects in mind, different countries have introduced different regulations and guidelines. The motive of this regulation or policy can be achieved through government initiatives, public participation, and innovative, technology-driven and viable business models (Blanc & Ottimofiore, 2021). There are various parameters on which food waste management initiatives and strategies are based, as summarized in Figure 2.10.

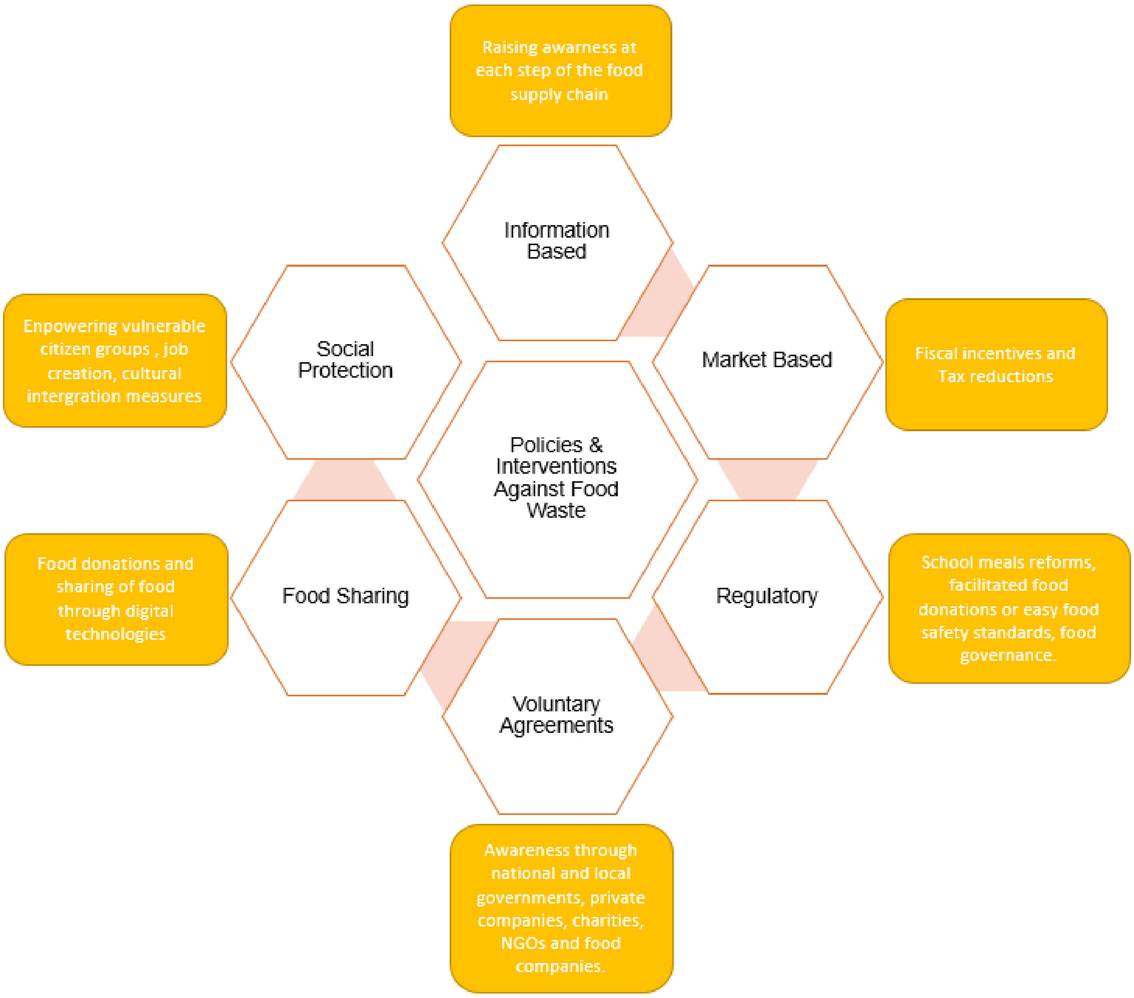



**Figure 2.11:** Different policies and interventions for food waste management. Source: Sharma et al. (2022)

2.12.3. The impact of the carbon tax policy in reduction of gas emissions

The amount of greenhouse gases present in the atmosphere is the biggest danger to humanity. The primary cause of climate change reached a record high of 405 points per million (ppm) in 2017, up from 403 points per million (ppm) in 2016 and 400 points per million (ppm) in 2015 (Michael, 2017). By the end of this century, countries will experience up to six different climatic conditions due to the rise in global temperatures from 3 to 4°C caused by current greenhouse gas concentrations. The intensity and frequency of natural disasters such as rising sea levels, floods, droughts, tropical storms, heat waves, wildfires, and a lack of clean water are increasing due to global warming, which is being fuelled by greenhouse gas emissions. Without lowering $CO_2$ emissions and other greenhouse gas levels, climate change will have an increasingly negative and irreversible impact on life as we know it. The window of time to act is gradually closing (WMO, 2022). South Africa's annual greenhouse gas emissions have been growing faster than the world average (2.3% per year compared to the world average of 1.8% per year) (StatsSA, 2019). Because greenhouse gas emissions are sensitive to the business cycle, it is anticipated that as South Africa's economy grows, its greenhouse gas emissions will continue to rise. Given our rising per capita emissions and the urgent need for preventive action, which is now more important than ever given our experience with the COVID-19 health crisis and the new normal, it would be irresponsible to wait for growth to resume before taking action. With minimal socio-economic effects and a real growth reduction of only 0,5% to 0,15%, it is predicted that the gradual implementation of an adequate carbon tax will reduce South Africa's greenhouse gas emissions by between 35 and 44% below normal business by 2030 (SARS, 2020).

South Africa voluntarily committed (at COP 15 in 2009) to reduce greenhouse gas emissions by 34% by 2020 and 42% by 2025 below the BAU trajectory, subject to support from developed countries – climate finance, capacity building and technology transfer. South Africa ratified the Paris Agreement in November 2016 and approved the submission of its Nationally Determined Contribution (NDC), which requires emissions to peak in 2020-2025, plateau for a 10-year period from 2025-2035, and decrease from 2036 onwards. South Africa's emissions will be in a range between 398 and 614 Mt $CO_2$eq by 2025 and 2030 as defined in national policy (Presidential Climate Commission, 2021). Major emitter nations, including developing nations, must significantly cut their energy-related greenhouse gas (GHG) emissions in accordance with the Paris Agreement (UNCC, 2017).

As part of the strategy to reduce greenhouse gas emissions, the NDC identified the carbon tax as a key component. The 2011 National Climate Change Response Policy (NCCRP) and the National Development Plan (NDP) include the carbon tax as a key component of their climate change response strategy as a cost-effective tool (Reuters, 2021). The $CO_2$ tax law implements that the polluter pays principle and helps ensure that businesses and consumers take these costs into account in their future production, consumption and investment decisions. This assists in reducing greenhouse gas emissions and ensures SA will meet its NDC obligations under the ratification of the 2015 Paris Agreement (SARS, 2020).

Any natural or legal persons who exceed the DEFF reporting thresholds, which also serve as the carbon tax threshold, are subject to the carbon tax. The carbon tax design is in line with this DEFF mandatory emissions reporting requirement. Carbon dioxide equivalent greenhouse gas emissions from fuel combustion, industrial processes, and fugitive emissions of a taxpayer in relation to a tax period are taxed at a rate of R120/$tCO_2eq$ for 2019 and R127/$tCO_2eq$ for 2020. The first phase of the tax's gradual implementation ran from 1 June 2019 to 31 December 2022, and the second phase from 2023 to 2030. The carbon tax rate rises every year by inflation plus 2% until 2022 and then every year by inflation. In order to give current significant emitters time to transition their operations to cleaner technologies through investments in energy efficiency, renewable energy, and other low-carbon measures, significant tax-free emissions allowances ranging from 60% to 95% will result in a modest nett carbon tax rate ranging from R6 to R48/$tCO_2eq$. The tax's design may be modified after this initial phase, depending on the economy and how well the tax has worked to reduce emissions at that point (Al-Obadi et al., 2022). The Carbon Tax Act was gazetted on 23rd May 2019 (Gazette No 42483) and the carbon tax became effective on 1 June 2019. Carbon offset regulations (Gazette No. 42873) with final regulations gazetted by the Minister of Finance in Nov 2019 (SARS, 2020).

#### 2.12.4. Paris Agreement on Climate Change

The Paris Agreement was adopted on December 12, 2015, at the 21st meeting of the Conference of the Parties to the United Nations Framework Convention on Climate Change (UNFCCC CoP21), held in Paris from November 30 to December 13, 2015. The agreement was adopted after four years of intense negotiations commissioned by the 17th UNFCCC CoP in Durban in 2011. United Nations Secretary-General Ban Ki-Moon, who acted in his capacity as depositary of the agreement, convened a high-level opening ceremony for the signing of the agreement in April 2016 (DEFF, 2016). The agreement is a comprehensive framework to guide international efforts to limit greenhouse gas emissions and address all related climate change challenges. It signals the shift in pace towards low-carbon development from 2020 through country commitments in ambitious national plans called Nationally Determined Contributions. This result recognizes that climate change poses an urgent threat to human society and the planet and requires the greatest possible cooperation from all countries and other stakeholders (World Bank, 2022). The main goal of the agreement is to limit global temperature rise to well below 2ºC, while making efforts to limit the rise to 1.5ºC (Fattibene et al., 2020).

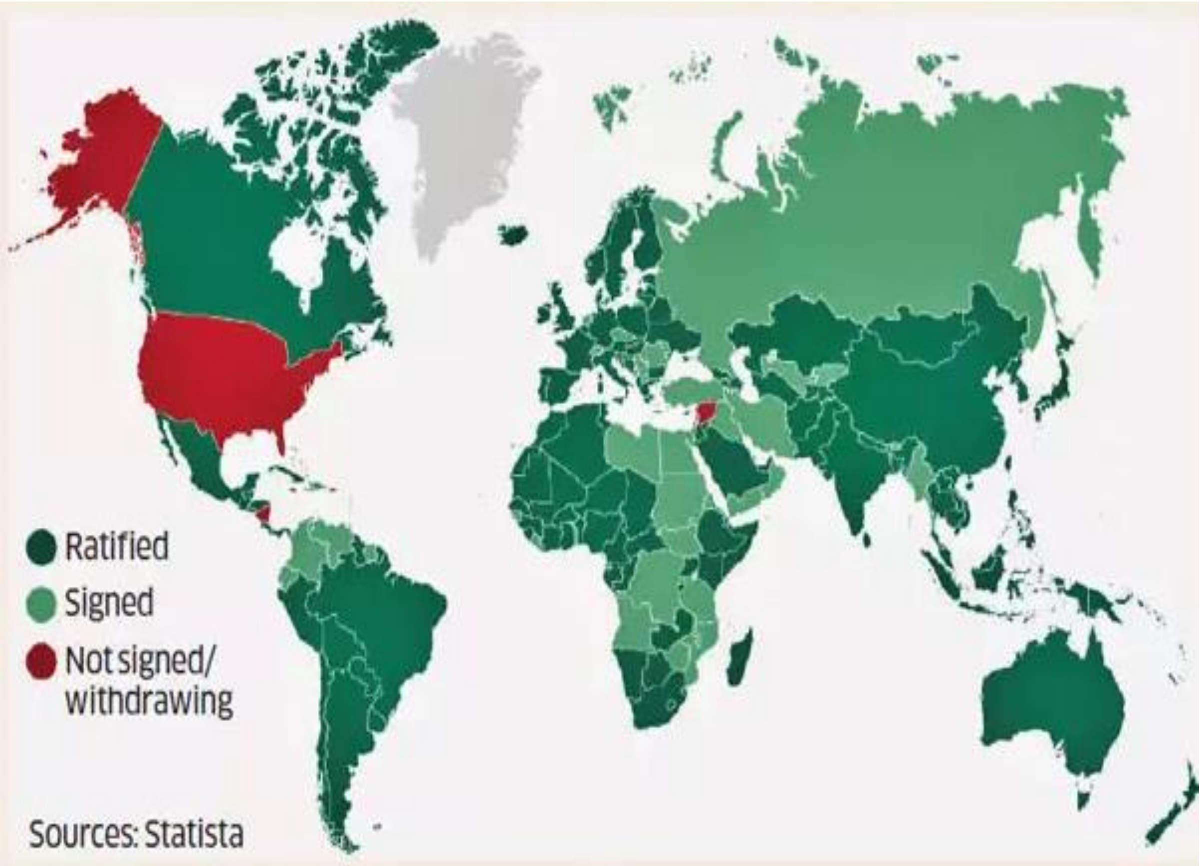



**Figure 2.12:** Countries that have ratified or signed the Paris Agreement as of June 1, 2017. Source: Statista, (2022)

The recognition of the 1.5-degree target is of central importance for South Africa as an African and developing country with a high vulnerability to climate change. The Paris Agreement is also a key vehicle for mobilizing finance, technological support and capacity-building for developing countries, and also helps to enhance global efforts to combat and minimize loss and damage from climate change and increase climate resilience (UNCC, 2017). Although climate action needs to be massively stepped up to meet the Paris Agreement's goals, the years since it came into force have already produced low-carbon solutions and new markets. More and more countries, regions, cities and companies are setting goals for climate neutrality (Tracey, 2023). Zero-carbon solutions will become competitive in all economic sectors that account for 25% of emissions. This trend is most noticeable in the energy and transportation sectors and has created many new business opportunities for pioneers. By 2030, zero-carbon solutions could be competitive in sectors that account for over 70% of global emissions (Skjærseth et al., 2021).

## 2.13. Conceptual and theoretical frameworks

### 2.13.1. Conceptual Framework

A conceptual framework is an analytical tool that helps you understand and organize the relationships between your research variables or concepts. It is based on the researcher's review of the literature, research objectives, and expected conclusions (Swaen & George, 2022). Figure 2.12 below presents the conceptual framework followed in this research study.

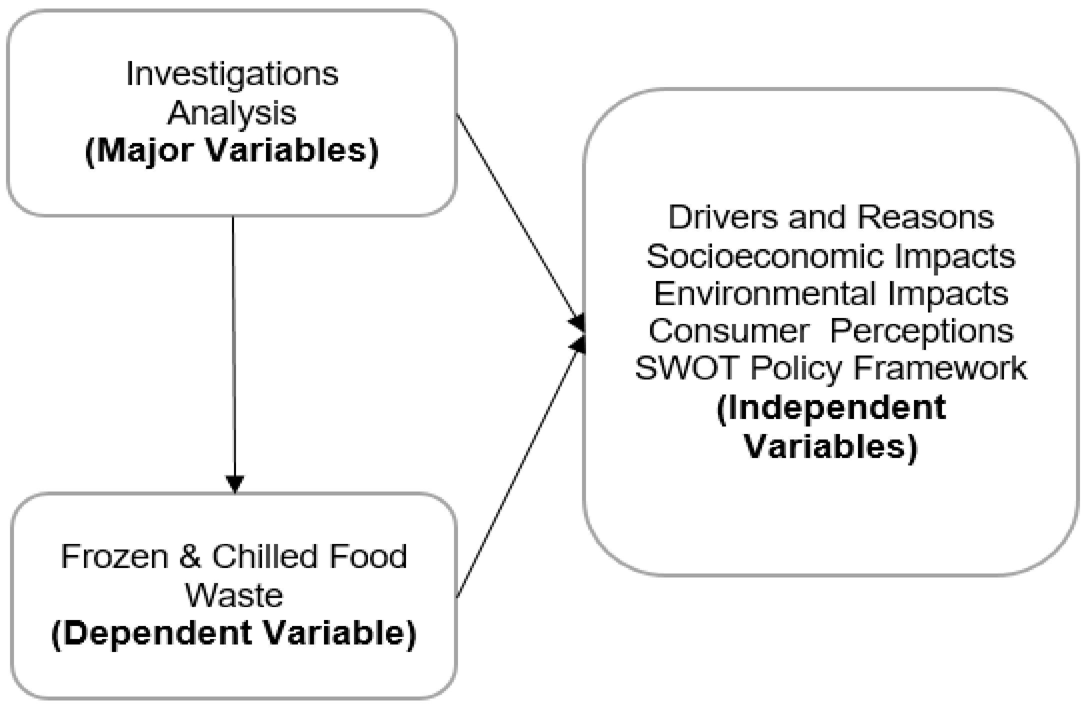



**Figure 2.13:** Conceptual framework of the study. Source: Researcher (2023)

2.13.1.1. The objective of drivers and reasons behind chilled and frozen food waste generation.

Chilled and frozen food waste generation can be attributed to several drivers and reasons. Drivers represent the overarching factors that lead to chilled and frozen food waste, while reasons provide specific explanations or circumstances that directly contribute to the generation of waste within that broader context (Oria & Schneeman, 2020). An analysis of the key drivers behind the generation of chilled and frozen food waste is based on the framework mentioned above. The Triple Bottom Line Theory has clearly indicated that the aspect of sustainability is dependent on all three areas of social, economic and environmental aspects (Bahraini, 2021).

The reasons and drivers of food waste generation, particularly chilled and frozen food, are diverse and complex but understanding them is critical to identifying effective ways to reduce chilled and frozen food waste generation. As in many behavioural domains, consumers' actions in this area are driven by cultural, personal, political, geographic, biological, and economic factors that influence conscious and unconscious decisions (Thyberg & Tonjes, 2016).

Inadequate cold chain management: The cold chain refers to the system that ensures the proper handling, storage, and transportation of chilled and frozen foods at controlled temperatures (Thyberg & Tonjes, 2016). Breaks or failures in the cold chain, such as temperature fluctuations or improper storage conditions, can lead to food spoilage and waste. Retailers play a significant role in the generation of chilled and frozen food waste. Factors such as overstocking, incorrect stock rotation, and insufficient monitoring of expiration dates can result in products reaching their sell-by or use-by dates without being sold or consumed, leading to waste (Ndraha et al., 2018).

Consumer behaviour is another important driver of chilled and frozen food waste. Consumers may buy more perishable items than they can consume within the desired time frame, resulting in items being discarded before use. Additionally, improper storage or handling by consumers, such as leaving items out of the freezer for extended periods or not following recommended thawing procedures, can contribute to food spoilage and waste (Ahmed et al., 2021).

The lack of infrastructure and technology: In regions with inadequate infrastructure and limited access to reliable refrigeration and freezing technologies, food waste is more likely to occur. Without proper storage facilities, perishable items are prone to spoilage and waste. Consumers buying more than they can consume before the food expires can result in disposal of unused frozen and chilled items (Ahmed et al., 2021). Misunderstanding "sell by," "use by," and "best before" dates might lead to unnecessarily discarding still-edible food (Hall-Phillips & Shah, 2017).

This perception of consumer behaviour and attitudes allows the researcher to review and investigate the drivers and reasons behind chilled and frozen food waste. Addressing these drivers and reasons requires a multifaceted approach involving improved cold chain management, better inventory management, consumer education on proper handling and storage, relaxation of cosmetic standards, investment in infrastructure and technology, and a more nuanced understanding and application of food handling regulations to minimize unnecessary waste while ensuring food safety (Gillespie et al., 2023). By understanding and addressing these drivers and reasons, stakeholders in the food industry can develop strategies and interventions to reduce frozen and chilled food waste, promoting sustainability and minimizing economic losses (Ndraha et al., 2018).

#### 2.13.1.2. The socioeconomic and environmental impacts of chilled and frozen food waste generation

Socioeconomic and environmental impacts are consequences of an action or event, while environmental impacts pertain to the changes or effects on the natural environment caused by human activities. Both types of impacts are crucial considerations when evaluating the overall sustainability and consequences of various actions, policies, or events (Wang et al., 2020). Finding the relationship between socio-economic determinants and environmental degradation has wide implications for evaluation and formulation of policy to improve environmental quality while the social factors responsible for environmental performance are required to be further explored.

Part of the socio-economic impact is economic loss where chilled and frozen food waste represents a significant economic loss for various stakeholders, including producers, retailers, and consumers. Wasted food translates into financial losses for businesses and households, impacting profitability and disposable income and could otherwise have been directed toward addressing food insecurity and hunger in communities (Berry, 2020). The management and disposal of chilled and frozen food waste incurs additional costs for businesses and municipalities. These costs include waste collection, transportation, landfill fees, and waste management infrastructure investments. Ultimately, these expenses can burden consumers and taxpayers. Chilled and frozen food waste generation represents lost opportunities to address food insecurity and hunger. By reducing food waste particularly chilled and frozen generation, more resources could be directed towards meeting the nutritional needs of vulnerable populations (Chakona & Shackleton, 2019). Decomposing frozen and chilled food waste generates methane, a potent greenhouse gas that contributes to climate change (Al-Rumaihi et al., 2020, Bahraini, 2021). Here an understanding of the fact that there are major impacts associated with the domain of chilled food waste and frozen food waste is effectively highlighted. The key area that can be considered here is the fact that with the appropriate use of the same Triple Bottom Line Framework, and it is clear that the social and environmental areas are major aspects related to the overall domain of sustainability.

In addition to methane production, the energy-intensive processes involved in food production, refrigeration, and transportation also contribute to carbon emissions and exacerbate climate change. The disposal of chilled and frozen food waste requires waste management systems, such as landfills or incinerators, which can have negative environmental impacts. Improper disposal or inadequate waste management can lead to pollution of soil, water, and air, affecting ecosystems and human health (Al-Rumaihi et al., 2020). Addressing these socioeconomic and environmental impacts requires comprehensive strategies such as improved supply chain management, better inventory control, consumer education and awareness, innovative food waste reduction initiatives, investment in sustainable infrastructure, and policy interventions that promote responsible food consumption and waste management practices (Pandey, 2021).

2.13.1.3. The reasons behind consumer perceptions on chilled and frozen food waste generation

Consumer or customer perceptions refer to the beliefs, opinions, attitudes, and subjective understandings that individuals have about products, brands, services, or any other aspect of the marketplace. These perceptions are shaped by a combination of personal experiences, cultural influences, marketing messages, social interactions, and various other factors. Consumer perceptions play a vital role in shaping consumer behaviour, decision-making processes, and purchasing choices. They can encompass a wide range of aspects, including quality, value, convenience, trustworthiness, reliability, sustainability, aesthetics, and more (DeLong & Grebitus, 2016).

Knowledge of consumer or customer behaviour towards a category of products is necessary for research and development during the development of new products generally, and food products in particular, in all phases of a product cycle. The generation of chilled and frozen food waste should concern consumers are as it has a negative impact on the environment and society and contributes to resource depletion, greenhouse gas emissions, and the inefficiency of the food system (Ahmed et al., 2021).

The main impact of understanding the key attitudes of customer and behaviours in this domain can be a beneficial area altogether. In this regard, it can be said that the main issue of food waste generation and, especially, the key area of fast food and chilled and frozen food waste generation, is entirely dependent on the purchasing patterns and the behaviours associated with the customers. In this regard, a study of these areas can be seen to be an extremely beneficial area and can help in understanding all the crucial areas that impacts the behavioural patterns and the related aspects as well (Zanoni & Zavanella, 2012). Overall, the use of the correct levels of understanding of the customers and their perceptions and behaviours is a critical area that can also help in ensuring appropriate generation of relevant frameworks that can be beneficial and can help in engendering a more positive result overall in the long run as well (Ahmed et al., 2021). It is beneficial for the overall region and can help in coming up with a more appropriate gaps analysis, which can be impactful and can help in engendering betterment (Marr, 2022).

Customers who are aware of the factors that contribute to food spoilage and waste easily understand the importance of proper storage and handling of chilled and frozen foods. They pay attention to expiration dates, follow recommended storage guidelines, and take measures to prevent food waste at household level. Not all consumers may be fully aware of the impact of chilled and frozen food waste generation or the actions during shopping can take impact either negatively or positively on chilled and frozen food (Hall-Phillips & Shah, 2017). Consumer ability to interpret date labels (e.g., "best before," "use by") accurately and make informed decisions (Lukić, 2016). Some may not understand the significance of proper storage, the importance of minimizing frozen and chilled food waste, or the potential environmental and socioeconomic consequences associated with it.

Consumers often associate value for money with the quantity of food they receive for the price paid (AFFI, 2021). This perception can lead to prioritizing quantity over quality and potentially contributing to overconsumption and higher levels of chilled and frozen food waste (Ahmed et al., 2021). Understanding consumer perceptions is crucial for businesses as it helps tailor marketing strategies, product positioning, communication efforts to align with consumer expectations and preferences. By gaining insights into consumer perceptions, businesses can develop products and services that meet or exceed consumer needs, build strong brand identities, and cultivate lasting customer relationships (Varese et al., 2022).

#### 2.13.1.4 The national policy and regulatory framework on chilled and frozen food waste generation

A policy and regulatory framework refer to a set of rules, guidelines, laws, and regulations established by government bodies or other governing entities to govern and guide behaviour in a specific domain or sector. It provides a structured approach to addressing societal, economic, or environmental issues and aims to achieve desired outcomes or objectives through the implementation of rules and policies (Gaiani & Fonseca, 2020). In the context of a policy and regulatory framework, "drivers" refer to the underlying factors or motivations that prompt the development or implementation of specific policies or regulations while "Reasons" are the specific justifications or rationales for the development and implementation of policies and regulations within a particular framework. They provide explicit or implicit explanations for why specific rules or guidelines are deemed necessary or beneficial (Cooper, 2021).

According to the Food Agricultural Organisation, food loss and waste, particularly chilled and frozen food loss and waste (FLW), currently represent a pressing challenge in the design of sustainable food systems. The FLW negatively impact food security and nutrition and significantly contribute to greenhouse gas (GHG) emissions, environmental pollution, degradation of natural ecosystems and biodiversity loss, and represents a waste of resources used in food production. Tackling food loss and waste is a defined target- SDG target 12.3 - within the internationally agreed Sustainable Development Goals (SDGs). As custodians of this target, FAO and the United Nations Environment Programme (UNEP) measure and monitor progress on efforts to reduce food loss and waste against the Global Food Loss and Waste Index. The national framework may set specific targets for reducing chilled and frozen food waste generation. These targets can be quantitative, such as percentage reduction goals, or qualitative, focusing on improved management practices (Colombo et al., 2020). The framework may provide guidelines for stakeholders involved in the supply chain, including producers, retailers, distributors, and food service providers (Chauhan et al., 2021).

These guidelines could cover aspects such as proper inventory management, cold chain maintenance, stock rotation, and quality control to minimize waste. The framework may emphasize the importance of consumer education and awareness programs to promote responsible consumption, proper storage, and handling practices. This could include public campaigns, educational materials, and collaborations with consumer organizations. The framework may include incentives and support mechanisms to encourage businesses and organizations to adopt sustainable practices and technologies that minimize chilled and frozen food waste. This could involve financial incentives, tax breaks, grants, or technical assistance. A policy and regulatory framework consisting of rules and guidelines established to guide behaviour and achieve specific objectives. Drivers are the underlying factors that prompt the development of policies and regulations, while reasons provide the justifications or rationales for the specific measures implemented within the framework. Together, these elements shape the governance and regulatory landscape within a particular domain or sector (Creecy, 2023).

### 2.13.2. Theoretical Framework

The terms theoretical and conceptual frameworks are often used interchangeably in research. However, there are stark differences between the two areas that must be effectively pointed out. The use of both a conceptual and a theoretical framework is permissible in the case of a single research as the theoretical framework provides an extensively broad and general overview of the overall research problem that is being studied in the research (Yoobic, 2021). On the other hand, the conceptual framework is used to pinpoint the core areas of the research problem that is being studied. Therefore, both areas have different requirements and cater to different overall needs of the research. The conceptual framework can be considered to be a plan that identifies the key areas associated with the research that can be easily generated and can be largely beneficial in the long run. Without the appropriate generation of a conceptual framework, a better plan of the study cannot be generated (Chauhan et al., 2021).

However, there is a need to understand that the conceptual framework of study is dependent on the theoretical framework that has been employed in any study (Figure 2.13). The use of the same has been noted as the entire conceptual framework is based on the Triple Bottom Line Theory, which is the main theoretical framework that has been employed in this research. This section provides a theoretical framework to address the objectives of this study.

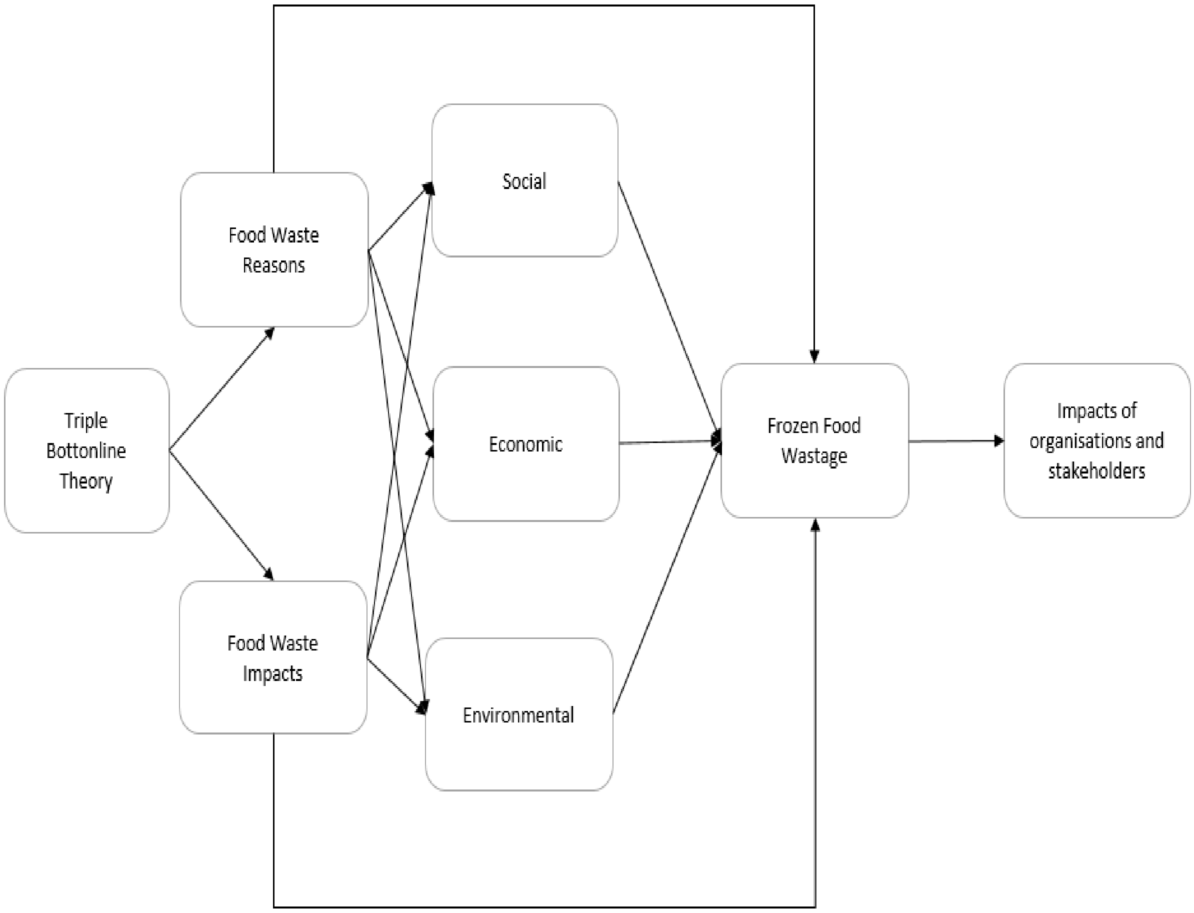



**Figure 2.14:** Theoretical framework process flow. Source: Bahraini (2021)

This framework clearly indicates that the use of the Triple Bottom Line Theory can be beneficial in ensuring better understanding of the reasons and the impacts of frozen food waste. The use of the theory in this regard, has pointed out the fact that there are social, economic, and environmental reasons for the generation of frozen food waste (Bahraini, 2021). On the other hand, in addition to these reasons, there are social, environmental, and economic impacts associated with frozen food waste as well. The overall impacts on the organisation and the stakeholders can be beneficially deduced from understanding the manner in which food waste generation patterns are appropriately analysed (Bhattacharya et al., 2022).

The Triple Bottom Line Theory asserts that a company must create value for people, the planet, and profit through its business operation. People mean the society, planet means the environment, and profit means the economic activity of the company. People often underestimate the amount of food wasted by them (van der Werf et al., 2020). Food manufacturing businesses prepare and distribute food for customers. Due to a low demand, at certain times food manufacturing businesses have to manage excessive inventory. Food products are perishable and so substantial amount of foods is wasted which causes sustainability issues. Besides, there are numerous people and communities in South Africa who are hungry. If the unsold foods are provided to them, they can enhance their living standards and satisfy their demand for nutrition. Besides, food wastage leads to wastage of resources, time, and skills which were used to prepare the foods (Falatouri et al., 2022).

#### 2.13.2.1. Triple Bottom Line Definitions

The theory of the Triple Bottom Line (TBL) is an established framework that accentuates the significance of examining three dimensions, namely economic, social, and environmental, in the assessment of an organization's or project's effectiveness. Each dimension serves as a distinctive "bottom line," which corresponds to a distinct facet of sustainability. Provided below are conceptual descriptions of each constituent of the Triple Bottom Line (Bhattacharya et al., 2022).

**Economic Bottom Line**: The economic foundation of the Triple Bottom Line concept pertains to the monetary facet of an establishment or venture. It encompasses the evaluation of economic achievement, profitability, and financial resilience. Within this realm, economic deliberations concentrate on the generation of earnings, the optimization of shareholder worth, and the assurance of the fiscal feasibility of the entity. It fosters conscientious financial administration and effective resource allocation to bolster enduring prosperity (Bahraini, 2021). The "profit" aspect of the TBL theory recognizes that sustainable business practices can contribute to long-term financial success by enhancing reputation, reducing risks, fostering innovation, and creating shared value for society.

**Social Bottom Line**: The social aspect that is located at the end of a spectrum and is concerned with the social and moral aspects of an organization's activities. It entails the assessment of the consequences of business operations on employees, communities, and the overall well-being of society. In terms of the social dimension, considerations extend beyond financial measures to encompass social responsibility, human rights, diversity and inclusion, labour practices, and community involvement.

The social aspect that is located at the end of a spectrum highlights the ethical treatment of employees and the promotion of favourable social consequences (Bhattacharya et al., 2022). Ultimately, the "people" aspect of the TBL theory emphasizes the importance of fostering healthy and thriving societies in which individuals can lead fulfilling lives.

**Environmental Bottom Line**: The ecological sustainability of an organization or project is the focus of the environmental bottom line. This entails evaluating the effects of activities on the environment and its natural resources. Within the environmental dimension, organizations are required to take into account the ecological footprint resulting from their operations. This encompasses endeavours to decrease resource usage, mitigate pollution, implement sustainable methods, and contribute to the preservation of biodiversity. The environmental bottom line underscores the significance of environmental stewardship and conservation (Bautista, 2020). The "planet" aspect of the TBL theory emphasizes the interconnectedness of human activities with the health and integrity of the natural world, highlighting the importance of responsible stewardship of the Earth's resources for present and future generations.

#### 2.13.2.2. Theoretical perspective

This research considered food waste and its impact on the Triple Bottom Line framework, to investigate the drivers and suggest ways in which it can be mitigated. This study aims to draw any connections that exist in the FMC’s policy and food waste reduction practices and how they relate to the food waste hierarchy. The triple bottom line framework highlighted in Figure 2.15, below is a concept that incorporates the environmental, economic, and social impacts of any project or business, and is therefore pivotal in transforming businesses into sustainability by encouraging the company to not only focus on the profits but also the other dimensions of the framework. Therefore, when one looks at the complexity and challenges of dealing with food waste, the benefits of reducing food waste from a Triple Bottom Line sustainability perspective are very clear.


**Figure 2.15:** A Venn diagram model highlighting the Triple Bottom Line framework. Source: Karwowska et al. (2021)

Sustainability is largely dependent on all three aspects of the model, social, economic, and environmental. Therefore, impacts of food waste on all these three domains can be beneficial in pointing out unsustainability (Filho et al., 2021). This can be seen as a critical area of need that must be considered and this can lead to issues as well overall. While several companies choose the easiest way to get rid of waste, the waste hierarchy (shown in Figure 2.15 below) provides more benefits for the environment, society and the economy in line with the Triple Bottom Line approach to sustainability (Karwowska et al., 2021).

Using the food hierarchy framework, various types of waste should be evaluated at various stages of the supply chain and decisions made on the best approach. The best approach should be source reduction (Figure 2.16), which is focused on preventative and mitigation measures. This is possible if drivers for food waste generation are known. Where food waste can't be avoided, surplus food or food waste which is deemed edible and can be eaten should be redistributed to the needy before going to the trash. The order of each treatment is determined not only by its impact on the environment but also by the economic and social advantages it offers. Food waste can be treated with anaerobic digestion, which is also used to treat all other biodegradable trash in conjunction with composting. Any kind of waste can be treated with thermal energy recovery - gas emissions, for instance, are significant effects on the environment (Betz et al., 2015).

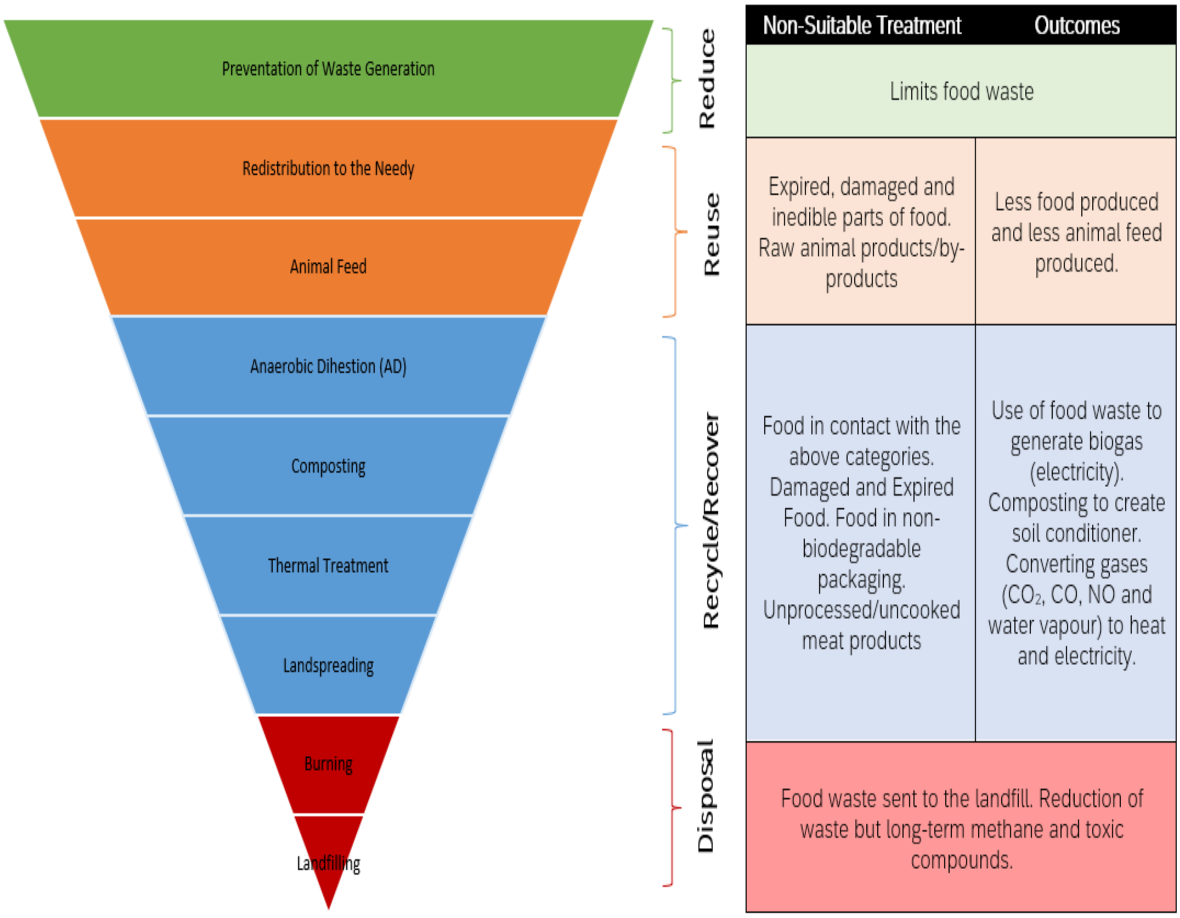



**Figure 2.16:** Food waste hierarchy, Source: Generated by researcher from DFFE (2019)

While much of the food returned to the FMC was labelled as food waste, there should be attempts to categorise the waste into various streams and employ the food waste hierarchy and the Triple Bottom Line framework to take the best option based on the best approach for dealing with the waste. For instance, several compounds in food waste can be extracted and used in a variety of ways. Even though complex technology is required for some extraction processes, the substances that are obtained typically may have a high value. There has been an increase in research interest in this field over the past few years, and therefore technologies are available for the valorisation of these wastes. However, most types of food waste do not require industrial-scale technologies (Betz et al., 2015). Composting and anaerobic digestion are two common solutions for mixed food waste which however fall much lower on the food waste hierarchy and may not be the best solutions for large cooperates where large volumes of food waste are produced. Worse still, meat or other animal by-products are not recommended for composting because of considerable environmental impacts (du Plessis, 2020).

2.13.2.3. Application to the Study

In order to verify conformity to the good practices for dealing with food waste highlighted above, a process flow is presented in Figure 2.13 for use in the present study. It describes food waste generation patterns and drivers within the FMC, as well as the current preventative and waste management practices employed in the company. In order to provide a thorough assessment of the context, drivers, and patterns of food waste generation, the food waste hierarchy for management of food waste and the risk framework to food supply change and food wastage were combined. In this framework, a waste audit was used as a tool to gather and analyse quantitative data for the returned retail food waste, and the reasons for the return of the food products. The purpose of waste audits was to estimate hotspots for food waste generation and inform strategies for preventing and managing it (WRAP, 2013). Weighing scales were used to measure waste streams' quantity and composition. Due to the time and labour involved, waste audits are usually conducted on small samples representing a larger population. By repeating those at various times, seasonal or other time-related variations are frequently taken into account. The majority (88%) of waste audits conducted in research are descriptive baseline waste characterisation studies (Wilkie et al., 2015) Newenhouse and Schmit (2015) stated that waste studies rely a lot on quantitative data, which can be analysed with industrial ecologies tools like eco-efficiency analysis and Material Flow Analysis (MFA). According to Brunner and Rechberger (2016), MFA is a methodical assessment of the flows and stocks of materials within a system that is defined in space and time.

As the Triple Bottom Line Theory asserts, food companies are accountable to create sustainable food and be careful all the produced foods are being utilised and properly consumed. As entrepreneurs are switching to digital business model, in South Africa, companies need to implement digital solutions in the food supply chain. Digital technologies consist of wide technology set such as big data analytics and data mobile (Annosi et al. 2021). Platform organisations can focus on multiple brokerage that these organisations can play a crucial role in waste recovery. Barriers and drivers behind the widespread adoption of technical solutions in the food supply chain is yet to be explored.

The food sector is a major sector in any economy. The worldwide demand for food is increasing. The requirement for meat and dairy products is also estimated to increase in the upcoming years (Lemaire & Limbourg, 2019). In order to cope with the rising demand, it is necessary to implement sustainable food production by taking a Triple Bottom Line approach, the new production should be in a way that can satisfy the need of the people without wasting food items. Such production also improves value creation for the economy and the environment. Thus, sustainable development should follow.

### 2.14. Conclusion

According to the literature assessment of supply chain food waste, food waste is a major issue both globally and in South Africa. It significantly affects supply chain behaviour upstream and downstream, despite not being on par with the vast amount of food that is wasted. The environment, the FSC's viability, and the safety of the world's food supply are all negatively impacted by food waste (Food Waste within Food Supply Chains: Quantification and Potential for Change to 2050, 2010). Food waste because of supply chain inefficiencies is not a recent phenomenon but is a well-known and widespread problem. According to Jensen et al. (2013), waste management is crucial to future sustainability and food waste is a particularly complicated challenge for retail businesses.

According to the literature, assumptions were made to determine how much food was wasted. These hypotheses must be examined by examining source data (Ali & Bharadwaj, 2014). According to Panda and Mohanty (2011), the bullwhip effect in the FSC may be avoided by concentrating on certain supply chain components and by effectively disseminating information along the whole supply chain. Upstream members may access demand and replenishment data, allowing all partners to compute their inventory needs concurrently using the same original raw data. Coordination and collaboration among supply chain participants are crucial for improving supply chain efficiency and reducing the bullwhip effect of food waste along the supply chain. (Panda & Mohanty, 2011). It is important to research how food waste drivers affect how much food is wasted as this could demonstrate how changes made to one part of the supply chain might have a detrimental impact on other parts. To better understand the issues with food waste and the factors that contribute to it, further research must be done on all other categories of food items. According to the literature, there are several factors that contribute to food waste, and they can change significantly depending on changing circumstance (Ali & Bharadwaj, 2014). There might be a large number of additional factors that contribute to food waste. In order to manage food waste more effectively, it is necessary to identify and explore additional food waste factors (Parfitt et al., 2021).

### 2.15. Chapter Summary

This chapter addressed the issue of food waste by highlighting the definition used in the literature and the problems that result from inconsistencies in definitions. The variety of techniques used in food waste studies was also highlighted. The literature on various classes of food waste, quantification studies, and management strategies were examined to review food waste that occurs at the grocery retail level. As a result, it became clear that different methodologies are employed all over the world to understand food waste. The most prevalent food waste categories identified by the literature, according to the review of the literature, are fresh produce, dairy products, and bakery products. The causes of food waste were also discussed, with shelf life and problems with date labelling being the main culprits. The final section of the literature review focused on governance/management approaches, the theoretical framework applicable to this study, and food waste management from South Africa's strategic direction.

# 3. CHAPTER 3: METHODOLOGY

## 3.1. Introduction

Food waste is one of the major issues that must be considered by all countries. This study contributes to an understanding of the extent of frozen food waste in the FMCG segment of KZN, South Africa. Methodology refers to the way in which procedures are used (Portia & Keating, 2017; Frankfort-Nachmias, 2020). The chapter is divided into various sections including: (i) description of the study area, (iii) population and sampling, (iv) sampling procedures, (v) data collection procedures, (vi) data collection instruments, (vii) validity and reliability measures, (viii) data analysis, (ix) ethical considerations, and (x) chapter summary.

The primary objective of the study was to investigate the food waste generation, driving factors and the impacts (economic and environmental) of frozen and chilled dairy, meat and fish product waste from the retail supply chain as these pertain to a major retail food supplier and producer in South Africa. The study research design used a mixed methods approach by including both quantitative and qualitative methods as well as analysis of secondary data. This approach allowed a reasonable response to the research question and proof of acceptable scientific standards for consistency (validity, reliability, and trustworthiness). A case study research approach was also used where one of the retail stores in the sample was selected for an in-depth investigation and to corroborate the secondary data from the supplier.

## 3.2. Research paradigm

The research paradigm considered in any study refers to the methods, models and patterns that are to be employed in the study (Newman & Gough, 2020). This is very important as it can impact the outcomes of the study. The research paradigm is also generally regarded as a series of theories and practices that can be employed in any study. The three pillars that can be associated with the aspect of research paradigm include ontology, epistemology, and methodology. In this regard, as Al-Ababneh (2020) suggests, ontology refers to the nature of reality that is generally applicable in the case of any study. It specifies the unitary nature of reality, which means that there can be only one reality or none at all.

On the other hand, epistemology is more associated with the manner in which knowledge can be effectively gained. Methodology, as per Dodds & Hess (2020), is the area that deals with the processes that are generally employed in the overall exploration of knowledge and underpinning the validity of the knowledge that is gained.

The positivist and interpretivist research paradigm were selected in this study. While interpretivism integrates human interest into a study (Blackwell, 2018), positivism underpins the fact that the reality that exists can be easily measured and interpreted (Babii, 2020). Thus, the use of positivism can allow better measurements pertaining to the overall frozen food waste aspects and their overall impacts. It also offers a greater scope for a real enquiry in any study.

As the study was conducted by making appropriate use of the mixed method approach, it can be said that the use of two philosophies has been employed. The positivism research philosophy is more aligned towards the aspect of quantitative study. However, as this study made use of both qualitative and quantitative data, for the qualitative part, the study used the interpretivism research philosophy.

The main role of this research philosophy is to come up with appropriate interpretations of the collected data through the use of the correct analysis techniques. In a qualitative study, a more subjective approach of data analysis is allowed. This allows a comprehensive review that is generally seen to be one of the most essential parts associated with any study (Xue et al. 2017). Further, it can be helpful in deriving the major areas associated with the overall dependent and independent variables associated with the study. The inter-relationship that is shared between these two variables allows a more comprehensive analysis to facilitate a robust study that is based on the study objectives.

According to Yasanur Kayikci et al. (2022), appropriate use of mixed data is beneficial in coming up with both statistical insights and descriptive analysis. The present study used a mixed method approach to ensure an understanding of food waste generation in the KZN region and identified key determinants of this process. With the correct use of quantitative data, statistical insights about the food waste generation, especially concerning frozen and packaged food waste were facilitated.

The overall quantity of food waste that is being generated and the trends in food waste generation has been effectively highlighted using quantitative data. On the other hand, the use of qualitative data was employed to ensure better comparisons. The study here has undertaken a critical comparative approach to data collection and data analysis. In this regard, the use of the correct data that can be used for the comparison purposes has been appropriately collected (Woolley et al. 2022). Further, it also ensured the use of appropriate theoretical underpinnings to inform the study and come up with more robust comparisons. This has allowed a critical comparative analysis which is unbiased, reliable and valid.

The study made use of three different research techniques including a survey and an interview. Thus, two surveys and two interviews were conducted and according to Wikurendra et al. (2022), the collection of quantitative data is generally done through the use of surveys in the case of primary data collection. The use of two surveys was considered to generate a more impactful study.

Unlike surveys, interviews are generally conducted to collect qualitative data. The use of appropriate qualitative data is essential in the case of this study, as it is used for a comparative study. Overall, the application of the interview process helped in developing better outcomes (Writer, 2022) and allowed the collection of a more robust set of qualitative data. Here again, the use of two different interviews was applied to collect a more comprehensive set of data. These data have been further analysed using appropriate analysis techniques.

The other major technique used in the study involved comprehensive data analysis. The use of a critical comparative data analysis technique ensured a better understanding of the research (Xue et al. 2017). The critical comparative analysis eliminated bias. Secondary qualitative data collected during this study also helped in identifying gaps that exist in the existing ways of food waste management. The techniques that were employed here allowed greater reliability and validity of the study and ensured that the best research outcomes were generated.

## 3.3. Research methods and field data collection

### 3.3.1. Data collection methods

A mixed-methods approach combining both qualitative and quantitative methods and primary and secondary data was used in this research to answer the research questions for the study. Primary data were collected using self-administered surveys and electronic interview questionnaires using mobile devices while secondary data were collected from the FMC's records on food waste from the retailers. According to Creswell (2003), using both quantitative and qualitative methodologies minimise the limitation associated with each method. The mixed-method approach considers the evaluation of statistical information from the collected quantitative data as well as several perspectives of all stakeholders involved and, thus, approaches the objectives of the study in a holistic manner (Huyler & McGill, 2019). The data collection tools are described in detail below in Figure 3.1.

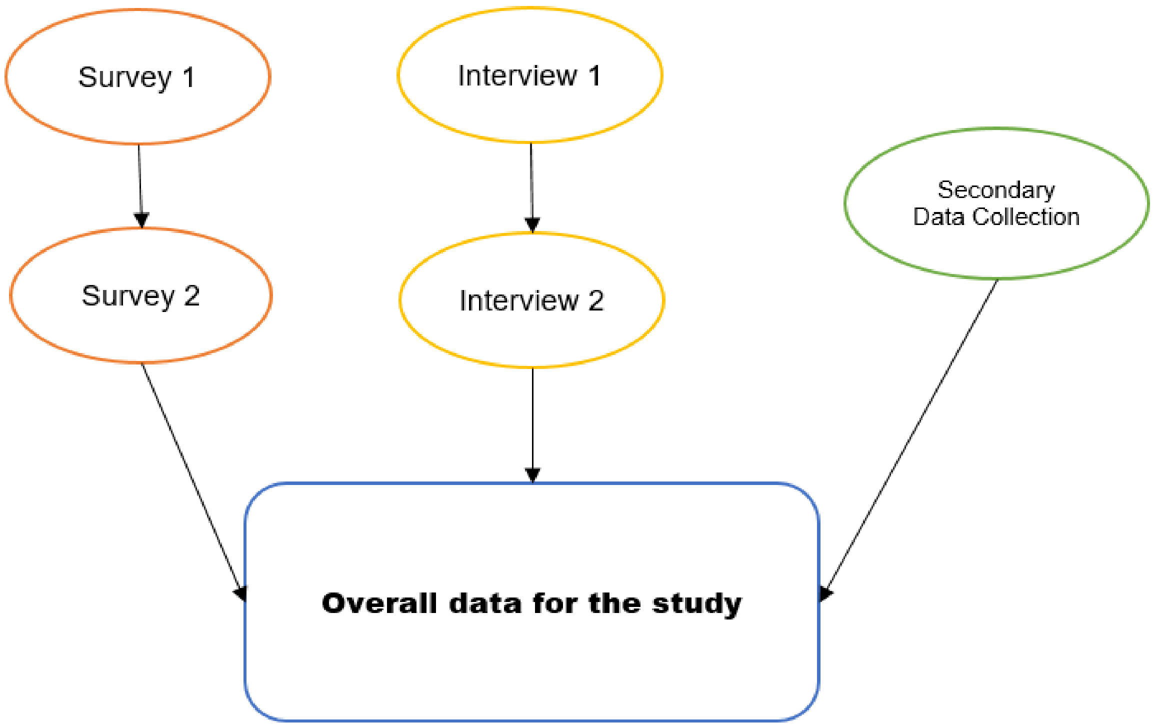



**Figure 3.1:** Data collections techniques employed in the study. Source: Researcher (2023)

3.3.1.1. Quantitative research method

Four Eyes is a survey platform with a data mining engine used for the first survey. The online Four Eyes survey involved retail stores and random selection of online respondents after supplying an electronic link to their customers. The questionnaire comprised 13 prescriptive questions where the respondent had to choose his most preferred choice of response. Triangulation (Nachmias & Nachmias, 2017; Chilisa & Preece, 2018; Singleton & Straights, 2017) was used to develop the questions from gaps arising from responses from retail outlet employees through reference from the literature review. This data collection method was chosen because it has the potential to reach a wider range of customers, it saves costs and time, and it is convenient for both the researcher and the customer since the retail outlets constituting the study universe has 202 retail outlets. The survey reached out to 600 customers of which 485 responded, details of which have been provided in the sampling chapter. The consumer survey questionnaire was uploaded in Four Eyes [Appendix J].

After the self-administered electronic questionnaire (Appendix J) was developed, it was uploaded in the Four Eyes online survey portal to be accessed through a circulated online survey link. The use of the online survey portal helped in ensuring the desired reach of the survey and that the survey process remained within budget. Respondents had to push the link to register their demographic details and login. The survey was pre-set to continue with interviews only if the provided date of birth qualified the respondents as being 18 years or older. After registration and login, the respondents would follow the prompts and instructions to complete the survey as illustrated in Figure 3.2.

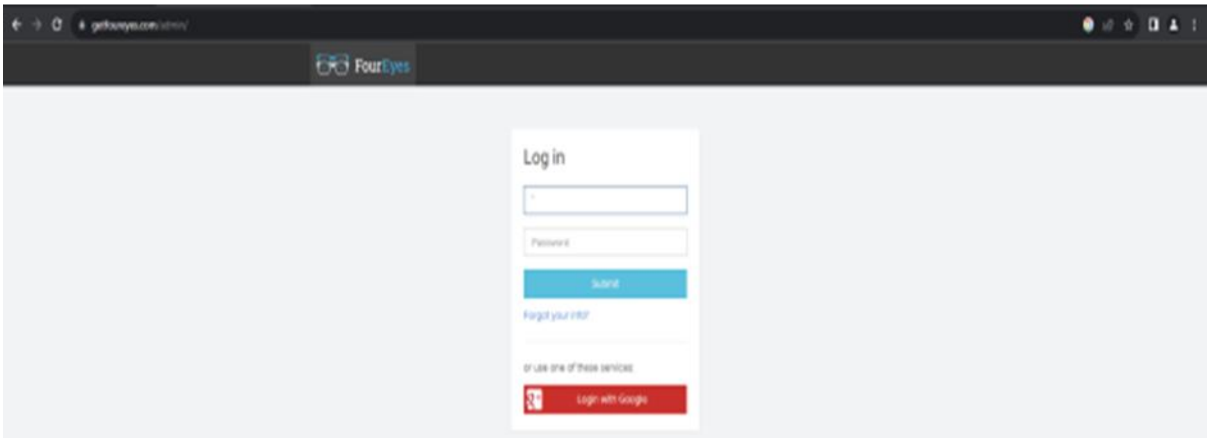



**Figure 3.2:** Four Eyes online survey registration and login page (Appendix K)

Figure 3.3 is a screen shot of where each respondent captured his or her demographic information before starting the survey. Using the login button allowed the respondent to login and logout of the portal using a username and password he or she generated during the registration process.

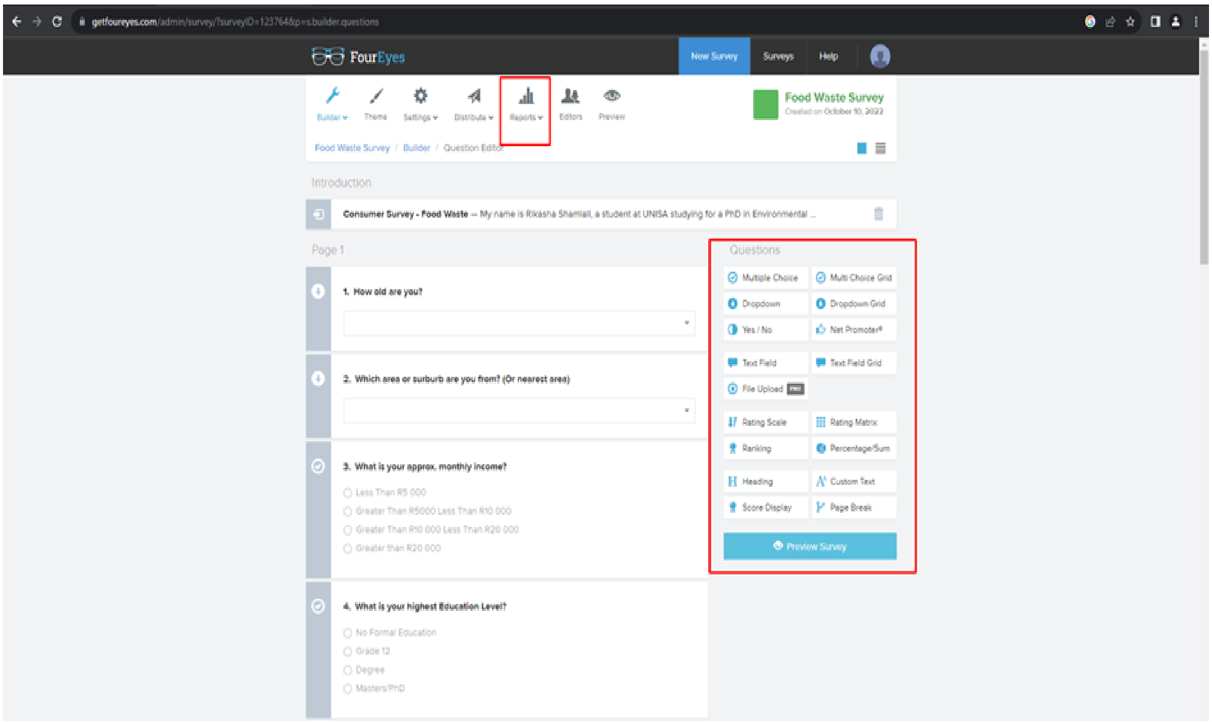



**Figure 3.3:** Four Eyes survey questionnaire participant responses online. Source: Generated by researcher (2023)

As the study was considered from the perspective of all retail stakeholders and customers of frozen food and food manufacturing company. One of the key aspects that led to respondents being selected for the survey was that if they agreed to participate, they would leave their mobile contact number for inclusion into a WhatsApp link broadcast group (Figure 3.4) and the four-eye survey link was distributed. The Four Eyes WhatsApp Questionnaire Survey Link Distribution list is available in Appendix J.

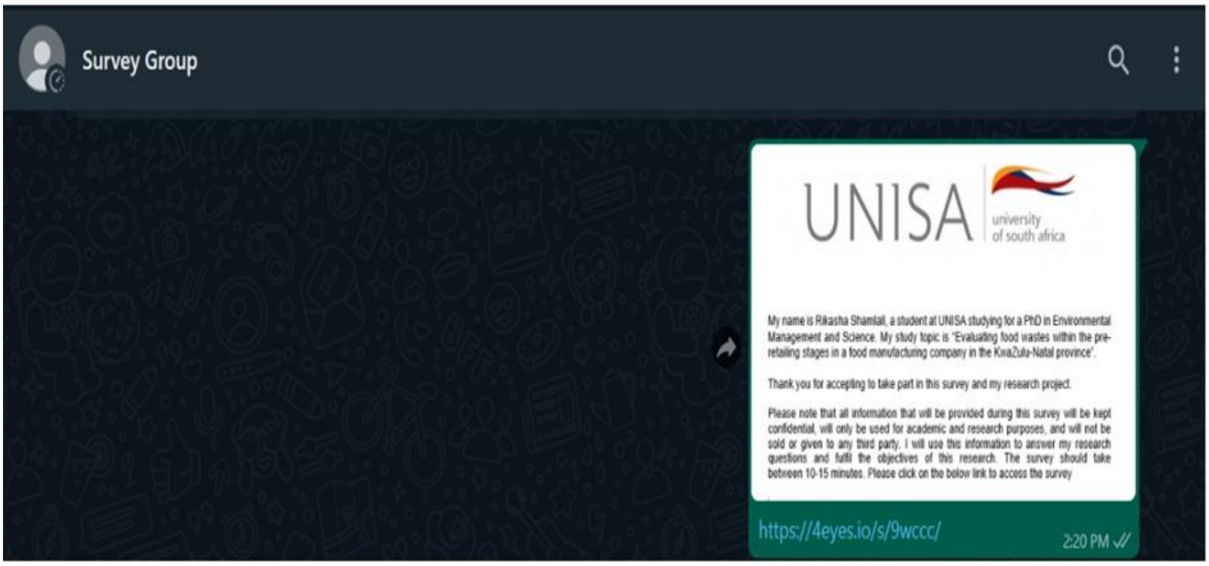
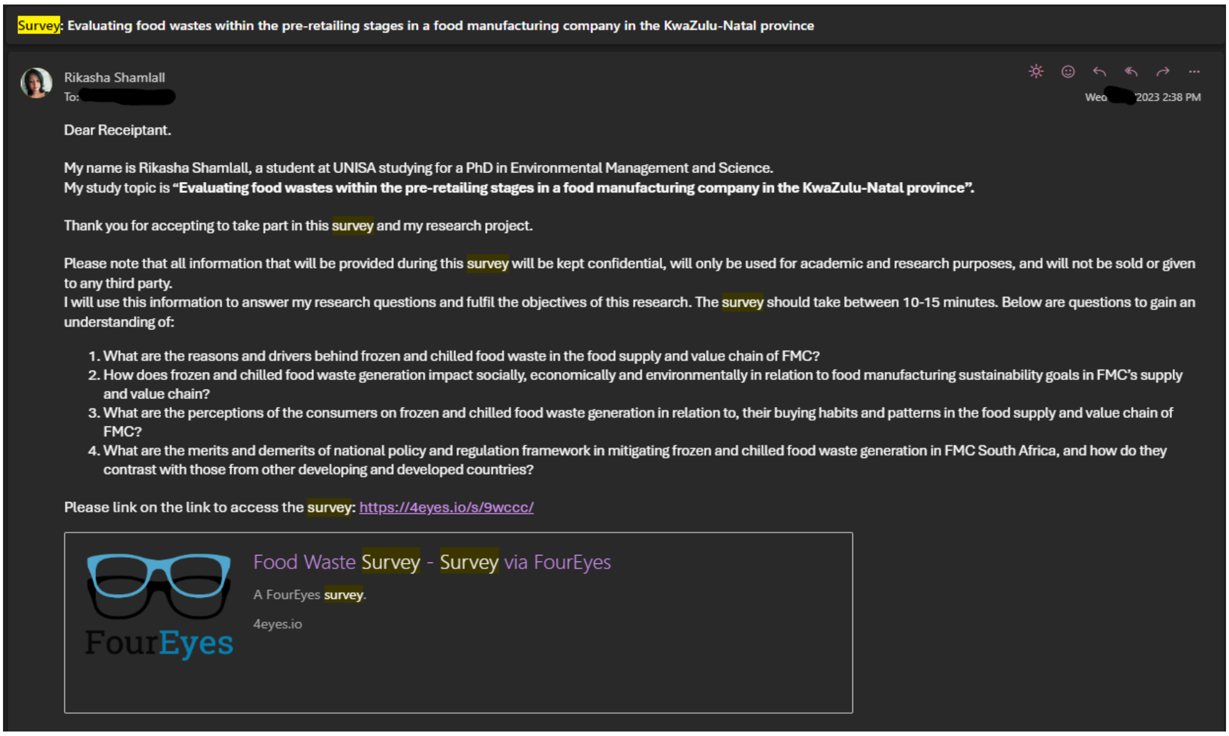



**Figure 3.4:** Screen shot of the WhatsApp message and link sent to respondents. Source: Generated by researcher (2023)

In addition, some respondents were drawn from store mobile phone number databases from those individuals who were card-carrying members of store clubs. Other than the WhatsApp broadcast group, electronic mails were also used to distribute the survey link to customers. In the case of store employees, emails were drawn from store databases and the survey link was distributed using electronic mail (Figure 3.5).

Another survey was conducted to test the results and collect a more robust data set overall. The survey was completed by the customer based on the respondents' response (George, 2022). Respondents for individual surveys were purposely identified during visits at stores.

An individual survey guide was prepared using a 5-point Likert rating scale. The respondents were expected to choose from an array of 5 responses which were [Strongly agree, Agree, Neutral, Disagree, Strongly Disagree]. For all the four objectives, 21 constructed positive statements were created per respondent and segregated in relation to the four study objectives.



Survey: Evaluating food wastes within the pre-retailing stages in a food manufacturing company in the KwaZulu-Natal province

Rikasha Shamlall
To: [redacted]

Wed [redacted] 2023 2:38 PM

Dear Receiptant.

My name is Rikasha Shamlall, a student at UNISA studying for a PhD in Environmental Management and Science.
My study topic is **"Evaluating food wastes within the pre-retailing stages in a food manufacturing company in the KwaZulu-Natal province".**

Thank you for accepting to take part in this survey and my research project.

Please note that all information that will be provided during this survey will be kept confidential, will only be used for academic and research purposes, and will not be sold or given to any third party.
I will use this information to answer my research questions and fulfil the objectives of this research. The survey should take between 10-15 minutes. Below are questions to gain an understanding of:

1. What are the reasons and drivers behind frozen and chilled food waste in the food supply and value chain of FMC?
2. How does frozen and chilled food waste generation impact socially, economically and environmentally in relation to food manufacturing sustainability goals in FMC's supply and value chain?
3. What are the perceptions of the consumers on frozen and chilled food waste generation in relation to, their buying habits and patterns in the food supply and value chain of FMC?
4. What are the merits and demerits of national policy and regulation framework in mitigating frozen and chilled food waste generation in FMC South Africa, and how do they contrast with those from other developing and developed countries?

Please link on the link to access the survey: https://4eyes.io/s/9wccc/

FourEyes

Food Waste Survey - Survey via FourEyes

A FourEyes survey.

4eyes.io

**Figure 3.5:** Four Eyes email questionnaire survey link distribution. Source: Generated by researcher (2023)

The questionnaires were formulated from a review of literature. Responses were captured through ticking the most preferred answer for the respondent (Appendix I). There were 31 respondents for this exercise, and they comprised professionals, store employees, walk-in customers, and policymakers.

#### 3.3.1.2. Qualitative Research Method

In-depth interviewing is a qualitative research technique used to conduct detailed interviews with a relatively small number of study participants. The interview questions were mostly open-ended and led to a discovery-based approach. The purpose of in-depth interviews was to obtain detailed information that sheds light on views, experiences, feelings, and meanings drawn from a particular topic or issue (Rutledge & Hogg, 2020). The same statements used to formulate the Likert scale were used to formulate questions whereby the research had to probe deeper. Respondents were expected to state why they agree or disagreed with the questions and statements. The same 31 respondents who participated in the Likert scale participated in this interview (Appendix I). Responses were obtained through an interview transcript, which was subsequently validated against pre-selected statements as themes. This validation process ensured that the chosen themes accurately captured the essence of the data and were relevant to the research objectives. Subsequently, an analysis of these themes was conducted to determine the outcomes of the respondents. The pre-selected statements, which served as the themes, were discussed with peers from the FMC who possessed knowledge in qualitative research. These peers provided valuable input to refine and validate the themes. This step is an integral part of the meta-analysis, in which key findings, themes, or concepts from each objective are extracted. This allows for the analysis of the data to identify common themes, patterns, or variations across studies. Following this, the findings from individual responses are integrated to form a higher-level interpretation or synthesis. This process involves examining overarching themes, relationships, or theoretical insights that emerge across studies (Hansen et al., 2021).

The informal interview is a type of unstructured interview that is less formal and more conversational than the structured or semi-structured interview. They are often used to gain an understanding of an environment and the views of its members. Informal interviews do not have questions ready but follow the natural flow of the conversation (George, 2022). The unstructured interviews were held with store managers in nine different retail outlets. A guide was prepared as a source reference to the researcher as she interacted with various store managers and questions were posed while the researcher moved around the shops and was shown around by the store managers. Questions were posed not in the chronological order in which they were prepared as this was an interactive process with all nine store managers (Appendix H). This process took place at the same time with observations. Responses were recorded digitally with the respondent's permission and thereafter for later transcription and analysis.

3.3.1.3. Secondary data collection method

The next major type of data collection involved secondary data collection. As per the ideas of Ryder et al. (2020), secondary data collection can be beneficial with appropriate facts and statistics that are peer-reviewed. The use of secondary data can be beneficial as it can help in engendering the desired understanding of any given area from the perspectives of different experts in any given domain. Its use in this study enhanced the overall impact of the study and facilitated appropriate results that were beneficial for the overall study.

Electronic store databases consisting of quantitative records for food waste from the retail stores, were collected from the FMC food waste records and used for the study. Food waste data from the FMC for the past five financial years (July 2017 to June 2022) was obtained from the central database of the FMC for analysis and analysed using both descriptive and inferential statistics. This central database is managed by a control tower or call centre whereby all products ordered or returned are logged after a valid approved invoice is received. This information is stored on Systems, Applications and Products in Data Processing (SAP), an enterprise resource planning (ERP) Software and Business Solution system which is integrated into Microsoft Power BI for business intelligence analysis and interactive dashboards.

This SAP database was accessed after permission was granted, with the researcher extracting approved data, such as volume in kilograms, case volume and rand value by store and category level. Names of stores and retailers where de-identified by the technology division before this dataset was approved by management for analysis. These data were exported into Microsoft Excel csv files which were imported into Microsoft Power BI for further analysis. Additional quantitative data from waste management companies that collected waste from the FMC was collected and used to evaluate the economic and environmental impacts of food waste from the selected categories.

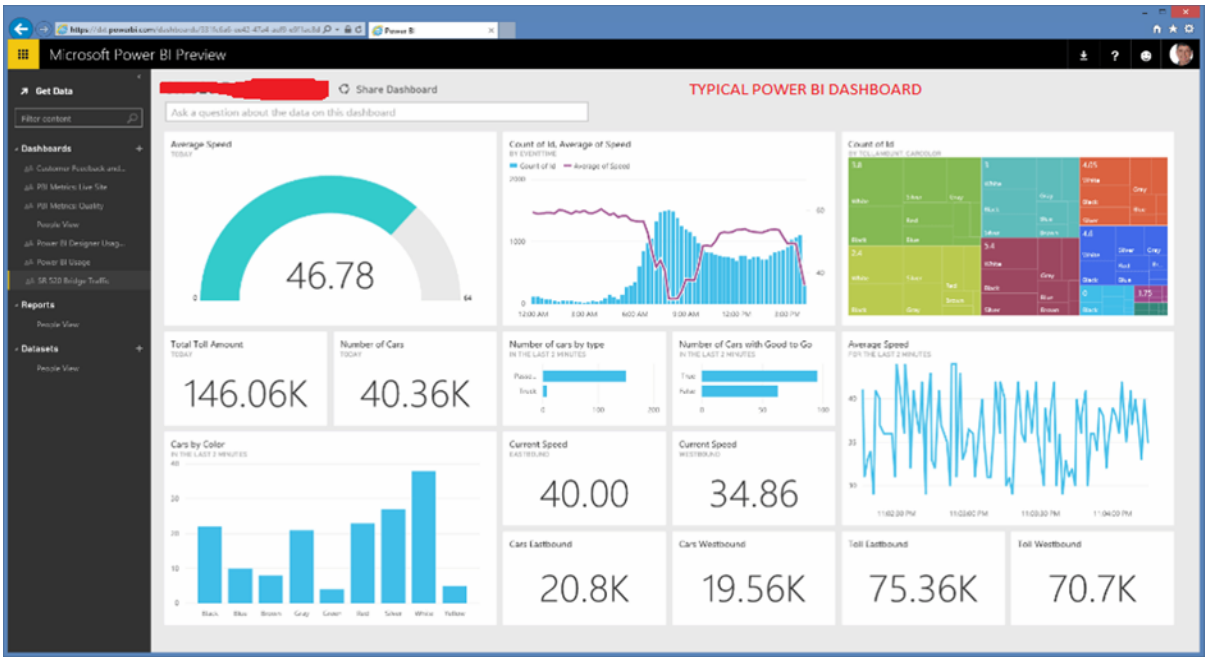



**Figure 3.6:** A typical dashboard of datasets imported from Excel being displayed in the dashboard of Power B as it is integrated to visuals and graphs. Source: Microsoft Power BI (2023)

Power BI for Office 365, now Microsoft 365, was initially based on Excel features such as Power Query, Power Pivot and Power View. Microsoft added features over time, including enterprise-level data connectivity and security options. By downloading the Power BI site or Windows 10, users can get Power BI Desktop from the Windows Store. Power BI components Microsoft Power BI works through connecting data sources and providing a dashboard of BI to the users. It can connect with just an Excel spreadsheet or bring together cloud-based and on-premises data warehouses. The use of Power BI has ensured ease of managing and interpreting data, which can be extremely beneficial and can help in generating more detailed outcomes using quantitative data.

With applications such as an Excel workbook or Power BI Desktop file connected to online or on-premises data sources, users can perform comprehensive data analysis and visualization tasks with ease and efficiency. Power BI consists of a collection of apps that can be used either on desktop, as a SaaS product or on a mobile device. Included within Power BI are several components that help users create and share data reports. Those are the following: a data mashup and transformation tool, memory tabular data modelling tool, a data visualization tool, geo-spatial data visualization tool and a natural language question and answering engine. Additionally, there are dozens of data sources that connect into Power BI, ranging from files (Excel, PDF, SharePoint, and XML), databases (SQL Server Database, Oracle Database, IBM databases, Amazon Redshift, Google Big Query), other Power BI data sets, Azure data connections and many online services (Dynamics 365, Salesforce Reports, Google Analytics, Adobe Analytics, Facebook, and others). Power BI Desktop is where analysts and other users can create data connections, data models and reports. To build a Power BI report, take the following steps:

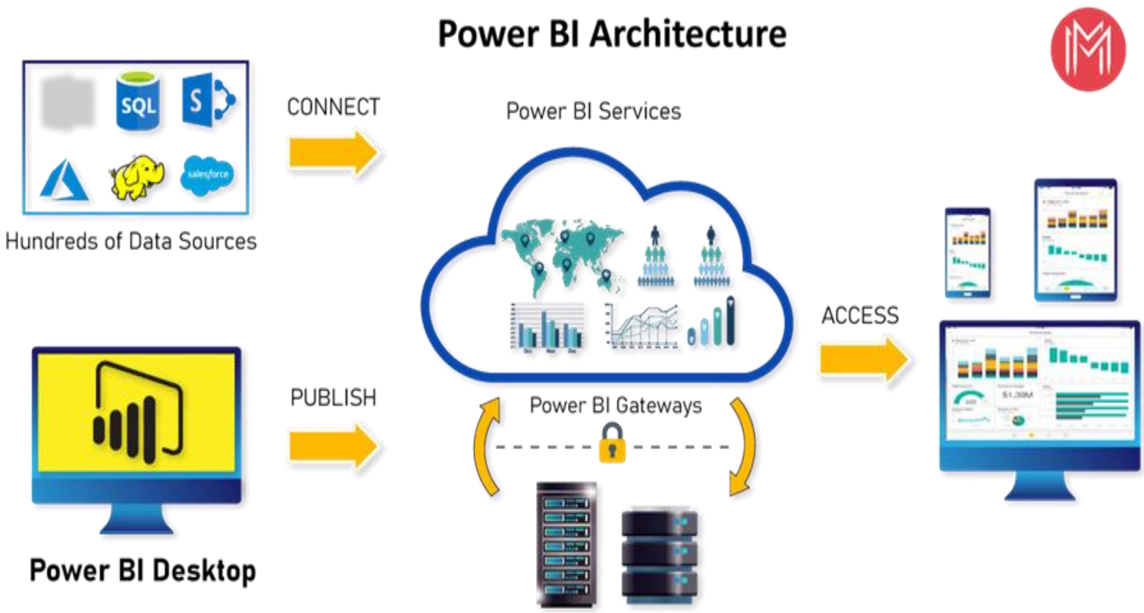



**Figure 3.7:** An illustration of Microsoft data integration processes from various sources to the server and conversion to visuals. Source: Power BI Architecture (2023)

Document analysis is a qualitative research technique used by researchers. This process involves evaluating electronic and physical documents so as to interpret them, understand their meaning, and expand on the information they provide (Kutsyuruba, 2023). The study analysis was also aided by employing a qualitative data approach using document collection and analysis as an additional source of secondary data from company records and policies on food waste. Sustainability reports for the last five years were accessed from the FMC central repository and used for analysis. The collected documents included waste management statutes, laws and policies regulating food waste management in South Africa. The researcher was specifically interested in identifying the following variables: strengths, weaknesses, opportunities, and threats of the regulatory framework in food waste management (Gürel, 2017). At least 6 important documents were reviewed and are as follows (Table 3.1). These were selected based on the relevance of the scope of this study to ensure a better and more detailed overall study.

**Table 3.1:** Document review. Source: prepared by researcher (2023)

| | |
|---|---|
| The Constitution | Provides for an unprecedented right-to-food (RTF); a fundamental right of every citizen. |
| The National Environmental Management Act (NEMA; 107 of 1998) | Provides the foundation for the treatment of the environment and outlines the core principles relating to waste (hence, indirectly food waste as a waste stream). |
| Foodstuffs, Cosmetics and Disinfectants Act (Act No 54 of 1972)<br><br>The Health Act (Act No 63 of 1977) | Addresses the sale, manufacture, and importation of foodstuffs. Offers regulations regarding the labelling and advertising of foodstuffs. Offers regulations on perishable goods with the definition Guides regulations related to the hygienic handling of food and the inspection of, inter alia, food premises are also enforced by local authorities |
| The International Health Regulations Act (Act No 28 of 1974) | Provides for the approval of the source of food for consumption at ports, airports, vessels and on aircraft, as well as for the inspection of such premises |
| Post-Harvest Loss Management Strategy (PHLMS; 2018) | Aims to achieve the target of the Malabo Declaration i.e., a commitment to ending hunger by 2025 through interventions such as halving the current levels of post-harvest loss.<br>In alignment with the Sustainable Development Goal 12.3. |

### 3.3.2. Breakdown of research methods and justification for each objective

Addressing this objective required the analysis of five years (July 2017 to June 2022) of secondary data consisting of monthly records of the food waste produced in the distribution phase of the FSC for chilled and frozen food from the FMC. This was based on returned food waste collected from the retail stores in KZN. Returned food waste is defined as any product that is deemed unfit to be sold due to several reasons such as packaging damages during transportation, expired products and contaminated products. Food waste was separated into different categories (meat, dairy and vegetable) and subcategories (fish, chicken, beef, pork, lamb, cheese, yoghurt, butter, vegetable, potato and soya). Reasons for the returned products were encoded in the data and were extracted and summarised. Using a sample size of 202 retail stores in KZN, the Power BI data analysis tool was used to summarise the data and for trend analysis. Major retailers and stores were given a unique ID to mask the names of stores and retailers. The findings from the Power BI tool were used to guide additional interview questions with the key participants based on any emerging issues that arise from the quantitative data analysis.

This objective was addressed using both qualitative and quantitative data from the primary and secondary data collection methods discussed earlier. Quantitative data from the company's records on food waste production, records from the waste management companies collecting the food waste from the FMC, and the evaluation of costs associated with returned food products and waste management were used to address the objective.

Environmental impacts were addressed by analysing secondary data of waste management processes currently in place for the different frozen waste fractions coming back from the retail shops. Waste volumes that were composted and landfilled monthly were used to develop projected environmental impacts of the various chilled and frozen wastes on the water and air quality. Predictive analysis based on trend analysis of historical waste management data for food waste in the company, and company documents (sustainability reports) provided data to achieve the environmental impact. Results of the analysis were exported into Excel and matched to document findings. Based on EPA calculations, for every ton of food waste 65 kg of methane gas ($CH_4$) is produced and 2500 kg of carbon dioxide ($CO_2$) (US EPA, 2015). With these estimates, the researcher calculated the impact on the environment.

The economic impacts of frozen food waste on the company were discussed in the project. Secondary data analysis of costs related to the management of frozen food wastes and the costs incurred by the FMC to reimburse the retailers for returned food was used to develop an economic profile associated with food waste in the company. The company did not offer consent for access and use of the financial data to achieve the economic impact. However, some of the important information to address this objective was collected from available information in the reports, the policy on the return of waste frozen foods in the company and surveys within retail shops (Table 3.2). A review of the existing model was used to determine if there are any gaps based on past studies, to determine the approach and if all the methods meet the required standards.

**Table 3.2:** Document and reports list used by researcher.

| Document | Report |
|---|---|
| Sustainability Reports (2018-2023) | Returns and Uplift Report (5 years) |
| Waste Management Policy | Sales Report (5 years) |
| Management Report (2018-2022) | Fridge and Freezer Breakdown Report (3 years) |
| Returns Process Policy | Management Waste Report |

The use of qualitative data from the interviews with the management team for the FMC and the retail store was used as a case study. The interview investigated the food waste processes within the distribution phase of the food supply chain and the drivers for the production of waste. The two respondents that oversee processes in the distribution phase and therefore were knowledgeable of the food waste problems in the FSC phase of interest. The interviews with the store managers investigated waste management processes taking place at the store level. The researcher also went to stores to observe the elements that drove food waste and to capture them on an observation sheet (Appendix L).

The consumer perceptions of food waste and their buying habits were measured using a five-point Likert scale. Descriptive statistics were used to answer the research questions on consumer perceptions. A questionnaire was created online and uploaded onto handheld devices in the store. The questionnaire interview was conducted with shoppers in the store by the researcher. The questionnaire consisted of a short introduction describing the study and went on to request permission to participate in this study about food waste. Once the participants had agreed and signed the informed consent form, they started the survey. The same online questionnaire was available on paper in the store.

A review of company documents, governing policies on food waste and interviews with the FMCs and the retail store's management teams was also conducted. The interviews and document review interrogated the current policies and practices on food waste and waste management within the distribution phase of the FSC, as well as the government's policy dealing with food waste. The results of the review were compared with international good practice as to the management of food waste to determine the gaps that may need to be examined to mitigate the food waste problem in the FSC in South Africa.

## 3.4. Population and Sampling

### 3.4.1. Population

A population is the object of the research and comprises individuals or groups of objects that the researcher was interested in studying and from which a researcher could sample in order to collect and analyse data (Berndt, 2020). In this study, there were two areas in which a study population was considered: first is the retail store base and secondly the consumer population. The retail store population of the current study was limited to all the retail stores that are serviced by the FMC and operating in KZN. As of June 2022, the FMC supplied its products to a total of 422 retail stores in KZN and constituted the total population. In terms of participants for the consumer surveys, the population consisted of all the customers of the retail stores (Figure 3.8).

**Table 3.3:** Sample size and category of respondents (Interviews & in-depth interviews). Source: Researcher (2023)

| **Category** | **Respondents** | **Actual Sample Size** | **Targeted Sample Size** | **% per 100** |
|---|---|---|---|---|
| Administered in-depth individual interview, individual Interview & informal individual interview Semi-structured interviews | | | | |
| 1. In-Depth Ind Interview (Que.) | Employees | 15 | 20 | 2,86% |
| 2. In-Depth Ind Interview (Que.) | Environmental Scientists | 8 | 10 | 1,53% |
| 3. In-Depth Ind Interview (Que.) | Walk-in Customers | 5 | 10 | 0,95% |
| 4. In-Depth Ind Interview (Que.) | Policy-Makers | 3 | 5 | 0,57% |
| 5. Second interview (Que.) | Store managers | 9 | 15 | 1,72% |
| Online consumer perception self-administered questionnaire | | | | |
| 6. Online Four Eyes (Quest) | Consumers | 484 | 600 | 92,37% |
| **Total** | | **524** | **660** | **100,00%** |

Respondents for individual semi-structured interviews included: 15 employees, 8 environmental scientists, 5 walk-in customers from retail outlets supplied by the Food Manufacturing Company, 3 policy makers, 9 store managers and 484 online survey participants.

**Table 3.4:** Store electronic data, document review and observations. Source: Researcher (2023)

| **Category** | **Source** | **Type of Document** | **Number of Documents/Records** | **Percentage per 100** |
|---|---|---|---|---|
| 1. Electronic Store Data | SAP (Intranet) | Sales | 202 | 100% |
| 2. Electronic Store Data | SAP (Intranet) | Stock returns | 202 | 100% |
| 3. Electronic Store Data | SAP (Intranet) | Products | 202 | 100% |
| 4. Electronic Store Data | SAP (Intranet) | Estimated R Value | 202 | 100% |
| 5. Electronic Store Data | SAP (Intranet) | KGs | 202 | 100% |
| 6. Electronic Store Data | SAP (Intranet) | Cases | 202 | 100% |
| 7. Policy Documents | Government, Stakeholders Online databases | Policies, Standards, Reports & Sustainability Reports | 6 | 75% |
| 8. Observations | In Store | Photos | 9 | 4% |

Further appropriate secondary data was collected from the policy documents and so these documents serve as the main samples for secondary quantitative data. The table above indicates the kinds of policy documents and their contribution to the study. Reviewed documents were sourced mainly from the Systems, Applications and Products Data Processing system for data processing. This software was developed for management of business processes, developing solutions and facilitating effective data processing and information flow across organisation(s). Sales reports, stock returns, product information, KGs and case documents for 202 retail outlets supplied by FMC were sourced from the company's intranet system. Three reports were sourced for the department's inter-waste wing, an external party that and conducted the waste management services at the FMC.

### 3.4.2. Sampling

Sampling is a process in which individual members or groups of objects, or a subset of the population, is selected in order to make statistical inferences from them to estimate or generalise to a given population (Berndt, 2020). In this study, the minimum sample size for this population was estimated by setting the target level of statistical significance for achieving a target level in an estimate for a specific population parameter (Bujang, 2021). Purposive sampling is a non-probability sampling method which involves choosing participants who offer the study rich amounts of information. By definition, convenience sampling refers to the selection of participants based on their availability and willingness to participate (Huyler & McGill, 2019). Convenience sampling was a type of non-probability sampling where participants are selected for inclusion in the sample due to convenience for instance closeness to the researcher. Almost all these sampling techniques were engaged in the study as it draws from four sources of data sets which are the four eyes, individual interviews, in-depth individual interviews, and document review.

A simple random sampling plan was used to select the retail store sample for the study. The process involved assigning each of the retail stores in KZN a number from 1 to 422, the total number of units in a spreadsheet in Excel to pick a random sample. The Andrew Fishers formulae was assigned to randomly draw a sample size of 202 retail outlets from 422 supplied by the Food Manufacturing Company and its reliability was checked against the Qualtrics online calculator.

**Andrew Fishers formula** = Sample Size (n) = $\dfrac{1 + z^2 \times p\,(1 - p)}{e^2\, N}$

| n | 1 | z | p | $e^2$ | N |
|---|---|---|---|---|---|
| 202 | 1 | 0.95 (95%) | 422 | 0.5 | 422 |

n = estimated sample size

z = Normal deviation at the desired confidence interval

p = Proportion of the population with the desired characteristic

The Qualtrics online sample size calculator (Qualtrics, 2022) determined that a minimum sample size of 202 retail stores was required in order to achieve a 95% confidence level with a 5% error margin in order to give an accurate estimate of sample size. The same Andrew Fisher's formulae was validated in Excel statistical package through the function Rand (0) gives the same result (n=202) (Figure 3.8). Similarly, a sample of 385 participants was determined to be sufficient to give a reliable sample size based on the above quoted population. Therefore, a sample size of 202 was assigned as randomly selected retail outlets where in-depth individual interviews, individual interviews and document review was to be done. This sample almost determined the sampling universe of any data collection process in the study.

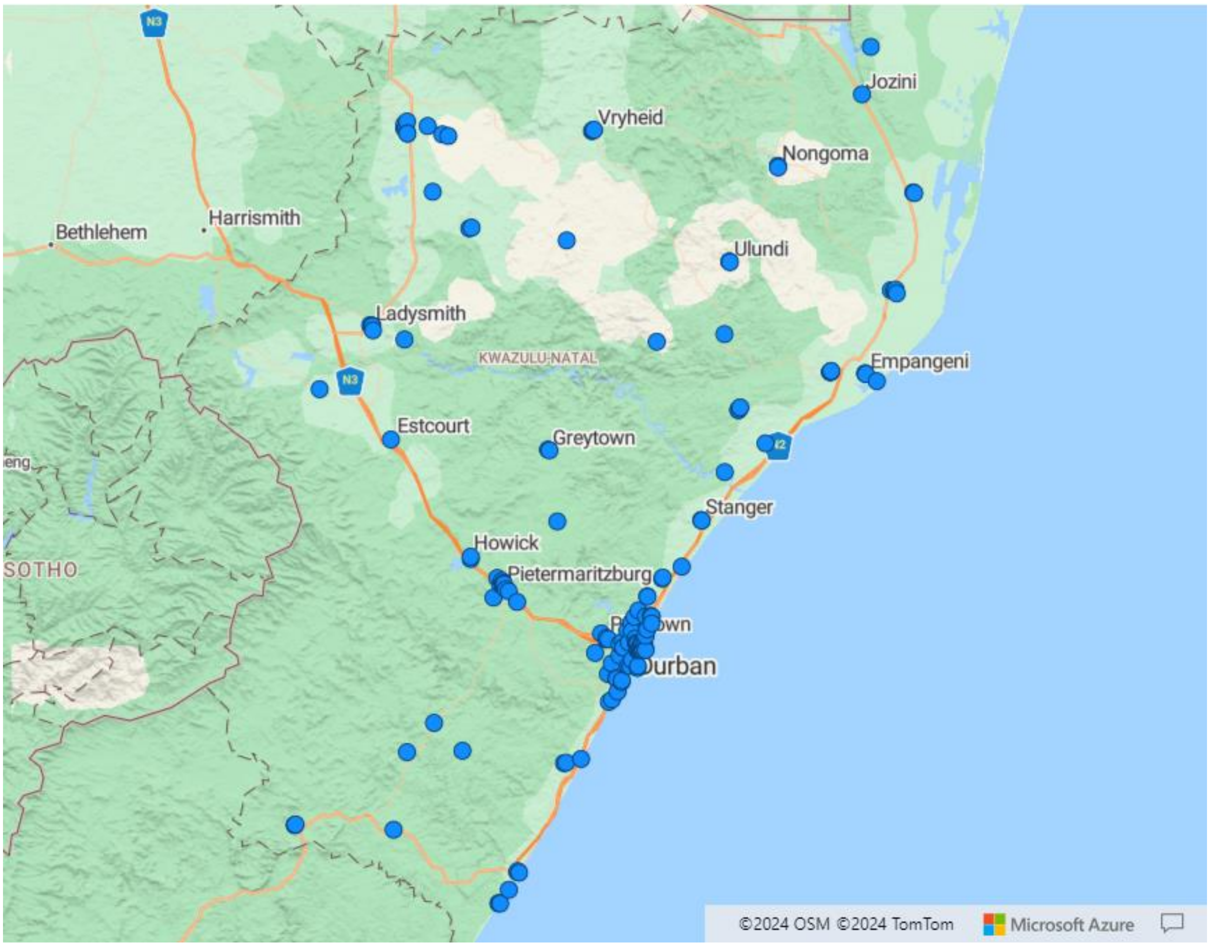



**Figure 3.8**:The geographical location and spatial distribution of the stores. Source: Generated by the researcher using Power BI

#### 3.5.2.1. Qualitative Data

Purposive sampling was used to collect the qualitative data. As per Wohlin & Runeson (2021), using purposive sampling can allow the researcher to select the samples as per their needs and the needs of the study. This means that the overall study here has been conducted using two kinds of sampling, random for the survey process and purposive for the interviews and the secondary data collection. The use of purposive sampling along with appropriate snowball sampling was employed to generate better overall results. The use of purposive sampling allowed the researcher complete liberty to select only those respondents who had participated in the second survey as mentioned in the data collection segment, so as to ensure better and more in-depth interview conduction.

An interview is a qualitative research method that involves asking questions to collect data. Interviews are a much more personal form of research than questionnaires (George, 2022). The sample for individual interviews was drawn from 31 respondents (Table 3.5) segregated into professionals, store employees, walk-in customers, policy makers and store managers. They comprise 5.91% of the total sample.

**Table 3.5:** Sample respondents for both Interviews (Source: Created by Researcher, 2023)

| Informant | Role | Position | Education | Age | Gender | Race | Interview Date | Duration |
|---|---|---|---|---|---|---|---|---|
| Informant A | Retail Sales Executive | Employee | Degree | 36-45 | Female | White | 2023-02-08 | 1:10:00 |
| Informant B | Retail Sales Executive | Employee | Degree | 26-35 | Male | White | 2023-02-08 | 0:58:20 |
| Informant C | Area Sales Manager | Employee | Degree | 36-45 | Male | Black | 2023-02-23 | 0:57:00 |
| Informant D | Area Sales Manager | Employee | Grade 12 | 18-25 | Male | Indian | 2023-02-28 | 1:02:30 |
| Informant E | Area Sales Manager | Employee | Diploma | 36-45 | Male | Black | 2023-02-23 | 1:10:00 |
| Informant F | Area Sales Manager | Employee | Grade 12 | 26-35 | Female | Coloured | 2023-03-01 | 0:56:30 |
| Informant G | Regional Sales Manager | Employee | Degree | 36-45 | Male | White | 2023-03-06 | 0:55:00 |
| Informant H | Sustainability Manager | Employee | MBA | 56 and + | Male | White | 2023-03-17 | 1:25:35 |
| Informant I | SHEQ Manager | Employee | Degree | 26-35 | Female | White | 2023-03-22 | 0:55:00 |
| Informant J | SHEQ Manager | Employee | Degree | 26-35 | Female | Indian | 2023-03-22 | 0:36:00 |
| Informant K | SHEQ Manager | Employee | Degree | 36-45 | Male | Black | 2023-03-23 | 0:45:00 |
| Informant L | SHEQ Manager | Employee | Degree | 46-55 | Female | Indian | 2023-03-24 | 0:56:00 |
| Informant M | SHEQ Manager | Employee | Degree | 36-45 | Female | Black | 2023-03-27 | 0:42:00 |
| Informant N | SHEQ Manager | Employee | Degree | 46-55 | Male | White | 2023-04-03 | 0:40:00 |
| Informant O | Compliance Manager | Employee | Degree | 46-55 | Male | White | 2023-04-05 | 1:15:00 |
| Informant P | Student | Student | Degree | 26-35 | Female | Indian | 2023-04-19 | 0:45:00 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Informant Q | Student | Merchandiser | Diploma | 18-25 | Female | Black | 2023-04-21 | 0:56:00 |
| Informant R | Student | Merchandiser | Degree | 26-35 | Male | Indian | 2023-04-25 | 0:42:00 |
| Informant S | Student | Student | Degree | 26-35 | Male | Indian | 2023-04-21 | 0:45:00 |
| Informant T | Student | Student | Degree | 18-25 | Female | Black | 2023-04-25 | 0:56:00 |
| Informant U | Environmental Professional | Environmental Professional | Degree | 36-45 | Male | Black | 2023-04-25 | 1:15:00 |
| Informant V | Environmental Professional | Environmental Professional | MSc | 46-55 | Female | White | 2023-04-19 | 0:42:00 |
| Informant W | Environmental Professional | Environmental Professional | PhD | 46-55 | Male | White | 2023-04-21 | 0:45:00 |
| Informant X | Landfill Manager | Civil Servants | PhD | 46-55 | Male | Indian | 2023-04-25 | 1:15:00 |
| Informant Y | Landfill Supervisor | Civil Servants | MBA | 46-55 | Male | Indian | 2023-04-25 | 1:15:00 |
| Informant Z | Landfill worker | Civil Servants | Degree | 36-45 | Male | Black | 2023-04-21 | 0:42:00 |
| Informant AA | Customer | Customer | Degree | 36-45 | Female | Indian | 2023-04-25 | 0:25:00 |
| Informant AB | Customer | Customer | Degree | 26-35 | Male | Black | 2023-04-19 | 0:25:00 |
| Informant AC | Customer | Customer | Diploma | 18-25 | Female | Indian | 2023-04-21 | 0:25:00 |
| Informant AD | Customer | Customer | Matric | 18-25 | Female | Coloured | 2023-04-21 | 0:25:00 |
| Informant AE | Customer | Customer | Degree | 26-35 | Male | Indian | 2023-04-19 | 0:25:00 |

An in-depth interview is a qualitative research technique used to conduct detailed interviews with a small number of participants. Unlike other forms of qualitative research, researchers using the in-depth interview method invest considerable time with each participant using a conversational format. The interview questions were mostly open-ended and led to a discovery-based approach. The purpose of in-depth interviews is to obtain detailed information that sheds light on views, experiences, feelings, and meanings drawn from a particular topic or issue (Rutledge & Hogg, 2020). The sample for individual interviews is the same sample of 31 respondents segregated into professionals, store employees, walk-in customers, policy makers and store managers. They comprise 5.91% of the total sample.

As the overall study consisted of three kinds of data collection in the form of two surveys, two interviews and secondary data collection, and both qualitative and quantitative data were collected two kinds of sampling have been employed. Firstly, random sampling was used for the survey and purposive sampling was employed for the interview and the secondary data collection. This was done to ensure that best the possible data were collected and analysed.

## 3.5. Data Analysis

### 3.5.1. Quantitative data analysis

Neuman (2011) regarded data analysis as the process that brings order, structure, and meaning to the collected data. The present research consists of both quantitative and qualitative data analysis was used to address the research questions of this study. Quantitative data analysis is summarised in Figure 3.20 below consisted of the following steps: preparing data, exploring data, analysing data, representing data analysis, interpreting results, and validating data and results (Creswell, 2011). Quantitative data in this study employed descriptive statistics to analyse the data. Descriptive statistics, also referred to as summary statistics, are used to summarize, organize, and reduce large numbers of observations. Quantitative data from the questionnaires were analysed using Statistical Package for Social Science (SPSS), IBM SPSS version 20. Descriptive and inferential statistics were used.

The demographic data of respondents were analysed quantitatively using percentages and frequencies. The remainder of the responses were collected from employees of the Food Manufacturing Company consisting of retail sales executives, sustainability managers, SHEQ managers and the sustainability director, environmental scientists and UNISA students and policy makers. Walk-in customers were randomly approached at retail outlets and requested to participate in the interview.

Data collected through individual survey guides were analysed quantitatively. The data was captured and run in IBM SPSS version 20. It was segregated into four constructs with 21 questions in total. The first data set involved (I) drivers and reasons for chilled and frozen food waste generation, (ii) socio-economic and environmental impacts and consumer perception and the policy framework. The questionnaire included a section for demographic details of the respondents. The constructs were subsequently transformed into mean variables through computation. The mean variables were then used to narrow down the arguments and a median value of the data set was then computed to show variables that were significant by way of being above the median value (Table 3.6) and those that are insignificant to values that were below the median value of the data set of the constructs. The significant data were used to infer the meaning supported by existing literature. In instances where literature did not substantiate the value, the research provided explanations for this absence. Subsequently, this literature was integrated with other sections of the datasets in this study to derive conclusions regarding the apparent implications of data interpretation.

**Table 3.6:** Median values of objectives. Source: developed by researcher (2023)

| Construct/Objective | Median Value |
|---|---|
| Reasons & Drivers | 4,345 |
| Socio-economic and Environmental | 4,064 |
| Consumer Perceptions | 3,523 |
| Policy Framework | 4,123 |

The computation of median values across each construct of the above four data sets enabled the researcher to depict significant and non-significant values. Anything below the above median values was considered insignificant and was ignored for discussion. However, almost all statements recorded a significant value. The reliability and consistency test were run through the Cronbach's Alpha reliability scale (Figure 3.9) which had to ensure quality so that if the same measure was done the results would be the same.

**Reliability Statistics**

| Cronbach's Alpha | Cronbach's Alpha Based on Standardized Items | N of Items |
|---|---|---|
| ,981 | ,982 | 24 |

**Figure 3.9:** Cronbach reliability measure (Source: SPSS)

Consistency is rated increasing from a value of 0.7, a value of 0.981 signifies a highly recommended value for reliability and consistency.

Data from the online Four Eyes questionnaire were exported from the online platform and imported to Microsoft Power BI to compute percentages of customer's perceptions on meat, dairy and vegetable products. Percentages were computed from the percentage of a 100 since respondents had an array of 13 questions each with an assortment of four questions with which the respondent had to choose one per question. Data were dovetailed with the rest of the data results from various data sets. The percentages in responses for the retail outlets were masked. To derive the statistics for chilled and frozen food waste generation, the frequencies of the commodities were fed into PBI to visualize in graphic percentages by way of a pie chart as segregated by size of retail outlets (Figure 3.10). The findings were then integrated and analysed with the rest of the data from other data sets.

Microsoft Power Business Intelligence is a tool for data analysis (Palma-Ruiz et al., 2022). Power Business Intelligence (Power BI) was also used in data analysis of the study. It is a business analytics service by Microsoft for processing huge volumes of data like in the case of the 202 retail outlets supplied by the Food Manufacturing Company (FMC). The data were segregated by the type of food waste produced as well as the retail store group. The Power BI provided interactive visualizations and created reports and dashboards that enabled a comparison of raw data and secondary data in interpreting study results. It mainly determined the trends and patterns that were collated and aligned with the aims and objectives of the study. The choice of model was due to the researcher’s experience in using the Power BI tool as it has many advantages over other tools and is very easy to use. End users do not need any technical knowledge and skills to create advanced reports and dashboards. Power BI is a standalone product that is more powerful when compared to Microsoft Office, Microsoft Teams, Power Platform, and Azure ecosystems.

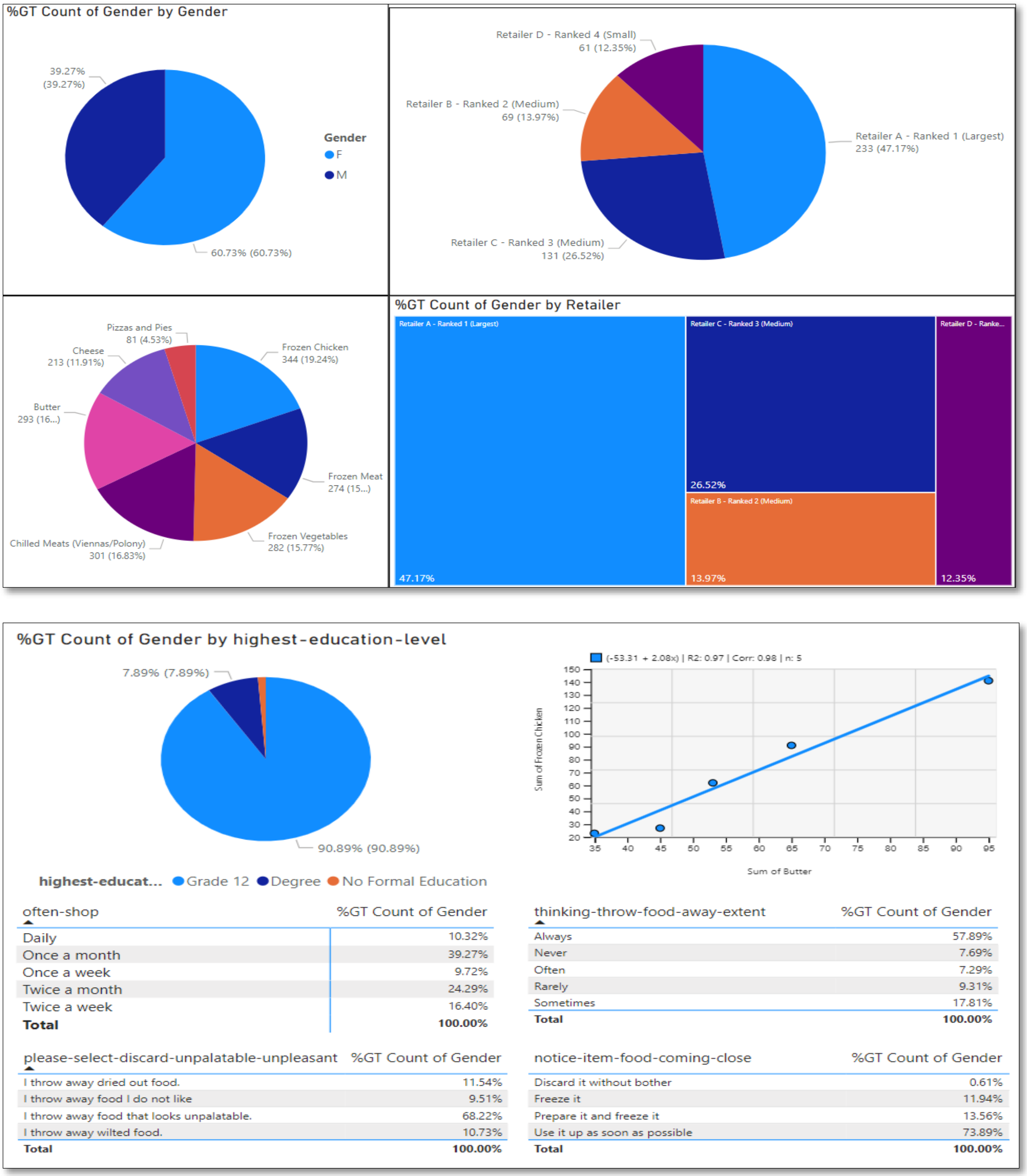



**Figure 3.10:** Illustration of computation of percentages on PBI. Source: Generated by Researcher (2023)

Qualitative data analysis in this study involved triangulation of data. Qualitative data was collected through interviews and document review. Power BI lacks statistical capability to narrow down data sets to statistical means values, standard deviations, correlations analysis and others. It is for this reason this study uses both the Statistical Package for Social Sciences and Microsoft Power BI to complement each other.

Databases were retrieved from the 202 retail outlets of the FMC. The aim was to establish sales against losses in sales of frozen and chilled food commodities. Furthermore, it was to establish stock returns of products, the estimated R-Value regarding kilograms waste, number of cases and to estimate the cost of chilled and frozen food that goes to waste because of reasons such as spoilage due to a number of factors such as poor storage facilities and refrigeration, delays in logistics and supply chain and faulty storage facilities as most of these commodities are fast moving consumer goods and have a short shelf life. Comparisons were also made as to stock lost versus stock ordered, returned damaged products, the tonnage, and quantification in terms of monetary value of the discarded products etc.

To arrive at such values and figures the researcher exported such databases from the FMC company server (intranet system) and uploaded those in Power Business Intelligence software. The software has the capability of processing and converting databases from a variety of other statistical software such as SQL, Microsoft, SPSS and others. The software is designed to compute percentage values and ratios and it has a great visualization capability. It can also produce visuals from values imported from other software packages. However, it has the weakness of not being able to compute statistical values. So, this software was used to compute the percentages of frozen and food waste generation in the entire 202 retail outlets of the FMC which were used to provide evidence of frozen and chilled food waste as a cause for concern within these retail outlets and the FMC. The data were analysed through computing it per 100% of the four different categories of the retail outlets by size per variable which include, sales losses, returns, estimated R-Value, losses in kilograms and the number of cases recorded.

### 3.5.2. Qualitative data analysis

Qualitative data analysis in the case of any study can be beneficial and has been conducted by making use of appropriate thematic analysis techniques (Bhatia, 2018). The main idea of data collection using the two interview techniques that were conducted was to ensure that a robust pool of qualitative data was available. Study data were collected and analysed by creating an interview transcript, which helped in forming effective codes from preselected statements. These codes were developed by identifying appropriate keywords from the overall interview transcripts. The entire process comprised 6 distinct phases, which allowed the generation of appropriate results. All these stages are interlinked and facilitated appropriate data analysis of the qualitative data using the most relevant themes.

The individual in-depth interview guides used open-ended questions in the in-depth interview process. The use of the overall questions that were used in the previous survey was again used but without the limitations of the Likert Scale. Thus, these questions were converted into interview questions, which was done to seek a justification for the choices that were made during the survey process. This is a critical aspect as it helped in understanding the responses of the survey better and again reinforced the importance of using mixed methods research. In addition, it generated a wider pool of qualitative data for analysis, which was conducted using thematic analysis. This iterative approach helped ensure data validity and provided a comprehensive understanding of stakeholder perspectives. The iterative approach employed in this research not only ensured data validity, but also allowed for a comprehensive understanding of stakeholder perspectives by utilising both quantitative and qualitative methods of data collection and analysis. Data were then processed into Microsoft Word documents.

A content analysis of the collected data was done according to Bryman (2016). This is a flexible method used to reveal the apparent content of the item in question and thus interprets meaning. Content analysis, according to Merino and SalasBlas (2018) takes one or both of two approaches: coding the narratives according to discrete themes or categories and rating the narratives on continuous dimensions. The data were coded and classified under identified categories (Leedy & Ormrod, 2019), which aided the researcher in identifying emerging themes. For all the 31 respondents, the prevalence of responses was converted to percentage of the total response. Significant responses were those with more than 50% as a percentage of overall response rate. Themes with a response rate less than 50% were considered insignificant. Examples of such response statements were then extracted verbatim to be a part of the evidence in presentation of the data and the percentage of the responses, for example (70%).

Semi-structured interviews were conducted by the researcher to establish the subjectivity of the retail stores managers as to the problem of food waste generation. An interview guide was prepared with a set of 29 questions, however not all the questions were posed due to time constraints. Nine interviews were conducted at from nine retail outlets with different store managers to identify common trends in food waste generation peculiar to each various outlet. The researcher carried a notebook to capture responses. For analysis, the researcher then navigated through the data to identify common thematic areas amongst the responses. The researcher identified 7 key words and responses which were most common in all the interviews. The themes and arguments were created around these keywords to depict the most compelling challenges pertaining to chilled and frozen food waste generation. The key words forming the themes for argument were “food, waste, product, freeze, store and policy” (Figure 3.11).

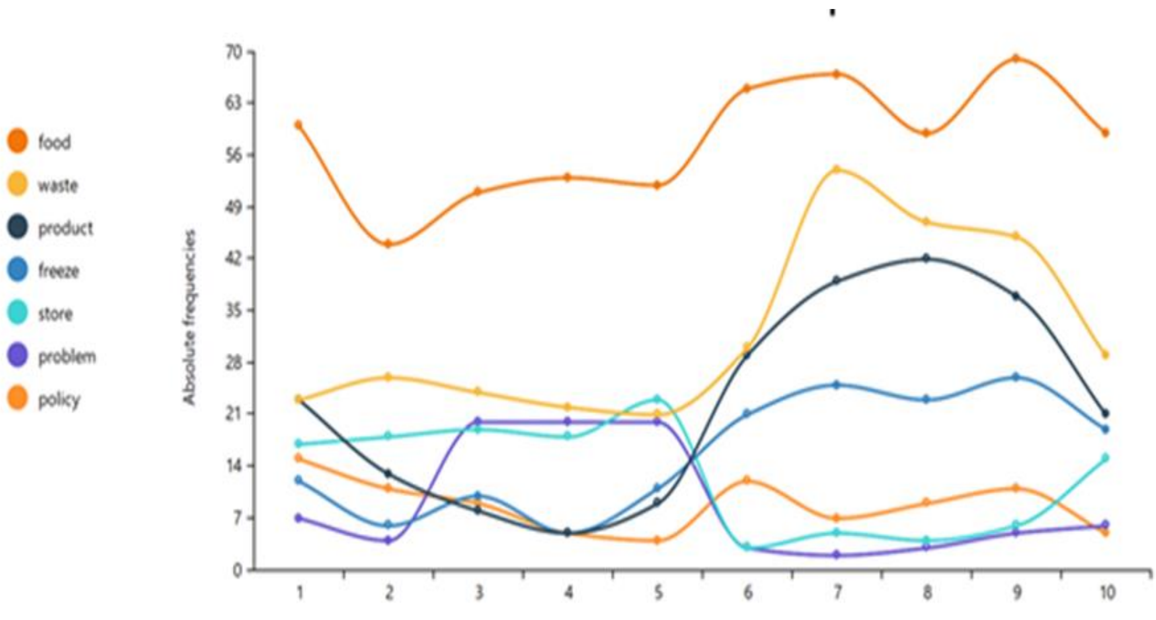



**Figure 3.11:** Interview Themes. Source: generated on SPSS by researcher (2023).

The respondents were recorded verbatim as they expressed true sentiments about the challenge of chilled and frozen food waste generation. Another major area was the analysis of the secondary data consisting of both quantitative and qualitative data. The quantitative data was analysed using Power BI models, but the qualitative data analysis segment was conducted using the thematic data analysis style. From the preselected statements, the themes were generated by making appropriate use of codes, which were generated through the keywords that were present in the data bases. These keywords were converted into codes, wherein, each code represented a different aspect, which is worthy of study. These codes were filtered, and the most appropriate ones were converted into the major themes that were appropriately analysed (Table 3.7). Therefore, the thematic analysis style was used for the analysis of the collected qualitative data (Kutsyuruba, 2023). This is one of the main analysis styles that was adopted throughout the study.

**Table 3.7:** Objective-based thematic coding. Source: Researcher (2023)

| **Theme name** | **Sub - Theme name** |
|---|---|
| Reasons and drivers | Cold and chilling storage, expiration, temperature levels |
| | Consumer buying patterns, over-ordering, and overstocking |
| | Inventory management and reporting |
| | Inadequate generation, transmission, and distribution of electric power |
| | Supplier packaging defects and pathogen contamination Rejection |
| Socio-economic and environmental impacts | Food insecurity, and malnutrition |
| | GDP, inflation and food price hike |
| | Greenhouse gas emissions |
| | Sustainability goals |
| Consumer perceptions | Shelf-life standards and Expiry dates |
| | Benefits of discounts |
| National policy and regulation framework | The national food waste management policy framework is highly commended with opportunities for growth |
| | The national food waste management policy framework is highly condemned with potential threats |
| | The national food waste management policy framework compares better to other regional under-developed and developed countries. |

In addition, a SWOT analysis (Figure 3.12) was used to assess and understand the internal and external forces that may create opportunities or risks for the FMC. This analysis of strengths, weaknesses, opportunities and threats highlights weaknesses and strengths as internal components and opportunities and risks as external factors (Gürel, 2017). This analysis was used for the document review process.

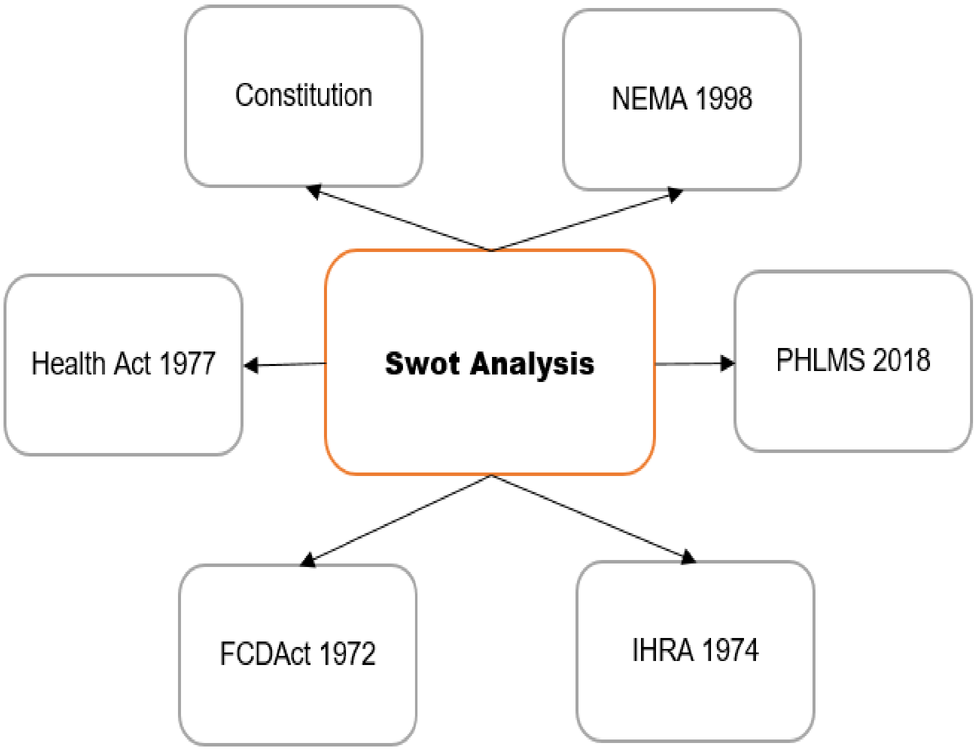



**Figure 3.12:** Document review and analysis process. Source: Researcher (2023)

## 3.6. Validity and Reliability Measures

### 3.6.1. Validity

Validity refers to the validity of the instruments (Singleton & Straits, 2010). Content validity (Leedy & Ormrod, 2019) of the instruments was carried out to determine the extent to which the instruments are a representative sample of the content area or domain being measured. Academic subject matter experts, the Supervisor and some selected colleagues from UNISA were approached for their input to validate the instruments.

### 3.6.2. Reliability

Reliability refers to the stability and consistency of the measurement instrument (Singleton & Straits, 2010; Yaddanapudi & Yaddanapudi, 2019). Reliability is also the extent to which the instrument will produce consistent results when the same characteristics being measured have not changed (Leedy & Ormrod, 2019; Merino & SalasBlas, 2018). In order to determine the reliability of the instruments, internal consistency reliability (Merino & SalasBlas, 2018) was ensured. Cronbach's alpha reliability coefficients were used to compute the reliability of the instruments.

The overall score was 0.981. The instruments were also pre-tested (piloted) using some of the employees of the Food Manufacturing Company who did not form part of the respondents of this study. According to Yaddanapudi and Yaddanapudi (2019) piloting helps in a number of ways, such as helping the researcher with the optimal wording of questions, sequencing of questions and thereby reducing the non-response rate. The pilot study provided valuable insights and feedback that assisted in refining the research methodology and approach. The pilot study helped identify areas of improvement in the questionnaire design, leading to revisions to ensure better comprehension and relevance of questions.

## 3.7. Research Limitation

This research involved frozen and chilled food waste in the distribution stage of the FSC that involves many factors such as losses of food in the FMC's warehouse before transportation to the retailers and wholesalers, transport damage, as well as losses once the food is transferred to the retailers. The current study was limited to food waste for retail stores and so does not cover food waste in the wholesale sector. It was also noted that records for food waste in the distributor depot do not form part of the captured data. Additionally, data for food waste before the various consignments are transferred to the retailers are not part of the recorded data.

The data available was for second-phase distribution that linked the manufacturer's data to the retailer's internal damage or losses. When seeking permission from a multinational company, there was some difficulty accessing some information and facilities. Gaining access to the food manufacturing company has a few limitations.

The researcher had sought approval to access some data (APPENDIX B). The process for approval was protracted and was accompanied by a level of restriction on some of the data required to answer all the objectives of this study. While the researcher did her level best to get access to the relevant information to complete the research, such restrictive factors may have placed limitations on the data available for the study. The limitations on the study's findings and conclusions included considerations of potential biases or gaps in the data resulting from the restricted access, as well as the impact on the study's ability to fully address its objectives. Overall, while the difficulty in accessing information and facilities posed challenges to the research process, the researcher took steps to navigate these obstacles transparently and mitigate impact on the study's validity and reliability.

### 3.8. Ethical considerations

The researcher followed all ethical guidelines in this study. Permission was obtained from the Unisa – CAES Health Ethics Committee (2023/CAES/HREC_014) to conduct the study. At the start of each interview, each respondent was informed on the nature and purpose of their involvement in the study. Each respondent was then requested to read and understand and sign an informed consent letter prior to the interview (APPENDIX D). To confirm their willingness to take part in the research study, participants signed an informed consent form. By responding "I agree with the above and would like to give consent to complete the questionnaire”. It was made clear that the study was solely for academic purposes and that participants' privacy would be upheld. By removing any identifying information from the final report and giving participants the option to accept or decline participation, confidentiality was maintained as much as possible.

Although some respondents' personal information was recorded for the study, respondent data were anonymised. In acknowledging the academic work of other researchers, information collected from secondary sources was cited. The respondents and the South African food manufacturing company were given access to the findings. All retailers’ names were withheld due to a non-disclosure signed between the food manufacturing company and the researcher. All information was presented and signed off by the food manufacturer company before being presented in this thesis. Data will be encrypted, and password protected on a hard drive for a minimal of 3 years. The data will be accessible to the FMC upon request.

## 3.9. Chapter Summary

This chapter serves as the backbone of this research, delineating the systematic approach adopted to answer the research questions and achieve the objectives outlined in the study. The overarching goal is to ensure the credibility, reliability, and validity of the findings. This chapter described the research design, study area, research population size, methods of sampling used, data collection methods applied, and the limitations of the study were also highlighted. These factors were considered while assessing food waste produced pre-retail in Durban, KwaZulu-Natal. The results will be discussed in the subsequent chapters.

# CHAPTER 4: RESULTS – PRIMARY AND SECONDARY QUANTITATIVE DATA

## 4.1. Introduction

This chapter describes the analysis of the data and presentation of the findings of the study. In total, 2 surveys, 2 interviews and secondary data collection have been included in for this study. In addition, different analysis techniques, using Power BI, SPSS and finally thematic analysis have considered as well. All these areas have been extremely beneficial in fostering better outcomes and the results that were generated have been presented in an way. Therefore, the overall study is in line with the needs of the objectives that were set in the first chapter and has aided in meeting the aim of the study as well through detailed research.

### 4.1.1. Description of the study sample

The quantitative data collected were collected from two surveys. As per Chauhan et al. (2021), the use of surveys in any research is the basic requirement for generating appropriate quantitative data that can benefit the study. The quantitative data was analysed using SPSS and Power BI. In addition, Power BI was also used to analyse a secondary data set obtained from the documents of the organisation.

Table 4.1 indicates demographic details of the study participants. These indicate that more respondents were male (61%) and the remainder were female (39%). The respondents were mainly male (46%) between 26 and 35 years of age. The overall data set that was gained has inputs from a diverse set of participants, which can ensure a diverse set of data, which can be critical and beneficial in understanding the main themes associated with the study better.

The stakeholders included three policy makers and eight environmental scientists. The majority of respondents were consumers (95 percent) and employees (3%). Only six respondents had no formal education, as evidenced by the customer, and 84% of respondents had completed grade 12 school. The highest monthly income bracket is found to be between R5,000 and R10,000 with only 16% of respondents earning more than R20 000.

**Table 4.1:** Demographic characteristics of respondents.

| Variable | Characteristics | Frequency | Percentage |
|---|---|---|---|
| **Gender** | Male | 308 | 60% |
| | Female | 207 | 40% |
| **Age Group** | 18-25 | 46 | 9% |
| | 26-35 | 247 | 48% |
| | 36-45 | 154 | 30% |
| | 46-55 | 51 | 10% |
| | 56+ | 17 | 3% |
| **Occupation** | Employee | 15 | 3% |
| | Environmental Scientist | 8 | 2% |
| | Customer | 489 | 95% |
| | Policy maker | 3 | 1% |
| **Education** | Degree | 76 | 15% |
| | Grade 12 | 433 | 84% |
| | No formal Education | 6 | 1% |
| **Income** | Less than R5 000 | 118 | 23% |
| | Greater than R5000 & less than R10 000 | 218 | 42% |
| | Greater than R10 000 & less than R20 000 | 98 | 19% |
| | Greater than R20 000 | 81 | 16% |

### 4.2. **Research Objective 1:** The reasons and drivers behind food waste generation of frozen and chilled food products in the supply and value chain of a food manufacturing company (FMC).

An analysis of the quantitative data that were collected in this study has ensured the collection of ten factors:

(i) inadequate cold and chilling storage facilities can result in frozen and chilled food expiring, damaged and/or contaminated thus food waste generation in the supply and value chain.

(ii) Improper temperature levels at loading bays, cold rooms, haulage cargo or display leads to chill and frozen food waste generation in the supply and value chain.

(iii) Unpredictable consumer buying patterns leading to over-ordering and stocking leads to frozen and chilled food waste generation in the value chain.

(iv) Poor inventory management (for example. not putting the oldest out first) leads to chilled and frozen food waste generation in the supply and value chain

(v) Inadequate generation, transmission and distribution of electric power resulting to electricity rationing (load-shedding) contributes to frozen and chilled food waste generation in the supply and value chain.

(vi) Over-production, overstocking and stores damages leads to expired products and are reasons behind frozen and chilled food waste generation in the supply chain.

(vii) Inadequate systems of checks and balances leading to invisibility and reporting of problems leads to frozen and chilled waste food generation in supply chain.

(viii) Supplier packaging defects can lead to frozen and chilled food waste generation in supply chain.

(ix) Rejection of food for food safety reasons (for example. pathogen contamination) can lead to frozen and chilled food waste generation in the supply chain.

(x) Discarding edible frozen and chilled food products because of appearance can lead to food waste generation in the supply chain.

These aspects of waste generation were analysed as these are all major areas impacting frozen food waste referred in Figure 4.1. During each interview, the researcher asked the respondents to indicate the extent of their agreement with each of these 10 statements using a 5-point Likert rating scale:
1= Strongly Disagree, 2=Disagree, 3=Neutral, 4=Agree, 5=Strongly Agree.

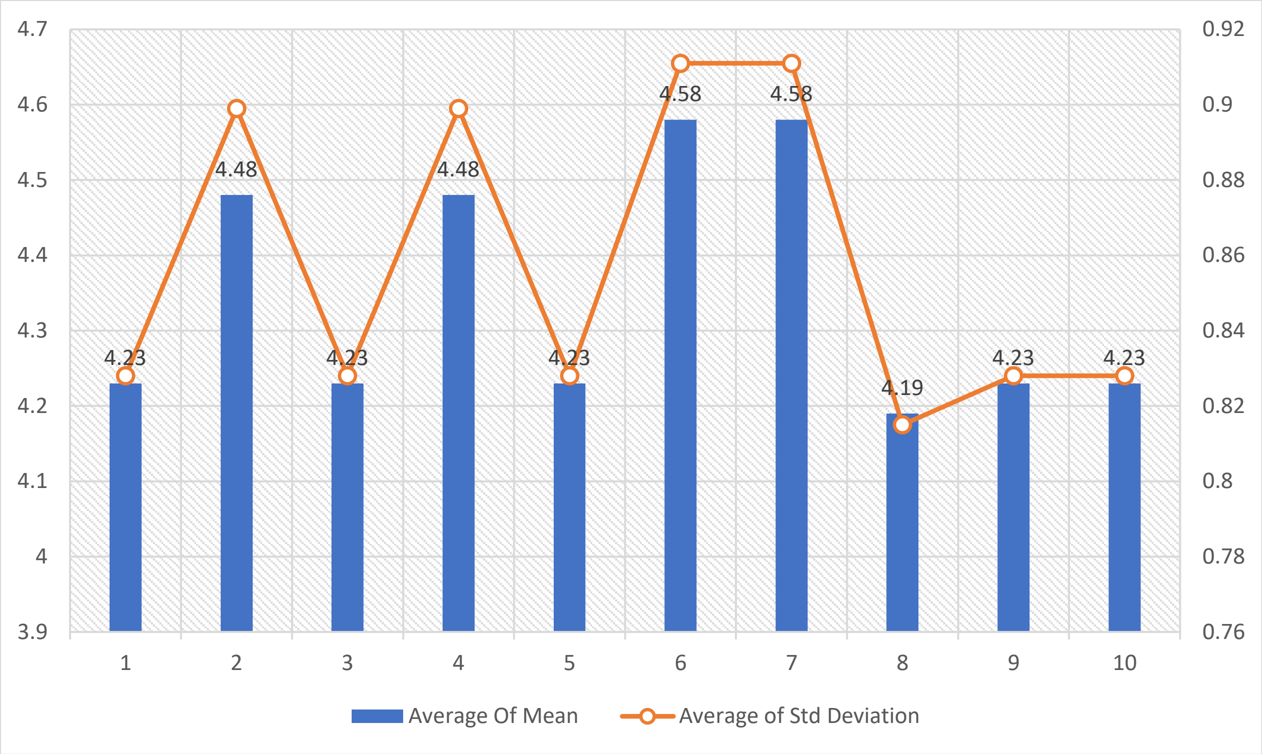



**Figure 4.1:** Reasons and drivers mean and standard deviation across all respondents
Source: Generated in SPSS by researcher (2023)

Responses obtained are presented in the Figure 4.1 above. Mean and standard deviations were computed. Mean values below 4.2 for the statements related to reasons and drivers of chilled and frozen food waste, it suggests that, on average, respondents expressed a level of agreement that these factors are less of a challenge. Mean values greater than or equal to 4.2 were interpreted as respondents perceiving that the statements included reasons and drivers that were more of a challenge to food supply and the food value chain.

The statements were rated as follows; (i) M=4.23, (ii) M=4.48, (iii) M=4.23, (iv) M=4.48, (v) M=4.23, (vi) M=4.58, (vii) M=4.58, (viii) M=4.19, (ix) M=4.23, and (x) M=4.23. A comprehensive and factual analysis of the same has been conducted in the qualitative segment, as the quantitative segments has only presented in Figure 4.2 the statistics that can be beneficial in generating a better study overall.

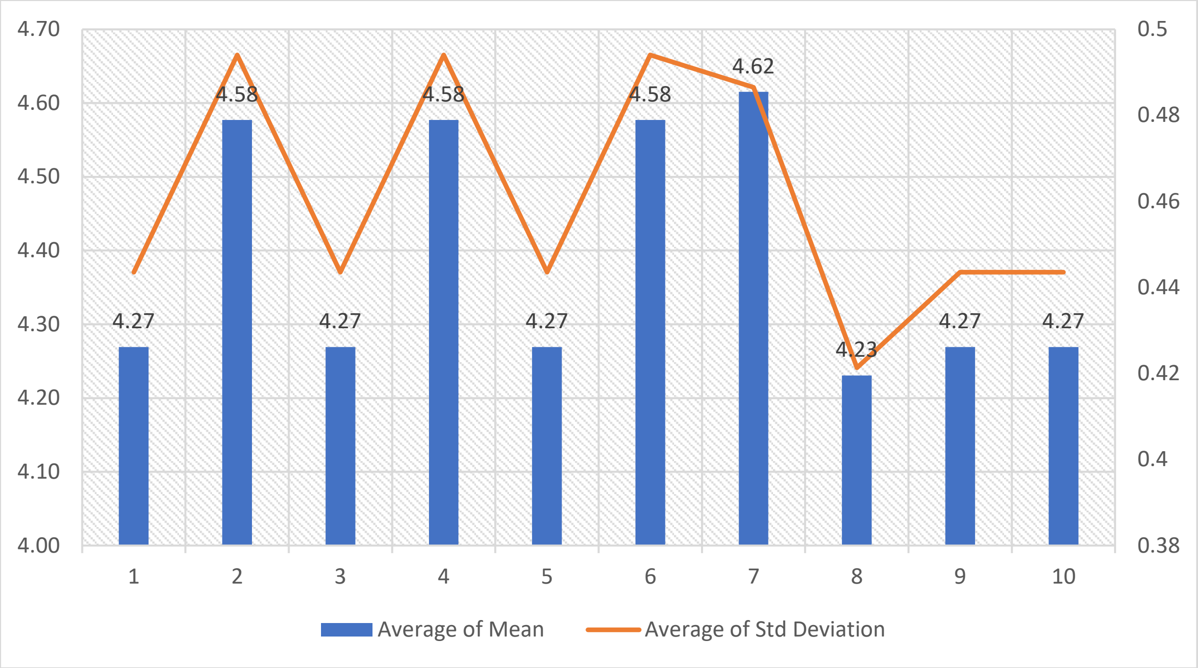



**Figure 4.2:** Reasons and drivers mean and standard deviation excluding consumers
Source: Generated in SPSS by researcher (2023)

Figure 4.2, illustrates scientist, policy makers and employee's opinions who has a vast knowledge of the frozen food waste problem. When comparing Figure 4.1 and Figure 4.2, the means are higher excluding the consumers indicating that frozen food waste is a problem.

The outcomes, derived from assertions 6 and 7, demonstrate that the occurrence of overstocking arises due to the inadequate systems and reporting of the FMC. The likelihood of food waste and spoilage increases when the inventory surpasses the threshold of effective management. The identification and management of issues such as overproduction, overstocking, and poor-quality control become arduous tasks in the absence of sufficient checks and balances, as well as ineffective monitoring and control mechanisms within the supply chain. Overproduction frequently emerges as a result of imprecise demand predictions or errors in production planning. Items that are excessively stocked may reach their expiration date before being purchased, thereby resulting in wastage. This wastage is caused by inaccuracies in production and inventory management, as well as mishandling during transportation and storage processes. The generation of waste is a consequence of insufficient supervision and control, thereby making the identification and resolution of issues that contribute to food spoilage a challenging endeavour.

The absence of suitable cold and chilling storage facilities, which has resulted in an upsurge in the generation of food waste, has been identified as the root cause of statements 2 and 4. The survey findings indicate that the likelihood of food waste is significantly higher in the absence of proper temperature regulation. It has been observed that this is contributing to an increase in the amount of food waste generated, particularly in relation to chilled and frozen food items. Furthermore, insufficient inventory management procedures within companies also play a part. The maintenance of consistent and appropriate temperatures in cold storage facilities is of utmost importance. Any fluctuations or deviations from the required temperatures can lead to the deterioration of food quality and compromise safety. In retail environments, failure to properly maintain display units at the required temperatures can result in the degradation of the products being showcased.

Effectively managing temperature levels at each stage of the supply chain is crucial for preserving the quality and safety of frozen and chilled foods. Neglecting to implement a first-in, first-out (FIFO) inventory management system can result in older products being relegated to the back and subsequently forgotten. Consequently, they may reach their expiration dates before being sold, thus contributing to waste. Inadequate tracking and monitoring of inventory levels can lead to a lack of visibility into the status of products, making it challenging to manage stock effectively. The implementation of effective inventory management practices, including proper stock rotation, real-time tracking, and demand forecasting, is crucial in minimizing waste within the supply and value chain.

To tackle these challenges, businesses must invest in technologies that offer real-time monitoring of temperature conditions, implement appropriate inventory management systems, and provide personnel with training on best practices for handling and storing chilled and frozen products throughout the supply chain. Additionally, the establishment and adherence to clear guidelines and protocols for temperature control and inventory management at each stage of the supply chain are imperative.

The remaining responses, which exhibit an average mean ranging from 4.19 to 4.23, signify that enterprises within the value chain possess the capability to mitigate excessive ordering and diminish the occurrence of frozen and chilled food waste through the implementation of measures aimed at upholding the quality and safety of frozen and chilled food items. Furthermore, the adoption of these measures by organizations operating within the supply and value chain can yield significant reductions in food waste and contribute to overall sustainability efforts, all while addressing the challenges posed by unpredictable consumer purchasing patterns.

Maintaining the requisite temperature conditions for perishable goods throughout the distribution process necessitates a reliable and consistent power supply. The rationing of electricity, particularly for goods that necessitate constant refrigeration, inevitably results in the production of food waste. Frozen or chilled foods are susceptible to deterioration caused by fluctuations in temperature, spoilage, and interruptions in power supply. The suboptimal packaging materials or techniques employed by suppliers in the packing and transportation of frozen and chilled food products are identified as supplier packaging defects and have a direct impact on the generation of frozen and chilled food waste within the supply chain. Examples of such defects include tears, leaks, insufficient insulation, and other issues that undermine the integrity of the packaging. Food products that are rejected at various stages of the supply chain due to concerns over food safety are designated as being rejected for food safety reasons, such as contamination by pathogens. The presence of pathogens, contamination, or other elements that put the safety of the food at risk are commonly cited as reasons for rejection. Food waste may ensue from the necessity to discard food that is deemed unsafe for consumption.

While both consumers and waste management professionals generally share a commitment to reducing food waste, disparities may arise in their perspectives, priorities, and roles in addressing this issue. This divergence was evident in the diverse array of respondents engaged in food waste management. Waste management experts frequently center their attention on improving infrastructure and addressing systemic issues. On the other hand, consumers often approach food waste from an individual behavior perspective, while also recognizing the importance of efficient waste collection, transportation, and processing systems for managing food waste on a larger scale. Their focus lies in minimizing household waste through meal planning, wise shopping practices, and proper food storage. Experts advocate for enhanced reporting mechanisms and the adoption of cutting-edge technologies, such as anaerobic digestion or composting facilities, for the processing and reuse of food waste at an industrial level. Conversely, consumers may emphasize the significance of education and awareness campaigns to inform people about the adverse effects of food waste on the economy and the environment. There is a general consensus among professionals and consumers alike regarding the importance of preventing and minimizing food waste. Commonly advocated strategies include reducing overconsumption, improving storage practices, and supporting food recovery initiatives.

## 4.3. **Research Objective 2:** The socio-economic and environmental impacts of frozen and chilled food waste in the supply chain.

The researcher identified and then included in a questionnaire four statements about chilled and frozen foods for use in assessing the respondents with respect to socio-economic and environmental impacts of frozen and chilled food waste in the supply chain. The statements were:

(i) frozen and chilled waste generation is associated with food insecurity, social inequalities, malnutrition, poor hygiene and sanitation and other social ills.

(ii) frozen and chilled food waste generation has an effect on the country's GDP, inflation, price hike, equitable distribution food products, affordability, profitability and other economic ills.

(iii) frozen and chilled food waste generation disposal harms the environment through greenhouse gas emissions, thus negatively impacting the environment.

- food manufacturing sustainability goals are efficiently upheld in the frozen and chilled food processing and manufacturing sector.

The study again used the 5-point Likert scale: 1=Strongly Disagree, 2=Disagree, 3=Neutral, 4=Agree, 5=Strongly Agree to generate quantitative results regarding the statements above. The results of the statistical analysis are indicated in Figure 4.3 below.

The mean and standard deviations were computed and mean values for statements below M=3.4 were interpreted as indicating that these statements about the socio-economic and environmental impacts of frozen and chilled food waste were less of a challenge in the food supply and value chain of the FMC. Mean values above (M=3.4) were interpreted as respondents perceive socio-economic and environmental impacts of frozen and chilled food waste as a real challenge. Results indicate that there is overall agreement by the study respondents with these socio-economic and environmental statements.

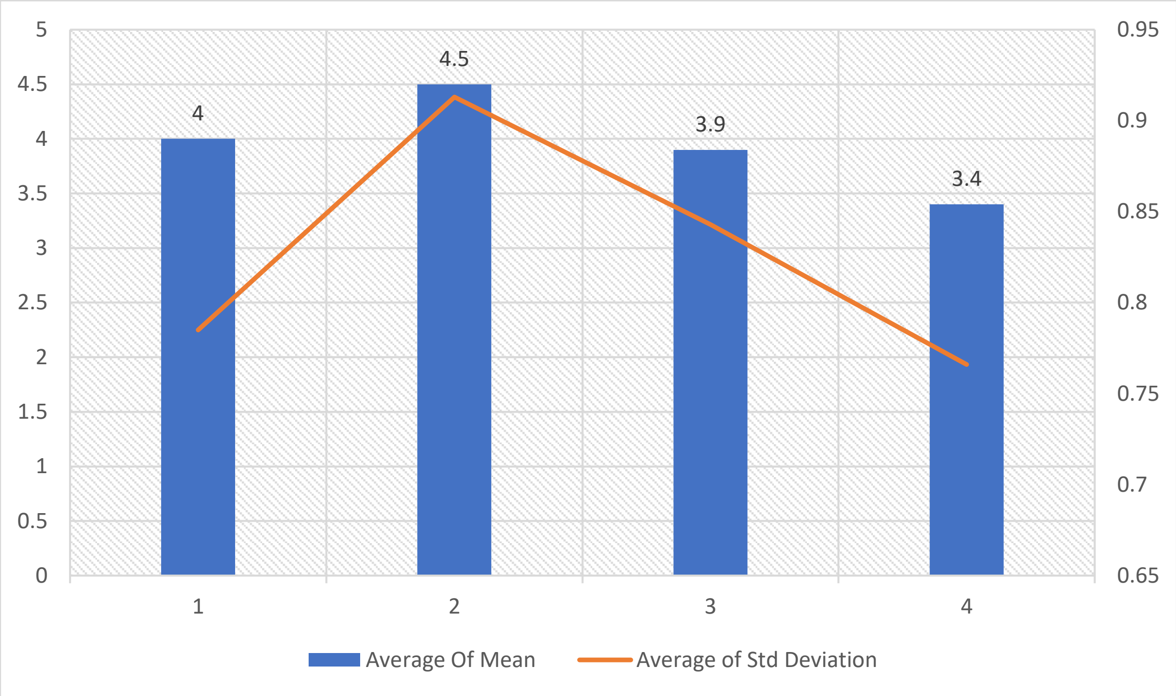



**Figure 4.3:** Mean and standard deviation values for responses to socioeconomic and environmental impact statements. Source: Generated in SPSS by researcher (2023)

The items or statements were rated as follows; (i) M=4.0, (ii) M=4.5, (iii) M=3.9, (iv) M=3.4. Therefore, most respondents agreed to these statements.

Frozen food waste, characterized by its highest mean of 4.5, serves as a prominent exemplification of a loss in resources. These resources encompass not only labour, but also the fundamental components of raw materials and energy that are expended during the production and distribution of sustenance. As the value of squandered goods and the resources they necessitate fail to contribute to economic output, the ensuing economic repercussions manifest in an overall decline in the Gross Domestic

Product (GDP). Furthermore, this phenomenon has the potential to precipitate inflation, owing to the disruption it imparts upon the equilibrium between supply and demand. Specifically, an extensive quantity of discarded food diminishes the accessibility of products within the marketplace, thereby engendering an escalation in prices due to a heightened state of scarcity.

Consequently, prices may exhibit an inclination to surge in concert with the expansion of the GDP and the ramifications stemming from the diminished availability induced by food waste. Undoubtedly, this shall exert an influence upon the cost of living incurred by consumers. Consequently, price hikes have the capacity to impact both food and non-food items, thereby engendering broader economic implications. In view of its multifaceted nature, food waste impinges upon affordability through two distinct avenues. Firstly, it has the potential to give rise to price increases, thereby resulting in a state of diminished affordability for consumers. However, it is essential to underscore that food waste represents an unnecessary dissipation of resources that could otherwise be harnessed to produce goods that are more reasonably priced.

Wasted food precipitates a reduction in the aggregate supply of food products within the marketplace. Should demand remain either constant or experience an upswing, the diminished supply which ensues may instigate a state of inflation, as prices rise commensurate with the scarcity that is engendered. Moreover, the expenses that producers incur as a result of their wasted inventory may be transferred onto consumers in the form of augmented prices, thereby contributing to a generalized amplification in the cost of living. Notably, food waste can act as a catalyst for price volatility. To this end, it is important to highlight that the stabilization of prices through the implementation of an efficient supply chain management system can enhance affordability, particularly with regard to essential food items, while simultaneously mitigating the impact upon the budgets of consumers. Governments may be compelled to assume supplementary costs associated with the management and disposal of food waste. Notwithstanding, it is important to underscore that a reduction in waste has the potential to yield cost savings for both the private sector and public authorities alike.

Despite the occurrence of food waste, it is evident based on statements 1 and 3 that certain individuals experience insufficient access to safe and nourishing food, resulting in hunger. The act of wasting food, regardless of whether it is frozen or chilled, has various effects that exacerbate social injustices. Inadequate allocation of resources leads to affluent individuals and communities having greater access to a diverse range of food options, while marginalized groups face food shortages and increased prices. The impact of frozen or chilled food waste extends beyond society and also affects the environment. The energy and water resources utilized in food production are squandered when it is discarded. Moreover, the landfilling of food waste leads to heightened emissions of greenhouse gases, which contribute to climate change. The presence of nearby decomposing food waste can negatively impact public health. Unpleasant odours, attraction of rodents to waste, and potential contamination of water sources can lead to a decline in the well-being of the community.

The resources utilized in the production, processing, and transportation of food that ultimately goes to waste could have been redirected to address the issue of food insecurity. Food waste represents missed opportunities to provide nourishment to individuals experiencing food insecurity, thereby contributing to social inequalities. The inefficiencies within the food supply chain that result in waste can exacerbate social inequalities by limiting access to affordable and nutritious food for certain segments of the population. The economic losses incurred as a result of food waste can disproportionately affect smaller farmers, thereby contributing to economic disparities. The discarded food could have played a role in addressing nutritional deficiencies, particularly in regions where malnutrition is prevalent. When food waste is deposited in landfills, it decomposes in an anaerobic manner, producing methane, a potent greenhouse gas that contributes to climate change. Large-scale food production necessitates significant land use. Consequently, when food is wasted, it represents unnecessary land use and deforestation, thereby contributing to habitat loss and decline in biodiversity. Strategies encompass enhancing the efficiency of the supply chain, implementing superior inventory management practices, promoting sustainable consumption habits, and investing in programs aimed at reducing waste and facilitating recycling. This comprehensive approach has the potential to foster social equity, diminish environmental impact, and establish a more sustainable and resilient food system.

Professionals possessed a greater comprehension of Statement 4 compared to consumers. The implementation of energy-efficient machinery, the optimization of production procedures, and the exploration of renewable energy sources were among the energy-efficient practices instituted within food processing and manufacturing facilities. Collaborating with suppliers to ensure the sustainable acquisition of raw materials is essential for promoting environmental stewardship and responsible resource management throughout the supply chain. This could involve the promotion of equitable labour standards throughout the entire supply chain, the endorsement of ethical farming techniques, and the reduction of the environmental impact caused by transportation. In general, experts and consumers alike are in agreement that the escalation of GDP and inflation has resulted in an increase in living expenses and has further exacerbated the issue of food insecurity.

Investment in energy-efficient technologies for the purposes of processing, refrigeration, and packaging is highly recommended. The act of upgrading equipment has the potential to yield significant energy savings. Furthermore, it is advisable for manufacturing operations to transition to renewable energy sources, as doing so reduces reliance on non-renewable resources and subsequently minimizes the carbon footprint. Additionally, it is encouraged that consumers be urged to engage in recycling packaging materials and to actively participate in extended producer responsibility initiatives, thereby undertaking the responsibility for the disposal of packaging at the end of its life cycle. Moreover, it is highly advisable to streamline transportation logistics in order to minimize the environmental impact associated with the transportation of raw materials and finished goods. This can be achieved by considering more sustainable transportation modes and routes. Furthermore, it is essential to obtain and adhere to recognized sustainability certifications, such as Fair Trade, Organic, or other pertinent standards that align with the values of environmentally conscious consumers. Investment in research and development is also highly recommended in order to identify and implement innovative technologies and practices that enhance sustainability. This may entail exploring alternative ingredients, adopting more efficient processing methods, and employing novel packaging solutions. By effectively integrating these strategies into the frozen and chilled food processing and manufacturing sector, companies can make significant contributions to a more sustainable and resilient food system, all while satisfying consumer demands for environmentally friendly and socially responsible products.

### 4.4. **Research Objective 3:** Consumer perceptions on chilled and frozen food waste generation in relation to their buying habits and patterns

The third research objective was analysed in relation to the responses by respondents to statements asked of them. The researcher had identified 5 statements about chilled and frozen foods and their waste generation from a review of the literature in relation to their buying habits and patterns. The statements were:

(i) as a customer of this retail outlet, I am satisfied with their shelf-life standards of frozen and chilled foods especially; dairy, meat and vegetable products are upheld in this retail outlet.

(ii) I buy my frozen and chilled foods here because they offer fresh, dairy, meat and vegetable products.

(iii) they sell fresh, non-expired frozen and chilled foods in this retail outlet especially, dairy. meat and vegetable products.

(iv) discounts in frozen and chilled food products especially, dairy, meat and vegetable products are a result of them being spoiled or closer to date of expiry.

(v) I always check expiry dates for frozen and chilled especially diary, meat and vegetables products.

The researchers asked the respondent to indicate their level agreement with each of the 5 statements using the 5-point Likert scale: 1=Strongly Disagree, 2=Disagree, 3=Neutral, 4=Agree, 5=Strongly Agree. This allowed the generation of Figure 4.4 that includes the mean and standard deviation of the responses according to the Likert scale.

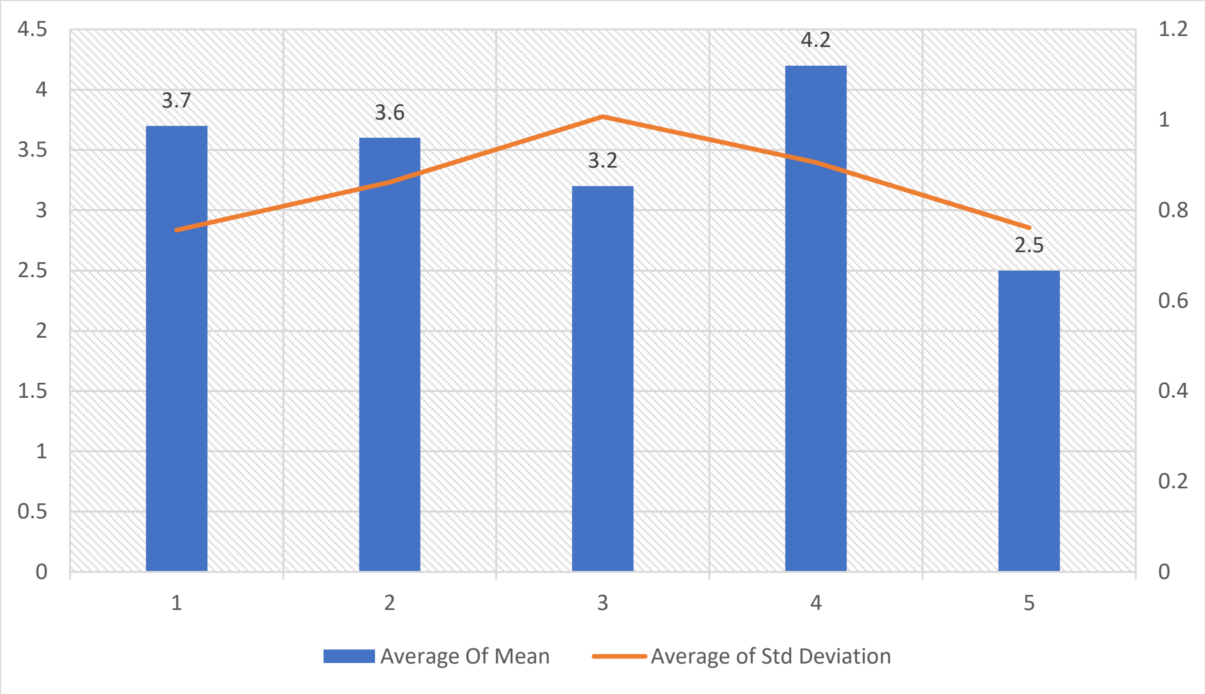



**Figure 4.4:** Mean and standard deviation values of responses in relation to food waste and buying habits. Source: Generated in SPSS by researcher (2023)

The items or statements were rated as follows: (i) M=3.7, (ii) M=3.6, (iii) M=3.2, (iv) M=4.2, (v) M=2.5.

With an average mean of 4.2, retailers employ a standard practice of reducing prices or offering discounts on chilled and frozen products that are nearing their expiration dates. This strategy aims to stimulate sales and minimize the risk of unsellable goods. Additionally, it facilitates the movement of inventory, especially when the retailer has an excess of certain items. Consequently, this approach reduces the likelihood of overstocking and wastage of products that are close to expiration. These discounted products, although still within their safe consumption range, may be perceived as slightly lower in quality due to factors such as changes in texture or colour. The provision of food discounts serves as a means to manage customer expectations and perceptions. Reputable merchants often take the initiative to explain to customers the reasons behind offering discounts. By providing information about the freshness and quality of discounted products, this transparent approach fosters trust. However, some consumers may hold the belief that products nearing their expiration dates might have compromised quality, resulting in a reduced willingness to pay the full price.

Retailers are responsible for maintaining product shelf life, and based on customer feedback, they can buy fresh and non-expired goods at stores they frequent. Due to ignorance, the majority of consumers search for the best deal rather than considering the products' shelf lives. However, experts have shown that once consumers start shopping, they do consider the products' shelf lives and expiration dates. Some customers don't check the expiration date because they assume the store will always have new and updated merchandise. A few customers were unaware that products on sale are almost out of date.

The average mean of 2.5 indicates that consumers tend to overlook expiration dates on products, possibly because they trust that the store consistently stocks fresh and non-expired items. Nevertheless, they would refrain from purchasing a product if its packaging appeared damaged or aged.

### 4.5. **Research Objective 4:** Critical analysis of the national policy and regulation framework on frozen and chilled food waste management in the food retail sector and make policy recommendations for sustainable food waste management in the supply and value chain.

The researcher identified statements about chilled and frozen foods from a review of the literature that could be used to test the respondents in regard to the national policy and regulation framework on chilled and frozen food waste management in the food retail sector. The statements were:

(i) The national food waste management policy framework is highly commended for its strengths in efficiently regulating waste management especially frozen and chilled foods.

(ii) The national food waste management policy framework is highly condemned for its weaknesses and flaws in the efficient regulation the waste management of especially frozen and chilled foods.

(iii) The national food waste management policy framework has great opportunities for growth in the efficient regulation of waste management especially frozen and chilled foods.

(iv) There are potential threats to the national food waste management policy framework which impedes its development efficient execution.

(v) The national food waste management policy framework compares better to other regional under-developed and developed countries.

The researchers asked the respondent to indicate their level of agreement with each of the 5 statements using a 5-point Likert scale in Figure 4.5: 1=Strongly Disagree, 2=Disagree, 3=Neutral, 4=Agree, 5=Strongly Agree.

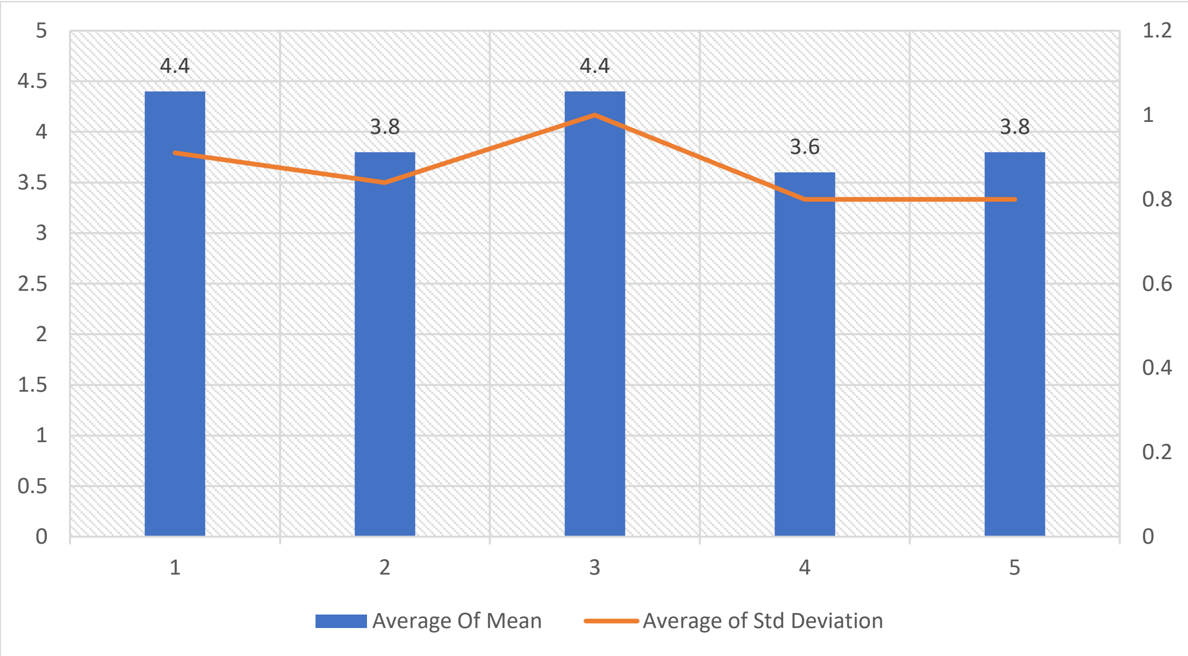



**Figure 4.5:** Mean and standard deviation values of responses in relation to policy regarding frozen foods waste. Source: generated in SPSS by researcher (2023)

The items or statements were rated as follows: (i) M=4.4, (ii) M=3.7, (iii) M=4.3, (iv) M=3.6, (v) M=3.7.

For this objective, responses are seen from the professionals due to the consumer lack of knowledge on the waste management policies in place. Figure 4.6 indicates the increase in the mean values when consumers are excluded from the data.

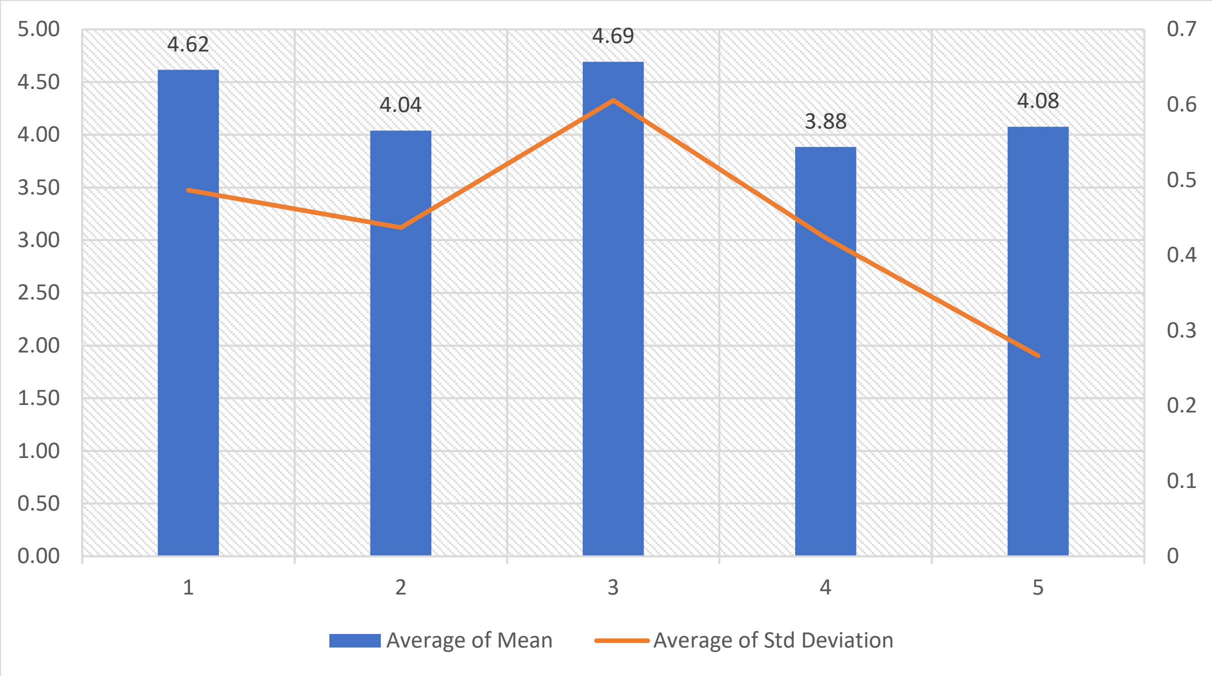



**Figure 4.6:** Mean and standard deviation values of responses in relation to policy regarding frozen foods waste excluding consumers. Source: generated in SPSS by researcher (2023)

Based on statements 1 and 3, the policy framework has received praise from experts for its clear and measurable objectives related to reducing food waste. These objectives include specific deadlines and targets, providing a solid basis for evaluating progress and success. The framework covers all stages of the food supply chain, including production, distribution, retail, and consumption, ensuring a comprehensive approach to addressing food waste. However, it is important to note that the framework does not specifically address frozen food separately.

To effectively manage food waste, there are existing laws in place that govern waste reduction, diversion, and responsible disposal. These laws support businesses, organizations, and individuals in their efforts to manage food waste. Customers have raised the need for public awareness campaigns and educational initiatives as part of the framework. These initiatives aim to educate and empower customers to make choices that reduce food waste. At the FMC, workers have suggested the use of technology to better monitor and manage both chilled and frozen food waste. Implementing advanced systems like blockchain and smart sensors can enhance traceability and reduce waste in the supply chain. The FMC also emphasizes the use of predictive modelling and data analytics to gain a better understanding of trends in frozen and chilled food waste. By anticipating potential issues in the supply chain and taking proactive measures, waste can be prevented before it occurs. Consumers have assumed that the policy is already in effect and is currently making progress in reducing food waste.

The limitations of the framework were highlighted by experts in statements 2 and 5, who emphasized that it may not comprehensively address the intricacies of the frozen and chilled food industry. This could result in regulatory gaps that lead to inefficiencies and wastage. The framework's inadequate coverage may fail to address specific issues that are unique to perishable goods. The absence of robust monitoring and reporting systems makes it challenging to collect accurate data on frozen and chilled food waste. Insufficient data hinders the ability of the FMC to identify trends, evaluate policy effectiveness, and implement targeted interventions. However, the framework effectively addresses the challenges associated with maintaining the integrity of the cold chain, which is crucial in reducing spoilage and waste during transportation and storage. One of the reasons for non-compliance with waste reduction initiatives is the absence of incentives for businesses to adopt sustainable practices. Tax breaks and certification programs are examples of incentives that can motivate companies to implement environmentally friendly measures. A comprehensive framework should encompass all stages of the food supply chain and address the unique complexities of managing frozen and chilled foods.

Statement 4 garnered comparable ratings from professionals and consumers, indicating that there is a likelihood of obstacles in establishing and executing a comprehensive national strategy to address food waste due to uncertainties surrounding potential risks. The primary concern expressed by experts is the potential hindrance in implementing waste management policies due to inadequate financial resources allocated for this purpose. Adequate funding is essential for the development of infrastructure, initiation of awareness campaigns, and enforcement actions. Subsequently, the opposition to change or lack of cooperation from companies, particularly those operating in the food industry, can pose a significant threat. Industries may exhibit resistance towards alterations that could impact their established practices or increase operational expenses.

### 4.6. Chapter Summary

The statistical analysis that has been presented above has indicated that the surveys that were conducted in the present study made appropriate use of analytical tools such as SPSS and Power BI. Results indicated that, overall, the respondents agreed with the interview statements. The awareness of frozen food waste within the retailer and FMC is a common trend and pattern observed. The causes of frozen food waste, including inadequate cold storage facilities and reporting, are highlighted. It is problematic that there is insufficient funding, and that technology is not being used to help with frozen food waste. In addition to increasing GHG emissions, a rise in food waste causes more people to go to bed hungry. Experts and customers cited load shedding as an issue, and the sharp increase in inflation came next. The waste management laws are broad and do not only address food waste that is frozen or refrigerated.

# CHAPTER 5: RESULTS OF PRIMARY QUALITATIVE ANALYSIS

## 5.1. Introduction

As mentioned in the methodology Chapter 3, the study also generated qualitative data from the two interviews that were conducted and from secondary data collection. Both interviews were conducted using open-ended questions to obtain an in-depth understanding of the reasons for the choices of the respondents and their points of views.

The development of questions for a qualitative research questionnaire involved careful consideration of the research objectives, the characteristics of the phenomenon under study, and the level of understanding required from participants. To gain a comprehensive understanding of the research topic, an extensive literature review was conducted to explore existing theories and knowledge. This review helped identify gaps or areas that required further investigation, which in turn influenced the formulation of research questions. The questions were structured in a logical and coherent manner, progressing from general to specific. In order to delve deeper into participants' responses and allow them to elaborate on their experiences or perspectives, probing questions were used. These probing questions were designed to elicit predefined statements, which in turn contributed to the formation of themes. These themes and sub-themes are presented in Chapter 3, Table 3.4, facilitating thematic analysis.

The process of content analysis of the qualitative data resulted in four main themes emerging (Reasons and drivers, Socio-economic and environmental impacts, Consumer perceptions and national policy and regulation framework), behind frozen food waste generation. From the four main themes and 14 sub-themes were identified seen in Figure 5.1.

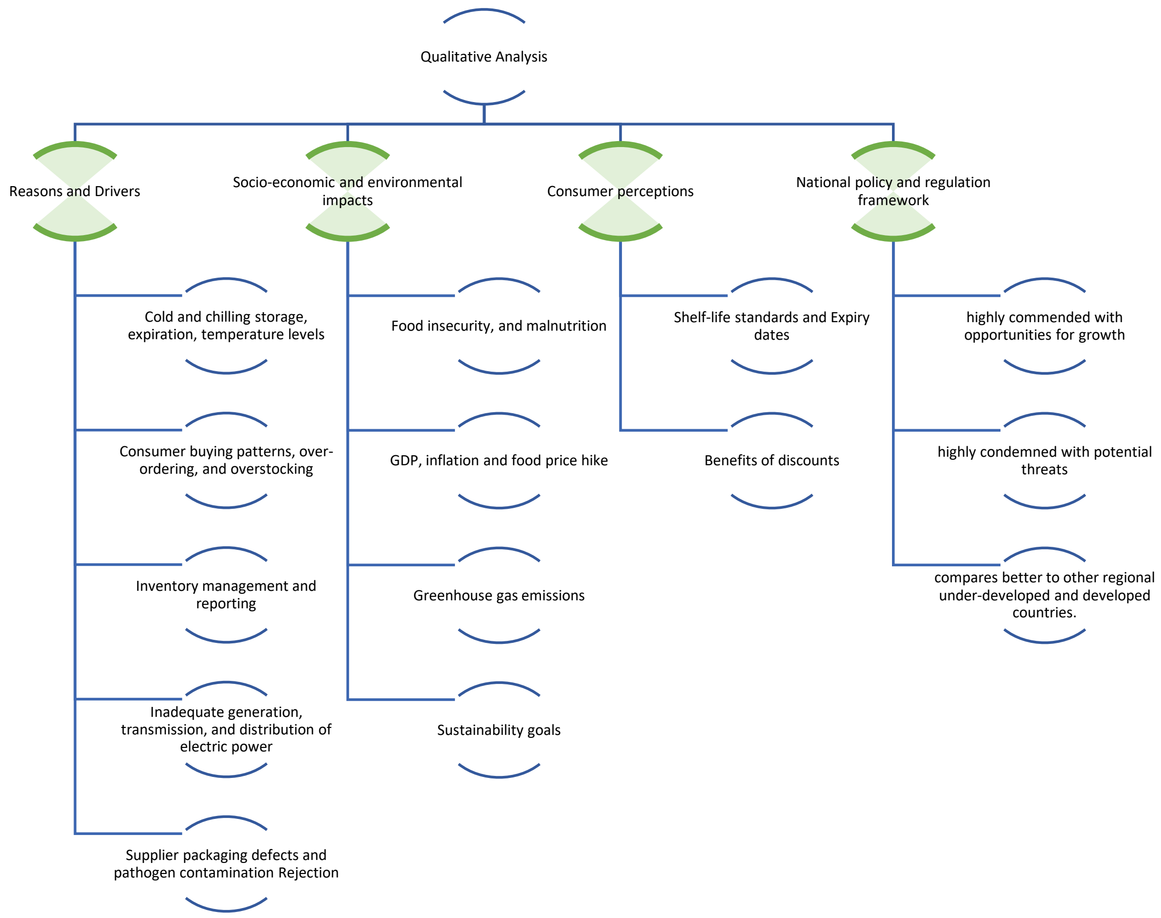



**Figure 5.1:** Illustration of how the main themes (highlighted in green) developed in relation to emerging sub-themes (highlighted in white) Source: Researcher (2023)

## 5.2. **Main Theme 1:** Reasons and drivers

In the literature review, section 2.5, it is shown that addressing frozen food waste requires a collaborative effort involving producers, retailers, consumers, and policymakers to improve supply chain efficiency, reduce overproduction, and raise awareness about proper storage and consumption practices. Additionally, implementing technology solutions such as temperature monitoring systems and advanced packaging techniques can help mitigate the risks of frozen food waste and ensure the quality and safety of frozen food products throughout the supply chain (Badia-Melis et al., 2018). By accurately monitoring and controlling temperature throughout the entire cold chain, from production to consumption, the risk of frozen food waste can be significantly reduced. Furthermore, implementing traceability systems and standardized guidelines for labeling and handling frozen food products can also contribute to minimizing waste. Overall, the successful reduction of frozen food waste relies on a comprehensive approach that addresses various factors, including production, supply chain management, consumer behavior, and policy interventions. It is evident that addressing frozen food waste requires a multi-faceted approach that involves collaboration between all stakeholders in the supply chain, including producers, retailers, consumers, and policymakers.

In order to establish the reasons and drivers and to answer the “why”, “when”, “where”, “who” or “how” questions related to frozen and chilled food waste generation, analysis of the responses to the following statements related to this study objective 1 allowed study findings to be categorised into **five** sub themes:

I. Cold and chilling storage, expiration, temperature levels
II. Consumer buying patterns, over-ordering, and overstocking.
III. Inventory management and reporting
IV. Inadequate generation, transmission, and distribution of electric power
V. Supplier packaging defects and pathogen contamination Rejection

### 5.2.1. Cold and chilling storage, expiration, temperature levels

Based on the responses of the respondents, this section examined how the sub-theme of inadequate cold and chilling storage, expiration, and temperature levels was perceived. The majority of respondents appeared to be generally aware of the impact that low temperatures can have on the quality of frozen food. A recently hired area sales manager (Informant F) of a store said, "I would assume so. I am fairly new here, but I do hear this cold storage issue been spoken of often.” Though the respondent may not be familiar with frozen food, he/she aware of the consequences of improperly stored frozen food. One of the key factors contributing to food waste is the lack of proper cold storage and chilling facilities.

Without these facilities, it becomes difficult to control and monitor the temperature of perishable food items throughout the supply chain. A retail sales executive (Informant A) asserted that:

> “I don’t think it's only about inadequate cold storage places, it's also about maintenance. As a business, we have a lot of facilities but personal I don’t see it maintained well, that’s why expired foods happen cause the cold chain breaks. It breaks when the food is not kept at the right temperatures. With so much stock coming into the store, I can only do so much.”

According to the interview, a significant majority of respondents (87%) agreed that product expiration and inadequate cold storage facilities contribute to the generation of waste in chilled and frozen food. One customer (Informant AA) emphasized that “Food is prone to go off if temperatures are high. Even if it wasn’t frozen food, if the temperature is not right it will go bad.” The respondents also acknowledged that while there are many facilities available, the maintenance of these facilities is a major concern. This lack of maintenance leads to the expiration of items when the cold chain is disrupted. When food is not stored at the appropriate temperatures, frozen food can become unsafe for consumption due to spoilage and microbial growth. Freezer-burned food can also experience changes in flavour, texture, and quality, making it unappealing to consumers. Additionally, improper segregation of raw meat and ready-to-eat foods can increase the risk of pathogens from the raw meat contaminating other food items. An environmental professional (Informant W) provided further insight and explained that:

> “Variations in the cold chain can be brought on by inconsistent or improper temperature management in storage facilities. Food can get spoiled and microbial development can occur if the temperature exceeds the levels advised for frozen or chilled meals, rendering the food unfit for human consumption. Frozen and chilled foods have a limited shelf life, even under ideal storage conditions. However, inadequate storage facilities can accelerate the deterioration process and shorten the usable time frame for the products. This can result in expired products being discarded before they are sold or consumed.”

Improper stacking, mishandling, or lack of appropriate shelving and equipment can lead to breakage, crushing, or other forms of damage to the products, rendering them unsellable. It is essential to invest in adequate cold and chilling storage facilities, maintain proper temperature control, implement good inventory management practices, and train personnel on proper handling and storage protocols.

An area sales manager (Informant D), who was in charge of bringing the frozen foods into the store said, "Most definitely, there are times that the frozen foods were delivered and left out in the delivery bay for a while before being taken to the appropriate fridge or freezer." It was noted that the cold chain requirements were broken when it took one to two hours to unpack the truck and get the contents into the in-store freezer. With customer (Informant AC) stating that “Yeah, I mean you can’t really keep frozen food in warm temperatures and expect it to be ok for eating.”

Besides, in retail or food service companies, improper temperature control in display areas, such as refrigerated display cases or freezer units, can impact the quality and shelf life of chilled and frozen food products. If the temperature is not maintained within the recommended range, it can lead to accelerated spoilage, degradation of texture, and loss of flavour, making the products unsuitable for sale or consumption. The quality and shelf life of chilled and frozen food goods can be negatively impacted in retail or food service facilities by inappropriate temperature management in display spaces, such as refrigerated display cases or freezer units. Therefore, the results indicate a need for appropriate temperature management, besides, ensuring appropriate temperatures as per the prescribed authorities is essential overall. It can help in fostering betterment and can promote the desired outcomes as well.

It was also explained by a compliance manager (Informant O), that there are financial costs associated to the frozen food waste by stating, “improper storage includes financial losses for businesses as well as potential health risks for consumers, so we have to always ensure we store food correctly.” Proper storage practices are essential to prevent food waste and maintain food safety. This can include storing perishable items at the appropriate temperature, using proper packaging and containers, and rotating stock to ensure older items are used first.

5.2.2. Consumer buying patterns, over-ordering, and overstocking.

Unforeseeable fluctuations in customer purchasing trends, excessive inventory and orders can result in severe repercussions for businesses, such as increased expenses, wastage, and potential disruptions in operations. An area sales manager (Informant C) in the region emphasized the challenges of catering to consumer demands, stating that "customers always change their minds about what products are their favourites, so it is very difficult to respond to customer demands." This highlights the occurrence of overstocking due to a lack of comprehension regarding customers' true desires. Another regional sales manager (Informant G) from retailer B added “Consumers like to try new things while maintaining their usual habits.” Engaging in interactions with customers to ascertain their preferences and purchasing patterns proves beneficial, as this information can aid in averting overstocking and adjusting stock levels to align with actual demand. A consumer (Informant AE) concurred with the notion that buying patterns undergo changes during religious festivals, birthdays, and even due to pricing factors, stating “I agree because, as a customer, I often change my opinion on purchases, mainly due to pricing and things that happen in the month especially when we fasting.”

An environmental professional (Informant U), explained why the unpredictable buying patterns add to the frozen food waste by asserting:

> “Unpredictable consumer buying patterns can make it challenging to accurately forecast demand. If retailers or suppliers underestimate demand, they may order insufficient quantities of chilled and frozen food products, resulting in stockouts. Conversely, if they overestimate demand, they may order excessive quantities, leading to waste when the products remain unsold or expire. Frozen and chilled food items typically have a limited shelf life compared to non-perishable goods.”

Retailers and suppliers face challenges in managing their inventory of cold and frozen food products. If they miscalculate the demand, they may end up ordering insufficient quantities, leading to shortages. On the other hand, if they overestimate the demand, they may order excessive amounts, resulting in waste when the products remain unsold or expire. Overordering and excessive stocking can also be attributed to a lack of storage capacity. Retailers and suppliers may purchase more products than they can handle if they have inadequate cooling storage facilities or limited space. If the surplus inventory cannot be stored and managed properly, it can contribute to food waste.

To address these issues, it is crucial to implement improvements that promote the desired overall outcomes. One effective approach is to utilize demand forecasting techniques. By accurately predicting the demand for cold and frozen food products, retailers and suppliers can minimize waste by avoiding overordering and excessive stocking. This, in turn, facilitates improvement in inventory management. Considering all these factors collectively can yield the desired results and play a significant role in reducing food waste as a whole. It is essential to recognize the importance of implementing effective strategies and practices to ensure the efficient management of inventory and minimize waste in the food supply chain.

There were 92% of the participants voiced their strong apprehension regarding the issue of product overstocking, which has the potential to cause damage to stored items. Moreover, it was elucidated that excessive production, surplus supply, and store damage can lead to significant financial losses and hinder the smooth functioning of businesses. In order to tackle these challenges, a comprehensive approach encompassing proactive waste reduction measures, efficient inventory management, and strategic planning is imperative. A resolute statement was made by the regional sales manager (Informant G) of the retail company that,

> “Guilty, we have no choice but to do this, we have seen a loss during covid so we are trying to cover up on sales, by increasing the volume in store this helps with sales but it can lead to expired products in store because it does not get sold. I know Covid is of the pass but we under pressure to cover up losses from 2020. Sometimes I don't have room to pack inventory because there is already products in the refrigerator, so they are left in the large back fridge in the back of

> the store. Stock does not always run out, but we will keep ordering in the hope that something will sell, which is ridiculous.”

The aforementioned statement was supported by a SHEQ manager (Informant L) who expressed that despite the fact that the stock is not consistently sold, the store persists in placing orders, "Although the stock is not always sold, the store continues to make orders, which is rather foolish." This practice has a significant impact on the entire supply and value chain. When more orders are placed, the food company increases production, only to discover that customers do not meet the expected demand, resulting in product expiration. Respondents have highlighted that excessive stocking negatively affects storage facilities, which are unable to accommodate all the delivered stocks according to the required standards, leading to stock returns. This issue arises because retailers tend to overstock in an attempt to meet consumer needs or due to promotional activities, assuming that they will generate profits. Consequently, a large quantity of stock is ordered but remains unsold. As a result, retailers are left with expired or damaged stock returns. The retail organization is compelled to adopt this approach as they have experienced losses during the Covid-19 pandemic. They attempt to conceal these losses by increasing the volume of stock in the store, which aids in boosting sales. At times, these excess stocks are stored in a large refrigerator at the back of the store, as the existing storage space is already occupied. Despite the fact that the stock does not always deplete, the store continues to place orders, which lacks commercial rationale.

#### 5.2.3. Inadequate inventory management and reporting

Insufficient supervision in managing inventory can have detrimental effects, as revealed by the findings. One of the consequences is the accumulation of perishable goods beyond their expiration dates. This occurs when proper oversight and control are lacking, preventing the timely utilization or sale of these products. Moreover, the absence of accurate reporting and tracking mechanisms hinders the prioritization of older stocks, leading to the oversight of items with shorter expiration dates. Consequently, inaccurate inventory reports can misguide companies in assessing customer demand, potentially resulting in an overestimation. This overestimation, particularly for perishable items, can lead to excessive ordering and the subsequent wastage of excess stock. In an attempt to avoid stock shortages, businesses may resort to ordering more than necessary, further contributing to overstocking and waste. Additionally, the utilization of manual or outdated inventory management systems can introduce errors in order processing, leading to mishandling and potential waste. A regional sales manager (Informant G) from FMC provided further insight into this matter by stating,

> “Since we don't always have enough staff in the stores to ensure that first in, first out is followed correctly, I can state that we are guilty of this. Yes, we have a method that we follow, but because we have so many items, it is difficult to keep up with. We can only do so much with inventory because it's an admin nightmare. Why, you ask? Because everything is done by hand and there is always a chance for error.”

The aforementioned claim was corroborated by a merchandiser (Informant Q) employed by the FMC, who expressed “We have to capture all the stock in a book, so it is difficult to follow the rule first to first out, but consumers move products, so the method to follow is not always maintained.” The management of inventory is a critical issue that contributes to the wastage of frozen food. In the absence of effective control and supervision of inventory, the potential for efficient waste management within any organization is greatly diminished. This predicament is further compounded by a dearth of human resources. Inadequate staffing in this area is yet another significant factor that adversely impacts inventory management, consequently leading to subpar waste management practices for frozen food products. The overall oversight of inventory is lacking, resulting in excessive orders and subsequent food wastage due to the fixed shelf life.

Hence, it is crucial to effectively manage this particular domain in order to attain optimal outcomes. Another merchandiser (Informant R) has expressed their inability to access resources that would facilitate their tasks by stating, "We honestly don't have access to what will make our jobs easier. We fly blind." implying the absence of direct communication channels with store managers or FMC stocks. A significant 92% of respondents concurred that reporting and inventory management pose challenges, with one customer highlighting the issue of storage being misplaced and moved, resulting in inventory discrepancies. The absence of suitable reporting tools may impede the collaborative efforts between retailers and suppliers, leading to disruptions and inefficiencies in the supply chain. FMC might not be aware of excess inventory that could be donated or redirected to prevent wastage if accurate reporting is not provided. Ineffective systems for managing unused stocks may hinder the redirection of surplus items to charitable organizations or other purposes. An environmental expert (Informant W) elaborated,

> "Limited visibility may be the result of ineffective methods or procedures for tracking and monitoring food goods across the supply chain. It is challenging to recognize any problems or difficulties that can occur during the handling, storing, or transportation of frozen and chilled food items when there is a lack of vision and accountability within the supply chain, it becomes challenging to ensure that all parties involved take responsibility for their actions or inactions. As a result, issues may go overlooked and result in waste."

Retail manufacturers do not possess a comprehensive system to effectively monitor the movement, demand, and availability of their products. The existing stock systems are outdated and fail to facilitate efficient management of inventory ordering and stocking. According to the respondents, there is a lack of integrated approach in tracking and monitoring stock levels between manufacturers and retailers. Consequently, the accuracy of data pertaining to stock is compromised, as the entry of goods into the store can be traced, but their subsequent departure cannot be accurately monitored. Expressing dissatisfaction, a area sales manager (Informant E) conveyed the following statement:

> "The company that makes the product and the store that sells it work by themselves. It's frustrating that we can't see how well the product is doing in stores. We can see what we put in the store, but we might not be able to see what gets taken out. There is no guarantee that the information is correct. The accuracy of the data is never guaranteed."

Currently, the efficacy of monitoring product performance in stores is encountering challenges, which raises concerns regarding the accuracy of the gathered data. This lack of transparency pertaining to the merchandise being sold can potentially give rise to significant issues. A customer (Informant AB) articulated this concern by stating, "This will be a problem because shops rarely know what they have on hand," thereby indicating that retailers are unaware of their stock levels post-sales. The monitoring of sales is evidently lagging behind in terms of stock supervision. The primary causes for this inadequate waste management are the presence of uncertainty and a lack of transparency in the sales process. In order to mitigate waste in KZN stores, it is imperative to acquire a more comprehensive comprehension of sales. Ultimately, due to excessive stocking, product expiration, inadequate rotation, inefficient stock management, and a lack of demand insights, subpar inventory management and reporting can result in the wastage of frozen food products.

Insufficient reporting hampers the identification of excess frozen food that could potentially be donated to charitable organizations or utilized in a suitable manner. Without surplus redistribution systems in place, the possibilities for utilizing surplus stock are constrained. To tackle these challenges and minimize wastage of frozen food, it is imperative to implement efficient inventory management systems and ensure accurate reporting.

#### 5.2.4. Inadequate generation, transmission, and distribution of electric power

Insufficient power generation or inadequate maintenance of the power distribution system can give rise to frequent power outages, which in turn can result in the failure of refrigeration systems. When these outages persist for a prolonged period, frozen foods may thaw, leading to spoilage and wastage. Moreover, an inconsistent power supply can cause fluctuations in electrical voltage, thereby impacting the performance of refrigeration equipment and causing temperature variations within storage units. Since frozen foods necessitate a steady and low temperature to ensure their safety for consumption, these fluctuations can lead to the thawing and refreezing of the products, ultimately compromising their quality. A SHEQ manager (Informant N) highlighted the detrimental impact of persistent power outages on frozen food wastage, stating, “Yoh this is a real issue, yet not many is seeing as much as us. We have a lot of stock that is called into the company as damages because of thermal abuse all because of no power.”

Refrigeration systems that are responsible for maintaining the required temperatures for frozen foods have the potential to experience malfunctions during power outages. This can lead to spoilage and wastage of the stored food items if the power outage persists. The inadequate supply of power can result in voltage fluctuations, which in turn can adversely affect the functionality of refrigeration equipment. As a consequence, temperature inconsistencies may arise within the storage units. In order to ensure the safety and quality of frozen foods, it is crucial to maintain a stable and low temperature. Any fluctuations in temperature can cause the food to thaw and refreeze, thereby compromising its overall quality. In a separate response, an area sales manager (Informant E) expressed their concern by stating,” Oh gosh, I mean it’s not our fault that Eskom puts the lights off and product goes off.”

Businesses face obstacles in investing in backup power systems due to the absence of dependable power. This situation can have adverse effects on frozen food storage facilities as they experience power outages, thereby increasing the likelihood of food spoilage. Furthermore, an unstable power supply can cause harm to refrigeration equipment, resulting in reduced efficiency and reliability. Consequently, businesses located in areas with unreliable power may be compelled to allocate resources towards more costly refrigeration systems or backup power solutions in order to mitigate the risks associated with food spoilage. However, these supplementary expenses can present economic challenges for businesses and ultimately lead to higher prices for frozen goods. The sustainability manager (Informant H) indirectly referred to this issue by implying that it is a concern by stating,

> “The cold chain must be maintained for food products that are frozen or chilled in order to ensure their safety and quality. Electricity is needed to power refrigeration systems and maintain the necessary temperatures along the supply chain. The cold chain can be broken by inadequate power or load

> shedding, which will result in temperature swings and reduce the quality of perishable food items. These kinds of electrical disruptions can affect how well cooling systems operate, which can result in uneven temperature regulation and a higher chance of food spoiling.”

Retailers sometimes use the lack of electricity as a justification for discarding food and passing the cost onto the Food Management Company (FMC), implying that they are not responsible for proper maintenance. When there is an inadequate supply of electricity, refrigeration equipment can be severely affected, particularly during power fluctuations that occur during restoration efforts. These electrical disturbances can have a negative impact on the effectiveness and performance of cooling systems, leading to inconsistent temperature control and a higher risk of food spoilage. The absence of electricity makes it impossible to maintain proper temperature control, creating a critical situation in terms of waste management. Load-shedding, which is a recurring problem in the KZN region, exacerbates these concerns as products are easily spoiled without the necessary temperature regulation. This ongoing issue not only contributes to increased food wastage but also hinders the overall efficiency of these systems, potentially causing further harm.

Load shedding schedules often display unpredictability, which can catch businesses off guard when power outages occur. This lack of foresight poses challenges for businesses in implementing effective backup plans, such as transferring perishable items to alternative storage facilities or promptly activating backup power sources. The frequent occurrence of load shedding and its negative impact on the quality of frozen goods can undermine consumer trust, potentially leading to financial setbacks for businesses. A customer (Informant AD) has expressed, “loadshedding is for many hours resulting in the food going off - this happens at home as well.” The quality of frozen food can be adversely affected, leading to a decline in consumer confidence and reluctance to purchase such products due to concerns about spoilage caused by an unreliable power supply. This can ultimately result in financial losses for businesses. Customers prioritize the safety and quality of the food they consume, and power outages only intensify concerns about the potential thawing and spoilage of frozen foods. Consumers genuinely fear consuming food that may have been exposed to temperature fluctuations, as this can compromise its safety.

5.2.5. Supplier packaging defects, appearance, and pathogen rejection

Packaging defects can also occur as a result of mishandling by customers, leading to damage. In some instances, insufficient durability of the packaging can contribute to damages in stores, as the packaging may break when customers handle the products. A customer (Informant AC) expressed their opinion, stating “No one will buy a damaged product since if it don’t look right I will not buy it.” This indicates that customers are reluctant to buy products that do not meet their visual expectations, even if the product itself is not expired. The presence of inadequate packaging is a significant concern and can result in increased wastage. Additionally, packaging defects can also occur when customers handle the products roughly in stores. Supporting the customer's viewpoint, an area sales manager (Informant C) acknowledged that, “Bad packaging is a problem, but it's not the only problem. But it stops customers from buying.” However, it does deter customers from making purchases.

Improper handling during transportation can give rise to these problems as well. Although the packaging may not be expired, it can still contribute to difficulties in storage. While certain packaging materials are environmentally friendly and approved, they may lack durability. When customers shift the plastic packets in search of their desired chicken pieces, the packaging can break due to its inherent weakness, rendering the meal unsellable and necessitating its disposal. Packaging flaws such as inadequate seals or leaks can permit air and moisture to enter, thereby contaminating and spoiling the frozen food. Consequently, the affected products may appear unappealing and pose a safety risk, leading to their disposal. The appearance of a product plays a significant role in the food industry, and consumers often form judgments based on it. If frozen food items exhibit packaging defects or an unattractive appearance, it can create a perception of low quality, even if the product is safe for consumption. As a result, consumers may opt not to purchase or consume these items, thereby contributing to food waste. A SHEQ manager (Informant J) has confirmed the correlation between packaging defects and the rejection of products based on their appearance and potential pathogen contamination by asserting that:

> "Although it is unquestionably a problem, poor packaging is only one aspect of the issue. There are others, and we do treat this as a problem, but we are unable to handle it since we do not manufacture some of the packaging. The ones we manufacture, despite being composed of environmentally friendly materials, our packaging is occasionally not robust. Similar to how the plastic for chicken is too thin, so when consumers move them around in search of the nice pieces, these packets rip and the food is thrown out even if it is still edible."

Customers express a strong preference for purchasing products that are not packaged in a damaged condition. One customer (Informant AC) emphasized the importance of intact packaging by stating, "damaged boxes also means the food gets damaged and I will not buy that." When it comes to packaging materials for chilled and frozen food products, it is crucial that they offer sufficient insulation to maintain the appropriate temperatures. Inadequate insulation or flaws in the insulation can result in temperature fluctuations, which in turn can cause the products to thaw or lose their desired quality. This can lead to wastage. Furthermore, packaging defects such as leaks or breaches can compromise the quality and safety of frozen and chilled food items. These defects allow air, moisture, or pollutants to enter, which can lead to spoilage, microbial growth, and accelerated deterioration of the products. Ultimately, this can result in waste.

Moreover, a typical customer (Informant AE) expressed, "I guess no one will buy anything in the food line if it didn't look right." The discontentment and distrust among consumers can stem from products that possess packaging flaws or an unappealing look. In the context of frozen foods, individuals who are dissatisfied with the packaging or find the appearance unsatisfactory might opt to return the items to the seller. Regrettably, even if the returned products are still perfectly safe to consume, they are frequently disposed of due to apprehensions regarding their history and handling.

Retailers are compelled to dispose of food that lacks visual appeal because if the product is not fresh or does not appear fresh, it will have a negative impact on the brand and result in the loss of customers. Consequently, governments have effectively enforced and adhered to regulations. Food that does not seem appetizing must be discarded as it would be detrimental to the business and would inconvenience the company's clientele. This encompasses criteria such as the size, shape, colour, or imperfections of frozen and chilled food items. Even if these products are perfectly safe and edible, they may be discarded if they fail to meet these aesthetic standards. It is common for retailers to have specific aesthetic criteria for the appearance of their products. These criteria often include specifications regarding the size, shape, colour, and any flaws of frozen and refrigerated food items. A area sales manager (Informant E) in the field mentioned that it is a regular practice to remove products from the shelves if they do not meet these appearance requirements by stating,

> “We've got to get rid of the stuff that doesn't look good on the shelf. Simple things like a torn label is removed. That's just to prevent damage to the brand and not to lose customers. Even if a product's box is damaged, we throw it away. It is the sad truth. No one will just eat something that looks weird or even smell bad. Its human reactions I guess.”

Even in the presence of any suspicion of contamination, any food that is expired or exposed and in close proximity to good food will be promptly removed from the shelves. A stringent rule is in place to ensure this, as it is considered a critical aspect of the policy that must be strictly followed. The removal of food due to a breach in the cold chain or if it has been mixed with waste is of utmost importance and is an integral part of the safety policy. If frozen and chilled food products are discovered to be contaminated with pathogens or other harmful microorganisms during testing or inspection, they are frequently rejected for the sake of food safety. This rejection can occur at various stages in the supply chain, including during production, transportation, or at distribution centers.

Government agencies have established stringent microbiological safety guidelines as part of food safety regulations and standards. In order to comply with these guidelines, frozen and chilled food items must undergo inspection and testing. Failure to meet these standards may result in the rejection of these products. The rules and regulations set by government agencies emphasize the importance of adhering to food safety protocols. If chilled or frozen food items do not meet the specified guidelines during inspection or testing, they may be rejected. This process of removing contaminated products from the supply chain not only guarantees the delivery of safe products to customers but also generates waste.

## 5.3. **Main Theme 2:** The socio-economic and environmental impacts of frozen food waste

In Chapter 2, section 2.2.1, the literature discusses the socio-economic and environmental impacts associated with the frozen food supply chain. Specifically, it highlights the economic losses suffered by businesses due to various factors such as production, storage, transportation, and disposal of wasted frozen food products. The accumulation of high levels of frozen food waste not only results in financial setbacks for businesses but also leads to an increase in food prices. To compensate for their losses, businesses may pass on the additional costs to consumers, thereby affecting the affordability of frozen food products. It is crucial to acknowledge that the production and distribution of frozen food heavily rely on natural resources such as water, energy, and agricultural inputs. Consequently, wasting frozen food also implies squandering these valuable resources, thereby exacerbating resource depletion.

The responses from the study were categorised into **four** sub themes:

I. Food insecurity, and malnutrition
II. GDP, inflation and food price hike
III. Greenhouse gas emissions.
IV. Sustainability goals

### 5.3.1. Food insecurity and malnutrition

The prevalence of food insecurity was acknowledged by the respondents, who also highlighted the unfortunate practice of discarding food reserves instead of distributing them to households facing food insecurity, malnutrition, and other related societal challenges. A regional sales manager (Informant G) expressed their perspective on the matter by stating,

> “Many people are affected by this directly and indirectly. Poor people get poorer, which sometimes results in people still eating food which are damaged

> or off. And then there are some who can't afford to buy food and cannot buy good quality food. We throw away more food than feeding people, which is sad cause even I wouldn't mind getting some food, things are very expensive. Its sad to say that now days this is how life is."

Customers hold diverse perspectives on food insecurity and malnutrition, yet there are several shared sentiments and concerns that they express. One customer (Informant AB) acknowledges the widespread nature of these issues, highlighting the unfortunate reality of discarded food being consumed by those living on the streets, leading to illness, stating that "Yeah this is seen everywhere I guess - food is thrown out and then the street dwelling eat this and get sick." This observation underscores the urgent need to address food waste and its detrimental impact on vulnerable populations.

Many customers exhibit empathy and compassion towards individuals and communities grappling with food insecurity and malnutrition. Recognizing the severity of the problem, one customer (Informant AD) laments, "It's awful that we waste more food than we do feed people." This sentiment reflects a growing awareness of the need to prioritize food distribution and minimize waste. Moreover, customers often perceive a societal responsibility to tackle these challenges. They actively endorse and support initiatives and programs aimed at alleviating food insecurity and malnutrition, both at local and global levels. By advocating for efforts that target the root causes of these issues, customers demonstrate a commitment to creating sustainable solutions.

In their quest for understanding, customers express a desire for increased knowledge and education regarding food insecurity and malnutrition. They seek to comprehend the underlying reasons, the far-reaching impacts, and the potential solutions in order to make informed decisions. By equipping themselves with this knowledge, customers can actively contribute to addressing these pressing concerns and effecting positive change.

Food waste is a prevalent issue that arises from inefficiencies and disparities within the food system. The presence of inadequate infrastructure, insufficient storage facilities, limited access to refrigeration, and underdeveloped transportation networks disproportionately impact marginalized communities. Consequently, these communities are more susceptible to heightened levels of frozen and chilled food waste, thereby exacerbating existing social inequalities.

Food waste has a detrimental impact on malnutrition through various means. Firstly, the squandering of nutritious food deprives individuals, especially those in vulnerable populations, of the opportunity to address their nutritional deficiencies and enhance their diets. This was emphasized by an area sales manager (Informant F) who expressed deep concern over the paradoxical situation by stating, “despite the fact that many people lack access to food, a lot of it is wasted, which is tragic.” The majority of respondents echoed this sentiment, recognizing the catastrophic consequences of food waste.

Improper management and improper disposal of frozen and chilled food waste can result in hygiene and sanitation problems. The decomposition of food can attract pests, generate unpleasant smells, and pollute the surroundings. These elements contribute to unhygienic circumstances, which pose health hazards and have the potential to impact the welfare of communities, especially in regions with insufficient waste management infrastructure. These societal problems can significantly contribute to food wastage and are also considered a significant concern that can lead to food wastage and associated complications. The Sustainability Manager (Informant H), who is accountable for supervising and executing sustainable practices within a company, addressed the concerns of food security and malnutrition by emphasizing the incorporation of social and environmental factors into their duties by stating,

> “Land, water, energy, and labour are just a few of the priceless resources that are lost as a result of food waste. Wasted food makes less food available, which worsens the situation of food insecurity. This is especially troubling in light of the fact that millions of people worldwide struggle with hunger and lack access to nourishing food.”

The importance of strong and reliable supply chains in ensuring food security was highlighted by this. Efforts may be made to identify vulnerabilities in the supply chain that could potentially result in food insecurity, and collaboration with suppliers may be undertaken to address these issues.

### 5.3.2. The country’s GDP, inflation and food price hike

Frozen food production and distribution necessitate a diverse range of resources, encompassing labour, raw materials, and energy. The squandering of these resources due to a substantial amount of wasted frozen food can have adverse consequences on the overall productivity of the economy. The wastage of resources signifies that the economy is not functioning at its utmost capacity. Consequently, the nation's GDP may experience a decline due to the reduced production compared to what could be achieved with a more efficient utilization of resources. Moreover, a significant quantity of wasted frozen food can lead to disruptions in the supply chain and inefficiencies in the manufacturing and delivery processes. The resultant costs borne by manufacturers and distributors due to this inefficiency may ultimately be passed on to customers in the form of elevated prices. A sustainability manager (Informant H) further emphasized this concern by stating,

> “Raw materials, labour, energy, and capital investments are all lost due to food waste. Food waste reduces the value of these resources, which can have a detrimental effect on a nation's GDP. It denotes production and distribution operations that are inefficient and cause financial losses. Inflation and price increases are influenced by food waste in a variety of ways. The demand and supply balance is upset when there is less food available owing to waste, which could result in a shortage and higher costs for consumers.”

Increased costs in the supply chain have the potential to worsen inflationary pressures throughout the economy, affecting not only the prices of frozen food but also those of related products and services. Interview participants concurred that the generation of waste from frozen and chilled food has numerous adverse consequences on the economy, including a negative impact on the country's Gross Domestic Product (GDP). An area sales manager (Informant C) highlighted that, “This makes it harder for the consumer to buy food.”

Consumers are lodging complaints against the government regarding the continuous rise in tariffs, with one customer (Informant AA) asserting, “Oh yeah! It's part of the problem, but it seems to be largely caused by poor management.” The generation of food waste directly influences the escalation in prices, consequently affecting inflation and rendering goods and commodities unaffordable for consumers.

They further disclosed that it impacts the profitability of these enterprises, which stimulates the economy to finance the tax revenue base in order for the government to distribute and finance her appropriation bill to maintain service delivery and other public goods and services. Nowadays, everything has become more expensive, particularly food and the cost of living. Food waste contributes to the increase in food production as manufacturers and farmers both need to recover the expenses incurred in producing wasted food. This situation is making it exceedingly challenging for individuals to survive. Food waste contributes to inflation and price surges in various ways. When the food supply diminishes due to wastage, the equilibrium between demand and supply is disrupted, resulting in potential scarcity and higher prices for consumers. Moreover, the expenses associated with producing, transporting, and storing wasted food are often transferred to consumers, further aggravating price hikes. The retail sales executive (Informant B) expressed his concern over the detrimental consequences of food wastage, emphasizing, “when we waste food, we waste money. That's why we have to increase prices to cover our losses. This is unfortunate because it hurts poor people, and now even those with average incomes are feeling the impact.”

During periods of economic decline or recessions, retailers may encounter a decline in consumer expenditure as individuals adopt a more cautious approach towards their finances. Consequently, this can result in decreased sales and, in certain instances, financial difficulties for retailers. This notion is reinforced by a customer (Informant AC) who stated, “Apart from our income, everything is rising, making it harder to make ends meet.” The sudden and substantial increase in food prices can impact consumer sentiment. Therefore, retailers must meticulously contemplate their pricing strategies and promotional approaches to remain competitive and uphold their customer loyalty.

Food waste has the potential to worsen disparities in the accessibility and distribution of food. When edible food is discarded, it fails to reach those who are in need, thereby contributing to unequal availability of food and exacerbating issues of food insecurity. The consequences of food waste extend beyond these social implications and also affect inflation and price fluctuations. The equilibrium between demand and supply is disrupted when there is a reduction in available food due to wastage, potentially leading to shortages and increased costs for consumers. Additionally, the expenses associated with producing, transporting, and storing wasted food further contribute to rising prices, which are often passed on to consumers. Consequently, the impact of food loss and wastage is evident in both environmental and socio-economic aspects.

### 5.3.3. Greenhouse gas emissions

Climate change is significantly influenced by greenhouse gas emissions, such as carbon dioxide ($CO_2$), methane ($CH_4$), and nitrous oxide ($N_2O$). The production and distribution of frozen food involve energy-intensive processes such as refrigeration, transportation, and packaging. However, when frozen food is wasted, the emissions associated with its production become unnecessary contributors to climate change. Respondents expressed agreement that the disposal of frozen food waste is harmful to the environment. Nevertheless, some individuals are uncertain about the specific mechanisms through which this harm occurs. For instance, an area sales manager (Informant D) admitted, "I don't know a lot about emissions, but I do know that it's not okay to waste food." This lack of knowledge about greenhouse gas emissions is evident even among professionals working in the food industry. Furthermore, another area sales manager (Informant E) acknowledged, "I'm aware that it's hurting the environment, but I don't know how. I know that rotten food smells very bad, and it's not good for you to be breathing in the fumes."

The implementation of sustainable measures is crucial in order to decrease the release of greenhouse gases during the manufacturing process of frozen food. This may involve the utilization of environmentally friendly packaging, enhancing the energy efficiency of cold storage facilities, and optimizing transportation routes. These approaches contribute to the overall sustainability of the food supply chain. It is important to note that climate change disproportionately affects vulnerable populations, particularly those residing in developing countries and low-income communities. These groups often lack the resources to adapt to changing environmental conditions, which can lead to socioeconomic disparities. The sustainability manager (Informant H) elaborated on this matter by stating that:

> "When frozen and chilled food waste is disposed of in landfills, it undergoes anaerobic decomposition in an oxygen-deprived environment. This process produces methane, a potent greenhouse gas that is significantly more impactful in terms of global warming potential compared to carbon dioxide. Methane emissions contribute to climate change and exacerbate environmental challenges…"

Customers possess knowledge about the impact of human activities, including the burning of fossil fuels, deforestation, and industrial processes, on the release of greenhouse gases. However, they lack comprehension regarding the extent to which frozen food waste contributes to these emissions. As a result, they remain oblivious to the far-reaching consequences, which encompass the exacerbation of global temperatures, the elevation of sea levels, the occurrence of extreme weather events, and the disruption of ecosystems. A customer (Informant AD) exemplified this lack of understanding and supported it by stating, "I don't know much about greenhouse gases, I would guess it does harm environment."

Moreover, the generation of food waste has a significant and undeniable impact on the environment. The increase in waste generation has been observed to have adverse effects on the environment. One of the key issues contributing to this impact is the lack of proper understanding regarding the mechanisms through which these environmental consequences occur. The manager of the landfill (Informant X) site provided an explanation for this phenomenon by stating,

> "Improper disposal of frozen and chilled food waste can lead to pollution of land and water resources. When wasted food ends up in landfills, it can contaminate soil and groundwater with hazardous substances, such as leachate and toxins. This pollution negatively impacts ecosystems, wildlife, and human health. Not many have this understanding, educating people is key."

Furthermore, the production, processing, and distribution of frozen and chilled food necessitate substantial amounts of energy, water, and other natural resources. When these products are wasted, the resources utilized in their production are also squandered. This encompasses the energy expended for transportation, refrigeration, and packaging, as well as the water employed for irrigation and processing. Another statement from the area sales manager (Informant F) acknowledges that “The greenhouse emissions you mentioned are seen in the corporate reports, but I'm not really sure what impact they have. We are all aware of the foul smell and disgusting appearance of food waste.” Despite the availability of reports in the FMC, the stakeholders lack comprehension regarding the consequences of greenhouse gas emissions. While there is a growing awareness of greenhouse gases, individuals do not possess an extensive understanding of the scientific and technical aspects pertaining to this subject. Education and communication endeavours, undertaken by both governmental and non-governmental organizations, as well as businesses, play a pivotal role in augmenting public comprehension and promoting sustainable practices.

### 5.3.4. Sustainability goals

The concept of "sustainability goals" within the FMC pertains to specific and measurable targets and commitments that a company establishes to minimize its environmental footprint, promote social responsibility, and ensure its long-term financial stability. These goals encompass various aspects such as sourcing, production, distribution, and waste management, all of which are interconnected with sustainability in the food industry. The sustainability manager (Informant H) elucidated that:

> “Implementing energy-efficient practices and technologies can significantly reduce the environmental impact of frozen and chilled food processing and manufacturing. This includes optimizing refrigeration systems, using energy-efficient equipment, and adopting energy management strategies to minimize energy consumption is part of our sustainability goals. Regularly review and assess sustainability performance, set targets for improvement, and monitor progress.”

The interview findings revealed that the participants expressed their agreement and recognition of their efforts to adhere to the established sustainability objectives and criteria. Nevertheless, the extent of their familiarity with these goals varied depending on their job positions. Some individuals, such as an area sales manager, admitted to following the standards as instructed by their superiors, despite not having a comprehensive understanding of the specific contents and significance of these goals. The SHEQ manager (Informant K) stated, “We've got targets, and I know our management's very close to them, and they're following them closely. I'm not familiar with all these goals, but we are trying to minimize waste.”

Suitable targets have been established to address the basic requirements that need to be considered. These targets align with the regulatory standards available within the KZN region, which is a valuable aspect to be taken into account. Additionally, organizations are closely monitoring sustainable development goals to achieve better outcomes in the long term. However, there is a need for clarity, as one of the major issues that must be considered is evident.

The objectives set aim to mitigate the adverse impacts of distribution, storage, and transportation on the environment. This will be achieved through the implementation of energy-saving techniques, the adoption of eco-friendly packaging, and the optimization of supply chain logistics. Efforts will be made to reduce the energy consumption in distribution and manufacturing processes. This may involve investing in energy-saving devices, utilizing renewable energy sources, and implementing conservation measures. Furthermore, adherence to international sustainability guidelines and standards will ensure a comprehensive and consistent approach to sustainability across international operations.

Customers may acknowledge that reducing food waste plays a significant role in addressing global hunger and food insecurity. Rather than discarding edible food, initiatives aimed at redirecting surplus food to those in need or supporting community food programs are viewed as socially responsible actions. A customer (Informant AE) expressed their perspective, stating, “I would think a goal is to stop wasting food, just how was we use less plastic.” However, there seems to be a lack of awareness regarding the positive impact of reducing food waste on efficient resource utilization.

This lack of awareness hinders businesses and consumers from optimizing production and distribution processes, which could ultimately benefit both parties.

Implementing energy-efficient practices and technologies can have a significant positive effect on the environmental impact of frozen and chilled food processing and manufacturing. Therefore, it is crucial to incorporate waste reduction strategies throughout the manufacturing process. These strategies should focus on minimizing raw material waste, optimizing production processes, and promoting recycling initiatives. One important aspect of waste reduction is the proper segregation and recycling of packaging materials. Additionally, it is essential to explore innovative ways to repurpose or utilize manufacturing by-products. In line with the company's recycling goals, the SHEQ manager (Informant M) emphasized the long-standing commitment to recycling, particularly in relation to paper, while acknowledging the relatively recent introduction of food recycling practices stated, “recycling is something we have being doing from the time I started here, that like 15 years of recycling, especially recycling of paper, food is new.”

It is crucial to highlight the importance of utilizing sustainable packaging materials that can be recycled, biodegraded, or composted. Moreover, incorporating lightweight packaging designs can contribute to the reduction of transportation emissions. Consistently evaluating and appraising sustainability performance, establishing improvement goals, and monitoring advancements are also vital. Lastly, obtaining certifications like ISO 14001 (Environmental Management Systems) or other pertinent sustainability certifications is significant in showcasing dedication and responsibility.

### 5.4. **Main Theme 3:** Consumer perceptions on frozen food waste

In section 2.7 of chapter 2, the focus is on customer perceptions regarding frozen food waste and its impact on consumers with limited financial resources. The wastage of frozen food is seen as a direct financial loss for households on a budget. This is because when food is wasted, it is equivalent to spending money on goods that are not utilized, which can have a significant effect on both family and individual budgets. Consumers also express concerns about how food waste can contribute to the overall cost of food. If a substantial amount of frozen food is wasted, it can lead to price increases that make it unaffordable for certain individuals or families.

Furthermore, some customers connect their concerns about global food security to the issue of food waste. They perceive food waste as a missed opportunity to address hunger and malnutrition on a global scale. From a consumer standpoint, all stakeholders share their perceptions regarding frozen food waste, regardless of their position or level of understanding on the subject.

The findings are categorised into **two** sub themes:

(i) Shelf-life standards and Expiry dates

(ii) Benefits of discounts

### 5.4.1. Shelf-life standards and Expiry dates

While the primary focus of this theme revolved around customer perceptions, it is noteworthy that area sales managers and sustainability managers also expressed their concerns from a consumer perspective. A regional sales manager (Informant G) explicitly stated that, “I'm a consumer, too, and I'd like to say that the standard of cleanliness is okay that I'm shopping at, and I'm not really checking to see if the standard of health is maintained.”

The respondents who expressed satisfaction with the quality of the products they obtained from these retail stores emphasized that the standards were commendable. They further emphasized that their primary concern while shopping was cleanliness. One consumer (Informant AA), relying on the cleanliness of the shelves, stated that, “had no problems, so far. Shelves are always clean.” It is widely known among most consumers that the shelf life of a frozen food product refers to the duration it can remain safe to consume and maintain its nutritional value when stored according to recommended guidelines. Therefore, customers often seek information about the specific shelf life of a product from its packaging, such as labels or product descriptions. This information may also include the suggested storage temperature and any special instructions for preserving the quality of the product.

Quality is a paramount aspect that demands careful consideration in the realm of frozen food. A sales manager (Informant E) in the field highlighted the disparity between their experiences as a customer and as a worker, stating that they rarely encounter expired food as a customer, but encounter it frequently in their professional capacity. It is crucial for customers to develop a comprehensive understanding of the most crucial areas pertaining to quality, as this can greatly contribute to fostering positive relationships with customers. Furthermore, it is imperative to recognize that maintaining high standards of shelf-life is a vital requirement, particularly since customers place significant emphasis on the safety and cleanliness of stores. This focus on quality can also lead to the desired outcome of minimizing food wastage. An environmental expert (Informant V) alluded to this notion by stating,

> “Retail outlets must comply with food safety regulations and guidelines set by regulatory authorities. Upholding shelf-life standards is essential to meet these requirements and maintain legal compliance in the sale and distribution of frozen and chilled foods.”

Respondents held the perception that the frozen foods available at these retail establishments were equivalent to fresh foods, despite acknowledging their inability to assess the quality. Nevertheless, they firmly believed that the frozen foods they purchased were both fresh and suitable for consumption. This belief was reinforced by a consumer's statement (Informant T), “Food that has been frozen lasts longer.” The notion of frozen food being synonymous with freshness is rooted in the convenience it offers. Furthermore, utilizing frozen food is more advantageous as it guarantees superior results and fosters greater acceptance and ease of use. Consequently, frozen food proves to be more beneficial, enabling the attainment of desired outcomes for customers while enhancing their satisfaction and ease of use.

It has been determined in this location that it is obligatory in the KZN region to develop suitable frozen food. Additionally, ensuring the maintenance of adequate quality in accordance with the established criteria renders these food products highly advantageous and practical, which constitutes another crucial aspect. The comprehension of expiry dates is acknowledged by 52% of the participants. Consumers express that, “I rarely checked expiry or best before dates.” The responses from consumers indicate a lack of comprehension regarding expiry dates and best before dates. Conversely, the environmental expert (Informant U) affirmed that,

> “Expiry dates serve as a guideline for food safety. They indicate the recommended timeframe within which the product is expected to be safe for consumption. By checking the expiry dates, you can avoid purchasing products that may have exceeded their safe consumption period, reducing the risk of foodborne illnesses.”

The verification of expiration dates for products is a crucial undertaking; however, the interview participants explicitly expressed their belief that a store would not offer them expired items. This perception can be attributed to the stringent adherence to established policies and the implementation of safety precautions within this field. While this approach can be viewed as advantageous in reducing food waste, it is not entirely effective.

### 5.4.2. Benefits of discounts

Customers have observed that the discounts offered on frozen and chilled foods serve as a means to expedite the sale of perishable items nearing their expiration date by retail stores. The perception of these discounts can vary among consumers based on their level of awareness, experience, and comprehension of pricing strategies. Often, customers compare the discounted price with the original or perceived "regular" price, and the significance of the discount may be amplified if the initial price appeared to be excessively high. The regional sales manager (Informant G) further elaborated on this matter by stating,

> “Retailers may provide discounts on frozen and chilled food products when customers make bulk purchases or take advantage of special deals, such as "buy one, get one free" offers. These discounts are designed to incentivise customers to purchase more and can be unrelated to the quality or expiration date of the products.”

The manner in which discounts are presented can have an impact on how customers perceive them. For example, individuals may regard discounts provided during clearance or holiday sales as being more significant. Customers assess the value of a product based on their own needs, preferences, and past experiences. If a customer believes that the product is worth its original or perceived regular price, a discount may be more appealing. Comparison shoppers tend to possess a greater understanding of market pricing and are adept at determining the true value of a discount. Additionally, an area sales manager (Informant D) mentioned in another response that “frequently offer discounts and promotions on a variety of goods to draw customers, increase sales.”

There are instances when products nearing their expiration date are offered at discounted prices, providing consumers with the opportunity to purchase them at lower costs. These discounted products are sold in order to prevent food waste, as they would otherwise be discarded. It is worth noting that some of these products may have an expiration date within the next 20 days. However, many consumers (Informant S) are unaware of this practice, as one consumer admitted, “I didn’t not notice this but I have seen the good are close to expiring.” In an effort to minimize food waste, retailers reduce the prices of these products to encourage their sale before they expire. Although this strategy does not always yield the desired results, it can be advantageous in generating appropriate discounts. Additionally, consumers may place more trust in certain brands when it comes to discount offers. The reputation of a brand can significantly influence how consumers perceive the value of a discount.

Retailers utilize discounts as a means to efficiently sell excess or slow-moving inventory. This approach aids in avoiding excessive stock levels, reducing carrying costs, and creating room for new merchandise. Moreover, discounts serve as an enticing factor for potential customers who are attracted by the opportunity to save money. Once these customers have a positive purchasing experience, they may become loyal buyers, thereby contributing to the establishment of long-term customer relationships. A customer (Informant AC) has expressed their preference for seeking out special offers by stating, “I look for specials, who doesn’t love to save some money.” However, despite the numerous advantages of discounts, retailers must exercise caution and carefully plan and implement their discount strategies to avoid any negative impact on profit margins or brand perception. By aligning discounts with their business objectives, retailers and customers can mutually benefit from a win-win situation.

### 5.5. **Main Theme 4:** Critical analysis of the national policy and regulation framework

In South Africa, the effectiveness of the national policy and regulation framework for food waste needs to be thoroughly analysed. This framework consists of a combination of policies, regulations, and initiatives that aim to reduce food waste, promote food security, and ensure the sustainable use of resources. Chapter 2, section 2.12 provides a detailed explanation of this framework. To address the issue of food waste, the government has implemented the National Environmental Management: Waste Act, which serves as a legal framework for waste management, including food waste. Additionally, the National Development Plan (NDP) has set targets for reducing food waste and improving resource efficiency as part of the country's sustainable development goals.

However, there are several challenges that hinder the effective implementation of these policies. Inadequate infrastructure and resources for efficient waste management pose significant obstacles. Furthermore, limited awareness and education on the importance of reducing food waste also contribute to the challenges faced in implementing these policies. The results obtained from the main theme and sub-themes of the analysis highlight both positive and negative aspects of the national policy and framework for food waste in South Africa.

One of the key issues is the limited understanding among consumers regarding the national policy and regulation framework for food waste. This lack of awareness and education prevents consumers from fully comprehending the environmental, social, and economic consequences of food waste, as well as the role of government policies and regulations in addressing this issue. To address this gap in knowledge, it is crucial to enhance public education and awareness about food waste and the relevant national policies and regulations. By doing so, consumers will be better equipped to understand the existing framework and actively participate in efforts to combat this critical issue.

The study findings are categorised into **three** sub themes:

(i) The national food waste management policy framework is highly commended with opportunities for growth.

(ii) The national food waste management policy framework is highly condemned with potential threats.

(iii) The national food waste management policy framework compares better to other regional under-developed and developed countries.

5.5.1. The national food waste management policy framework is highly commended with opportunities for growth.

The findings from the interview revealed that the participants held a differing viewpoint regarding the effectiveness of the food and waste management policy in efficiently regulating food waste. While the respondents acknowledged the existence of the policy for a considerable period of time, they expressed dissatisfaction with its enforcement and emphasized the need for a more comprehensive policy that encompasses the entire waste management industry. This new policy should be a direct result of a collaboration between the private and public sectors. Despite its shortcomings, the current policy has demonstrated its strengths by providing guidance in areas other than frozen food. However, there is a concern regarding the level of awareness about these policies, which can be addressed through their implementation to enhance waste management governance. The sustainability manager (Informant H) further elaborated by stating,

> "In order to effectively manage food waste, a regulatory framework must target the entire supply chain, from production to consumption. It should take into account various food waste streams, including that from frozen and chilled foods, and cover waste prevention, reduction, recycling, and disposal techniques. A legislative framework that covers the entire supply chain, from production to consumption, is necessary to manage food waste properly."

The area sales manager (Informant C) emphasized the importance of increasing public awareness, “Raising public awareness about the impacts of food waste.” This issue arises due to a lack of comprehension regarding the national food waste management policy framework and the potential it holds. This sentiment is echoed by a regional sales manager (Informant G) who acknowledges that, “I guess we all follow the policy in some way but don’t realise it. But I have no seen or read it before.” Furthermore, consumers themselves exhibit a lack of understanding about the policy framework, as evidenced by one customer's (Informant AB) response expressing uncertainty about its specifics stating that, “I am unsure of this policy.”

An all-encompassing policy framework is crucial for efficient management of food waste, as it should address the complete supply chain from production to consumption. This framework should account for various forms of food waste, such as frozen and chilled foods, and incorporate strategies for waste prevention, reduction, recycling, and appropriate disposal. To ensure effective management of food waste, it is imperative for a regulatory framework to target the entire supply chain, spanning from production to consumption. This framework should consider different streams of food waste, including frozen and chilled foods, and encompass measures for waste prevention, reduction, recycling, and disposal techniques. The national policy framework for frozen food waste offers numerous prospects for expansion. With an increasing number of individuals and organizations becoming aware of the environmental consequences of food waste, there is a rising need for policies that tackle the problem specifically in the frozen food sector. A potential avenue for growth involves the establishment of comprehensive regulations and guidelines to streamline food waste management practices within the frozen food industry. An environmental expert (Informant V) elaborated on this notion, stating that,

> “Implementing robust monitoring, reporting, and evaluation mechanisms enables the assessment of waste management practices and the identification of areas for improvement. Regular data collection, analysis, and reporting can inform evidence-based decision-making and foster continuous improvement in waste management policies and practices.”

Furthermore, the area sales manager (Informant E) stated that “Using new technology and thinking of new ideas can help you improve.” The potential for growth lies within the realm of technology and innovation, particularly in the context of AD. The framework in place encourages businesses to embrace novel technologies that have the capacity to mitigate food waste, such as intelligent packaging and tracking systems. However, without a comprehensive understanding of the policy, achieving this objective may prove challenging. By fostering innovation and fostering collaboration among stakeholders, there exists a remarkable opportunity to expand upon the policy and effectively reduce food waste. By embracing technological advancements and innovative solutions, waste management efficiency can be significantly enhanced. In essence, the policy framework has the capacity to support research and development in various areas, including smart tracking systems, cold chain management technologies, and waste-to-energy conversion methods, thereby optimizing resource utilization and minimizing waste.

An alternative avenue for potential lies in incentivizing the advancement of food packaging and preservation technologies, aiming to minimize waste and extend the shelf life of frozen food products. This objective can be achieved by offering tax incentives or grants to businesses that invest in sustainable packaging or preservation methods. Additionally, the government has the potential to collaborate with industry stakeholders to support educational initiatives and campaigns that raise consumer awareness about food waste reduction, ultimately encouraging behavioural change. Respondents highlighted the importance of integrating efforts from various stakeholders and emphasized the policy's focus on adopting innovative technologies like smart packaging and tracking, which aim to streamline activities among partners and stakeholders. Consequently, this highlights the significant challenges within the supply chain, involving the FMC, retail outlets, and other external stakeholders that are beyond their direct control.

Moreover, the national policy framework for reducing frozen food waste presents an opportunity for collaboration with other countries and international organizations, allowing for the exchange of best practices and lessons learned from successful food waste reduction initiatives in different regions. By aligning national policies with global endeavours to combat food waste, there is potential to develop more efficient and sustainable solutions to address frozen food waste on a global scale.

5.5.2. The national food waste management policy framework is highly condemned with potential threats.

The national food waste management policy framework in South Africa has faced severe backlash due to its perceived shortcomings in effectively managing frozen food waste. Despite its intended purpose of tackling the issue of food waste in the country, the policy framework has been criticized for its inadequacy in adequately addressing the unique challenges associated with managing frozen food waste. Consequently, there are growing concerns regarding the potential adverse impacts on both the environment and public health resulting from the lack of proper management of frozen food waste. Respondents have expressed their dissatisfaction with the policy, highlighting its vagueness due to the absence of specific targets and guidelines. In fact, an environmental professional (Informant V) has explicitly stated,

> “Weak or inconsistent regulations related to frozen and chilled food waste can lead to confusion and non-compliance. Clear and consistent guidelines are necessary to ensure proper handling, storage, transportation, and disposal of these types of foods throughout the supply chain.”

The policy framework has been heavily criticized for its inability to offer precise instructions on the appropriate management and disposal of frozen food waste. This deficiency has raised apprehensions regarding the possibility of food waste being deposited in landfills, thereby posing potential risks to the environment and public health. A landfill supervisor (Informant Y) expressed their concerns, highlighting that “weak or inconsistent regulations related to food waste can lead to confusion and non-compliance, all this food waste ends up here at the landfill.”

Moreover, the absence of well-defined policies and regulations has posed challenges for businesses and households in effectively managing their frozen food waste. Consequently, this has resulted in unnecessary waste and inefficiencies within the food supply chain. Respondents have indicated that while there are no mandatory requirements, certain aspects of waste management rely on voluntary actions from waste generators. Furthermore, the current policy fails to comprehensively address waste management across both businesses and households. The findings have also highlighted that other countries have implemented stringent penalties for food waste, highlighting a significant gap in the policy's ability to transform itself into actionable objectives. This is a critical area that necessitates attention, as it can have far-reaching consequences on the overall effectiveness of the framework and give rise to numerous practical waste-related issues. Additionally, it is crucial to acknowledge that the presence of gaps within the food waste management policy framework can lead to resource mismanagement. The lack of clear and transparent goals and objectives within the framework contributes to significant confusion, ultimately impacting its performance and resulting in a higher prevalence of challenges related to its proper implementation.

The critique of the national framework for managing food waste emphasizes the necessity for more extensive and efficient policies in addressing the problem of food waste, particularly in relation to frozen food. It also emphasizes the importance of enhancing public awareness and education regarding the significance of appropriate food waste management. In the absence of substantial enhancements to the policy framework, South Africa may encounter significant difficulties in mitigating the environmental and health consequences associated with frozen food waste.

Respondents identified several factors that posed a challenge to the effectiveness of the national waste management policy. These included a perceived lack of political determination, inadequate infrastructure, limited awareness, and a shortage of skills and innovation. These deficiencies hindered the implementation of necessary improvements to ensure efficient waste management. One area sales manager (Informant F) highlighted that, “resistance from various stakeholders within the food industry.” Additionally, a SHEQ manager (Informant I) expressed their disappointment with the infrastructure, emphasizing that “In a 3rd world country, we lack infrastructure.”

The lack of political will and commitment to enforce the policy stands as a significant obstacle in addressing the issue at hand. A considerable number of individuals still fail to grasp the profound impact that food waste has on the environment, economy, and society. Consequently, there is a noticeable dearth of active participation in initiatives aimed at reducing food waste. Furthermore, resistance from various stakeholders within the food industry, such as retailers, manufacturers, and consumers, can present a formidable challenge. This resistance may arise from concerns regarding increased costs, alterations to established practices, or misconceptions about the feasibility of waste reduction measures. In the absence of resolute leadership and support from policymakers, surmounting this resistance and fostering behavioural change necessitates targeted communication, incentives, and the appropriate allocation of resources. Without these crucial steps, the prospects of achieving substantial change remain bleak.

Consumers in South Africa have expressed strong disapproval of the national food waste management policy framework. They argue that the policy is widely condemned and poses potential threats to the handling of frozen food waste in the country. One consumer (Informant P) even goes as far as stating that “its definitely a threat if the food waste amount is still increasing, so the policy not working.” The primary concern for consumers lies in how this policy will impact the management of frozen food waste and its potential consequences for the environment and food security. Additionally, consumers are frustrated by the lack of involvement they had in the policy's development, feeling that their concerns have been disregarded. Consequently, they are demanding greater transparency and collaboration between the government and stakeholders to find solutions that effectively address the complex issue of food waste while also safeguarding the interests of consumers and the environment. Overall, consumers hold a predominantly negative sentiment towards the national food waste management policy framework and are advocating for a more comprehensive and inclusive approach to managing frozen food waste in South Africa.

### 5.5.3. The national food waste management policy framework compares better to other regional under-developed and developed countries.

In under-developed countries, the policy framework for managing frozen food waste at a national level may be absent or inadequately established. These countries often face challenges in terms of lacking the necessary infrastructure, technology, and resources to efficiently handle food waste, particularly frozen food waste. The absence of a comprehensive policy framework results in the disposal of frozen food waste in landfills or its wastage, thereby exacerbating environmental pollution and perpetuating issues of food insecurity and poverty.

On the contrary, developed nations generally possess more sophisticated and all-encompassing national frameworks for managing food waste. These frameworks often encompass regulations and incentives aimed at encouraging food producers, processors, distributors, and retailers to minimize food waste, even extending to frozen food products. The sales managers (Informant E) in the region expressed their observation, stating, “Developed countries have unity and I don’t see this here, everyone is doing here own things.” Developed countries may also implement initiatives to promote food donation and recycling, alongside endeavours to educate individuals on minimizing household food waste. Despite lacking comprehension of the national policy framework, a consumer (Informant P) expressed, “I would guess that developed countries got this in more control.”, even with the lack of understanding of the national policy framework. In general, the national framework in developed nations strives to diminish food waste and enhance sustainability within the food distribution network.

An environment professional (Informant U) further added,

> “While comparing the national food waste management policy framework to other countries can provide valuable insights, it's important to approach these comparisons with caution. Each country has unique socio-economic, cultural, and environmental contexts that influence the design and implementation of waste management policies. Policy effectiveness should be evaluated based on the specific goals, targets, and outcomes set within the national context.”

The National Food Waste Management Policy Framework sets a benchmark for other policies in less developed regions. Its holistic approach to mitigating food waste and promoting sustainability makes it an exemplary model for emulation. When comparing this framework to those of other countries in the same region, it is crucial to evaluate its alignment with regional priorities, existing infrastructure, cultural practices, and economic conditions. Various factors, such as waste management infrastructure, regulatory frameworks, stakeholder engagement, and public awareness campaigns, can exhibit significant variations within a region. Some countries may possess well-established systems for waste collection, recycling, and composting, along with comprehensive monitoring and reporting mechanisms. Developed countries often prioritize waste prevention, reduction, and resource recovery in their policy frameworks. Both developed and under-developed countries encounter the challenge of managing frozen food waste in a manner that minimizes its adverse impact on the environment and society. However, the approaches and resources available to each may differ considerably. Ultimately, both types of countries must strive to establish effective and sustainable food waste management policies to address the global issue of food waste.

## 5.6. Chapter Summary

In conclusion, the examination of original qualitative data in this chapter has exposed profound insights into the intricate fabric of themes. The interviews captured a wide range of perspectives, offering a diverse and comprehensive view. The identified themes serve as a captivating narrative, interweaving the varied experiences, opinions, and perceptions of the participants. Through a process of data analysis and thematic coding, significant patterns and recurring motifs emerged, illuminating the underlying complexities inherent in the research questions.

This chapter has not only presented unprocessed data but has also undertaken a process of sense-making, transforming the qualitative information into meaningful and coherent narratives. The themes not only exist as separate entities but also constitute interconnected networks that reflect the intricacies of the phenomenon being investigated. These themes will continue to guide the exploration, establishing a strong basis for subsequent analyses and discussions in the upcoming chapters.

# CHAPTER 6: RESULTS – SECONDARY QUALITATIVE DATA

## 6.1. Introduction

Meta-analysis research was conducted by the researcher to investigate trends in chilled and frozen food waste generation in 202 out of 422 retail outlets supplied by the FMC in KwaZulu-Natal. As indicated in Figure 6.1, these data were sourced from various company systems and through the review of documents.

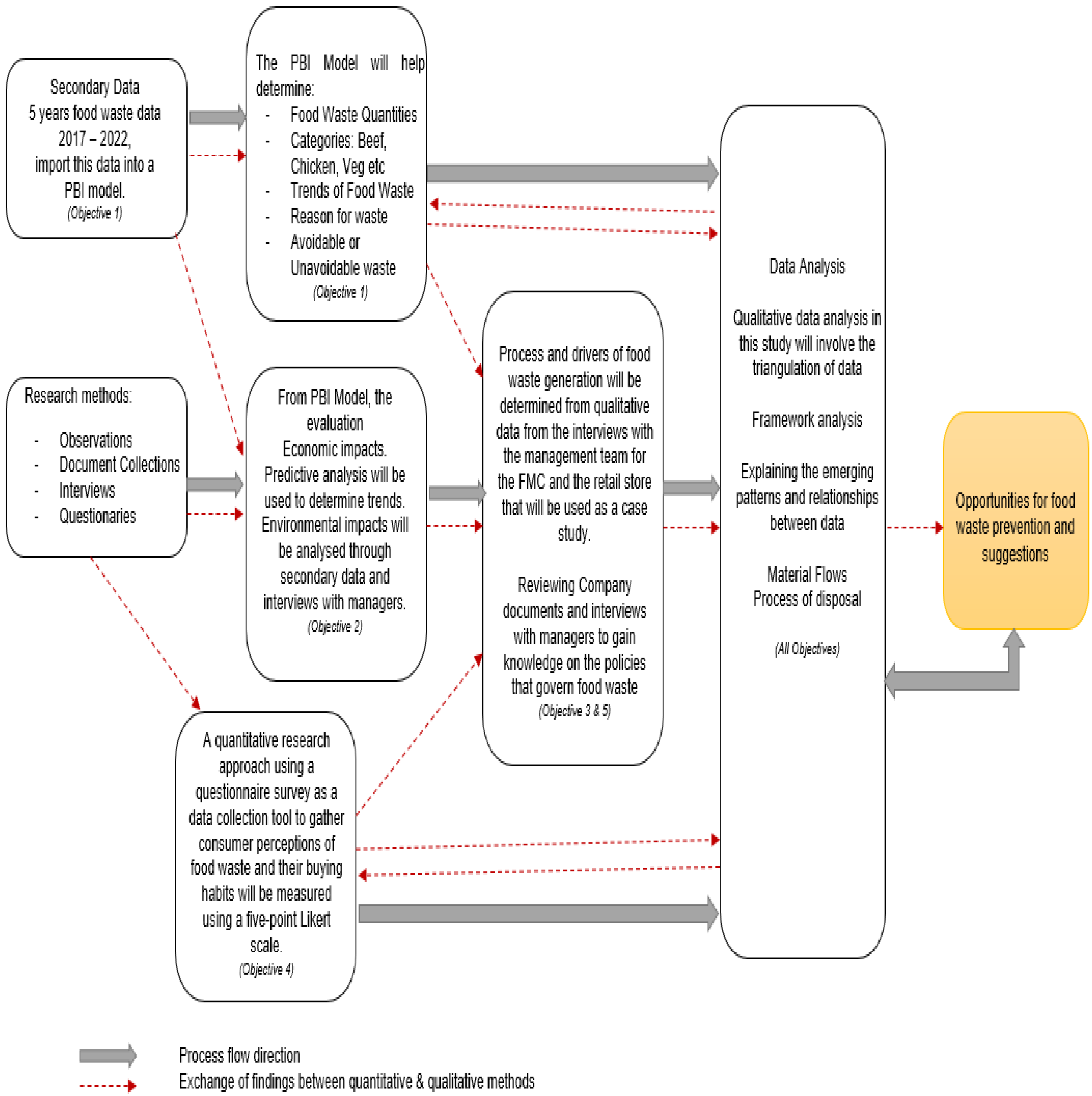



**Figure 6.1:** The process flow of waste generation and mitigation. Source: Researcher (2023)

A Power BI model was developed by importing financial data spanning over a period of 5 years, specifically focusing on frozen food waste that was returned to the FMC. This model enables the end user to identify the retailers and stores that exhibit a significant volume of frozen food waste. The model is structured based on geographical areas and product categories, providing the business with insights into which specific product category is primarily contributing to food waste in each area. By offering clear visibility into the problematic areas, the model empowers the business to formulate action plans aimed at reducing frozen food waste. In essence, the Power BI model serves as a comprehensive tool that consolidates, organizes, and enhances the usability of data, facilitating effective analysis and visualization. It acts as a foundation for generating impactful reports and dashboards, enabling businesses to make well-informed decisions based on their data.

## 6.2. Chilled and frozen food waste categorisation and quantification in 202 retail outfits in KwaZulu-Natal province South Africa.

### 6.2.1. Categories of frozen and chilled foods

Frozen and chilled foods can be categorized into various types based on their nature, ingredients, preparation, and intended use. Some common categories of frozen and chilled foods are indicated in Table 6.1 as follows:

**Table 6.1:** Categories and sub-categories of frozen foods

| **Category** | **Subcategory** |
|---|---|
| Dairy | Butter |
| | Cheese |
| | Yoghurt |
| Meat | Beef |
| | Chicken |
| | Fish |
| | Lamb |
| | Pork |
| Vegetables | Potato |
| | Soya |
| | Vegetables |

Study results revealed that there was a total of 2123 products that could be placed in categories and sub-categories that predominantly drove chilled and frozen food waste generation in the KZN stores. These categories included freezer to fryer, individually quick-frozen (IQF) etc.

6.2.2. Ranking of spilt frozen and chilled food waste by retailer tonnage

The researcher captured data from the uplifts of returned products distributed by the FMC for the 202 stores, uploaded these to Microsoft Power BI and linked them to the categories and sub-categories to rank retailers from highest to lowest in terms of spillage. Retailers were named A for largest, B for medium, C for medium and D for small. Data were recorded in number of cases, kilograms, and tonnage of spilt chilled and frozen food waste.

Relatively higher quantities of food waste were noted from the largest retailer in South Africa, retailer A with 127 stores with 1953.23 tons of waste, particularly involving the chicken (54.08%) and butter (27%) sub-categories. Each retailer may not have the same suite of products but has the same categories and sub-categories (Table 6.2).

**Table 6.2:** Retailer split as to food waste (in tons). Source: Researcher (2023)

| **Retailer** | **Number of Stores** | **Number of Products** | **Tons of Food Waste** |
|---|---|---|---|
| Retailer A - Ranked 1 (Largest) | 127 | 1670 | 1953.23 |
| Retailer B - Ranked 2 (Medium) | 33 | 1219 | 216.37 |
| Retailer C - Ranked 3 (Medium) | 26 | 941 | 218.33 |
| Retailer D - Ranked 4 (Small) | 16 | 640 | 115.09 |
| | **202** | **2123** | **2503.03** |

6.2.3. Chilled and frozen food waste segregated by product.

The researcher extracted data by product to establish trends and patterns of chilled and frozen food waste generated from the 202 retail outlets supplied by the FMC.

As indicated in Figure 6.2, results revealed that chicken recorded the highest waste, at 71.27%, vegetable products at 71.27%, followed by dairy at 57.63%.

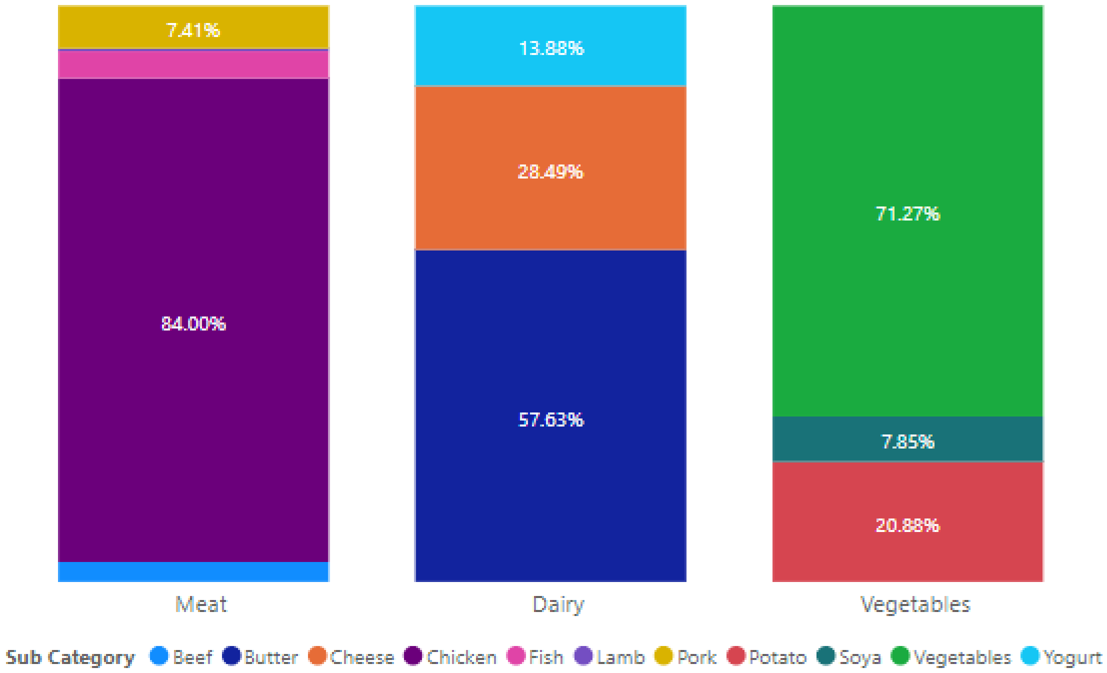



**Figure 6.2:** Frozen and chilled food waste segregated by product (in tons) - (Created by the researcher, 2023)

6.2.3.1. Generated meat food waste

The researcher extracted data to establish trends in meat food waste generated from the 202 retail outlets supplied by the FMC (Figure 6.3).


**Figure 6.3:** Meat food waste in tons from July 2017 - June 2022. Source: Researcher (2023)

The results revealed that the meat category makes up 57.88% of food waste in retail stores with chicken contributing to 84% (1216.84 tons) of meat wasted, followed by pork at 7.4% (107.31 tons). The COVID-19 pandemic, particularly over the period in South Africa from 5th of March 2020 to the 1st of October 2021), led to a massive disruption in the food system whereby, more meat was returned from the retailer. In the early days of the pandemic, there was uncertainty about the availability of food due to supply chain disruptions and lockdown measures. This prompted consumers to engage in panic buying and stockpiling, leading to increased purchases of non-perishable and long-lasting items like frozen meat which led in an increase in frozen and chilled food waste. A life cycle assessment (LCA) conducted by Aldaco et al., 2020, indicated that food waste increased by 12% and cost increased by 10%.

6.2.3.2. Generated dairy food waste

The researcher extracted data to establish trends in dairy food waste generated from the 202 retail outlets supplied by the FMC (Figure 6.4).

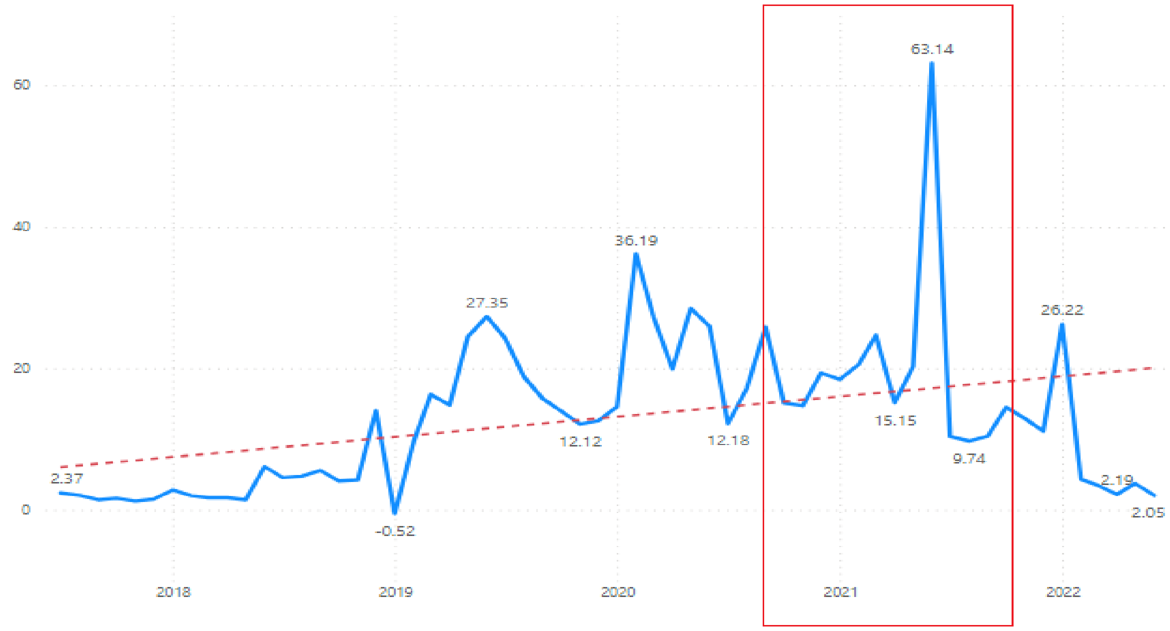



**Figure 6.4:** Dairy food waste from July 2017 - June 2022. Source: Researcher (2023)

The results obtained showed that the dairy category makes up 31.27% of the food waste in the retail sector with butter contributing 57.63% (451 tons) of food waste and cheese contributing 28.49% (223 tons) in this category. The pandemic contributed to dairy food waste as well.

6.2.3.3. Generated vegetable food waste

The researcher extracted data to establish trends in vegetable food waste generated from the 202 retail outlets supplied by the FMC (Figure 6.5).

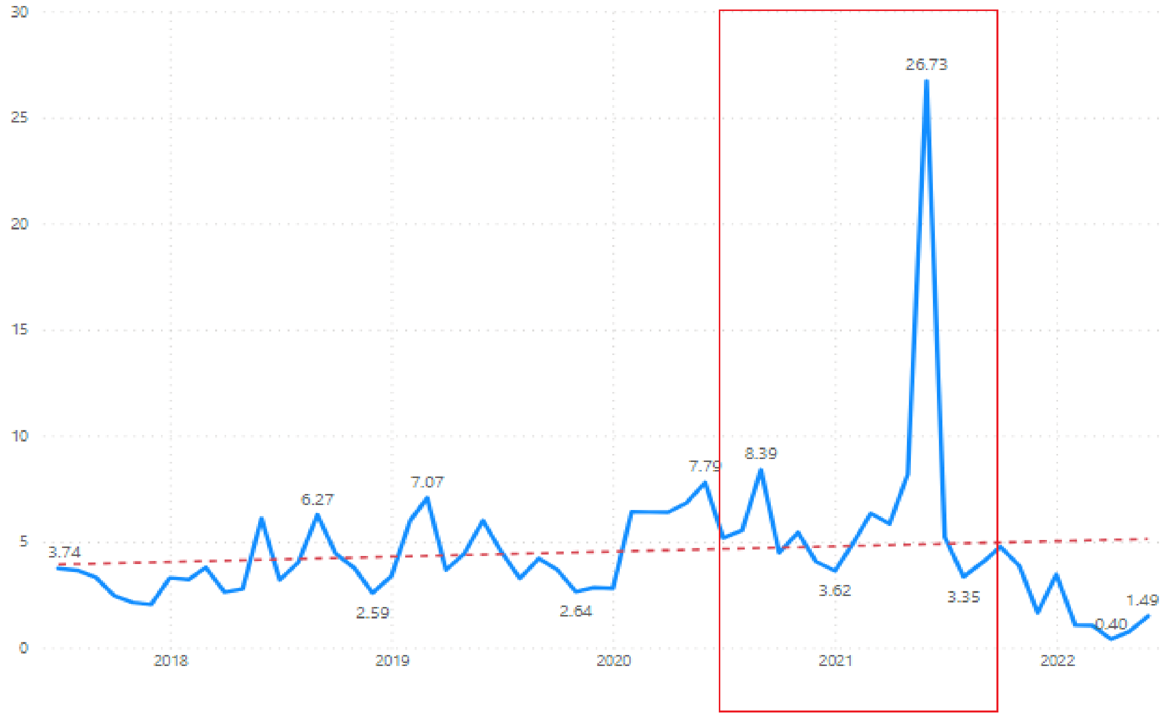



**Figure 6.5:** Vegetable food waste from July 2017 to June 2022 Source: Researcher (2023).

The results revealed that the vegetable category makes up 10.85% of food waste with vegetables contributing 71.27% (193.56 tons) to food waste. This occurred during a period from July 2017 to June 2022.

6.2.4. The drivers behind frozen and chilled products wastage

The results further revealed the reasons and drivers of food waste in the 202 retail stores included in the study. Stock returns are a reason that drives frozen and chilled waste generation. This research included 202 stores that represent 47.8% of the KZN store base of 422 stores. Table 6.3 presents reasons for stock returns giving rise to frozen and chilled food waste generation.

**Table 6.3:** Reason for returns from a retailer. Source: Researcher (2023)

| Summarised Reason | Definition |
|---|---|
| Packaging Defect | The outer packaging of the product was damaged at distributing or delivery stage. The supplier of the product is liable for the poor packaging. Including Bar, Codes do not scan |
| Store Damages | The product delivered to the store is in good condition, but with the movement of stock, the packaging is damaged, and the product is either smashed or broken |
| Expired Product | Product delivered to the store with a close expiry date of 60 days or expired in-store due to no sales |
| Discontinued | The product range is no longer produced, and the supplier requested product to be removed from the shelves |
| Customer Rejected | The customer in the retail store rejects and orders due to incorrect pricing or product. This can happen manually upon delivery or via the system (EDI) before delivery. |

Not all retail stores have the same food waste sub-categories and products, as seen in two sub-categories (butter and chicken) available in all 202 stores. (Table 6.4). With a higher store base, a larger quantity of food is also produced. Observations and figures revealed that in the meat category, lamb and pork are only seen in 168 stores while yoghurt (dairy category) and soya (vegetable category) are only seen in 174 stores. Reasons given for food waste returns were driven by packaging defects (996.42 tons) and store damages (749.82 tons) (Figure 6.6). Packaging defects are seen in the meat category and chicken sub-category while store damage is seen in the dairy category for the butter sub-category.

### 6.2.5. Food Waste and Store Base by Retailer Sub-Categories

The researcher sought to establish frozen and chilled food waste by retailer categorization in terms of tonnage. Retailer A being the largest category, retailer B and C medium category and retailer D being the small category (Table 6.4).

**Table 6.4:** Food waste by category and retailer. Source: Researcher (2023)

| Sub-Category | Retailer A Ranked 1 (Largest) | | Retailer B Ranked 2 (Medium) | | Retailer C Ranked 3 (Medium) | | Retailer D Ranked 4 (Small) | | Food Waste (Tons) | Store Freq. | Ratio |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Food Waste (Tons) | Store Freq. | Food Waste (Tons) | Store Freq. | Food Waste (Tons) | Store Freq. | Food Waste (Tons) | Store Freq. | | | |
| Beef | 29.73 | 127 | 17.39 | 33 | 2.25 | 25 | 0.37 | 9 | 49.74 | 194 | 96% |
| Butter | 306.23 | 127 | 9.66 | 33 | 69.79 | 26 | 65.44 | 17 | 451.11 | 203 | 100% |
| Cheese | 204.18 | 127 | 3.06 | 33 | 11.04 | 25 | 4.75 | 6 | 223.03 | 191 | 95% |
| Chicken | 1005.87 | 127 | 81.85 | 33 | 95.96 | 26 | 33.17 | 15 | 1216.84 | 201 | 100% |
| Fish | 48.13 | 127 | 14.21 | 33 | 3.95 | 25 | 1.86 | 9 | 68.15 | 194 | 96% |
| Lamb | 4.11 | 121 | 2.32 | 33 | 0.16 | 13 | 0.01 | 3 | 6.60 | 170 | 84% |
| Pork | 89.22 | 125 | 16.71 | 33 | 1.36 | 9 | 0.01 | 1 | 107.31 | 168 | 83% |
| Potato | 33.33 | 127 | 16.33 | 33 | 6.42 | 20 | 0.65 | 9 | 56.72 | 189 | 94% |
| Soya | 17.18 | 127 | 3.06 | 33 | 0.74 | 15 | 0.35 | 5 | 21.33 | 180 | 89% |
| Vegetables | 125.68 | 127 | 51.48 | 33 | 12.58 | 26 | 3.83 | 11 | 193.57 | 197 | 98% |
| Yoghurt | 89.58 | 126 | 0.32 | 18 | 13.85 | 24 | 4.88 | 11 | 108.63 | 179 | 89% |

The results revealed that chicken was the most discarded in all retail facilities with a total of 1216.8 tons lost and lamb (mutton) with the least waste loss, standing at 6.60 tons lost.

### 6.2.6. Tonnage of frozen and chilled food waste generation by reason

The researcher extracted data trends in tonnage of frozen and chilled food waste generation by category in 202 retail outfits supplied by the FMC.

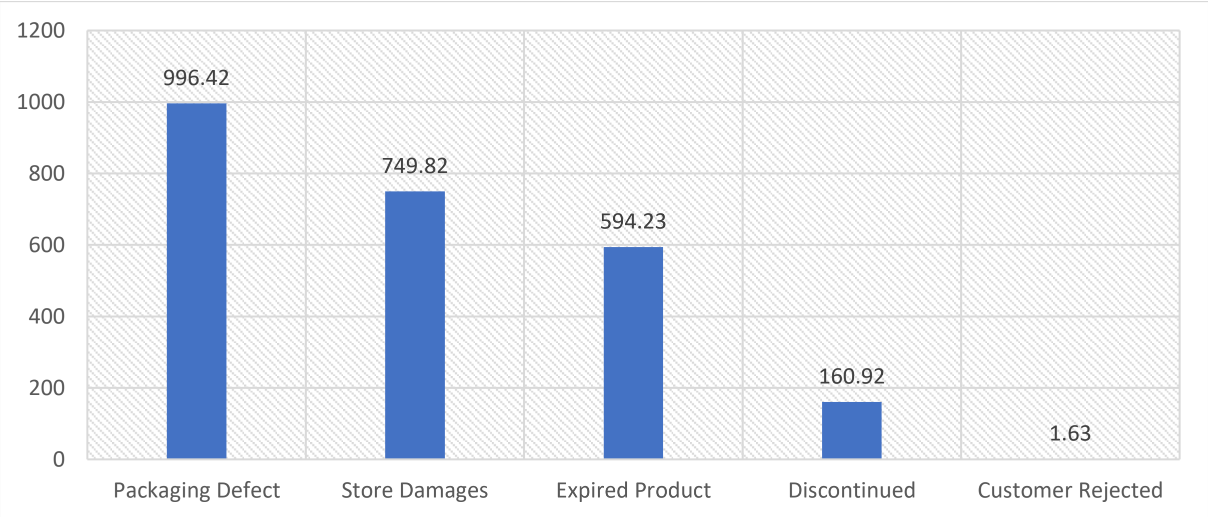



**Figure 6.6:** Reason for food waste. Source: Researcher (2023)

The results show that packaging defects resulted in massive food wastage in all stores with 996.42 tons lost followed by store damage with 749.82 tons and customer rejection with the lowest figure at 1.63 tons (Figure 6.6).

6.2.6.1 Date Labelling

The researcher aimed to delve into the specifics of why expired products constituted the third reason for returns, examining data from the 202 retail stores supplied by the FMC. A concern regarding words as “sell-by date”, “expiry date” and “best-before date” was noted.

These were broken down and explained as follows:

- Best Before - will indicate when the product is at its best.
- Sell By date - must have been sold by this date, (may not necessarily mean that the product is no longer fit for consumption
- Expiry date - the product is deemed no longer safe for consumption or usage.

The researcher made observations on shelf health elements and standards in some selected stores of the 202 retail outfits supplied by the FMC (Table 6.5).

**Table 6.5:** Shelf health elements. Source: Researcher (2023)

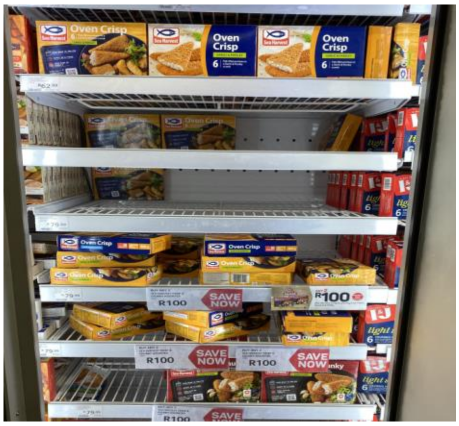
| **Shelf Health Element** | **Definition and How to Achieve** |
|---|---|
| Full Shelves Always | **Ensure stocks, on lines listed or ranged for store and Principal**<br>- Shelves must look presentable and full and ensure Stock Counts are done correctly<br>- Ordering systems, use the Rate of Sale and Current Stock |
| Forward Share | **Amount of space on the shelf**<br>**Measured by the number of facings for a specific category**<br>- Divided by the total number of facings (FMC Products and other Products)<br>- Our rate of sale determines how many facings we can use as a % |
| Spotless Shelves | **Ensure shelves are clean before unpacking new stock**<br>- Wipe soiled products and shelves with a wet cloth (wipe with vinegar and water solution). Cleaning agents to be obtained from store management |
| PI Labels Present and Correct | **PI labels must be present per SKU**<br>- Must be updated in the 1st week of every month, or before and after promotions<br>- Ensure the correct price is displayed on the day of change |

| | |
|---|---|
| Stock Rotation | **When refilling the shelf, take all stock off the shelf, pack new stock according to First in First Out (FIFO). Place old stock in front of new stock**<br>- Ensure that there is never EXPIRED stock on the Shelf<br>- Complete short dated stock, and full stock rotation, on every line<br>- This must be done weekly<br>- Inform your area manager four months before the stock expires |
| Best Shelf Position | **Is it at eye level?**<br>- Always obtain the best position for our products<br>- Ensure that it is visible to the consumer and not Lost on the shelf |
| Product Quality Obsession | **Products being packed onto the shelf must be in the best possible condition**<br>- No Squashed, or torn boxes, bags or packaging is allowed onto the shelf<br>- if the packaging is damaged and the product is exposed this is a Health Risk<br>- Ask yourself if you would buy this product |
| Right Range | Ranging is having all lines available in-store based on the store profile (size of store, Principal Strategy, Demographics, Space on the shelf) (Number of known Key Value Items (KVI) lines to be listed)<br>- Replenish all of the shelves, and ensure that all of the listed stock-keeping units (SKUs) are present<br>- Obtain the Range Catalogue from your Line Manager |

The researcher sought to explain the shelf health standards as highlighted above in Table 6.5 above which has eight keep standards: (a) full shelves always (b) forward share (c) spotless shelves (d) PI labels present and correct (e) stock rotation (f) best shelf position (g) product quality (h) obsession, and (i) right range which are used to benchmark correct practices.

The researcher took photographs of frozen and chilled items depicting what is acceptable and what is not acceptable shelving (Table 6.6). Pictures depicting each shelf health standard are juxtaposed with one another showing the correct practice compared to the one showing non-acceptable practice.

**Table 6.6:** Images that highlight the eight health-related shelves. Source: Photographs taken by the researcher (2023)

| Element | Correct practice | Not acceptable practice |
|---|---|---|
| Full shelves always |  |  |
| Forward share |  |  |
| Spotless shelves |  |  |
| PI Labels present and correct |  |  |

| | | |
|---|---|---|
| Stock rotation |   |   |
| Best shelf position |  |  |
| Product quality obsession |   |   |
| Right range |   |   |

The researcher observed that from all the 8 health shelf practices both acceptable and non-acceptable standards were occurring.

### 6.2.6.2 Food safety regulations

The researcher established that within the retail outlets, key chilled and frozen food waste generation is driven by such factors as: “Fridge breakdowns”, “Short dated stock” and “shelf health” were prevalent. In Retailer A, there were 4 fridge breakdowns logged. Fridge breakdowns are called into the FMC call centre to inform managers of the incident and to make arrangements to move products. Upon speaking to the FMC compliance manager, only 10% of stores call in a fridge or freezer breakdown. Although the retailer is responsible for the maintenance of the fridge and freezer, the FMC has the responsibility to ensure their products are safeguarded. Due to inefficient communication channels, stock is often damaged or gets spoilt because of being kept in warmer temperatures for long periods.

The researcher obtained fridge and freezer breakdown information from the FMC Call Centre from January 2022 to January 2023 (Figure 6.7), with over 7 367 units of products being damaged in KZN stores. This showed an upward trend with fridge breakdowns with Retailer A and Retailer B having 42% and 26% fridge/freezer breakdowns respectively. It is also seen that during peak time no calls were received regarding fridge/freezer breakdown. By extending the shelf life of a product, refrigeration and freezing are essential in reducing food waste. Due to its impact on microbial growth and ripening, temperature is crucial to the refrigeration and freezing of food. Food should be stored at a temperature of 0°C, -4°C for refrigeration, and -17°C for freezing. Therefore, it's critical to make sure food is kept at the proper temperature during storage (Carter, 2022).

### 6.2.6.3 Logged fridge and freezer breakdowns between the periods of January 2022 to January 2023.

The research sought records of freezer and fridge breakdowns which results in chilled and frozen food waste generation. The following trends were observed Figure 6.7.

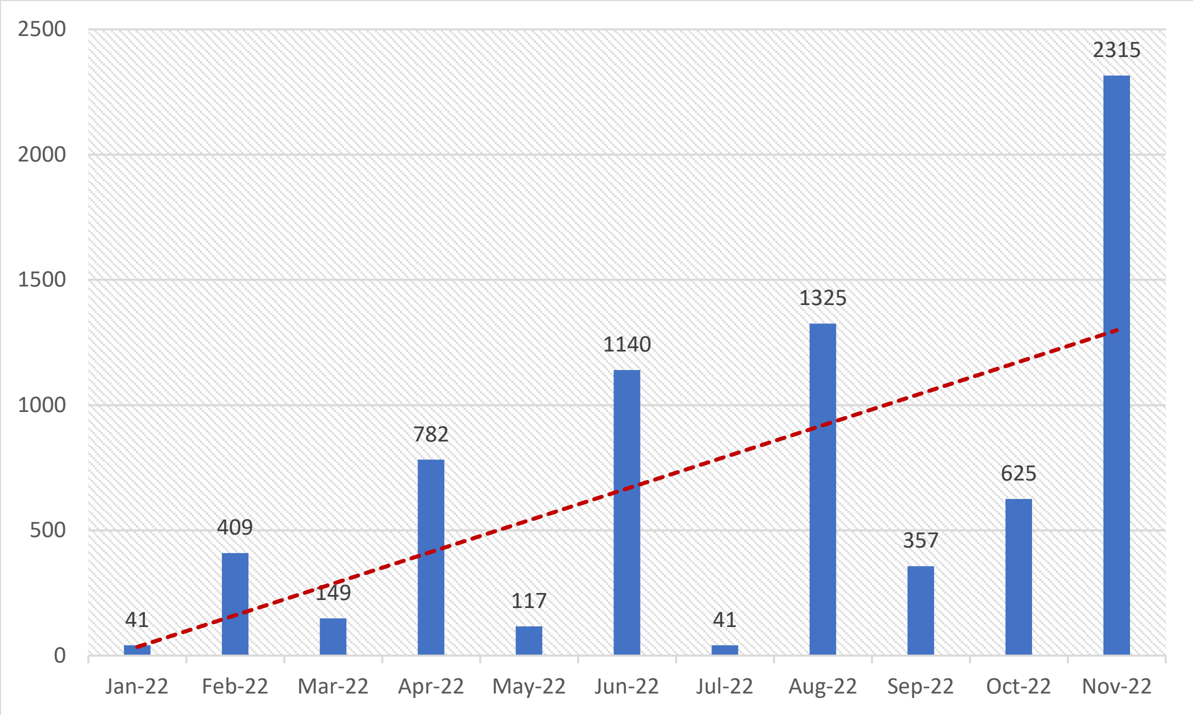



**Figure 6.7:** Logged fridge and freezer breakdowns from January 2022 - November 2022. Source: Researcher (2023)

In the 12-month period from January 2022, 41 cases of freezer and fridge break downs were recorded. By June 2022 the prevalence was recorded to be 1140, and 2315 cases were recorded by November 2022.

#### 6.2.6.4 Short dated stock

Short-dated stock is stock which has exceeded a certain number of stipulated days in the supply and value chain. When a product has 180 days shelf life, but stays in the FMC warehouse for 150 days, once it is sold to the retailer, ownership of the product is now transferred. The store requires by law a minimum on-shelf life (selling validity period) of 90 days. It is considered short-dated, as it only has a 30-day effective shelf life. In many cases, there are short-dated products delivered to retailers. Few retailers call the FMC call centre to log short-dated stock. Management has confirmed that over 42 914 units of stock were received short-dated in KZN from January 2022 to January 2023. In a recent article, Retailer A has implemented various technologies to combat food waste. The retailer aims to use artificial intelligence and machine learning to predict sales in its stores. Replenishment orders are placed automatically to ensure stock is always available for customers while reducing food waste (Writer, 2022).

#### 6.2.6.5 Stock handling

Poor handling of products results in in-store damages which is another driver for food waste within the retailers. Thus, mishandling is a cause of food waste production, mainly related to the mishandling of food by retail workers and improper loading, which can affect the quality of fresh produce - one of the main reasons dairy products are thrown away within the supply and value chain of the FMC. The researcher observed in Retailer B that there were many promotions held within the store. The “marked-down” pricing is used to entice customers to buy more and allow the store to remove short-dated stock from the shelf quickly. Furthermore, during promotions, the bulk of stock gets damaged due to poor handling by the customers, rushing to get a promotional product which leads to more chilled and frozen food waste generation.

#### 6.2.6.6 Absence of diversion routes related to frozen and chilled food waste generation.

When it comes to preventing food waste from going to the landfill, diversion routes are crucial. Diversion routes contribute to more sustainable waste management practices, promote resource conservation, and reduce the environmental impact of waste disposal. Some of these routes are recycling, composting, waste-to-energy (WTE). The researcher observed that there was lack of infrastructure for processing food waste, a lack of coordinated market for compost made from organic waste, and a lack of knowledge about redistribution channels. Redistribution of food waste ranks second in the hierarchy of food recycling. The store claimed that they were unable to donate because of worries about food safety regulations and a lack of knowledge regarding who should receive the food. There is numerous red tape surrounding donating food to the homeless or schools. In stores where food waste was donated to food rescue charities, food collection was voluntary and based on the charity staff coming to the stores to collect food. If the charity staff did not come, the food waste was disposed of.

#### 6.2.6.7. Food to be returned is bagged and tagged without separation to be sent to the landfill.

The researcher captured pictures (Figure 6.8) of food to be returned as stock damage and food to be sent to landfill from within some of the retail stores.

**Figure 6.8:** Returned products sent to landfill. Source: Photograph taken by the researcher (2023)

Composting was not observed as an option to divert their food waste from the landfill. Another option was the donation of food. However, due to the lack of demand for composting in KZN, there is no development in composting areas and all food waste from the distribution phase is sent to the landfill.

## 6.3. Economic and environmental impacts of food waste

The researcher established that the FMC has joined the international “10x20x30 initiative” which is an initiative launched by Champions 12.3 to bring together 10 of the world's largest food retailers and suppliers, each partnering with 20 of their key suppliers to halve food loss and waste by 2030. Champions 12.3 is a high-level, voluntary coalition of leaders from government, business, international organisations, research institutions and civil society, aiming to inspire ambition, mobilize action and drive progress towards SDG 12.3 goal by 2030 accelerate (UN, 2019). The FMC is committed to focusing on rooting out the food waste causes in the supply chain.

### 6.3.1. Economic Impacts

Food waste not only impacts the health of our communities, creatures, and ecosystems, but it also has real and very significant economic impacts. These include lower land values, less tourism, wasted resources, and clean-up costs. The FAO of the UN estimates that around a third of the global food intended for human consumption is lost or wasted. This amounts to over a billion tons of food and $940 billion in economic losses each year (FAO, 2020). In South Africa, food waste occurs at multiple points along the food supply chain and the costliest food waste occurs during food distribution with a loss of R19.6 billion, followed by processing and packaging with a loss of R15.6 billion, and agricultural production with a loss of R12.5 billion (DEFF & CSIR, 2021). Based on the average cost of food per ton, the researcher calculated the estimated R-value loss due to food waste. The cost associated with inedible food waste in South Africa, in terms of lost value from not recovering this waste, was estimated at R6.4 billion (US$0.64) per year, or R2668 (US$266) per ton (DEFF & CSIR, 2021).

Adding this to the previous estimate for edible food waste of R61.5 billion per year (in 2012 prices; equivalent to R65 billion in 2013 prices) gives the total opportunity cost of food waste in South Africa (in terms of the loss of a potentially valuable food). Source or resource of R71.4 (US$7.14) billion per year or R5667 (US$567) per ton (DEFF & CSIR, 2021).

Estimates of the costs associated with disposing of this food waste in a landfill, including both financial costs and externalities (social and environmental costs), are then considered. This cost comes to 255 Rand (US$25) per ton, resulting in a total food waste cost in South Africa of R75 billion (US$7.5 billion) per year, or R5922 (US$592) per ton (DEFF & CSIR, 2021). This corresponds to 2.2% of South Africa's GDP in 2013 (de Lange & Nahman, 2015). Based on R5922 per ton, approximately R15 million were lost, with R8.58 million from the meat category, R4.64 million from the dairy category and R1.61 million from the vegetable category. The highest losses are seen during the pandemic in 2020 and 2021 (Figure 6.9), with a total loss of R9.15 million (62% of food waste over the researched period). The chicken category has shown an alarming R7.2 million loss (Table: 6.7) and also shows the highest yearly loss.

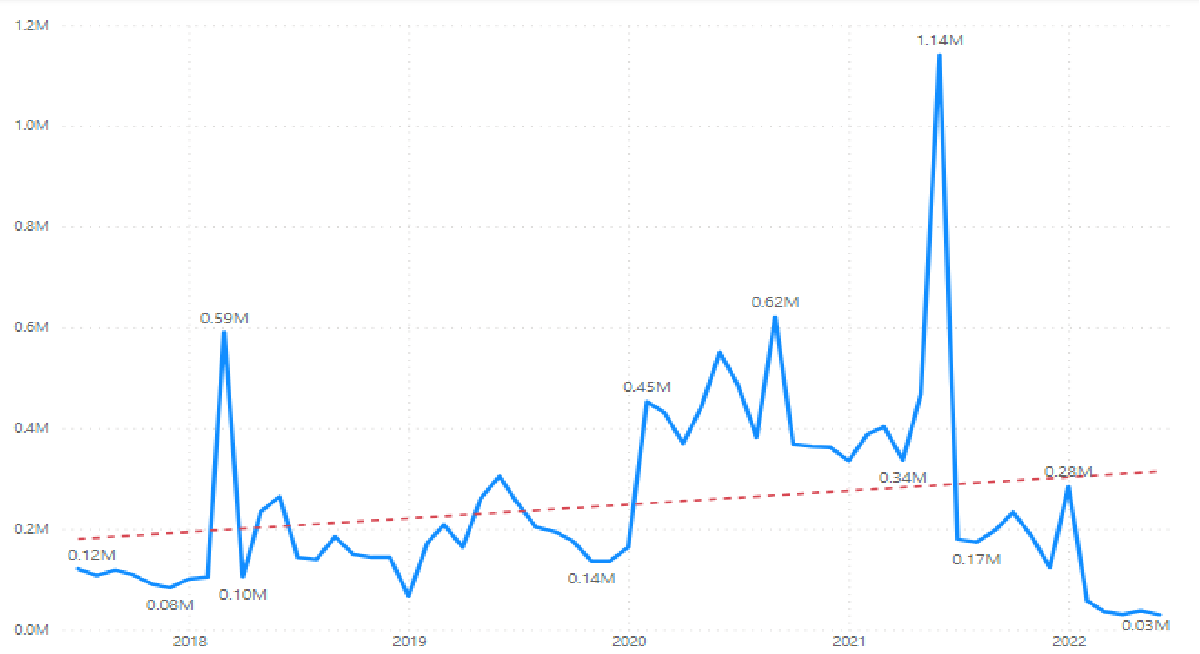



**Figure 6.9:** Economic impacts - 5-year estimated R-value food waste. Source: Researcher (2023)

**Table 6.7:** Estimated R-value (in millions) by sub-category. Source: Researcher (2023)

| **Subcategory** | **2017** | **2018** | **2019** | **2020** | **2021** | **2022** |
|---|---|---|---|---|---|---|
| Beef | R21 165 | R56 616 | R90 106 | R67 025 | R52 349 | R7 284 |
| Butter | R58 701 | R147 209 | R817 134 | R704 068 | R787 366 | R157 022 |
| Cheese | R2 434 | R157 226 | R158 673 | R524 484 | R408 854 | R69 127 |
| Chicken | R366 138 | R1 462 938 | R490 559 | R2 719 878 | R2 015 459 | R151 161 |
| Fish | R30 113 | R73 228 | R98 372 | R112 210 | R79 497 | R10 140 |
| Lamb | R447 | R8 251 | R8 257 | R4 336 | R16 536 | R1 255 |
| Pork | R45 660 | R112 196 | R154 249 | R154 643 | R162 052 | R6 694 |
| Potato | R16 924 | R45 880 | R57 880 | R84 864 | R117 442 | R12 925 |
| Soya | R10 198 | R23 207 | R27 763 | R29 308 | R30 753 | R5 061 |
| Vegetables | R75 596 | R203 891 | R220 606 | R298 477 | R316 976 | R30 768 |
| Yoghurt | | R9 398 | R146 599 | R291 573 | R173 465 | R22 260 |
| **Total** | **R627 375** | **R2 300 039** | **R2 270 198** | **R4 990 867** | **R4 160 748** | **R473 695** |

The cost of food waste at each stage of the food supply chain and for a variety of food groups is shown in Figure 6.10. The data presented were based on data reported by Oelofse and Nahman (2013) in the 2012 Council for Scientific and Industrial Research (CSIR) report. The y-axis represents the cost of food waste expressed in billions of rand and the x-axis illustrates food waste at each stage of the supply chain for a variety of commodity groups (Oelofse & Nahman, 2013). The finding of meat in the distribution phase being the highest cost is in line with the researchers' current findings.

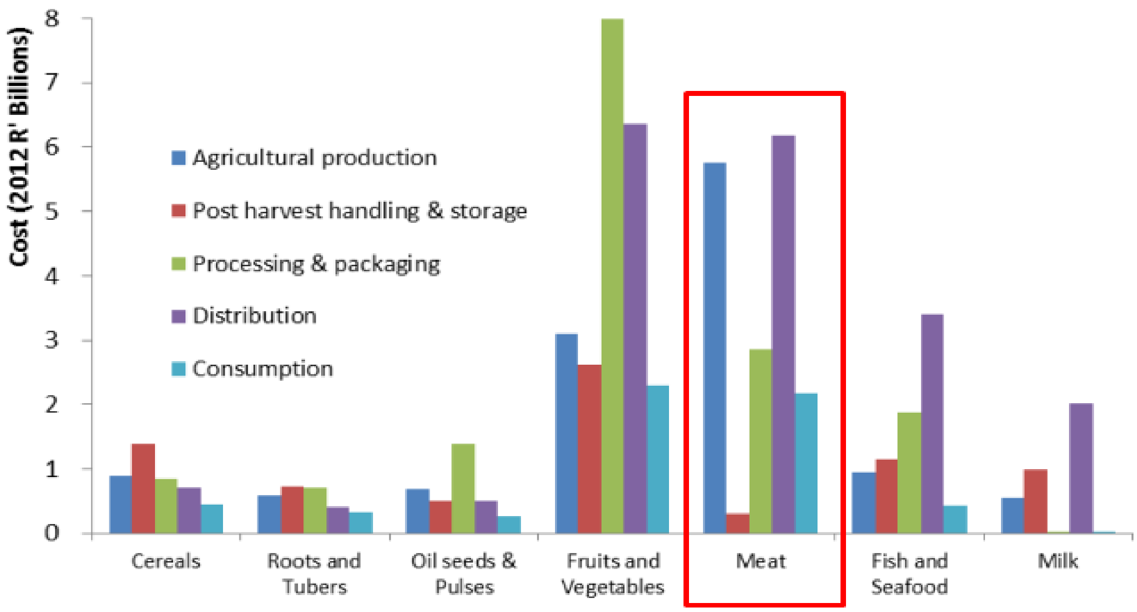



**Figure 6.10:** Cost of food waste. Source: adapted from Oelofse and Nahman (2013)

Apart from returned goods from retail stores, the researcher obtained additional food waste information which were actual food waste sent to the Mariannhill landfill from the FMC. This information was from July 2020 – December 2022 (Figure 6.11). This was food waste recorded from the uplifts and distribution phase within the retail space. Total food waste for 30 months is 1101.07 tons with an estimated cost of R6.5 million. Thus, an average of 40 tons of food waste is sent to landfill every month bearing in mind the municipality's declining landfill airspace and the severity of urban food insecurity (Moodley et al., 2019). Once again, the pandemic has shown the stress created by increasing the amount of food waste sent to landfill and estimated costs were increased. During the pandemic (June 2020 – September 2021), an average of 51.05 tons per month of food waste was disposed of at the landfill, whereas after the lifting of the state of disaster (October 2021 – December 2022), the average food waste sent to the landfill dropped to 22.32 tons per month.

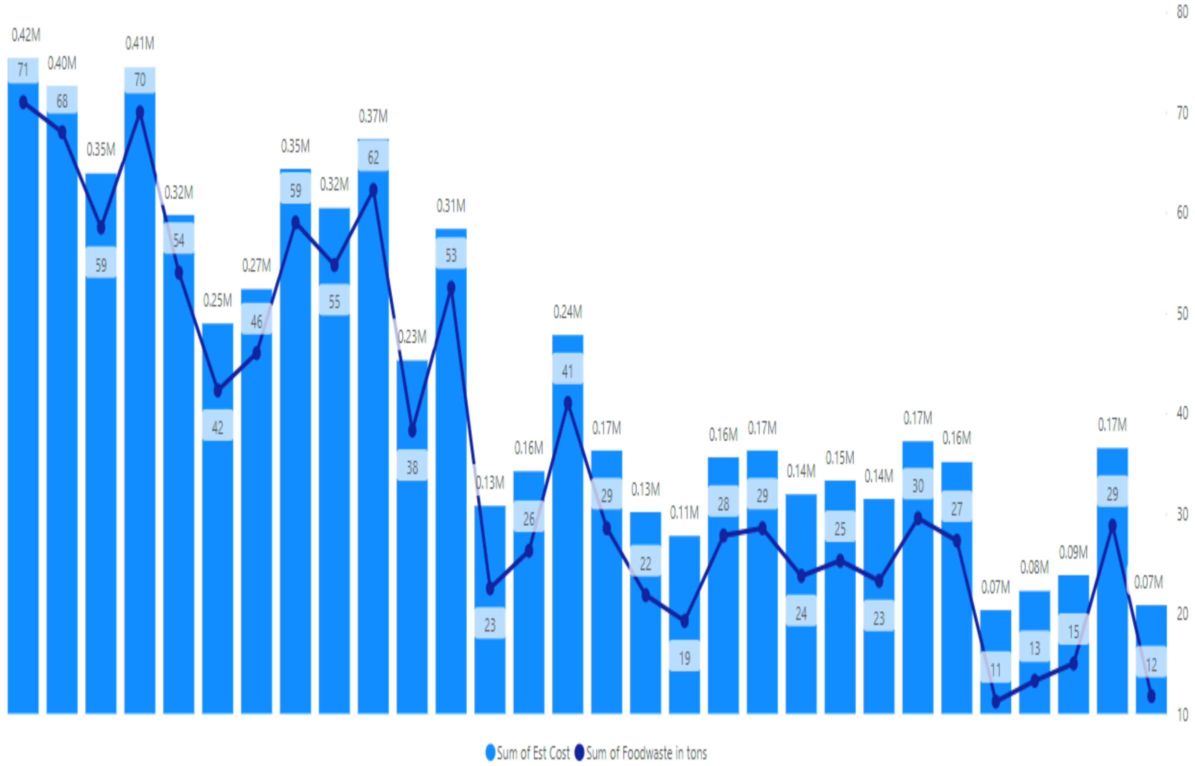



**Figure 6.11:** Estimated cost vs food waste (in tons). Source: Researcher (2023)

The researcher established that the butter category has started receiving rebates upon recycling. This rebate started in June 2022 and although it's a small rand value rebate, it's still a saving of 15% based on the estimated cost of food waste sent to the landfill. The FMC previously only received rebates for cardboard and plastic.

### 6.3.2. Environmental Impacts

The wasted embedded water would fill over 600,000 Olympic-size swimming pools, a massive waste for SA, the 30th driest country on earth. About 90% of waste in South Africa goes to landfill, where the food waste component leads to the production of methane gas and carbon dioxide (WWF, 2017). Based on the food waste values from the returned products from retailers and food waste values going to the landfill, the researcher used this to calculate the $CO_2$ and $CH_4$ values. Methane is a primary contributor to the formation of ground-level ozone, a hazardous air pollutant and greenhouse gas whose exposure causes 1 million premature deaths each year.

Methane is also a powerful greenhouse gas so that, over 20 years, it is eighty times more warming than carbon dioxide. Carbon dioxide in the atmosphere warms the planet and causes climate change. Human activities have increased the $CO_2$ content of the atmosphere by 50% in less than two hundred years (UNEP, 2021). The researcher used the following calculation from the EPA to determine the amounts of $CO_2$ and $CH_4$ produced from food waste returned from retailers, within the FMC (Figure 6.12):

1 ton of food waste = 2500kg (2.5 tons) of $CO_2$ (US EPA, 2015)

1 ton of food waste = 65kg (0.065 tons) of $CH_4$ (US EPA, 2015)

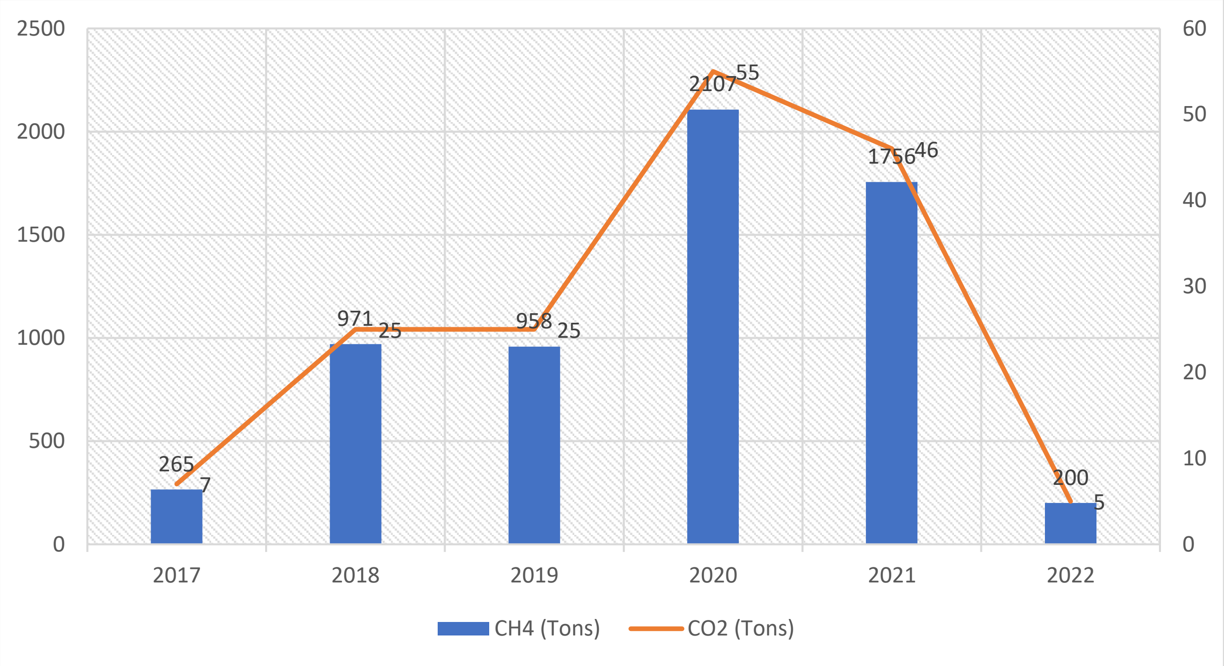



**Figure 6.12:** $CO_2$ and $CH_4$ production from food waste - returned products. Source: Researcher (2023)

The chain effect of the quantity of food vs GHG gases-produced was seen especially during the pandemic period. Meat and dairy categories (Table 6.8) stand out according to the amount of $CO_2$ and $CH_4$ produced and this huge impact on the environment. Chicken and butter have the highest contribution of GHG gases, but the FMC had found a way to recycle butter from June 2022, this number will start to decrease.

**Table 6.8:** Category and sub-category breakdown for $CO_2$ and $CH_4$ production.

| Sub - Category | Dairy | | Meat | | Vegetables | | $CO_2$ (Tons) | $CH_4$ (Tons) |
|---|---|---|---|---|---|---|---|---|
| | $CO_2$ (Tons) | $CH_4$ (Tons) | $CO_2$ (Tons) | $CH_4$ (Tons) | $CO_2$ (Tons) | $CH_4$ (Tons) | | |
| Beef | | | 124.34 | 3.23 | | | 124.34 | 3.23 |
| Butter | 1127.79 | 29.32 | | | | | 1127.79 | 29.32 |
| Cheese | 557.58 | 14.50 | | | | | 557.58 | 14.50 |
| Chicken | | | 3042.10 | 79.09 | | | 3042.10 | 79.09 |
| Fish | | | 170.36 | 4.43 | | | 170.36 | 4.43 |
| Lamb | | | 16.50 | 0.43 | | | 16.50 | 0.43 |
| Pork | | | 268.28 | 6.98 | | | 268.28 | 6.98 |
| Potato | | | | | 141.81 | 3.69 | 141.81 | 3.69 |
| Soya | | | | | 53.31 | 1.39 | 53.31 | 1.39 |
| Vegetables | | | | | 483.92 | 12.58 | 483.92 | 12.58 |
| Yoghurt | 271.57 | 7.06 | | | | | 271.57 | 7.06 |
| **Grand Total** | **1956.94** | **50.88** | **3621.59** | **94.16** | **679.04** | **17.66** | **6257.57** | **162.70** |

When looking at the food waste going to landfills, a total of 1101.07 tons of food waste produced an estimated 2752.68 tons of $CO_2$ and 71.57 tons of $CH_4$ from July 2020 to December 2022 (Figure 6.13) with an average of 91.76 tons of $CO_2$ and 2.39 tons of $CH_4$ per month.

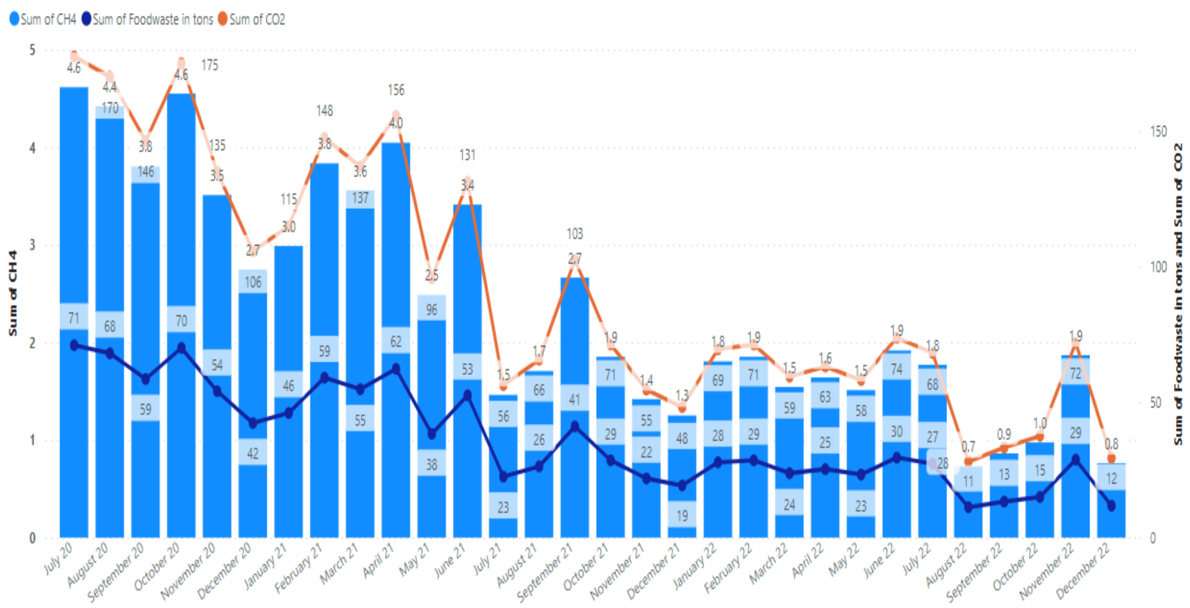



**Figure 6.13:** Correlation of $CO_2$ vs $CH_4$ vs Food Waste (in tons). Source: Researcher (2023)

### 6.3.3. Social impacts

When looking at the data collected from the consumer questionnaires, it can be seen that food waste concerns people. With the rising cost of living and food, it is important to understand that more people will go hungry. This is seen in the income groups, who rather shop for essential items only which is done once a month. These foods are thrown away even though they are still good-quality and safe. Although adequate food is produced, there are frozen foods that are still thrown away. Since frozen and chilled foods are known to reduce food waste and allow foods to last longer, most people buy more frozen vegetables and meat products.

Due to South Africa's ever-rising fuel prices and Eskom's constant breakdowns, this is often a costly option. With the ongoing power cuts and black outs, frozen food cannot be maintained in an interrupted cold chain. Two hours is the limit for keeping food safe outside the refrigerator or freezer; one hour if the outside temperature is 90 °F (32.2 °C) or above. Frozen food can thaw if it is exposed to the sun's rays even when the temperature is very cold. After a 2 hours period, frozen and chilled foods are rendered as unsafe to eat and so retailers are forced to dispose of the products.

Power cuts are anything between 2 to 4 hours for a minimum of twice a day. This results in frozen food contributing to the total food waste. Frozen and chilled foods used to maintain a longer shelf life which is no more the case. Thawing food can promote the growth of bacteria sufficiently to make consumers ill. Any food that has been taken out of the fridge should be frozen within two hours. The most flavour, colour, and texture of the food will be preserved in this way. To ensure the safety of any frozen food, it should be labelled with the date it was frozen. Do not store the food too close to other frozen foods and add a small amount of food at a time when refreezing it. This enables the item to be quickly and safely refrozen using cold air. Refreeze food that has been completely defrosted or that is still frozen enough to contain ice crystals. Refreeze only partially thawed food only once.

Due to load shedding, cold chains cannot be kept intact. The result is much higher volumes of wastage and spoilage within food chains. This has a direct impact on the price the consumer pays for a product. The FMC managers stated that, "frozen chicken selling price has increased to recover its high feed input costs and the impact of load shedding". This is damaging to the consumers' financials as well as the retailer. Meat frozen food waste has a significant impact on the environment due to the high number of resources required to produce meat products. The production process requires large amounts of water, energy, and land use. Dairy frozen food waste also has a significant impact on the environment due to its high carbon footprint. The production process for dairy products releases large amounts of greenhouse gases into the atmosphere. In contrast, vegetable frozen food waste has less environmental impact than meat or dairy products. Vegetables require fewer resources to produce and have a lower carbon footprint compared to animal-based products. Reducing frozen food waste can have positive social impacts by reducing resource consumption and greenhouse gas emissions. By choosing more plant-based options and reducing meat and dairy consumption, this can help reduce our impact on the environment while also promoting healthier eating habits.

#### 6.3.4. Mariannhill Landfill

As part of these social, economic, and environmental impacts, the researcher visited the Mariannhill Landfill (Figure 6.14), which is used by the FMC to dispose of food waste from KZN and surrounding areas. It has become a major concern due to the amount of food waste that is being dumped there. The Mariannhill landfill receives tons of food waste every day, which could have been used to feed people who are starving in the country. The problem with food waste is that it takes up space and produces methane gas, which is a potent greenhouse gas that contributes significantly to climate change.


**Figure 6.14:** Entrance of Mariannhill Landfill. Source: Photograph taken by the Researcher (2023)

The Mariannhill Landfill Waste to Value Plant for Food Waste is a revolutionary project that aims to transform food waste into valuable resources. The plant, located in Durban, South Africa, uses anaerobic digestion technology to convert food waste into biogas and organic fertilizer. This process not only reduces the amount of waste going to landfills but also produces renewable energy and nutrient-rich fertilizer for agriculture. Once the frozen and chilled food waste is “bagged and tagged” (Figure 6.8), this is transported to the landfill. At the entrance, a weigh bridge weighs (Figure 6.15) the frozen and chilled food waste for invoicing to the FMC.


**Figure 6.15:** Weigh bridge at the entrance to the Landfill. Source: Photograph taken by the researcher (2023)

The landfill has implemented a process for managing food waste that is both environmentally friendly and economically sustainable. The process involves the separation of food waste from other types of waste, which is then transported to an anaerobic digester. The anaerobic digester breaks down the food waste into biogas and fertilizer (Figure 6.16). The biogas is collected and used as a renewable energy source, while the fertilizer is used to enrich soil for agricultural purposes. This process not only reduces the amount of methane gas produced by decomposing food waste but also provides an alternative source of energy and reduces the need for chemical fertilizers. Mariannhill Landfill's process for managing food waste has created job opportunities for local communities through the establishment of small-scale businesses that collect and transport food waste to the landfill. This approach promotes sustainable development while addressing environmental challenges associated with food waste management.


**Figure 6.16:** Waste to Value Plant at the Landfill. Source: Photograph taken by the Researcher (2023)

The "3 Rs"—Reduce, Reuse, and Recycle—are at the centre of the waste hierarchy, which is nevertheless situated in a particular context (South Africa) and thus adopts some of the peculiarities of that setting. The 3 Rs have undoubtedly been incorporated by Mariannhill Landfill. These include waste reduction efforts that take place at the Materials Recycling Facility (MRF), re-use of materials such as treated leachate for irrigation and dust reduction, and recycling programs. The Mariannhill Landfill Waste to Value Plant for Food Waste is an innovative solution that demonstrates how we can turn waste into value while addressing environmental challenges. This project has the potential to inspire similar initiatives around the world and contribute to building a more sustainable future for all.

## 6.4. Consumer perceptions of food waste and their buying habits

The researcher established that the FMC ran customer perception measures timeously online in a simple and quick questionnaire. These surveys were designed on a web-based application called Four-Eyes and conducted via a hand-held electronic device and paper. Results were stored in an encrypted password-protected cloud or server for the researcher to download into Microsoft Power BI for analyses. The researcher established that surveys were conducted between January 2023 and March 2023 in the retail stores.

Over 600 surveys were conducted of which 484 surveys were fully completed within an average time of 4 minutes and 6 seconds. The analysis was based on completed surveys (77% of administered surveys) only. From retailer A, being the largest and busiest, the researcher was able to conduct more surveys, making up almost 47.17% of total surveys (Figure 6.17). The survey respondents included 60.7% (n=300) female and 39.3% n=194) male consumers.

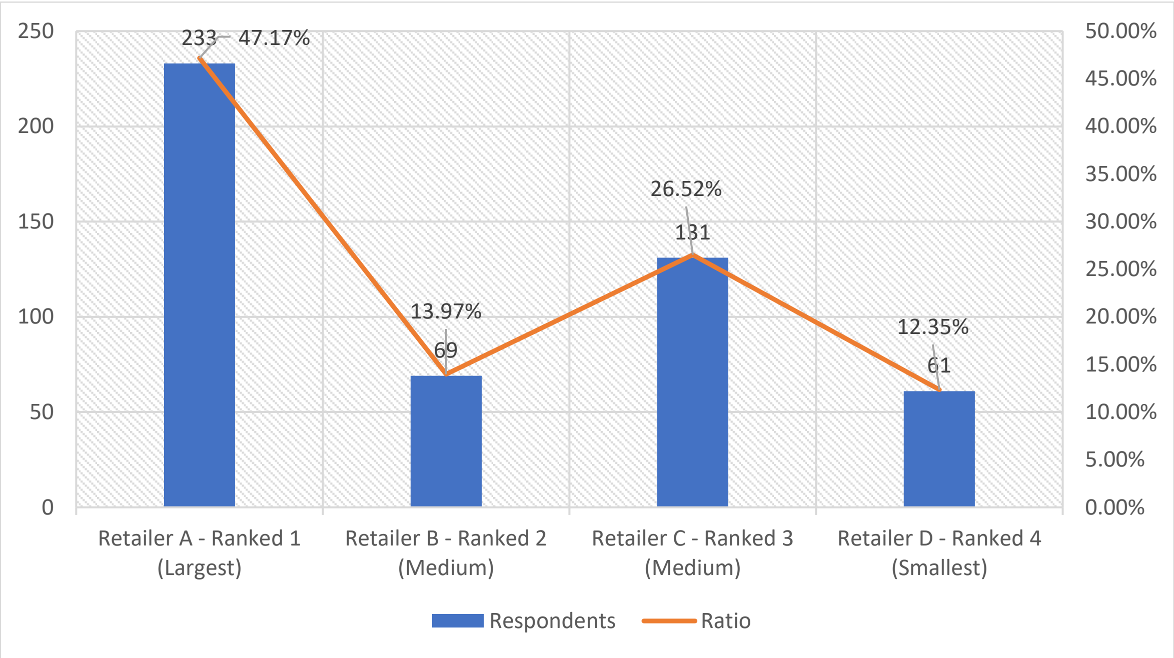



**Figure 6.17:** Retailer split for Consumer Surveys conducted from January 2023 - March 2023. Source: Researcher (2023)

These surveys were conducted anonymously and involved gathering information about gender, income, perception of food waste and buying habits. Some consumers (22.5%) aborted the survey due to time constraints and could not complete the survey. Based on the retailer's size, the type of income earner was matched which clearly shows that the higher income earners shop in malls and larger stores (Table 6.9) while the lower income earners shopping in Retailer C and Retailer D. The results also show that 90.89% of shoppers have a Grade 12 education with 1.21% with no formal education and 7.89% with a degree. There are 78% of shoppers between the ages of 26-35 years (46.96%) and 36-45 (31.17%). These age groups have a monthly income greater than R10 000.

**Table 6.9:** Income bracket split by a retailer with counts of survey. Source: Researcher (2023)

| Income Brackets | Retailer A Ranked 1 (Largest) | Retailer B Ranked 2 (Medium) | Retailer C Ranked 3 (Medium) | Retailer D Ranked 4 (Small) | Grand Total |
|---|---|---|---|---|---|
| Less Than R5 000 | | | 70 | 51 | 121 |
| Greater Than R5000 Less Than R10 000 | 122 | 38 | 61 | 10 | 231 |
| Greater Than R10 000 Less Than R20 000 | 36 | 25 | | | 61 |
| Greater than R20 000 | 75 | 6 | | | 81 |
| **Grand Total** | **233** | **69** | **131** | **61** | **494** |

Retailers located in low-income areas typically have a narrower assortment of products, prioritizing essential items that are more affordable. In contrast, retailers situated in high-income areas tend to provide a wider and more varied selection of products, encompassing premium and luxury items. These establishments often prioritize quality, uniqueness, and specialty goods. There are consumers with low incomes, various levels of education and food security status who say that healthy food is not expensive. However, in South Africa and other countries, there is evidence that healthier food is often more expensive. It is also important to note that healthier food may mean different things to low-income consumers and high-income consumers. The most influential factor when choosing where to shop is the price.

### 6.4.1. Consumer buying patterns.

Customers typically make purchasing decisions based on many factors, such as their personality, their location, or their preferences. This survey helped understand the buying patterns of consumers by the FMC. Some of the following points were raised:
The researcher uncovered from the FMC survey that consumers prefer to shop once or twice a month with 39.27% buying once a month and 24.29% buying twice a month.

These consumers buy from large to medium retailers and they are aged between 25 and 45 years. Those that bought once a week were from the younger age group who stayed alone or who pensioners who only cooked for themselves were. With 37% of survey's conducted in the higher-income areas in KZN (Figure 6.18) which are Durban North, Umhlanga, and Westville with a combined population of 124 936 (COGTA, 2020), these were also the area with huge malls and larger consumer bases. With 68% of consumers indicated that they enjoy shopping during promotions and intend to buy more than usual. The observation is that stores tend to overstock during promotions resulting in consumers handling more products and when not sold, products expire in store creating food waste. Although 50% of consumers state they buy food that they need, 24.90% buy as much food as possible at one time. This is concerning since if food is not eaten, it will be wasted.

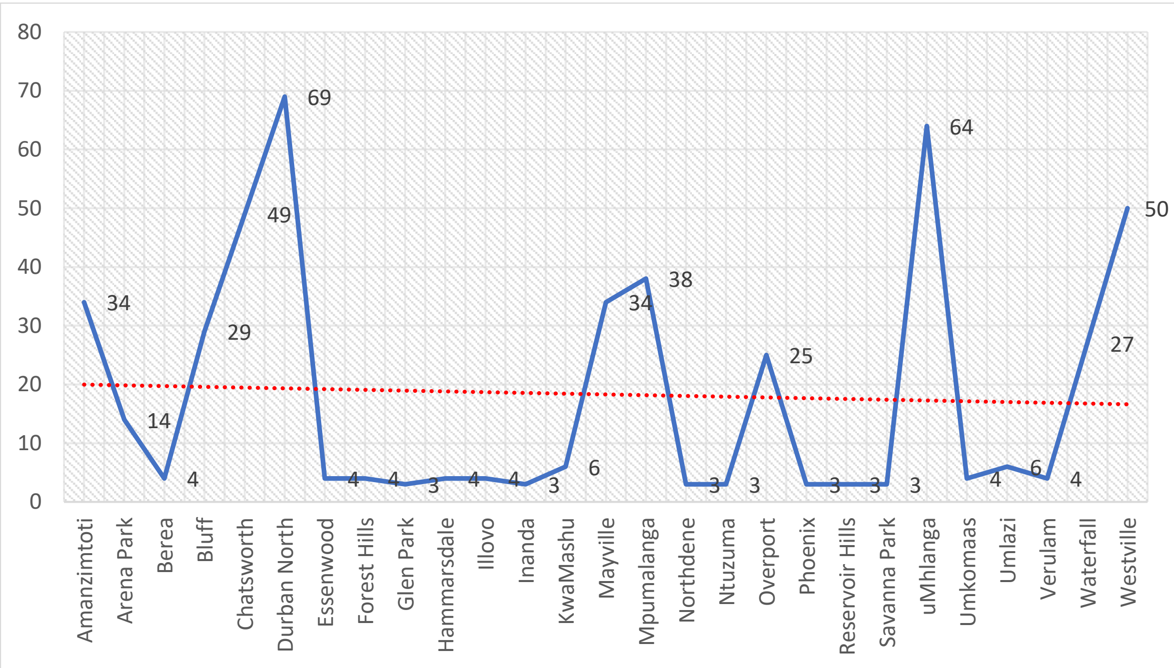



**Figure 6.18:** Survey breakdown by LSM and population. Source: Researcher (2023)

Once again, frozen chicken and frozen meat were the most popular purchases by the surveyed consumers (Figure 6.19). Fruits and vegetables were highlighted as being thrown away most often which is in line with a study done by Gustavsson et al. (2012), with 17% of food waste from fruits and vegetables in the distribution phase. As Millennials drive demand for frozen foods, one of the main reasons behind their preference is convenience. This type of eating allows them to get an entire meal ready without having to fit a lot of time into their busy schedules, this is seen from the age group vs category foods where pies and pizzas are bought 49.38% by the 26-35 age group.

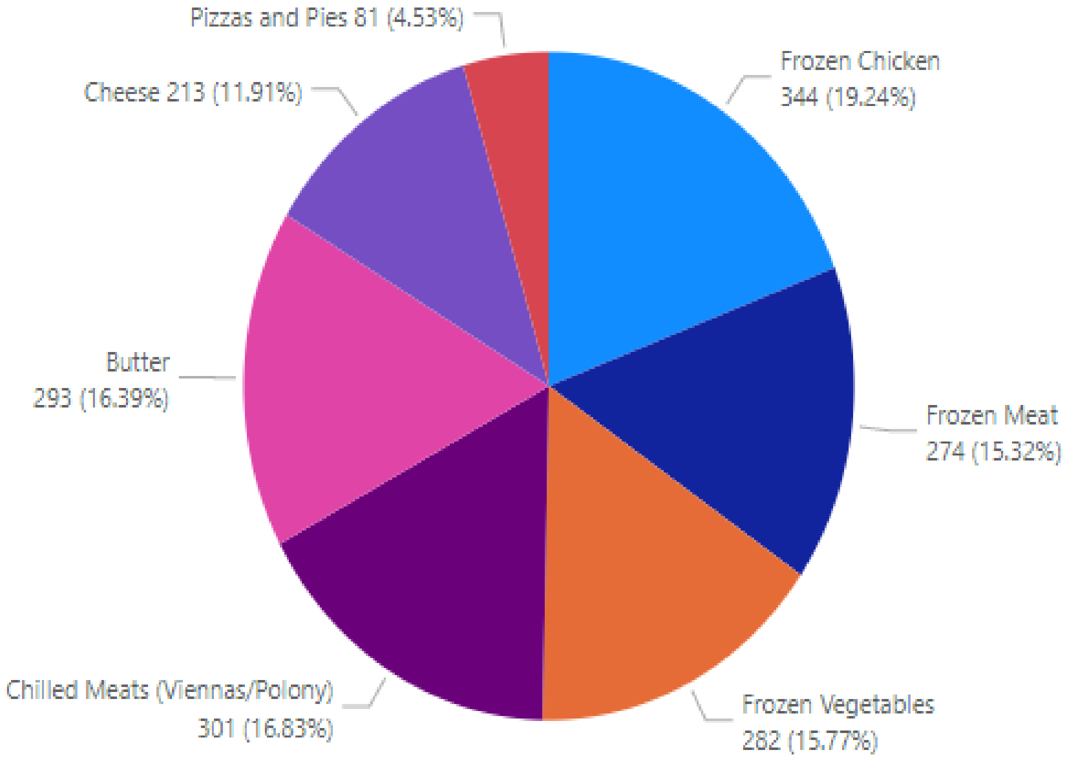



**Figure 6.19:** Types of chilled and frozen foods bought. Source: Researcher (2023)

By closely examining customer buying behaviour, the researcher can learn why and how consumers make certain purchasing decisions or choose one brand over another. Armed with this knowledge, targeted consumers with specific buying behaviour can help attract more customers, increase sales, and increase customer retention rates. Providing the right product to the targeted consumers will also reduce food waste. There are four main types of behaviour patterns identified during this study which is in line with a study by Tao et al. (2022) on consumer behaviour change post-pandemic. The factors that lead to consumers wasting food are complex.

### 6.4.2. Consumer views on shopping

From the survey it is clear that consumers prefer to shop either once a month (39%) or twice a month (24%). This indicates that consumers do bulk buying during month ends (Figure 6.20).

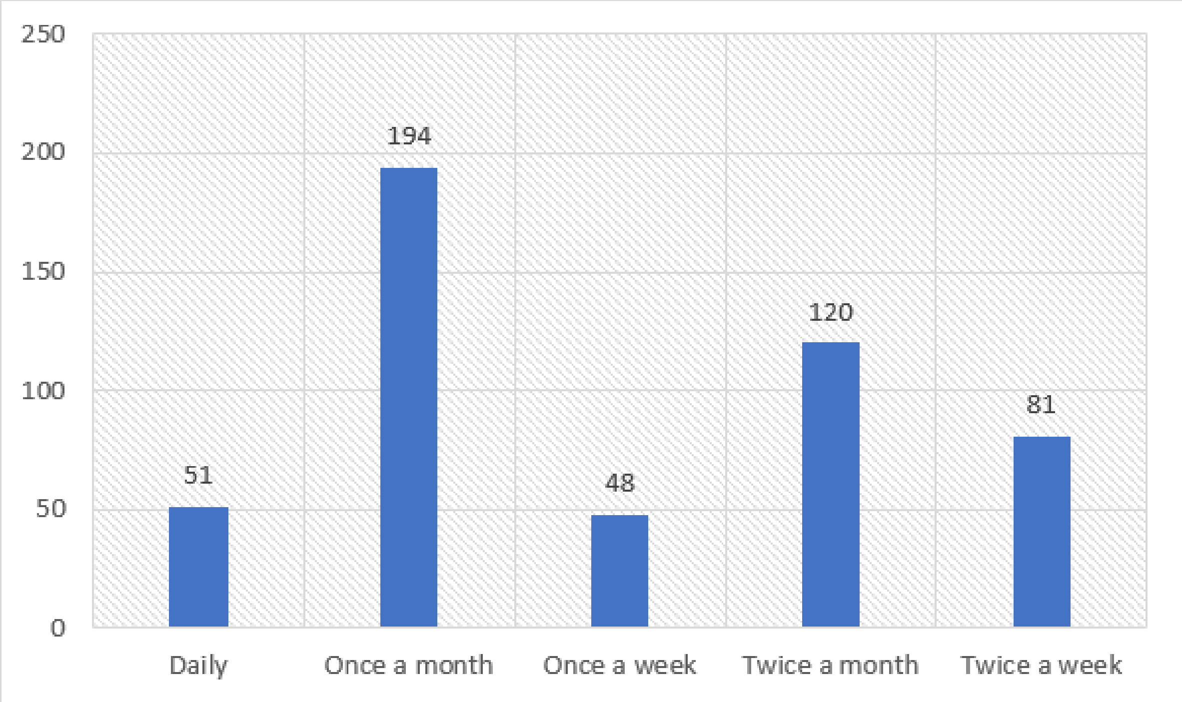



**Figure 6.20:** Monthly shopping frequency by consumers. Source: Researcher (2023)

Further to gathering data from the survey regarding buying patterns, the researcher posed closed-ended questions to understand how much the consumer understands food waste and their sense towards throwing away food. Closed-ended questions posed such as:

1. Do you throw away food when you know it is coming up for expiring?
2. Do you intend to over shop at times?
3. Does throwing away food bother you?
4. Do you shop more during promotions?
5. Do you recycle food waste?

The frequency as to actual consumer understanding of food waste based on a 5-point Likert scale is presented in Table 6.10. It is seen that throwing away food often bothers the consumer when food is seen to be close to its expiry date, and the consumer will opt to prepare and finish the food or freeze it before throwing away. Consumers never or rarely recycle food waste since the easier option is to throw it away in the dustbin, which is not ideal. This concerns the question as to whether consumers are aware of the food waste programme, and 55.67% are not aware of food waste programmes within the retailer and FMC.

**Table 6.10:** Frequency of consumer response to food waste, over-shopping and recycling food

| Frequency Description | Likert Scale | Does throwing away food bother you? | Do you throw away food when you know it's coming up for expiring? | Do you intend to over shop at times? | Do you shop more during promotions? | Do you recycle food waste? |
|---|---|---|---|---|---|---|
| Never | 1 | 38 | 146 | 19 | 64 | 307 |
| Rarely | 2 | 46 | 59 | 105 | 12 | 12 |
| Sometimes | 3 | 88 | 67 | 50 | 196 | 140 |
| Often | 4 | 36 | 219 | 123 | 196 | 19 |
| Always | 5 | 286 | 3 | 197 | 26 | 16 |
| | | **3.98** | **2.74** | **3.76** | **3.22** | **1.84** |

The researcher conducted semi-structured interviews with consumers who manually filled out the survey and discovered that most consumers look for best buy irrespective of the expiry dates. After the pandemic, consumers tend to stock up on food items that can be found at a lower retail price. The pattern of avoiding crowds and visiting the stores multiple times is still instilled in them from the initial lockdown and they continue to follow this pattern. With consumer patterns constantly changing and products constantly evolving and becoming more diverse, consumer patterns can change from day to day.

Finding that balance between FMC, retailers and consumer is not an easy task as conditions and consumer choices are constantly changing.

The majority (96.4%) of respondents think that retailers do not do enough to maintain sustainability and reduce food waste. Consumers also expect lower prices, top quality, and transparency as they sacrifice choice, brands, and convenience. Customers showed that they know what food waste is, but not about those aspect that affects them in their households. They had concerns about food waste because, according to their social norms, it is morally wrong to waste food, but the majority (90%) lack awareness of the impact of large-scale food waste affecting the economy remained a major concern for this study. Phasha et al. (2020) discussed that the issue of food waste is a social problem that entails the loss of energy, water, and financial resources throughout the food supply chain. The study also stressed the importance of raising public awareness of the environmental impact of this phenomenon. The results of this study on consumer and retailer behaviour confirmed what Phasha's previous study had mentioned, that the community is unaware of the impact of food waste on the economy, it is only understood at the household level and, hence, the stakeholders should investigate the formulation of awareness strategies. Consumers expect government agencies and retailers to lead the conversations and initiatives to tackle the food waste phenomenon.  Fifty percent of respondents stated that they only buy food that is needed while 25% buys as much as possible at once (Figure 6.21).

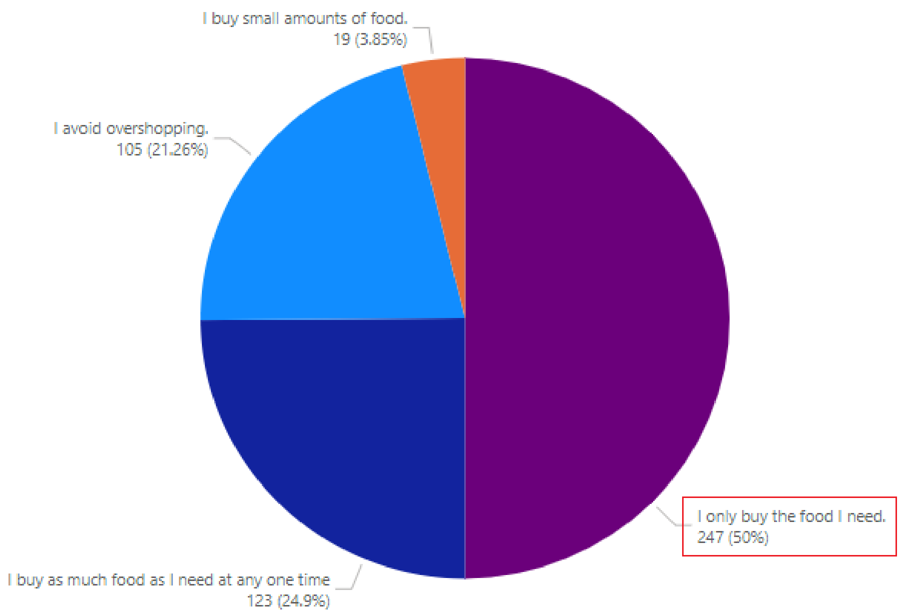



**Figure 6.21:** Relative quantities of food bought by consumers? Source: Researcher (2023)

The majority (89%) of managers concurred that consumers do not fully understand the scope of the food waste problem or how it affects the environment when they shop. When necessary, they have a tendency to purchase additional groceries, which results in waste. Even though this is partially true, certain supermarkets' corporate marketing strategies—which rely on buy one, get one free or buy one, get two free offers (BOGTF) —indirectly encourage excessive consumption (Morley, 2016). According to Blythman (2016), some retailers may just be playing the responsibility-shifting game by blaming consumers for their low environmental awareness. Retailers must recognize their mediating role in generating food waste at the household level and adjust their marketing strategies accordingly. Half of the participants expressed their expectation that the store should take responsibility to educate their customers, while the other half acknowledged their responsibility for reducing food waste.

Consumer behaviour encompasses several dimensions including emotions, eating, and shopping habits, values, and beliefs, which can inform any FLW reduction initiative. At a societal level, factors such as social norms, culture, policies, regulations, retail sales strategies, or education can influence consumer behaviour. While promotions can be a great way for consumers to save money on items they need, it is important for individuals to be mindful of their spending habits and not get caught up in the excitement of a sale. By setting a budget and sticking to it, consumers can avoid overspending during promotions and make more informed purchasing decisions.

### 6.5. Current policy and governance of food waste in the FMC

A semi-structured interview with the FMC and a review of the 5 years of sustainability documents, confirmed that there is no direct policy for food waste. The FMC follow the National Environmental Management: Waste Act 59 OF 2008 which is known to managers and retailers. South Africa's legal framework for waste management underpins food waste and loss in the country. However, there are other laws related to the management and control of food materials in South Africa seen in Table 6.11. National Waste Management Strategy 2020 with updated waste management on food waste is not implemented in the FMC (DEFF, 2021). The waste management plan is reviewed annually. The company has a valid ISO 14001 certification in place.

**Table 6.11:** Food waste policy, legislation, and regulations (Source: DFFE-IWMF)

| | |
|---|---|
| The Constitution | Provides for an unprecedented right-to-food (RTF); a fundamental right of every citizen. |
| The National Environmental Management Act (NEMA; 107 of 1998) | Provides the foundation for the treatment of the environment and outlines the core principles relating to waste (hence, indirectly food waste as a waste stream). |
| Foodstuffs, Cosmetics and Disinfectants Act (Act No 54 of 1972)<br><br>The Health Act (Act No 63 of 1977) | Addresses the sale, manufacture, and importation of foodstuffs. Offers regulations regarding the labelling and advertising of foodstuffs. Offers regulations on perishable goods with the definition Guides regulations related to the hygienic handling of food and the inspection of, inter alia, food premises are also enforced by local authorities |
| The International Health Regulations Act (Act No 28 of 1974) | Provides for the approval of the source of food for consumption at ports, airports, vessels and on aircraft, as well as for the inspection of such premises |
| Post-Harvest Loss Management Strategy (PHLMS; 2018) | Aims to achieve the target of the Malabo Declaration i.e., a commitment to ending hunger by 2025 through interventions such as halving the current levels of post-harvest loss.<br>In alignment with the Sustainable Development Goal 12.3. |

The FMC is part of the Food Loss and Waste Voluntary Agreement (VA). A key benefit of using a Food Loss and Waste Agreement approach is that changes can be implemented more quickly and flexibly compared to command and control interventions (CGCSA, 2020). The VAs can be designed better than legislation as they are usually prepared by people with in-depth knowledge of the sector concerned and can also address more holistic issues along the food supply chains, which cannot simply be formulated through more prescriptive measures. Although reducing food waste seems like a win-win for consumers, our planet and industry, it is a very complex issue that requires diverse and well-tailored governance actions. A thorough environmental, social and governance (ESG) data table has been included by the FMC in its most recent sustainability report to enable outside parties to review the priorities that will be turned into workable goals and targets in the coming year. The Sustainable Development Goals can only be attained with the help of the EU's Common Agricultural Policy (CAP). The FMC's overarching goal, linked to the timing of its purpose and sustainability strategy initiatives, is to ensure that sustainability is at the center of its purpose. Note that agriculture contributes to 13 of the 17 SDGs dealing with economic and environmental sustainability (RCL Foods, 2022).

According to the Department of Forestry, Fisheries and the Environment (DFFE) and the Department of Agriculture, Land Reform and Rural Development (DALRRD) both require environmental impact assessments (EIAs). By incorporating feedback and comments from affected parties and other interested stakeholders, these allow the FMC to carefully consider the effects of the proposed investments on the local environment. Food date labeling is regulated by Regulation 146 of March 2010 relating to the Foodstuffs, Cosmetics and Disinfectants Act (54 of 1972), which stipulates that date labeling on food is required. In general, all perishable prepackaged foods must have a best before or best before date (Patra et al., 2020). Food waste governance instruments (Figure 6.22) are a component of effective environmental governance. Fiscal, command-and-control, civil-based, and voluntary instruments for food waste governance with the FMC food supply chain. While the FMC does donate food before landfill, Retailer B confirmed the donation of over 2000 tons of food for redistribution in 2017 to people in need with their partnership with FoodForwardSA(Nel, 2017). Charities can collect from their closest store to redistribute food in their local community which is scheduled on specific days and times. This set is seen only in the Western Cape and not yet in KZN.

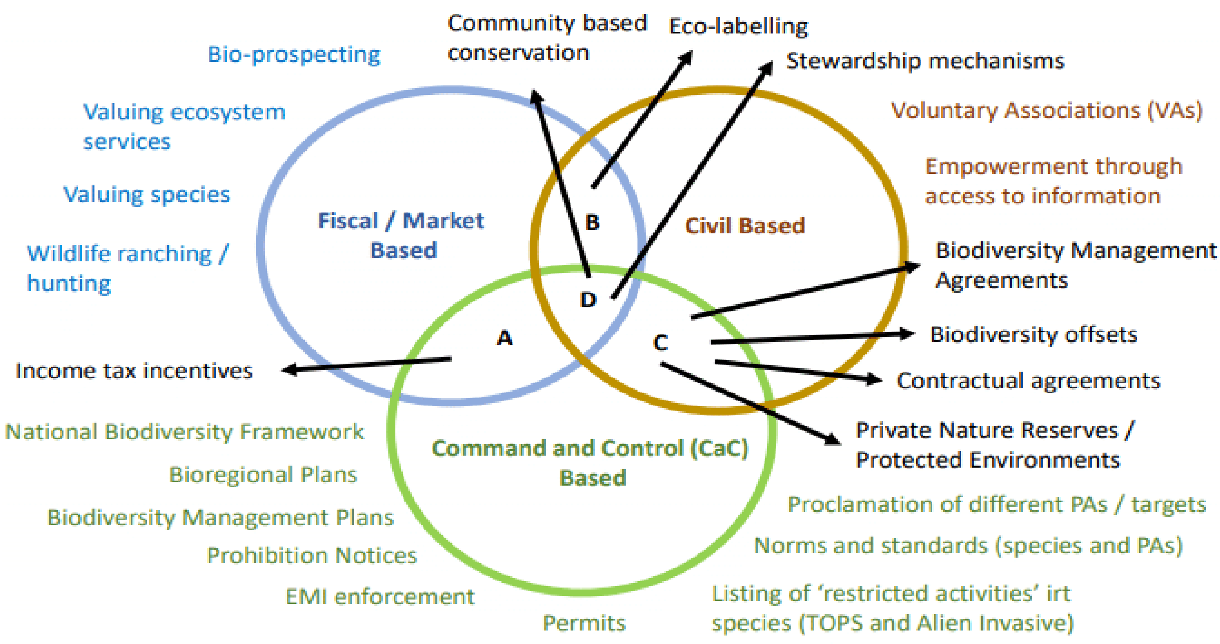



**Figure 6.22:** Governance approaches for food waste management in South Africa Source: Matlhare (2020).

The landfilling of food waste is currently not expressly prohibited or restricted in South Africa, but there are a number of legal measures in place to prevent it. The norms and standards from the General Notice 636 related to the disposal of waste on land restrict the landfilling of waste with high calorific value and waste with high liquid content and these restrictions currently apply mainly to hazardous waste (du Plessis, 2020). Retailer and FMC made mention of the need for government support to set up and operate such infrastructure, as cited by one study participant. There are programs in place to inform staff about waste management strategies, but this is limited to staff in the SHEQ. As part of the ISO 14001 continual improvement process, there should be continuous improvement programs in place. This analysis also extended to evaluating the local policies in comparison to those of other developing and developed nations. The findings of this examination revealed that a significant portion of the regulatory framework lacks enforceability due to the absence of policies that facilitate the smooth implementation of laws and statutes. Additionally, the government, acting as the regulator, faces challenges in effectively enforcing policy objectives and ensuring compliance.

A targeted set of waste management policies can be implemented to reduce food waste generation and maximize the separate collection of unavoidable food waste. Pay-As-You-Throw (PAYT) systems are based on the polluter pays principle. Waste generators, which can be households, industries or companies, have to contribute to the disposal of the food waste they generate. The payment could be based on the actual weight or volume of food waste generated, or on the number of bins and collection frequency, or the prepaid bags used. It is recommended to split the payment into a minimum fee and a variable component. The fixed fee minimizes illegal waste dumping and there is a strong case for reducing the variable component. In a way, the base fee covers the unavoidable food waste, while the variable portion covers the disposal of the partially avoidable or avoidable waste. Regarding landfills, several jurisdictions have progressively banned the disposal of organic waste in landfills. This policy instrument is most commonly applied to commercial bio-waste producers above a certain capacity.

This policy instrument works through a gradual overhaul of existing waste management systems towards separate collection and recycling of food waste.

Through the questionnaires and informal discussions with the risk officers, it was highlighted that many discussions around continual improvement take place but are not documented. As our population grows and the demand for food increases, the business ensures that they continue to provide a balanced basket of safe, high-quality food that meets consumers' needs while complying with all regulations (RCL Foods, 2021). The World Business Council for Sustainable Development/World Resources Institute GHG Protocol for Corporate Accounting Standards is the accepted international methodology for GHG corporate accounting and reporting that the FMC uses to report on GHG emissions on an annual basis. The FMC hired an outside party in order to verify claims about our greenhouse gas emissions and to conduct a gap analysis of our carbon footprint inventory (KPMG, 2023).

This review process evaluated the alignment of the FMC procedures and methods with the above protocol as well as the technical correctness of the quantification procedures/methods of GHG inventory. The GHG Protocol requires companies to report both direct and indirect emissions from purchased electricity. All other indirect emissions can be reported on a voluntary basis (RCL Foods, 2021). 2021 FMC $CO_2$eq (carbon dioxide equivalent) for Scope 1 and 2 emissions was 1,045,842 tons, down 1% from 2021. The FMC Scope 1 GHG emissions (direct emissions from our operations) were 518,861 tons $CO_2$eq during Scope 2 emissions (indirect emissions from the use of purchased electricity) amounted to 526,981 tons of $CO_2$eq (RCL Foods, 2022). Carbon Disclosure Project (CDP) conducts an annual survey of the world's leading companies regarding their management of climate change impacts, water security and forests. Survey submissions are based on previous years' climate performance (RCL Foods, 2022). The CDP scores for 2021 for climate change was regional average of B, and higher than the Food & Beverage Processing sector average of B-.

## 6.6. Chapter Summary

Food waste is a multifaceted issue with far-reaching social, economic, and environmental consequences. Evidence suggests that significant amounts of food are discarded at various stages of the supply chain and consumption process, contributing to a global problem with wide-ranging impacts. This chapter has presented and analysed the data collected in phase 1 and 2 of the data collection process. The data show a high level of social, economic, and environmental issues. While frozen and chilled food is wasted, many people around the world suffer from hunger and lack of access to nutritious meals. Frozen and chilled food waste affects farmers, distributors, and workers along the supply chain, leading to economic hardships and potential job losses. These include a waste of economic resources, including labor, energy, water, and capital invested in production. This also drives up costs for businesses and consumers due to inefficiencies in production, transportation, and storage. Retailers experience reduced profitability when unsold food is discarded. Food production requires valuable resources like land, water, and energy. When food is wasted, these resources are wasted. Decomposing food waste in landfills generates methane, a potent greenhouse gas that contributes to climate change. Agriculture's impact on ecosystems, such as deforestation and habitat destruction, is exacerbated by the inefficient use of food.

In conclusion, food waste is a complex issue that goes beyond the mere disposal of excess food. Its societal, economic, and environmental impacts highlight the urgent need for comprehensive solutions that involve various stakeholders, from individuals and businesses to governments and international organizations (Creecy, 2023).

# CHAPTER 7: DISCUSSION

## 7.1. Introduction

This chapter focuses on discussing and merging the findings in Chapter 4, 5 and 6 merging qualitative and quantitative results. The qualitative and quantitative findings are discussed and compared to the existing body of knowledge (see Chapter 2 and 3) that either confirmed and/or refuted the findings of the study so as to make informed conclusions and recommendations (see Chapter 8).

This chapter discusses the outcomes of the empirical research and considers the results of previous studies conducted in relation to the four-study objectives:

- To investigate the reasons and drivers behind food waste generation of frozen and chilled food products in the supply and value chain,
- To investigate the socio-economic and environmental impacts of frozen and chilled food waste generation,
- To investigate consumer perceptions on chilled and frozen food waste generation in relation to their buying habits and patterns and
- To critically analyse the national policy and regulation framework on frozen and chilled food waste management in the food retail sector and make policy recommendations for sustainable food waste management.

## 7.2. Reasons and drivers behind food waste generation of frozen and chilled food products

The study investigated the drivers and reasons behind food waste generation. The study population was as follows: policy makers, employees, professionals (environmental scientists/students) and customers.

### 7.2.1 Cold and chilling storage, expiration, temperature levels

These findings are in line with a previous study by James and James (2014) who asserted that frozen food thawing can lead to contamination of the food and reaching the expiry date for the food requires that the food be discarded. Further findings from the present quantitative data indicate that 84% of respondents concur that the change in temperature results in frozen and chilled food waste (Brodribb & McCann, 2020). Temperature is considered to be the most important factor affecting food quality so that inappropriate temperature controls and settings in the food refrigeration line can accelerate the deterioration of food quality, which can contribute to food loss and waste (Ndraha et al., 2020). According to USDA (2020), if the temperature rises above the recommended levels for frozen or chilled foods, it can lead to spoilage and microbial growth, making the food unsafe for consumption.

The responses generated from the interviews explained how the frozen and chilled foods need to be maintained at a certain temperature to avoid the contamination of the foods (Brodribb & McCann, 2020). It was identified that cold storage facilities are designed to maintain specific temperature ranges to preserve the quality and safety of perishable foods. If these facilities have inadequate insulation, faulty refrigeration systems, or poor temperature control, temperature fluctuations can occur (Dupont et al., 2020). Such fluctuations can lead to the growth of spoilage microorganisms and accelerate the degradation of frozen and chilled foods, resulting in a shorter shelf life (Morya, 2020). The responses that were generated throughout the interview process clearly indicated the fact that there is a gap in the appropriate maintenance of the facilities that are already available (Damiani et al. 2021). This leads to inadequate chilling and cold, which leads to expiration of the frozen goods. This is a major issue that is leading to the wastage of frozen food and must be considered for better strategy development in the future as well.

Furthermore, incorrect temperature settings in loading bays, cold rooms, haulage cargo, and display leads have also been found to have a negative impact on the amount of food waste produced (Zanoni and Zavanella, 2012). Thus, these represent the main causes or motivators of food waste production. It is impossible to guarantee long-term preservation of the food products without suitable cooling facilities. This increases the amount of food that is wasted and causes food waste to occur more frequently. In addition, inadequate cooling facilities have a significant negative effect on food quality and increase wastage. In order to guarantee better outcomes in this direction, it is imperative to ensure a larger number of cold facilities. A critical issue in addition to this is the absence of control, proper temperature, and sufficient temperature levels (Wikurendra et al. 2022).

With inadequate cooling and storage facilities, the chances of food wastage are always higher. Cooling and storage facilities and largely designed to store food and conserve their value. However, due to inadequacies in this domain, discrepancies regarding the overall value of food are generated (Writer, 2022). These food materials are generally spoiled and usable. Therefore, it triggers a massive wastage of all these food items and can lead to unwonted food wastage. Overall, the lack of adequate storage facilities can be seen to be a major driver and can lead to expiration of food. Moreover, it can also lead to unnecessary losses for these retailers. Therefore, the overall area of cold and chilling storage is essential as it can prevent the food from getting spoiled. Expiration of food is another key aspect that must be considered as expired food is totally wasted. It is the duty of the retailers to better understand the demands in the market and come up with adequate supply. This will help in reducing wastage as there will be an equilibrium between the demand and supply. As per Xue et al. (2017), maintaining a balance between demand and supply can be a beneficial option as it helps in minimising wastage by ensuring appropriate sale of all the products. Therefore, it is essential for any business to come up with appropriate checks on the unnecessary production and manufacturing of these food products.

A comprehensive analysis of the results that have been presented here have also indicated the fact that mishandling of the food products is another critical issue. As per the opinions of Yoobic (2021), mishandling of food items can lead to spoiling of the food and can also render it inedible. This can lead to severe food losses to significantly impact the levels of social and economic implications associated with same. It can also result in a higher environmental issue that must be largely curtailed. Therefore, it becomes critical for the retailers to come up with an appropriate understanding of the demand situations. However, changes in customer buying behaviour can pose a serious threat to any such aspect. Without an appropriate demand forecasting, expiration of food might not be able to be managed. This can significantly reduce the chances of any kind of food waste management within the region. Therefore, the onus is upon the retailers to understand the demand and manufacture the products as per the demand to regulate the supply and ensure betterment.

Throughout the desk research, data were imported into the Microsoft Power BI tool for analysis, a total of three food categories and eleven food subcategories (Table 6.1) was formed by the researcher from secondary data extracted from the core FMC systems for 202 retailers. The retailers where split into Retailer A, Retailer B, Retailer C and Retailer D and ranked based on the number of stores allocated to each retailer and the overall size of the retailer seen in Table 6.2. The correlation between the retailers is clear, the larger the retailer the more frozen and chilled food waste is generated. Based on the findings in Figure 6.1, chicken, vegetable and dairy, respectively, are the most commonly generated frozen and chilled food waste. In partial agreement with these results, a study conducted by the CSIR (2021) reported that vegetables, fish, milk (dairy) and meat were most commonly generated frozen and chilled food waste. In terms of the present study, the researcher identified that the FMC under study had one of the largest ranges of chicken products and, hence, why the meat category and subcategory chicken showed the highest waste generated, at 84%. The vegetable category is in line with the study down by the CSIR (2021), with the FMC generating 71.27% of the food waste from this category. The FMC does not supply or produce milk, but they do manufacturer and supply butter, which was the highest chilled food waste generated at 57.63%.

The COVID-19 pandemic has had a significant impact on the food industry, particularly in terms of food waste. Upon detailed analysis, findings indicate that during the COVID-19 pandemic there was significant impacts on various aspects of the food supply chain, including meat, dairy and vegetable sectors, as highlighted in Figure 6.2, Figure 6.3, and Figure 6.4. Lockdowns, travel restrictions, and labour shortages disrupted the supply chain, making it challenging to move food products from farms and processing facilities to consumers (Amicarelli et al., 2021). This resulted in produce being left unharvested or unsold, leading to waste in the vegetable sector. In addition, restaurants, cafeterias, and other food service establishments were closed or reduced their operations due to lockdown and restrictions. This led to decreased demand for perishable products like meat, dairy, and vegetables, resulting in surpluses that could not easily be redirected to other markets (Bancal & Ray, 2022).

Likewise, iinternational trade disruptions impacted the movement of goods across borders. Some countries faced export restrictions or struggled with importing agricultural products, leading to oversupply in domestic markets and an increase in potential waste. One type of food that was affected was chilled foods such as butter.

The pandemic caused a decrease in demand for these products due to changes in consumer behaviour and restrictions on hospitality businesses (Bancal & Ray, 2022). Thus, on the one hand, chilled food waste during COVID-19 can be compared to pre-pandemic times as it is still a significant issue, mostly due to overproduction and expiration dates but more recently, such waste is due to reduced demand and logistical challenges (Zhao et al., 2022). On the other hand, there are also differences between pre-pandemic chilled food waste and current chilled food waste. During the COVID-19 epidemic in South Africa, there was an increase in home cooking which led to an increase in demand for certain types of chilled foods such as butter. However, this increased demand has not been enough to offset the decrease in demand from hospitality businesses. Overall, while there are similarities between pre-pandemic and current chilled food waste issues, there are also notable differences that have arisen due to changes in consumer behaviour and restrictions on businesses during the covid-19 epidemic (Borghesi & Morone, 2022).

The study was also able to narrow down the main reasons for the frozen and chilled food waste generation, which was based on the frozen foods return or disposed of by the FMC, as seen in Table 6.3. In interviews with one store manager from each retailer, it was determined that the largest retailer had the highest packing defects and expired products (Retailer A). However, in comparing the two medium retailers, one was highlighted for store damages (Retailer B) and other for packaging defects (Retailer C). Packaging defects and store damages contributed most to food waste with Retailer D, a smaller retailer. The store managers did state that they have an issue with expired products, and from the returns data, the expired products are mainly within the dairy category with butter and cheese returned due to product date expiry on a shelf or delivery in short-dated stock (product close to expiring).

As a result, and based on the study findings, the FMC set out standards within the retailer to ensure best practices for shelf health. Photographs were taken to indicate examples of shelf health best practice. It was found that 75% of stores does not adhere to best practice, particularly in the larger and medium retailers. Conversation with retail store managers as to following best practice or not indicated absence of capacity as well as thermal abuse from the ongoing load-shedding in KwaZulu-Natal and South Africa (De Lange, 2022). Retailers are now calling into the FMC call centre and logging thermal abuse, fridge and freezer breakdowns from January 2022 to November 2022. This now allows the FMC to be proactive and move the frozen and chilled products before they thaw out or get spoilt due to the increased temperatures.

The consequences of frozen and chilled waste generation involve environmental and economic impacts (Al-Rumaihi et al., 2020). This is particularly the case when the disposal of food waste contributes to landfill pollution, as these waste items degrade in landfills to release methane, a potent greenhouse gas that significantly contributes to climate change (Buzby, 2022). In addition, food waste represents a direct financial loss for consumers, retailers, and producers. Discarded food equates to wasted money spent on production, transportation, and storage. With these findings it can be concluded that inadequate cold and chilling storage can results in frozen and chilled food waste. Addressing the issue of frozen and chilled food waste requires a combination of efforts across the entire food supply chain, from producers to consumers, as well as policy changes, public awareness campaigns, and technological innovations to improve storage and distribution processes (WRI, 2019).

A recent study conducted by Gillespie et al., (2023), who indicated around 88 million tons of food waste is generated each year in the EU alone. Food spoiled during distribution is part of this waste. To minimize this spoilage, it is most important to maintain the cold chain during transportation of perishable foods such as meat, fruits and vegetables. Unfortunately, frozen food is often wasted in large quantities when unpredictable failures occur in the refrigeration components of a transport vehicle (Gillespie et al., 2023). From qualitative findings, 89% of respondents agreed that improper temperature is an issue that results in food waste generation. It has helped in understanding that if the temperature at the loading bays is not adequately controlled, this can expose chilled and frozen food products to unfavourable conditions during the loading and unloading process. For example, if the loading bay is not properly sealed or insulated, the outside ambient temperature could affect the products, leading to temperature fluctuations and potential spoilage (James et al., 2019).

Respondent’s answers were in agreement with answers from FMC employees regarding the importance of temperature control for frozen and chilled food. Rapid temperature changes can cause condensation on the packaging, leading to moisture build-up and potential damage to the products (Karakas, 2021). In addition, if products are left at loading bays for extended periods, they might experience temperature changes, resulting in compromised quality and reduced shelf life. If the temperature at the loading bays is not adequately controlled, it can expose chilled and frozen food products to unfavourable conditions during the loading and unloading process. For example, if the loading bay is not properly sealed or insulated, the ambient temperature outside could affect the products, leading to temperature fluctuations and potential spoilage (Heng & House, 2022). If the temperature is not kept within the advised range, it can hasten deterioration, cause texture to deteriorate, and cause flavour to disappear, rendering the products unfit for sale or consumption (Adeniran & Shakantu, 2022).

This explained the reasoning behind the high packaging defects seen in Figure 6.5. With the packaging being damaged through condensation, cardboard boxes used for packaging were later prone to damage when handled by the customer or merchandiser. Sub-optimal temperature levels at various stages of the supply and value chain can have a cascading effect on the quality and safety of chilled and frozen foods, leading to waste generation (Alamri et al., 2021). Cold rooms are designed to maintain specific temperature and humidity levels to preserve the freshness of products, but if the product is kept at the loading bay for a longer period, damage starts at the loading bays. If cold rooms have inadequate insulation, faulty refrigeration systems, or poor temperature monitoring, the internal environment can fluctuate beyond the desired temperature range (Ndraha et al., 2018). During transportation, haulage vehicles must maintain consistent and appropriate temperatures to prevent temperature abuse. Inadequate temperature control during transit can lead to temperature spikes or drops, causing damage to the frozen or chilled foods. Likewise, uneven airflow or poor packaging arrangement can result in uneven temperature distribution within the cargo, leading to certain areas of the load being exposed to temperature abuse (GCCA, 2022). Display freezers and fridges in retail stores are crucial for maintaining the quality and safety of chilled and frozen foods. Thus, incorrect temperature settings in display cases can lead to a number of detrimental changes: thawing and refreezing of products, causing texture degradation, moisture loss, and loss of flavour, while condensation on packaging affecting product quality and can potentially promote microbial growth (Nenwell, 2021).

Implications arise with waste management challenges whereby frozen and chilled waste requires specialized disposal methods due to the need to maintain low temperatures to prevent spoilage and odour. Chilled and frozen foods exposed to temperature fluctuations or improper storage conditions will degrade faster, leading to a shorter shelf life and potentially reaching their expiration dates before being consumed (Ndraha et al., 2020). Retailers, distributors, and manufacturers may need to discard compromised products, resulting in financial losses and increased waste generation. Consumers expect high-quality chilled and frozen foods. When products have degraded due to temperature-related issues, can lead to dissatisfaction and decreased consumer trust in the brand and retailer (Conradie et al., 2018). This can complicate waste management processes. It is essential to establish strict temperature control measures, implement monitoring systems, provide training to personnel, and adopt technologies like real-time temperature monitoring and data logging throughout the supply chain (Gie, 2022). Proper communication between all stakeholders involved in the handling and transportation of chilled and frozen foods is also critical to ensure that temperature-sensitive products maintain their quality and safety (Centobelli et al., 2020).

### 7.2.2. Consumer buying patterns, over-ordering, and overstocking.

With the qualitative findings in the present study, it is clear that 85% of respondents agree that buying patterns change often. Unpredictable consumer buying patterns can make it challenging to accurately forecast demand and so retailers or suppliers may find it difficult order sufficient quantities of chilled and frozen food products, resulting in stock-outs. Conversely, if they overestimate demand, they may order excessive quantities, leading to waste when the products remain unsold or expire. It is true that consumers' preferences are always changing, this also means that supply and demand is fluctuating, which contributes somewhat to food waste. A study conducted by Aschemann-Witzel et al. (2015) indicated that to successfully reduce consumer-related food waste, it is necessary to fully understand the factors that influence consumer perception and behaviour towards food waste. Research results show that consumers' motivation to avoid food waste, sourcing, and food handling skills, as well as trade-offs between priorities have a significant influence on behaviour (Aschemann-Witzel et al., 2015). Unpredictable consumer buying patterns can make it challenging to accurately forecast demand (Barrera & Hertel, 2021). It is essential to note here that the responses that have been presented here have indicated clearly that there is a need for better understanding of consumer demands to regulate the supply-demand scenarios (Berjan et al. 2022).

The response received from the sales manager explained that overstocking and over-ordering is done to keep the customer happy by ensuring that the shelves are always full. It is the responsibility of the store to always ensure that when a promotion is advertised, there is sufficient stock on the shelves and back-up (Le Borgne et al., 2018). With overstocking, there is a need to improve measures particularly as increased sales of a product may occur in some months compared to other months. However, without accurate predictions, ordering of the product is simply maintained (Ovezmyradov, 2022). This response relates to one of the shelf health policies seen in Table 6.5 to always have full shelves in retail outlets. The researcher also captured photos of stores with acceptable and non-acceptable shelf health practices, as seen in Table 6.6.

When retailers or distributors anticipate higher demand for chilled and frozen foods due to seasonal trends, promotions, or special events, they may over-order or over-stock to ensure they have sufficient supply to meet potential demand spikes (Zanoni & Zavanella, 2012). This can be a reaction to unpredictable shifts in consumer buying patterns or an attempt to prevent stock outs, which can lead to missed sales opportunities. Chilled and frozen foods generally have limited shelf lives compared to non-perishable goods. This is because the cold storage only slows down degradation processes but doesn't stop them entirely (Valášková et al., 2021). Over-ordering and over-stocking can lead to products remaining as inventory items for extended periods, especially if demand doesn't meet inflated expectations. This increases the likelihood of products reaching their expiry dates before being sold or prolonged storage due to over-ordering can expose these products to temperature variations, leading to quality deterioration (Weber et al., 2011).

Food quality deterioration happens as chilled and frozen foods are highly sensitive to temperature fluctuations. For frozen foods, thawing and refreezing can cause texture changes and moisture loss, affecting taste and overall appeal (İlkin et al., 2023). Chilled foods can lose their freshness and may develop off-flavours and odours. When chilled and frozen foods approach their expiration dates or suffer from quality degradation, retailers and distributors may need to discard these products to maintain quality standards and ensure consumer safety. It is important that customers and employees understand date labelling to help avoid quality degradation (Wikurendra et al., 2022). Consumers often purchase more perishable items than they can consume before they expire. Misunderstanding of date labels (such as "best before" vs. "use by" dates) can also lead to unnecessary discarding of still-edible food. Over-ordering and over-stocking can tie up valuable resources in excess inventory. If products go unsold and have to be discarded, it results in financial losses for retailers and distributors (Ntobaki et al., 2022).

Addressing data analysis and forecasting by utilising historical sales data and advanced analytics to identify trends and patterns in consumer behaviour can assist in making more accurate predictions about future demand (Falatouri et al., 2022). This is facilitated by using demand forecasting models that take into account various factors such as seasonality, promotions, economic conditions, and external events. Consumers also lack the awareness of the environmental and economic impacts of food waste, which can contribute to careless disposal habits (Al-Obadi et al., 2022). Fostering closer collaboration and communication between retailers, distributors, and suppliers may ensure a more accurate understanding of demand and supply dynamics (Benavides et al., 2012). The most common causes of perishable food waste at retail are overstocking, consumer behaviour, quality control, and improper product handling (Buisman et al., 2019). With 92% of respondents from the qualitative findings supportive of this statement, and whereby a retailer store manager stated that there is a problem that retailers tend to overstock because they want to meet consumer demands, or they have some promotions and assume they will make money so they will order a lot of stock but not sell. Then stock at such retailers may exceed their expiry date or be damaged be returned to the FMC (Falatouri et al., 2022).

Poor inventory and poor stock visibility are also regarded as major issues that tend to impact the performance of frozen food waste management (Costello et al., 2016). There is a major issue that has been noted pertaining to poor inventory and poor stock visibility, which have had major impacts as well (Weber & Herrlein, 2012). The study has effectively pointed out the same and there is a clear understanding of the area as well. These retailers overstock not by choice but to ensure product on the shelf for the consumer. However, this can lead to expired products in store that are not sold (Salam et al. 2022). Therefore, it is clear that overstocking is a recurrent issue in the KZN region. Nevertheless, this is also causing a greater rise in the overall domain of frozen food waste, which is impacting these businesses negatively again (Mladenov et al. 2022). Therefore, the use of the appropriate food items here is a major concern and overstocking is leading to a greater rise in food waste, which must be seen as a critical concern overall.

### 7.2.3. Inventory management and reporting

A study by Riesenegger & Hübner, 2022, revealed that poor inventory management leads to overstocking and understocking, both of which can be detrimental to the business and its operations. Inventory management is crucial for all businesses as it impacts costs and customer satisfaction, among other factors. The qualitative data also concurred with this statement with 89% of respondents agreeing that poor inventory management does result in food waste generation. There is a clear lack of manpower to manage this area, which can be seen as a critical issue here. This can lead to severe gaps, which must be mitigated for better results in this direction. The management of frozen food waste, as per Rogerson (2021), is largely dependent on the critical aspect of inventory management and control.

Stock rotation is an essential shelf health element, and as indicated in Table 6.2, the FIFO principle dictates that the oldest products should be sold or used first to prevent items from expiring or becoming unusable (Jedermann et al., 2014). Ignoring this principle can result in older products being pushed to the back of storage areas and forgotten. As a result, newer items are placed in front, and older items may end up expiring before they are used or sold (Rawat, 2023). Images seen in Table 6.6 shows the effect of stock rotation being ignored by poor upkeep of inventory.

With limited sales data analysis, the FMC cannot adjust their orders based on actual demand patterns. This can lead to over ordering or under ordering, both of which can contribute to frozen and chilled food waste. Investing in inventory management software that allows for real-time tracking and reporting of inventory levels and implementation of proper storage practices and adhere to recommended temperature and storage conditions can mitigate the food waste generation (Tally Solutions, 2022). Organization storage areas to ensure that older items are easily accessible and visible. Training of staff on proper inventory management practices, including FIFO, and emphasize the importance of minimizing food waste (Atnafu & Balda, 2018).

The cold chain must be maintained to preserve the quality and safety of chilled and frozen foods. Inadequate checks and balances can compromise cold chain integrity. Lack of visibility can occur at multiple stages of the supply chain, including production, transportation, storage, and retail. Research done by Sibanda et al. (2020) pointed out that weak implementation of internal audit policies and controls make it difficult for oversight committees to detect unethical supply chain management practices in a timely manner, or unfair, unequal, opaque, non-competitive, and unprofitable practices leading to increased waste of frozen and chilled food (Sibanda et al., 2020). Without effective monitoring and reporting systems, it is challenging to track progress, identify trends, and assess the impact of the policy on reducing food waste (Närvänen et al., 2020). Between the manufacturer and the retailer, separate operations are available. Since there is a lack of observation about how the product is performing in stores, this is aggravating (Farounbi & Ngqwala, 2020).

The study has pointed out the fact that the manufacturer and the retailer may operate separately, and this practice is aggravated if these entities cannot observe how the product is performing in stores. Unfortunately, the accuracy of data is never guaranteed particularly regarding what the retailers put in the store - and is visible to them - but not what is necessarily leaving the store (Teuteburg, 2020). While retailers do not have a system, they do have Microsoft Excel to manage inventory. There are many problems faced with these stores using MS Excel spreadsheet since everyone will download at different times so the supply and sale numbers may not correspond (Cotter, 2023). A Microsoft Power BI model was set up with five financial years of data by the researcher (as seen in Appendix M). This was created to see the frozen and chilled food waste by retailer. This is still in the development phase but does provide more visibility of the frozen and chilled food in store. This instrument will allow real time reporting which can be viewed via the mobile or tablet application (Bansa & Upadhyay, 2017). Without proper checks and balances, problems such as temperature fluctuations, mishandling, delays, and product damages may go unnoticed (Gie, 2022). As Centobelli et al. (2021) suggest, the use of an appropriate tracking of the key aspects associated with these products is clearly one of the most important areas that must be considered as it can help in gaining better insights into the overall areas of sales of products. Nevertheless, the use of the correct tracking systems here can be beneficial by ensuring a better understanding of the sales, stocking requirements and in the management of waste generation. As mentioned above, there is a clear issue pertaining to overstocking and poor inventory management systems, which can pose severe threats to the overall waste management aspect (Karakas, 2021).

The theoretical framework of Triple Bottom Line shows that food manufacturers need to understand the impact of food wastage on society and environment (Bahraini, 2021). The inadequate systems can lead to excess ordering, being unable to manage inventory during seasonal shifts in demand. Not adjusting inventory levels accordingly can lead to surpluses or shortages. A regular review of inventory levels and adjustment in orders is possible that is based on actual sales data and demand patterns and implementation of the first-in, first-out (FIFO) principles for rotation of inventory (Rawat, 2023). Investing in the correct reporting tools such as Microsoft Power BI, Systems Applications and Products (SAP) in data processing and salesforce can all assist in monitoring and checking stock balances (Bansa & Upadhyay, 2017).

### 7.2.4. Inadequate generation, transmission, and distribution of electric power

An article published by Averda, 2023 stated that in case of load shedding, frozen food may thaw and refrigerated food may heat up. Small retail stores without backup generators will experience more food loss after a power outage. Frozen foods that have been thawed should be purchased and consumed immediately afterwards, but often these foods are not purchased. The same situation also occurs with restaurants and bakeries that are not equipped with backup power systems. Foods that are in the middle of cooking or require a complete cycle in the oven, such as bread, are often damaged by power outages. These foods cannot be reheated or recooked when the power is restored, so bakers and chefs have no choice but to throw them away (Averda, 2022). From the qualitative findings, 85% of respondents agreed that electricity rationing, or load-shedding results in frozen and chilled food waste generation. The poor distribution of electricity is a real issue and must be considered important. The temperatures in KZN are extremely hot at times and therefore, with no electricity, there is a clear crisis of refrigeration, which can cause severe concerns as well (Nzima et al. 2020). Power outages are causing problems for businesses and our company is no exception. Whenever there is no electricity, it causes issues because things like food and items can get spoiled or broken. Sometimes, the retailer might use this as an excuse to throw away food and make us pay more. They won't put in generators or take care of their refrigerators. In particular in our industry, load shedding has become a major problem. The stores anticipate issues every time there is load shedding since it causes a lot of damaged goods and food to spoil (Matei et al. 2021)

One of the respondents emphasised stock that is recalled to the company as damaged because of thermal abuse as being a significant ongoing issue leading to economic loss for the FMC. This is because when the power is off, and if there is not enough back-up power, the products are exposed to warmer temperatures (De Lange, 2022). In KZN there can be some very hot days so such exposure to increased temperatures can lead to contamination and wastage of frozen food (USDA, 2020). Energy issues and loadshedding were highlighted as a major issue and the study clearly indicated an increase in loadshedding and a concomitant rise in food wastage. Besides, it was indicated that food wastage cannot be minimised if appropriate temperature control is not initiated. In this regard, there is a need to understand that without an appropriate energy scenario, there is a high chance that temperature regulation will be flawed, which can be seen as an area of deep concern (De Lange, 2022).

Regarding refrigeration and freezing, load shedding can disrupt their operation, causing the temperature inside these appliances to rise. This can lead to spoilage and potential food safety concerns, especially for perishable items like dairy products, meats, and other frozen and chilled products (Ho & Hoosen, 2023). This also results in damage to the fridge or freezer mechanism and replacements are required.

Although it has only recently being tracked, the FMC from January 2022 requested that fridge or freezer failure be communicated, as indicated in Figure 6.6. This is growing month-on-month with a more fridge and freezer breakdowns occurring daily. Refrigeration and cold storage are crucial for preserving the quality and safety of chilled and frozen foods. Electricity rationing can lead to interruptions in power supply, causing refrigeration systems to shut down or operate inefficiently (Marshall, 2022).

Extended periods of power outage can create conditions that promote the growth of spoilage microorganisms and pathogens within refrigerated environments. Increased temperatures can accelerate microbial activity, leading to more rapid spoilage of chilled and frozen foods and posing health risks if such food is consumed (Larsen et al., 2014). The FMC affected by electricity rationing incurs financial losses due to waste, as well as increased costs related to backup power solutions, such as generators. Increased operational costs can contribute to higher product prices, affecting consumers and overall economic efficiency (Khonjelwayo & Nthakheni, 2021). To mitigate this ongoing problem, additional cost is faced by investing in back-up power supplies such as generators or uninterrupted power supply (UPS) systems that help in maintaining essential appliances like refrigerators and freezers during power outages. In addition, thermal insulation materials help to keep refrigerators and freezers colder for longer periods during load shedding (Taylor, 2022).

### 7.2.5. Supplier packaging defects and pathogen contamination Rejection

A study conducted by Raak et al. (2017), who stated that packaging can add date labels to provide information about palatability, but higher food prices in society are still needed to increase consumer acceptance of suboptimal foods. Packaging defects can lead to microbial spoilage, physical damage, chemical damage or sensory changes to frozen and refrigerated foods (Ganeson et al., 2023). However, only 83% respondents from the qualitative data analysis saw this to be a significant issue. An employee of the FMC stated that packaging defects can also happen when the customer handles the products roughly in stores (Soma, 2022).

Packaging defects contribute towards the highest amount of frozen and chilled waste produced by the FMC seen in Figure 6.5. With poor packaging, store damage can take place resulting from the movement of products into and out of the store. Store damage is ranked second to contributing to frozen and chilled food waste, as seen in Figure 6.5. Packaging defects can allow moisture to infiltrate, leading to the formation of ice crystals on frozen foods or moisture accumulation on chilled products (Kasza et al., 2022). This can result in texture changes, loss of flavour, and overall quality degradation. Packaging defects can expose products to contaminants, including microorganisms or foreign substances, which can lead to spoilage or safety concerns. Contaminated products may need to be discarded to ensure consumer safety (Raak et al., 2017a). Proper packaging is crucial for maintaining the quality and safety of perishable products, such as frozen and chilled foods. Packaging defects can lead to various issues that result in increased waste. Packaging defects can compromise the insulation and integrity of the packaging, leading to temperature fluctuations during transportation and storage. In the case of frozen and chilled foods, temperature control is critical to prevent spoilage and maintain quality (WRAP, 2013).

If the packaging fails to provide adequate insulation, the products may thaw or experience temperature variations that negatively impact their safety and freshness. To mitigate frozen and chilled food waste resulting from supplier packaging defects, supply chain stakeholders can increase supplier communication by establishing clear communication with suppliers about packaging requirements and expectations to ensure that packaging is of high quality and suitable for maintaining product integrity (Mladenov et al. 2022). Implementation of stringent quality control measures to inspect incoming shipments for packaging defects before products reach retailers or consumers. Indigenous packaging is always good, but products of other manufacturers have often been found to be prone to such issues (van der Werf et al. 2020). Packaging defects, such as leaks or breaches, can allow air, moisture, or contaminants to enter the packaging, compromising the quality and safety of the frozen and chilled food items. This can lead to spoilage, microbial growth, and accelerated deterioration of the products, resulting in waste (Ribeiro et al. 2022). Air, moisture, or pollutants can enter the packaging due to flaws in the packaging, such as leaks or breaches, endangering the quality and safety of the frozen and chilled food products. This may cause waste due to product spoiling, microbial development, and hastened deterioration (Mladenov et al. 2022).

A study by Kasza et al. (2022) indicated that food safety is important for every food handling facility and is closely related to food nutrition. Many factors can make food unsuitable for human consumption. The obvious concerns about food hazards are mainly microorganisms, pesticide residues, chemicals and allergens. The study by Morya et al. (2020) reported that food poisoning caused by pathogenic microorganisms can be avoided by using safety measures such as personal care and hygiene. Therefore, individual efforts in hygiene, government legislation and safety rules in handling certain food tissues are recommended.

With 86% of respondents from the qualitative data findings agreeing that food is rejected for safety reasons. In the case of contaminated frozen and chilled food products, they are rejected for food safety reasons by manufacturers, distributors, or retailers to prevent their consumption (Larsen et al., 2014). Thus, this can occur at various points in the supply chain, including during production, transportation, or at distribution centres. Rejected products are typically removed from the market to prevent potential health risks, leading to waste (Chauhan et al., 2021). Rejected products may need to be isolated or quarantined to prevent them from entering the market. This is done to avoid potential health risks to consumers or risk damage the brand's reputation and consumer trust. Rejected products are typically removed from the market to prevent potential health risks, leading to waste (Heng & House, 2022). This ensures that only safe products reach consumers, but it also results in waste when contaminated items are removed from the supply chain (Chauhan, 2020).

In cases where frozen and chilled food products are identified as part of a food safety recall due to pathogen contamination, they are typically recalled from the market and disposed of to prevent consumer illnesses. Recalls can occur due to identified contamination risks during production, packaging, or distribution, resulting in significant waste. During testing or inspection, frozen and refrigerated food products are frequently rejected for food safety reasons if they are found to be contaminated with pathogens or other dangerous micro-organisms (Nzima et al. 2020). This may happen during numerous stages of the supply chain, such as manufacturing, shipping, or at distribution facilities. Waste results from the removal of rejected products from the market to avoid potential health problems. In order to mitigate potential liability and reputational risks, companies in the supply chain may err on the side of caution and reject frozen and chilled food items if there are concerns about pathogen contamination. While this approach prioritizes consumer safety, it can lead to the disposal of otherwise usable products and contribute to waste (Barrera & Hertel, 2021). There is multiple implication when food is rejected to avoid the risk of contamination spread. When a batch of frozen or chilled food products is found to be contaminated with pathogens, there's a risk that the contamination might spread to nearby products during transportation or storage (Onyeaka et al., 2024).

To mitigate this risk, entire batches or shipments might be rejected and discarded, even if only a portion of the products is affected. Retailers or distributors might reject shipments from suppliers if they suspect or confirm that the products are contaminated (Lobdell, 2023). This can lead to the return or disposal of large quantities of products, resulting in waste. To minimize frozen and chilled food waste resulting from rejection for food safety reasons, supply chain stakeholders can consider the following strategies: (1) implementing rigorous quality control measures throughout the supply chain to identify potential contamination issues early, and (2) prevent contaminated products from entering the market; (3) educate employees about proper hygiene practices, temperature control, and food safety protocols to minimize the risk of contamination during handling and storage and, (4) regularly testing and monitoring products for pathogens and other contaminants to identify issues before they escalate.

Consumers often have high visual expectations for food products. If a frozen or chilled product doesn't meet their aesthetic standards, they might avoid purchasing it, leading to food being left on the shelves or eventually being discarded. Consumers often associate certain product appearance with freshness and quality. If a frozen or chilled product looks discoloured, freezer-burned, or slightly damaged, consumers might assume it's not safe to eat, even if it's perfectly fine (Kasza et al., 2022; Morya et al., 2020). With 84% of respondents agreeing to this statement from the qualitative data findings, which a store manager stating that food that doesn't appear appetizing must be thrown away because if it doesn't look fresh or isn't fresh, it will be bad for business and cost these stores their clients (Morya, 2020). Therefore, they just abide by the established business and legal guidelines. Frozen and chilled foods might have minor cosmetic imperfections like discoloration, uneven shape, or minor blemishes (Alegbeleye et al., 2022). These imperfections do not necessarily indicate spoilage or a decline in quality, but consumers will not buy a product with imperfections. Organizations strictly adhere to the prescribed business and legal protocols (Matei et al. 2021). Retailers and food service establishments frequently uphold particular aesthetic criteria for the presentation of their merchandise. Despite a product's complete safety and edibility, it may be excluded if it fails to meet these aesthetic criteria (Farounbi & Ngqwala, 2020).

Retailers often prioritize products with uniform shapes, colours, and sizes, as these are more appealing to consumers. There are implications such as products that don't meet these aesthetic standards might be deemed less desirable and rejected, even if they are perfectly edible (Alegbeleye et al., 2022). Retailers often prioritize visually attractive displays to attract customers. Products that don't meet the desired appearance criteria might not be displayed prominently, leading to lower sales and potentially resulting in their removal and waste. To alleviate this, educating consumers that appearance deviations do not necessarily indicate lower quality or safety can help shift consumer preferences and reduce the emphasis on cosmetic perfection (Kapteyn, 2018). In addition, it would then be useful to explore opportunities to sell appearance-differentiated products in secondary markets, such as bulk sales, processing for food ingredients, or partnerships with food processors. In addition, consideration should be given to donating products with minor cosmetic imperfections to food banks or charitable organizations to minimize waste. Implementation of marketing strategies that highlight the value of imperfect but edible products emphasises the reduction of food waste. Labelling products with minor cosmetic imperfections as being safe to eat encourages consumers to make informed choices (Kazaz et al., 2023).

### 7.3. The socio-economic and environmental impacts of frozen and chilled food waste in the supply chain.

The generation of food waste can have significant socio-economic and environmental consequences. Xue et al. (2017) argue that the extent of food waste generation is influenced by critical drivers that have been identified. These drivers highlight the major impacts of food waste generation, particularly in relation to food insecurity and social inequalities. The consequences of food waste generation include an increased risk of malnutrition, poor hygiene, and sanitation, which can negatively affect the overall health and well-being of communities. Additionally, certain segments of society may not have access to an adequate food supply, leading to further social inequalities and food insecurity within the region. Therefore, the socio-economic impact of food waste generation is substantial. Furthermore, as highlighted by Yoobic (2021), the generation of a large amount of food waste can have a significant impact on inflation and hinder the country's GDP growth. The economy incurs high costs due to food waste, which can limit GDP growth and overall output. Moreover, the lack of an appropriate food supply can lead to inflation and an increase in food prices. These social and economic aspects have far-reaching consequences for society.

### 7.3.1. Food Insecurity and malnutrition

A study by Chakona and Shackleton (2019) indicated that while food is wasted, there are people around the world who lack access to sufficient, safe, and nutritious food. Food waste exacerbates food insecurity by diverting resources away from those who need it most. Reducing food waste can contribute to addressing food insecurity and ensuring that available resources are used effectively. By reducing food waste, more food resources can be directed toward addressing malnutrition and improving the nutritional status of populations, particularly in underserved areas (Berry, 2020; Chakona & Shackleton, 2019).

From the qualitative data (interviews), it is seen that 83% of respondents agreed with this statement as well. There are significant socio-economic impacts of food wastage as well, which were highlighted in the study (Strotmann et al., 2022). There is a critical need to understand the fact that frozen food tends to lose their overall purity if they are thrown away unused and therefore, they become unusable, which can be a cause of severe concern overall. Many people are unaware that a considerable amount of food is wasted, oblivious to the reality that there are individuals who do not have access to adequate nourishment. Despite the disposal of food, homeless individuals resort to rummaging through garbage in search of sustenance. However, this practice exposes them to the consumption of spoiled food, ultimately leading to health issues (Karakas, 2021). Conversely, the misallocation of resources in the production of food that ultimately goes to waste obstructs the availability of nutritious sustenance for those who require it (Chauhan et al., 2021).

Frozen and chilled food waste is often a result of inefficiencies and overconsumption in wealthier regions. Meanwhile, many vulnerable communities face limited access to nutritious food due to financial constraints - this highlights and perpetuates social inequalities, where resources are misallocated, and certain groups lack basic access to sustenance (Karakas, 2021). In addition, improperly managed food waste can lead to poor hygiene and sanitation conditions, attracting pests and creating environments where diseases can thrive. This has a direct impact on public health, especially in areas with inadequate waste management systems (Abubakar et al., 2022).

Frozen food waste is a major issue that has significant economic, environmental, and social impacts. It is estimated that around one-third of all food produced globally is wasted, with frozen food being a significant contributor to this problem (Seberini, 2020). Investigating the economic, environmental, and social impacts of frozen food waste can help us understand the severity of this issue and take necessary steps to address it. The FMC has joined the international “10x20x30 initiative” which is an initiative launched by Champions 12.3 to bring together 10 of the world's largest food retailers and suppliers, each partnering with 20 of their key suppliers to halve food loss and waste by 2030 (RCL Foods, 2022). Champions 12.3 is a high-level, voluntary coalition of leaders from government, business, international organisations, research institutions and civil society, aiming to inspire ambition, mobilize action and drive progress towards SDG 12.3 goal by 2030 accelerate (UN, 2019). The FMC is committed to focusing on identifying food waste causes in the supply chain.

From an environmental perspective, frozen food waste contributes to greenhouse gas emissions as it decomposes in landfills. This not only harms the environment but also exacerbates climate change. Additionally, producing and transporting frozen foods requires energy expenditure and resources which further contribute to environmental degradation (Buzby, 2022). The environmental impacts determined in this study were based on estimates from the US EPA (2015), and it is seen that the butter and chicken sub-categories are indeed the leading contributors to the frozen and chilled waste. Due to the large amounts of frozen and chilled food waste in 2020 and 2021, a spike in $CO_2$ and $CH_4$ emissions was seen in those years, as illustrated in Figure 6.12. The correlation of the GHG gas emissions to food waste gives a clear indication that as food waste increases, the GHG emissions also increases (Buzby, 2022). Socially, frozen food waste exacerbates issues related to hunger and poverty. Millions of people around the world go hungry every day while perfectly good food is being thrown away. Food waste reduces the overall availability of food in the market, which can lead to increased prices for consumers. When food prices rise, individuals and families with limited financial means may struggle to afford enough food to meet their basic needs. This lack of access to affordable and nutritious food contributes to food insecurity and malnutrition, particularly among vulnerable populations such as children and the elderly. Therefore, investigating the economic, environmental, and social impacts of frozen food waste is crucial in addressing this issue. We must take action by reducing our own consumption of frozen foods where possible and advocating for better policies that promote sustainable practices in the production and distribution of these products (Action Against Hunger, 2022). Overall, reducing the consumption of frozen food can lead to a reduction in food waste by minimizing over-purchasing, improving meal planning, reducing storage issues, promoting fresh options, decreasing dependency on packaged foods, and encouraging sustainable practices.

The wastage of nutrient-rich foods contributes to malnutrition, impacting the health and well-being of individuals who lack access to a diverse and balanced diet. Food waste disproportionately affects marginalized communities, perpetuating social inequalities in access to food and resources. Wasted food represents lost economic opportunities for farmers, producers, retailers, and other stakeholders, potentially leading to job losses and financial instability (Agostoni et al., 2023). The resources invested in producing, processing, transporting, and distributing frozen and chilled food are wasted when products are discarded, leading to economic losses across the supply chain (Albizzati et al., 2019). Unsustainable food systems are less resilient to environmental changes and can undermine the long-term viability of agricultural and food-related industries. Environmental impacts such as decomposing food waste in landfills generates methane, a potent greenhouse gas that contributes to global warming and climate change (Abubakar et al., 2022). However, according to Heng and House (2022), the current state of the environment is experiencing significant effects that raise concerns. It is crucial to consider specific areas that have a substantial and influential impact. When frozen and chilled food waste is discarded in landfills, it undergoes anaerobic decomposition in an environment deprived of oxygen. This decomposition process results in the production of methane, a potent greenhouse gas that has a much greater impact on global warming potential than carbon dioxide. The emission of methane contributes to climate change and worsens environmental issues (Barrera & Hertel, 2021).

Producing, processing, and transporting food requires vast amounts of resources such as land, water, energy, and nutrients. When food is wasted, these resources are squandered (Raak et al., 2017a). Food production and distribution involve energy-intensive processes. Wasted food represents wasted energy, contributing to increased energy consumption and associated environmental impacts. Agriculture accounts for a significant portion of global freshwater use. Wasted food means unnecessary water consumption and can worsen water scarcity issues. Expansion of agricultural land to compensate for food waste can lead to land use change, impacting natural ecosystems and biodiversity (Ingrao et al., 2023). The wastage of nutrient-rich foods leads to a loss of organic matter and nutrients that could have been returned to the soil through composting. Improper disposal of food waste can result in nutrient runoff into water bodies, leading to water pollution and eutrophication. Addressing frozen and chilled food waste requires a holistic approach that considers both the socio-economic and environmental impacts (WWF, 2017). This includes reducing waste at the source, improving supply chain efficiency, implementing proper waste management practices, and raising awareness among stakeholders and consumers about the consequences of food waste.

Frozen and chilled chicken food and also butter waste that goes to landfill generates high levels of $CO_2$ and $CH_4$, as seen in Table 6.8. In landfills, organic waste, such as food scraps, undergo decomposition in the absence of oxygen, a process called anaerobic decomposition. This process differs from aerobic decomposition, which occurs when organic matter breaks down in the presence of oxygen (Mondal et al., 2023). When chicken and butter, which contain organic materials, are discarded in a landfill, they become part of the organic waste stream. Over time, these organic materials break down as microorganisms break down the complex molecules into simpler compounds. One of the by-products of anaerobic decomposition is methane gas ($CH_4$). Methane is a potent greenhouse gas with a significantly higher global warming potential compared to carbon dioxide (McArthur, 2021). In the oxygen-deprived environment of a landfill, certain microorganisms produce methane as they break down organic matter. Carbon dioxide ($CO_2$) is another by-product of the decomposition process, resulting from the breakdown of carbon-containing molecules in the organic waste (Du Plessis, 2020). While carbon dioxide is also a greenhouse gas, its impact on global warming is generally considered to be lower than that of methane.

As organic materials decompose in a landfill, liquid by-products called leachate are generated. Leachate is a mixture of water, organic compounds, and other chemicals that can further contribute to environmental pollution if not properly managed (Moodley, 2017). The by-products in correlation to frozen and chilled food waste is seen in Figure 6.12. The release of methane and carbon dioxide gases from landfills contributes to global warming and climate change by trapping heat in the atmosphere. Methane, in particular, has a much higher warming potential over a shorter timescale compared to carbon dioxide, making it a significant contributor to short-term climate impacts (Bruggers, 2021).

There is a range of implications linked to social issues, exacerbating food insecurity, social inequalities, malnutrition, poor hygiene, and other challenges. Food insecurity is highlighted as the number one factor, representing a lost opportunity to provide nourishment to those in need (Berry, 2020). When edible food is discarded, it could have been directed to individuals or communities facing food insecurity (Chakona & Shackleton, 2019). The waste of frozen and chilled foods further limits access to nutritious options, especially for vulnerable populations. Social inequalities disproportionately affect marginalized communities and populations with limited resources (Al-Obadi et al., 2022). The inability to afford or access fresh and nutritious food exacerbates existing social inequalities. The resources invested in producing, processing, packaging, and transporting frozen and chilled foods are wasted when these products are discarded. This inefficiency contributes to economic losses in the food supply chain (FAO, 2013). Frozen and chilled food waste generates a significant environmental footprint in terms of land use, water consumption, energy usage, and greenhouse gas emissions. This exacerbates environmental challenges that affect disadvantaged communities the most (Hannah, 2019).

To address these social issues related to frozen and chilled food waste, concerted efforts are needed, such as raising awareness about the impacts of food waste on food security, nutrition, and social inequalities. Educate consumers, businesses, and policymakers about ways to minimize waste (United Nations Environmental Program, 2022). Implement systems to donate excess frozen and chilled food to organizations that can distribute it to vulnerable populations. Develop and implement technologies that improve food traceability, shelf-life extension, and efficient supply chain management to minimize waste. By addressing frozen and chilled food waste within a broader social context, we can work towards a more equitable, sustainable, and food-secure future (Goossens et al., 2019).

### 7.3.2. GDP, inflation and food price hike

Recent study by Buthelezi (2023) reported that efforts to minimize frozen and chilled food waste can contribute to a more resilient and sustainable economy by optimizing resource use, improving supply chain efficiency, reducing costs, and ensuring equitable access to food. Collaborative actions involving governments, businesses, and consumers can play a crucial role in achieving these economic benefits (Buthelezi, 2023). Food is often wasted throughout the supply chain, with an estimated 35% loss generated at the consumer level. As a result, household food waste makes up a significant portion of the total waste generated throughout the food supply chain. However, these wastes vary considerably between developed and developing countries. Results from 44 countries at different income levels, the impact of legislation and economic incentives on food waste generation showed that well-defined regulations, policies, and strategies are more effective than financial measures in reducing food waste generation (Chalak et al., 2016). As many as 93% of respondents agreed to this statement from the qualitative data that there is a noted rise in the overall inflation levels associated with any organisation. The present study pointed out that without appropriate food security, there is a minimal chance that the overall food wastage can be stopped, contribute to a rise in inflation, and limit the purchasing power of customers (Berry, 2020). Food security plays a crucial role in reducing food waste by improving access to food, promoting efficient consumption habits, supporting food recovery programs, investing in infrastructure, and raising awareness about the importance of reducing waste. By addressing underlying issues of access, affordability, and distribution, food security initiatives contribute to efforts to create a more sustainable and equitable food system.

These are all factors that can cause issues for food companies, particularly those that overproduce to lead to an even greater wastage of food altogether. In the KZN region, there is a well-documented issue of inflation, which also serves as evidence of a noticeable decrease in affordability (Rogerson, 2021). Food waste, on the other hand, results in the squandering of valuable resources such as raw materials, labour, energy, and capital investment. When food is discarded, the full value of these resources remains unrealized, thereby exerting a detrimental impact on a nation's GDP. This phenomenon highlights inefficiencies within the production and distribution processes, ultimately leading to economic losses (Bahraini, 2021). Moreover, it exacerbates the disparity between various socio-economic groups and undermines endeavours aimed at achieving a fair distribution of resources (Rogerson, 2021).

In South Africa, food waste occurs at multiple points along the food supply chain and the costliest food waste occurs during food distribution with a loss of R19.6 billion, followed by processing and packaging with a loss of R15.6 billion, and agricultural production with a loss of 12.5 billion Rand (DEFF & CSIR, 2021). Economic impacts have been increasing year on year based on the 5-year financial data. During the COVID-19 pandemic, the meat category with subcategory chicken was most effected. Years 2020 and 2021 saw the highest financial losses within the FMC. When the researcher also found that this type is pattern is present post the COVID-19 pandemic, as highlighted in Figure 6.12. This was also reported in research done by Oelofse and Nahman (2013) and Oelofse and Nahman (2019). The meat category is the number one contributor to high frozen and chilled food waste and costs, as seen in Figure 6.9.

### 7.3.3. Greenhouse gas emissions

Impacts were quantified for ten categories of environmental impacts, ranging from global warming to water depletion, including indirect effects on land-use change driven by land-use demand. Food waste, especially when it can be avoided, leads to significant resource loss and environmental impact due to the many processes involved in the life cycle (Tonini et al., 2018). A study by Buzby (2022) indicated that the link between food loss and waste and climate change is increasingly important, as is the link between climate change and agricultural and supply chain resilience. We are seeing more and more extreme weather events disrupt the resilience of both the agriculture industry and supply chains. From the qualitative data, 79% of respondents agreed to this statement whereby adverse implications of food wastage impact the environment. Food wastage can lead to massive issues pertaining to environmental sustainability, which is clearly one of the key reasons for the generation of appropriate food waste management frameworks (Kohli et al., 2024).

As can be seen in Figure 6.11, for KwaZulu-Natal, are GHG emissions growing when there is an increase in frozen and chilled food waste. Furthermore, if frozen and chilled waste is not disposed of correctly, this can also lead to environmental damage and an increase in GHG emissions (Buzby, 2022). The current process at the FMC is to place all frozen and chilled food waste into plastic bags, as seen in Figure 6.7. This is not ideal since the waste products are not separated into categories (Hannah, 2019). When frozen and chilled food waste is disposed of in landfills, it undergoes anaerobic decomposition due to the lack of oxygen in the landfill environment. Methane has a much higher heat-trapping capacity compared to carbon dioxide over a short period (20 years), making it a significant contributor to short-term global warming (McArthur, 2021). Although methane dissipates more quickly than carbon dioxide, its immediate impact on warming is significant. Over a 100-year timescale, methane is about 28-36 times more effective at trapping heat than carbon dioxide. Greenhouse gases, including methane, trap heat in the Earth's atmosphere, leading to global warming and climate change (McArthur, 2021). Climate change results in altered weather patterns, more frequent and severe weather events, rising sea levels, and disruptions to ecosystems and biodiversity. The emission of greenhouse gases contributes to environmental degradation, impacting air quality, water resources, and soil health (Agostoni et al., 2023). Emissions from food waste contribute to the overall atmospheric carbon dioxide and methane levels, overwhelming the Earth's natural carbon sinks like forests and oceans. The production, transportation, and disposal of food waste consume resources such as water, energy, and land. This further contributes to environmental strain (Mortillaro, 2023).

To mitigate the environmental impact of frozen and chilled food waste disposal, several strategies can be adopted to minimize food waste at the source by better inventory management, proper storage, and consumer education (Oelofse & Nahman, 2013). Diverting food waste from landfills by composting it not only reduces GHG but produces nutrient-rich soil amendments. Capturing methane emissions from food waste through anaerobic digestion, is a process that converts organic waste into biogas and nutrient-rich digestate (Avicenna et al., 2015). Creating waste-to-energy conversions, allows some facilities to use food waste as a source of renewable energy through incineration or anaerobic digestion, reducing greenhouse gas emissions and producing energy (Kiran et al., 2014).

### 7.3.4. Sustainability Goals

According to Zanoni and Zavanella (2012), efficiently upholding sustainability goals in frozen and chilled food manufacturing involves a commitment to ongoing improvement, innovation, collaboration with stakeholders, and a genuine dedication to reducing the environmental footprint of the entire production process. From the qualitative data, 68% of respondents agree to this statement. The frozen and chilled food sector has adopted practices to reduce waste, optimize resource use, and minimize energy consumption in their manufacturing processes. The FMC releases yearly sustainability reports to provide information on how the business is tracking progress towards meeting set goals (Jere et al., 2021). This is also shared on the internet to assist other stakeholders who are trying to find ways to increase sustainability. There is ongoing research and innovation aimed at developing more sustainable packaging materials, processing methods, and distribution practices (Fobbe & Hilletofth, 2021). The organisations are doing their best to uphold sustainability goals. The sustainability achievement, include installation of solar panels and switching to renewable sources of energy (Damiani et al. 2021). This includes optimizing refrigeration systems, using energy-efficient equipment, and adopting energy management strategies to minimize energy consumption (Salam et al. 2022).

This helps minimize waste generation and reduces the environmental impact of packaging throughout the supply chain (Nzima et al. 2020).

It is crucial to have food manufacturing sustainability goals efficiently upheld in the frozen and chilled food processing and manufacturing sector. Sustainability in food manufacturing encompasses a range of practices and initiatives that aim to minimize the environmental, social, and economic impacts of the industry (Abubakar et al., 2022). The frozen and chilled food processing sector consumes significant energy, water, and other resources. Ensuring that sustainability goals are met helps reduce the sector's carbon footprint, minimize resource depletion, and limit pollution. Understanding the environmental impact of various stages in the supply chain identifies opportunities for improvement by optimizing energy and water usage, reducing waste, and implementing technologies that enhance process efficiency (United Nations, 2022). By prioritizing sustainability in frozen and chilled food processing and manufacturing, the industry can contribute to a more environmentally responsible, socially equitable, and economically viable food system (Adams et al., 2021).

## 7.4. Consumer perceptions on chilled and frozen food waste generation in relation to their buying habits and patterns

Results in Figure 4.15 indicated mean values below (M= 3.4) were interpreted as the level of agreement that consumers were not satisfied with the quality of frozen and chilled products that they buy from the supply and value chain of the FMC. Mean values above M=3.4 were interpreted as indicating that respondents were satisfied with products they buy.

### 7.4.1. Shelf-life standards and Expiry dates

Food Shelf Life and Its Importance for Consumers (2023) conducted a survey indicating that shelf-life determination is an integral part of a manufacturer's food safety management system. As part of regular evaluation of these systems, the manufacturer confirms the shelf life. This is especially important when modifying products, production sites, or production equipment (Ntobaki et al., 2022). From the qualitative data, some consumers experienced problems that changed their buying patterns while 74% of consumers were happy with the shelf health standards of frozen and chilled foods in the stores.

Consumers often associate fresh and aesthetically pleasing food appearance with higher quality. If consumers perceive that chilled and frozen foods with minor imperfections are of lower quality, they might be less likely to purchase these items, thereby contributing to waste generation (Zhang et al., 2022). Consumers may prefer foods with excessive packaging, assuming it indicates higher quality or better preservation. This preference can lead to increased waste when unnecessary packaging is discarded. Accurate and transparent labelling is crucial. Customers want to know the accurate expiration dates, storage instructions, and any relevant nutritional information. Proper labelling helps customers make informed choices and avoid consuming expired or improperly stored products (DeLong & Grebitus, 2016). A wide variety of frozen and chilled food products, including different types of dairy, meat, and vegetables, contributes to customer satisfaction. If the retail outlet consistently stocks a diverse range of options, customers are more likely to find products that suit their preferences and dietary needs. The retail outlet's responsiveness to customer feedback and concerns also plays a role in customer satisfaction (Maziriri et al., 2021). If the outlet actively listens to customer opinions and takes actions to address any issues or concerns, it can enhance customer trust and satisfaction. Adherence to local and national food safety and quality regulations is imperative. Customers are likely to be more satisfied if they perceive the retail outlet as being compliant with relevant food safety standards (Kasza et al., 2022). As per the ideas of Karakas (2021), ensuring appropriate quality of the overall frozen foods and other food items is an essential requirement from the perspectives of the customers.

An article by P. F. Group (2022) indicated that frozen and chilled food are becoming more popular because of convenience. These foods take less time to prepare, significantly reduce waste, and always come with proper nutritional information. From the qualitative data, there are 72% of respondents that are happy with the frozen and chilled food purchase from the stores. One consumer response was “yeah - I prefer frozen over fresh cause it can be kept longer”, in line with the study conducted by P. F. Group (2022). This is seen in the retailer ranking in Figure 6.16, where most customers prefer the larger retailers since there is more variety of products. The larger retailers have more capacity in fridges and freezers to maintain more stock which is pleasing to the customer. It is also seen that the higher income earners prefer the larger to medium retailer more often, as seen in Table 6.9. Although there is awareness that fresh foods from the garden have greater nutrition, frozen meals still have nutrients - frozen facilitates life, which is a critical area (Ribeiro et al. 2022).

The freezing and chilling processes help preserve the freshness and quality of products, allowing consumers to keep items in their homes for longer periods without worrying about spoilage. Frozen and chilled foods allow consumers to enjoy seasonal products year-round (James & James, 2014). Fruits and vegetables, for instance, can be frozen at their peak ripeness and enjoyed out of season. Properly frozen and chilled products are less prone to bacterial growth and contamination, promoting food safety (Falatouri et al., 2022). As consumer demand for frozen and chilled foods continues to grow, it's essential for the industry to balance this demand with sustainable practices that minimize waste, energy consumption, and environmental impact. Educating consumers about responsible consumption, proper storage, and reducing food waste can further enhance the positive impacts of frozen and chilled foods on convenience and sustainability (Zamuz et al., 2021).

According to research by Maziriri et al. (2021), consumers have a positive outlook when they purchase products from a larger well-known retailer. From the qualitative data, only 64% of the consumers agreed that the retailer sold fresh, non-expired frozen and chilled foods. This can help in facilitating betterment for the customers and can enhance the overall domain of ease of use of these food products (Mladenov et al. 2022). The consumer survey conducted was based on an FMC business partners and managers feedback during the semi-formal interview. These questions were random consumer questions to gauge the perceptions of the consumers on frozen and chilled food waste. Retailer A, one of the largest retailers in South Africa, had consumers earning an average R10 000 per month or more. Fruits and vegetables were highlighted as being thrown away more often, which is in line with a study done by Gustavsson et al. (2012), where 17% of food waste involved fruits and vegetables in the distribution phase. Consumer buying behaviours are driven by product type, price, place, and promotion as seen in literature Table 2.5. As Millennials drive demand for frozen foods, one of the main reasons behind their preference is convenience. Consumers are also seen shop twice a month instead of daily. Selling fresh and non-expired frozen and chilled foods, especially dairy, meat, and vegetable products, is generally important for customer satisfaction, trust, and safety. It's in the best interest of a retail outlet to uphold these standards to maintain a positive reputation and ensure the well-being of its customers (Shoup, 2022). Selling expired foods can result in legal and regulatory issues, potentially leading to fines or other penalties. Thus, selling food products within their shelf life is essential for complying with food safety regulations. A retail outlet that adheres to these regulations demonstrates a commitment to quality and safety (Le Borgne et al., 2018).

### 7.4.2. Discounts

A study conducted by Buisman et al. (2019), indicated that it is important to note that not all discounted products are spoiled or of lower quality. Many products that are nearing their expiry dates are still perfectly safe to consume and retain good quality. Retailers usually follow guidelines and standards to determine the safety and quality of products before discounting those food products. Food manufacturers may also give away or sell certain products that are near to their expiry date, or have expired (Stephan, 2021). Some of these different foods can also be sold at a discount at surplus grocers, food rescue stores, or other inexpensive stores (Chen et al., 2020). Customers should exercise their judgment and consider factors such as the product's appearance, packaging integrity, and smell when purchasing discounted items. Additionally, being aware of the date of expiry and proper storage conditions at home is crucial to ensure the safety and enjoyment of the purchased products (Sung et al., 2023). This has to be done to try and avoid food waste, so these stores lower the prices to get it sold before we waste (Rogerson, 2021).

The qualitative data showed that 86% of respondents were in agreement that discounts in frozen and chilled food products are a result of them being spoilt or closer to the date of expiry. Discounts have been found to be a major area when it comes to food wastage, as it can lead to a higher wastage of food, as organisations attempt to clear their stocks at lower prices to mitigate any chance of loss that might be incurred (Buisman et al., 2019). Discounts on frozen and chilled food products, particularly dairy, meat, and vegetable products, can indeed be a result of them approaching their date of expiry or becoming less visually appealing due to spoilage (Buisman et al., 2019). These discounts are often offered by retailers to incentivize consumers to purchase these products before they become unsellable. Many discounted items are still perfectly edible and nutritious but might not meet the visual or shelf-life expectations of some consumers (Le Borgne et al., 2018). However, consumers should exercise caution and consider factors such as the product's appearance, smell, and overall condition before making a purchase. Consumers need to be educated and need to understand the difference between "use by," "sell by," and "best before" dates to make informed decisions about product freshness (Institute of Food Technologists (IFT), 2015). Once purchased, store discounted items according to recommended storage instructions to maintain their quality. And mainly if the product is close to its expiration date, plan to use it promptly to avoid food waste (Marshall, 2022).

Frozen and chilled food waste is often the result of conflicting goals such as convenience, taste, and money saving. Consumer food waste behaviour is determined by motivation (including attitudes, awareness, and social norms regarding food waste), opportunity (including time availability, access to technology, and the quality and quantity of food) and ability (skills and knowledge) the consumer decides to control or change behaviour related to food waste (Ntobaki et al., 2022). Phasha et al. (2020) attributed food waste in South Africa to a cultural aspect of South Africans buying food in bulk, and this was confirmed by one of the participants who stated that he would like to have more than enough food in his household. Young et al. (2017) found that leading retail brands have left the issue of food waste control to consumers because the government failed to engage in enabling a strong sustainable business strategy to reduce the impact of food waste. The results of this study were aligned to this observation, as the participants contributed to the fact that the retailers and the government should take responsibility for educating consumers about the impact of food waste, given the current insufficient information available (Qaddo, 2019).

The mean value was a low 2.5, with only 50% of consumers checking the expiring on the products purchased. By not checking the expiring date on chilled and frozen foods, it can result in contamination and waste food that requires disposal. Expiry dates provide crucial information about the recommended timeframe for consuming or using a product before it may become unsafe or lose its intended quality (Stephan, 2021). Retailers often discount products approaching their expiry dates. By checking these dates, consumers can make informed decisions about purchasing discounted items and using them promptly (Institute of Food Technologists (IFT), 2015). Consumers should plan their shopping and meal preparation based on expiry dates to ensure you consume products within their recommended timeframe. Disposing of products that have passed their expiry dates to prevent potential health risks (Hall-Phillips & Shah, 2017).

Research suggests that customers should always check the expiration date on the food and use the first in, first out (FIFO) method to store and rotate products. This applies to frozen, refrigerated, and dry storage items (Orbiteers, 2014). Consumers who trust the retail outlet and believe it consistently sells fresh products might be less likely to check expiry dates. In a busy shopping environment, consumers might not have the time to thoroughly inspect each product's expiry date (Stephan, 2021). Some cconsumers who are familiar with the shelf life of certain products and their typical consumption patterns might not feel the need to check expiry dates as frequently. If the packaging design effectively highlights expiry dates, consumers are more likely to notice them and take them into consideration (Nicosia et al., 2022). In cases of impulse purchases or quick shopping trips, consumers might overlook expiry dates. The extent to which consumers check expiry dates varies based on a complex interplay of these factors. Retail outlets play a role in encouraging awareness of food safety by providing clear and accurate labelling, maintaining consistent product quality, and educating consumers about the importance of checking expiry dates for their well-being (United Nations Environmental Program, 2022).

Consumers tend to over-shop during promotions due to the psychological effects of sales and discounts but aim to use up food before discarding food. In a general conversation with a customer in store, the researcher recorded the following response with regards to promotions, “The feeling of getting a good deal or saving money can be very enticing.” This can lead to consumers to buy more than they need (Le Borgne et al., 2018). Retailers take advantage of this by offering limited time promotions and creating a sense of urgency. This can lead consumers to make impulsive purchases without considering whether they actually need the item. Retailers often use tactics such as bundling products together or offering free gifts with purchase to encourage consumers to spend more than they originally intended (Thakker, 2018).

## 7.5. Critical analysis of the national policy and regulation framework on frozen and chilled food waste management in the food retail sector and make policy recommendations for sustainable food waste management in the supply and value chain.

### 7.5.1. The national food waste management policy framework is highly commended with opportunities for growth.

A study by Närvänen et al. (2020), indicated that the national food waste management policy framework is being commended for its effectiveness in regulating waste management, especially when it comes to frozen and chilled foods. A well-designed and well-implemented policy framework is essential for addressing food waste and its associated environmental, social, and economic impacts.

The qualitative data showed that 88% of respondents were in agreement that the national food waste management's policy framework is highly commended for its strengths. A policy marker within the FMC stated, "The policy has been around for a while and it has to have some strength to have brought us this far, it does not directly help with frozen food, but it does give us guidelines". An effective policy framework should have clear and comprehensive guidelines and regulations specifically tailored to frozen and chilled foods. These guidelines should cover aspects such as storage, transportation, handling, and disposal of these foods to minimize waste generation (Sheahan & Barrett, 2017). This is seen in the current policy which we follow. Although it is meant for food waste, we still apply the same principle to frozen and chilled food waste. Thus, these guidelines, even though indirect, they can benefit and facilitate an improvement in outcomes within this domain (Chauhan et al., 2021). Engaging various stakeholders, such as government agencies, food industry players, NGOs, and consumers, is essential for the success of any food waste management policy. Collaboration promotes knowledge sharing, innovation, and collective responsibility in tackling food waste challenges (Heng & House, 2022).

As noted in Table 6.11, there are four policies that the FMC follows and has an ISO 14001 certification in place. The policy is focused on food waste in general and not on frozen and chilled food waste. The FMC is part of the Food Loss and Waste Voluntary Agreement (VA), and a key benefit of using such an approach is that changes can be implemented more quickly and flexibly compared to command-and-control interventions (CGCSA, 2020). Efficient coordination within the supply chain is essential to minimize waste. Policies that promote collaboration and communication among producers, suppliers, distributors, retailers, and consumers can help reduce overstocking and ensure timely delivery of goods (Soosay, 2023). Educating consumers about the proper storage, handling, and use of frozen and chilled foods can significantly reduce waste. The policy framework should include public awareness campaigns that provide practical tips on minimizing waste at the consumer level (Ceanu, 2023). The policy framework might have provisions that specifically address the challenges posed by frozen and chilled food waste. This recognition of the unique nature of these products demonstrates a comprehensive and tailored approach to waste management (Fattibene et al., 2020). The policy might encourage collaboration between different stakeholders, including producers, retailers, consumers, and waste management facilities, to collectively address the challenges of frozen and chilled food waste.

Cooper (2021) stated that the framework might not offer sufficient incentives for businesses and individuals to actively participate in food waste reduction efforts. Incentives can play a crucial role in driving positive behaviour change. The framework might lack clear guidelines, definitions, and standards for managing frozen and chilled food waste. This ambiguity can lead to inconsistent interpretations and implementations across stakeholders (Närvänen et al., 2020). From the qualitative data findings, 74% of respondents agreed that the national food waste management policy has weaknesses and flaws. The policy should outline proper storage and handling protocols for frozen and chilled foods to prevent spoilage, preserve quality, and extend shelf life. This could include temperature requirements, packaging guidelines, and best practices for retailers, distributors, and consumers (Goossens et al., 2019). Also, a strong policy framework should emphasize the maintenance of the cold chain, which ensures that frozen and chilled foods are consistently stored and transported at the right temperatures (Chauhan et al., 2021). This prevents spoilage and extends the shelf life of these foods. Currently, the waste management plan within the FMC is only reviewed once a year.

The policy lacks specific guidelines and regulations tailored to the unique challenges posed by frozen and chilled food waste. This can result in ineffective waste management strategies for these products. The lack of coordination and collaboration among stakeholders, including producers, retailers, and waste management facilities, can hinder effective waste reduction efforts (Oelofse, et al., 2021). The condemnation of the National Food Waste Management Policy framework for its weaknesses in regulating frozen and chilled food waste management suggests that there are significant shortcomings that need to be addressed. These weaknesses may hinder efforts to reduce waste, ensure food safety, and promote sustainability in the context of perishable products (Ariyani & Ririh, 2020). Addressing these flaws would likely require policy revisions, increased collaboration, better resource allocation, and a more comprehensive approach to waste management. There are programs in place to inform staff about waste management strategies, but this is limited to staff in the SHEQ. As part of the ISO 14001 continual improvement process, there should be continuous improvement programs in place (Hudson et al., 2019). The policy framework should be adaptable to changes in technology, consumption patterns, and market dynamics. Flexibility allows the policy to remain relevant and effective over time (Fattibene et al., 2020).

In South Africa, the issue of food waste is addressed within the broader context of waste management and environmental sustainability. Some key aspects of the policy and governance framework include the National Environmental Management: Waste Act (2008). It emphasizes waste minimization, separation of waste at source, and the establishment of waste management plans. The DEFF is responsible for environmental matters in South Africa, including waste management. They oversee the implementation of policies and regulations related to waste management and may play a role in addressing food waste (United Nations Environmental Program, 2022). While there might not be a specific policy focused solely on food waste, South Africa has taken steps to address the issue. This could involve partnerships with NGOs, businesses, and international organizations to promote awareness, education, and sustainable practices.

Also, in reference to part of the findings (iii) the national food waste management policy framework has great opportunities for growth in the efficient regulation of waste management especially frozen and chilled foods (M=4.3), Cooper (2021) stated that the National Food Waste Management Policy framework has great opportunities by fostering stronger collaboration among government agencies, industry stakeholders, non-governmental organizations, and communities. By working together, a more comprehensive approach to waste management can be achieved (Cooper, 2021). From the qualitative data, 86% of respondents agreed that there were growth opportunities within the policy framework, particularly in efficiency because it addresses the root causes of food waste and encourages collaboration between stakeholders. However, people need to understand and know this policy and there is a need to embrace and promote technological advancements in cold chain management, food preservation, and waste reduction. Improved sensors, monitoring systems, and data analytics can help optimize temperature control, reduce spoilage, and minimize waste. Developments include introducing incentives for businesses that implement innovative waste reduction strategies, such as donating excess food, adopting circular economy practices, or investing in energy-efficient cold storage solutions (Nutrition, 2020).

Specific guidelines are part of opportunities for growth of the policy framework as these could address the unique challenges posed by frozen and chilled food waste. This targeted approach can lead to more effective waste management strategies for chilled and frozen food products (Cattaneo et al., 2021). Promoting greater coordination and collaboration among stakeholders, including producers, retailers, and waste management facilities, can result in more successful waste reduction efforts. The opportunities for growth in the national food waste management policy framework suggest that with strategic enhancements and improvements, the policy can become a powerful tool in addressing the challenges of waste management for frozen and chilled foods (Närvänen et al., 2019). By capitalizing on these opportunities, the policy can contribute to reducing waste, promoting food safety, and fostering a more sustainable approach to managing perishable products (Sharma & Joshi, 2019).

By having consistent data, policymakers can identify trends, assess the effectiveness of interventions, and make informed decisions. As a result, decisions can be made to encourage entrepreneurs to invest in research and infrastructure and develop businesses that focus on repurposing surplus frozen and chilled foods, such as creating value-added products or bioenergy through anaerobic digestion (Avicenna et al., 2015). This approach not only reduces waste but also contributes to renewable energy production. In addition, behavioural scientists may better understand consumer behaviours and attitudes towards food waste and develop tailored interventions based on psychological insights that can lead to more effective communication and behaviour change (Le Borgne et al., 2018). By seizing these growth opportunities, the National Food Waste Management Policy framework can evolve into a more dynamic and effective tool for regulating waste management, especially for frozen and chilled foods.

#### 7.5.2. The national food waste management policy framework is highly condemned with potential threats

A study done by Wikurendra et al. (2022) who stated that food waste is a major challenge that threatens our food system as well as our natural and economic resources. This is especially true for food that is wasted in the consumption stages of the food supply chain due to the resources used to produce the final product. There is a great opportunity to prevent and manage food waste throughout the food supply chain, but especially in FSC's consumption phase through behaviour change, education, and awareness. From the qualitative data, only 72% of respondents agreed to the potential threats to the national food waste management policy. As there is insufficient political commitment to prioritize food waste reduction, the policy framework might not receive adequate resources, support, or enforcement mechanisms (Wikurendra et al., 2022). This can lead to weak implementation and limit its impact. Insufficient budget allocation can impede the implementation of waste reduction initiatives, such as public awareness campaigns, research, infrastructure development, and monitoring systems indirectly leading to an increase in frozen and chilled food waste (Food Forward SA, 2023).

Sometimes different jurisdictions or agencies have conflicting regulations or policies related to food waste management, and this can create confusion, inefficiencies, and hinder cross-sector collaboration. Industries involved in the production, distribution, and sale of frozen and chilled foods might resist changes that increase costs or disrupt established practices, potentially slowing down policy implementation (Ramukhwatho et al., 2016). Failure to involve key stakeholders, such as food producers, retailers, and consumers, in the policy development process can lead to unrealistic regulations and lack of buy-in, hampering effective implementation. Without accurate and consistent data on food waste generation, it becomes challenging to measure progress, identify trends, and evaluate the impact of interventions. Limited access to or adoption of technology for cold chain management, data tracking, and waste reduction can hinder the implementation of modern, efficient solutions (GCCA, 2022). If policy measures prioritize short-term economic gains over long-term sustainability, waste reduction efforts might take a backseat to immediate business interests. Shifts in consumer preferences toward convenience foods or products with shorter shelf lives can challenge waste reduction efforts. Bureaucratic complexities, slow decision-making processes, and resistance to change within government agencies can delay policy development and implementation. Economic downturns, supply chain disruptions, or natural disasters can impact food distribution and waste management, potentially leading to increased waste (Aragie et al., 2018).

To mitigate these threats, it's essential to conduct comprehensive stakeholder engagement, build robust data collection systems, ensure cross-sector collaboration, and prioritize education and communication. Addressing potential threats head-on will help create a more resilient and adaptable food waste management policy framework that can navigate challenges and deliver sustainable results. There have implications when policymakers and government officials do not prioritize food waste reduction, the policy framework might not receive the necessary support, resources, and attention for effective implementation (Wikurendra et al., 2022). Opposition or reluctance from stakeholders, such as businesses, producers, and retailers, can impede the adoption of waste reduction practices outlined in the policy. If consumers, businesses, and other stakeholders are unaware of the importance of food waste reduction and the policy's objectives, it might be challenging to gain their cooperation (Nwangwu, 2016). Addressing these threats requires proactive measures such as building broad awareness and support for food waste reduction through education campaigns, ensuring proper allocation of resources and funding and establishing strong enforcement mechanisms and penalties for non-compliance (United Nations

Environmental Program, 2022). According to the theoretical framework of this study, the stakeholders associated with food wastage are the food producer, consumers, suppliers, the environment and profit (Bautista, 2020). A large number of South Africans are suffering from hunger and inadequate nutrition, and excess food is being thrown away. Equal distribution of foods is required to meet the demand for food by all people without wasting foods (Helmold, 2022). Producers can consider catering the excessively produced foods to marginalised and poor people before those foods reach their expiry dates (Stephan, 2021). It will be a philanthropic approach for them and improve their ESG performance. Sustainable food production is required to avoid food wastage (Zamuz et al., 2021).

### 7.5.3. The national food waste management policy framework compares better to other regional under-developed and developed countries.

A study by Fattibene et al. (2020), indicated that open-air dumping and open burning are the final disposal and waste treatment systems practiced mainly in low-income countries. The main impacts are due to poor waste management in developing countries, focusing on environmental pollution and social issues. The performance of the informal sector in developing cities is also examined, with an emphasis on the main health risks from waste collection. The qualitative data findings show that 74% respondents agreed that developed countries have a better food waste management policy framework. Developed countries framework includes measures to prevent food waste at all stages of the supply chain, including production, distribution, and consumption (Hodges et al., 2011). This approach is more holistic than many other policies that only focus on one stage of the supply chain.

There is a long way to go before we get to the level of developed countries particularly regarding the amount of corruption we have in South Africa. Developed countries generally have better infrastructure for cold chain management, waste collection, and disposal. This infrastructure can support more efficient regulation of waste management for frozen and chilled foods (van der Werf & Gilliland, 2017).

Developed countries often have greater access to advanced technologies, which can enhance monitoring, tracking, and waste reduction efforts along the supply chain while underdeveloped countries lack the necessary infrastructure for efficient cold chain management and waste disposal, making waste management more challenging (Hodges et al., 2011). Financial limitations restrict investments in waste reduction technologies and initiatives with our country. Higher levels of education and awareness in developed countries can lead to better consumer understanding of food waste issues and more responsible food consumption practices (Mak et al., 2020). Developed countries may have the resources to enforce regulations effectively and invest in comprehensive waste reduction programs. Cultural norms and practices can influence food consumption habits, potentially leading to different levels of food waste generation in underdeveloped countries (Monterrosa et al., 2020). Underdeveloped countries might be more focused on addressing immediate issues such as food security and basic infrastructure, which could impact the prioritization of food waste reduction. Efforts are made to raise public awareness about food waste and encourage responsible consumption. Educational campaigns and initiatives aim to inform consumers about the impacts of food waste on the environment and society (Casonato et al., 2023).

The policy adopts a holistic and comprehensive approach to food waste management, covering various stages of the supply chain from production to consumption in developed countries. Adequate resourcing, including funding and personnel dedicated to the implementation and enforcement of the policy, may not be found in developing countries (Oelofse, 2019). The policy incentivizes responsible waste management practices and imposes penalties for non-compliance in developing countries compared to underdeveloped countries (DEFF, 2021). The country's policy framework might compare favourably to others, but it is important to continually assess its effectiveness, adapt to new challenges, and share best practices with other countries to foster global food waste reduction efforts (Abubakar et al., 2022). A collaborative and international approach can lead to more comprehensive and impactful solutions.

The above discussions that have been presented have clearly indicated certain aspects associated with food waste management in South Africa. Especially, in the case of the KZN region of the country, the results of the survey indicated that there are multiple drivers that lead to the overall generation of food waste. The levels of food waste generation have increased due to these drivers that have been identified and discussed above. In this regard, an understanding of the basic principles of the Triple Bottom Line Theory indicated the fact that these drivers significantly impacted all the three domains of sustainability (de Bruin et al., 2021). The three domains of sustainability, as per the theory, include people, profit and planet. These represent the social, economic and environmental aspects, respectively and can have severe implications as well (Purvis et al., 2018). Overall, an understanding of the above analysis that has been presented has clearly indicated the fact that food waste generation is being noted, especially, in the case of frozen and packaged food. This can be seen to be an extremely detrimental area to the overall sustainability aspects of the business (Ngulube, 2015). All the three areas of sustainability are largely impacted due to the same and this can be seen as a long-term impact of the overall issue. Nevertheless, the need to come up with appropriate strategies in this direction has also been indicated.

Along with this, there is a clear understanding of the fact that the social and economic impacts associated with the overall domain of food waste generation is high. Higher food insecurity is being noted and there is a growing chance of inflation due to this. High wastage of food means that there is a greater chance of unavailability of these products (Harduth et al., 2017). Moreover, it has been noted that the country at present is seeing immense problems associated with the domain of food waste management. This is largely due to the consumer buying behaviour that can be associated with the country (Ahmed et al., 2021). There are massive irregularities and fluctuations in the consumers purchasing pattern, which makes appropriate estimation of the required supplies difficult (Lee, 2018). This results in an imbalance between demand and supply, which creates the higher chances of food waste generation. Theoretically, it can be said that due to the implications of inappropriate equilibrium in demand and supply, the economic and social hazards are increasing. There is a growing chance of food, insecurity and malnutrition among the population of the region (Erokhin et al., 2023). Besides, owing to the fact that the higher the levels of food wastage, the greater is greenhouse gas emissions, it can be easily stated that the environment aspect is also being compromised. Planet plays a central role in the generation of appropriate levels of sustainability associated with any region (Writer, 2022). Without an appropriate strategy in this direction, there cannot be appropriate enhancement in the overall domain of sustainability. Nevertheless, it has been identified that due to the lack of appropriate cooling and storage facilities and mishandling of food products, the wastage associated with frozen and packaged food is increasing drastically in the region (Marshall, 2022). The KZN has a higher rate of food wastage due to these issues. Therefore, the environmental impacts associated with the same are also high. The Triple Bottom Line Theory of sustainability clearly describes the need to conserve the planet and ensure greater environmental footprint. However, owing to the higher levels of waste that is facilitated due to unnecessary wastage, and mismanagement and the lack of infrastructure, it is becoming increasingly difficult to ensure greater levels of sustainability, which is a clear requirement here. All these areas can have significant implications on the economic and social growth of the region as well.

Social inequality due to unavailability of the requisite amount of food is an area that must be considered as well. In the ideas of Writer (2022), the prevailing issues of overall purchasing of food and the lack of appropriate estimation of demand scenarios can be increasingly difficult to manage. This leads to the inequalities in the purchasing of frozen and packaged food in the region (Alamri et al., 2021). Therefore, availability of food products is also being hampered, and the rate of inflation associated with this is rising. In such scenarios, the issues that are being faced by the economically backward sections of the society are high. There is a growing consensus that over-utilisation of food resources and unnecessary purchasing is also leading to a higher amount of food wastage. This is leading to the social inequalities that are being spoken about here. With limited access to food, there is a greater chance of higher amounts of malnutrition. Besides, unequal division of food resources is also not possible, which is leading to significant problems. Overall, it can be stated that the problems being generated due to the wastage of food is largely impacting the sustainable footprint, encompassing social, economic and environmental concerns. Developed countries have established comprehensive frameworks that encompass various measures to combat food waste throughout the entire supply chain, encompassing production, distribution, and consumption. This approach is more comprehensive compared to numerous other policies that solely concentrate on a single stage of the supply chain (Karakas, 2021). Developed countries frequently possess more sophisticated waste management systems and policies, which include specific regulations aimed at addressing the issue of food waste (Ribeiro et al., 2022).

A proper understanding of all the theoretical areas have clearly indicated massive discrepancies in the existing systems of the country and the region. Even though the country has come up with a national level policy, there are clear gaps that tend to address the social, economic and environmental problems of food wastage. There have been significant developments in the area of food waste management, but it is also to be noted that these developments are not as swift as required (Yoobic, 2021). Further, there is a high possibility of improper implementation of the same, which can altogether lead to even further crucial issues. Nevertheless, there is a need to understand that food waste management is largely dependent on the principles of sustainability and the importance of the Triple Bottom Line Theory here is largely noted. The use of the same can help in understanding the essence of strategies that can ensure improvement across all the three domains (Bahraini, 2021). Besides, the needs of such strategies are also largely indicated by the theoretical framework. Overall, the use of the theory in this study has allowed a better understanding of the problems and the solutions to the problems as a whole.

## 7.6. Chapter Summary

This chapter has merged the findings from qualitative interviews and a quantitative online survey. The results indicated frozen and chilled food waste is a growing issue within KwaZulu-Natal that needs to be addressed urgently. The drivers behind this wastage are numerous, but the most prominent ones include poor storage facilities, lack of proper transportation, and inadequate inventory management. Consumer perceptions of frozen food waste play a significant role in their buying habits. While some consumers view frozen foods as wasteful, others see them as convenient and cost-effective. Ultimately, it's up to individual preferences when deciding between fresh or frozen foods based on their perceived value and benefits. To reduce frozen food waste, both high and low LSM consumers can benefit from buying only what they need and using it before it goes bad. Efforts are made to raise public awareness about food waste and encourage responsible consumption. Educational campaigns and initiatives aim to inform consumers about the impacts of food waste on the environment and society. The next chapter presents the conclusions, research contributions and recommendations regarding these research findings.

# CHAPTER 8: CONCLUSIONS AND RECOMMENDATIONS

## 8.1. Introduction

Chapter 7 discussed the convergence of the findings presented in Chapter 4, 5 and 6. This study has evaluated frozen and chilled food waste within the pre-retailing stages in a food manufacturing company in KwaZulu-Natal. The conclusions drawn from this study and recommendations that now follow are based on the outcomes of the results presented in Chapters 4, 5 and 6. The focus of the results chapter was the articulation of how the research problem, together with the primary and secondary objectives of the study were addressed. Chapter 7 draws discussions based on the findings and recommendations which are made for improving the body of knowledge, together with methodological and practical recommendations. The chapter then concludes with the limitations of the study and recommendations for future research.

## 8.2. Summary of Key Findings

The study aimed to investigate the food waste generation, driving factors and the impacts (environmental and economic) of frozen and chilled dairy, meat, and vegetable product wastes from the pre-retail supply chain for a major retail food supplier and producer in South Africa. The key findings for each of the four objectives that the study set out to accomplish in Chapter 1 are listed below.

8.2.1. Investigate the drivers and reasons for food waste generation from frozen and chilled food products in the distribution phase of the FSC by categorising and quantifying retail food waste from major retail companies in KwaZulu-Natal.

Data records from the last five financial years were analysed. Products were split between three food categories and 11 sub-categories. Retailer names were masked for ethical reasons. Total stores vs retailer food waste categories were mapped to determine which categories and sub-categories were driving food waste by retailer. The meat category makes up 57.88% of food waste in the retail stores with chicken contributing to 84% of food waste while the dairy category makes up 31.27% of the food waste in the retail sector with butter contributing 57.63% (451 tons) of food waste. The vegetable category makes up 10.85% of food waste with vegetables contributing 71.27% (193.56 tons) to food waste. A Microsoft Power BI model (Appendix J) was developed by the researcher to allow the FMC to identify the stores that were contributing to ongoing food waste over the last five years. This allowed management to start removing products that did not sell in-store before the expiring dates and place them in stores that had a higher potential to sell the product.

Frozen and chilled products wastage is a significant issue that needs to be addressed urgently. The drivers behind this wastage are numerous, but the most prominent ones include poor storage facilities, lack of proper transportation, and inadequate inventory management. During the semi-structured interview, it was determined that the FMC follows an 8-shelf health elements structure to ensure that correct practices are maintained. These elements are audited by trade agents randomly instore to determine the compliance of products within the stores. Another PBI model (Appendix K) was set up to analyse the results of this audit whereby it was determined that date labelling, food safety standards, and stock handling are the main drivers for food waste among retailers. There were five main reasons why products were returned from stores with stores damages and packaging defects being the main reason – these are directly related to stock handling. Date labelling plays a part in products being returned due to the misunderstanding of the date presented (Best Before, Sell-By Date and Expiry Date). Expired products were seen as a problem since too much stock was ordered and remained on the shelves for long periods, or that stock that was up for expiry in 60 days was delivered to stores. Managers indicated that promotions also play a major role in this process as stores do not have measures in place to determine which product is in demand and which products, and their stocks, do not sell.

Promotions might result in increased food waste in the period right after their promotion. Promotions, according to Panda and Mohanty (2011), have a cascading impact on the time spent not receiving a promotion. Due to the price advantage, customers buy more than is necessary for the promotion, which lowers demand for the product outside of the promotion. The assumption made by supply chain management is that after the promotion, demand for the products will return to normal levels. However, when this doesn't happen, food waste may result. According to seasonal demand, there are patterns where consumer demand rises, typically at the end of the month, during the holiday season, and around Christmas.

Promotions and seasonal demand are closely related. This is due to the fact that the majority (89%) of promotions take place when demand is at its peak, such as at month's end and during holidays. Demand according to the season does not affect food waste as much as promotions do. Seasonal demand fluctuations correlate with an increase in food waste, proving that both shortages and increases in food waste are caused by changes in demand. The impact of food waste and performance metrics need to be re-evaluated in supply chain management. Jensen et al. (2013) call for further research on supply chain innovation to foster collaboration among chain stakeholders to reduce inefficiencies and waste to create value for the whole. According to the study's findings, managing food waste drivers could have both positive and negative effects on food waste. If managers are unable to manage the causes of food waste in the direction of a more effective supply chain, unrealistic performance metrics and targets are useless. To ensure long-term sustainability and competitiveness, supply chain management must play a crucial role in managing food waste (Jensen et al., 2013).

Other drivers highlighted where poor storage facilities are a major contributor to frozen and chilled products wastage. Many retailers do not have adequate refrigeration systems to store these products at the required temperature. This results in spoilage of the products, leading to significant financial losses. The lack of proper transportation also contributes significantly to frozen and chilled products wastage. Products that require specific temperatures during transportation may not be adequately catered for during transit resulting in spoilage. Lastly, inadequate inventory management is another driver behind frozen and chilled products wastage. Retailers often overstock or understock their stores leading to either excess or insufficient supply of these products resulting in waste.

In this study, a power BI analysis returns model was created that can be used by sales managers to better manage the extent of food waste by focusing on the efficiency of specific food waste factors. The findings of this study demonstrate that managing special offers, missed days, and supply shortages can predict a 26.4% decrease in food waste with a 95% accuracy. Sales managers can forecast the net effect of improving promotions' efficiency, stock-outs, and supplier shortages on food waste using the Power BI analysis model.

In conclusion, addressing these drivers behind frozen and chilled product wastage is essential for reducing food waste and ensuring profitability for businesses. It is crucial for retailers to invest in proper storage facilities, transport systems, and inventory management practices to significantly reduce waste levels.

8.2.2. Investigate the economic and environmental impacts of food waste from the retail supply chain on the supplier and producer of frozen and chilled food products.

Economic and environmental impacts were calculated based on the returns received over the last five financial years. Landfill food waste data were also used for 36 months. The total tonnage waste was converted into $CO_2$ and $CH_4$ to determine the estimated environmental impact from EPA while the economic impacts were calculated from the estimated cost per ton of R5 922. In line with the amounts of food wasted in sub-categories butter and chicken, the amounts of $CO_2$ and $CH_4$ produced are high, and pushing up the cost as well. Landfill data were based on tonnage only and no category splits. All food waste shipped off to the landfill is not separated from general waste. During the pandemic (June 2020 – September 2021), an average of 51.05 tons per month, of food waste was disposed of at the landfill while after the uplifting of the state of disaster (October 2021 – December 2022), the average food waste sent to the landfill dropped to 22.32 tons per month. A radical action plan to better manage food waste is necessary given the amount of food waste lost in the supply chain, which has significant financial and commercial ramifications for the supply chain. The amount of wasted food in the supply chain is in agreement with Gustavsson et al. (2011), who calls for immediate action to increase public awareness of the issue of food waste in order to fight hunger and enhance global food security.

In addition to this, the issue of food wastage poses a significant threat to the environment. According to Writer (2022), the disposal of frozen and chilled food waste has a profound impact on the environment, resulting in substantial pollution in the form of land, air, and water contamination. Consequently, the health and well-being of the local population can be adversely affected. Pollution plays a crucial role in the development of various diseases, making it imperative to minimize its occurrence. However, due to the extensive generation of food waste, pollution levels associated with any business are significantly amplified, leading to wider gaps in human health and safety.

Furthermore, the carbon footprint resulting from food waste generation is alarmingly high. The more frozen and chilled food waste is produced, the greater the release of carbon into the atmosphere. This contributes significantly to the greenhouse effect and can ultimately lead to global warming. Additionally, the emission of greenhouse gases is closely intertwined with the issue of food waste generation. Consequently, a comprehensive understanding of the overall impact of food waste generation reveals significant social, environmental, and economic consequences. Therefore, in accordance with the triple bottom line theory, it is evident that food waste generation has profound implications for the overall sustainability of the region.

8.2.3. Investigate consumer perceptions of food waste and their buying habits.

A survey was conducted electronically within the sample stores and the results indicated that consumers are aware of food waste but not from a retail standpoint. Consumer buying habits have changed after the COVID-19 pandemic, where consumers will shop once or twice a month and bulk buy goods to avoid going back to stores. A total of 27% of the survey was conducted in the higher income brackets in the largest retailer situated in malls in much-developed areas. Consumer buying behaviours are driven by product type, price, place, and promotion. With the current state of the economy, consumers are looking for saving and will switch between brands just to save a few rands.

The factors that lead to consumers wasting food are complex. Food waste is often the result of conflicting goals such as convenience, taste, and money-saving. Throwing away food bothers consumers as they try to buy the food they require. The adoption of more efficient methods for minimizing food waste by retailer managers is being hampered by a lack of consumer awareness, limited control over suppliers, imperfect regulations, and strict company policies. Consumers must be made aware of the environmental impact of their food choices, food donations at the store level must be encouraged through more active involvement with neighbourhood charities and improved technology, and on-site retailer managers must be given more flexibility and negotiating power.

Frozen food waste is a significant issue that has been affecting consumers' buying habits. The perception of frozen food waste varies among consumers, and it affects their purchasing decisions. Some consumers believe that frozen food is wasteful because it has a shorter shelf life than fresh produce, while others think that frozen food is convenient and reduces waste by allowing them to only use what they need.
On the other hand, consumer buying habits are also influenced by the perception of frozen food waste. Some consumers prefer to buy fresh produce because they believe it is healthier and more environmentally friendly. Others opt for frozen foods because they are cheaper and have a longer shelf life.

The attitude of customers and the purchasing behaviour associated with the customers of chilled and frozen food is another critical aspect that can impact the levels of waste. In the opinions of Zanoni & Zavanella (2012), the purchasing patterns associated with any customer is one of the key areas that can impact the overall levels of wastage. The waste of food products in the case of any organisation is largely dependent on the purchasing that is being generated. If the products are not purchased, as per the supplies available, it can lead to wastage. On the other hand, if there is unnecessary purchasing of any food product, it can also lead to severe wastage. Therefore, these are the critical aspects that can have significant implications on the overall purchasing behaviour of the business. The wastage of food products, essentially, frozen and packaged food is dependent on the overall purchasing behaviour of the customers. It has been identified that unnecessary purchasing by the customers also leads to greater food wastage. This is another area that triggers a higher amount of food insecurity in the region (Yaddanapudi & Yaddanapudi, 2019). Due to unnecessary purchasing, the food products are not being made available to the actually needy people. These people are other ones who are in need of such food products and can help in minimising the levels of food wastage. However, owing to the inappropriate purchasing behaviour of customers, it can be seen to be one of the most important issues that is being faced by businesses in the sector.

The levels of food waste that is being generated in the case of such businesses is high due to the fact that there is a greater amount of unnecessary purchasing. This can be attributed to the discounts and the other offers that are being given to the customers by the businesses (Writer, 2022). It has been identified in the survey that the customers are more excited to buy products that are being provided at a discounted price. Owing to such discounts, the customers tend to buy a greater quantity of these products than they require. This is being done to ensure that a discounted price is being charged in cases where the costs can be significantly higher. Therefore, in such scenarios, it has been identified that the purchasing behaviour of the customers lead to the wastage of food products. Besides, another major area is the shelf life of frozen and packaged food materials. It has been noted that customers tend to ignore food products that have reached their shelf life. This can also lead to edit wastage of food materials. These materials are easily consumable and are safe for the health of the individuals as well. Nevertheless, owing to the prejudices and customer buying behaviour associated with these individuals, it leads to a wastage of such food products (Wilkie, Graunke & Cornejo, 2015). Therefore, it can be concluded that the level of food waste generation is largely dependent on the area of customer buying behaviour. Any minor change in the purchasing behaviour of the customers can largely impact the levels of food waste generation.

In conclusion, consumer perceptions of frozen food waste play a significant role in their buying habits. While some consumers view frozen foods as wasteful, others see them as convenient and cost-effective. Ultimately, it is up to individual preferences when deciding between fresh or frozen foods based on their perceived value and benefits. To reduce frozen food waste, both high and low LSM consumers can benefit from buying only what they need and using it before it goes bad. Meal planning can also help reduce waste by ensuring that all ingredients are used efficiently. Overall, reducing frozen food waste requires a change in consumer behaviour regardless of their LSM status.

8.2.4. To critique the current policy and governance of food waste in the retail food supply chain and make recommendations for sustainable food waste management in the distribution phase of the FSC.

The current policy and governance of food waste in the retail food supply chain is a complex issue that requires immediate attention. While there have been efforts to reduce food waste, such as the introduction of expiration dates and donation programs, more needs to be done. One major issue is the lack of standardization in expiration dates, which can lead to confusion among consumers and result in perfectly good food being thrown away. Additionally, many retailers prioritize aesthetics over quality, leading to perfectly edible but imperfect produce being discarded.

The FMC currently is part of the voluntary agreement and only follows the National environmental management: waste act 59 OF 2008 which is known by the retailers and management. According to the director of sustainability, they conduct Environmental Impact Assessments (EIAs) when the Department of Agriculture, Land Reform and Rural Development (DALRRD) and the Department of Forestry, Fisheries, and the Environment (DFFE) require them. These give the FMC the opportunity to carefully consider the effects of the proposed investments on the local environment by taking into account the opinions and input of interested parties and those who will be directly impacted. Another barrier to implementing good food waste management practices at the store level has been identified as company policies. Bulk purchases, the inability to control the volume and frequency of supplier deliveries, and the requirement to strictly adhere to internal health, safety, and quality control standards were all mentioned. Managers asked for greater flexibility on-site while acknowledging the need to adhere to company policies. The possibility of standard storage temperatures for perishable foods should still be investigated, it is advised. Consumption labelling relates to food safety and should only be applied to perishable foods when the storage time, even under prescribed conditions, can result in an immediate health risk. Otherwise, edible, and safe food may be thrown away, resulting in unnecessary food waste. There are also challenges related to infrastructure and technology. Some countries have successfully implemented similar policies by providing incentives for businesses to reduce their food waste, but do not really have the motivation to reduce food waste (Farounbi & Ngqwala, 2020).

Furthermore, there is a need for increased transparency and accountability within the supply chain. Retailers should be required to report their levels of food waste and take steps to reduce it. Governments can also play a role by implementing policies that incentivize retailers to reduce waste. Overall, while progress has been made in reducing food waste in the retail food supply chain, there is still much work to be done. It is crucial that all stakeholders work together towards a more sustainable future for our planet and its resources. The framework has great opportunities for growth in efficiency because it addresses the root causes of food waste and encourages collaboration between stakeholders, but people need to understand and know this policy (Matei et al, 2021).

Developing adequate national level policies that can be helpful in regulating waste generation is essential. The aspect of waste management is directly linked with the overall sustainable footprint associated with any country. On the international level, it is essential for all countries to develop with robust strategies that can help them to meet the UN sustainable development goals that have been set (Writer, 2022). In this regard, South Africa is also in need of better strategies and policies. At the executive level, the use of the correct policies at the national level can be beneficial and can help in ensuring better outcomes. Other than this, there is a need to understand that without the correct implementation of such policies, there is a higher risk of unwanted scenarios that might impact the overall sustainability levels associated with the country.

The national policy that is being considered here has been developed and a set framework of regulations has been created for frozen and chilled food waste management. The results of the survey that has been conducted here has clearly indicated that the existing framework is not totally perfect but is commendable. Nevertheless, there is a scope of enhancement throughout this framework, and this can be further developed to ensure the best possible results in this direction (Yasanur Kayikci et al. 2022). The use of an appropriate national policy can be seen as a critical aspect that can help in determining greater levels of success. Overall, without the appropriate implementation of such national level policies, it can be difficult to attend the levels of waste management that is required.

However, it has been clearly identified that the national food waste management policy framework that has been generated in South Africa is better than many other underdeveloped and developed countries in the region. This is one of the most positive areas that can be associated with the country as a whole. The country is showing major concern in this domain and therefore, it can be extremely beneficial for the country (Zanoni & Zavanella, 2012). The economic and social impacts of food waste generation can be largely curtailed by making use of this framework. Besides, it can minimise the environmental footprint associated with food waste generation in the long run. All these areas together can be of extreme significance and can impact the performance associated with the country and the region. With the proper implementation of food waste policies, KZN stands to gain significant benefits, potentially aiding in the eradication of food insecurity in the region. Therefore, the national policy for food waste management is one of the instrumental areas that can help in ensuring betterment in this direction. Further, with appropriate implementation of the said framework, it can be beneficial for the overall communities in the region (Yoobic, 2021). Nevertheless, there is a scope for enhancement in this framework as prevailing gaps have been clearly identified. These gaps must be mitigated with appropriate strategies to ensure the best possible outcomes in the long run.

## 8.3. Theoretical contribution

In this study, the Triple Bottom Line (TBL) Theory was used as a theoretical framework. This theory suggests that economic activities must create value for environment and people. This framework is aligned with the discussion and findings of the study. This study extensively researches the causes and impacts of food wastage in KZN, South Africa. The Triple Bottom Line theory helps in understanding the relationship between economic activities and the well-being of the environment. The theoretical contribution of this study is that it integrates Triple Bottom Line theory to its rationale, literature review, findings, and conclusion. Theoretically, by exploring these dimensions and putting forth creative solutions, this can help apply the Triple Bottom Line Theory to the frozen food market, eventually leading to a more sustainable and ethical sector. The paper's theoretical contribution is that it examines the relationship between food waste and the environment within the broad theoretical framework of the Triple Bottom Line.

The Triple Bottom Line theory is used in this study as a theoretical framework because it is widely used in the research topic related to sustainability issues and sustainable development goals. The Triple Bottom Line theory demonstrates the value creation for people, planet, and profit. Food waste and food loss in South Africa has become a global sustainability issue and hinders the accomplishment of sustainable development goals. In addition, due to the massive amount of food waste, people are deprived of adequate food and nutrition in several provinces across South Africa. However, this theory is criticised for having several limitations.

This theory does not include any specific guidelines. It is a vague model that is pursued by companies. Not all companies associated with food production in KZN follow the triple bottom line. Some of the companies claim that the Triple Bottom Line Theory is not required to change their behaviour. It is also possible that businesses can easily brag about the triple bottom line approach without doing anything. They lack the ideas where to start, where to invest, and how to invest. On the other hand, this theory encourages status-quo capitalism. While the TBL theory may have its limitations and criticisms, its deployment as a theoretical framework for a thesis can be justified based on its broad perspective, alignment with research objectives, practical relevance, conceptual framework, potential for comparative analysis, and interdisciplinary approach. Ultimately, the decision to use the TBL theory should be based on its suitability for addressing the specific research questions, objectives, and context of the thesis.

The Triple Bottom Line Theory emphasizes the importance of measuring performance in each dimension. However, determining accurate metrics for the social and environmental impact of frozen food waste can be challenging. It may be difficult to establish precise and generally applicable measures for social and environmental aspects. The TBL theory does not explicitly define the scope and boundaries of each dimension. In the context of frozen food waste, this lack of clarity might make it difficult to determine which social and environmental factors are directly relevant and should be included in the analysis. The TBL framework may not adequately address cultural and contextual differences in perceptions of sustainability. What is considered socially and environmentally responsible in one region may not be applicable in another, and this can create challenges when applying a universal framework to a diverse industry such as frozen foods. Also, with the rapid changes in technology, consumer behaviour, and regulatory environments could impact the relevance of the TBL framework over time.

Developing countries such as South Africa, often face significant resource constraints, both in terms of financial resources and technological capabilities. Simultaneously prioritizing economic, social, and environmental goals, as suggested by the TBL, may be impractical if basic economic needs are not adequately met. In areas where poverty and social inequality are prevalent, social factors like community development and social justice may be prioritized over environmental concerns. South Africa is frequently distinguished by its diverse cultures, socio-economic environments, and legal systems. Applying a general framework like the TBL might not fully capture the opportunities and challenges that are particular to each context, leading to the development of insufficient or ineffective sustainability strategies. This study demonstrated that the TBL's ability to assess performance across all dimensions is predicated on solid data and metrics. Developing nations like South Africa may encounter difficulties gathering precise and thorough data because of gaps in institutional capacity, monitoring systems, and data infrastructure. The legislative structure and enforcement tools required to successfully advance sustainability is absent from South Africa. The TBL depends on regulations and policies that are supportive, which may be absent or inadequately implemented in some areas. The pressing issues of unemployment, poverty, and unstable economic conditions may make the need for economic sustainability in South Africa even more. This could result in the disregard for social and environmental concerns in favour of economic objectives. For sustainable practices, the TBL assumes that cutting-edge technologies are available. Developing countries including South Africa might, however, encounter obstacles to technology transfer and be unable to create novel, sustainable solutions.

In conclusion, the TBL treats the economic, social, and ecological dimensions equally, without prioritizing one over the other. In practice, companies may need to prioritize certain aspects based on the industry and its specific challenges, potentially leading to a deviation from the TBL's balanced approach. Analyzing frozen food waste within the TBL framework encourages systems thinking, which considers the interconnectedness of economic, social, and environmental factors. Researchers can explore how changes in one dimension of the TBL such as reducing food waste to improve environmental sustainability) may have ripple effects on other dimensions such as reducing costs and improving access to food. This systems perspective enhances understanding of the complex relationships between food waste and sustainability within the TBL framework.

### 8.4. Recommendations

Frozen food waste management is a critical aspect of sustainability that cannot be ignored. The distribution phase of frozen food is one area where significant amounts of waste can occur, and it is essential to make recommendations for sustainable practices in this phase. One recommendation is to implement better inventory management systems that track the shelf life of frozen foods and ensure that they are distributed before they expire. The development of sustainable supply chains focuses on improving economic, environmental, and social benefits. Waste reduction is one of the main goals of the concept of sustainability, and when it comes to food, the impact is even broader. Various initiatives have been launched to reduce food waste in supply chains (food recycling and donation, food waste recycling and use for animal feed), and in this research, the focus is on waste prevention. Policy interventions that improve consumers' food skills are likely to have an impact. However, campaigns that only provide information and raise awareness about the negative impact of food waste do not seem to have an impact. Policymakers should conduct campaigns aimed at influencing social norms. Social norm campaigns are effective because they exploit individuals' tendency to conform to what they think others are doing. Policymakers should consider interventions based on regulation, economic tools, and nudging approaches. Interventions need to be monitored and evaluated to gain insight into their effectiveness and allow for adjustments. An integrated approach to food waste reduction/food policy is needed, in relation to health policy, economic framework conditions, resource efficiency and waste policy.

Another recommendation is to encourage retailers to donate unsold frozen foods to local food banks or charities instead of throwing it away. This not only reduces waste but also helps those in need. Additionally, retailers can work with suppliers to reduce packaging waste by using recyclable materials and minimizing excess packaging. Finally, educating consumers on proper storage and handling of frozen foods can help reduce waste at home. This includes using freezer-safe containers, labelling items with dates, and avoiding over-purchasing. In conclusion, sustainable frozen food waste management in the distribution phase requires a collaborative effort between retailers, suppliers, and consumers. By implementing these recommendations, we can reduce waste and promote a more sustainable future for our planet.

8.4.1. Using Business Intelligence (BI) to improve the management of food waste.

Order forecasting can be enhanced by reducing the discrepancy between predicted and actual sales by utilizing a digital information management tool like Microsoft Power BI or Tableau. The food supply chain is tracked and traced by this technology, which also enhances inventory management. Stores can exchange product information via this decentralized platform, especially in relation to product demand and forecasts and over-stocking. Currently, the researcher has implemented a functional model to allow the FMC to review the last five financial years of products returned based on reasons in Table 4.5. This included manufacturer detail, product, stores, and area detail. With the correlation between sales and returns, the stores can be stocked with the in-demand product for a particular age, gender, income group and area.

There is a need to improve understanding and awareness of food waste at the retail and consumer levels. This is the key to changing behaviour towards reducing food waste (Gruber et al., 2016). Consumers are unaware that when a product is mishandled or removed from a fridge/freezer and left out of the correct temperature, this results in the product being thrown away and deemed as unfit for consumption. Campaigns to raise awareness can tackle problems like the detrimental effects of food waste and misunderstandings surrounding date label interpretation. Other nations have successfully organized similar campaigns, such as "Love Food-Hate Waste" in the United Kingdom and "Too Good for the Bin" in Germany (Weber & Herrlein, 2012). With BI, communication channels can change from magazines and newsletters to social media and real-time statistics creating awareness of food waste and educating consumers on date labelling and handling of frozen and chilled products. This can influence consumer behaviour and future perceptions and reduce retail and household food waste. It has been determined that regulating food waste through laws and policies may be able to prevent and reduce food waste. The emphasis must switch to a regulatory framework that enhances food redistribution by addressing concerns about food safety and date-tagging, which frequently prevent retailers from dispensing surplus food (Goodman-Smith et al., 2020). By giving social institutions legal authority over end users, policies could be developed to lessen the liability burden placed on the retailer who is donating (Gruber et al., 2016). The introduction of landfill bans or restrictions would also limit the disposal of food waste in landfills.

Currently, the FMC has waste-to-value plants in Rustenburg and Worcester that convert production waste into electricity. Collaborative efforts between the government and public sector are required to invest in the waste management sector and focus on food waste separately. The composting market needs to be enhanced while promoting the resale of bio-products. It is known to be one of the biggest causes of food waste in the supply chain. Additionally, examining the impact of increased online retailing and investments in upstream assistive technologies in the FMC could provide valuable insights. Investment in artificial intelligence systems, Internet of Things capabilities and big data management are likely to have increased with recent changes in consumer behaviour. The impact of this is likely to be improved demand planning and inventory management, so it would be useful to know the downstream impact this can have on food waste. Quantitative studies could help to uncover relevant connections between the identified food waste factors. A deeper understanding of this could help support management decisions to reduce food waste across all dimensions. Supply chain managers can forecast what the overall effect on food waste will be if promotional efficiencies, inventory levels, and supplier shortages increase.

### 8.4.2. Awareness campaigns and educating consumers.

Frozen food waste is a growing concern in today's society. Consumers often do not understand the impact of their actions when it comes to throwing away frozen food. Many believe that because it is frozen, it can be kept for an indefinite amount of time, leading to overbuying and ultimately wasting food. Research suggests that designing, implementing, and testing campaigns that aim to influence social norms could be helpful. Social norm campaigns exploit the tendency of individuals to conform to what they think people around them are thinking or doing (Matlhare, 2020). Thus, there is an opportunity to shape behaviour by giving people information about the behaviour or attitudes of others in the population that has been carefully selected to maximize the adoption of positive behaviours. Educating people alone may not reduce food waste because knowledge and appreciation of food are not enough to make changes directly related to food waste to curb the amount and impact of food waste. It is therefore important to understand the diversity of cultures in their variance to take appropriate measures that could reduce the impact of food waste on the environment.

One of the main issues with frozen food waste is the environmental impact. When food is thrown away, it ends up in landfills where it produces methane gas, a potent greenhouse gas that contributes to climate change. Additionally, resources such as water and energy are wasted in the production and transportation of this food. To combat this issue, consumers need to educate themselves on proper storage and expiration dates for frozen foods. They should also consider buying only what they need and using leftovers before they go bad. By reducing their own waste, consumers can help reduce the overall impact on the environment.

It is advised that consumer scientists provide consumers with the knowledge and skills to increase their awareness of retail food waste and the consequences of food waste, as this is a key component in changing consumer behaviour with regard to food waste. Food and nutrition security are thought to be achieved in large part by reducing food waste. To promote the reduction of food waste at the retail level, which can spread to households, consumer scientists should run awareness campaigns like the Stop Waste Food Program. To prevent food waste, consumers should be encouraged to plan their meals, properly prepare their meals, and maintain shopping lists with the necessary items. Consumers should be urged to save leftovers, and consumer scientists should equip them with the know-how to repurpose leftovers and turn them into a new meal. It is advised that communication campaigns to change consumer behaviour at the retail level be developed using the empirical data and insights presented here.

In order to reduce retail and household food waste, there should also be more awareness-raising and educational campaigns focusing on consumer shopping techniques, using leftovers to make new meals, interpreting sell-by, use-by, and sell-by dates, and food management and storage by the food manufacturing company or the retail stores owners. To conserve food, it is also important to communicate the proper methods of food storage in rural areas. Therefore, integrated approaches are needed to address this development issue in KZN, including promoting proper food management to reduce retail food waste. Based on the results of research in the present study, it will propose that retailers should help consumers avoid over-buying groceries by offering a tailored range and smaller pack sizes and limiting purchases of perishable foods. Encouraging or conveying the spirit of Ubuntu in both African and Western cultures, and also encourage eating leftovers or sharing food with the neighbours or those in need, will add value to this development.

In conclusion, understanding frozen food waste is crucial for consumers to make informed decisions about their consumption habits. By taking small steps towards reducing waste, individuals can make a significant difference in protecting our planet's resources for future generations.

### 8.4.3. Policy around redistribution and disposal

During the interviews with managers and staff, it was mentioned numerous times that they would like to redistribute food but were unable to since there is a lot of “red tape” and no approvals. Regulatory tools to support retail food redistribution and limit food waste landfilling need to be designed that will be suitable for the retailer, FMC and consumers. A study by Hermsdorf et al. (2017), expressed the importance of the redistribution of surplus food for reuse in preventing food waste from retailers. Concerns about food safety and date labelling continue to prevent the retail sector from donating excess food (Goodman-Smith et al., 2020). By overlaying sales data with returned products, one can determine the rate at which the product is being sold. This will allow the FMC to place the correct types of products in stores. Some countries have implemented a variety of tools to aid in the distribution of extra food while shielding the donor from responsibility. Italy's adoption and application of the Good

Samaritan Law serves as an illustration. This law defines non-profit and social institutions as end users (Baglioni et al., 2016).

Although South Africa has not yet specifically banned or restricted the landfilling of food waste, there are several legal tools in place to keep food waste out of the landfill. The norms and standards for the disposal of waste on land (GNR. 636 of August 2013) restrict the landfilling of waste with high calorific value and waste with a high liquid content (Morley, 2016). The NWMS promotes composting and energy recovery as two options, but building a food waste processing infrastructure is still difficult. As a result, cooperation between the public and private sectors as well as other interested parties is required to encourage investment in finding solutions to this problem. One strategy supported by the NWMS to fulfil the NEMWA's waste management hierarchy goals is composting. Driving best practices and enforcing changes to the law will be made easier with the help of a central platform with searchable information. Policies and initiatives related to food waste may also be integrated into broader sustainability and waste management strategies.Since policies and initiatives can evolve, I recommend visiting official government websites, environmental agencies, or relevant NGOs for the most current and detailed information on food waste policies and actions in South Africa.

## 8.5. Future Research

Food waste in retailers is a fairly narrow field of research, but an expansion would be desirable due to the potential to reduce both economic and environmental impacts. This thesis digs deeper than many other studies, but still only reveals the tip of the iceberg. Therefore, there is a constant need to push the frontiers of knowledge. Some suggested areas that need further investigation are:

1. Risk factors to waste generation in retail stores such as the quantities and circumstances leading to the waste.
2. To investigate measures in place to reduce food waste in retail other than norms.

3. Theoretical and practical assessments should include both the cost of implementing the measure and the potential waste reduction to achieve a net result.
4. Repeating the study's goals and methodology in additional South African provinces.

Consumer demand for online retail has increased significantly due to the COVID-19 pandemic, which has accelerated the adoption of assistive technologies. The literature reviewed for this study suggests that technology is much more likely to help reduce food waste than it creates.

## 8.6. Conclusion

For businesses, South Africa as a whole, and the entire world, food waste is an urgent problem. Both the research in the literature and the study's findings indicate that there are particular factors that contribute to food waste that can be controlled to lower the amount of food waste. Businesses can lower the amount of food waste in the food supply chain by coming up with creative ways to boost productivity without having unintended consequences, as with food waste elsewhere in the supply chain. Oelofse and Nahman (2019) cited the lack of data to quantify food waste as one of the barriers to improving food waste management in South Africa. When it came to quantifying food waste, participating stores displayed a high level of efficiency. Food waste quantification practices were supported by historical quantification data and on-site assessment. One area highlighted in the on-site assessment was the recording of the whereabouts of food waste after it was "classified" as waste by the stores. Stores did not have records showing how much food waste was donated, reused in the in-house kitchen, and collected for final disposal.

Based on the study's findings, it can be concluded that both internal business operations and outside factors contribute to food waste in the food retailing industry. Problems with date labelling, food safety regulations, shelf life, handling, advertising, and a lack of opportunities for diversion are some of the root causes that have been found. In this study, the primary driver for reducing food waste was found to be financial gain, with store managers stating that doing so would lower lost profits in their establishments. The results of this study highlighted the role that education and raising awareness could play in reducing food waste. The study participants said that in order to affect change, staff education programs and consumer education about the concept of food waste, including how it affects consumers and how to interpret date marking, are necessary. As a way to reduce food waste, processed food waste was also identified in this study by the respondents, who felt that retail leadership should adopt such initiatives. In order to address issues with food safety and hygiene, the interpretation of date labels, corporate image, and donor indemnification, legislation supporting food waste donation is essential. Composting and energy recovery are two of the options promoted by the NWMS; however, the infrastructure for processing food waste is still a problem, necessitating coordinated efforts from the public, private, and other interested parties in order to encourage investment in solutions (Godfrey et al., 2020).

Food waste is produced by internal factors, such as inadequate promotional planning. The retail group provided too many products during promotions to display full shelves and draw customers, some of the food waste in this study was caused by advertised products. Store managers should be involved in promotional planning at the headquarters because they are the ones who are most familiar with actual product demand, which will help to align forecasts with demand for the product. Finally, employees and customers have cited poor handling practices as a contributing factor to food waste, especially on busy days. One interview mentioned issues with food safety, sanitation, and corporate image as obstacles to the redistribution of food waste. Food that had passed its use-by or expiration date was a common association among store managers for food waste. The shelves had these items on them when they were deemed unsellable, and the items were removed. Food waste is still a result of issues with date interpretation. All employees working in food retail, particularly those who perform merchandising duties, need to be knowledgeable in order to ensure that the company's policies on reducing food waste are followed. A strong and dedicated administration with a clear leadership mission, capacity, and financial support is necessary to develop, monitor, and sustain a successful voluntary agreement.

Food waste management is an essential part of modern organizations' competitive advantage and food safety. The study's findings offered new perspectives on the issue of food waste that will encourage discussion and further study in a field that is essential for an ethical and sustainable food supply chain. The use of the PBI model created by the researcher, has allowed the FMC to target the problem stores with high food waste. This also led to a mass ranging exercise for products, placing the correct products in the right area dependents on population and income. The rate of sale of products was also looked at during the ranging exercise, allowing the FMC and retailer to move stock to stores that will sell out the product before expiry or stores damages occurred. After implementation of this PBI tool, returns have decreased by 15%, and show a downward trend. This also provided the FMC direction and posed swell allowances to stores with high returns reducing the internal costing of waste produced. This PBI model, can be implemented in other regions.

## REFERENCES

Abdel-Shafy, H. I., & Mona S.M. Mansour. (2018). Solid waste issue: Sources, composition, disposal, recycling, and valorisation. Egyptian Journal of Petroleum, 27(4), 1275–1290. https://doi.org/10.1016/j.ejpe.2018.07.003

Abiad, M. G., & Meho, L. I. (2018). Food loss and food waste research in the Arab world: a systematic review. Food Security, 10(2), 311–322. https://doi.org/10.1007/s12571-018-0782-7

Abubakar, I. R., Maniruzzaman, K. M., Dano, U. L., AlShihri, F. S., AlShammari, M. S., Ahmed, S. M. S., Al-Gehlani, W. A. G., & Alrawaf, T. I. (2022). Environmental Sustainability Impacts of Solid Waste Management Practices in the Global South. International Journal of Environmental Research and Public Health, 19(19), 12717. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9566108/

Action Against Hunger. (2022). World Hunger Facts & Statistics | Action Against Hunger. Action against Hunger. https://www.actionagainsthunger.org/the-hunger-crisis/world-hunger-facts/

Adams, D., Donovan, J., & Topple, C. (2021). Achieving Sustainability in Food Manufacturing Operations and their Supply Chains: Key Insights from a Systematic Literature Review. Sustainable Production and Consumption, 28, 1491–1499. https://doi.org/10.1016/j.spc.2021.08.019

Adel, M., Dawood, A. E.-B., Rady, A., & Taleb, M. A. (2021). Managing food waste: What happens after food waste generation in hotels? Journal of Tourism, Hotels and Heritage, 3(1), 21–41. https://doi.org/10.21608/sis.2021.105411.1025

AFFI. (2021). New study pinpoints frozen food gain to three p's. https://affi.org/new-study-pinpoints-frozen-food-gain-to-three-ps/#:~:text=A%20recent%20study%20from%20Deloitte,influencing%20consumers'%20desire%20for%20frozen.&text=The%20Deloitte%20report%2C%20%E2%80%9CFresh%20vs.

African Union Commission. (2018). AFRICAN UNION COMMISSION POST-HARVEST LOSS MANAGEMENT STRATEGY. https://au.int/sites/default/files/documents/34934-doc-au_post-harvest_loss_management_strategy.pdf

African Union. (2022). The African Continental Free Trade Area | African Union. Au.int. https://au.int/en/african-continental-free-trade-area

Agostoni, C., Baglioni, M., La Vecchia, A., Molari, G., & Berti, C. (2023). Interlinkages between Climate Change and Food Systems: The Impact on Child Malnutrition—Narrative Review. Nutrients, 15(2), 416. https://doi.org/10.3390/nu15020416

Ahi, P., & Searcy, C. (2015). Measuring social issues in sustainable supply chains. Measuring Business Excellence, 19(1), 33–45. https://doi.org/10.1108/MBE-11-2014-0041

Ahmed, S., Stewart, A., Smith, E., Warne, T., & Shanks, C. B. (2021). Consumer perceptions, behaviors, and knowledge of food waste in a rural american state. Frontiers in Sustainable Food Systems, 5. https://doi.org/10.3389/fsufs.2021.734785

Aktas, E., & Oledinma, A. (2017). Policies to minimise food waste in retail environment APN project view project future proofing transportation infrastructure projects view project. www.cranfield.ac.uk/som

Alamri, M. S., Qasem, A. A. A., Mohamed, A. A., Hussain, S., Ibraheem, M. A., Shamlan, G., Alqah, H. A., & Qasha, A. S. (2021). Food packaging's materials: A food safety perspective. Saudi Journal of Biological Sciences, 28(8), 4490–4499. https://doi.org/10.1016/j.sjbs.2021.04.047

Albizzati, P. F., Tonini, D., Chammard, C. B., & Astrup, T. F. (2019). Valorisation of surplus food in the French retail sector: Environmental and economic impacts. Waste Management, 90, 141–151. https://doi.org/10.1016/j.wasman.2019.04.034

Aldaco, R., Hoehn, D., Laso, J., Margallo, M., Ruiz-Salmón, J., Cristobal, J., Kahhat, R., Villanueva-Rey, P., Bala, A., Batlle-Bayer, L., Fullana-i-Palmer, P., Irabien, A., & Vazquez-Rowe, I. (2020). Food waste management during the COVID-19 outbreak: a holistic climate, economic and nutritional approach. Science of the Total Environment, 742, 140524. https://doi.org/10.1016/j.scitotenv.2020.140524

Alegbeleye, O., Odeyemi, O. A., Strateva, M., & Stratev, D. (2022). Microbial spoilage of vegetables, fruits and cereals. Applied Food Research, 2(1), 100122. https://doi.org/10.1016/j.afres.2022.100122

Ali, S. S., & Bharadwaj, S. (2014). Prospects for detecting the 326.5 MHz redshifted 21-cm HI signal with the ooty radio telescope (ORT). Journal of Astrophysics and Astronomy, 35(2), 157–182. https://doi.org/10.1007/s12036-014-9301-1

Alimi, B. A., Lawal, R., & Odetunde, O. N. (2022). Food safety and microbiological hazards associated with retail meat at butchery outlets in north-central Nigeria. Food Control, 139. https://doi.org/10.1016/j.foodcont.2022.109061

Al-Obadi, M., Ayad, H., Pokharel, S., & Ayari, M. (2022). Perspectives on food waste management: Prevention and social innovations. Sustainable Production and Consumption, 31, 190–208. https://doi.org/10.1016/j.spc.2022.02.012

Al-Rumaihi, A., McKay, G., Mackey, H. R., & Tareq Al-Ansari. (2020). Environmental impact assessment of food waste management using two composting techniques. Sustainability (Switzerland), 12(4). https://doi.org/10.3390/su12041595

Alvarez, E., Fazleena Badurdeen, & Paul Eric Dossou. (2020). Sustainable consumption by reducing food waste: A review of the current state and directions for future research. Procedia Manufacturing, 51, 1791–1798. https://doi.org/10.1016/j.promfg.2020.10.249

Amicarelli, V., Lagioia, G., & Bux, C. (2021). Global warming potential of food waste through the life cycle assessment: An analytical review. Environmental Impact Assessment Review, 91. https://doi.org/10.1016/j.eiar.2021.106677

Amicarelli, V., Tricase, C., Spada, A., & Bux, C. (2021). Households' food waste behavior at local scale: A cluster analysis after the COVID-19 lockdown. Sustainability. https://api.semanticscholar.org/CorpusID:233627309

Aragie, E., Balié, J., & MoralesOpazo, C. (2018). Does reducing food losses and wastes in sub-Saharan Africa make economic sense? Waste Management & Research, 36(6), 483–494. https://doi.org/10.1177/0734242x18770247

Aramyan, L., Grainger, M., Logatcheva, K., Piras, S., Setti, M., Stewart, G., & Vittuari. M. (2021). Food waste reduction in supply chains through innovations: a review. Measuring Business Excellence, 25(4), 475–492. https://doi.org/10.1108/MBE-11-2019-0105

Arbinolo, R. (2023). Arbinolo R%2C 2023. Bing. https://www.bing.com/search?pglt=41&q=Arbinolo+R%2C+2023&cvid=ca6879484d1047239f03afc741ef430f&aqs=edge..69i57.923j0j1&FORM=ANNTA1&PC=U531

Ariyani, L., & Ririh, K. (2020). Understanding behavior of household food waste management: Food waste hierarchy context. Jurnal Ilmiah Teknik Industri, 19(2), 142–154. https://doi.org/10.23917/jiti.v19i2.11994

Ariyani, L., & Ririh, K. R. (2020). Understanding behavior of household food waste management: Food waste hierarchy context. Jurnal Ilmiah Teknik Industri, 19(2), 142–154. https://doi.org/10.23917/jiti.v19i2.11994

Aschemann-Witzel, J., de Hooge, I., Amani, P., Bech-Larsen, T., & Oostindjer, M. (2015). Consumer-Related Food Waste: Causes and Potential for Action. Sustainability, 7(6), 6457–6477. https://doi.org/10.3390/su7066457

Aschemann-Witzel, J., Giménez, A., & Ares, G. (2020). Suboptimal food, careless store? Consumer's associations with stores selling foods with imperfections to counter food waste in the context of an emerging retail market. Journal of Cleaner Production, 262. https://doi.org/10.1016/j.jclepro.2020.121252

Atnafu, D., & Balda, A. (2018). The impact of inventory management practice on firms' competitiveness and organizational performance: Empirical evidence from micro and small enterprises in Ethiopia. Cogent Business & Management, 5(1), 1–16. Tandfonline. https://doi.org/10.1080/23311975.2018.1503219

Averda. (2022). Load shedding increases food waste. Averda. https://www.averda.com/rsa/news/load-shedding-increases-food-waste

Averda. (2023, August 9). Load shedding increases food waste. Averda. https://www.averda.com/rsa/news/load-shedding-increases-food-waste

Avicenna, Mel, M., Ihsan, S., & Setyobudi, R. (2015). Process improvement of biogas production from anaerobic co-digestion of cow dung and corn husk. Procedia Chemistry, 14, 91–100. https://doi.org/10.1016/j.proche.2015.03.014

Axon, S., Morrissey, J., Aiesha, R., Hillman, J., Revez, A., Lennon, B., Mathieu Salel, Dunphy, N., & Boo, E. (2018). The human factor: Classification of European community-based behaviour changes initiatives. Journal of Cleaner Production, 182, 567–586. https://doi.org/10.1016/j.jclepro.2018.01.232

Ayeleru, O., Oboirien, B. O., Olubambi, P., & Onu, M. (2023). Challenges of wastewater generation and management in subSaharan Africa: A Review. Environmental Challenges, 11, 100686. https://doi.org/10.1016/j.envc.2023.100686

Babayemi, J. O., Nnorom, I. C., Osibanjo, O., & Weber, R. (2019). Ensuring sustainability in plastics use in Africa: consumption, waste generation, and projections. Environmental Sciences Europe, 31(1). https://doi.org/10.1186/s12302-019-0254-5

Babii, A. (2020). Important aspects of the experimental research methodology. Scientific Journal of the Ternopil National Technical University, 97, 77–87. https://doi.org/10.33108/visnyk_tntu2020.01.077

Bagherzadeh. M, Inamura. M, & Jeong. H. (2014). Food waste along the food chain. OECD Food, Agriculture and Fisheries Papers, 71, 29. https://doi.org/10.1787/5jxrcmftzj36-en

Baglioni, S., De Pieri, B., & Tallarico, T. (2016). Surplus food recovery and food aid: The pivotal role of non-profit organisations. Insights from italy and germany. VOLUNTAS: International Journal of Voluntary and Nonprofit Organizations, 28(5), 2032–2052. https://doi.org/10.1007/s11266-016-9746-8 Bahraini, A. (2021, November 1). The Triple Bottom Line of Sustainability in Waste Management. Waste4Change. https://waste4change.com/blog/the-triple-bottom-line-of-sustainability-in-waste-management/

Bancal, V., & Ray, R. (2022). Overview of Food Loss and Waste in Fruits and Vegetables: From Issue to Resources (p. 1). https://doi.org/10.1007/9789811695278_1

Bansa, A., & Upadhyay, A. K. (2017). Microsoft power BI. In International Journal of Soft Computing and Engineering (IJSCE).

Bautista, J. (2020). Crafting a theoretical framework on waste management: A case for sustainable cities. International Journal of GEOMATE, 18. https://doi.org/10.21660/2020.68.5683

BCAR. (2019). Brazilian Agricultural Research Corporation (Embrapa) | AGROVOC. Www.fao.org. https://www.fao.org/agrovoc/institutions/brazilian-agricultural-research-corporation-embrapa

Beck, A. (2020). Greeks vs. Goblins. Sweet Greeks, 84–105. https://doi.org/10.5622/illinois/9780252043406.003.0006

Beega, S. (2021). South Africa wastes 10mn tons of food a year. Mail & Guardian. https://mg.co.za/environment/2021-08-21-south-africa-wastes-10-million-tons-of-food-a-year/

Bellemare, M. F., Çakir, M., Peterson, H. H., Novak, L., & Rudi, J. (2017). On the Measurement of Food Waste. American Journal of Agricultural Economics, 99(5), 1148–1158. https://doi.org/10.1093/ajae/aax034

Benavides, L., De Eskinazis, V., & Swan, D. (2012). Six steps to successful supply chain collaboration | McKinsey. Www.mckinsey.com. https://www.mckinsey.com/capabilities/operations/our-insights/six-steps-to-successful-supply-chain-collaboration

Benyam, A., Soma, T., & Fraser, E. (2021). Digital agricultural technologies for food loss and waste prevention and reduction: Global trends, adoption opportunities and barriers. Journal of Cleaner Production, 323. https://doi.org/10.1016/j.jclepro.2021.129099

Beretta, C., Stoessel, F., Baier, U., & Hellweg, S. (2013). Quantifying food losses and the potential for reduction in Switzerland. Waste Management, 33(3), 764–773. https://doi.org/10.1016/j.wasman.2012.11.007

Berndt, A. E. (2020). Sampling methods. Journal of Human Lactation, 36(2), 224–226. https://doi.org/10.1177/0890334420906850

Berry, E. M. (2020). Food Insecurity, Social Inequity, and Sustainability. World Review of Nutrition and Dietetics, 121, 95–104. https://doi.org/10.1159/000507489

Bessa, L., Olayemi Aganga, & Bonolo Monthe. (2021). Turning africa's food waste problem into a regenerative opportunity - climate champions. https://racetozero.unfccc.int/turning-africas-food-waste-problem-into-a-regenerative-opportunity/

Betz, A., Buchli, J., Göbel, C., & Müller, C. (2015). Food waste in the Swiss food service industry – Magnitude and potential for reduction. Waste Management, 35, 218–226. https://doi.org/10.1016/j.wasman.2014.09.015

Beullens, P., & Ghiami, Y. (2022). Waste reduction in the supply chain of a deteriorating food item – Impact of supply structure on retailer performance.

European Journal of Operational Research, 300(3), 1017–1034. https://doi.org/10.1016/j.ejor.2021.09.015

Beverland, M. (2021). Brand management: Co-creating meaningful brands. In Thousand Oaks: Sage.

Bhada-Tata, P., & Hoornweg, D. (2016). Solid waste and climate change. State of the World, 239–255. https://doi.org/10.5822/978-1-61091-756-8_20

Bhattacharya, A., Zutshi, A., & Prajogo, D. (2022). Food waste challenges at downstream interfaces: a triple bottom line dilemma. Australasian Journal of Environmental Management, 29, 1–30. https://doi.org/10.1080/14486563.2022.2139768

Binda, L., Clayford, M., Kasongo, A., Kondlo, L., Mudavanhu, P., Mathekga, J., Molotja, N., Mahlaela, A., Mavi, S., Mhlanga , N., Mustapha, N., Ralphs, G., Sass, T., Saunders, N., Ramoroka, K., Sigenu, V., Sithole, M., Slater, A., Vlotman, N., & Whisgary, D. (2022). South African National Survey of Research and Experimental Development: main report 2019/2020. Repository.hsrc.ac.za. https://repository.hsrc.ac.za/handle/20.500.11910/19633

Blackwell, R. (2018). Introduction to positivism, interpretivism and critical theory. Nurse Researcher, 25, 14–20. https://doi.org/10.7748/nr.2018.e1466

Blagojević, M., & Micić, Z. (2013). A web-based intelligent report e-learning system using data mining techniques. Computers & Electrical Engineering, 39(2), 465–474. https://doi.org/10.1016/j.compeleceng.2012.09.011

Blanc, F., & Ottimofiore, G. (2021). Regulatory Compliance in a Global Perspective: Developing Countries, Emerging Markets and the Role of International Development Institutions (B. van Rooij & D. D. Sokol, Eds.). Cambridge University Press; Cambridge University Press. https://www.cambridge.org/core/books/abs/cambridge-handbook-of-compliance/regulatory-compliance-in-a-global-perspective-developing-countries-emerging-markets-and-the-role-of-international-development-institutions/4E8F29CCCDB80B078FDC007953D3C7C7

Blay-Palmer, A., Santini, G., Dubbeling, M., Henk Renting, Taguchi, M., & Giordano, T. (2018). Validating the city region food system approach: Enacting inclusive, transformational city region food systems. Sustainability (Switzerland), 10(5), 1680. https://doi.org/10.3390/su10051680

Borghesi, G., & Morone, P. (2022). A review of the effects of COVID-19 on food waste. Food Security. https://doi.org/10.1007/s12571-022-01311-x

Boyle, J. O. (2020). JohnoboylecP51043. In No time to waste tackling climate change and retail food waste.

Breitenmoser, L., Gross, T., Ragini Huesch, Rau, J., Dhar, H., Kumar, S., Hugi, C., & Wintgens, T. (2019). Anaerobic digestion of biowastes in India: Opportunities, challenges and research needs. Journal of Environmental Management, 236, 396–412. https://doi.org/10.1016/j.jenvman.2018.12.014

Brodribb, P., & McCann, M. (2020). Cold Hard Facts. https://www.agriculture.gov.au/sites/default/files/documents/cold-hard-facts-2020.pdf

Brouwers, J., René Oostewechel, & Regis, Y.-L. (2021). Wageningen university & research haiti business development and investment project: Final report. https://doi.org/10.18174/556778

Browne, A. L., Sharp, L., & Watson, M. (2017). Food waste and kitchen practices: implications for policy and intervention Change Points-finding innovative interventions for less resource-intensive ways of living View project. https://doi.org/10.13140/RG.2.2.23212.56960

Bruggers, J. (2021, July 13). Your Trash Is Emitting Methane In The Landfill. Here’s Why It Matters For The Climate. NPR.org. https://www.npr.org/2021/07/13/1012218119/epa-struggles-to-track-methane-from-landfills-heres-why-it-matters-for-the-clima

Bryman, A. (2016). Social Research Methods. In Google Books. Oxford University Press.

https://books.google.co.za/books/about/Social_Research_Methods.html?id=N2zQCgAAQBAJ&redir_esc=y

Buisman, M. E., Haijema, R., & Bloemhof-Ruwaard, J. M. (2019). Discounting and dynamic shelf life to reduce fresh food waste at retailers. International Journal of Production Economics, 209, 274–284. https://doi.org/10.1016/j.ijpe.2017.07.016

Bulelwa, M. (2023). An Analysis of Regulation 363 of the National Health Act (61 of 2003) Regarding the Management of Human Remains from the Perspective of Emerging Funeral Directors. African Journal of Governance and Development, 12(2), 20–39. https://doi.org/10.36369/26169045/2023/v12i2a3

Burek, J., & Nutter, D. W. (2020). Environmental implications of perishables storage and retailing☆. Renewable and Sustainable Energy Reviews, 133. https://doi.org/10.1016/j.rser.2020.110070

Busetti, S. (2019). A theory-based evaluation of food waste policy: Evidence from Italy. Food Policy, 88. https://doi.org/10.1016/j.foodpol.2019.101749

Buthelezi, E. M. (2023). Impact of Money Supply in Different States of Inflation and Economic Growth in South Africa. Economies, 11(2), 64. https://doi.org/10.3390/economies11020064

Buzby, J. (2022, January 24). Food Waste and its Links to Greenhouse Gases and Climate Change. Www.usda.gov; U.S. DEPARTMENT OF AGRICULTURE. https://www.usda.gov/media/blog/2022/01/24/food-waste-and-its-links-greenhouse-gases-and-climate-change

Buzby, J. C., Wells, H. F., & Hyman, J. (2014). The estimated amount, value, and calories of postharvest food losses at the retail and consumer levels in the United States. Food Loss in the United States: Selected Analyses, 1–42. https://doi.org/10.2139/ssrn.2501659

Campbell, C., & Feldpausch, G. L. (2022). Invited review: The consumer and dairy food waste: An individual plus policy, systems, and environmental perspective.

Journal of Dairy Science, 105(5), 3736–3745. https://doi.org/10.3168/jds.2021-20994

Cánovas, A., Bernstad, A., & Valle, R. (2016). Mapping of food waste prevention actions into the Food Supply Chain for Life Cycle Management strategies. www.refed.com

Carter, A. (2022). R638 Regulations. [online] Food Consulting Services. Available at: https://foodconsulting.co.za/r638-regulations-governing-general-hygiene-requirements-for-food-premises/#:~:text=The%20R638%20Food%20Regulations%20were%20introduced%20in%20South [Accessed 22 May 2024].

Casonato, C., García-Herrero, L., Caldeira, C., & Sala, S. (2023). What a waste! Evidence of consumer food waste prevention and its effectiveness. Sustainable Production and Consumption, 41, 305–319. https://doi.org/10.1016/j.spc.2023.08.002

Cattaneo, A., Federighi, G., & Vaz, S. (2021). The environmental impact of reducing food loss and waste: A critical assessment. Food Policy, 98. https://doi.org/10.1016/j.foodpol.2020.101890

Ceanu, D. (2023, November 8). Reducing Food Waste Through Education. FrozeNet. https://frozenet.com/sustainability-environment/reducing-food-waste/mindful-consumption-educating-consumers-for-a-waste-free-future/

Centobelli, S., Centobelli, P., Cerchione, R., & Ertz, M. (2020). Food cold chain management: what we know and what we deserve. Supply Chain Management: An International Journal, 26(1), 102–135. https://doi.org/10.1108/SCM1220190452

Cerulean. (2020). How to avoid food waste in chilled ready meals and frozen food. https://www.cerulean.com/en/news/how-to-avoid-food-waste-in-chilled-ready-meals-and-frozen-food

Ceryes, C. A., Antonacci, C. C., Harvey, S. A., Spiker, M. L., Bickers, A., & Neff, R. A. (2021). “Maybe it’s still good?” A qualitative study of factors influencing food waste and application of the E.P.A. Food recovery hierarchy in U.S. supermarkets. Appetite, 161. https://doi.org/10.1016/j.appet.2021.105111

CGCSA. (2020). Consumer Goods Council of South Africa (CGCSA) launches the South African food loss and waste voluntary agreement. In Consumer Goods Council of South Africa (CGCSA) launches the South African food loss and waste voluntary agreement.

Chakona, G., & Shackleton, C. M. (2017). Local setting influences the quantity of household food waste in mid-sized South African towns. PLoS ONE, 12(12), e0189407. https://doi.org/10.1371/journal.pone.0189407

Chakona, G., & Shackleton, C. M. (2019). Food insecurity in South Africa: To what extent can social grants and consumption of wild foods eradicate hunger? World Development Perspectives, 13, 87–94. https://doi.org/10.1016/j.wdp.2019.02.001

Chalak, A., Abou-Daher, C., Chaaban, J., & Abiad, M. G. (2016). The global economic and regulatory determinants of household food waste generation: A cross-country analysis. Waste Management, 48, 418–422. https://doi.org/10.1016/j.wasman.2015.11.040

Chatterjee, S., Mehtani, P., & Gupta, N. (2015). In situ bioremediation of dairy waste Water–A novel approach in dairy waste management. Iisu Jost, 4(1), 6–10. https://www.researchgate.net/publication/318571165

Chauhan, C., Dhir, A., Manzoor Ul Akram, & Salo, J. (2021). Food loss and waste in food supply chains. A systematic literature review and framework development approach. Journal of Cleaner Production, 295. https://doi.org/10.1016/j.jclepro.2021.126438

Chen, C., Chaudhary, A., & Mathys, A. (2020). Nutritional and environmental losses embedded in global food waste. Resources Conservation and Recycling, 160, 104912. https://api.semanticscholar.org/CorpusID:219452554

Chua, S. (2019). व ा र ् ष ि क प ् रत ि व े दन annual report annual report. Fresenius.com. https://www.rtda.gov.rw/fileadmin/templates/publications/RWANDA_Annual_Report_2018-2019_SHARING.pdf,

Cicatiello, C., Franco, S., Pancino, B., Blasi, E., & Luca Falasconi. (2017). The dark side of retail food waste: Evidence from in-store data. Resources, Conservation and Recycling, 125, 273–281. https://doi.org/10.1016/j.resconrec.2017.06.010

Ciccullo, F., Fabbri, M., Abdelkafi, N., & Pero, M. (2022). Exploring the potential of business models for sustainability and big data for food waste reduction. Journal of Cleaner Production, 340. https://doi.org/10.1016/j.jclepro.2022.130673

COGTA. (2020). Ethekwini. In Metropolitan KZN.

Cohen, L. et al. (2018). Research Methods in Education. Abingdon, Oxon Routledge. - References - Scientific Research Publishing. (n.d.). Www.scirp.org. Retrieved January 16, 2024, from https://www.scirp.org/reference/referencespapers?referenceid=2733922

Cole-Hamilton, D. (2023). UN sustainable development goal 2 – zero hunger. RSC Sustainability, 1(2), 177–178. https://doi.org/10.1039/d3su90005c

Colombo, C., Henrique, F., Carla Roberta Pereira, Lago, A., & Ivete Delai. (2020). Retail food waste: mapping causes and reduction practices. Journal of Cleaner Production, 256. https://doi.org/10.1016/j.jclepro.2020.120124

Conradie, P., Hofmeyr, A., Dekker, C., & Inc, H. (2018). Product liability and safety in South Africa: overview, Practical Law Country Q&A... Product liability and safety in South Africa: overview. https://www.cliffedekkerhofmeyr.com/export/sites/cdh/news/press-releases/downloads/Product-liability-and-safety-in-South-Africa-Overview-2018.pdf

Cooper, J. (2021, January 1). Chapter Fourteen - Food Waste Policy (J. Wong, G. Kaur, M. Taherzadeh, A. Pandey, & K. Lasaridi, Eds.). ScienceDirect; Elsevier. https://www.sciencedirect.com/science/article/pii/B9780128191484000142

Corrado, S., Caldeira, C., Eriksson, M., Ole Jørgen Hanssen, Hauser, H.-E., Freija van Holsteijn, Liu, G., Östergren, K., Parry, A., Secondi, L., Åsa Stenmarck, & Sala, S. (2019). Food waste accounting methodologies: Challenges, opportunities, and further advancements. Global Food Security, 20, 93–100. https://doi.org/10.1016/j.gfs.2019.01.002

Costello, C., Esma Birisci, & McGarvey, R. G. (2016). Food waste in campus dining operations: Inventory of pre- and post-consumer mass by food category, and estimation of embodied greenhouse gas emissions. Renewable Agriculture and Food Systems, 31(3), 191–201. https://doi.org/10.1017/S1742170515000071

Cotter, S. (2023, October 21). Excel for Inventory Management: Tips, Best Practices, Pros and Cons. Asset Vue. https://assetvue.com/excel-for-inventory-management/

Creecy, B. (2023). Minister Barbara Creecy: Food Loss and Waste Voluntary Agreement virtual launch | South African Government. Www.gov.za. https://www.gov.za/speeches/minister-barbara-creecy-food-loss-and-waste-voluntary-agreement-virtual-launch-29-sep-2020

Creswell, J. W., & Clark, V. L. P. (2017). Designing and Conducting Mixed Methods Research. In Google Books. SAGE Publications. https://books.google.co.za/books/about/Designing_and_Conducting_Mixed_Methods_R.html?id=eTwmDwAAQBAJ&redir_esc=y

Cristóbal, J., Castellani, V., Manfredi, S., & Sala, S. (2018). Prioritizing and optimizing sustainable measures for food waste prevention and management. Waste Management, 72, 3–16. https://doi.org/10.1016/j.wasman.2017.11.007

Cronje, N., van, & Muller, I.-M. (2018). Household food waste: A case study in kimberly, south africa. Journal of Consumer Sciences, 46(August), 1–9. https://www.ajol.info/index.php/jfecs/article/view/174702

Cruz, M., Tiago Guimarães, António Abelha, & Manuel Filipe Santos. (2021). Business analytics components for public health institution - nursing decision area. Procedia Computer Science, 198(2021), 347–352. https://doi.org/10.1016/j.procs.2021.12.252

CSIR, D., Oelofse, S., Sooklal, R., Dumisani Buthelezi, Sihle Matinise, Tsebo Mohapi, Katlego Mabatle, & Kabela Phakoe. (2021). Food waste prevention and management: A guideline for South Africa. In Food waste prevention and management: A guideline for South Africa (Issue 1, p. 38).

de Bruin, S., Dengerink, J., & van Vliet, J. (2021). Urbanisation as driver of food system transformation and opportunities for rural livelihoods. Food Security, 13(4), 781–798. https://doi.org/10.1007/s12571-021-01182-8

de Gorter, H., Drabik, D., Just, D. R., Reynolds, C., & Sethi, G. (2021). Analyzing the economics of food loss and waste reductions in a food supply chain. Food Policy, 98. https://doi.org/10.1016/j.foodpol.2020.101953

De Lange, R. (2022). Load shedding probably leads to more fresh food wastage. News24. https://www.news24.com/citypress/news/load-shedding-probably-leads-to-more-fresh-food-wastage-20220820

de Lange, W., & Nahman, A. (2015). Costs of food waste in South Africa: Incorporating inedible food waste. Waste Management, 40, 167–172. https://doi.org/10.1016/j.wasman.2015.03.001

De Neve, J.-E., & Sachs, J. D. (2020). The SDGs and human well-being: a global analysis of synergies, trade-offs, and regional differences. Scientific Reports, 10(1). https://doi.org/10.1038/s41598-020-71916-9

de Souza, M., Pereira, G., Beatriz, A., Chiappetta, J., Luiz Reni Trento, Borchardt, M., & Zvirtes, L. (2021). A digitally enabled circular economy for mitigating food waste: Understanding innovative marketing strategies in the context of an emerging economy. Technological Forecasting and Social Change, 173. https://doi.org/10.1016/j.techfore.2021.121062

DEFF. (2016). South africa signs Paris agreement on climate change in new york. Department of Forestry, Fisheries and the Environment. https://www.dffe.gov.za/mediarelease/southafricasignsparisagreementonclimate

DEFF. (2021). National waste management strategy 2020. In National Waste Management Strategy 2020.

DeLong, K., & Grebitus, C. (2016). Why U.S. Consumers Support Country of Origin Labeling: Examining the Impact of Ethnocentrism and Food Safety. Journal of International Food & Agribusiness Marketing, 28, 1–17. https://doi.org/10.1080/08974438.2015.1110548

Department of Environmental Affairs. (2017). Annual Report. Https://Nationalgovernment.co.za/Department_annual/180/2017-Department:-Environmental-Affairs-Annual-Report.pdf. https://nationalgovernment.co.za/department_annual/180/2017-department:-environmental-affairs-annual-report.pdf

Deutz, P., & Ioppolo, G. (2015). From theory to practice: Enhancing the potential policy impact of industrial ecology. Sustainability, 7(2), 2259–2273. https://doi.org/10.3390/su7022259

Diaz-Ruiz, R. (2018). Understanding food waste behaviours along the food supply chain – a multilevel approach. INSTITUTE for Sustainability Science and TECHNOLOGY. http://www.tdx.cat/?locale-

Djekic, I., Operta, S., Nermina Djulancic, Lorenzo, J. M., Barba, F. J., Vesna Djordjević, & Igor Tomasevic. (2019). Quantities, environmental footprints and beliefs associated with household food waste in Bosnia and Herzegovina. Waste Management and Research, 37(12), 1250–1260. https://doi.org/10.1177/0734242X19873709

Dlomo, T. H. (2021). Understanding food waste management practices in the grocery retail sector in Durban, KwaZulu-Natal Supervisor: May. https://doi.org/orcid.org/0000-0003-4558-7899

Dora, M., Biswas, S., Choudhary, S., Nayak, R., & Irani, Z. (2021). A system-wide interdisciplinary conceptual framework for food loss and waste mitigation strategies in the supply chain. Industrial Marketing Management, 93, 492–508. https://doi.org/10.1016/j.indmarman.2020.10.013

Dou, Z., & Toth, J. D. (2021). Global primary data on consumer food waste: Rate and characteristics – A review. Resources, Conservation and Recycling, 168. https://doi.org/10.1016/j.resconrec.2020.105332

Dreyer, H. C., Iskra Dukovska-Popovska, Yu, Q., & Carl Philip Hedenstierna. (2019). A ranking method for prioritising retail store food waste based on monetary and environmental impacts. Journal of Cleaner Production, 210, 505–517. https://doi.org/10.1016/j.jclepro.2018.11.012

Du Plessis, R. (2020). Evaluation of the applicability of draft national norms and standards for organic waste composting to composting facilities on landfill sites. Opportunities for Biomass and Organic Waste Valorisation, 29–46. https://doi.org/10.4324/9780429201998-5

Du Toit, K. (2018). A model for consumer forces of food waste in the retail industry. https://scholar.sun.ac.za

Dudovskiy, J. (2019). Observation - Research-Methodology. Research-Methodology. https://research-methodology.net/research-methods/qualitative-research/observation/

Dung, T., Kumar, G., & Lin, C. (2015). An overview of food waste management in developing countries: Current status and future perspective. Journal of Environmental Management, 2015, 200–209. https://doi.org/10.1016/j.jenvman.2015.04.022

Dupont, J. L., Ahmar, E. L., & Guilpart, J. (2020, March 26). The Role of Refrigeration in Worldwide nutrition (2020), 6th Informatory Note on Refrigeration and Food. Iifiir.org. https://iifiir.org/en/fridoc/the-role-of-refrigeration-in-worldwide-nutrition-2020-142029

Duque-Acevedo, M., Belmonte-Ureña, L. J., Francisco Joaquín Cortés-García, & Camacho-Ferre, F. (2020). Agricultural waste: Review of the evolution, approaches and perspectives on alternative uses. Global Ecology and Conservation, 22, e00902. https://doi.org/10.1016/j.gecco.2020.e00902

Duque-Acevedo, M., Belmonte-Urenaq, L., Cortez-Garcia, F., & Camacho-Ferre, F. (2019). Review of the evolution approaches and perspectives on alternative uses. In Agricultural Waste (pp. 45–60).

Dzumbunu, S. (2017). The causes of food waste in a quick service restaurant supply chain: A South African exploratory case study.

Edwards, R., & Holland, J. (2013). What is qualitative interviewing? Bloomsbury Academic. https://doi.org/10.5040/9781472545244

Elgarahy, A. M., Eloffy, M. G., Alengebawy, A., El-Sherif, D. M., Gaballah, M. S., Guibal, E., & El-Qelish, M. (2023). Sustainable management of food waste; pre-treatment strategies, techno-economic assessment, bibliometric analysis, and potential utilizations: A systematic review. A Systematic Review, 225, 115558–115558. https://doi.org/10.1016/j.envres.2023.115558

Emeji, I. (2015). Production and characterisation of biofuel from waste cooking oil. In The 2015 International Conference on Chemical Engineering 2015. (Issue August, p. 18).

Eriksson, M. (2012). Retail food wastage. a case study approach to quantities and causes (p. 57). Department of Energy and Technology, Swedish University of Agricultural Sciences. http://pub.epsilon.slu.se/9264/1/eriksson_m_121126.pdf

Eriksson, M. (2015). Supermarket food waste: Prevention and management with the focus on reduced waste for reduced carbon footprint (p. 97). Department of Energy and Technology, Swedish University of Agricultural Sciences. http://pub.epsilon.slu.se/12756/1/Eriksson_m_151029.pdf

Eriksson, M., Strid, I., & Per Anders Hansson. (2012). Food losses in six Swedish retail stores: Wastage of fruit and vegetables in relation to quantities delivered.

Resources, Conservation and Recycling, 68, 14–20. https://doi.org/10.1016/j.resconrec.2012.08.001

Erokhin, V., Tianming, G., & Andrei, J. (2023). Demand and Supply. 143–177. https://doi.org/10.1007/978-981-19-9542-2_5

Fabi, C., Cachia, F., Conforti, P., English, A., & José Rosero Moncayo. (2021). Improving data on food losses and waste: From theory to practice. Food Policy, 98. https://doi.org/10.1016/j.foodpol.2020.101934

Facchini, E., Iacovidou, E., Gronow, J., & Nikolaos Voulvoulis. (2018). Food flows in the United Kingdom: The potential of surplus food redistribution to reduce waste. Journal of the Air & Waste Management Association, 68(9), 887–899. https://doi.org/10.1080/10962247.2017.1405854

Falasconi, L., Vittuari, M., Politano, A., & Segrè, A. (2015). Food waste in school catering: An Italian case study. Sustainability (Switzerland), 7(11), 14745–14760. https://doi.org/10.3390/su71114745

Falatouri, T., Darbanian, F., Brandtner, P., & Udokwu, C. (2022). Predictive analytics for demand forecasting - a comparison of SARIMA and LSTM in retail SCM. Procedia Computer Science, 200, 993–1003. https://doi.org/10.1016/j.procs.2022.01.298 FAO. (2013). Food waste footprints. In Food and agriculture organization of the united nation.

FAO. (2014). Innovation in family farming analyses family farms and the role of innovation in ensuring global food security, poverty reduction and environmental sustainability.

FAO. (2020). World food and agriculture - statistical yearbook 2020. In World Food and Agriculture - Statistical Yearbook 2020. FAO. https://doi.org/10.4060/cb1329en

FAO. (2023). The State of Food and Agriculture 2023 | Agrifood Economics | Food and Agriculture Organization of the United Nations. Www.fao.org. https://www.fao.org/agrifood-economics/publications/detail/en/c/1661488/

Fattibene, D., Recanati, F., Dembska, K., & Antonelli, M. (2020). Urban Food Waste: A Framework to Analyse Policies and Initiatives. Resources, 9(9), 99. https://doi.org/10.3390/resources9090099

Feyaerts, H., Van, & Maertens, M. (2019). Global and local food value chains in Africa: A review. Agricultural Economics, 51. https://doi.org/10.1111/agec.12546

Fidersek, A. (2015). Towards Zero Waste Grocery Retail in Scotland: Merging sustainable purchase intentions with actual purchase behaviour. April, 87. https://doi.org/10.13140/RG.2.1.5093.1928

Filho, W. L., Matandirotya, N. R., Lütz, J. M., Alemu, E. A., Brearley, F. Q., Baidoo, A. A., Kateka, A., Ogendi, G. M., Adane, G. B., Emiru, N., & Mbih, R. A. (2021). Impacts of climate change to African indigenous communities and examples of adaptation responses. Nature Communications, 12(1). https://doi.org/10.1038/s41467-021-26540-0

Filimonau, V., & De, A. (2019). Food waste management in hospitality operations: A critical review. Tourism Management, 71, 234–245. https://doi.org/10.1016/j.tourman.2018.10.009

Filimonau, V., & Gherbin, A. (2017). An exploratory study of food waste management practices in the UK grocery retail sector. Journal of Cleaner Production, 167, 1184–1194. https://doi.org/10.1016/j.jclepro.2017.07.229

Flanagan, A., & Anushree Priyadarshini. (2021). A study of consumer behaviour towards food-waste in Ireland: Attitudes, quantities and global warming potentials. Journal of Environmental Management, 284. https://doi.org/10.1016/j.jenvman.2021.112046

Flanagan, K., Robertson, K., & Hanson, C. (2019). Reducing food loss and waste: Setting a global action agenda. World Resources Institute. https://doi.org/10.46830/wrirpt.18.00130

Flower, T., & Ferrier, K. (2012). The truth about food waste. http://www.shiftdesign.org.uk/content/uploads/2014/09/shift_Infographic_outline_FINAL.pdf

Fobbe, L., & Hilletofth, P. (2021). The role of stakeholder interaction in sustainable business models. A systematic literature review. Journal of Cleaner Production, 327(129510), 129510. Sciencedirect. https://doi.org/10.1016/j.jclepro.2021.129510

Food Forward SA. (2023, October 12). Actions to reduce food loss and waste and the regulatory environment in South Africa - FoodForward SA. https://foodforwardsa.org/2023/10/12/actions-to-reduce-food-loss-and-waste-and-the-regulatory-environment-in-south-africa/

Food loss and waste and food security. (2019). Food Loss and Food Waste, 1–26. https://doi.org/10.4337/9781788975391.00006

Food shelf life and its importance for consumers. (2023). www.eufic.org. https://www.eufic.org/en/healthy-living/article/food-shelf-life-and-its-importance-for-consumers

Foureyes. (2023, August 16). Foureyes: The Sales Intelligence Platform. Foureyes. https://foureyes.io/

Franco, S., & Cicatiello, C. (2021). Levering waste taxes to increase surplus food redistribution at supermarkets: Gains and scenarios in Italian municipalities. Waste Management, 121, 286–295. https://doi.org/10.1016/j.wasman.2020.11.042

Friedland, J. (2018). Less than mighty fresh: Confronting supermarket food waste. SAGE Publications: SAGE Business Cases Originals. https://doi.org/10.4135/9781526460783

FUSION. (2014). Food waste quantification manual to monitor food waste amounts and progression. In Fusions (pp. 1–165).

Gaiani, S., & Fonseca, J. (2020). Food security and food waste: key issues. Preventing Food Losses and Waste to Achieve Food Security and Sustainability, 152, 1–36. https://doi.org/10.19103/as.2019.0053.01

Gamboa, G., Kovacic, Z., Marina Di Masso, Mingorría, S., Tiziano Gomiero, Rivera-Ferré, M., & Giampietro, M. (2016). The complexity of food systems: Defining relevant attributes and indicators for the evaluation of food supply chains in Spain. Sustainability (Switzerland), 8(6), 515. https://doi.org/10.3390/su8060515

Ganeson, K., Govindan, M., Bhubalan, K., Razifah, M., Jeyanthi, J., So, S., Amirul, A., Vigneswari, S., & Ramakrishna, S. (2023). Smart packaging − A pragmatic solution to approach sustainable food waste management. Food Packaging and Shelf Life, 36, 101044. https://doi.org/10.1016/j.fpsl.2023.101044

Gao, S., Bao, J., Li, R., Liu, X., & Wu, C. (2021). Drivers and reduction solutions of food waste in the Chinese food service business. Sustainable Production and Consumption, 26, 78–88. https://doi.org/10.1016/j.spc.2020.09.013

Garrone, M., Emmers, D., Olper, A., & Swinnen, J. (2019). Jobs and agricultural policy: Impact of the common agricultural policy on EU agricultural employment. Food Policy, 87, 101744. https://doi.org/10.1016/j.foodpol.2019.101744

Garrone, P., Melacini, M., & Perego, A. (2014). Opening the black box of food waste reduction. Food Policy, 46, 129–139. https://doi.org/10.1016/j.foodpol.2014.03.014

GCCA. (2022). About cold chain. https://www.gcca.org/about/about-cold-chain

George, T. (2022, March 10). Types of Interviews in Research | Guide & Examples. Scribbr. https://www.scribbr.com/methodology/interviews-research/

Ghafari, D. (2022). Sustainable Development Goals (SDG) Waste Indicators. https://wesr.unep.org/sites/default/files/2022-02/Waste_Methodologies.pdf

Ghosh, R., & Eriksson, M. (2019). Food waste due to retail power in supply chains: Evidence from Sweden. Global Food Security, 20, 1–8. https://doi.org/10.1016/j.gfs.2018.10.002

Gie, A. (2022, April 12). Why Quality Control and Temperature Monitoring are important in the Food and Pharmaceutical Industries. Temperature Monitor Solutions Africa. https://temperaturemonitorsolutions.co.za/2022/04/12/why-quality-control-and-temperature-monitoring-are-important-in-the-food-and-pharmaceutical-industries/

Gillespie, J., Pacheco, T., Cama-Moncunill, X., Cadden, T., Condell, J., Cowderoy, T., Ramsey, E., Murphy, F., Kull, M., Gallagher, R., & Ramanathan, R. (2023). Real-time anomaly detection in cold chain transportation using IoT technology. Sustainability. https://api.semanticscholar.org/CorpusID:256324341

Giordano, C., Luca Falasconi, Cicatiello, C., & Pancino, B. (2020). The role of food waste hierarchy in addressing policy and research: A comparative analysis. Journal of Cleaner Production, 252. https://doi.org/10.1016/j.jclepro.2019.119617

Girotto, F., Luca Alibardi, & Cossu, R. (2015). Food waste generation and industrial uses: A review. Waste Management, 45, 32–41. https://doi.org/10.1016/j.wasman.2015.06.008

Glazewski, J. (2011). Fuggle & rabie's environmental management in south africa. Transactions of the Royal Society of South Africa, 66(2), 156–157. https://doi.org/10.1080/0035919x.2011.593204

Godfrey, L. K., & Oelofse, S. H. H. (2017). Historical review of waste management and recycling in South Africa. Resources, 6(4), 57

Godfrey, L., Ahmed, M., Gebremedhin, K., Katima, J., Oelofse, S., Osibanjo, O., Richter, U., & Yonli, A. H. (2020). Solid waste management in Africa: Governance failure or development opportunity? In Regional Development in Africa. (Edomah, N. Ed.). IntechOpen. https://doi.org/10.5772/intechopen.86974

Godfrey, L., Mohamed Tawfic Ahmed, Kidane Giday Gebremedhin, Jamidu H.Y. Katima, Oelofse, S., Oladele Osibanjo, Ulf Henning Richter, & Yonli, A. H. (2020). Solid waste management in africa: Governance failure or development opportunity? Regional Development in Africa. https://doi.org/10.5772/intechopen.86974

Goggins, G., & Rau, H. (2016). Beyond calorie counting assessing the sustainability of food provided for public consumption. Journal of Cleaner Production, 112, 257–266. https://doi.org/10.1016/j.jclepro.2015.06.035

Gokarn, S., & Choudhary, A. (2021). Modeling the key factors influencing the reduction of food loss and waste in fresh produce supply chains. Journal of Environmental Management, 294. https://doi.org/10.1016/j.jenvman.2021.113063

Goodman-Smith, F., Mirosa, M., & Skeaff, S. (2020). A mixed-methods study of retail food waste in New Zealand. Food Policy, 92. https://doi.org/10.1016/j.foodpol.2020.101845

Goonan, S., Mirosa, M., & Spence, H. (2014). Getting a taste for food waste: A mixed methods ethnographic study into hospital food waste before patient consumption conducted at three new zealand foodservice facilities. Journal of the Academy of Nutrition and Dietetics, 114(1), 63–71. https://doi.org/10.1016/j.jand.2013.09.022

Goossens, Y., Wegner, A., & Schmidt, T. (2019). Sustainability assessment of food waste prevention measures: Review of existing evaluation practices. Frontiers in Sustainable Food Systems, 3. https://doi.org/10.3389/fsufs.2019.00090

Government of Mauritius. (2016). Reduce food waste. FWH Mauritius. https://fwhmauritius.com/reduce-food-waste

Graham-Rowe, E., Jessop, D. C., & Sparks, P. (2014). Identifying motivations and barriers to minimising household food waste. Resources, Conservation and Recycling, 84, 15–23. https://doi.org/10.1016/j.resconrec.2013.12.005

Gray, M. (2017). Applied qualitative research design: A total framework approach roller margaret and lavrakas paul applied qualitative research design: A total framework approach 398pp £36.99 guilford press 9781462515752 1462515754. Nurse Researcher, 24(3), 6–6. https://doi.org/10.7748/nr.24.3.6.s3

GreenCape. (2022). Waste Market Intelligence Report. https://greencape.co.za/assets/WASTE_MIR_7_4_22_FINAL.pdf

Greggio, N., Serafini, A., Enrico Balugani, Carlini, C., Contin, A., & Marazza, D. (2021). Quantification and mapping of fish waste in retail trade and restaurant sector: Experience in Emilia-Romagna, Italy. Waste Management, 135, 256–266. https://doi.org/10.1016/j.wasman.2021.09.010

Group, P. F. (2022, October 5). Ambient Foods vs Chilled Foods Vs Frozen Foods [Actual Difference]. Food Distribution Industry News & Trends. https://pentagonfoodgroup.co.uk/blog/difference-between-ambient-chilled-and-frozen-foods/

Group, S. (2022). Food waste: a complex problem tackled systematically by Shoprite. Food Waste. https://www.shopriteholdings.co.za/articles/Newsroom/2022/food-waste-complex-problem-tackled-systematically-by-shoprite.html

Gruber, V., Holweg, C., & Teller, C. (2016). What a waste! Exploring the human reality of food waste from the store manager's perspective. Journal of Public Policy & Marketing, 35(1), 3–25. https://doi.org/10.1509/jppm.14.095

Guion, L. A., Diehl, D. C., & McDonald, D. (2011). Conducting an in-depth interview. Edis, 2011(8). https://doi.org/10.32473/edis-fy393-2011

Gunders. D. (2021). Wasted: How america is losing up to 40 percent of its food from farm to fork to landfill author. In Natural Resources Defense Council.

Gürel, E. (2017). SWOT ANALYSIS: A THEORETICAL REVIEW. Journal of International Social Research, 10, 994–1006. https://doi.org/10.17719/jisr.2017.1832

Gusinja, B. (2018). Analyzing and controlling food waste inside supermarkets. Evaluation of implemented prototype to connect supermarkets with charities.

Gustavsson, J. (2011). Global food losses and food waste. https://api.semanticscholar.org/CorpusID:134229251

Gustavsson, J., Cederberg, C., U. Sonnesson, R. van Otterdijk, & A. Meybeck. (2011). Global food losses and food waste: Extent, Causes and Prevention. Food and Agriculture Organization of the United Nations. https://www.madr.ro/docs/ind-alimentara/risipa_alimentara/presentation_food_waste.pdf%0Ahttp://www.unep.org/wed/2013/%20quickfacts

Halim, K. K., Halim, S., & Felecia. (2019). Business intelligence for designing restaurant marketing strategy: A case study. Procedia Computer Science, 161, 615–622. https://doi.org/10.1016/j.procs.2019.11.164

Hall-Phillips, A., & Shah, P. (2017). Unclarity confusion and expiration date labels in the United States: A consumer perspective. Journal of Retailing and Consumer Services, 35, 118–126. https://doi.org/10.1016/j.jretconser.2016.12.007

Hannah, R. (2019). Food production is responsible for one-quarter of the world's greenhouse gas emissions. Our World in Data. https://ourworldindata.org/emissions-by-sector#:~:text=scalable%20and%20affordable.-,Food%20waste%20is%20responsible%20for%206%25%20of%20global%20greenhouse%20gas,is%20a%20basic%20human%20need.

Hansen, C., Steinmetz, H., & Block, J. (2021). How to conduct a meta-analysis in eight steps: a practical guide. Management Review Quarterly, 72(1). https://doi.org/10.1007/s11301-021-00247-4

Har, L., Rashid, U., Chuan, L., Sen, S., Xia, L. (2022). Revolution of retail industry: From perspective of retail 1.0 to 4.0. Procedia Computer Science, 200, 1615–1625. https://doi.org/10.1016/j.procs.2022.01.362

Harding, K., Basson, L., Brent, A., Freidlich, E., Mbohwa, C., Notten, P., Pineo, C., Ruiters, L., Blottnitz, von, & Vuuren, van. (2015). Status and prospects of lifecycle assessment in South Africa.

Harduth, N., Du Plessis, A., Stais, P., Wickins, G., & Nahman, A. (2017). Food donations as a mechanism to limit food waste , food insecurity and malnutrition. https://www.southernafricafoodlab.org/wp-content/uploads/2017/08/4648377_4.pdf

Hartmann, T., Jahnke, B., & Hamm, U. (2021). Making ugly food beautiful: Consumer barriers to purchase and marketing options for Suboptimal Food at retail level – A systematic review. Food Quality and Preference, 90. https://doi.org/10.1016/j.foodqual.2021.104179

Harvey, J., Smith, A., Goulding, J., & Branco Illodo, Ines. (2020). Food sharing, redistribution, and waste reduction via mobile applications: A social network analysis. Industrial Marketing Management, 88, 437–448. https://doi.org/10.1016/j.indmarman.2019.02.019

Hawkes, C., & Ruel, M. (2011). Value chains for nutrition. 2020 conference: Leveraging agriculture for improving nutrition and health.

Hegazy, R. (2016). Postharvest Situation and Losses in India. https://doi.org/10.6084/M9.FIGSHARE.3206851

Helmold, M. (2022). Supply Chain Management and Distribution Channels. Supply Chain Management and Distribution Channels, 185–198. https://doi.org/10.1007/978-3-031-10097-0_18

Henning, J., Ballen, C., Molina, S., & Cotner, S. (2019). Hidden Identities Shape Student Perceptions of Active Learning Environments. Frontiers in Education, 4. https://doi.org/10.3389/feduc.2019.00129

Hermanussen, H., & Loy, J. (2023). Household Food Waste: A MetaAnalysis. Environmental Challenges, 14, 100809. https://doi.org/10.1016/j.envc.2023.100809

Hermsdorf, D., Rombach, M., & Bitsch, V. (2017). Food waste reduction practices in German food retail. British Food Journal, 119(12), 2532–2546. https://doi.org/10.1108/BFJ-06-2017-0338

Ho, K. S., & Chu, L. M. (2019). Characterization of food waste from different sources in Hong Kong. Journal of the Air and Waste Management Association, 69(3), 277–288. https://doi.org/10.1080/10962247.2018.1526138 Kalia, V., & Gong, C. (2023). Microbial valorization of food wastes to value-added products. In Microbial Bioprocessing of Agri-food Wastes. CRC Press.

Ho, S., & Hoosen, F. (2023). Load shedding: A chilling disruption of the cold chain. Www.bdo.co.za. https://www.bdo.co.za/en-za/insights/2023/advisory/load-shedding-a-chilling-disruption-of-the-cold-chain

Hodges, R. J., Buzby, J. C., & Bennett, B. (2011). Postharvest losses and waste in developed and less developed countries: Opportunities to improve resource use. Journal of Agricultural Science, 149(S1), 37–45. https://doi.org/10.1017/S0021859610000936

Home Biogas. (2021). Home biogas. In Home Biogas - Beginners Guide.

Huang, I., Manning, L., James, K. L., Vasilis Grigoriadis, Millington, A., Wood, V., & Ward, S. (2021). Food waste management: A review of retailers' business practices and their implications for sustainable value. Journal of Cleaner Production, 285. https://doi.org/10.1016/j.jclepro.2020.125484

Hudson, B., Hunter, D., & Peckham, S. (2019). Policy Failure and the policy-implementation gap: Can Policy Support Programs help? Policy Design and Practice, 2(1), 1–14. Tandfonline. https://doi.org/10.1080/25741292.2018.1540378

Hudson, U., & Messa, M. (2015). Position paper on food losses and waste. In Slow Food.

Hunt, X., Stein, D. J., Nic Spaull, & Tomlinson, M. (2021). Hunger as a driver of depressive symptoms: Optimising responses to mental health aspects of the COVID-19 pandemic. South African Medical Journal, 111(7), 604–605. https://doi.org/10.7196/SAMJ.2021.v111i7.15754

İlkin, Y. Ö., Ayşe, A. Ö., & Ecer, F. (2023). Prioritizing causes and drivers of retail food waste through a fuzzy DombiBonferroni operatorsbased best–worst approach: an emerging economy perspective. Environmental Science and Pollution Research, 30(2), 4899–4916. https://doi.org/10.1007/s11356022225534

Ingrao, C., Strippoli, R., Lagioia, G., & Huisingh, D. (2023). Water scarcity in agriculture: An overview of causes, impacts and approaches for reducing the risks. Heliyon, 9(8), e18507. https://doi.org/10.1016/j.heliyon.2023.e18507

Institute of Food Technologists (IFT). (2015). The difference between "Use-By" "Sell-By" and "Best-By" dates. ScienceDaily. https://www.sciencedaily.com/releases/2015/04/150415203336.htm

International Institute of Refrigeration [IIF/IIR]. (2021). International Institute of Refrigeration (IIR). Iifiir.org. https://iifiir.org/en

IOL Reporter. (2021, October 12). More than 40% of South Africans go to bed hungry every night. IOL News. https://www.iol.co.za/news/south-africa/kwazulu-natal/more-than-40-of-south-africans-go-to-bed-hungry-every-night-d11dce16-b5c3-4a28-96ed-c51a105c1747

Irani, Z., Sharif, A. M., Lee, H., Emel Aktas, Zeynep Topaloğlu, Tamara van't Wout, & Huda, S. (2018). Managing food security through food waste and loss: small data to big data. Computers and Operations Research, 98, 367–383. https://doi.org/10.1016/j.cor.2017.10.007

Ishangulyyev, R., Kim, S., & Lee, S. (2019). Understanding food loss and Waste—Why are we losing and wasting food? Foods, 8(8), 297. https://doi.org/10.3390/foods8080297

James, C., Accorsi, R., & Manzini, R. (2019, January 1). Chapter 13 - Food transportation and refrigeration technologies—Design and optimization. ScienceDirect; Academic Press. https://www.sciencedirect.com/science/article/abs/pii/B9780128134115000132

James, S. J., & James, C. (2014, January 1). Chapter 20 - Chilling and Freezing (Y. Motarjemi & H. Lelieveld, Eds.). ScienceDirect; Academic Press. https://www.sciencedirect.com/science/article/abs/pii/B9780123815040000202

Jedermann, R., Nicometo, M., Uysal, I., & Lang, W. (2014). Reducing food losses by intelligent food logistics. Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences, 372(2017), 20130302–20130302. https://doi.org/10.1098/rsta.2013.0302

Jedermann, R., Nicometo, M., Uysal, I., & Lang, W. (2014). Reducing food losses by intelligent food logistics. Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences, 372(2017), 20130302–20130302. https://doi.org/10.1098/rsta.2013.0302

Jenkin, N. (2018). Causes of food waste in international supply chains Sustainable Banking View project Understanding the interface between South Africa's pulp and paper sector and skill required to adopt biorefinery technologies: A case study View project. https://www.researchgate.net/publication/322266297

Jenkin, N., Bormann, T., de Vries , L., Tian, N., Modau, I., Pillay, P., Carle, B., & Notten, P. (2017). Food Loss and Waste: Facts and Futures: Taking steps towards a more sustainable food future.

Jensen, J., Kristin Balslev Munksgaard, & Jan Stentoft Arlbjørn. (2013). Chasing value offerings through green supply chain innovation. European Business Review, 25(2), 124–146. https://doi.org/10.1108/09555341311302657

Jere, A. K., Parker, J., Thembeka Sikobi, Jones, P., & Mason, R. B. (2021). Food waste and its effect on green retailing in South Africa. African Journal of Business and Economic Research, 16(3), 93–115. https://doi.org/10.31920/1750-4562/2021/V16N3A5

Jesse, B., Perotti, A., & Roos, D. (2022). Decarbonizing grocery | McKinsey. Www.mckinsey.com. https://www.mckinsey.com/industries/retail/our-insights/decarbonizing-grocery

Jeswani, H. K., Figueroa-Torres, G., & Adisa Azapagic. (2021). The extent of food waste generation in the UK and its environmental impacts. Sustainable Production and Consumption, 26, 532–547. https://doi.org/10.1016/j.spc.2020.12.021

Joardder, M. U. H., & Masud, M. H. (2019). Food Preservation in Developing Countries: Challenges and Solutions. Springer International Publishing. https://doi.org/10.1007/978-3-030-11530-2

Johnston, J., Garmyn, A. J., Cown, C., Kelly, J., & Miller, M. F. (2017). Retail meat case survey-2015. Meat and Muscle Biology, 1(3), 36–36. https://doi.org/10.22175/rmc2017.033

Joshi, P., & Visvanathan, C. (2019). Sustainable management practices of food waste in Asia: Technological and policy drivers. Journal of Environmental Management, 247, 538–550. https://doi.org/10.1016/j.jenvman.2019.06.079

Jung, S.-H. (2014). Stratified Fisher’s exact test and its sample size calculation. Biometrical Journal, 56(1), 129–140. https://doi.org/10.1002/bimj.201300048

Kaptein, M. (2018). The appearance standard: Criteria and remedies for when a mere appearance of unethical behavior is morally unacceptable. Business Ethics: A European Review, 28(1), 99–111. https://doi.org/10.1111/beer.12195

Karatay, S. T., & Shanty, O. (2019). Statistical yearbook - statistical yearbook. Uae. https://www.moh.gov.sa/en/Ministry/Statistics/Book/Pages/default.aspx

Karwowska, M., Łaba, S., & Szczepański, K. (2021). Food loss and waste in meat Sector—Why the consumption stage generates the most losses? Sustainability, 13(11), 6227. https://doi.org/10.3390/su13116227

Kasza, G., Veflen, N., Scholderer, J., Münter, L., Fekete, L., Csenki, E. Z., Dorkó, A., Szakos, D., & Izsó, T. (2022). Conflicting Issues of Sustainable Consumption and Food Safety: Risky Consumer Behaviors in Reducing Food Waste and Plastic Packaging. Foods, 11(21), 3520. https://doi.org/10.3390/foods11213520

Kayikci, Y., Demir, S., Mangla, S. K., Subramanian, N., & Koc, B. (2022). Data-driven optimal dynamic pricing strategy for reducing perishable food waste at retailers. Journal of Cleaner Production, 344. https://doi.org/10.1016/j.jclepro.2022.131068

Kazaz, B., Xu, F., & Yu, H. (2023). Retailing Strategies of Imperfect Produce and the Battle Against Food Waste. SSRN Electronic Journal. https://doi.org/10.2139/ssrn.4392397

Khanam, S. (2021). Retail food waste: Existing research and research gap. Annals of Social Sciences & Management Studies, 6(5). https://doi.org/10.19080/asm.2021.06.555696

Khonjelwayo, B., & Nthakheni, T. (2021). Determining the causes of electricity losses and the role of management in curbing them: A case study of City of Tshwane Metropolitan Municipality, South Africa. Journal of Energy in Southern Africa, 32(4), 45–57. https://doi.org/10.17159/2413-3051/2021/v32i4a8704

Killeen, E. (2016). Food waste at retail. ProQuest Dissertations and Theses. http://scholarworks.uark.edu/etdhttp://scholarworks.uark.edu/etd/1283%0Ahttp://0-search.proquest.com.pugwash.lib.warwick.ac.uk/docview/1710035922?accou ntid=14888%5Cnhttp://webcat.warwick.ac.uk:4550/resserv??genre=dissertations+%26+theses&issn=&title=Food+

King, A. P., & Eckersley, R. J. (2019). Experimental design and sample size calculations. In Statistics for Biomedical Engineers and Scientists (pp. 201–216). Elsevier. https://doi.org/10.1016/B978-0-08-102939-8.00018-9

Kıran, E. U., Trzcinski, A. P., & Liu, Y. (2015). Platform chemical production from food wastes using a biorefinery concept. Journal of Chemical Technology & Biotechnology, 90(8), 1364–1379. https://doi.org/10.1002/jctb.4551

Kiran, U., Trzcinski, A. P., Ng, W. J., & Liu, Y. (2014). Bioconversion of food waste to energy: A review. Fuel, 134, 389–399. https://doi.org/10.1016/j.fuel.2014.05.074

Kirby, M. E., Hornung, A., Miloud Ouadi, & Theodorou, M. K. (2017). The role of thermo-catalytic reforming for energy recovery from food and drink supply chain wastes. Energy Procedia, 123, 15–21. https://doi.org/10.1016/j.egypro.2017.07.279

Kliaugaitė, D., & Kruopienė, J. (2017). Lietuvos mažmeninės prekybos sektoriuje susidarančių maisto atliekų įvertinimas ir prevencijos priemonės: Lyginamasis tyrimas. Environmental Research, Engineering and Management, 73(4), 7–20. https://doi.org/10.5755/j01.erem.73.4.19941 Koktsidis, A. (2016). Waste management and sustainable development in the retail sector: The case of supermarkets.

Kohli, K., Prajapati, R., Shah, R., Das, M., & K. Sharma, B. (2024). Food waste: environmental impact and possible solutions. Sustainable Food Technology. https://doi.org/10.1039/D3FB00141E

Kotiranta, A., Tahvanainen, A., Kovalainen, A., & Poutanen, S. (2020). Forms and varieties of research and industry collaboration across disciplines. Heliyon, 6(3), e03404. https://doi.org/10.1016/j.heliyon.2020.e03404

Koupal, J., DeFries, T., Palacios, C., Fincher, S., & Preusse, D. (2014). Motor vehicle emissions simulator input data: Evaluation and sensitivity analysis of data submitted for 2011 national emissions inventory. Transportation Research Record, 2427(1), 63–72. https://doi.org/10.3141/2427-07

Kowalski, Z., Kulczycka, J., Makara, A., & Harazin, P. (2021). Quantification of material recovery from meat waste incineration – An approach to an updated food waste hierarchy. Journal of Hazardous Materials, 416. https://doi.org/10.1016/j.jhazmat.2021.126021

Kowaltowski, A., & Abdulkader, F. (2020). Where does all that food go? Where Does All That Food Go? https://doi.org/10.1007/978-3-030-50968-2

KPMG. (2023). Carbon Tax - Extending the utilisation period in the Carbon Offsets Regulations. https://assets.kpmg.com/content/dam/kpmg/us/pdf/2023/02/tnf-sa-feb23-2023.pdf

Krzywoszynska, A. (2011). ¡i¿Waste: Uncovering the global food scandal¡/i¿. Geography, 96(2), 101–104. https://doi.org/10.1080/00167487.2011.12094317

Kubanza, S., & Simatele, M. (2019). Sustainable solid waste management in developing countries: a study of institutional strengthening for solid waste management in Johannesburg, South Africa. Journal of Environmental Planning and Management, 63, 1–14. https://doi.org/10.1080/09640568.2019.1576510

Kuhlmann, K., & Agutu, A. L. (2020, March 16). The African Continental Free Trade Area: Toward a New Legal Model for Trade and Development. Papers.ssrn.com. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3599438

Kushner, D. (2017). Allies or Adversaries: NGOs and the State in Africa. The Journal of Development Studies, 53(11), 1963–1964. https://doi.org/10.1080/00220388.2017.1361136

Kutsyuruba, B. (2023). Document Analysis. Springer Texts in Education, 139–146. https://doi.org/10.1007/978-3-031-04394-9_23

Lagorio, A., & Pinto, R. (2021). Food and grocery retail logistics issues: A systematic literature review. Research in Transportation Economics, 87. https://doi.org/10.1016/j.retrec.2020.100841

Larsen, M. H., Dalmasso, M., Ingmer, H., Langsrud, S., Malakauskas, M., Mader, A., Møretrø, T., Smole Možina, S., Rychli, K., Wagner, M., John Wallace, R., Zentek, J., & Jordan, K. (2014). Persistence of foodborne pathogens and their control in primary and secondary food production chains. Food Control, 44, 92–109. https://doi.org/10.1016/j.foodcont.2014.03.039

Le Borgne, G., Sirieix, L., & Costa, S. (2018). Perceived probability of food waste: Influence on consumer attitudes towards and choice of sales promotions. Journal of Retailing and Consumer Services, 42, 11–21. https://doi.org/10.1016/j.jretconser.2018.01.004

Lebersorger, S., & Schneider, F. (2014). Food loss rates at the food retail, influencing factors and reasons as a basis for waste prevention measures. Waste Management, 34(11), 1911–1919. https://doi.org/10.1016/j.wasman.2014.06.013

Lee, D., & Mustafa Hayri Tongarlak. (2017). Converting retail food waste into by-product. European Journal of Operational Research, 257(3), 944–956. https://doi.org/10.1016/j.ejor.2016.08.022

Lee, D., Erkut Sönmez, Gómez, M. I., & Fan, X. (2017). Combining two wrongs to make two rights: Mitigating food insecurity and food waste through gleaning operations. Food Policy, 68, 40–52. https://doi.org/10.1016/j.foodpol.2016.12.004

Lee, K. C. L. (2018). Grocery shopping, food waste, and the retail landscape of cities: The case of Seoul. Journal of Cleaner Production, 172, 325–334. https://doi.org/10.1016/j.jclepro.2017.10.085

Leedy, P. D., & Ormrod, J. E. (2019). Practical Research: Planning and Design, 12th Edition. In ERIC. Pearson. https://eric.ed.gov/?q=leedy+and+ormrod&id=ED594592

Lehtokunnas, T., & Pyyhtinen, O. (2022). Food, excess, wastage and waste: An ethnography of the practices of framing food products in the Finnish retail sector. Geoforum, 129, 28–38. https://doi.org/10.1016/j.geoforum.2022.01.004

Leverenz, D., Hafner, G., Salua Moussawel, Kranert, M., Goossens, Y., & Schmidt, T. (2021). Reducing food waste in hotel kitchens based on self-reported data. Industrial Marketing Management, 93, 617–627. https://doi.org/10.1016/j.indmarman.2020.08.008

Li, C., Bremer, P., Harder, M. K., Lee, M. S., Parker, K., Gaugler, E. C., & Mirosa, M. (2022). A systematic review of food loss and waste in China: Quantity, impacts and mediators. Journal of Environmental Management, 303. https://doi.org/10.1016/j.jenvman.2021.114092

Liang, T., Zhang, T., Xipeng, L., Tafone, A., Legrand, M., He, X., Kildahl, H., Lu, C., Chen, H., Romagnoli, A., Wang, L., He, Q., Li, Y., & Ding, Y. (2022). Liquid air energy storage technology: a comprehensive review of research, development and deployment. Progress in Energy, 5(1), 012002–012002. https://doi.org/10.1088/2516-1083/aca26a

Linneberg, M., & Korsgaard, S. (2019). Coding qualitative data: a synthesis guiding the novice. Qualitative Research Journal. https://doi.org/10.1108/QRJ1220180012

Lipinski, B. A., Hanson, C. A., Waite, R., Searchinger, T. D., Lomax, J., & Kitinoja, L. A. (2013). Reducing food loss and waste. https://api.semanticscholar.org/CorpusID:220662143

Loannou, A., Georgali, P. Z., & Fokaides, P. A. (2022). Quantification of food waste in an insular island state for all stages of the food supply chain. Resources, Conservation and Recycling, 185, 106486. https://doi.org/10.1016/j.resconrec.2022.106486

Lobdell, K. (2023). Supply chain risk management strategies. Tax.thomsonreuters.com. https://tax.thomsonreuters.com/en/insights/articles/supply-chain-risk-management-strategies

Lombardi, M., & Costantino, M. (2021). A hierarchical pyramid for food waste based on a social innovation perspective. Sustainability (Switzerland), 13(9), 4661. https://doi.org/10.3390/su13094661

Lourenco, C., Porpino, G., Lobo, M., Luciana Marques Vieira, & Daniele Eckert Matzembacher. (2022). We need to talk about infrequent high volume household food waste: A theory of planned behaviour perspective. Sustainable Production and Consumption, 33, 38–48. https://doi.org/10.1016/j.spc.2022.06.014

LS Retail. (2022). Six ways supermarkets can reduce food waste. In Six ways supermarkets can reduce food waste.

Lukić, R. (2016). Sustainable reporting in the retail food. Food Markets: Consumer Perceptions, Government Regulations and Health Impacts. https://www.researchgate.net/publication/320138915

Luo, N., Olsen, T., Liu, Y., & Zhang, A. (2022). Reducing food loss and waste in supply chain operations. Transportation Research Part E: Logistics and Transportation Review, 162. https://doi.org/10.1016/j.tre.2022.102730

Mabaso, C. (2017). Food waste management within an hotel group in gauteng. PQDT - Global. https://www.proquest.com/dissertations-theses/food-waste-management-within-hotel-group-gauteng/docview/2524198240/se-2?accountid=159111%0Ahttps://ujcontent.uj.ac.za/vital/access/manager/Repository/uj:28905?site_name=GlobalView

Magalhães, V. S., Ferreira, L., & Silva, C. (2021). Causes and mitigation strategies of food loss and waste: A systematic literature review and framework development. Sustainable Production and Consumption, 28, 1580–1599. https://doi.org/10.1016/j.spc.2021.08.004

Magnuson , J., & Dixon, B. E. (2020). Public Health Informatics: An Introduction. In J. A. Magnuson & B. E. Dixon (Eds.), Public Health Informatics and Information Systems (pp. 3–16). Springer International Publishing. https://doi.org/10.1007/9783030412159_1

Mahmudul, H. M., Rasul, M. G., Akbar, D., Narayanan, R., & M. Mofijur. (2022). Food waste as a source of sustainable energy: Technical, economical, environmental and regulatory feasibility analysis. Renewable and Sustainable Energy Reviews, 166, 112577. https://doi.org/10.1016/j.rser.2022.112577

Mak, T. M. W., Xiong, X., Tsang, D. C. W., Yu, I. K. M., & Poon, C. S. (2020). Sustainable food waste management towards circular bioeconomy: Policy review, limitations and opportunities. Bioresource Technology, 297. https://doi.org/10.1016/j.biortech.2019.122497

Makanjuola, O., Arowosola, T., & Du, C. (2020). The Utilization of Food Waste: Challenges and Opportunities Open Access. Journal of Food Chemistry & Nanotechnology, 6. https://doi.org/10.17756/jfcn.20200100

Mannie, N., & Bowers, A. (2014). Challenges in determining the correct waste disposal solutions for local municipalities - a South African overview. https://api.semanticscholar.org/CorpusID:107397410

Marais, L., Owen, J. R., Kotzè, T., Nel, P., Cloete, J., & Molefi Lenka. (2021). Determinants of place attachment among mineworkers: Evidence from South Africa. Extractive Industries and Society, 8(3). https://doi.org/10.1016/j.exis.2021.100943

Marr, B. (2022, February 3). How To Understand Your Customers And Their Needs With The Right Data. Forbes. https://www.forbes.com/sites/bernardmarr/2022/02/03/how-to-understand-your-customers-and-their-needs-with-the-right-data/

Marrucci, L., Marchi, M., & Daddi, T. (2020). Improving the carbon footprint of food and packaging waste management in a supermarket of the Italian retail sector.

Waste Management, 105, 594–603. https://doi.org/10.1016/j.wasman.2020.03.002

Marshak, M. (2012). Systems in transition: From waste to resource. A study of supermarket food waste in cape town.

Marshall, M. (2022). The refrigerator as a problem and solution: Food storage practices as part of sustainable food culture. Food and Foodways, 30(4), 1–26. https://doi.org/10.1080/07409710.2022.2124726

Martindale, W., & Schiebel, W. (2017). The impact of food preservation on food waste. British Food Journal, 119(12), 2510–2518. https://doi.org/10.1108/BFJ-02-2017-0114

Martin-Rios, C., Demen-Meier, C., Gössling, S., & Clémence Cornuz. (2018). Food waste management innovations in the foodservice industry. Waste Management, 79, 196–206. https://doi.org/10.1016/j.wasman.2018.07.033

Martin-Rios, C., Juan Carlos Arboleya, Bolton, J., & Erhardt, N. (2022). Editorial: Sustainable food waste management. Frontiers in Sustainable Food Systems, 6. https://doi.org/10.3389/fsufs.2022.885250

Marx-Pienaar, N., RAND, G. D., VILJOEN, A., & FISHER, H. (2018). FOOD WASTAGE: A CONCERN ACROSS THE SOUTH AFRICAN QUICK SERVICE RESTAURANT SUPPLY CHAIN. WIT Transactions on Ecology and the Environment. https://doi.org/10.2495/wm180221

Mateboho, L., & Chenene, L. (2020). the relationship between household-generated food waste in rural and urban lesotho: an investigation.

Mathee, L-M. (2020). Exploring household behaviour contributing to food waste in mangaung, free state.

Matlhare, M. (2020). Sustainability in a complex environment: A systems thinking approach to the mining sector.

Mavraki, V., Thompson, K., Ward, P. R., & Coveney, J. (2015). Food waste. In The SAGE Encyclopedia of Food Issues. SAGE Publications, Inc. https://doi.org/10.4135/9781483346304.n194

Maziriri, E. T., Rukuni, T. F., & Chuchu, T. (2021). Factors influencing food consumption satisfaction and purchase decisions of restaurant consumers. Cogent Business & Management, 8(1). https://doi.org/10.1080/23311975.2021.1968731

McArthur, J.-A. (2021, August 20). Methane emissions are driving climate change. Here’s how to reduce them. United Nations Environment Programme. https://www.unep.org/news-and-stories/story/methane-emissions-are-driving-climate-change-heres-how-reduce-them

McCombes, S. (2019). Descriptive research design | definition, methods and examples. Scribbr. https://www.scribbr.com/methodology/descriptive-research/

Mena, C., B. Adenso-Diaz, & Yurt, O. (2011). The causes of food waste in the supplier–retailer interface: Evidence from the UK and Spain. Resources, Conservation and Recycling, 55(6), 648–658. https://doi.org/10.1016/j.resconrec.2010.09.006

Mena, C., Terry, L. A., Williams, A., & Ellram, L. (2014). Causes of waste across multi-tier supply networks: Cases in the UK food sector. International Journal of Production Economics, 152, 144–158. https://doi.org/10.1016/j.ijpe.2014.03.012

Mensah, E., & Goderre, J. L. (2020). Data Sources and Data Tools: Preparing for the Open Data Ecosystem. Health Informatics, 105–127. https://doi.org/10.1007/978-3-030-41215-9_7

Menyuka, Sibanda, & Bob. (2020). Perceptions of the Challenges and Opportunities of Utilising Organic Waste through Urban Agriculture in the Durban South Basin. International Journal of Environmental Research and Public Health, 17(4), 1158. https://doi.org/10.3390/ijerph17041158

Merino, C., & SalasBlas, E. (2018). Brief Sensation Seeking Scale: Latent structure of 8item and 4item versions in Peruvian adolescents. Adicciones, 30, 41–53.

Messner, R., Johnson, H., & Richards, C. (2022). Towards systemic solutions to food waste: Creative destabilisation and escaping food waste lock-in. Journal of Rural Studies, 92, 180–188. https://doi.org/10.1016/j.jrurstud.2022.03.023

Michael, S. (2017). United nations development programme (UNDP). In Max Planck Encyclopedia of Public International Law. Oxford University Press. https://doi.org/10.1093/law:epil/9780199231690/e550

Miguéis, V. L., Pereira, A., Pereira, J., & Figueira, G. (2022). Reducing fresh fish waste while ensuring availability: Demand forecast using censored data and machine learning. Journal of Cleaner Production, 359. https://doi.org/10.1016/j.jclepro.2022.131852

Ming Juan Ding, Jie, F., Parton, K. A., & Matanda, M. J. (2014). Relationships between quality of information sharing and supply chain food quality in the Australian beef processing industry. International Journal of Logistics Management, 25(1), 85–108. https://doi.org/10.1108/IJLM-07-2012-0057

Modibedi, T. P., Maake, M., Masekoameng, M. R., Tekana, S. S., & Oduniyi, O. S. (2021). Vegetable consumption patterns of urban farmers in community gardens in Emfuleni local municipality, Gauteng province of South Africa. African Journal of Food, Agriculture, Nutrition and Development, 21(04), 17891–17906. https://doi.org/10.18697/ajfand.99.18910

Mohajan, H. (2021). Quantitative Research: A Successful Investigation in Natural and Social Sciences. Journal of Economic Development, Environment and People, 9. https://doi.org/10.26458/jedep.v9i4.679

Mohan, S., Mohan, S., & K Jagadeesan. (2022). Production of biogas by using food waste solid waste management, biomethanation technology view project production biogas anaerobic digestion food waste view project production of biogas by using food waste. 3, 390–394. https://www.researchgate.net/publication/357991833

Mohanty, A., Megha Mankoti, Prangya Ranjan Rout, Sumer Singh Meena, Dewan, S., Kalia, B., Sunita Varjani, Jonathan W.C. Wong, & J. Rajesh Banu. (2022). Sustainable utilization of food waste for bioenergy production: A step towards circular bioeconomy. International Journal of Food Microbiology, 365, 109538. https://doi.org/10.1016/j.ijfoodmicro.2022.109538

Molina, G., Sharma, M., Benhida, R., Gupta, V. K., & Kuhad, R. C. (2023). Microbial Bioprocessing of Agri-food Wastes. CRC Press.

Møller, H., Hanssen, O., Svanes, E., Hartikainen, H., Kirsi Silvennoinen, Gustavsson, J., Östergren, K., Schneider, F., Soethoudt, H., Canali, M., Politano, A., Gaiani, S., Redlingshöfer, B., Moates, G., Waldron, K., & Åsa Stenmarck. (2014). Standard approach on quantitative techniques to be used to estimate food waste levels. http://www.eu-fusions.org/index.php/download?download=2:standard-approach-on-quantitative-techniques

Mondal, T., Choudhury, M., Kundu, D., Dutta, D., & Samanta, P. (2023). Landfill: An eclectic review on structure, reactions and remediation approach. Waste Management, 164, 127–142. https://doi.org/10.1016/j.wasman.2023.03.034

Mondéjar-Jiménez, J. A., Ferrari, G., Secondi, L., & Principato, L. (2016). From the table to waste: An exploratory study on behaviour towards food waste of Spanish and Italian youths. Journal of Cleaner Production, 138, 8–18. https://doi.org/10.1016/j.jclepro.2016.06.018

Monterrosa, E. C., Frongillo, E. A., Drewnowski, A., de Pee, S., & Vandevijvere, S. (2020). Sociocultural Influences on Food Choices and Implications for Sustainable Healthy Diets. Food and Nutrition Bulletin, 41(2), 59S73S. https://doi.org/10.1177/0379572120975874

Moodley, L. (2017). Landfill 2017: what to expect. Sabinet African Journals. https://journals.co.za/doi/10.10520/EJC-966e0c97c

Moodley, L., Papanicolaou, R., & Domun, V. (2019). Insufficient airspace – Please load airspace.

https://iwmsa.co.za/sites/all/themes/corporateclean/pdf/landfill%2520papers/LAWTIG%25202019%252%0A0-%2520Academic%2520Paper%2520%2528L%2520Moodley%2529.pdf

Moraes, N. V., Lermen, F. H., & Soares, E. (2021). A systematic literature review on food waste/loss prevention and minimization methods. Journal of Environmental Management, 286. https://doi.org/10.1016/j.jenvman.2021.112268

Morley, K. (2016). End to multi-buy deals as Sainsburys and Tesco to axe "old fashioned" offers. The Telegraph. http://www.telegraph.co.uk/finance/personalfinance/household-bills/12151067/Supermarkets-face-ban-on-special-offers-that-cost-shoppers-1000-a-year.html

Mortillaro, N. (2023, December 12). Here's why food waste is a major climate change issue. CBC. https://www.cbc.ca/news/science/food-waste-emissions-1.7050863

Morya, S. (2020). Food poisoning hazards and their consequences over food safety. Microorganisms for Sustainable Environment and Health, 383–400. https://doi.org/10.1016/B978-0-12-819001-2.00019-X

Mosna, D., Bottani, E., Vignali, G., & Montanari, R. (2021). Environmental benefits of pet food obtained as a result of the valorisation of meat fraction derived from packaged food waste. Waste Management, 125, 132–144. https://doi.org/10.1016/j.wasman.2021.02.035

Mullick, S., Néomie Raassens, Haans, H., & Nijssen, E. J. (2021). Reducing food waste through digital platforms: A quantification of cross-side network effects. Industrial Marketing Management, 93, 533–544. https://doi.org/10.1016/j.indmarman.2020.09.021

Munir, K. (2022). Sustainable food waste management strategies by applying practice theory in hospitality and food services- a systematic literature review. Journal of Cleaner Production, 331. https://doi.org/10.1016/j.jclepro.2021.129991

Muposhi. A, & Dhurup. M. (2021). Psychosocial correlates of deceptive e-cigarette counterfeit susceptibility: A Web's law-persuasion-trait theory perspective. African Journal of Business and Economic Research, 16(2), 95–115. https://doi.org/10.31920/1750-4562/2021/V16N2A5

Muriana, C. (2017). A focus on the state of the art of food waste/losses issue and suggestions for future research. Waste Management, 68, 557–570. https://doi.org/10.1016/j.wasman.2017.06.047

Muzenda, E., Ntuli, F., & Pilusa, T. J. (2012). Waste Management, Strategies and Situation in South Africa: An Overview. World Academy of Science, Engineering and Technology, International Journal of Environmental, Chemical, Ecological, Geological and Geophysical Engineering. https://www.semanticscholar.org/paper/Waste-Management%2C-Strategies-and-Situation-in-South-Muzenda-Ntuli/78563c1783c8137f637f7c77e78b1ccc31771e88

Nachmias, C. F., Nachmias, D., & DeWaard, J. (2014). Research Methods in the Social Sciences. In Google Books. Macmillan Learning. https://books.google.co.za/books/about/Research_Methods_in_the_Social_Sciences.html?id=2aDJoQEACAAJ&redir_esc=y

Närvänen, E., Mattila, M., Joona Keränen, Kaivonen, I., & Mikael Nurminen. (2022). Framing value propositions in the food waste business: A sociocultural approach. Industrial Marketing Management, 105, 211–222. https://doi.org/10.1016/j.indmarman.2022.06.008

Närvänen, E., Mesiranta, N., Mattila, M., & Heikkinen, A. (2019). Introduction: A Framework for Managing Food Waste. Food Waste Management, 1–24. https://doi.org/10.1007/978-3-030-20561-4_1

National Waste Management Strategy. (2020). NATIONAL WASTE MANAGEMENT STRATEGY 2020. https://www.dffe.gov.za/sites/default/files/docs/2020nationalwaste_managementstrategy1.pdf

National Zero Waste Council. (2022). NZWC - Home. Nzwc.ca. https://nzwc.ca/

Navarro Ferronato, Torretta, V., Godfrey, L., Oelofse, S., Gregory, L., Glushkov, I. V., Lupachik, V. V., Zhuravleva, I. V., A Yu. Yaroshenko, Komarova, A. F., Drozdovskaya, M. A., Drozdovskiy, A. N., Pilipenko, A. V., N Yu. Barakova, M Yu. Vasilieva, Koltsov, D. B., Zenkevitch, Y. E., Zudkin, A. G., Andreeva, A. A., & Erdener Karadağ. (2018). Corporate social responsibility and accountability: a new theoretical foundation for regulating CSR. Corporate Social Responsibility and Environmental Management, 55(1), 261–272. https://doi.org/10.1002/csr.140

Ndlovu, M., Clulow, A. D., Savage, M. J., Luxon Nhamo, Magidi, J., & Tafadzwanashe Mabhaudhi. (2021). An assessment of the impacts of climate variability and change in KwaZulu-Natal province, South Africa. Atmosphere, 12(4). https://doi.org/10.3390/atmos12040427

Ndraha, N., Hsiao, H.-I., Vlajic, J., Yang, M.-F., & Lin, H.-T. V. (2018). Time-temperature abuse in the food cold chain: Review of issues, challenges, and recommendations. Food Control, 89, 12–21. https://doi.org/10.1016/j.foodcont.2018.01.027

Ndraha, N., Vlajic, J., Chang, C.-C., & Hsiao, H.-I. (2020). Challenges with food waste management in the food cold chains. In Food Industry Wastes (pp. 467–483). Elsevier. https://doi.org/10.1016/B978-0-12-817121-9.00022-X

Nel, A. (2017). Pick n pay food waste strategy. In Food Waste Industry-meets-Science workshop.

Nel, L., Teffo, T., Mabuyakhulu, M., Kruger, P., Munnisunker, S., & Nzimande, N. (2020). Sustainable development of South AfricaAn incountry perspective.

NEMWA. (2014). Government Gazette. https://www.dffe.gov.za/sites/default/files/legislations/nemwa_actno26of2014.pdf

Nenwell. (2021). Types And Purposes Of Commercial Display Freezers For Retail Businesses. Https://Www.nenwell.com/. https://www.nenwell.com/news/types-and-purposes-of-commercial-display-freezers-for-retail-businesses/

Ngulube, P. (2015). Qualitative Data Analysis and Interpretation: Systematic Search for Meaning. https://doi.org/10.13140/RG.2.1.1375.7608

Nicosia, C., Fava, P., Pulvirenti, A., & Licciardello, F. (2022). Secondary shelf-life assessment of UHT milk and its potential for food waste reduction. Food Packaging and Shelf Life, 33, 100880. https://doi.org/10.1016/j.fpsl.2022.100880

Nieuwenhuis, J. (2016). Introducing qualitative research. In: Maree, k. ed. First steps in research (pp. 50–68).

Nikolicic, S., Milorad Kilibarda, Marinko Maslaric, Dejan Mircetic, & Bojic, S. (2021). Reducing food waste in the retail supply chains by improving efficiency of logistics operations. Sustainability (Switzerland), 13(12). https://doi.org/10.3390/su13126511

Nouruzpour, N., & Broumand, Z. (2014). The survey effective factors the consumer behavior on the Kalleh food products. In Arabian Journal of Business and Management Review, 1(12).

Ntobaki, P., HawkinsMofokeng, R., & Tlapana, T. (2022). Consumer purchase behaviour of perishable products from selected stores in Durban. International Journal of Research in Business and Social Science (21474478), 11, 76–81. https://doi.org/10.20525/ijrbs.v11i1.1559

Nunley, M., & Phillips, S. (2013). From farm to fork to landfill: Food waste and consumption in america food waste and consumption in america. http://scholarship.claremont.edu/pitzer_theses/37

Nwangwu, G. (2016). Stakeholder Opposition Risk. Palgrave Macmillan UK EBooks, 185–218. https://doi.org/10.1057/978-1-137-54242-7_9

Nyika, J., Onyari, E., Mishra, S., & Dinka, M. (2019). Waste Management in South Africa (pp. 327–351). https://doi.org/10.4018/9781799801986.ch014

Nyika, J., Onyari, E., Mishra, S., & Dinka, M. (2019). Waste Management in South Africa (pp. 327–351). https://doi.org/10.4018/9781799801986.ch014

O'Donnell, S. T., Caldwell, M. D., Barlaz, M. A., & Jeremy W.F. Morris. (2018). Case study comparison of functional vs. organic stability approaches for assessing threat potential at closed landfills in the USA. Waste Management, 75, 415–426. https://doi.org/10.1016/j.wasman.2018.02.001

OECD. (2019). Plastic Leakage and Greenhouse Gas Emissions Are Increasing - OECD. Oecd.org. https://www.oecd.org/environment/plastics/increased-plastic-leakage-and-greenhouse-gas-emissions.htm

Oelofse, S. (2019). Food waste research for south africa presentation by prof suzan oelofse research group leader: Waste for development competency area: Solutions for a green economy operating unit: Natural resources and the environment. www.csir.co.za

Oelofse, S., & Nahman, A. (2013). Estimating the magnitude of food waste generated in South Africa. Waste Management and Research, 31(1), 80–86. https://doi.org/10.1177/0734242X12457117

Oelofse, S., Polasi, T., Haywood, L., & Musvoto, C. (2021). Increasing reliable, scientific data and information on food losses and waste in south Africa. https://wasteroadmap.co.za/wp-content/uploads/2021/06/17-CSIR-Final_Technical-report_Food-waste.pdf

Oelofse, S., Sooklal, R., Buthelezi, D., Matinise, S., Mohapi, T., Katlego Mabatle, K., & Phakoe, K. (2021). Food waste prevention and management: A guideline for South Africa. In Food waste prevention and management: A guideline for South Africa (Issue 1, p. 38).

Ohnishi, S., Fujii, M., Ohata, M., Inaba Rokuta, & Fujita, T. (2018). Efficient energy recovery through a combination of waste-to-energy systems for a low-carbon city. Resources, Conservation and Recycling, 128, 394–405. https://doi.org/10.1016/j.resconrec.2016.11.018

Olio. (2023). Oil 2023 – Analysis. IEA. https://www.iea.org/reports/oil-2023

Onyeaka, H., Ghosh, S., Obileke, K., Miri, T., Odeyemi, O. A., Nwaiwu, O., & Tamasiga, P. (2024). Preventing chemical contaminants in food: Challenges and prospects for safe and sustainable food production. Food Control, 155, 110040. https://doi.org/10.1016/j.foodcont.2023.110040

Orbiteers. (2014, September 23). Food Safety Tips for Storing and Rotating Product. Gordon Food Service. https://gfs.com/en-us/ideas/food-safety-tips-storing-and-rotating-product/

Oria, M., & Schneeman, B. O. (2020). A National Strategy to Reduce Food Waste at the Consumer Level. In PubMed. National Academies Press (US). https://pubmed.ncbi.nlm.nih.gov/33211448/

Ormrod, J. E., Anderman, E. M., & Anderman, L. H. (2020). Educational Psychology: Developing Learners, 10th edition.

Orr, L., & Schmidt, T. G. (2021). Reducing food waste in retail. Semantic Scholar; Johann Heinrich von Thünen-Institut. https://doi.org/10.3220/PB1615797125000

Östergren, K., Gustavsson, J., Bos-Brouwers, H., Timmermans, T., Hanssen, O. J., Møller, H., Anderson, G., O'Connor, C., Soethoudt, H., Quested, T., Easteal, S., Politano, A., Bellettato, C., Canali, M., Falasconi, L., Gaiani, S., Vittuari, M., Schneider, F., Moates, G., & Waldron, K. (2014). FUSIONS definitional framework for FoodWaste.

Ovezmyradov, B. (2022). Product availability and stockpiling in times of pandemic: causes of supply chain disruptions and preventive measures in retailing. Annals of Operations Research. springer. https://doi.org/10.1007/s10479-022-05091-7

Ozone Secretariat. (2021). Climate Action. Unep.org. https://ozone.unep.org/

Palma-Ruiz, J., Torres-Toukoumidis, A., González-Moreno, S., & Valles-Baca, H. (2022). An overview of the gaming industry across nations: using analytics with power BI to forecast and identify key influencers. Heliyon, 8(2). https://doi.org/10.1016/j.heliyon.2022.e08959

Palmisano, G., Bottalico, F., Cardone, G., & Capone, R. (2020). Food losses and waste in the context of sustainable food and nutrition security. Food Security and Nutrition, June, 235–255. https://doi.org/10.1016/B978-0-12-820521-1.00010-1

Panda, T. K., & Mohanty, P. K. (2011). Supply chain management and bull whip effect: A conceptual framework for efficiency improvement in supply chain. IUP Journal of Supply Chain Management, 8(4), 16–29. http://search.ebscohost.com/login.aspx?direct=true&db=bth&AN=78153535&site=ehost-live

Pandey, A. (2021). FOOD WASTAGE: CAUSES, IMPACTS AND SOLUTIONS. Science Heritage Journal, 5, 17–20. https://doi.org/10.26480/gws.01.2021.17.20

Papargyropoulou, E., Lozano, R., Steinberger, J. K., Wright, N., & Zaini Bin Ujang. (2014). The food waste hierarchy as a framework for the management of food surplus and food waste. Journal of Cleaner Production, 76, 106–115. https://doi.org/10.1016/j.jclepro.2014.04.020

Paritosh, K., Kushwaha, S., Yadav, M., Pareek, N., Chawade, A. and Vivekanand, V. (2017). Food Waste to Energy: An Overview of Sustainable Approaches for Food Waste Management and Nutrient Recycling. BioMed Research International, 2017, pp.1–19. doi:https://doi.org/10.1155/2017/2370927.

Parfitt, J., Barthel, M., & MacNaughton, S. (2010). Food waste within food supply chains: Quantification and potential for change to 2050. Philosophical Transactions of the Royal Society B: Biological Sciences, 365(1554), 3065–3081. https://doi.org/10.1098/rstb.2010.0126

Parfitt, J., Croker, T., & Brockhaus, A. (2021). Global food loss and waste in primary production: A reassessment of its scale and significance. Sustainability (Switzerland), 13(21), 12087. https://doi.org/10.3390/su132112087

Parizeau, K., Mike von Massow, & Martin, R. (2015). Household-level dynamics of food waste production and related beliefs, attitudes, and behaviours in Guelph, Ontario. Waste Management, 35, 207–217. https://doi.org/10.1016/j.wasman.2014.09.019

Paruchuri, V. (2022). Data quest. https://www.dataquest.io/blog/learn-power-bi/

Patra, D., Leisnham, P. T., Tanui, C. K., & Pradhan, A. K. (2020). Evaluation of global research trends in the area of food waste due to date labeling using a scientometrics approach. Food Control, 115, 107307. https://doi.org/10.1016/j.foodcont.2020.107307

Pavone, L. E., & Song, H.-J. (2020). Exploration of the food waste environment in the university setting and its implications toward a sustainable food system. ProQuest Dissertations and Theses. http://search.proquest.com.ezaccess.library.uitm.edu.my/dissertations-theses/exploration-food-waste-environment-university/docview/2465807671/se-2?accountid=42518%0Ahttps://media.proquest.com/media/hms/PFT/2/sRlNH?_a=ChgyMDIyMDcwNTA2MzUwMzA2Njo2NzYxMzgSBT

Payne, K. K. (2014). The Consequences of Food Waste. Inquiries Journal. https://www.semanticscholar.org/paper/The-Consequences-of-Food-Waste-Payne/804f3c79676c741d0eb229447477a94161bed894

Phasha, L., Molelekwa, G. F., Mokgobu, M. I., Morodi, T. J., Mokoena, M. M., & Mudau, L. S. (2020). Influence of cultural practices on food waste in South Africa - A review. Journal of Ethnic Foods, 7(1), 37. https://doi.org/10.1186/s42779-020-00066-0

Phillips, C., Hoenigman, R., Higbee, B., & Reed, T. (2013). Understanding the sustainability of retail food recovery. PLoS ONE, 8(10). https://doi.org/10.1371/journal.pone.0075530

Piccolella, S., Bianco, A., Crescente, G., Santillo, A., Gabriella Chieffi Baccari, & Pacifico, S. (2019). Recovering cucurbita pepo cv. “Lungo fiorentino” wastes: UHPLC-HRMS/MS metabolic profile, the basis for establishing their nutra- and cosmeceutical valorisation. Molecules, 24(8), 1479. https://doi.org/10.3390/molecules24081479

Pillay, G. (2021). Optimization of waste reduction in the construction sector: The case study of the eThekwini municipality in south africa.

Pimentel, B., Fotios Misopoulos, & Davies, J. (2022). A review of factors reducing waste in the food supply chain: The retailer perspective. Cleaner Waste Systems, 3, 100028. https://doi.org/10.1016/j.clwas.2022.100028

Pino, G., Peluso, A. M., & Guido, G. (2012). Determinants of regular and occasional consumers’ intentions to buy organic food. Journal of Consumer Affairs, 46(1), 157–169. https://doi.org/10.1111/j.1745-6606.2012.01223.x

Pirani, S. I., & Arafat, H. A. (2016). Reduction of food waste generation in the hospitality industry. Journal of Cleaner Production, 132, 129–145. https://doi.org/10.1016/j.jclepro.2015.07.146

Pires, A., Martinho, G., & Chang, N.-B. (2011). Solid waste management in European countries: A review of systems analysis techniques. Journal of Environmental Management, 92(4), 1033–1050. https://doi.org/10.1016/j.jenvman.2010.11.024

Porpino, G., Wansink, B., & Parente, J. (2016). Wasted positive intentions: The role of affection and abundance on household food waste. Journal of Food Products Marketing, 22(7), 733–751. https://doi.org/10.1080/10454446.2015.1121433

Presidential Climate Commission. (2021). Www.climatecommission.org.za. https://www.climatecommission.org.za/publications/south-africas-ndc-targets-for-2025-and-2030

Pretorius, M., Ingrid le Roux, Rosslyn-Smith, W., & Rebaona Letsholo. (2021). Artificial entrepreneurship and fallacy assumptions that inform enterprise development failure. Critical Management Studies in South Africa: Directions and Contexts, 123–142. https://doi.org/10.4102/aosis.2021.bk322.07

Priefer, C., Jörissen, J., & Bräutigam, K. (2016). Food waste prevention in Europe – A causedriven approach to identify the most relevant leverage points for action. Resources, Conservation and Recycling, 109, 155–165. https://doi.org/10.1016/j.resconrec.2016.03.004

Purvis, B., Mao, Y., & Robinson, D. (2018). Three Pillars of sustainability: in Search of Conceptual Origins. Sustainability Science, 14(3), 681–695. springer. https://doi.org/10.1007/s11625-018-0627-5

Qaddo, M. (2019). Participant Observation as Research Methodology: Assessing the Validity of Qualitative Observational Data as Research Tools.

Qualtrics. (2022). The Qualtrics online sample size calculator.

Raak, N., Symmank, C., Zahn, S., Aschemann-Witzel, J., & Rohm, H. (2017a). Processing- and product-related causes for food waste and implications for the food supply chain. Waste Management, 61, 461–472. https://doi.org/10.1016/j.wasman.2016.12.027

Ramanathan, U., Bentley, Y., & Pang, G. (2014). The role of collaboration in the UK green supply chains: An exploratory study of the perspectives of suppliers, logistics and retailers. Journal of Cleaner Production, 70, 231–241. https://doi.org/10.1016/j.jclepro.2014.02.026

Ramanathan, U., He, Q., Subramanian, N., Gunasekaran, A., & Sarpong, D. (2023). Collaborative closed loop supply chain framework for sustainable manufacturing: Evidence from the Indian packaging industry. Technological

Forecasting and Social Change, 191, 122489. https://doi.org/10.1016/j.techfore.2023.122489

Ramukhwatho, F., Oelofse, S., & Muswema, A. (2018). Household food waste disposal in South Africa: A case study of Johannesburg and Ekurhuleni. South African Journal of Science, 114(5-6). https://doi.org/10.17159/sajs.2018/20170284

Ranganathan, J., Waite, R., Searchinger, T., & Hanson, C. (2018). How to Sustainably Feed 10 Billion People by 2050, in 21 Charts.

Rawat, S. (2023, October 13). Demystifying FIFO: What The Method Requires. New Tech behind a Restaurant Menu | Your Guide to Managing Restaurant Business. https://orderific.com/blog/what-does-fifo-require/

RCL Foods. (2022). Sustainability report. In Sustainability Report.

Read, Q. D., Brown, S., Cuéllar, A. D., Finn, S. M., Gephart, J. A., Marston, L. T., Meyer, E., Weitz, K. A., & Muth, M. K. (2020). Assessing the environmental impacts of halving food loss and waste along the food supply chain. Science of the Total Environment, 712. https://doi.org/10.1016/j.scitotenv.2019.136255

Redlingshöfer, B., Barles, S., & Weisz, H. (2020). Are waste hierarchies effective in reducing environmental impacts from food waste? A systematic review for OECD countries. Resources, Conservation and Recycling, 156. https://doi.org/10.1016/j.resconrec.2020.104723

Redlingshöfer, B., Coudurier, B., & Georget, M. (2017). Quantifying food loss during primary production and processing in France. Journal of Cleaner Production, 164, 703–714. https://doi.org/10.1016/j.jclepro.2017.06.173

Remgro. (2022). Remgro limited. Group Investments. https://www.remgro.com/

Renisha Sahathu. (n.d.). An evaluation of the waste management cycle utilised by fresh produce market informal traders in Durban, KwaZulu-Natal. https://api.semanticscholar.org/CorpusID:249686528

Rethink Food Waste. (2020). Rethink food waste. In A roadmap to reduce U.S Food Waste by 20 percent. Further with Food.

Reuters. (2021). South Africa proposes reduced 2030 greenhouse gas emission targets. Reuters. https://www.reuters.com/article/us-climate-change-safrica-emissions-idUSKBN2BM16D/

Reutter, B., & Susaeta Bengscs. (2018). The environmental burden of food waste.

Reynolds, C., & Mavrakis, V. (2016). Food waste sustainable cookery view project. https://www.researchgate.net/publication/311258278

Reynolds, C., Goucher, L., Quested, T., Bromley, S., Gillick, S., Wells, V. K., Evans, D., Koh, L., Annika Carlsson Kanyama, Katzeff, C., Åsa Svenfelt, & Jackson, P. (2019). Review: Consumption-stage food waste reduction interventions – What works and how to design better interventions. Food Policy, 83, 7–27. https://doi.org/10.1016/j.foodpol.2019.01.009

Ribeiro, A., Rok, J., Harmsen, R., Jesús Rosales Carreón, & Worrell, E. (2019). Food waste in an alternative food network – A case-study. Resources, Conservation and Recycling, 149, 210–219. https://doi.org/10.1016/j.resconrec.2019.05.029

Ribeiro, T. B., Voss, G. B., Coelho, M. C., Pintado, M. E., & Bhat, R. (2022). Chapter 33Food waste and byproduct valorization as an integrated approach with zero waste: Future challenges. In Future Foods (pp. 569–596). Academic Press. https://doi.org/10.1016/B9780323910019.000177

Richards, C., Hurst, B., Messner, R., & O'Connor, G. (2021). The paradoxes of food waste reduction in the horticultural supply chain. Industrial Marketing Management, 93, 482–491. https://doi.org/10.1016/j.indmarman.2020.12.002

Ridder, H.-G. (2012). Rezensionen: Case study research. Design and methods. German Journal of Human Resource Management: Zeitschrift Für Personalforschung, 26(1), 93–95. https://doi.org/10.1177/239700221202600101

Rieckhof, R., Bergmann, A., & Guenther, E. (2015). Interrelating material flow cost accounting with management control systems to introduce resource efficiency into strategy. Journal of Cleaner Production, 108, 1262–1278. https://doi.org/10.1016/j.jclepro.2014.10.040

Riesenegger, L., & Hübner, A. (2022). Reducing Food Waste at Retail Stores—An Explorative Study. Sustainability, 14(5), 2494. https://doi.org/10.3390/su14052494

Rinkesh. (2023). 11 Outstanding Ways to Reduce Manufacturing Waste - Conserve Energy Future. Www.conserve-Energy-Future.com. https://www.conserve-energy-future.com/manufacturing-waste.php

Rodrigues, V. S., Demir, E., Wang, X., & Sarkis, J. (2021). Measurement, mitigation and prevention of food waste in supply chains: An online shopping perspective. Industrial Marketing Management, 93, 545–562. https://doi.org/10.1016/j.indmarman.2020.09.020

Roeder, J., Palmer, M., & Muntermann, J. (2022). Data-driven decision-making in credit risk management: The information value of analyst reports. Decision Support Systems, 158, 113770. https://doi.org/10.1016/j.dss.2022.113770

Roodhuyzen, D. M. A., Luning, P. A., Fogliano, V., & Steenbekkers, L. P. A. (2017). Putting together the puzzle of consumer food waste: Towards an integral perspective. Trends in Food Science and Technology, 68, 37–50. https://doi.org/10.1016/j.tifs.2017.07.009

Rosenlund, J., Nyblom, Å., Ekholm, H., & Sörme, L. (2020). The emergence of food waste as an issue in Swedish retail. British Food Journal, 122(11), 3283–3296. https://doi.org/10.1108/BFJ-03-2020-0181

Ruslin, Mashuri, S., Rasak, A., Alhabsyi, F., & Syam, H. (2022). Semi-structured interview: A methodological reflection on the development of a qualitative research instrument in educational studies. In Journal of Research & Method in Education.

Rutledge, P. B., & Hogg, J. L. C. (2020). In-Depth Interviews. The International Encyclopedia of Media Psychology, 1–7. https://doi.org/10.1002/9781119011071.iemp0019

Sanders, R. (2017). The economics of retail food waste. Ssrn, 28–29. https://doi.org/10.2139/ssrn.2994426

SARS. (2020). Carbon tax implementation in South Africa. Policies. chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://www.sars.gov.za/wp-content/uploads/Docs/CarbonTax/Carbon-Tax-Roadshow-August-2020.pdf

Scafetta, N. (2023). Empirical assessment of the role of the Sun in climate change using balanced multi-proxy solar records. Geoscience Frontiers, 14(6), 101650. https://doi.org/10.1016/j.gsf.2023.101650

Schanes, K., Dobernig, K., & Burcu Gözet. (2018). Food waste matters - A systematic review of household food waste practices and their policy implications. Journal of Cleaner Production, 182, 978–991. https://doi.org/10.1016/j.jclepro.2018.02.030

Scherhaufer, S., Moates, G., Hartikainen, H., Waldron, K., & Obersteiner, G. (2018). Environmental impacts of food waste in Europe. Waste Management, 77, 98–113. https://doi.org/10.1016/j.wasman.2018.04.038

Schneider, F., & Eriksson, M. (2020). Food waste (and loss) at the retail level. Routledge Handbook of Food Waste, 114–128. https://doi.org/10.4324/9780429462795-10

Schneider, K., Recke, S., Kaiser, E., Götte, S., Henrike Berkefeld, Lässig, J., Rüdiger, T., Lindtner, O., & Oltmanns, J. (2019). Consumer behaviour survey for assessing exposure from consumer products: a feasibility study. Journal of Exposure Science & Environmental Epidemiology, 29(1), 83–94. https://doi.org/10.1038/s41370-018-0040-2

Scholz, K. (2013). Institutionen för energi och teknik independent thesis 2013:05 Department of Energy and Technology Carbon footprint of retail food wastage a case study of six Swedish retail stores. In Carbon footprint of retail food waste.

Scholz, K., Eriksson, M., & Strid, I. (2015). Carbon footprint of supermarket food waste. Resources, Conservation and Recycling, 94, 56–65. https://doi.org/10.1016/j.resconrec.2014.11.016

Seberini, A. (2020). Economic, social and environmental world impacts of food waste on society and Zero waste as a global approach to their elimination. SHS Web of Conferences, 74, 03010. https://doi.org/10.1051/shsconf/20207403010

Selvam, A., Ilamathi, P., Udayakumar, M., Murugesan, K., Banu, J., Khanna, Y., & Wong, J. (2020). Food waste properties. In Current Developments in Biotechnology and Bioengineering: Sustainable Food Waste Management: Resource Recovery and Treatment (pp. 11–41). Elsevier. https://doi.org/10.1016/B978-0-12-819148-4.00002-6

Sgarbossa, F., & Russo, I. (2017). A proactive model in sustainable food supply chain: Insight from a case study. International Journal of Production Economics, 183, 596–606. https://doi.org/10.1016/j.ijpe.2016.07.022

Sgqolana, T. (2022, March 31). Plastic waste polluting South Africa's oceans needs answers from bright young minds Plastic waste polluting our oceans needs bright young minds to provide answers. Daily Maverick. https://www.dailymaverick.co.za/article/2022-03-31-plastic-waste-polluting-south-africas-oceans-needs-answers-from-bright-young-minds/

Shahid, K., & Hittinger, E. (2021). Techno-economic optimization of food waste diversion to treatment facilities to determine cost effectiveness of policy incentives. Journal of Cleaner Production, 279. https://doi.org/10.1016/j.jclepro.2020.122634

Sharma, M., & Joshi, S. (2019). Brand sustainability among young consumers: an AHP-TOPSIS approach. Young Consumers, 20(4), 314–337. https://doi.org/10.1108/yc-12-2018-0914

Sharma, P., Archana Vimal, Vishvakarma, R., Kumar, P., Luciana, Vivek Kumar Gaur, & Sunita Varjani. (2022). Deciphering the blackbox of omics approaches and artificial intelligence in food waste transformation and mitigation. International Journal of Food Microbiology, 372, 109691. https://doi.org/10.1016/j.ijfoodmicro.2022.109691

Sharma, V., Sharma, D., Tsai, M.-L., Guanga, G., Yadav, A., Parushi Nargotra, Chen, C.-W., Sun, P., & Dong, C.-D. (2023). Insights into the recent advances of agro-industrial waste valorization for sustainable biogas production. Bioresource Technology, 129829–129829. https://doi.org/10.1016/j.biortech.2023.129829

Sheahan, M., & Barrett, C. (2017). Food loss and waste in SubSaharan Africa: A critical review. Food Policy, 70, 1–12. https://doi.org/10.1016/j.foodpol.2017.03.012

Shoup, M. E. (2022, January 13). Millennials drive growth of frozen foods category sparked by interest in premium, challenger brands. Foodnavigator-Usa.com. https://www.foodnavigator-usa.com/Article/2022/01/13/Millennials-drive-growth-of-frozen-foods-category-sparked-by-interest-in-premium-challenger-brands

Shrivastava, M., & Tamvada, J. P. (2017). Which green matters for whom? Greening and firm performance across age and size distribution of firms. Small Business Economics, 52(4), 951–968. https://doi.org/10.1007/s11187-017-9942-y

Sibanda, M., Zindi, B., & Maramura, T. (2020). Control and accountability in supply chain management: Evidence from a South African metropolitan municipality. Cogent Business & Management, 7(1), 1785105. https://doi.org/10.1080/23311975.2020.1785105

Silva, P., & Campos, M. (2013). Food waste carbon footprint. http://projekter.aau.dk/projekter/files/198510758/Masters_Thesis.pdf

Simms, C., Trott, P., Ellis, & Erik Jan Hultink. (2020). Barriers to the adoption of waste-reducing eco-innovations in the packaged food sector: A study in the UK and the Netherlands. Journal of Cleaner Production, 244. https://doi.org/10.1016/j.jclepro.2019.118792

Singleton, R., & Straits, B. C. (2018). Approaches to social research. New York Oxford University Press.

Skeaff, S., Goodman-Smith, F., & Mirosa, M. (2019). A quantitative and qualitative study of retail food waste in new zealand. 18. https://doi.org/10.3390/proceedings2019008018

Skjærseth, J. B., Andresen, S., Bang, G., & Heggelund, G. M. (2021). The Paris agreement and key actors' domestic climate policy mixes: comparative patterns. International Environmental Agreements: Politics, Law and Economics, 21(1), 59–73. https://doi.org/10.1007/s10784-021-09531-w

Slorach, P. C., Jeswani, H. K., Cuéllar-Franca, R., & Adisa Azapagic. (2019). Energy demand and carbon footprint of treating household food waste compared to its prevention. Energy Procedia, 161, 17–23. https://doi.org/10.1016/j.egypro.2019.02.053

Socas-Rodríguez, B., Álvarez-Rivera, G., Valdés, A., Ibáñez, E., & Cifuentes, A. (2021). Food by-products and food wastes: are they safe enough for their valorisation? Trends in Food Science and Technology, 114, 133–147. https://doi.org/10.1016/j.tifs.2021.05.002

Soma, T. (2022). A bad wrap? Using packaging well to reduce food waste. https://doi.org/10.54377/7869-6dad

Soomro, A. H., Shaikh, N., Miano, T. F., Marri, A., Khaskheli, S. G., & Kumar, D. (2021). Food waste management strategies in food supply chain. International Journal of Ecosystems and Ecology Science (IJEES), 11(4), 759–766. https://doi.org/10.31407/ijees11.413

Soosay, C. (2023). Coordination in Supply Chains. Springer EBooks, 1–26. https://doi.org/10.1007/978-3-030-89822-9_57-1

Sosna, D., Lenka Brunclíková, & Patrik Galeta. (2019). Rescuing things: Food waste in the rural environment in the Czech Republic. Journal of Cleaner Production, 214, 319–330. https://doi.org/10.1016/j.jclepro.2018.12.214

South African Government. (2019). Constitution of the Republic of South Africa, 1996 - Chapter 2: Bill of Rights | South African Government. Www.gov.za. https://www.gov.za/documents/constitution/chapter-2-bill-rights

Spaull, N., & Tomlinson, M. (2021). Food crisis: 2.5 million South Africans experience hunger "every day." Food Crisis: 2.5 million South Africans Experience Hunger "Every Day." https://www.leader.co.za/infocentrearticle.aspx?s=5&c=5&a=8231&p=41&title=Society

Spiker, M. L., Hazel A.B. Hiza, Siddiqi, S. M., & Neff, R. A. (2017). Wasted food, wasted nutrients: Nutrient loss from wasted food in the United States and comparison to gaps in dietary intake. Journal of the Academy of Nutrition and Dietetics, 117(7), 1031-1040.e22. https://doi.org/10.1016/j.jand.2017.03.015

Spring, C., Soma, T., Lazell, J., & Reynolds, C. (2020). Routledge handbook of food waste. In Routledge Handbook of Food Waste (pp. 1–523). https://doi.org/10.4324/9780429462795

Stanciu, M., Popescu, A., Antonie, I., Sava, C., & Bogdan Gabriel Nistoreanu. (2022). Good practices on reducing food waste throughout the food supply chain. Amfiteatru Economic, 24(60), 566–582. https://doi.org/10.24818/EA/2022/60/566

Statista. (2022). Population of south africa by province. https://www.statista.com/statistics/1112169/total-population-of-south-africa-by-province/

STATS SA. (2019). Library cataloguing-in-publication (CIP) data. Towards measuring the extent of food security in south africa: An examination of hunger and food adequacy/ statistics south africa. Pretoria: Statistics south africa. http://www.statssa.gov.za/publications/03-00-14/03-00-142017.pdf

Stenmarck, A., Jensen, C., Quested, T., & Moates, G. (2016). Estimates of European food waste levels. https://doi.org/10.13140/RG.2.1.4658.4721

Stephan, A. (2021). Understanding Expiry Dates. FoodBank SA. https://www.foodbanksa.org/news/understanding-expiry-dates/

Stepniewski, W., Pawlowska, M., Widomski, M. K., Pawlowski, A., & Hung, Y. T. (2013). Landfilling of municipal solid waste in Europe. Handbook of Environment and Waste Management: Volume 2: Land and Groundwater Pollution Control, 365–402. https://doi.org/10.1142/9789814449175_0004 Strazzera, G., Battista, F., Andreolli, M., Menini, M., Bolzonella, D., & Lampis, S. (2021). Influence of different household Food Wastes Fractions on Volatile Fatty Acids production by anaerobic fermentation. Bioresource Technology, 335. https://doi.org/10.1016/j.biortech.2021.125289

Strotmann, C., Baur, V., Börnert, N., & Gerwin, P. (2022). Generation and prevention of food waste in the German food service sector in the COVID-19 pandemic – Digital approaches to encounter the pandemic related crisis. Socio-Economic Planning Sciences, 82. https://doi.org/10.1016/j.seps.2021.101104

Sucheran, S., & Olanrewaju, O. A. (2021). Food Waste Management of Restaurants in KwaZulu-Natal South Africa. Proceedings of the International Conference on Industrial Engineering and Operations Management. https://doi.org/10.46254/AN11.20210011

Sung, E., Chung, W. Y., & Lee, D. (2023). Factors that affect consumer trust in product quality: a focus on online reviews and shopping platforms. Humanities and Social Sciences Communications, 10(1), 1–10. https://doi.org/10.1057/s41599-023-02277-7

Swaen, B., & George, T. (2022, May 4). What Is a Conceptual Framework for Research? | Example. Scribbr. https://www.scribbr.co.uk/research-methods/conceptual-frameworks/

Swaffield, J., Evans, D., & Welch, D. (2018). Profit, reputation and “doing the right thing”: Convention theory and the problem of food waste in the UK retail sector. Geoforum, 89, 43–51. https://doi.org/10.1016/j.geoforum.2018.01.002

Świechowski, K., Matyjewicz, B., Telega, P., & Białowiec, A. (2022). The influence of low-temperature food waste biochars on anaerobic digestion of food waste. Materials, 15(3). https://doi.org/10.3390/ma15030945

Szulecka, J., Strøm-Andersen, N., Scordato, L., & Skrivervik, E. (2019). Multi-level governance of food waste: Comparing Norway, Denmark and Sweden. In From Waste to Value: Valorisation Pathways for Organic Waste Streams in Circular Bioeconomies (pp. 253–271). Routledge. https://doi.org/10.4324/9780429460289-13

Szymkowiak, A., Borusiak, B., Bartłomiej Pierański, Pavel Kotyza, & Luboš Smutka. (2022). Household food waste: The meaning of product’s attributes and food-related lifestyle. Frontiers in Environmental Science, 10. https://doi.org/10.3389/fenvs.2022.918485

Tally Solutions. (2022, February 1). Symptoms of Poor Inventory management - 6 Mistakes to Avoid | Tally Solutions. Tally. https://tallysolutions.com/inventory/6-symptoms-of-poor-inventory-management/

Tao, H., Sun, X., Liu, X., Tian, J., & Zhang, D. (2022). The impact of consumer purchase behavior changes on the business model design of consumer services companies over the course of COVID-19. Frontiers in Psychology, 13. https://doi.org/10.3389/fpsyg.2022.818845

Taylor, Z. (2022, December 1). Loadshedding: A small business continuity plan. Sage Advice South Africa. https://www.sage.com/en-za/blog/loadshedding-a-small-business-continuity-plan/

Teller, C., Holweg, C., Reiner, G., & Kotzab, H. (2018). Retail store operations and food waste. Journal of Cleaner Production, 185, 981–997. https://doi.org/10.1016/j.jclepro.2018.02.280

Teuteburg, S. (2020). The Future of RETAIL IN AFRICA. https://www.lrs.org.za/wp-content/uploads/2021/01/The-future-of-retail-in-Africa.pdf

Thakker, K. (2018, June 25). Why limited-time offers bring long-term benefits to retailers. Grocery Dive. https://www.grocerydive.com/news/grocery--why-limited-time-offers-bring-long-term-benefits-to-retailers/533907/

The Global Food Donation Policy Atlas. (2020). The Global Food Donation Policy Atlas. Mapping the barriers to food donation. The Global Food Donation Policy Atlas. https://atlas.foodbanking.org/

Thyberg, K. L., & Tonjes, D. J. (2016). Drivers of food waste and their implications for sustainable policy development. Resources, Conservation and Recycling, 106, 110–123. https://doi.org/10.1016/j.resconrec.2015.11.016

Tkáč, F., Košičiarová, I., Horská, E., & Mušinská, K. (2022). Socioeconomic relations of food waste in selected european countries. Economies, 10(6), 144. https://doi.org/10.3390/economies10060144

Toma, L., Revoredo-Giha, C., Costa-Font, M., & Thompson, B. (2020). Food waste and food safety linkagesalong the supply chain. EuroChoices, 19(1), 24–29. https://doi.org/10.1111/1746-692X.12254

Tonini, D., Paola Federica Albizzati, & Thomas Fruergaard Astrup. (2018). Environmental impacts of food waste: Learnings and challenges from a case study on UK. Waste Management, 76, 744–766. https://doi.org/10.1016/j.wasman.2018.03.032

Tracey, L. (2023, April 22). The Paris Agreement: Annotated. JSTOR Daily. https://daily.jstor.org/the-paris-agreement-annotated/

Trento, L. R., Pereira, G. M., Chiappetta, J., Ndubisi, N. O., Mani, V., Hingley, M., Borchardt, M., Gustavo, J. U., & de Souza, M. (2021). Industry-retail symbiosis: What we should know to reduce perishable processed food disposal for a wider circular economy. Journal of Cleaner Production, 318. https://doi.org/10.1016/j.jclepro.2021.128622

Treutwein, R., & Langen, N. (2021). Setting the agenda for food waste prevention – A perspective on local government policymaking. Journal of Cleaner Production, 286. https://doi.org/10.1016/j.jclepro.2020.125337

Tromp, S., Haijema, R., Rijgersberg, H., & van der Vorst, J. (2016). A systematic approach to preventing chilled-food waste at the retail outlet. International Journal of Production Economics, 182, 508–518. https://doi.org/10.1016/j.ijpe.2016.10.003

Tropea, A. (2022). Food waste valorization. Fermentation, 8(4). https://doi.org/10.3390/fermentation8040168

Trubetskaya, A., Benjamin, P., & Milena Corredig. (2022). Changes towards more sustainable food packaging legislation and practices. A survey of policy makers and stakeholders in Europe. Food Packaging and Shelf Life, 32. https://doi.org/10.1016/j.fpsl.2022.100856

UNEP , & FAO. (2023). Sustainable Food Cold Chains: Opportunities, Challenges and the Way Forward. Unep.org. https://wedocs.unep.org/20.500.11822/41240

UNEP. (2021). Methane emissions are driving climate change. Here's how to reduce them. Climate Action. https://www.unep.org/news-and-stories/story/methane-emissions-are-driving-climate-change-heres-how-reduce-them#:~:text=Methane%20is%20the%20primary%20contributor,at%20warming%20than%20carbon%20dioxide.

United Nations Climate Change. (2017). The Paris agreement. United Nations Climate Change. https://unfccc.int/process-and-meetings/the-paris-agreement

United Nations Environmental Program (Ed.). (2022). International Day of Awareness of food loss and waste 2022. United Nations Environment Programme. https://www.unep.org/events/un-day/international-day-awareness-food-loss-and-waste-2022

United Nations Environmental Program. (2022). International day of awareness of food loss and waste 2022. United Nations Environment Programme.

https://www.unep.org/events/un-day/international-day-awareness-food-loss-and-waste-2022

United Nations. (2019). Global Sustainable Development Report 2019. United Nations. https://www.un.org/en/desa/global-sustainable-development-report-2019

United Nations. (2019). Observance - end food waste day - background.- Food Waste and Loss Reduction. https://www.un.org/en/observances/end-food-waste-day/background#:~:text=That%20is%20why%2C%20in%202019,promoting%20food%20security%20and%20nutrition.

United Nations. (2022). Sustainable Development Goals: 17 Goals to Transform our World. United Nations. https://www.un.org/en/exhibits/page/sdgs-17-goals-transform-world

United States Environmental Protection Agency. (2015). United States 2030 food loss and waste reduction goal. Sustainable Management of Food. https://www.epa.gov/sustainable-management-food/united-states-2030-food-loss-and-waste-reduction-goal

United States Environmental Protection Agency. (2019). Regulations docket. https://www.regulations.gov/docket/EPA-HQ-OPP-2021-0523

United States Food and Drug Administration. (2020). Surplus, Salvaged, and Donated Foods. FDA. https://www.fda.gov/food/buy-store-serve-safe-food/surplus-salvaged-and-donated-foods

USDA. (2020, October 19). How Temperatures Affect Food | Food Safety and Inspection Service. Usda.gov. https://www.fsis.usda.gov/food-safety/safe-food-handling-and-preparation/food-safety-basics/how-temperatures-affect-food

USEPA. (2019). Regulations docket. https://www.regulations.gov/docket/EPA-HQ-OPP-2021-0523

Valášková, K., Durana, P., & Adamko, P. (2021). Changes in Consumers' Purchase Patterns as a Consequence of the COVID19 Pandemic. Mathematics, 9, 1788. https://doi.org/10.3390/math9151788

van der Werf, P., & Gilliland, J. A. (2017). A systematic review of food losses and food waste generation in developed countries. Proceedings of the Institution of Civil Engineers - Waste and Resource Management, 170(2), 66–77. https://doi.org/10.1680/jwarm.16.00026

van Geffen, L., van Herpen, E., & Hans. (2019). Household food waste-how to avoid it? An integrative review. Food Waste Management: Solving the Wicked Problem, 27–55. https://doi.org/10.1007/978-3-030-20561-4_2

Varese, E., Maria Chiara Cesarani, & Wojnarowska, M. (2022). Consumers' perception of suboptimal food: strategies to reduce food waste. British Food Journal. https://doi.org/10.1108/BFJ-07-2021-0809

Vaverková, M. D., Adamcová, D., Zloch, J., Radziemska, M., Berg, A. B., Voberková, S., & Maxianová, A. (2018). Impact of municipal solid waste landfill on environment - A case study. Journal of Ecological Engineering, 19(4), 55–68. https://doi.org/10.12911/22998993/89664

Verstraete, W., Clauwaert, P., & Vlaeminck, S. E. (2016). Used water and nutrients: Recovery perspectives in a "panta rhei" context. Bioresource Technology, 215, 199–208. https://doi.org/10.1016/j.biortech.2016.04.094

Vinz, S. (2022, October 14). The Theoretical Framework: What and How? | A Quick Guide. Scribbr. https://www.scribbr.com/dissertation/theoretical-framework/

Wallace, M. (2023). How long can frozen food sit out before it goes bad. In Food & Drink.

Wang, C., Yang, J., Cheng, Z., & Ni, C. (2021). Correction: Wang, C.; et al. Postgraduate Education of Board Members and R&D Investment—Evidence from China. Sustainability 2019, 11, 6524. Sustainability, 13(6), 3324. https://doi.org/10.3390/su13063324

Wangsa, I. D., Vanany, I., & Siswanto, N. (2023). A sustainable supply chain coordination model with an investment in green technology and electric equipment. International Journal of Systems Science: Operations and Logistics, 10(1), 2221078. https://doi.org/10.1080/23302674.2023.2221078

Wastes. (2023). Wastes – Solutions, Treatments and Opportunities. Https://Www.wastes2023.org/. https://www.wastes2023.org/

Watson, M., Browne, A., Evans, D., Foden, M., Hoolohan, C., & Sharp, L. (2020). Challenges and opportunities for re-framing resource use policy with practice theories: The change points approach. Global Environmental Change, 62. https://doi.org/10.1016/j.gloenvcha.2020.102072

Weber, B., & Herrlein, S. (2012). Retailers step up to the next level of inventory management. In The Challenge of Food Waste.

Weber, B., Herrlein, S., & Hodge, G. (2011). The Challenge of Food Waste Retailers step up to the next level of inventory management. Planet Retail/ Sponsored by IBM. www-03.ibm.com

Wegren, S. (2023). Challenges to global food security: A policy approach to the 2021–2022 food crisis. World Food Policy, 9. https://doi.org/10.1002/wfp2.12057

Welch, D., Swaffield, J., & Evans, D. (2021). Who's responsible for food waste? Consumers, retailers and the food waste discourse coalition in the United Kingdom. Journal of Consumer Culture, 21(2), 236–256. https://doi.org/10.1177/1469540518773801

Wentzel, W. (2022). The NEMLA Act - the long-awaited shift in South Africa's environmental legislative landscape is imminent. Www.polity.org.za. https://www.polity.org.za/article/the-nemla-act---the-long-awaited-shift-in-south-africas-environmental-legislative-landscape-is-finally-here-2022-06-28

Wikurendra, E. A., Ferto, I., Nagy, I., & Nurika, G. (2022). Strengths, weaknesses, opportunities, and threats of waste management with circular economy principles in developing countries: A systematic review. Environmental Quality Management. https://doi.org/10.1002/tqem.21846

Wilkie, A., Graunke, R., & Cornejo, C. (2015). Food waste auditing at three florida schools. Sustainability, 7(2), 1370–1387. https://doi.org/10.3390/su7021370

Woolley, E., Luo, Z., Aicha Jellil, & Simeone, A. (2022). A data driven approach to reducing household food waste. Sustainable Production and Consumption, 29, 600–613. https://doi.org/10.1016/j.spc.2021.11.004

World Bank. (2020). Trends in solid waste management. The World Bank. https://datatopics.worldbank.org/what-a-waste/trends_in_solid_waste_management.html%0Ahttp://datatopics.worldbank.org/what-a-waste/trends_in_solid_waste_management.html

World Bank. (2022). South Africa: Integrating Development and Climate Goals Requires a Transition that is Low-Carbon, Climate-Resilient, and Just. World Bank. https://www.worldbank.org/en/news/press-release/2022/11/01/south-africa-development-and-climate-goals-can-be-achieved-by-adopting-a-low-carbon-climate-resilient--just-transition

World Food Programme. (2022). WFP Strategic Plan 2022-25 | World Food Programme. Www.wfp.org. https://www.wfp.org/publications/wfp-strategic-plan-2022-25

World Meterological Organization. (2022). World Meteorological Organization. https://public.wmo.int/en

Worldwide Responsible Accredited Production. (2013). Estimates of food and packaging waste in the UK grocery retail and hospitality supply chains. Wrap. http://www.wrap.org.uk/sites/files/wrap/UK%20Estimates%20October%2015%20(FINAL)_0.pdf

WorldWideFund. (2017). Food loss and waste: Facts and futures. World Wide Fund for Nature. https://wwfafrica.awsassets.panda.org/downloads/wwf%202017%20food%20l oss%20and%20waste%20facts%20and%20futures.pdf?21641/Food-Loss-and-Waste-Facts-and-FuturesReport

WRI. (2019). Creating a Sustainable Food Future: A Menu of Solutions to Feed Nearly 10 Billion People by 2050 i CREATING A SUSTAINABLE FOOD FUTURE WORLD RE SOURCE S REP OR T. https://research.wri.org/sites/default/files/2019-07/creating-sustainable-food-future_2_5.pdf

Writer, S. (2022). Shoprite uses AI and machine learning to fight food waste. Shoprite Uses AI and Machine Learning to Fight Food Waste. https://techfinancials.co.za/2022/05/04/shoprite-uses-ai-and-machine-learning-to-fight-food-waste/

Xue, L., Liu, G., Parfitt, J., Liu, X., Erica Van Herpen, Åsa Stenmarck, O'Connor, C., Östergren, K., & Cheng, S. (2017). Missing food, missing data? A critical review of global food losses and food waste data. Environmental Science and Technology, 51(12), 6618–6633. https://doi.org/10.1021/acs.est.7b00401

Yaddanapudi, S., & Yaddanapudi, Lakshmi Narayana. (2019). How to design a questionnaire. Indian Journal of Anaesthesia, 63, 335–337. https://doi.org/10.4103/ija.IJA33419

Yoobic. (2021). 5 ways grocery retailers can reduce food waste in 2021. https://blog.yoobic.com/reduce-food-waste

Zamuz, S., Munekata, P. E. S., Meiselman, H. L., Zhang, W., Xing, L., Lorenzo, J. M., Lorenzo, J. M., Munekata, P. E. S., & Barba, F. J. (2021, January 1). Chapter 2 - Consumer and Market Demand for Sustainable Food Products. ScienceDirect; Academic Press. https://www.sciencedirect.com/science/article/abs/pii/B9780128212332000083

Zanoni, S., & Zavanella, L. (2012). Chilled or frozen? Decision strategies for sustainable food supply chains. International Journal of Production Economics, 140(2), 731–736. https://doi.org/10.1016/j.ijpe.2011.04.028

Zhang, S., Qian, J., Wu, C., He, D., Zhang, W., Yan, J., & He, X. (2022). Tasting More Than Just Food: Effect of Aesthetic Appeal of Plate Patterns on Food Perception. Foods, 11(7), 931. https://doi.org/10.3390/foods11070931

Zhao, J., Madni, G. R., & Anwar, M. A. (2022). Exploring rural inhabitants' perceptions towards food wastage during COVID-19 lockdowns: Implications for food security in Pakistan. PLOS ONE, 17(3), e0264534. https://doi.org/10.1371/journal.pone.0264534

Zhao, W., Gjalt Huppes, & Ester. (2011). Eco-efficiency for greenhouse gas emissions mitigation of municipal solid waste management: A case study of Tianjin, China. Waste Management, 31(6), 1407–1415. https://doi.org/10.1016/j.wasman.2011.01.013

Zhong, R., Xu, X., & Wang, L. (2017). Food supply chain management: systems, implementations, and future research. Industrial Management and Data Systems, 117(9), 2085–2114. https://doi.org/10.1108/IMDS-09-2016-0391

Zimmermann, K. K. (2017). Food waste reduction strategies in supermarkets: the lived experiences of perishable food managers in Michigan. Dissertation Abstracts International, A, 79-02, -.

# APPENDICES

## 9.1. APPENDIX A: Ethics Clearance

UNISA university of south africa

**UNISA-CAES HEALTH RESEARCH ETHICS COMMITTEE**

Date: 20/02/2023

NHREC Registration # : REC-170616-051
REC Reference # : 2023/CAES_HREC/014
Name : Ms R Shamlall
Student #: 36408468

Dear Ms Shamlall

**Decision: Ethics Approval from 16/02/2023 to 31/01/2028**

---

**Researcher(s):** Ms R Shamlall
36408468@mylife.unisa.ac.za; 082-636-4101

**Supervisor (s):** Prof L Leonard
llewel@unisa.ac.za; 011-471-2311

**Working title of research:**

Evaluating food wastes within the pre-retailing stages in a food manufacturing company in the KwaZulu-Natal Province

**Qualification:** PhD Environmental Management

---

Thank you for the application for research ethics clearance by the Unisa-CAES Health Research Ethics Committee for the above mentioned research. Ethics approval is granted for five years, **subject to further clarification and submission of yearly progress reports. Failure to submit the progress report will lead to withdrawal of the ethics clearance until the report has been submitted.**

**The researcher is cautioned to adhere to the Unisa protocols for research during Covid-19.**

**Due date for progress report: 31 January 2024**

The progress report is available on the college ethics webpage: https://www.unisa.ac.za/sites/corporate/default/Colleges/Agriculture-&-Environmental-Sciences/Research/Research-Ethics

*Please note the points below for further action:*

University of South Africa
Preller Street, Muckleneuk Ridge, City of Tshwane
PO Box 392 UNISA 0003 South Africa
Telephone: +27 12 429 3111 Facsimile: +27 12 429 4150
www.unisa.ac.za

## 9.2. APPENDIX B: Permission letter from RCL Foods

COLLEGE OF AGRICULTURE AND ENVIRONMENTAL SCIENCES

UNIVERSITY OF SOUTH AFRICA

DURBAN CAMPUS 4001

7 February 2022

Dear Chair of the UNISA Ethics Committee

Re: Letter of Permission to R Shamlall (36408468) to conduct research within RCL Foods/ Vector Logistics

I, Mark Clayton, Sales Director for RCL Foods/Vector Logistics, confirm that Rikasha Shamlall (ID Number: 851108 0057 084) is an employee of RCL Foods in the capacity of a Senior Data Analyst. I am aware of her requirement to conduct research of fulfilling her degree requirements to complete her studies. I hereby grant permission to Rikasha Shamlall to conduct research within RCL Foods.

The research topic: "Evaluating food wastes within the pre-retailing stages in a food manufacturing company in the KwaZulu-Natal province"

I wish to inform you of the acceptance of her request to conduct research and hereby assured her of our utmost cooperation towards achieving her academic goals with the view that the outcome may add value to our organization.

Regards,

Mark Clayton

REGISTERED OFFICE Ten The Boulevard • Westway Office Park • Westville • 3629 • PO Box 2734 • Westway Office Park • 3635 • KZN • South Africa
TEL +27 31 242 8600 RCL FOODS LIMITED REGISTRATION NO. 1966/004972/06

## 9.3. APPENDIX C: Mariannhill Landfill Permission Letter

ETHEKWINI MUNICIPALITY

CLEANSING AND SOLID WASTE UNIT
17 Electron Road, Springfield
P.O.Box 1038,Durban,4000
Tel: 031 3111111
Fax: 031 263 1119
Helpline: 031 311 8804
Website: www.durban.org.za

DSW
☎ 031 311 8804

COLLEGE OF AGRICULTURE AND ENVIRONMENTAL SCIENCES
UNIVERSITY OF SOUTH AFRICA
DURBAN CAMPUS
4001

23 March 2022

Dear Chair of the UNISA Ethics Committee

Re: Letter of Permission to R Shamlall (36408468) to conduct research within Mariannhill Landfill Site.

I, Melvan Govender, Senior Landfill Officer for Mariannhill Landfill Site, confirm that Rikasha Shamlall (ID Number: 851108 0057 084) has been granted permission to conduct research within Mariannhill Landfill Site. I know her requirements to conduct research to fulfil her degree requirements to complete her studies.

The research topic: Evaluating food wastes within the pre-retailing stages in a food manufacturing company in the KwaZulu-Natal province

I wish to inform you of the acceptance of her request to conduct research and hereby assured her of our utmost cooperation towards achieving her academic goals with the view that the outcome may add value to our organization.

Regards,

Melvan Govender

Senior Landfill Officer

eThekwini Municipality

Cleansing & Solid Waste

Mariannhill & Shallcross Landfill Sites

1 Landfill Lane

Mariannhill Park

Pinetown

Tel: 031322 8943

Cell: 084 240 6818

eMail: Melvan.Govender@durban.gov.za

BETTER WITHOUT LITTER

### 9.4. APPENDIX D: Consent Letter for Participation

UNISA

LETTER OF CONSENT TO PARTICIPATE IN RESEARCH STUDY

Dear Sir/Madam

My name is **Rikasha Shamlall (Student Number: 36408468)**, PhD in Environmental Management student at UNISA in the College of Agriculture and Environmental Sciences and inviting you to take part in my Research Project which forms part of the fulfilment of my Hons Research study under the following topic:

**Evaluating food wastes within the pre-retailing stages in a food manufacturing company in the KwaZulu-Natal province**

Your participation in this research will be highly appreciated and the information you provide shall be kept confidential and no participant shall be held responsible for any information provided. You can withdraw from the research project at your own discretion and signing this document does not put you in any contract whatsoever with the researcher or UNISA and this is not a legal document.

Your consent through signing this document only gives the researcher the right to use the information only for academic purposes related to the research with the title given above and any damages or misrepresentations from this information by the researcher are not your responsibility or that of your business employees.

Participant signature: ……………………………………………………

Date: ………………………………………………………………………

Researcher' Name: Rikasha Shamlall

Cell Number: 0826364101

Email: 36408468@mylife.unisa.ac.za

Supervisor: Prof. Leonard

Telephone: 0792442087

Email: llewel@unisa.ac.za

### 9.5. APPENDIX E: Interview Schedule

| # | Date of Interview | Participant (Manager/Merch) | Store Type | Duration | Sign |
|---|---|---|---|---|---|
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

# 9.6. APPENDIX F: Informed Consent Letter for Interviews

UNISA university of south africa

**PARTICIPANT INFORMATION SHEET**

Ethics clearance reference number: Pending
Research permission reference number: Pending

30th November 2022

Title: Evaluating food wastes within the pre-retailing stages in a food manufacturing company in the KwaZulu-Natal province

**Dear Prospective Participant**

My name is Rikasha Shamlall, and I am doing research with Prof L Leonard, a Professor in the Department of Environmental Sciences towards a PhD in Environmental Management at the University of South Africa. We are inviting you to participate in a study entitled Evaluating food wastes within the pre-retailing stages in a food manufacturing company in the KwaZulu-Natal province

**WHAT IS THE PURPOSE OF THE STUDY?**

I am conducting this research to investigate the food waste generation, driving factors and the impacts (environmental and economic) of frozen and chilled dairy, meat and fish product wastes from the retail supply chain for a major retail food supplier and producer in South Africa.

**WHY AM I BEING INVITED TO PARTICIPATE?**

You have been selected due to your experience and work within the food manufacturing company. The selection is limited to management as per the authorizations provided by the company.

**WHAT IS THE NATURE OF MY PARTICIPATION IN THIS STUDY?**

The study involves questionnaires, interviews, and document reviews. A combination of semi-structured interviews and a questionnaire will be used to collect information about the categories

University of South Africa
Preller Street, Muckleneuk Ridge, City of Tshwane
PO Box 392 UNISA 0003 South Africa
Telephone: +27 12 429 3111 Facsimile: +27 12 429 4150
www.unisa.ac.za

of food waste from the retail store whereby food was supplied. Mixed methods will be used to understand and interpret the social interactions with the use of interviews, and participant measurements using structured observations, field notes, reflections, and document analysis. The research question seeks to evaluate food waste within the pre-retailing stages in a food manufacturing company in the KwaZulu-Natal province

**CAN I WITHDRAW FROM THIS STUDY EVEN AFTER HAVING AGREED TO PARTICIPATE?**

Participating in this study is voluntary and you are under no obligation to consent to participation. If you do decide to take part, you will be given this information sheet to keep and be asked to sign a written consent form. You are free to withdraw at any time and without giving a reason.

**WHAT ARE THE POTENTIAL BENEFITS OF TAKING PART IN THIS STUDY?**

The findings from your participation will allow the researcher to determine food wastes within the pre-retailing stages in a food manufacturing company in the KwaZulu-Natal province. The findings will assist the business to also determine, ways to reduce food waste before reaching retail stores.

**ARE THERE ANY NEGATIVE CONSEQUENCES FOR ME IF I PARTICIPATE IN THE RESEARCH PROJECT?**

There are no negative consequences when you participate in this research

**WILL THE INFORMATION THAT I CONVEY TO THE RESEARCHER AND MY IDENTITY BE KEPT CONFIDENTIAL?**

You have the right to insist that your name will not be recorded anywhere and that no one, apart from the researcher and identified members of the research team, will know about your involvement in this research OR your name will not be recorded anywhere and no one will be able to connect you to the answers you give Your answers will be given a code number or a pseudonym and you will be referred to in this way in the data, any publications, or other research reporting methods such as conference proceeding. Otherwise, records that identify you will be available only to people working on the study, unless you give permission for other people to see the records.

**HOW WILL THE RESEARCHER(S) PROTECT THE SECURITY OF DATA?**

Hard copies of your answers will be stored by the researcher for a period of five years in a password-protected hard drive for future research or academic purposes; electronic information will be stored on a password protected computer. Future use of the stored data will be subject to further Research Ethics Review and approval if applicable. After 5 years, records will be permanently deleted, and the hard drive formatted.

**WILL I RECEIVE PAYMENT OR ANY INCENTIVES FOR PARTICIPATING IN THIS STUDY?**

No payment or incentives will be received. This is strictly for academic purposes.

**HAS THE STUDY RECEIVED ETHICS APPROVAL**

This study has received written approval from the Health Research Ethics Committee of the College of Agriculture and Environmental Sciences, Unisa. A copy of the approval letter can be obtained from the researcher if you so wish.

**HOW WILL I BE INFORMED OF THE FINDINGS/RESULTS OF THE RESEARCH?**

If you would like to be informed of the final research findings, please contact **Rikasha Shamlall** at **0826364101**. The findings are accessible for **24 months.**
Should you have concerns about the way in which the research has been conducted, you may contact **Prof. L Leonard** on **0114712311**. Contact the research ethics chairperson of the CAES Health Research Ethics Committee, Prof MA Antwi on 011-670-9391 or antwima@unisa.ac.za if you have any ethical concerns.

Thank you for taking time to read this information sheet and for participating in this study.
Thank you.

Ms. Rikasha Shamlall

University of South Africa
Preller Street, Muckleneuk Ridge, City of Tshwane
PO Box 392 UNISA 0003 South Africa
Telephone: +27 12 429 3111 Facsimile: +27 12 429 4150
www.unisa.ac.za

## CONSENT TO PARTICIPATE IN THIS STUDY

I, ___________________ (participant name), confirm that the person asking my consent to take part in this research has told me about the nature, procedure, potential benefits and anticipated inconvenience of participation.

I have read (or had explained to me) and understood the study as explained in the information sheet.

I have had sufficient opportunities to ask questions and am prepared to participate in the study.

I understand that my participation is voluntary and that I am free to withdraw at any time without penalty (if applicable).

I am aware that the findings of this study will be processed into a research report, journal publications and/or conference proceedings, but that my participation will be kept confidential unless otherwise specified.

I agree to the recording of the <insert specific data collection method>.

I have received a signed copy of the informed consent agreement.

Participant Name & Surname.................................................. (please print)

Participant Signature……………………………………………Date…………………

Researcher's Name & Surname: Rikasha Shamlall

Researcher's signature…………………………………………..Date…………………

## 9.7. APPENDIX G: Questionnaire

UNISA university of south africa

**QUESTIONNAIRE**

An investigating on frozen and chilled food waste generation, its drivers , socio-economic and environmental impacts in the supply and value chain for major food manufacturing company supplying chilled and frozen foods to 4 main retailers KwaZulu-Natal province, South Africa.

## QUESTIONNAIRE

**Dear respondents,**

The researcher of this proposal is a PhD student at the University of South Africa pursuing a Doctor of Philosophy in Environmental Science. She is caring out academic research on The study aims at investigating frozen and chilled food waste generation, its drivers , socio-economic and environmental impacts in the supply and value chain for a major food manufacturing company supplying chilled and frozen foods to 4 main retailers in KwaZulu-Natal province, South Africa.. Thus, you have been selected as a respondent in this research. Your active participation is very significant, and your honest responses will be highly appreciated.

All information is classified and for academic purposes only.

INSTRUCTIONS:

(i) Please do not write your name on the questionnaire.

(ii) Answer all the questions in the questionnaire to the best of your ability.

(iii) Answer questions by [x] against the answer boxes provided, and in a situation where you need to explain, space has been provided for you.

Thank You.

**Rikasha Shamlall**

**+27826364101**

**rikasha.shamlall@gmail.com**

**Individual Interview Guide & Individual In-Depth Interview Guide**

*N.B Please read all instructions carefully*

| **Key:** | | | | | |
|---|---|---|---|---|---|
| **Mitigating frozen and chilled food waste generation in the retail food supply and value chain.** | | | | | |
| **Key Words** | | | | | |
| Waste | Retail | Social | Economic | Supply | Chain |
| Mitigation | Frozen | Chilled | Food | Meat | Vegetables |
| Milk | Distribution | Sustainable | Perceptions | Habits | Environmental |

| **Section A : Demographic Information** | | | | | | | | | | | **Serial Number** | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Question 1 Please Check Box with X** | | | | | | | | | | | | |
| **Gender** | | **Male** | | | | | **Female** | | **Other** | | | |
| **Age/yrs.'** | **18-25** | | **26-35** | | **36-45** | | **46-55** | | **56 and +** | | | |
| **Category/Position** | | **Employee** | | **Environ Sc** | | | **Customer** | | **Policy-maker** | | | |
| **Education** | | **Degree** | | **Grade12** | | | **No Formal Education** | | | | | |
| **Income** | | **<R5k** | | **>R5k<R10k** | | | **>10k<20k** | | **>20k** | | | |

| **Section B: Exploration of the drivers behind frozen and chilled products waste generation in the supply and value chain. (I.e. diary, meat and vegetable products).** |
|---|
| *Main focus area: **factors driving** frozen and chilled food waste generation in the food supply and value chain. (I.e. diary, meat and vegetable products).* |
| **Question 4 (Instructions)** Please indicate the extent to which you agree to the following statements per category (1= Strongly Disagree, 2= Disagree, 3= Neutral, 4= Agree and 5=Strongly Agree)<br>*( In case of additional information some space below is provided)* |

| Category | SD | D | N | A | SA |
|---|---|---|---|---|---|
| (a) **Inadequate cold and chilling storage facilities** can result in frozen and chilled food expiring, damaged and/or contaminated thus food waste generation in the supply and value chain. | | | | | |
| (b) **Improper temperature levels** at loading bays, cold rooms, haulage cargo or display leads to chill and frozen food waste generation in the supply and value chain. | | | | | |
| (c) **Unpredictable consumer buying patterns** leading to over-ordering and stocking leads to frozen and chilled food waste generation in the value chain. | | | | | |
| (d) **Poor inventory management** (for example, not putting the oldest out first) leads to chilled and frozen food waste generation in the supply and value chain. | | | | | |
| (e) **Inadequate generation, transmission** and **distribution** of electric power resulting to electricity **rationing (load-shedding)** contributes to frozen and chilled food waste generation in the supply and value chain. | | | | | |
| (f) **Over-production**, **overstocking** and stores **damages** leads to expired products and are reasons behind frozen and chilled food waste generation in the supply chain. | | | | | |
| (g) **Inadequate systems of checks and balances** leading to invisibility and reporting of problems leads to frozen and chilled waste food generation in supply chain. | | | | | |
| (h) Supplier **packaging defects** can lead to frozen and chilled food waste generation in supply chain. | | | | | |
| (i) **Rejection** of food for food safety reasons (for example, pathogen contamination) can lead to frozen and chilled food waste generation in the supply chain. | | | | | |
| (j) **Discarding** edible frozen and chilled food products because of appearance can lead to food waste generation in the supply chain. | | | | | |

**In-depth Interview**

**The interviewer needs to conduct an in-depth interview relating to each response above though probing using the "What, Why, When, Who" and "How" question to seek solutions.**

Eg. You **strongly disagreed/agreed/ strongly agreed/agreed or were neutral** regards the statement "Inadequate cold and chilling storage facilities can result in frozen and chilled food expiring, damaged and/or contaminated thus food waste generation in the supply and value chain", can you state your reasons **"why, where, who, when"** and **how** do you think this can be addressed?

**Capture responses from (a-j):**

*Why:*

*When:*

*Where:*

*Who:*

*And How? it can be addressed (Solution)*

| **Section C investigates the socio-economic and environmental impacts of frozen and chilled food waste in the supply chain.** | | | | | |
|---|---|---|---|---|---|
| *Main Focus Area: The **impact** of frozen and chilled food waste generation **socially**, **economically** and **environmentally** in relation to food manufacturing **sustainability goals**.* | | | | | |
| **Question 3 (Instructions)** Please indicate the extent to which you agree to the following statements per category (1= Strongly Disagree, 2= Disagree, 3= Neutral, 4= Agree and 5=Strongly Agree) | | | | | |
| Category | SD | D | N | A | SA |
| **(k)** Frozen and chilled waste generation is associated with **food insecurity**, **social inequalities**, **malnutrition**, **poor hygiene** and **sanitation** and other **social** ills. | | | | | |
| **(l)** Frozen and chilled food waste generation has an effect on the country's **GDP**, **inflation**, **price hike**, **equitable distribution food products**, **affordability**, **profitability** and other **economic** ills. | | | | | |
| **(m)** Frozen and chilled food waste generation disposal **harms** the environment through **greenhouse gas emissions**, thus **negatively impacting** the environment. | | | | | |
| **(n)** Food manufacturing **sustainability goals** are efficiently upheld in the frozen and chilled food processing and manufacturing sector. | | | | | |

**In-depth Interview**

**The interviewer needs to conduct an in-depth interview relating to each response above though probing using the "What, Why, When, Who" and "How" question to seek solutions.**

Eg. You strongly disagreed/agreed/ strongly agreed/agreed or were neutral regards the statement "Frozen and chilled waste generation is associated with food insecurity, social inequalities, malnutrition, poor hygiene and sanitation and other social ills.", can you state your reasons **"why, where, who, when"** and **how** do you think this can be addressed?

**Capture responses (k-n):**

*Why:*

*When:*

*Where:*

*Who:*

*And How? it can be addressed (Solution)*

**Section D: Investigation on consumer perceptions on chilled and frozen food waste generation in relation to their buying habits and patterns.**

*Main Focus Area: The **perceptions** of the consumers on frozen and chilled food waste generation in relation to, their **buying habits** and **patterns** in the food supply and value chain.*

**Question 5 (Instructions)** Please indicate the extent to which you agree to the following statements per category (1= Strongly Disagree, 2= Disagree, 3= Neutral, 4= Agree and 5=Strongly Agree)

*( In case of additional information some space below is provided)*

| Category | SD | D | N | A | SA |
|---|---|---|---|---|---|
| **(o)** As a customer of this retail outlet, I am **satisfied** with their shelf life **standards** of frozen and chilled foods especially; dairy, meat and vegetable products are upheld in this retail outlet. | | | | | |
| **(p)** I buy my frozen and chilled foods here because they **offer fresh**, dairy, meat and vegetable products. | | | | | |
| **(q)** They sell **fresh, non-expired** frozen and chilled foods in this retail outlet especially, dairy, meat and vegetable products. | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| (r) **Discounts** in frozen and chilled food products especially, dairy, meat and vegetable products are a result of them being **spoiled** or closer to **date of expiry**. | | | | | |
| (s) I **always check expiry dates** for frozen and chilled especially diary, meat and vegetables products. | | | | | |

**In-depth Interview**

**The interviewer needs to conduct an in-depth interview relating to each response above though probing using the "What, Why, When, Who" and "How" question to seek solutions.**

Eg. You strongly disagreed/agreed/ strongly agreed/agreed or were neutral regards the statement "As a customer of this retail outlet, I am satisfied with their shelf life standards of frozen and chilled foods especially; dairy, meat and vegetable products are upheld in this retail outlet", can you state your reasons **"why, where, who, when"** and **how** do you think this can be addressed?

**Capture responses:**

*Why:*

*When:*

*Where:*

*Who:*

*And How? it can be addressed (Solution)*

**Section E: A critical analysis of the national policy and regulation framework on frozen and chilled food waste management in the food retail sector and make policy recommendations for sustainable food waste management in the supply and value chain.**

*Main Focus Area: The* ***strengths, weaknesses, opportunities and threats*** *of national policy and regulatory framework in mitigating frozen and chilled food waste generation in South Africa, and how do they* ***contrast*** *with those from other developing and developed countries.*

**Question 6 (Instructions)** Please indicate the extent to which you agree to the following statements per category (1= Strongly Disagree, 2= Disagree, 3= Neutral, 4= Agree and 5=Strongly Agree)

*( In case of additional information some space below is provided)*

| Category | SD | D | N | A | SA |
|---|---|---|---|---|---|

| | | | | | |
|---|---|---|---|---|---|
| **(t)** The national food waste management policy framework is highly commended for its **strengths** in efficiently regulating waste management especially frozen and chilled foods. | | | | | |
| **(u)** The national food waste management policy framework is highly condemned for its **weaknesses and flaws** in the efficient regulation the waste management of especially frozen and chilled foods. | | | | | |
| **(v)** The national food waste management policy framework has **great opportunities for growth** in the efficient regulation of waste management especially frozen and chilled foods. | | | | | |
| **(w)** There are **potential threats** to the national food waste management policy framework which impedes its development efficient execution. | | | | | |
| **(x)** The national food waste management policy framework **compares** better to other regional, under-developed and developed countries. | | | | | |

**In-depth Interview**

**The interviewer needs to conduct an in-depth interview relating to each response above though probing using the "What, Why, When, Who" and "How" question to seek solutions.**

Eg. You strongly disagreed/agreed/ strongly agreed/agreed or were neutral regards the statement "(t) The national food waste management policy framework is highly commended for its strengths in efficiently regulating waste management especially frozen and chilled foods." can you state your reasons **"why, where, who, when"** and **how** do you think this can be addressed?

**Capture responses:**

*Why:*

*When:*

*Where:*

*Who:*

*And How? it can be addressed (Solution)*

## 9.8. APPENDIX H: Interview Guide with Key Informants (Informal)

UNISA university of south africa

**Individual Interview Guide & Individual Semi Structured Interview Guide**

**INTRODUCTION:** My name is Rikasha Shamlall, a student at UNISA studying for a PhD in Environmental Management. My study topic is "EVALUATING FOOD WASTES WITHIN THE PRE-RETAILING STAGES IN A FOOD MANUFACTURING COMPANY IN KWAZULU-NATAL". Thank you for accepting to take part in this interview and my research project.

Please note that all information that will be provided during this interview will be kept confidential, will only be used for academic and research purposes, and will not be sold or given to any third party. I will use this information to answer my research questions and fulfil the objectives of this research. Please take a quick look at this Participation letter that was sent to you with the invite for the interview and sign it for me if you are happy for us to proceed with the interview. The interview should take between 30-45 minutes. Below are questions to gain an understanding of:

**Objective 2:** Investigate the economic and environmental impacts of food waste from the retail supply chain on the supplier and producer of frozen and chilled food products.
**Objective 3:** Explore the drivers behind frozen and chilled products wastage during the distribution phase of the retail FSC

The following questions will be asked at the start of the interview:

1. Please tell me about yourself. What is your position within the company?
2. What are you responsible for in your role?
3. Are you permanently employed by the company?

It serves as an icebreaker by allowing participants to tell the researcher about themselves before going directly into the research questions. The purpose of these questions is to confirm that the respondent is the intended participant. Researchers can also establish rapport with participants by answering these questions and gaining background information about them.

| Key: |  |  |  |  |  |
|---|---|---|---|---|---|
| **Mitigating frozen and chilled food waste generation in the retail food supply and value chain.** |  |  |  |  |  |
| **Key Words** |  |  |  |  |  |
| Waste | Retail | Social | Economic | Supply | Chain |
| Mitigation | Frozen | Chilled | Food | Meat | Vegetables |
| Milk | Distribution | Sustainable | Perceptions | Habits | Environmental |

| **Section A : Demographic Information** | **Serial Number** |  |
|---|---|---|
| **Question 1 Please Check Box with X** |  |  |

|  |  |  |  |  |  |  |  |  |  |  |
|---|---|---|---|---|---|---|---|---|---|---|
| **Gender** |  | **Male** |  |  | **Female** |  |  |  | **Other** |  |
| **Age/yrs.'** | **18-25** |  | **26-35** |  | **36-45** |  | **46-55** |  | **56 and +** |  |
| **Category/Position** |  | **Employee** |  | **Environ Sc** |  | **Customer** |  | **Policy-maker** |  |  |
| **Education** |  | **Degree** |  | **Grade12** |  | **No Formal Education** |  |  |  |  |
| **Income** |  | **<R5k** |  | **>R5k<R10k** |  | **>10k<20k** |  | **>20k** |  |  |

Based on the objectives, an informal interview was conducted with retail store managers and their staff. The questions posed to the key informants was to gather a better understanding within the retailer space.

1. **The reasons and drivers behind food waste generation of frozen and chilled food products in the supply and value chain of a food manufacturing company.**

   Informal questions posed where:

i. What is your understanding of frozen and chilled food waste?

ii. How would you define frozen and chilled food waste?

iii. How does your position have influence on frozen and chilled food waste?

iv. In your experience, what are the factors that influence frozen and chilled food waste in the supply chain?

v. How does your area of management result in frozen and chilled food waste?

vi. How is frozen and chilled food waste in your area of management influenced by another stage of the supply chain? Do you have any observations about packaging?

2. **Investigate the socio-economic and environmental impacts of frozen and chilled food waste generation in the supply chain and value chain**

Informal questions posed where:

i. How do you think frozen and chilled food waste can be reduced?
ii. As a manager, what changes would you make in processes within your department to minimise or reduce frozen and chilled food waste?
iii. In what area of the supply chain would you say there is the largest amount of frozen and chilled food waste?
iv. As a manager, what are the strategies that you would recommend to the organisation to minimise frozen and chilled food waste?
v. Do you experience challenges around minimising the amount of frozen and chilled food waste?
vi. As a manager, are you involved in the financial planning, is so does frozen and chilled food waste have a major or minor impacts?
vii. Do you follow any processes to avoid environmental impacts? If so, can you describe this process briefly?
viii. Is there any relationship between the level of environmental education and the attitudes towards frozen and chilled food waste?

3. **Investigate consumer perceptions on chilled and frozen food waste generation in the supply and value chain in relation to their buying habits and patterns.**

Informal questions posed where:

i. How would you market the company's products as green?
ii. What advantages would the company derive from positioning their products as being 'green'?
iii. Do you know what customers what from the frozen and chilled foods?
iv. Do you see a specific buying pattern with customers?

4. **To critically analyse the national policy and regulation framework on frozen and chilled food waste management in the food retail sector and make policy recommendations for sustainable food waste management in the supply and value chain.**

Informal questions posed where:

i. What kind of analytics do you have in place to measure frozen and chilled food waste and where frozen and chilled food waste is coming from? If so what tool and how is it used?
ii. How is frozen and chilled food waste collected?
iii. Does the company donate excess frozen and chilled food before disposal?
iv. What are the methods of disposals within the company, like an offsite composting site?
v. What is the level of awareness amongst the people of the company around frozen and chilled food waste?
vi. What are the factors that influence people's incentives to adopt proper frozen and chilled food waste procedures?
vii. What are the other levels of the frozen and chilled food supply chain that are impacting on the company's waste management of food waste?
viii. Is there anything else you would like to share?

The insights you shared about food waste in the retail supply chain and ways to minimize food waste have been very valuable. In summary, I recorded the following information during the interview. Did I capture it correctly? Do you have any questions or comments to add? It was a pleasure to conduct this interview with you, and I appreciate your time. If I have further questions or am unclear about anything, may I call or email you? I would like to thank you once again, and I wish you a good day ahead.

## 9.9. APPENDIX I: Interview Guide with Key Informants (In-Depth)

UNISA university of south africa

**Individual Interview Guide & Individual In-Depth Interview Guide**

**INTRODUCTION:** My name is Rikasha Shamlall, a student at UNISA studying for a PhD in Environmental Management. My study topic is "EVALUATING FOOD WASTES WITHIN THE PRE-RETAILING STAGES IN A FOOD MANUFACTURING COMPANY IN KWAZULU-NATAL". Thank you for accepting to take part in this interview and my research project.

Please note that all information that will be provided during this interview will be kept confidential, will only be used for academic and research purposes, and will not be sold or given to any third party. I will use this information to answer my research questions and fulfil the objectives of this research. Please take a quick look at this Participation letter that was sent to you with the invite for the interview and sign it for me if you are happy for us to proceed with the interview. The interview should take between 30-45 minutes.

The following questions will be asked at the start of the interview:

1. Please tell me about yourself. What is your position within the company?
2. What are you responsible for in your role?
3. Are you permanently employed by the company?

It serves as an icebreaker by allowing participants to tell the researcher about themselves before going directly into the research questions. The purpose of these questions is to confirm that the respondent is the intended participant. Researchers can also establish rapport with participants by answering these questions and gaining background information about them.

| | | | | | |
|---|---|---|---|---|---|
| **Key:** | | | | | |
| **Mitigating frozen and chilled food waste generation in the retail food supply and value chain.** | | | | | |
| **Key Words** | | | | | |
| Waste | Retail | Social | Economic | Supply | Chain |
| Mitigation | Frozen | Chilled | Food | Meat | Vegetables |
| Milk | Distribution | Sustainable | Perceptions | Habits | Environmental |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Section A : Demographic Information** | | | | | | | | | **Serial Number** | | |
| **Question 1 Please Check Box with X** | | | | | | | | | | | |
| **Gender** | | **Male** | | | | **Female** | | | **Other** | | |
| **Age/yrs.'** | **18-25** | | **26-35** | | **36-45** | | **46-55** | | **56 and +** | | |
| **Category/Position** | | **Employee** | | **Environ Sc** | | **Customer** | | | **Policy-maker** | | |
| **Education** | | **Degree** | | **Grade12** | | **No Formal Education** | | | | | |
| **Income** | | **<R5k** | | **>R5k<R10k** | | **>10k<20k** | | | **>20k** | | |

Based on the objectives, an in-depth individual interview was conducted with retail store managers and their staff. The questions posed to the key informants was to gather a better understanding within the retailer space.

**The reasons and drivers behind food waste generation of frozen and chilled food products in the supply and value chain of a food manufacturing company.**

1. How do you think inadequate cold and chilling storage facilities can result in frozen and chilled food expiring, damaged and/or contaminated thus food waste generation in the supply and value chain?
2. How does improper temperature levels at loading bays, cold room, haulage cargo or display leads to chill and frozen food waste generation in the supply and value chain?
3. Does unpredictable consumer buying patterns leading to over-ordering and stocking leads to frozen and chilled food waste generation in the value chain?
4. Why does poor inventory management (for example. not putting the oldest out first) leads to chilled and frozen food waste generation in the supply and value chain?

5. Does inadequate generation, transmission and distribution of electric power resulting to electricity rationing (load-shedding) contributes to frozen and chilled food waste generation in the supply and value chain?
6. Does over-production, overstocking and stores damages leads to expired products and are reasons behind frozen and chilled food waste generation in the supply chain? Why and how?
7. Does inadequate systems of checks and balances leading to invisibility and reporting of problems leads to frozen and chilled waste food generation in supply chain? Where, why and how?
8. Would supplier packaging defects can lead to frozen and chilled food waste generation in supply chain? How?
9. Does the rejection of food for food safety reasons (for example. pathogen contamination) can lead to frozen and chilled food waste generation in the supply chain? How?
10. Does discarding edible frozen and chilled food products because of appearance can lead to food waste generation in the supply chain? How and why?

**Investigate the socio-economic and environmental impacts of frozen and chilled food waste generation in the supply chain and value chain**

1. Is frozen and chilled waste generation is associated with food insecurity, social inequalities, malnutrition, poor hygiene and sanitation and other social ills. Explain, how and why?
2. Does frozen and chilled food waste generation has an effect on the country's GDP, inflation, price hike, equitable distribution food products, affordability, profitability and other economic ills? Why and how?
3. How do you think frozen and chilled food waste generation disposal harms the environment through greenhouse gas emissions thus negatively impacting the environment and why?
4. Do you think food manufacturing sustainability goals are efficiently upheld in the frozen and chilled food processing and manufacturing sector and why?

**Investigate consumer perceptions on chilled and frozen food waste generation in the supply and value chain in relation to their buying habits and patterns.**

1. As a customer of this retail outlet do you think you are satisfied with their shelf life standards of frozen and chilled foods especially; dairy, meat and vegetable products are upheld in this retail outlet and why?
2. Why do you buy your frozen and chilled foods here especially dairy, meat and vegetable products?
3. Would you agree that in your retail store they sell fresh, non-expired frozen and chilled foods in this retail outlets especially dairy, meat and vegetable products and why do you agree if yes and why don't you agree if no?.
4. What is your view regarding discounts in frozen and chilled food products especially, dairy, meat and vegetable products in relation to their shelf life or date of expiry in retail stores?
5. When buying commodities do you always check expiry dates for frozen and chilled especially diary, meat and vegetables products?

**To critically analyse the national policy and regulation framework on frozen and chilled food waste management in the food retail sector and make policy recommendations for sustainable food waste management in the supply and value chain.**

1. What are the areas of strength under-which the food waste management policy framework is highly commended in efficiently regulating waste management especially frozen and chilled foods?
2. In which policy framework areas is the national food waste management policy framework highly condemned for its weaknesses and flaws in the efficient regulation the waste management of especially frozen and chilled foods? Why?
3. Which growth opportunities does the national food waste management policy framework has in the efficient regulation of waste management especially frozen and chilled foods? How and why?
4. Are there potential threats to the national food waste management policy framework which impedes its development efficient execution? Where, how and why?
5. Does the national food waste management policy framework compares better to other regional, under-developed and developed countries? Why and how?

## 9.10. APPENDIX J: Online Survey Questions - Consumers

Survey Link: https://4eyes.io/s/9wccc/

UNISA university of south africa

### Consumer Survey - Food Waste

My name is Rikasha Shamlall, a student at UNISA studying for a PhD in Environmental Management and Science. My study topic is "Evaluating food wastes within the pre-retailing stages in a food manufacturing company in the KwaZulu-Natal province".

Thank you for accepting to take part in this survey and my research project.

Please note that all information that will be provided during this survey will be kept confidential, will only be used for academic and research purposes, and will not be sold or given to any third party. I will use this information to answer my research questions and fulfil the objectives of this research. The survey should take between 10-15 minutes. Below are questions to gain an understanding of:

Start survey

1. How old are you?

| | |
|---|---|
| 18-25 | |
| 26-35 | |
| 36-45 | |
| 46-55 | |
| 56-65 | |
| >65 | |

2. What is your gender?

| | |
|---|---|
| Male | |
| Female | |

3. Which area or surburb are you from? (Or nearest area)

| | | | | | | |
|---|---|---|---|---|---|---|
| Durban North | Reservoir Hills | Waterfall | Illovo | Amanzimtoti | KwaMashu | Umlazi |
| Chatsworth | Mpumalanga | Bluff | Umkomaas | Forest Hills | Ntuzuma | Northdene |
| Westville | Mayville | Essenwood | Berea | Overport | Inanda | Glen Park |
| uMhlanga | Arena Park | Hammarsdale | Verulam | Savanna Park | Phoenix | Other |

4. What is your approx. monthly income?

| | |
|---|---|
| Less Than R5 000 | |
| Greater Than R5000 Less Than R10 000 | |
| Greater Than R10 000 Less Than R20 000 | |
| Greater than R20 000 | |

5. What is your highest education?

| | |
|---|---|
| Degree | |
| Grade 12 | |
| No Formal Education | |

6. What types of Chilled and Frozen foods do you buy?

| | |
|---|---|
| Frozen Meat | |
| Frozen Chicken | |
| Frozen Vegetables | |
| Chilled Meats (Viennas/Polony) | |
| Butter | |
| Cheese | |
| Pizzas and Pies | |
| Other (please specify) | |

7. How often do you shop?

| | |
|---|---|
| Daily | |
| Once a week | |
| Twice a week | |
| Twice a month | |
| Once a month | |

8. Thinking about when you throw food away, to what extent, if at all, does it bother you?

| | |
|---|---|
| Always | |
| Often | |
| Sometimes | |
| Rarely | |
| Never | |

9. Please select how do you discard unpalatable (unpleasant) foods?

| | |
|---|---|
| I throw away food I do not like | |
| I throw away dried out food. | |
| I throw away wilted food | |
| I throw away food that looks unpalatable. | |

10. What category of food do you tend to overbuy and end up throwing out?

| | |
|---|---|
| Meat | |
| Fruits and vegetables | |
| Dairy | |
| Convenience foods | |
| Take-aways | |

11. Do you buy food as needed?

| | |
|---|---|
| I only buy the food I need. | |
| I buy small amounts of food. | |
| I buy as much food as I need at any one time | |
| I avoid overshopping. | |

12. If you notice that an item of food is coming close to its best before date, do you?

| | |
|---|---|
| Use it up as soon as possible | |
| Freeze it | |
| Prepare it and freeze it | |
| Discard it without bother | |

13. When I buy perishable food items, I check the date on the pack first

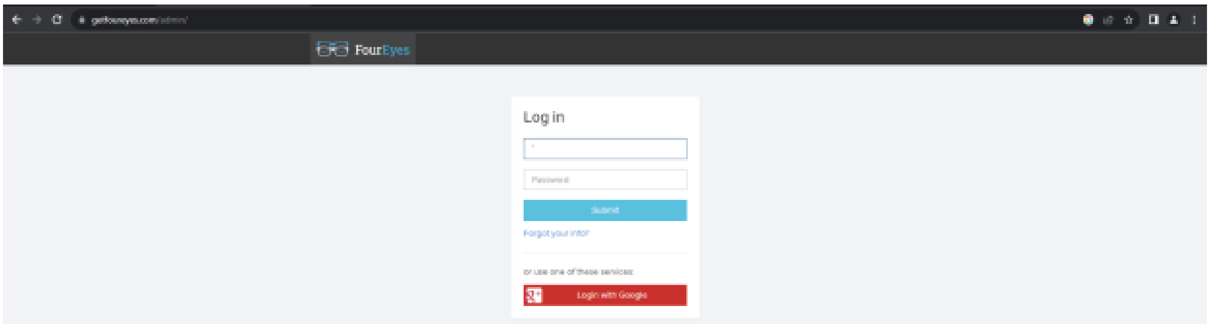
| | |
|---|---|
| Yes | |
| No | |

14. Are you aware of the stop food waste programme?

| | |
|---|---|
| Yes | |
| No | |

**Thank you for your participation**

## 9.11. APPENDIX K: Registration page for Four eyes



## 9.12. APPENDIX L: Observation Sheet

UNISA university of south africa

**OBSERVATION SHEET**

Observation will be conducted at the store level by the researcher. This observation sheet will be uploaded onto a handheld device to allow the researcher to capture her observation promptly.

This observation sheet will assist to answer:

**Objective 3: Explore the drivers behind frozen and chilled products wastage during the distribution phase in the retail supply chain.**

**Store Count: 1**

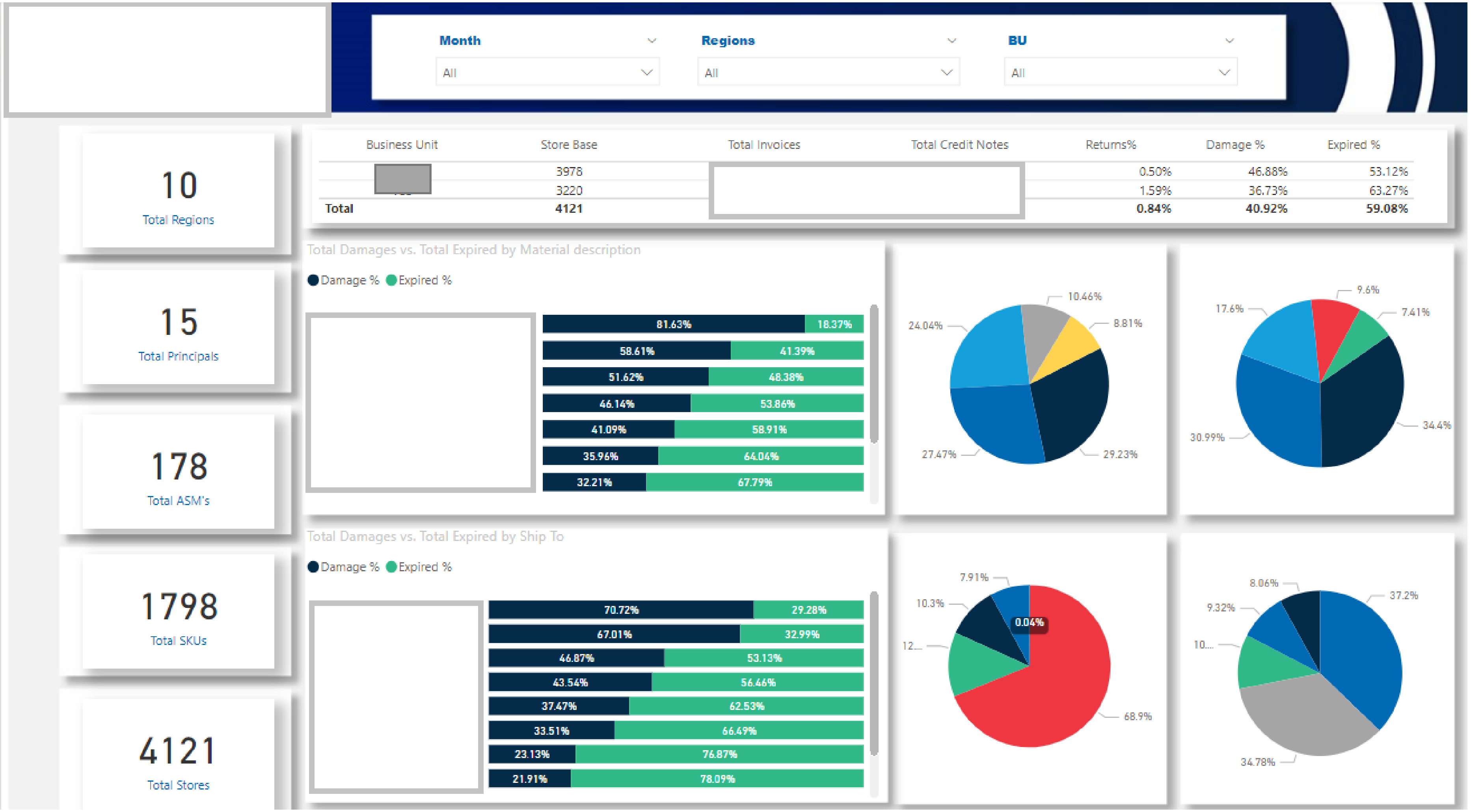
**Date:**

**Time:**

| Observation | Rate 1(poor) and 5(excellent) | How to improve? |
|---|---|---|
| The Right Range | | |
| On Shelf Availability (OSA) | | |
| Just Pack Enough Stock | | |
| All Pi Labels are Updated Present and Correct | | |
| Maintain Forward Share | | |
| The Right Forward Share | | |
| Good Stock Pressure | | |
| Best Shelf Position | | |
| Stock Rotation | | |

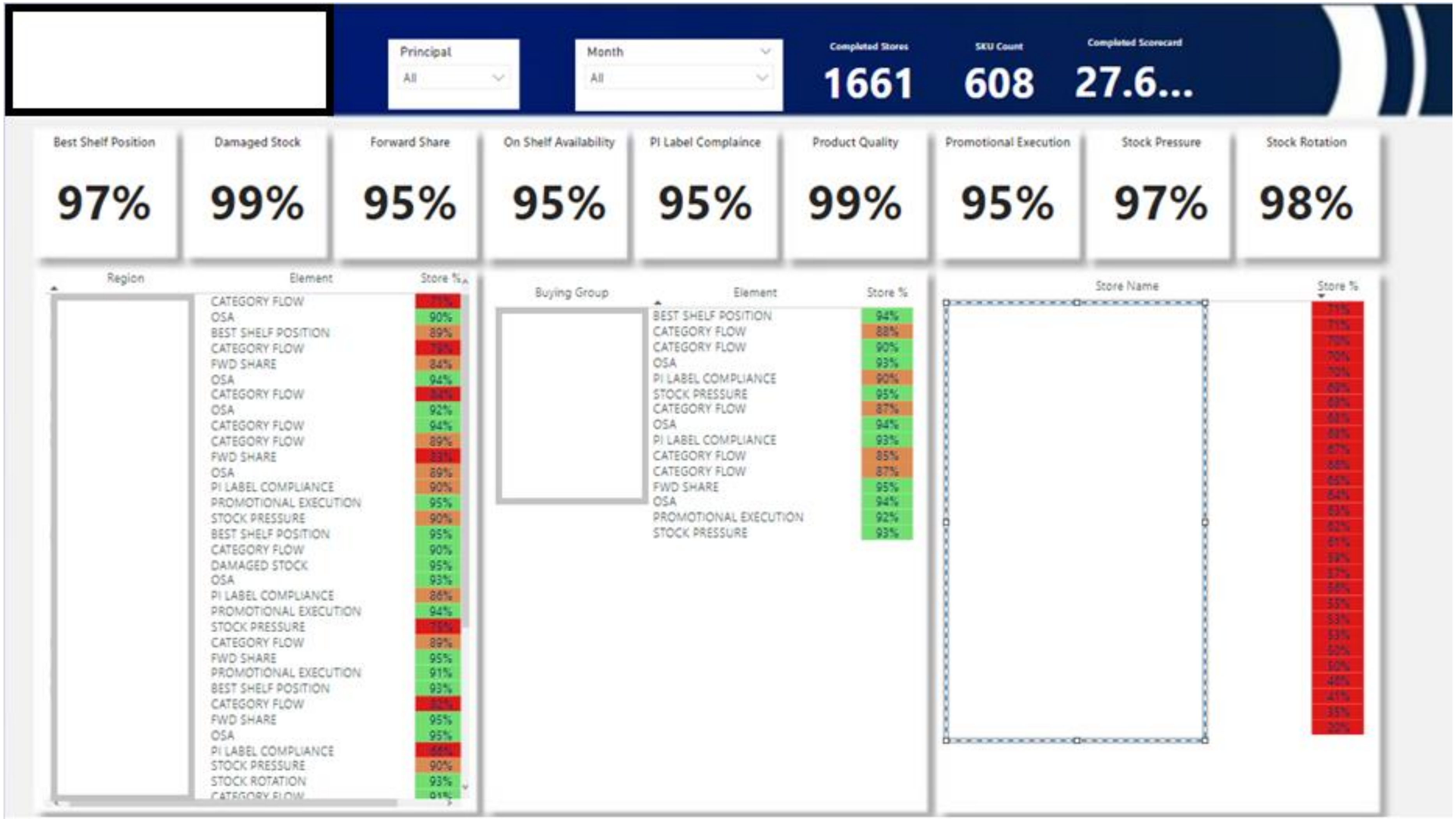
## 9.13. APPENDIX M: Microsoft Power BI Model - Returns

**Information masked** - as signed NDA



## 9.14. APPENDIX N: Microsoft Power BI Model – Shelf Health

**Information masked** - as signed NDA



## 9.15. APPENDIX O: Proofreading and Editing Confirmation

John Dewar Tel: +27833210844
PhD, DAHM Email: johndewar65@gmail.com

21 Jan 2024

Dear Professor Leonard,

This letter is to confirm that I completed a language and content edit of a thesis entitled: **EVALUATING FROZEN FOOD WASTE WITHIN PRE-RETAIL LEVELS IN A FOOD MANUFACTURING COMPANY IN KWAZULU-NATAL**.

This thesis describes a research study under your supervision and will be presented to the Department of Environmental Sciences, College of Agriculture and Environmental Sciences, University of South Africa in fulfilment for the requirements for the degree PhD in Environmental Management. The thesis was prepared by Rikasha Shamlall.

My edit included the following:

- Spelling and grammar,
- Vocabulary and punctuation
- Checking the formatting of the reference list in APA format

Text formatting included:

- Repaginated thesis with Roman and Arabic numerals
- Suggested that quantitative results be analysed after stratifying according to positions occupied in food retail and waste or as consumers.
- Suggested that more qualitative comments be included and analysed as described in Methodology chapter.
- Suggested that Discussion chapter should include more references.
- Suggested that the text for the study summary is appropriate for study conclusions.

Yours sincerely,

John Dewar

## 9.16. APPENDIX P: Turn It in Report

turnitin

# Digital Receipt

This receipt acknowledges that Turnitin received your paper. Below you will find the receipt information regarding your submission.

The first page of your submissions is displayed below.

| | |
|---|---|
| Submission author: | RIKASHA SHAMLALL |
| Assignment title: | Chapter 3 Final |
| Submission title: | Complete Thesis |
| File name: | Rikasha_PhD_thesis_-_2_Feb_2024_Version_5.docx |
| File size: | 24.59M |
| Page count: | 432 |
| Word count: | 115,767 |
| Character count: | 670,004 |
| Submission date: | 02-Feb-2024 03:37PM (UTC+0200) |
| Submission ID: | 2284504534 |

UNISA

EVALUATING FROZEN FOOD WASTE WITHIN PRE-RETAIL LEVELS IN A FOOD MANUFACTURING COMPANY IN KWAZULU-NATAL

By

RIKASHA SHAMLALL

Submitted in accordance with the requirements for the degree

Doctor of Philosophy

in the subject

Environmental Management

To the

DEPARTMENT OF ENVIRONMENTAL SCIENCES

in the

COLLEGE OF AGRICULTURE AND ENVIRONMENTAL SCIENCES

UNIVERSITY OF SOUTH AFRICA

SUPERVISOR: Prof L Leonard

January 2024



Turnitin Originality Report

Document Viewer

Processed on: 02-Feb-2024 15:41 SAST
ID: 2284504534
Word Count: 115767
Submitted: 1

Complete Thesis By RIKASHA SHAMLALL

| Similarity Index | Similarity by Source | |
|---|---|---|
| 12% | Internet Sources: | 6% |
| | Publications: | 10% |
| | Student Papers: | 1% |

exclude quoted | include bibliography | exclude small matches | mode: quickview (classic) report | print | download

1% match ("Sustainable food cold chains: Opportunities, challenges and the way forward", Food and Agriculture Organization of the United Nations (FAO), 2022)
"Sustainable food cold chains: Opportunities, challenges and the way forward", Food and Agriculture Organization of the United Nations (FAO), 2022

1% match ()
"The extent and drivers of perishable food waste in the retail supply chain industry of South Africa.", 'University of Pretoria - Department of Philosophy', 2017

1% match (Internet from 29-Nov-2021)
https://repository.nwu.ac.za/bitstream/handle/10394/37871/Dlomo%20TH%2025920146.pdf?isAllowed=y&sequence=1

<1% match ()
Loo, Lynne Xin Hui. "Improving Outcomes for Shell and Shucking By-Products in Australian Abalone Fisheries – A Supply Chain Perspective", Curtin University, 2023

<1% match (Internet from 13-Oct-2022)
https://ebin.pub/routledge-handbook-of-food-waste-9781138615861-9780429462795.html

<1% match (R. Santagata, M. Ripa, A. Genovese, S. Ulgiati. "Food waste recovery pathways: Challenges and opportunities for an emerging bio-based circular economy. A systematic review and an assessment", Journal of Cleaner Production, 2021)
R. Santagata, M. Ripa, A. Genovese, S. Ulgiati. "Food waste recovery pathways: Challenges and opportunities for an emerging bio-based circular economy. A systematic review and an assessment", Journal of Cleaner Production, 2021

<1% match ("Zero Hunger", Springer Science and Business Media LLC, 2020)
"Zero Hunger", Springer Science and Business Media LLC, 2020

<1% match ()
Papargyropoulou, Effrosyni. "Food waste generation in the hospitality and food service sector: Prevention insights from Malaysia", University of Leeds, 2016

<1% match ("Food and Nutrition Security in the Kingdom of Saudi Arabia, Vol. 2", Springer Science and Business Media LLC, 2024)
"Food and Nutrition Security in the Kingdom of Saudi Arabia, Vol. 2", Springer Science and Business Media LLC, 2024

<1% match (Internet from 15-Dec-2022)
https://researchcommons.waikato.ac.nz/bitstream/handle/10289/15386/thesis.pdf?isAllowed=y&sequence=6

<1% match (Matshusa, Khoḓani. "The Potential for Geotourism at the Kruger National Park for Social Sustainability", University of Johannesburg (South africa), 2021)
Matshusa, Khoḓani. "The Potential for Geotourism at the Kruger National Park for Social Sustainability", University of Johannesburg (South africa), 2021

<1% match ("Responsible Consumption and Production", Springer Science and Business Media LLC, 2020)
"Responsible Consumption and Production", Springer Science and Business Media LLC, 2020

<1% match (Barbara Flores Pimentel, Fotios Misopoulos, Jennifer Davies. "A review of factors reducing waste in the food supply chain: the retailer perspective", Cleaner Waste Systems, 2022)
Barbara Flores Pimentel, Fotios Misopoulos, Jennifer Davies. "A review of factors reducing waste in the food supply chain: the retailer perspective", Cleaner Waste Systems, 2022

## After Examiner Edits

**Similarity Report**

| PAPER NAME | AUTHOR |
|---|---|
| After Examiner Edits.docx | RIKASHA SHAMLALL |

| WORD COUNT | CHARACTER COUNT |
|---|---|
| 116736 Words | 676150 Characters |
| **PAGE COUNT** | **FILE SIZE** |
| 434 Pages | 25.1MB |
| **SUBMISSION DATE** | **REPORT DATE** |
| May 25, 2024 3:10 PM GMT+2 | May 25, 2024 3:16 PM GMT+2 |

● 19% Overall Similarity

The combined total of all matches, including overlapping sources, for each database.

- 10% Internet database
- 14% Publications database
- Crossref database
- Crossref Posted Content database
- 12% Submitted Works database