

**AN ASSESSMENT OF THE FACTORS CAUSING FOOD WASTE ALONG THE
VEGETABLE SUPPLY CHAIN - A CASE OF SOWETO MARKET IN LUSAKA**

By

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requirements for the award of the Degree of Master of Science Operations, Project and
Supply Chain Management**

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DECLARATION

I, **Misael Tembo**, do hereby declare that this work is my original work achieved through personal reading and research. This work has never been submitted to the University of Zambia or any other Universities. All sources of data used and literature on related works previously done by others, used in the production of this Dissertation have been duly acknowledged. If any omission has been made, it is not by choice but by error.

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ABSTRACT

Globally, 14% of the world's food valued at \$400 billion per year continues to be wasted along the supply chain after it is harvested and before it reaches consumers. In Zambia, there has been an increase in vegetable production from 157,500 tons in 1972 to 445,625 tons in 2021. Soweto Market holds an average share of 74% to 87% of vegetables produced in Zambia. However, Soweto Market has been recording an increase in vegetable waste and there is a significant research gap particularly on the causes of food waste along the vegetable supply chain. As such the study aimed to assess the factors causing food waste along the vegetable supply chain at Soweto Market. The specific objectives were to establish the major types of food waste generated along the Soweto market vegetable supply chain; to determine the factors that cause food waste along the Soweto market vegetable supply chain; to evaluate the cause of these factors on food waste along the Soweto market vegetable supply chain; to propose measures that can be applied to mitigate food waste along the Soweto market vegetable supply chain. The study adopted a deductive research approach and employed a descriptive research design. Stratified Random Sampling was used to determine a sample size of 110 smallholder vegetable farmers who farm, package, transport, store, and sale for themselves. Structured questionnaires were used to collect primary data and were summarized by descriptive statistics. Inferential statistics provided an in-depth analysis of the hypothesis tests through regression analysis. The study used SPSS software version 25.0 to aid the data analysis. The findings indicated that the independent variables, except for packaging, showed high reliability and internal consistency, indicating their suitability for factor analysis. It was also found that processing linkage has a significant positive effect on food waste. The study recommends Supply chain stakeholders to focus on improving processing linkages and review regulations among others to reduce food waste. The study has a theoretical and industrial impact because it contributes towards the current literature on the reduction of food waste along the vegetables supply chain and provides practical guidance to sales managers and policy makers.

KEYWORDS: *Food waste, Vegetable supply chain, Regulations, Process linkage, Supply chain management*

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DEDICATION

This thesis is dedicated to the almighty God for giving me strength to pull through this study. Also, to my daughters Drusilla Tembo and Yamika Tembo, and son Kondwelani Tembo. Finally, to my treasured mother Georgina Sakala and my lovely wife Sendy Banda.

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LIST OF ACRONYMS

FAO	Food and Agriculture Organisation
GHGs	Global Greenhouse Gas Emissions
MT	Metric Tonnes
AGS	Accelerated Growth for SMEs
TNO	The Netherlands Organization for Applied Scientific Research
CUTS	Consumer Unity and Trust Society
ACIAR	Australian Centre for International Agricultural Research
FVAZ	Fruits and Vegetable Association of Zambia
MATEP	Market Access, Trade, and Enabling Policies
EU	European Union
COMESA	Common Market for Esat and Southern Africa
SCCG	Supply Chain Consulting Group
ISM	Interpretive Structural Modelling
MCDM	Multi-criteria Decision-Making
KMO	Kaiser – Meyer – Olkin
SPSS	Statistical Package for Social Science
SSA	Sub-Saharan Africa
EFA	Exploratory Factor Analysis

CHAPTER 1 – INTRODUCTION

1.0 Introduction

Largely, food waste is the quantity or quality of food wasted resulting from decisions and actions by retailers, food services and consumers (Surucu-Balci & Tuna, 2021). Food waste also refers to discarded food product that is fit to proceed in the food supply chain (Gustavsson, et al., 2011). In the agriculture sector, the supply chain of vegetables constitutes of processes from the farm where production occurs to the customer (Negi & Anand, 2016). Hence, it is expected that players in the vegetable supply chain such as farmers, traders, intermediaries, transporters, processors, wholesalers, and retailers would prevent wastage along the vegetable supply chain. The prevention of vegetable waste is vital because vegetable production forms a substantial percentage of food crops cultivated and is a major source of livelihood (Idah, et al., 2007). However, due to supply chain challenges, food waste occurs along the vegetable supply chain before procession or consumption (Marissa & Toshihiko, 2021). In Zambia, vegetable production was 157,500 tons in 1972 and 445,625 tons while in 2021 (Knoema, 2021) indicating a production increase of 283%. However, food waste along the vegetable supply chain at Soweto Market has been increasing (Hichaambwa & Tschirley, 2006). The food and vegetable Association of Zambia indicated that 40% to 50% for tomatoes goes to waste at Soweto Market (FVAZ, 2023). Researchers in Zambia have focused on understanding the value chains of fruits and vegetables (Hichaambwa & Tschirley, 2006). Other researchers have looked at the impact of COVID-19 on smallholder farmers of vegetables, fruits, meat production, processing and marketing (Kapembwa & Joshi, 2020). The other authors have focused on the impact of road network on vegetable production (Musonda, 2020), post-harvest losses of fruits and vegetables (Phiri, 2010) and small scale producers and traders market supply chain for fresh vegetables (Mukololo, 2009).

This study seeks to assess the factors causing food waste along the vegetable supply chain at Soweto market in Lusaka. The study shall establish the major types of food waste generated along the Soweto market vegetable supply chain, determine the factors that cause food waste along the Soweto market vegetable supply chain, evaluate the influence of these factors on the

supply of vegetables on the market and propose measures that can be applied to mitigate food waste along the Soweto market vegetable supply chain.

1.1 Background of the Study

In general, food is described as a social glue, a cultural expression, an economic commodity, and a source of nutrients that plays a key role in maintaining life, and growth of humans and animals (Mwanamwenge & Harris, 2017). Food waste is discarded food products that is fit for consumption or fit to proceed in the food supply chain (Gustavsson, et al., 2011). According to Harvard T.H Chan of Public Health, vegetables are an important part of a healthy diet.

In the agriculture Sector, the supply chain of vegetables constitutes of processes from the farm where production of fresh produce occurs to delivery of the produce to the customer (Negi & Anand, 2016). The vegetable production forms a substantial percentage of food crops cultivated and so it is the source of livelihood (Idah, et al., 2007). However, due to supply chain factors, food waste of vegetables occurs along the supply chain beforeconsumption (Marissa & Toshihiko, 2021).

Globally, 14% of the world's food valued at \$400 billion per year continues to be lost after it is harvested and before consumption (FAO, 2019). The Food and Agriculture Organisation (FAO) report further indicates that 17% of our food ends up being wasted in retail along the supply chain. FAO estimates that the food that is wasted could feed 1.26 billion hungry people every year. Therefore, it is very clear that food waste along the vegetable supply chain is a major problem across the globe, with the latest studies pointing to one third of the food produced wasted worldwide (Ribeiro, et al., 2018). Ribeiro, et al explains that this problem occurs throughout the food supply chain and has economic, environmental, and social consequences.

In Assia, particularly India and China are the largest producers of fruits and vegetables and constitutes about 12.6% and 14% of the total world production of fruits and vegetables respectively (Handbook on Horticulture Statistics, 2014). However, 18% of the total amount of fruits and vegetables produced in India are wasted beginning from the post-harvest stages along the supply chain (Balaji & Arshinder, 2016).

In Brazil, before the COVID-19 pandemic, approximately 26 million tonnes of food were wasted annually, in which 5.3 million tonnes are related to fruit and 5.6 million tonnes to vegetables (Moraes, et al., 2022).

In South Africa, approximately 10 million tonnes (Mt) of food is wasted every year. Fruits, vegetables, and cereals account for 70% of the wastage. Food waste in South Africa has numerous negative impacts on the health of humans, animals, and the environment when disposed (Mudau, 2022).

In Zambia, the *Zambian Circular Economy Study* conducted under the Accelerated Growth for SMEs (AGS) Programme private sector development initiative funded by the Ministry for Foreign Affairs of Finland revealed that Zambia generates an estimated 3.7 million tons of waste annually out of which over 1.2 million tons is food waste (AGS Programme, 2023). The Netherlands Organization for Applied Scientific Research (TNO) revealed that out of the total waste generated in Zambia, food waste makes up the majority, accounting for 51% on average.

In the period between 2004 and 2005, farms were producing average of 1,600 mt of tomato, 50 mt of onion, 4,400 mt of cabbage in Zambia (Hichaambwa & Tschirley, 2006) an indication that tomatoes, onion and cabbage are among the prominent vegetables farmed in Zambia. Further, in the period between 1972 and 2021 vegetable production was 157,500 tons and 445,625 tons respectively (Knoema, 2021). Therefore, the trends shows that there is an increase in the vegetable production from 1972 to 2021 growing at an average annual rate of 2.22%. After production, vegetables are sold through the traditional informal market channels rather than modern supermarket chains (Mwanamwenge & Harris, 2017). As a result, the large amount of food waste of vegetables is generated from informal markets. In Lusaka, there is heavy dependence on regional food networks for vegetable supplies because 73% of the vegetables are from outside Lusaka while 27% are produced within the administrative boundaries of the city. (Nyawali, 2018). The Consumer Unity and Trust Society (CUTS) on the Food Security Initiative indicated that food traders in Lusaka face storage challenges which remain poor and undeveloped with only three cold-room facilities functional for the entire Soweto market (CUTS, 2020). According to Routledge *Studies in Cities and Development*, Soweto Market located in Lusaka is Zambia's largest market that serves as both a wholesale and retail space for various food products farmed and manufactured from within and outside Lusaka (Marrengane & Croese,

2021). Marrengane and Croese further explains that Soweto Market is the largest landing site for food from farms, traders in the Lusaka City region and acts as an important contributor to food security in Lusaka.

The Australian Centre for International Agricultural Research (ACIAR) indicates that out of an average total of 4621.3 Kgs of vegetables produced from the Lusaka city region 1429 kg are transported to Soweto Market (ACIAR, 2023). In the period between 2007 and 2008, Soweto Market transacted over 50,000 mt of tomato, rape and onion per year, valued at over US\$13m (Hichaambwa & Tschirley, 2010) a clear indication that vegetables move all the way from farmers to Soweto market.. Hichaambwa and Tschirley explains that the vegetable supply chain at Soweto market is linked to foreign countries such as south Africa, Malawi and other countries who supply onions and other related vegetables which are sold to consumers at Soweto market. Hichaambwa and Tschirley adds that vegetable wholesaling at Soweto market takes place in an uncovered dirt field at one end of the market complex with no dedicated entry and exit points, very limited storage capacity, and no cold storage.

According to Hichaambwa and Tschirley in their study under the USAID and Zambia mission through Market Access, Trade, and Enabling Policies (MATEP) Program, the dominance of open-air markets at Soweto is most pronounced in vegetables and they hold an estimated share of 74% to 87% of vegetables produced in Zambia. It was further revealed in their study that, wastage of vegetables at Soweto Market before they are purchased by consumers ranges from 3%-5% (Hichaambwa & Tschirley, 2006). Further, according to the Fruits and Vegetable Association of Zambia (FVAZ), about 40 to 50% of tomatoes go to waste at Soweto Market (FVAZ, 2023).

CSO-SUN Alliance Zambia explains that at Soweto Market, fresh fruits and vegetables such as cabbage, kalembula, lettuce and tomatoes are wasted daily raising concern over Zambia's capacity to preserve food for both consumption and export purposes (CSO-SUN, 2021). In addition, the consequences of food waste include increased cost of production, trade and distribution, increases consumer prices and reduces farmers income (Phiri, 2010). Thus, what is happening at Soweto Market presents a huge challenge on food security because Soweto Market is by far the largest retail and wholesale vegetable supply chain market in Zambia (Hichaambwa, 2019).

Therefore, it will be valuable to appreciate the factors causing food waste along the vegetable supply chain at Soweto market.

1.2 Problem Statement

Soweto Market located in Lusaka is by far the biggest vegetable supply chain market in Zambia affected by factors that cause food waste along the vegetable supply chain. Despite having registered an increase in vegetable production from 157,500 tons in 1972 to 445,625 tons in 2021 representing an annual growth rate of 2.22% (Knoema, 2021), the Country is experiencing an increase in vegetable waste in that out of 4621.3 Kgs of vegetables produced in Lusaka only 1429 kgs are loaded onto vehicles for transportation. The wastage of vegetables at Soweto Market before purchase by consumers at retail stage ranges from 3% to 5% (Hichaambwa & Tschirley, 2006). Further, the report from the Fruits and Vegetable Association of Zambia (FVAZ) that 40 to 50% of tomatoes go to waste at Soweto Market (FVAZ, 2023) underscore the severity of food waste along the vegetable supply chain in Zambia.

Understanding factors causing food waste along the vegetable supply chain and formulating appropriate measures is critical (Bagherzadeh, et al., 2014). Thus, failure to conduct a detailed study on this crisis could result in a failing vegetable supply chain. Food waste along the vegetable supply chain has long term economic, environmental, and social consequences (Ribeiro, et al., 2018).

Despite the need for research in this area, there exists a gap in the body of knowledge. Numerous studies investigated factors causing food waste along the vegetable supply chain (Alsbu, et al., 2023; Adhikari & Herath, 2022; Negi & Anand, 2016) but they are broad and none of them focused on developing countries in Africa (Rauta, et al., 2019; Kalidas., et al., 2014; Iradeep & Kumar, 2021; Moraes, et al., 2022; Valery, 2023; Surucu-Balci & Tuna, 2021; Anand & Barua, 2022; Onwude, et al., 2020). In Zambia, studies assessing factors causing food waste along the vegetable supply chain is ideal. This study aims to address this gap and contribute valuable insights toward the development of effective measures to mitigate the current obtaining problem.

1.3 Research Aim

This study aims to assess factors causing food waste along the Soweto market vegetable supply chain.

1.4 Research Objectives

1. To establish the major types of food waste generated along the Soweto market vegetable supply chain.
2. To determine the factors that cause food waste along the Soweto market vegetable supply chain.
3. To evaluate the influence of these factors on food waste along the Soweto market vegetable supply chain
4. To propose measures that can be applied to mitigate food waste along the Soweto market vegetable supply chain.

1.5 Research questions

1. What are the major types of food waste generated along the Soweto market vegetable supply chain?
2. What are the factors that cause food waste along the Soweto market vegetable supply chain?
3. How do the factors influence food waste along the Soweto market vegetable supply chain?
4. What are the measures that can be applied to mitigate food waste along the Soweto market vegetable supply chain?

1.6 Significance of the Study

1.6.1 Researchers and Academicians

This study shall contribute valuable insights that shall enrich the existing body of knowledge. Firstly, it illustrates the importance of quantitative methodology in the evaluation of factors that influence food waste along the Soweto market vegetable supply chain. In many cases, researchers would qualitatively collect data related to this topic. However, this study exploited the strengths of quantitative research methodology to evaluate the factors that influence food waste along the Soweto market vegetable supply chain. Therefore, this approach provides a new

perspective that provides much more detailed information for future use. Future researchers shall find this study and approach interesting.

1.6.2 Government and Policy Makers

The factors causing food waste along the vegetables supply chain at Soweto market remain not well understood. This study evaluated the factors influencing food waste along the vegetables supply chain at Soweto market. Therefore, the findings of this study will help improve the policy framework on how food waste along the supply chain of vegetables can be mitigated. The study will also help identify key factors for the attention of policy makers along the vegetables supply chain at Soweto. Market. Farmers, wholesalers, retailers, transporters, and storage facility managers who are key players and stakeholders in policy making will be able to have a full understanding on how the factors are linked to them and will be able to develop policies and procedures aimed at eliminating food waste along the vegetables supply chain at Soweto market.

1.6.3 Vegetable Supply Chain Sector

This study shall contribute remarkably to industry as it highlights the benefits of reducing food waste along the vegetable supply chain being among them efficiency and price reduction among supply chain players such as producers, famers, wholesalers, and retailers at Soweto market. It will also present an opportunity for processing firms to look at Soweto market as a great game changer in the mobilization of raw material from a single point or location thereby reducing time, packaging hiccups and transportation cost. The study shall also provide ways on how information can be shared among industry players in the vegetable supply chain to their advantage to reduce on loses, delays, damages and wastage of their products.

1.7 Scope of the Study

The study will be conducted in Lusaka Province of Zambia at Soweto Market. The reason for selecting this area in Lusaka is that Soweto Market is Zambia's largest formal, council-managed, urban market that serves as both a wholesale and retail space for various food products farmed and manufactured from within and outside Lusaka. Further, Soweto Market is the largest landing site for food from farms, traders in the Lusaka city region, and beyond and acts as an important contributor to food security in Lusaka.

The supply chain of vegetables consists of producers, transporters, wholesalers, retailers, market managers and consumers. The sample target shall be drawn based on the types of food waste

along the vegetable supply chain. Stratified sampling method shall be used because the population shall be divided into subgroups of producers, transporters, wholesalers, retailers, market managers and consumers. A total of 110 players from the targeted population in the vegetable supply chain that shall be divided into subgroups will be considered through Stratified sampling method.

1.8 Theoretical and Conceptual Framework

1.8.1.1 Theoretical Framework

As stated in the introduction, this section describes the theories that attempt to explain the relationships involving the study variables. Three theories relevant to the study have been identified to provide the theoretical background of the conceptual framework. The three theories include the Interpretive structural modelling (ISM) theory, Network theory and stakeholder theory.

1.8.1.2 Network Theory

Network theory provides a useful framework for analysis of a business situation, and it adds a new complexity level to understanding the relationship perspective (Jarillo, 1988; Turnbull et al., 1996; Möller & Halinen, 1999; Croom et al., 2000; Edelenbos & Klijn, 2005). Network relations create information sharing, which enables buyers and sellers to have access to resources and knowledge beyond their abilities, leading to long-term relationships in the fruit and vegetable export chain (Mikkola, 2008) (Jraisat, 2010).

In recent years, many studies have identified the importance of relationship networks for doing business. The network perspective has been applied in order to explain network functions (e.g. business resources) examining a set of business relationships in the export supply chain (Jraisat, 2010).

The network theory was employed in a research study where it was found that actor network and supply chain theory can provide frameworks for further understanding the social relations of trust and cooperation, linking actors in regional agri-food in the United States (Jarosz, 2000).

Further, network theory was applied in study where resources were found to influence product and process changes in food industry. Supplier and customer collaboration were not found to have any moderating effects (Koops et al., 2002).

Network Theory is relevant to this study because the assessment of factors as independent variables causing food waste along the vegetable supply chain as a dependent variable is a business situation that requires the network theory to full appreciate the relationship perspective along the vegetable supply chain.

1.8.1.3 Interpretive structural modelling (ISM) theory

According to Attri, et al, Interpretive structural modelling (ISM) theory is a well-established methodology for identifying relationships among specific items, which define a problem or an issue. This approach has been increasingly used by various researchers to represent the interrelationships among various elements related to the issue. ISM approach starts with an identification of variables, which are relevant to the problem or issue. Then a contextually relevant subordinate relation is chosen (Attri, et al., 2013).

In the study conducted by Raut & Gardas, the Interpretive structural modelling theory was employed in the study aimed at reducing food wastage at every stage of a fresh produce supply chain to achieve balance among all three dimensions (social, ecological and economic) of the sustainability to stimulate growth and develop the agricultural domain. The purpose of the study was to address the causal factors of post-harvesting losses (PHLs) occurring in the transportation phase. After through exhaustive literature survey and expert opinions, 12 crucial barriers to sustainable transportation of vegetables were identified. The interpretive structural modelling (ISM) methodology, a multi-criteria decision-making (MCDM) approach, was employed for developing a structural model of the identified barriers (Raut & Gardas, 2018).

Further, the interpretive structural modelling (ISM) theory was applied in the study conducted by Balaji & Arshinder to model the interactions among the causes of food wastage in fruits and vegetables supply chain from the harvesting stage till it reaches the consumer (Balaji & Arshinder, 2016).

The interpretive structural modelling (ISM) theory is relevant to this study because it will help in the evaluation of the influence of the factors such packaging, transport, storage, production units, quality, and regulation as independent variable on food waste along the vegetable supply chain as dependent variables. Using this theory the relationship between the independent and dependent variables along the vegetable supply chain shall be identified.

1.8.1.4 Stakeholder Theory

The stakeholder management rationale for supply chain formation envisions firms on the centre of an association of stakeholders (Akhter, et al., 2018). A firm's stakeholders are any group of those who can influence the firm (Freeman, 1994), along with its investors, suppliers, employees, customers, competitors, and many others in its operating environment.

The stakeholder's theory was utilized in the studies where they explained that stakeholders across the food supply chain have attributed higher legitimacy and urgency to collaboration as an instrumental approach for alleviating food waste along the supply chain of vegetables (Govindan, 2018; Mena, Terry, & Ellram, 2014; Parry, Bleazard, & Okawa, 2015; Priefer, Jörissen, & Bräutigam, 2016). In the study conducted by Bhattacharya and Fayezi, this collaborative approach was rooted in stakeholders' recognition that waste happens at different stages of the food supply chain and for various reasons, and as such addressing the complex problem of food waste warrants multi-stakeholder collaboration. h

The stakeholder theory relevant to this study because the supply chain of vegetables requires collaboration among key actors or stakeholders along the chain to mitigate the factors that influence food waste of vegetables. The key stakeholders along the supply chain of vegetables included farmers or producers, transporters, retailers, market managers and regulators. There is a strong need for close collaboration with the different stakeholders, to achieve the implementation of sustainable practices within the supply chain (Seuring & Müller, 2008).

1.8.1.5 Summary of theoretical Frameworks

Network Theory: This theory is relevant to this study because the assessment of factors causing food waste along the vegetable supply chain is a business situation that requires the network theory to full appreciate the relationship perspective along the vegetable supply chain.

Interpretive structural modelling (ISM) theory: This theory is relevant to this study because it will help in the evaluation of the influence of the factors such packaging, transport, storage, production units, quality, and regulation on food waste along the vegetable supply chain. Using this theory the relationship between the factors and food waste along the vegetable supply chain shall be identified.

Stakeholder Theory: The key stakeholders along the supply chain of vegetables included farmers or producers, transporters, retailers, market managers and regulators. There is a strong need for close collaboration with the different stakeholders in the supply chain to mitigate food waste of vegetables.

1.9 Conceptual Framework

A review of the research theories supporting the study was presented in the immediate past sections. Further, in chapter two, a detailed analysis of the empirical literature on factors influencing food wastes along the vegetables supply chain. Drawing on the lessons learned so far, the current section develops the conceptual framework by looking at the factors that negatively influence food waste along the vegetable supply chain and how the measure can be employed to positively influence food waste along the vegetable supply chain.

The empirical literature shows that market information, packaging, transportation, storage, link to processing units, quality and regulations are among the factors that cause food waste along the vegetables supply chain (Aschemann-Witzel, et al., 2016) (Manalili, et al., 2014) (Guarnieri, et al., 2021) (Lagorio, et al., 2021) (Raak, et al., 2017) (Narrood, et al., 2009) (Baldwin & Black, 2008). The studies have also revealed measures that can be employed to reduce food waste along the vegetables supply chain are information sharing, suitable packaging, transportation, storage and linking processing units to producers of vegetables (Kaipia, et al., 2013) (Verghese, et al., 2015) (Raut, et al., 2019) (Li, et al., 2015) (Raak, et al., 2017) (Batt & Cadilhon, 2007).

From the theoretical perspective, the study adopted three theories presented in the theoretical framework explaining the factors and the measures that influence food waste along the vegetable supply chain.

In this Conceptual framework, the factors are the independent variables whereas food waste along the supply chain of vegetables is the dependent variable.

Network Theory assessed factors influencing food waste along the vegetable supply chain as a business situation that requires the network theory to full appreciate the relationship perspective between factors such as packaging, transport, storage, production units, quality, regulation as independent variables and food waste along the vegetable supply chain as a dependent variable. The Interpretive structural modelling (ISM) theory evaluated the influence of the factors such

packaging, transport, storage, production units, quality, and regulation on food waste along the vegetable supply chain and the relationship between the factors and food waste along the vegetable supply chain was identified. The Stakeholder theory isolated farmers or producers, transporters, retailers, market managers and regulators as key stakeholder along the vegetables supply chain and emphasized the need for close collaboration with the different stakeholders in the supply chain to mitigate food waste of vegetables.

From the empirical literature, food waste occurs in every food supply chain sector along the distribution route at different stages namely handling, transportation, and storage after harvest and before processing, processing, distribution, and consumption (Ju, et al., 2017) (Cassani & Gomez-Zavaglia, 2022) (Kalidas., et al., 2014) (Rais & Sheoran, 2015) (Sihariya, et al., 2013).

The conceptual framework's development shows the independent and dependent variables derived from the empirical literature of Adhikari & Herath (2022).

According to Adhikari & Herath (2022), the purpose of the study was to analyse the impact of transportation, packaging, excess supply, and a storage facility categorised as factors on perceived post-harvest wastage of vegetables and fruit in the Dambulla Dedicated Economic Center. The study adopted a quantitative research approach and thus, the study has addressed the survey type research method and a structured questionnaire was used to collect data and utilized a sample frame of farmers, whole-sellers, and retailers who enter the Dambulla Dedicated Economic Center and random sampling was used. To test the hypothesized relationships between the constructs, the multiple regression analysis was performed using SPSS. The results of the study discussed the 100% significant positive impact of transportation, 97% significant positive impact of packaging, 98% significant positive impact of a storage facility, and 99% significant positive impact of excess supply on post-harvest wastage of vegetables according to the Sri Lankan context. It is expected that the model will support the policymaking process regarding people keeping progress activities in economic centres and affecting increment of additional cost from farm to fork. This problem may affect families who depend on cultivation as well as final consumers who have to pay the additional cost (Adhikari & Herath, 2022).

Given the empirical and theoretical literature views, the interaction of factors causing food waste along the vegetables supply are represented in the conceptual framework in figure 3.1.

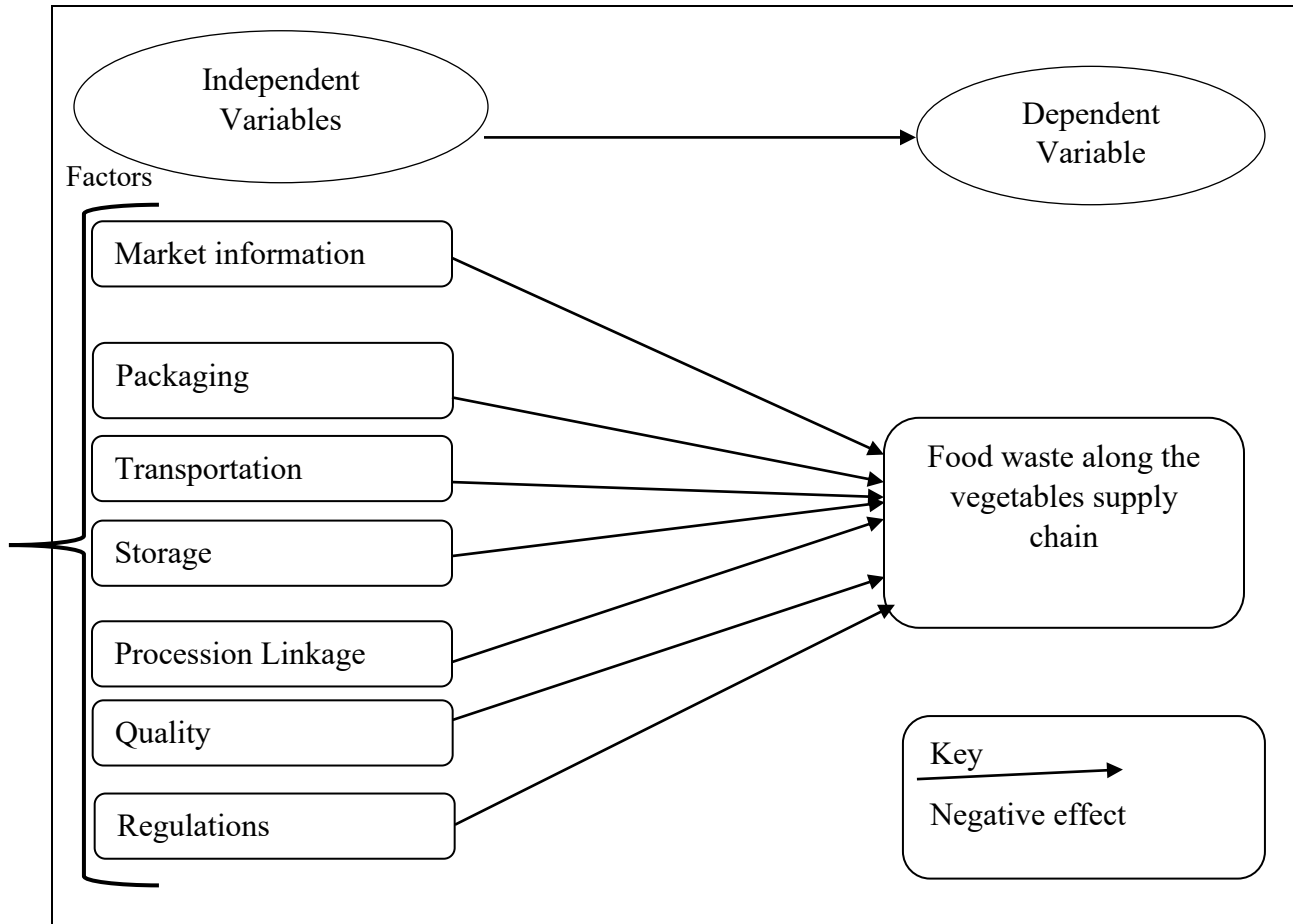


Figure 1.1: Conceptual Framework (Source: Author, 2024)

1.9.1 Operationalization of Variables

This study considers variables, as presented in the conceptual framework: Food waste along the vegetables supply chain as the dependent variable, factors (packaging, transport, storage, production units, quality, regulation) as independent variables. Table 3.1 provides a summary of these variables.

Table 1.1: Summary of Variables

Variable	Dimension	Indicator	Operationalization	Measurement
Dependent Variable	Food waste along the vegetables supply chain	Spillage of Vegetable s	Oscillations in quantity of vegetables making it to the market due to spillage along the supply chain	Average mean scores of 1 – 5
				Point Likert scale

Independent Variable	Market information	Pest Infestation	The frequency of pest and insect infesting vegetables along the supply chain	Average mean scores of 1 – 5 Point Likert scale
		Rotting of vegetables	The rate of early sales of vegetables due to threat of rotting along the supply chain	Average mean scores of 1 – 5 Point Likert scale
		Quality loss in vegetables	The swing in sale prices of vegetables due to reduced quality along the supply chain	Average mean scores of 1 – 5 Point Likert scale
		Quantity loss of vegetables	The ability that the same quantity of vegetables from the point of origin will make it to the market along the supply chain	Average mean scores of 1 – 5 Point Likert scale
		Wastage of vegetables	Fluctuations in the volume of vegetable wasted along the supply chain	Average mean scores of 1 – 5 Point Likert scale
		Sales Loss	Change in sales volume of vegetables along the supply chain	Average mean scores of 1 – 5 Point Likert scale
		Income loss	Swings in revenue from vegetables along the supply chain	Average mean scores of 1 – 5 Point Likert scale
		lack of market informatio	Over supply of vegetables along the supply chain due to zero	Average mean scores of 1 – 5 Point Likert scale

	facilities	the supply chain	
			Average mean scores of 1 – 5 Point Likert scale
Processing Linkage	Absence of processing linkage	supply of vegetables will always be higher than demand leading to wastage	Average mean scores of 1 – 5 Point Likert scale
			Average mean scores of 1 – 5 Point Likert scale
			Average mean scores of 1 – 5 Point Likert scale
Quality	Quality failure	Loss of sales of vegetables	Average mean scores of 1 – 5 Point Likert scale
			Average mean scores of 1 – 5 Point Likert scale
Regulations	insufficient regulations	producers lack bargaining power to negotiate future contracts for vegetables thereby reducing demand	Average mean scores of 1 – 5 Point Likert scale
	Lack of standards	uncompetitive market for vegetables leading to only few producers selling to processing units	Average mean scores of 1 – 5 Point Likert scale

1.9.2 Research Hypothesis

- 1.0 H₁: Market information has a positive influence on food waste along the vegetables supply chain.
H₀ Market information has a negative influence on food waste along the vegetables supply chain.
- 2.0 H₁: Packaging has a positive influence on food waste along the vegetables supply chain.
H₀ Packaging has a negative influence on food waste along the vegetables supply chain.
- 3.0 H₁: Transportation has a positive influence on food waste along the vegetables supply chain.
H₀ Transportation has a negative influence on food waste along the vegetables supply chain.
- 4.0 H₁: Storage has a positive influence on food waste along the vegetables supply chain.
H₀ Storage has a negative influence on food waste along the vegetables supply chain.
- 5.0 H₁: Processing linkage has a positive influence on food waste along the vegetables supply chain.
H₀ Processing linkage has a negative influence on food waste along the vegetables supply chain
- 6.0 H₁: Quality has a positive influence on food waste along the vegetables supply chain.
H₀ Quality has a negative influence on food waste along the vegetables supply chain.
- 7.0 H₁: Regulations has a positive influence on food waste along the vegetables supply chain.
H₀ Regulations has a negative influence on food waste along the vegetables supply chain.

1.10 Definition of Key Terms

Supply chain: It is a network between a company and its suppliers to produce and distribute a specific product to the final buyer (Dubey, et al., 2020).

Vegetable: It is the edible portion of a plant and are usually grouped according to the portion of the plant that is eaten such as leaves (lettuce), stem (celery), roots (carrot), tubers (potato), bulbs (onion) and flowers (broccoli) (Nesamvuni, et al., 2001) (Pennington & Fisher, 2009)

Packaging: it is the science, art and technology of enclosing or protecting products for distribution, storage, sale, and use (Kushe & P.T, 2016).

Transportation: is the intentional movement of humans, animals, and goods from one location to another (Beregszásziová & Takáčová, 2023).

Storage: is a supply chain activity of storing products at warehouses and logistics centres. Its role is to provide a steady supply of goods to the market to fill the temporal gap between producers and consumers (Lagorio, et al., 2021).

Linkage: in the supply chain is defined as explicit or implicit connections that a firm creates with critical entities of its supply chain to manage the flow and quality of inputs from suppliers into the firm and of outputs from the firm to customers (Barratt & Barratt, 2011).

Quality: is the degree to which an object or entity such as a process, product, or service satisfies a specified set of attributes or requirements (Golder, et al., 2012).

Regulation: is the controlling of an activity or process, usually by means of rules (Baldwin & Black, 2008).

CHAPTER 2 - LITERATURE REVIEW

2.0 Introduction

The previous chapter delivered the introductory part of the research upon which the literature framework is based. This Chapter presents a literature review on the types of vegetables, factors influencing food waste along the vegetable supply chain and the measures to be applied. The chapter is divided into several sections and subsections, with each section and the corresponding section addressing specific areas that aid the overall analysis of the literature review. The literature review under consideration discloses current happening in the discipline of food waste along the vegetables supply chain and demonstrates how this study fits and contributes to the overall existing knowledge on food waste along the vegetables supply chain.

2.1 Supply Chain

A supply chain is a network between a company and its suppliers to produce and distribute a specific product to the final buyer (Dubey, et al., 2020). The supply chain also represents the steps it takes to get the product or service from its original state to the customer (Dubey, et al., 2020). Examples of supply chain activities provided by Dubey, et al include farming, refining, design, manufacturing, packaging, and transportation. Thus, supply chains are networks of individuals, companies, and suppliers through which the production and distribution of products up to the final consumer is made possible.

Given that a supply chain is a network, Mwanza and Telukdarie explains that supply chain networks are so complex because of the number of participants that include suppliers, manufacturers, distributors, retailers and customers (Mwanza & Telukdarie, 2022). Thus, Mwanza and Telukdarie further explains that the interdependencies in supply chains are complex and solving the challenges is not limited to single factors. Therefore, there are several factors that cause food waste along the vegetable supply chain. In a vegetable supply chain, wholesalers who are mostly farmers are intermediaries and a predominant link in the retail vegetable logistical chain (Somashekhar, et al., 2014). In general, all the retailers are inevitably dependent on the local wholesales market with the major constraints being poor transport facilities, non-availability of large-scale cold storage, no clean policy guidelines from government and fragmented and small farmers (Somashekhar, et al., 2014)

2.2 Vegetable Supply Chains in Developed Economies

The following developed countries Spain, Portugal, Turkey and Brazil were selected for the study review because of their large-scale vegetable production and having agriculture as their second largest contributor to the Gross Domestic Product (Statista , 2023), (European Commission , 2023), (Kadakoğlu & Gul, 2023), (Statista, 2021).

2.2.1 Spain

Spain is the leading vegetable producer in the European Union (EU) and one of the top three exporters in the world (Duque-Acevedo, et al., 2022).

The Spanish vegetables sector is both diverse and fragmented, comprising many different players whose produce varies according to its geographical origin. However, these players tend to converge in the latter stages of the distribution process of their products (Hernández-Rubio, et al., 2016).

Duque-Acevedo, et al explains that it has been estimated that between 25% and 50% of food produced in Spain is wasted along the supply chain and the major sectors involved include agriculture, food manufacturing, packaging, retail, and catering.

2.2.2 Portugal

In Europe generally, fruits and vegetables are the most wasted food products, representing 54% of total food waste. In Portugal particularly, 17% of the edible parts of the food produced for human consumption are wasted, corresponding to about 1 million tonnes per year. 42% of this waste are fruits and vegetables (Magalhães, et al., 2021). Magalhaes, Ferreira and Silva further explain that food products can deteriorate and be discarded at all stages of the food supply chain, while they are transported, cooled, processed, traded, treated, and packaged. So, an analysis focusing on the different food supply chain stages is necessary to fully understand why food products are being discarded and what can be done to prevent food waste.

2.2.3 Turkey

In Turkey, approximately 30% of the vegetable production turn into loss during production, postharvest handling, storing, processing, packaging, and distribution, while 5% of the vegetable production turn into waste during consumption, 10 percent becomes waste during processing and packaging (Surucu-Balci & Tuna, 2021). Surucu-Balci and Tuna explains that warehousing,

transportation, communication, and packaging are the main logistics related drivers that lead to food waste in Turkey.

2.2.4 Brazil

In Brazil, before the COVID-19 pandemic, approximately 26 million tonnes of food were wasted annually, in which 5.3 million tonnes are related to fruit and 5.6 million tonnes to vegetables (Moraes, et al., 2022). From the total amount of daily food wasted in Brazil, 40% occurs in distribution, in which retail accounts for 12%. Moraes, et al explains that the rate of fruit and vegetable waste in supermarkets in 2020 represented 5.25% of its gross revenue and was one of the highest percentages compared to other perishable categories. Moraes, et al further explains packaging, traceability, refrigeration, and transport are among that factors that lead to food waste of vegetables.

2.3 Vegetable Supply Chains in Developing Economies

The following developing countries were selected for the study because they produce vegetables on a much larger scale and have a population size of more than 20 million people with similar vegetable supply chains (Statista, 2021).

2.3.1 Vietnam

Moustier conducted a study on the on the organization of vegetable chains supplying urban markets in Vietnam where it was revealed that Fresh vegetables supplied by urban and peri-urban agriculture are leafy vegetables such as morning glory, various varieties of cabbage, and lettuces that are sold through short supply chains: farmers commonly transport their produce for night wholesale markets by motorbike and sell to retailers. (Moustier, 2017). Moustier indicated that 65% of farmers sell to collectors in the field, while 27% sell in wholesale markets to wholesalers or retailers. Direct sales to consumers were only observed for 8% of farmers, and they mostly take place in village markets (Moustier, 2017). Moustier further explains that transportation is one of the key factors that influence perishability of vegetables in Vietnam due to geographical location of farmers who are mostly not near the markets.

According to the Ministry of Agriculture and Rural Development of Vietnam, post-harvest handling, storage, transportation are the main contributors to waste along the supply chain of vegetables which was standing at 12% in 2019 (Ministry of Agriculture and Rural Development, 2019)

2.3.2 India

As the Indian population continues to grow, the demand for fresh vegetables is increasing. However, infrastructure connecting numerous small stakeholders like farmers, wholesalers, food manufacturers, retailers is very weak (Halder & Pati, 2011). Halder and Pati further explains that farmers bring whatever they produce to the market without any knowledge about the demand in the market. Inadequate usage/improper management of cold chains are leading to loss in quality of the vegetables.

India is the second largest producer of fruits and vegetables next to China. India produced 88.97 million metric tonnes of fruits and 162.98 million metric tonnes of vegetables during 2014, which constitutes around 12.6% and 14% of the total world production of fruits and vegetables respectively (Handbook on Horticulture Statistics, 2014). Despite this enormous volume of production, the amounts of exports are only 1–2%. As high as 18% of the total amount of fruits and vegetables produced are wasted beginning from the post-harvest stage until they reach consumers (Balaji & Arshinder, 2016)

The major contributors to food waste in the supply chain are processing waste, lack of cold-storage facilities, process contamination, improper packaging, transportation losses, higher inventory due to poor forecasts (Papargyropoulou, et al., 2014)

In India, post-harvest loss and waste of agricultural products is estimated at \$13 billion. The loss is nearly thrice of the new budget for the agriculture, which has seen a sharp increment of 44 percent from Rs 24,909 crore (\$4 billion) in 2015 to 2016 to 35,984 crore (\$5 billion) in 2016 to 2017 (Anand & Barua, 2022). Anand and Barua explain that despite the enormous production of fruits and vegetables in India, wastage of fruits and vegetables stands at 70% of the total production causing 40% of the economic losses. Anand and Barua further explain that lack of specialized vehicles, improper handling of packed during loading and unloading, inadequate packaging, lack of production planning and demand forecasting have resulted into food waste of vegetables.

2.3.3 South Africa

In South Africa, postharvest waste in the vegetable supply chain occurs predominantly at the pre-consumer level, in contrast to similar supply chains in developed countries (Sibomana, et al.,

2016). The South African vegetable supply chain consists of farmers, wholesalers, retailers who are mainly chain stores and consumers.

In South Africa, approximately 10 million tonnes (Mt) of food is wasted every year. Fruits, vegetables, and cereals account for 70% of the wastage. Food waste in South Africa has numerous negative impacts on the health of humans, animals, and the environment when disposed (Mudau, 2022). Mudau further highlights the factors that influence food waste which include overstocking, poor storage management practices, improper production planning, cleaning of processing plant and not having proper refrigeration among other factors.

2.3.4 Sri Lanka

In Sri Lanka they produce more than 1,019,000 and 2,962,000 metric tons of fruits and vegetables annually (Department of Agriculture Sri Lanka, 2022) and exports 900,000 metric tons of both fresh and processed vegetables and fruits to any destinations in the world. Research conducted in Sri Lanka revealed that there is 100% significant positive impact of transportation, 97% significant positive impact of packaging, 98% significant positive impact of a storage facility, and 99% significant positive impact of excess supply on post-harvest wastage of vegetables (Adhikari & Herath, 2022). Therefore, transportation, packaging, excess supply, and a storage facility influence wastage of vegetables in the Dambulla Dedicated Economic Centre in Sri Lanka.

2.4 Vegetable Supply Chain in Zambia

In Zambia, Soweto Market is by far the largest retail and wholesale vegetable supply chain market located in Lusaka (Hichaambwa, 2019). In 2007 and 2008 it transacted over 50,000 mt per year just of tomato, rape and onion, valued at over US\$13m (Hichaambwa & Tschirley, 2010). Therefore, most of the vegetables move all the way from small scale and commercial farmers outside Lusaka to Soweto market. The movement along the vegetable supply chain provides linkage between small, medium and commercial farms outside Lusaka and Soweto as the destination which then outlines a supply chain network involving transportation, packaging, storage, handling and many others that play a role in ensuring that vegetables get to consumers at Soweto market in a fresh condition without being wasted either along the way or at the market. Hichaambwa and Tschirley further explains that the vegetable supply chain at Soweto market is linked to foreign countries such as south Africa, Malawi and other countries who supply onions

and other related vegetables which are sold to consumers at Soweto market. Hichaambwa and Tschirley adds that the wholesaling at Soweto market takes place in an uncovered dirt field at one end of the market complex with no dedicated entry and exit points, very limited storage capacity, and no cold storage. Soweto market is also known for having a lot of wasted vegetables piled up in different points across the market.

2.5 Food Waste in Vegetable Supply Chains

Food waste occurs in every food supply chain sector along the distribution route (Ju, et al., 2017). Food waste occurs at five different stages in the supply chain, namely agriculture, postharvest which includes handling, transportation, and storage after harvest and before processing, processing, distribution, and consumption (Cassani & Gomez-Zavaglia, 2022).

It's evident that when vegetables are produced by a farmer and packaged in readiness for distribution to consumers.

Given the characteristics of vegetables such as perishability, seasonality, bulkiness and delicate nature of the product coupled with inadequate storage and transport facilities, the supply chain can be made efficient by reducing the length of the chain and improving cold chain facilities (Kalidas., et al., 2014).

Proper supply chain management in fruits and vegetables must be improved in all the stages of the supply by adopting best global practices in storage, packaging, handling, transportation, value added service etc to meet the country's demand of fruits and vegetables (Rais & Sheoran, 2015).

Supply Chain efficiency not only helps in increased production and per capita consumption, but also contributes to economic development of the country (Sihariya, et al., 2013).

2.6 Types of Vegetable Food Wastes

A vegetable is the edible portion of a plant and are usually grouped according to the portion of the plant that is eaten such as leaves (lettuce), stem (celery), roots (carrot), tubers (potato), bulbs (onion) and flowers (broccoli) (Nesamvuni, et al., 2001) (Pennington & Fisher, 2009)

In East Africa, vegetables include white and red cabbage, tomatoes, French beans, carrots, spinach, onions, green peas, eggplants, and green pepper (Maina & Mwangi, 2008) . Maina and

Mwangi explain that the listed vegetables are more popular in urban areas where many households cultivate their own small gardens to meet some of the household requirements. However, for many urban households, a good proportion of vegetables consumed are purchased from markets (Maina & Mwangi, 2008).

The main vegetable crops produced by smallholders in Zambia are tomatoes, onions, watermelons, Chinese cabbage, pumpkins, French beans, okra, and lettuce (Phiri, 20110).

The following list of vegetables have been explained in detail.

2.6.1 Tomatoes

Tomatoes are one of the world's most popular vegetables, their varieties as well as origin are based on cultured artifacts, linguistic and genetic evidence. Musa and Bitrus explains that tomatoes are a source of vitamins A and C and have economic value Tomatoes (Musa & Bitrus, 2009). According to the Fruits and Vegetable Association of Zambia (FVAZ), about 40 to 50 per cent of tomatoes on the market go to waste every year in the hot season when production is high (FVAZ, 2023). According to the Common Market for Esat and Southern Africa (COMESA), most of the tomatoes produced in Zambia go to waste, resulting in farmers losing valuable income they could earn by exporting paste (African Farming, 2023).

2.6.2 Onion

Onion is a round vegetable with a brown skin that grows underground, it has many white layers on its inside which have a strong, sharp smell and taste (PIATE & HARRISON, 2023). Onion is one of the important crops among all horticultural commodities and is second to tomato in terms of global production (Sagar, et al., 2022). Sagar, et al explains that onion is a major agricultural commodity accountable for 500,000 tons of annual waste in just the European Union, which is a serious concern for the ecosystem.

According to the Vincent Corporation, Onion processors will easily generate 10,000 to 100,000 pounds per day of waste. The Vincent Corporation explains that the waste comes from two flows: cull onions (spoiled, bruised, crushed), and the skins (parchment with outer layers of onion, with top and bottom trims) (Vincent Corporation, 2003)

2.6.3 Carrots

Carrot is among the top ten most economically important vegetable crops in the world, in terms of both area of production and market value (Simon, et al., 2008). Simon, et al explains that the total global market value of the more widely traded carrot seed crop has been estimated to be in the range of \$100 million.

In agricultural, food loss ranges from 1% to 20-25% of the total production. Meanwhile, carrot food loss ranges from 25 to 28% to a maximum of 58% (Valery, 2023). Valery also observed that a percentage of approximately 1 to 2% of the total retail sales of carrots result in wastage weekly and food wastage in the supply chain for tomatoes and carrots varies across stages.

2.6.4 Okra

Okra (*Abelmoschus caillei*) is a vegetable crop that is popular in the tropical region because of its easy cultivation, dependable yield, adaptability to varying weather conditions and resistance to diseases and pests (Olaniyan & Omoleiyomi, 2013). Okra, also known as ladies' fingers, is a fuzzy green vegetable filled with seeds (Smith, 2019). Smith adds that like many other vegetables, okra is full of antioxidants, vitamins, and minerals.

Olaniyan and Omoleiyomi explains that okra is seasonal and highly perishable in its natural state after harvest resulting in huge postharvest losses during the production season and extreme scarcity in the off-season (Olaniyan & Omoleiyomi, 2013).

2.6.5 Cabbage

Featherstone explains that a Cabbage (*Brassica oleracea*) is a cruciferous vegetable. Featherstone further explains that a cabbage is a leafy green or purple biennial plant, grown as an annual vegetable crop for its dense-leaved heads (Featherstone, 2016).

Cabbage makes up around 6.5% of global vegetable production with around 30% wasted from the farm to plate, making it a considerable and widely available biochar feedstock (Pradhan, et al., 2020)

A head of cabbage loses 44 to 66% of its wet weight before reaching the consumer, as stakeholders trimmed the outer leaves at each node of the value chain (Ortiz-Gonzalo, et al., 2021). Ortiz-Gonzalo, et al explains that stakeholders associated with modern retailers produced on average significantly more waste from trimming.

2.7 Causes of Food Wastes Along Vegetable Supply Chains

Gardas, et al found that the most critical factors that should be tackled to reduce food waste of vegetables reduction are: lack of proper packaging facilities, lack of proper storage facilities, insufficient infrastructure, handling of the products at the farm and marketplace, lack of processing facilities, lack of linkage between the farmers and processing units, lack of linkages in the marketing channel, and large number of intermediaries (Gardas, et al., 2018).

Negi and Anand allude that factors leading to wastages in the supply chain of vegetables include Poor Infrastructure, Intermediaries, Harvesting, Transportation, Energy, Infrastructure and Transportation, Information, Knowledge of Farmer's, Storage and Handling (Negi & Anand, 2016).

Further, Alsbu, et al explains that there are several categorised factors that contribute to food waste of vegetables, including pre-harvest weather conditions, harvesting practices, handling practices, quality standards and regulations, packing practices, trimming and cleaning, grading, lack of storage capacity and warehouses, lack of transportation infrastructure, and lack of knowledge about the market demand (Alsbu, et al., 2023).

In addition, according to Göbel, et al and Bernstad, et al explains that, storage, transportation, standardized packaging, product quality, marketing form part of the causes food waste in the supply chain of vegetables (Göbel, et al., 2015), (Bernstad, et al., 2017).

Arising from the above, below are the causes that influence food waste in the supply chain of vegetables in Zambia and across the globe:

2.7.1 Market Information

Soysal and Krishnamurthi explains that market demand describes the demand for a given product and who wants to purchase it (Soysal & Krishnamurthi, 2012). They further allude that market demand is determined by how willing consumers are to spend a certain price on a particular good or service. Soysal and Krishnamurthi highlights that as market demand increases, so does price and when the demand decreases, price goes down as well (Soysal & Krishnamurthi, 2012). Aschemann-Witzel, et al explains that food marketing and retailing contribute to consumer-related food waste via decisions on pricing strategies encouraging over purchase, as well as communication shifting consumer priorities to the disadvantage of food waste avoidance.

Aschemann-Witzel, et al emphasized that potential actions to tackle food waste relate to market demand information (Aschemann-Witzel, et al., 2016). Therefore, when there is lack of knowledge of the market demand on the vegetables, then it is likely that the farmer or producer of vegetables may plant a vegetable that will not sale on the market which may result into food waste at the market.

2.7.2 Packaging

Packaging is the science, art and technology of enclosing or protecting products for distribution, storage, sale, and use (Kushe & P.T, 2016). Packaging can protect food, prolong shelf life, and reduce environmental impact by reducing food waste (Brennan, et al., 2021).

The Food and Agriculture Organization of the United Nations (FAO) states that ‘losses at almost every stage of the food chain may be reduced by using appropriate packaging’ and that the higher losses at pre- and post-harvest stages in developing countries are ‘underscoring the need to focus on packaging solutions (Manalili, et al., 2014). Therefore, when vegetables are packed in a package that is not right, there may be challenges during transportation and would result into wastage along the way to the market. For examples, when onions are packed in a plastic pack without ventilation, it may get rotten due to moisture.

2.7.3 Transportation

Transport or transportation is the intentional movement of humans, animals, and goods from one location to another (Beregszásziová & Takáčová, 2023). Guarnieri, et al explains that within the agri-food supply chain, specifically for fruits and vegetables, food waste can occur, mainly due to transportation (Guarnieri, et al., 2021). The Global Agenda Council on Logistics and Supply Chains noted that fruit and vegetable losses are due to improper handling and lack of proper cold transportation, such as cold logistic facilities or inadequate infrastructure (Raut, et al., 2019). Therefore, the use of improper transportation in transporting tomatoes from a farm to the market may result into wastage along the way as some of the tomatoes may either be rotten or crashed during the movement. Transportation entails using a good route or road appropriate for the type of vegetable being transported to the market.

2.7.4 Storage

Storage is a supply chain activity of storing products at warehouses and logistics centres. Its role is to provide a steady supply of goods to the market to fill the temporal gap between producers

and consumers (Lagorio, et al., 2021). Storage is a key point of relevance because it constitutes the physical place where food is sold and, thus, where food waste occurs (Gruber, et al., 2016). Gruber, et al explains that retail and wholesale stores are the institutional actors closest to disposal and recycling and given the high transaction volumes taking place in stores, the absolute amount of food waste occurring at this stage is significantly higher.

2.7.5 Processing Linkage

Linkage in the supply chain is defined as explicit or implicit connections that a firm creates with critical entities of its supply chain in order to manage the flow and quality of inputs from suppliers into the firm and of outputs from the firm to customers (Barratt & Barratt, 2011). In many cases it is processing that links agricultural materials to the consumer. It is therefore important to ensure processing efficiency, and to have sufficient information on factors which may induce or prevent food waste generation on the processing level (Raak, et al., 2017)

2.7.6 Quality

Quality is the degree to which an object or entity such as a process, product, or service satisfies a specified set of attributes or requirements (Golder, et al., 2012). Thus, quality issues can arise at any point in the vegetable supply chain, and it is critical that players uncover them as early as possible to prevent incurring excess costs and mitigate risks including those that relate to food waste of vegetables. Given the perishable nature of vegetables and the demand for quality attributes, relationships, networks, skills, and coordination mechanisms are needed to manage the flow of products through the supply chain so that quality specifications are met (Narrod, et al., 2009).

The potential quality of fresh vegetables in the horticultural supply chain is defined in the period preceding harvest, however the full development of quality characteristics can be optimized with appropriate postharvest technology along the supply chain (Kyriacou & Rouphael, 2018). Therefore, when there are quality issues relating to market information, packaging, transportation, storage, and processing linkage there is likely to be food waste along the supply chain of vegetables.

2.7.7 Regulations

Regulation is the controlling of an activity or process, usually by means of rules (Baldwin & Black, 2008). Therefore, the activities along the supply chain of vegetables requires regulations so that there is control on the level of food waste of vegetables.

The current regulatory context for vegetable quality comprises crop-specific class standards based on key visual and limited compositional criteria and lays primary emphasis on visual attributes at the expense of flavour, nutritional and functional attributes related to phytonutrient content (Kyriacou & Rouphael, 2018).

Göbel, et al explains that in the vegetable product group, marketing, and retailer product quality standards as well as product specifications were identified as the main causes of food waste. To meet high quality standards, retailers offer products in a way they believe consumers want them to be presented. Furthermore, consumers receive food in the right appearance, weight, size and shape, so farmers waste large portions of their crops instead of delivering them to the retail. Thus, Standardized packaging additionally contributes to the problem of food waste in the vegetable sector (Göbel, et al., 2015). In addition, Göbel, et al explains that interviews with experts in the vegetable supply chain, revealed that direct marketing with vegetable leads to less waste than other channels of distribution. This is because direct marketing involves fewer middlemen between grower and consumer, and so there are fewer quality checks, fewer restrictions on quality and less transport which might damage food (Göbel, et al., 2015). Therefore, regulations to standardize the vegetable supply chain would play a key role in reducing or eliminating food waste along the vegetable supply chain. Regulations can cover communications, packing, transportation, storage, processing and quality along the vegetable supply chain.

2.8 Measures for Reducing Food Waste Along the Vegetable Supply Chains

According to the Supply Chain Consulting Group (SCCG) controlling food waste starts with monitoring each process in the supply chain and identifying where the waste is occurring (SCCG, 2024). The SCCG explains the following as measures for reducing food waste:

2.8.1 Enhancing Market Information sharing, Forecasting, and planning

The performance of the vegetable supply chain can be improved by more efficient information sharing (Kaipia, et al., 2013). Therefore, the key to improved operations is how and for which

purposes the shared data should be used. Forecasts based on shared information have traditionally served as the basis for planning and executing supply chain activities (Boone, et al., 2019). Boone, et al explains that forecasts drive supply chain decisions, and they have become critically important due to increasing customer expectations, shortening lead times, and the need to manage scarce resources.

However, Sreerag & Shanmugam explains that farmers typically rely on their personal experience in directing the produce to a sales channel which creates a risk of food waste along the supply chain of vegetables. In their study they examined how sales forecasting of fresh vegetables along multiple channels enables marginal and small-scale farmers to maximize their revenue by proportionately allocating the produce considering their short shelf life (Sreerag & Shanmugam, 2023).

Therefore, marketing information requires enhanced forecasting and planning because analyzing sales trends and seasonal requirements informs farmers or producers of the expected demand which then reduces food waste along the vegetable supply chain.

2.8.2 Using suitable and sustainable distribution packaging

Verghese, et al explains that food waste along the supply chain of vegetables can be reduced using packaging that improves product protection, ventilation, and temperature control. Verghese, et al further explains that improved design of distribution packaging reduces damage during transportation and handling along the supply chain of vegetables (Verghese, et al., 2015).

Therefore, improved packaging is a significant measure that will have an impact on reducing food waste along the supply chain of vegetables.

2.8.3 Utilizing Suitable Transportation vehicle and network

Infrastructure could be defined as fixed installations that allow vehicles to operate (Marsden., et al., 2002). It consists of a roadway, a terminal, and facilities for parking and maintenance whereas a vehicle is a non-living device that is used to move people and goods (Marsden., et al., 2002).

The Global Agenda Council on Logistics and Supply Chains indicated that vegetables food waste is due to improper handling and lack of proper cold transportation such as cold-logistics facilities/providers or inadequate infrastructure (Raut, et al., 2019). Therefore, the use of proper

transportation infrastructure and vehicles is one such measure that could reduce food waste along the vegetable supply chain.

Rauta, et al explains that logistics infrastructure such as cooling, cold storage, refrigerated trucks, better information sharing process, and tracking system does not only improve the logistics performance but reduces food waste in the supply chain (Rauta, et al., 2019). Therefore, stakeholders including government in the supply chain should consider investing in proper transportation infrastructure and vehicles as one of the measures to reduce food waste along the vegetable supply chain.

2.8.4 Employing proper storage facility

Ramanathan, et al identified major sources of wastages in vegetable retail storage which require attention such as long travel distances, lack of labour, poor packing methods, damage due to handling during cleaning, sorting, and grading (Ramanathan, et al., 2017). Therefore, if these sources are addressed vegetable waste will be reduced. In general, prolonging the storage of the vegetables at the wholesale market, especially without proper cooling, results into vegetable waste because it cause increases in weight loss, decreases in firmness and flavor acceptability, changes in color, and increases in decay and physiological disorders (Li, et al., 2015). Therefore, reducing storage time is a key measure to reduce vegetable waste either at wholesale or retails stage in the vegetable supply chain.

Li, et al suggested that by means of proper logistics management, especially by ordering the proper amounts of produce, it will be possible to reduce the amounts of vegetables that are unnecessarily stored in wholesale markets or supermarket logistics centers, and thereby reducing wastage.

Onwude, et al indicated that refrigeration in the storage of vegetables is a key measure in reducing vegetable waste in the supply chain because it enhances the quality of fresh produce, and extends the shelf-life, thereby enabling adequate supply in the chain (Onwude, et al., 2020).

2.8.5 Linking Processing Units with producers

Raak, et al explains that in many cases it is processing that links agricultural materials to the consumer. It is therefore important to ensure processing efficiency, and to have sufficient information on factors which may reduce or prevent food waste along the supply chain (Raak, et

al., 2017). Thus, when agricultural products are well linked with processing then post-harvest wastage of vegetables will be minimized.

Augustin, et al emphasized that local processing companies are an important channel for farmers to send their produce to for value-adding. The concept of a centrally located food processing hub, likely to be located in regional areas where most farms are, will reduce transport costs and provide the infrastructure for a range of processing operations to produce value-added food ingredients and product, ultimately reducing food waste along the vegetable supply chain (Augustin, et al., 2020).

Therefore, when processing units are linked to producers or farmers, food waste shall be reduced along the vegetable supply chain because processing units buy in bulk and vegetables shall not be stored for a long time at wholesale or retail stage.

2.8.6 Quality enhancement

Golder, et al explains that quality is the degree to which an object or entity such as a process, product, or service satisfies a specified set of attributes or requirements (Golder, et al., 2012). Given the perishable nature of vegetables and the demand for quality attributes, quality measures are needed to ensure that products flow through the supply chain while maintaining their quality standards all the way to the final consumer (Narro, et al., 2009). The potential quality of fresh vegetables in the horticultural supply chain is defined in the period preceding harvest, however the full development of quality characteristics can be optimized with appropriate postharvest technology along the supply chain (Kyriacou & Rouphael, 2018). Therefore, when there are quality issues relating to market information, packaging, transportation, storage, and processing linkage there is likely to be food waste along the supply chain of vegetables.

Thus, if a vegetable and all requirements that relate to it are of poor quality, there is likely to be no chance of surviving along the supply chain. Enhancing quality in every respect is key to guarantee safe passage throughout the vegetable supply chain. Quality improvement is a key measure that all players in the vegetable supply chain must adopt.

2.8.7 Developing policies to Standardize the vegetable supply chain.

Interpersonal trust and working to standards are both important to build more sustainable local and many conserved foods supply chains, but inadequate to transform mainstream agriculture

and raw material supplies to food markets (Smith, 2007). Thus, cooperation among farmers, food manufacturers, retailers, NGOs, governmental and farmers' organizations is vital to raise standards for the vegetable supply chain and to enable farmers to adopt more sustainable agricultural practices.

Batt & Cadilhon explains that Sri Lanka, Abeysekera and Abeysekera have focused on how the alternative supply chain management practices adopted by leading supermarkets have impacted on the performance of existing supply chains. The most significant change has been the emergence of a more dynamic marketing system that is more responsive to consumer needs. Batt & Cadilhon adds that at the producer level, supply chain modernization has facilitated the introduction of contract farming and forward purchase mechanisms (Batt & Cadilhon, 2007). For example, The EUREPGAP1 standards for fresh fruits and vegetables, were initiated by 13 European retailers in the late 1990s that have now expanded its international role as one of the major international private standards that link farmers and other suppliers to a growing number of international retailers (Gereffi & Lee, 2009).

Therefore, the development of policies is such a measure that a play a key role in reducing food waste along the vegetable supply chain.

2.9 Empirical Studies on the Topic

Adhikari and Herath (Adhikari & Herath, 2022) conducted a study analysing five factors that influence on Perceived Post-Harvested Wastage of Vegetables and Fruits in the Dambulla Dedicated Economic Center in Sri Lanka. The variables comprised of transportation, packaging, excess supply, and a storage facility. The methodological approach of the study was quantitative, and it used primary data to test the hypotheses. The sample of the study included only 105 people who entered the Dambulla Dedicated Economic Center to sell their vegetables and fruit. The study revealed that transportation, packaging, storage facility, and excess supply positively impact the post-harvest wastage of vegetables.

Further (Parimi & Chakraborty, 2022) conducted a study The study explores and analyses the factors affecting food wastage in post harvesting of fruits and vegetables. The study narrowed down on key factors and empirically analysed the impact of productivity and quality standards, awareness linked knowledge, quantity related aspects, efficiency and wastage related aspects and transportation linked aspects. The sampling frame for the study was the farmers, procurement

and storage partners and retailers from the districts of West Bengal. The districts considered were North 24 Parganas and South 24 Parganas of West Bengal. The Study revealed statistically supported hypotheses as Product and quality standards, Quantity related aspects, Efficiency and wastage related aspects and Transportation linked aspects. However, awareness linked knowledge was not supported as the farmers in west Bengal had an idea about the actual market demand.

In agreeing with the finding of the above studies, Ndirangu, et al (Ndirangu, et al., 2017) in their study on the determinants of postharvest losses among high moisture content vegetables traders in Kenya focused on postharvest losses of vegetables, namely kales, cabbages, tomato, and other indigenous crops. Four counties were selected for the study due to their specialization in the production of these vegetables, namely: Kakamega and Kisii Counties for indigenous vegetables, Kirinyaga County for tomato, and the Kiambu County for cabbages and kales. A total of 187 traders found in 14 markets in the four counties were interviewed. The study found that transportation, storage, packaging, and market information were among the determinants of postharvest losses among high moisture content vegetables traders.

2.10 Lessons Learnt from Reviewed Literature

Lesson learnt on each research question addressed is as follows:

On the major types of food waste generated along the supply chain of vegetables at Soweto Market in Zambia, the study established that tomatoes, onion, carrots, okra and cabbages are among the types of food waste generated along the supply chain of vegetables.

On the factors that influence of food waste generated along the supply chain of vegetables at Soweto Market in Zambia, a lesson has been learnt that market information, packaging, transportation, storage and processing are among the factors that should be improved to mitigate food waste along the supply chain of vegetables.

On the question of what measures should be applied to mitigate food waste along the supply chain of vegetables at Soweto Market in Zambia, a lesson has been learnt that setting up proper information systems that would allow quick access to market information would enable the farmers to be informed on market demand and prevailing prices. When farmers harvest, the produce must be packaged in the right packs for the appropriate transport system or vehicle

being used to prevent exposure to conditions that may result into wastage. Choosing the right vehicle and having a suitable road network would reduce delays or breakdowns during transportation which may result into wastage along the way. Using the correct storage facility appropriate for the type of vegetable such as refrigerated stores, air-conditioned containers would reduce chances of wastage. Processing unit linkage would enable farmers have several sale options which would then minimise the time it would take to sale when there are no processing units.

CHAPTER 3 – METHODOLOGY OR MATERIALS AND METHODS

3.0 Introduction

The preceding chapter presented the theoretical and conceptual framework, which provided the theoretical base and demonstrated the relationships involving the study variables of the research. This chapter outlines the methodological procedure that will be followed by the researcher in conducting the study and the justification of the research methods used. It lays the approach and choice of research method, the design of the research, the target population, sample design, and sampling techniques. It describes the data collection, data analysis procedure, and data collection instruments. It concludes with a summary of the chapter.

3.1 Research Philosophical and Approach

The research adopted the positivism philosophy as it tested the theories by maintaining an objective and independent view of the data collected from the field and focusing on quantified observations (Saunders, et al., 2009). According to Scholz (Scholz, 2021), positivism assumed that reality exists externally, which required defining the constructs and proving the existing relationships through quantitative measurements. This research developed the conceptual framework which provided the external reality of the relationships between the variables.

A deductive approach was adopted to generalize the study results. The deductive approach followed the principles of reductionism and generalization to reduce the problem to its simplest form to be better understood (Saunders, et al., 2009). Following the deduction principle, the conceptual framework was developed in the first place from the existing literature and theories. The hypotheses were then extracted and tested to prove the theories.

The philosophical approach applied in this study was Positivism Paradigm which referred to a branch of philosophy that rose to prominence during the early nineteenth century because of the works of the French philosopher Auguste Comte (Richards, 2003). Positivism assumed that reality exists independently of humans. It was not mediated by our senses, and it was governed by immutable laws. The ontological position of positivists was that of realism. Positivists strive to understand the social world like the natural world. In nature, there was a cause-effect relationship between phenomena, and once established, they can be predicted with certainty in the future (Rehman & Alharthi, 2016).

3.2 Research Design

In line with the objectives and questions, the study followed the research design approach adopted by Ndiema & Muli (2021), which involved a descriptive research design method.

According to Cong and Chau, descriptive case studies are used to describe an event/process in its natural setting, with the primary goal of answering the questions of how, who, and what (Cong & Chau., 2012). As a result, the design was appropriate for this study, which aimed to determine what factors cause food waste along the supply chain of vegetables.

Through descriptive research design, a survey research strategy was be considered, which enabled the collection of a large amount of data required to describe the variables and establish the nature of statistical relationships among them. According to Saunders et al. (2009), survey research strategies are usually recommended for studies describing and analysing relationships between the study variables.

3.3 The Population and Location of the Study

The Study was conducted at Soweto Market with focus on smallholder famers who farm, package, transport, store, and sale. Soweto. Soweto Market located in Lusaka is Zambia's largest market that serves as both a wholesale and retail space for various food products including vegetables produced from within and outside Lusaka (Marrengane & Croese, 2021).

According to the World Food Programme Country Report (2020), Zambia had a total of 1.5 million smallholder vegetable farmers who in most cases farm, package, transport, store, and sale the produce themselves. The research population scaled down on farmers who operate throughout the supply chain who are producers' transporters, wholesalers and retailers as cited by (Adhikari & Herath, 2022). Therefore, the study's target population consisted of 1.5 million smallholder vegetable famers who farm, package, transport, store, and sale for themselves (WFP, 2020).

3.4 Sampling

The sample targets were assumed to be active players along the supply chain of vegetables who have either farmed or produced, packaged, transported, stored, sold or processed vegetables (Iradeep & Kumar, 2021). Stratified random sampling was chosen due to the nature of the study.

3.4.1 Sampling Frame

A sample frame is a crucial part of any study, and it consists of a set of information, material, or equipment from which a sample is derived (Haslam, et al., 2024). The sample frame for this research consisted of farmers who operate throughout the supply chain who are producers' transporters, wholesalers and retailers as cited by (Adhikari & Herath, 2022)

3.4.2 Sampling Technique

The study employed stratified random sampling for the survey to draw a representative study sample of smallholder famers who farm, package, transport, store, and sale for themselves at Soweto Market. Stratified sampling was adopted to group famers into groups of vegetable type of tomatoes, onions, carrots, okra, and cabbages. The smallholder farmers were selected randomly through stratified random sampling from the groups using computer-generated random numbers in an excel spreadsheet.

3.4.3 The Sample Size

The Yamene (1967) formula was used to calculate the sample size to be used in the study. There are over 1.5 million smallholder vegetable farmers in Zambia from which the sample size was derived using the formula as follows.

$$n = \frac{N}{1 + N e^2}.$$

n = Sample Size

N= Total Population

e = Margin of error

$$n = x, \quad N = 1,500,000.00, \quad e \text{ in this case} = 10\% \quad n = \frac{1,500,000}{1 + 1,500,000.00(0.10^2)}$$

$$n = \frac{1500000}{15001}$$

n= 99.99 round off to 100 factoring 10% (10) non-response, the final Sample shall be 110

3.5 Data Collection Instruments

Self-administered structured questionnaires was used to capture smallholder farm sales managers views of the study variables presented in the conceptual framework and summarized in the operationalization. The questionnaire had closed questions and consisted of five sections: Section 1 for general information, Section 2 food waste along the vegetable supply chain, Section 3 for causes of food waste along the vegetable supply chain at Soweto Market, Section 4 for the impact of the causes and Section 5 for measures to mitigate the impact.

3.6 Data Collection Procedure and Timeline

The first step of data collection involved establishing the target smallholder farmers at Soweto Market from the sample size obtained from the sampling frame. The second step was to issue questionnaires to each of the smallholder famers. Data collection activity was completed within 4 weeks.

3.7 Data Analysis Instruments and Procedures

3.7.1 Pilot and Diagnostic Tests

A pilot survey representing 10% of the sample size was conducted on a few selected smallholder famers. The participants who participate in the pilot survey were not included in the study. The goal of the pilot survey was to pre-test the data collection instrument to ensure that it measured what was intended to be measured. The feedback from the pilot survey was used to make relevant amendments to the questionnaire before it was administered to the actual survey. The data obtained from the study variables in the questionnaire were subjected to diagnostics testing through normality, reliability, and validity tests (Odollo, et al., 2018).

3.7.2 Normality Test

The significant test adopted in the study was the 0.05 level of significance which required testing for normality since significance tests were based on the normal distribution (Wanyoike, 2016). Normality assumed that the error term was distributed normally with a zero mean and constant variance (Anderson, et al., 2011). Pearson correlation analysis was used to measure the strength and direction of the relationship among variables (Cohen et al., 2020).

3.7.3 Reliability

Besides assessing the normality of data collection instruments, testing the constructs' reliability was employed. Reliability tests assessed the measurements' internal consistency to judge the reliability of data instruments (Ndiema & Muli, 2021). A 0.7 Cronbach's Alpha statistic was used to ensure reasonable reliability of the instrument (Hu, 2017). Further, according to Hair et al. (2019), the reliability was exceptional if the values of Cronbach's alpha were around 0.9, good if the range was between 0.7 to 0.8, and acceptable if the range was 0.6 to 0.7. However, if the obtained values were less than 0.6, then internal consistency did not exist, justifying that the data set was not reliable (Scholz, 2021).

3.7.4 Validity Test

As described by Scholz (2021), validity testing measured the degree to which a construct was accurately presented in a quantitative study. Both content and factor validity were exploited to assess the validity of the data collection instrument. The content validity was assessed through related studies with similar constructs and data collection instruments which all proved to measure the constructs accurately. The factor validity extended the content validity test by performing a test of the items using a statistical model referred to as factor analysis. Factory analysis reduced the amount of data to determine the correlation between the factor loadings (Hu, 2017). However, before performing factor analysis, the Kaiser – Meyer – Olkin (KMO) test and Bartlett's test of sphericity was performed to assess the sampling adequacy and strength of the relationships between the variables, respectively (Pallant, 2013). According to Odollo et al. (2018), a KMO index greater than the minimum of 0.5 indicated that the data was appropriate for factor analysis. Similarly, the significance values of less than 0.05 for Bartlett's test of sphericity indicated that the data was suitable for further analysis (Scholz, 2021).

3.7.5 Data Preparation and Analysis

The data preparation and analysis started by computing collected data from completed survey questionnaires that was administered through physical interviews. The information from completed questionnaires was entered in excel to facilitate data coding and editing for completeness and consistency to ensure the data was of good quality. The data preparation was succeeded by analysis of the quantitative data. A twofold data analysis comprising descriptive statistics such as frequencies, percentages, means, and standard deviations and inferential

statistics such as the correlation coefficient (R), coefficient of determination (R^2), F - value, and t-test, was carried out using a statistical package for social science (SPSS) software version 25.0.

The relationship between the variables were analysed using correlation analysis and the hypotheses through regression analysis at a 0.05 level of significance to prove whether the independent variables (packaging, transport, storage, production units, quality and regulation) significantly affected the dependent variable (Food waste along the vegetables supply chain). If the P-value obtained was less than or equal to the significance level (0.05), the null hypothesis would be rejected, and the alternative hypothesis would be retained. Simple linear regression models of formulated hypotheses and the inferential test statistics was used for testing the model fit.

CHAPTER 4 - RESULTS PRESENTATION

4.0 Introduction

The previous chapter presented a methodological procedure followed in conducting the research. This chapter presents the study's findings, starting with descriptive statistics involving demographic factors and indicators of the study variables. This is followed by an inferential statistics analysis of the relationships between the variables through regression analysis. Finally, two multiple regression models are developed to represent a regression assessment model for food wastage along the vegetable supply chain.

4.1 Response Rate

The sample target of the study involved active players along the supply chain of vegetables who had either farmed or produced, packaged, transported, stored, sold or processed vegetables (Iradeep & Kumar, 2021). The total sample target was 110 smallholder farmers at Soweto Market located in Lusaka, Zambia's capital city. The smallholder farmers were represented by a single participant from Soweto Market and data was successfully obtained from all the 110 smallholder farmers as shown in table 4.1. This represented a response rate of 100% because the survey administrator had control over engagement as he was on the ground on site to engage with the targeted respondents.

Table 4.1: Response Rate of Participants

Sample Target	Actual Response	Response Rate
110	110	100%

Source: Author (2024)

4.2 Demographic

The demographic information involved the job titles or position of participants in their respective businesses, their education qualification levels, types of vegetables, size of the farm, years in farming business, Average Sales per day in the Period of High Demand and Average Sales per day in the Period of low demand.

4.2.1 Position in the farming business

The participants were requested to specify their current job titles on the questionnaire to establish their positions. Figure 4.1 below shows the job titles of the participants. The results show that Sales Managers ranked first accounting for 48.18% of the total participants. Marketing Managers

ranked second at 44.55%, Product Managers ranked third at 5.45% and General Managers ranked lowest at number with 1.82%.

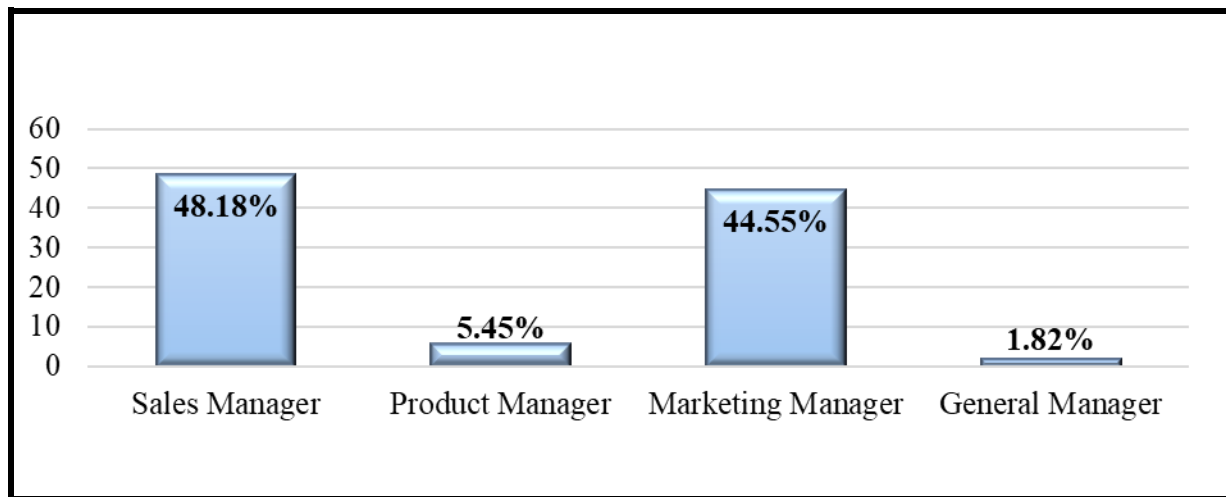


Figure 4.1: Position in the farming business (Source: Own Survey Results, 2024)

4.2.2 Education Qualification Level

The findings in figure 4.2 display the participants' education qualification level distribution. It was fascinating to learn that 50% of participants were under the secondary and primary category, 21% were diploma holders, 18% were Certificate holders, 10% were bachelor's degree holders and 1% were master's degree holders.

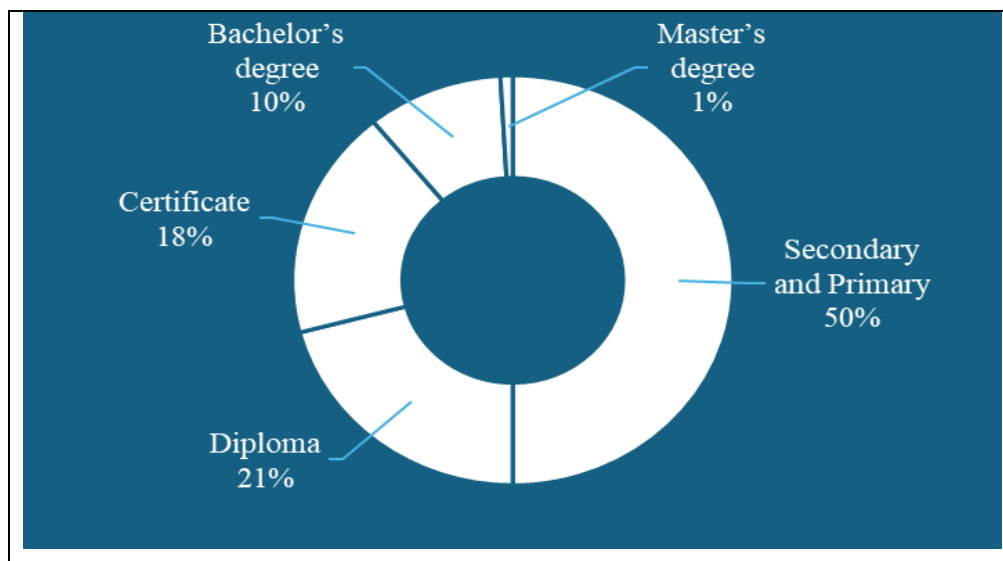


Figure 4.2: Education Qualification Level (Source: Own Survey Results, 2024)

4.2.3 Size of the Farm

The participants were requested to indicate the size of their farms in the questionnaires. The findings in figure 4.3 show that 92% of participants had farms with a size of up to 5 hectors, 5% had farm size of up to 10 hectors, 2% had farms with a size of more than 20 hectors and 1% had farms with a size of up to 20 hectors.

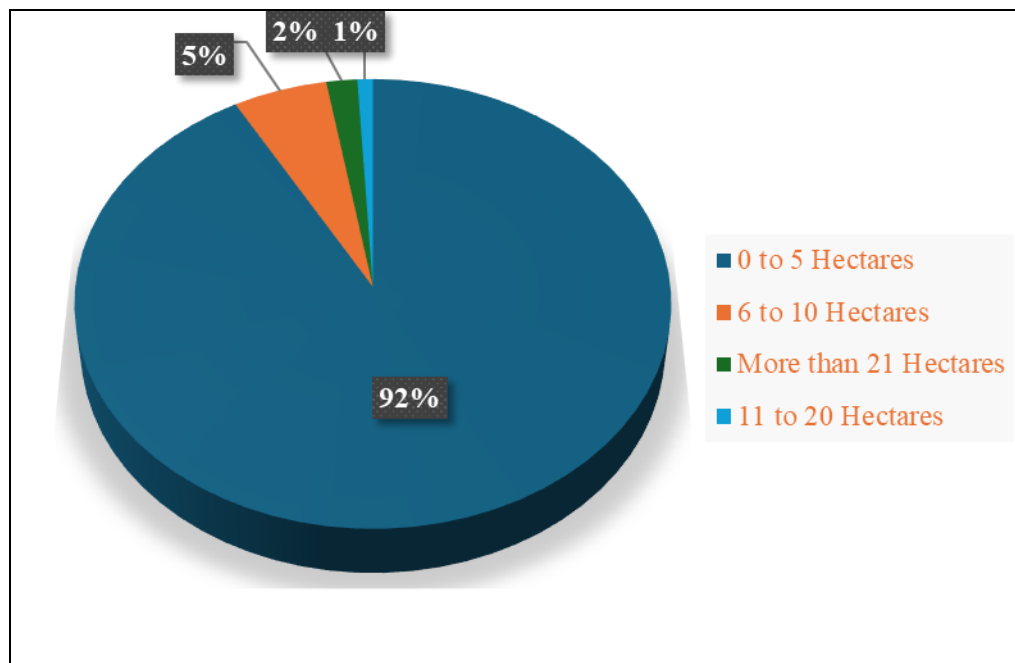


Figure 4.3: Size of the Farm (Source: Own Survey Results, 2024)

4.2.4 Years in Farming Business

The experiences of smallholder farmers in the vegetable supply chain were established by the participants' responses about the number of years they had in farming business. Based on table 4.2 below, 58.2% confirmed to have been in the farming business up to 2 years. 31.8% confirmed to be between 3 to 5 years, 9.1% confirmed to be between 1 to 10 years while 0.9% confirmed to be above years.

Table 4.2: Years in Farming Business

	Frequency	Percent	Valid Percent	Cumulative Percent
0 to 2 Years	64	58.2	58.2	58.2
3 to 5 Years	35	31.8	31.8	90
6 to 10 Years	10	9.1	9.1	99.1
Above 10 Years	1	0.9	0.9	100
Total	110	100	100	

4.2.5 Average Sales per day in the Period of High Demand

The participants were requested to state their average sales per day in the period of high demand to appreciate demand. Figure 4.4 below shows that 55.5% of the smallholder farmers had their average sales oscillating between ZMW10,000.00 to ZMW50,000.00, 34.5% were at below ZMW10,000.00 and 10% were above ZMW50,000.00.

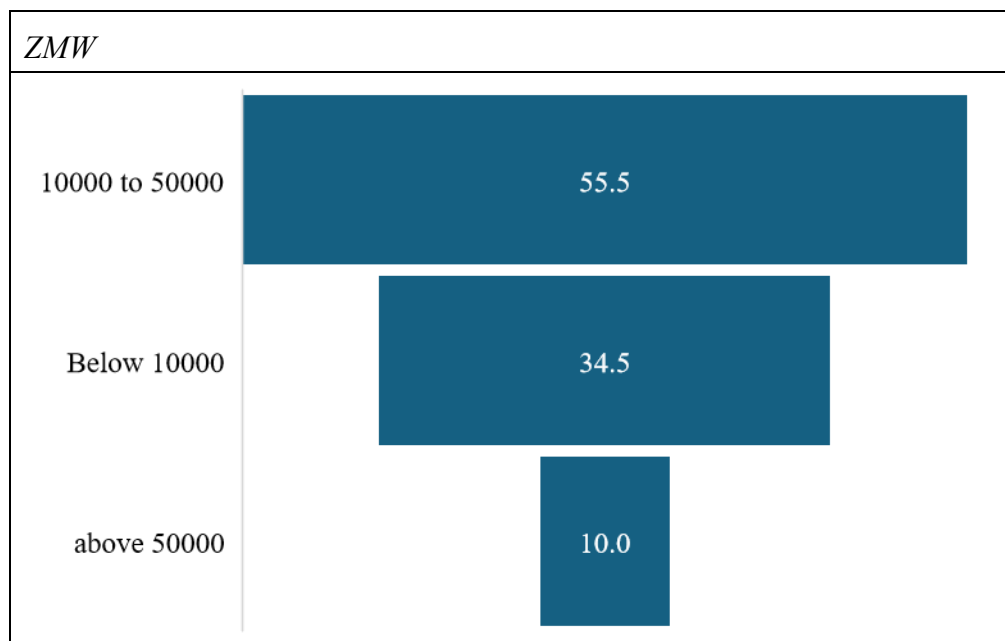


*Figure 4.4: Average sales per day in the period of high demand
(Source: Own Survey Results, 2024)*

4.2.6 Average Sales per day in the Period of low demand

Finally, the participants were also requested to state their average sales per day in the period of low demand. at Soweto Market. Figure 4.5 below shows that 92.7 % of the smallholder farmers had their average sales below ZMW10,000.00, 5% were between ZMW10,000.00 to ZMW50,000.00, while 1.8% were between ZMW50,000.00 to ZMW100,000.00.

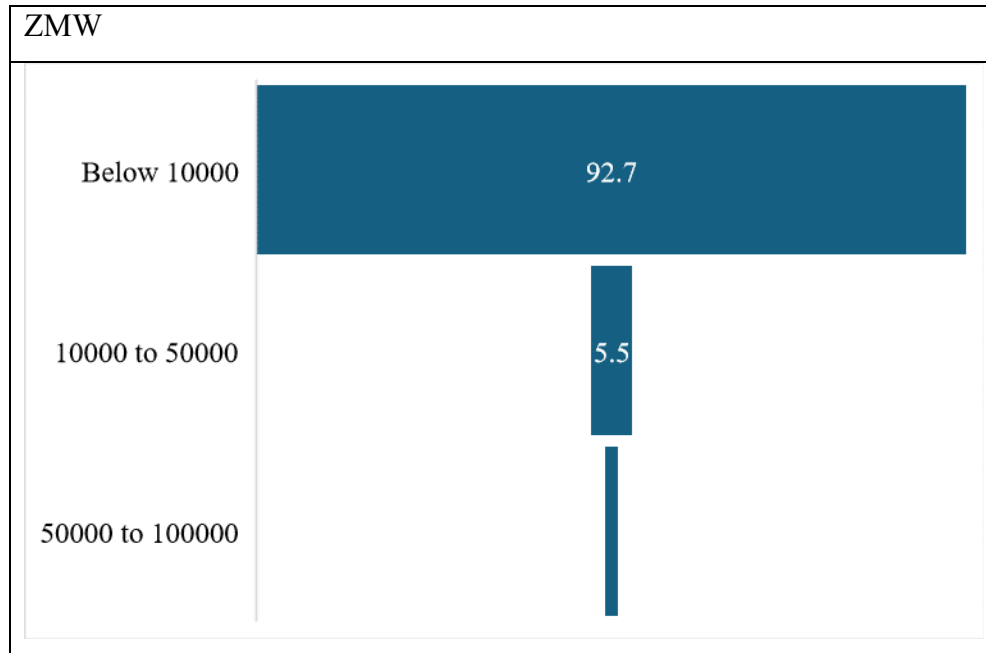


*Figure 4.5: Average sales per day in the period of low demand
(Source: Own Survey Results, 2024)*

4.3 Descriptive analysis of Study variables

Besides analysing the demographic characteristics, the study also examined the study variables. The frequency counts expressed as percentages of the sample size were used to explain the number of times the participants responded to the study variable items by agreeing or disagreeing. The means used to measure the statements was a 5 – point Likert scale.

4.3.1 Type of Food Waste

The type of food waste along the vegetable supply chain were established by the participants responses on each identified type of food waste.

The findings in table 4.3 shows participants responses to the types of food waste along the vegetable supply chain. 63% of the participants agreed that Tomatoes, Onions, Carrots, Okra and Cabbages are the type of food waste along the vegetable supply chain, while 0.3% disagreed leading and 35.45% opted to remain neutral leading to a mean score of 3.7. Further, the findings in figure 4.6 display distribution on the type of vegetables that go to waste along the supply chain. Tomatoes were established to be a high-ranking food waste along the vegetable supply

chain accounting for 36.4%, Onions and Cabbages ranked second at 24.5%, Okra ranked third at 8.2% and Carrots ranked lowest at 6.4%.

Table 4.3: Descriptive Statistics for the Type of Food Waste

Type of Food Waste		SD	D	N	A	SA	ME	S.DE
Tomatoes								
Tomatoes go to waste along the vegetable supply chain when demand information is not available	f	0	0	31	75	4		
	%	0	0	28.2	68.2	3.6	3.75	0.510
Tomatoes go to waste along the vegetable supply chain when not properly packaged	f	1	1	30	75	3		
	%	0.9	0.9	27.3	68.2	2.7	3.71	0.580
Tomatoes go to waste along the vegetable supply chain when not properly transported	f	0	1	31	74	4		
	%	0	0.9	28.2	67.3	3.6	3.74	0.536
Tomatoes go to waste along the vegetable supply chain when not in good quality and properly stored	f	0	0	32	74	4		
	%	0	0	29.1	67.3	3.6	3.75	0.515
Onion								
Onions go to waste along the vegetable supply chain when market demand information is not available	f	0	1	38	69	2		
	%	0	0.9	34.5	62.7	1.8	3.65	0.532
Onions go to waste along the vegetable supply chain when not properly packaged	f	0	0	38	70	2		
	%	0	0	34.5	63.6	1.8	3.67	0.509
Onions go to waste along the vegetable supply chain when not properly transported	f	0	0	38	70	2		
	%	0	0	34.5	63.6	1.8	3.67	0.509
Onions go to waste along the vegetable supply chain when not properly stored	f	0	0	39	69	2		
	%	0	0	35.5	62.7	1.8	3.66	0.512
Carrots								
Carrots go to waste along the vegetable supply chain when market demand information is not available	f	0	0	44	66	0		
	%	0	0	40	60	0	3.60	0.492
Carrots go to waste along the vegetable supply chain when not properly packaged	f	0	1	43	66	0		
	%	0	0.9	39.1	60	0	3.59	0.512
Carrots go to waste along the vegetable supply chain when not properly transported	f	0	0	45	65	0		
	%	0	0	40.9	59.1	0	3.59	0.494
Carrots go to waste along the vegetable supply chain when not properly stored	f	0	0	43	67	0		
	%	0	0	39.1	60.9	0	3.61	0.49
Okra								
Okra goes to waste along the	f	0	0	43	65	2		

Type of Food Waste		SD	D	N	A	SA	ME	S.DE
vegetable supply chain when market demand information is not available	%	0	0	39.1	59.1	1.8	3.63	0.522
Okra goes to waste along the vegetable supply chain when not properly packaged	f	0	0	44	65	1		
	%	0	0	40	59.1	0.9	3.61	0.509
Okra goes to waste along the vegetable supply chain when not properly transported	f	0	0	44	65	1		
	%	0	0	40	59.1	0.9	3.61	0.509
Okra goes to waste along the vegetable supply chain when not properly stored	f	0	0	44	65	1		
	%	0	0	40	59.1	0.9	3.61	0.509
Cabbages								
Cabbages go to waste along the vegetable supply chain when market demand information is not available	f	0	1	38	71	0		
	%	0	0.9	34.5	64.5	0	3.64	0.502
Cabbages go to waste along the vegetable supply chain when not properly packaged	f	0	1	38	71	0		
	%	0	0.9	34.5	64.5	0	3.64	0.502
Cabbages go to waste along the vegetable supply chain when not properly transported	f	0	0	39	71	0		
	%	0	0	35.5	64.5	0	3.65	0.481
Cabbages go to waste along the vegetable supply chain when not properly stored	f	0	0	38	71	1		
	%	0	0	34.5	64.5	0.9	3.66	0.494
Overall Average			0.3%	35.45%	63%		3.7	

Source: Own Survey Results (2024)

Key: SD =Strongly Disagree, D = Disagree, N = True to some extent, A = Agree, SA = Strongly Agree, ME= Mean, S.DE= Standard Deviation

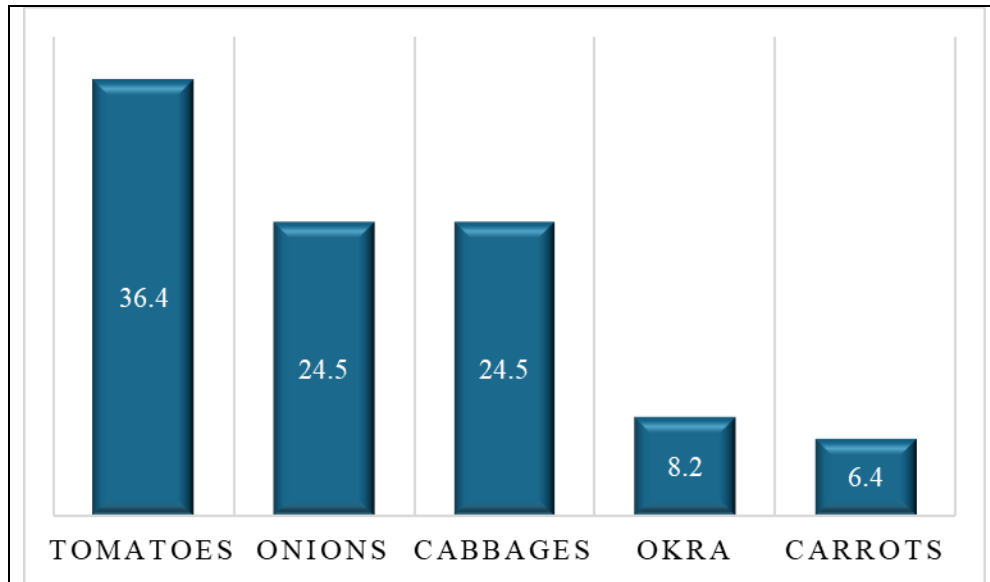


Figure 4.6: Type of Vegetables (Source: Own Survey Results, 2024)

4.3.2 Factors Causing Food Waste

The study assessed the factors that cause food waste along the vegetable supply chain. Table 4.4 shows that on overall average, 94% of participants agreed that market information, packaging, transportation, storage, processing units, quality and regulations cause food waste along the vegetable supply chain while 0.23% disagreed and 1.81% opted to remain neutral leading to a mean score of 4.01.

Table 4.4: Descriptive Statistics for the Factors Causing Food Waste

Factors Causing Food Waste		SD	D	N	A	SA	ME	S.DE
Market Information								
Over supply of vegetables along the supply chain is due to market demand forecast failure	f	0	0	2	104	4		
	%	0	0	1.8	94.5	3.6	4.02	0.234
Vegetable wastage along the supply chain is due to lack of access to market information	f	0	1	1	104	4		
	%	0	0.9	0.9	94.5	3.6	4.01	0.287
Food waste along the vegetable supply chain is due to inaccurate market information	f	0	0	2	104	4		
	%	0	0	1.8	94.5	3.6	4.02	0.234
Vegetable wastage along the supply chain is due to unreliable sources of market information	f	0	0	1	105	4		
	%	0	0	0.9	95.5	3.6	4.03	0.212
Packaging								
Spillage of vegetables along the vegetable supply chain is due to packaging failure	f	0	0	1	104	5		
	%	0	0	0.9	94.5	4.5	4.04	0.232

Factors Causing Food Waste		SD	D	N	A	SA	ME	S.DE
The frequency of pest and insect infesting vegetables is due to poor packaging	f	6	2	18	80	4		
	%	5.5	1.8	16.4	72.7	3.6	3.67	0.814
Rotting along the vegetable supply chain is due to use of unsuitable packaging	f	0	0	2	104	4		
	%	0	0	1.8	94.5	3.6	4.02	0.234
Food waste along the vegetable supply chain is due to use of unsuitable packaging	f	0	0	1	104	5		
	%	0	0	0.9	94.5	4.5	4.04	0.232
Transportation								
Exposure of vegetables to abnormal temperatures is due to use of unsuitable transportation	f	0	0	2	104	4		
	%	0	0	1.8	94.5	3.6	4.02	0.234
Perishable vegetables along the supply chain is due to transportation delays	f	0	0	2	104	4		
	%	0	0	1.8	94.5	3.6	4.02	0.234
Vegetable wastage along the supply chain is due to poor transport network	f	0	0	2	104	4		
	%	0	0	1.8	94.5	3.6	4.02	0.234
Non-reliable of transport vehicles lead to vegetable wastage along the supply chain	f	0	0	1	104	5		
	%	0	0	0.9	94.5	4.5	4.04	0.232
Storage								
Selling at reduced price along the supply chain is due to non-existence of proper storage facilities	f	0	0	1	105	4		
	%	0	0	0.9	95.5	3.6	4.03	0.212
Vegetable wastage along the supply chain is due to lack of proper storage facilities	f	0	0	2	104	4		
	%	0	0	1.8	94.5	3.6	4.02	0.234
Exposure of vegetables to high temperatures is due to lack of cold storage facilities in the chain	f	0	0	1	105	4		
	%	0	0	0.9	95.5	3.6	4.03	0.212
Loss of sales of vegetables along the supply chain due to lack of suitable storage causing	f	0	1	1	104	4		
	%	0	0.9	0.9	94.5	3.6	4.01	0.287
Processing Units								
Supply of vegetables will always be higher than demand due to absence of processing units	f	0	1	1	104	4		
	%	0	0.9	0.9	94.5	3.6	4.01	0.287
Vegetables are wasted along the supply chain due to lack of linkage with processing units	f	0	0	2	104	4		
	%	0	0	1.8	94.5	3.6	4.02	0.234
Food waste along the vegetable supply chain is due to lack of	f	0	1	1	104	4		
	%	0	0.9	0.9	94.5	3.6	4.01	0.287

Factors Causing Food Waste		SD	D	N	A	SA	ME	S.DE
appropriate processing units								
Wastage of vegetables along the supply chain is due to limited access to processing units	f	0	0	1	104	5		
	%	0	0	0.9	94.5	4.5	4.04	0.232
Quality								
Loss of sales of vegetables is due to quality failure	f	0	0	2	104	4		
	%	0	0	1.8	94.5	3.6	4.02	0.234
Wastage of vegetables along the supply chain is due to diminishing quality	f	0	0	2	104	4		
	%	0	0	1.8	94.5	3.6	4.02	0.234
Supply of poor-quality vegetables will always cause wastage along the supply chain	f	0	1	1	104	4		
	%	0	0.9	0.9	94.5	3.6	4.01	0.287
Failure to sale vegetables on time leads to wastage due to reduced quality	f	0	0	1	105	4		
	%	0	0	0.9	95.5	3.6	4.03	0.212
Regulation								
Wastage of vegetables along the supply chain is due lack of market information regulations	f	0	0	1	105	4		
	%	0	0	0.9	95.5	3.6	4.03	0.212
Food waste along the vegetable supply chain is due to lack of packaging regulations	f	0	0	1	105	4		
	%	0	0	0.9	95.5	3.6	4.03	0.212
Wastage of vegetables along the supply chain is due lack of transport regulations	f	0	0	2	104	4		
	%	0	0	1.8	94.5	3.6	4.02	0.234
Food waste along the vegetable supply chain is due to lack of regulations on processing units	f	0	0	1	105	4		
	%	0	0	0.9	95.5	3.6	4.03	0.212
Overall Average			0.23%	1.81%	94%		4.01	

Source: Own Survey Results (2024)

Key: SD =Strongly Disagree, D = Disagree, N = True to some extent, A = Agree, SA = Strongly Agree, ME= Mean, S.DE= Standard Deviation

4.3.3 Influence of Factors on Food Waste

The study also assessed the influence of factors that cause food waste along the vegetable supply chain. Table 4.5 shows that on overall average, 94.83% of participants agreed that market information, packaging, transportation, storage, processing units, quality and regulations does influence food waste along the vegetable supply chain while 0.10% disagreed and 1.20% opted to remain neutral leading to a mean score of 4.02.

Table 4.5: Descriptive Statistics for the Influence of Factors on Food Waste

Influence of Factors on Food Waste		SD	D	N	A	SA	ME	S.DE
Demand forecast failure influences oversupply of vegetables along the supply chain leading to wastage	f	0	0	2	104	4		
	%	0	0	1.8	94.5	3.6	4.02	0.234
Access to market information influences sales leading vegetable wastage along the supply chain	f	0	0	1	105	4		
	%	0	0	0.9	95.5	3.6	4.03	0.212
Inaccurate market information has an impact on food waste along the vegetable supply chain	f	0	0	1	105	4		
	%	0	0	0.9	95.5	3.6	4.03	0.212
Unreliable source of market information influences vegetable wastage along the supply chain	f	0	0	1	105	4		
	%	0	0	0.9	95.5	3.6	4.03	0.212
Packaging failure influence Spillage of vegetables along the vegetable supply chain	f	0	0	2	104	4		
	%	0	0	1.8	94.5	3.6	4.02	0.234
Poor packaging influence frequency of pest and insect infesting vegetables along the supply chain	f	0	1	2	103	4		
	%	0	0.9	1.8	93.6	3.6	4.00	0.303
Unsuitable packaging contributes to rotting along the vegetable supply chain	f	0	1	1	104	4		
	%	0	0.9	0.9	94.5	3.6	4.01	0.287
Unsuitable packaging influence food waste along the vegetable supply chain	f	0	0	2	104	4		
	%	0	0	1.8	94.5	3.6	4.02	0.234
Unsuitable transportation results into exposure of vegetables to abnormal temperatures	f	0	0	1	105	4		
	%	0	0	0.9	95.5	3.6	4.03	0.212
Transportation delays influence perishable vegetables along the supply chain	f	0	0	1	104	5		
	%	0	0	0.9	94.5	4.5	4.04	0.232
Poor transport network influence vegetable wastage along the supply chain	f	0	0	2	104	4		
	%	0	0	1.8	94.5	3.6	4.02	0.234
Non-reliable transport vehicles influence vegetable wastage along the supply chain	f	0	0	1	105	4		
	%	0	0	0.9	95.5	3.6	4.03	0.212
Non-existence of proper storage facilities have an impact on sales at reduced price along the supply chain	f	0	0	1	105	4		
	%	0	0	0.9	95.5	3.6	4.03	0.212
Proper storage facilities influence vegetable wastage along the supply chain	f	0	0	1	104	5		
	%	0	0	0.9	94.5	4.5	4.04	0.232
Cold storage facilities in the chain influences exposure of vegetables to high temperatures	f	0	0	2	104	4		
	%	0	0	1.8	94.5	3.6	4.02	0.234
Lack of suitable storage influence loss of sales of vegetables along the supply chain	f	0	0	1	105	4		
	%	0	0	0.9	95.5	3.6	4.03	0.212
The absence of processing units has an	f	0	0	1	104	5		

Influence of Factors on Food Waste		SD	D	N	A	SA	ME	S.DE
impact on the supply of vegetables leading to supply being higher than demand	%	0	0	0.9	94.5	4.5	4.04	0.232
Linkage with processing units influences vegetable waste along the supply chain	f	0	0	2	104	4		
	%	0	0	1.8	94.5	3.6	4.02	0.234
Appropriate processing units influence food waste along the vegetable supply chain	f	0	0	1	105	4		
	%	0	0	0.9	95.5	3.6	4.03	0.212
Limited access to processing units influences wastage of vegetables along the supply chain	f	0	0	1	105	4		
	%	0	0	0.9	95.5	3.6	4.03	0.212
Quality failure influences loss of sales of vegetables	f	1	0	1	104	4		
	%	0.9	0	0.9	94.5	3.6	4.00	0.358
Diminishing quality influences wastage of vegetables along the supply chain	f	0	0	2	104	4		
	%	0	0	1.8	94.5	3.6	4.02	0.234
Supply of poor-quality vegetables will always influence wastage along the supply chain	f	0	1	1	104	4		
	%	0	0.9	0.9	94.5	3.6	4.01	0.287
Reduced quality influences failure to sale vegetables on time leads to wastage along the supply chain	f	0	0	1	104	5		
	%	0	0	0.9	94.5	4.5	4.04	0.232
Regulating market information can influence wastage of vegetables along the supply chain	f	0	0	1	104	5		
	%	0	0	0.9	94.5	4.5	4.04	0.232
Regulating packaging can influence food waste along the vegetable supply chain	f	0	0	2	104	4		
	%	0	0	1.8	94.5	3.6	4.02	0.234
Regulating vegetable transportation can influence wastage of vegetables along the supply chain	f	0	0	1	105	4		
	%	0	0	0.9	95.5	3.6	4.03	0.212
Regulating processing units influences food waste along the vegetable supply chain	f	0	0	1	104	5		
	%	0	0	0.9	94.5	4.5	4.04	0.232
Overall Average			0.1%	1.20%	94.83%		4.02	

Source: Own Survey Results (2024)

Key: SD =Strongly Disagree, D = Disagree, N = True to some extent, A = Agree, SA = Strongly Agree, ME= Mean, S.DE= Standard Deviation

4.3.4 Measure to Mitigate Food Waste

The study further assessed the measures to mitigate food waste along the vegetable supply chain. Table 4.6 shows that on overall average, 94.80% of participants agreed that measures relating to market information, packaging, transportation, storage, processing units, quality and regulations

can mitigate food waste along the vegetable supply chain while 0.16% disagreed and 1.13% opted to remain neutral leading to a mean score of 4.02.

Table 4.6: Descriptive Statistics for Measures to Mitigate Food Waste

Measures to Mitigate Food waste		SD	D	N	A	SA	ME	S.DE
Enhancing access to market demand information for vegetables can reduce wastage along the supply chain	f	0	1	1	104	4		
	%	0	0.9	0.9	94.5	3.6	4.01	0.287
Forecasting demand can reduce over supply and reduce food waste along the vegetable supply chain	f	0	0	2	104	4		
	%	0	0	1.8	94.5	3.6	4.02	0.234
Ensuring reliability of market information can reduce wastage of vegetables along the supply chain	f	0	0	1	104	5		
	%	0	0	0.9	94.5	4.5	4.04	0.232
Verifying the accuracy of demand information for vegetables can reduce wastage along the supply chain	f	0	0	1	105	4		
	%	0	0	0.9	95.5	3.6	4.03	0.212
Using a suitable package for a particular vegetable can reduce wastage along the supply chain	f	0	0	1	104	5		
	%	0	0	0.9	94.5	4.5	4.04	0.232
Adopting a robust packaging can prevent the frequency of pest and insect infesting vegetables along the supply chain	f	1	0	1	104	4		
	%	0.9	0	0.9	94.5	3.6	4.00	0.358
Enhancing packaging can prevent vegetables from rotting along the vegetable supply chain	f	0	0	2	104	4		
	%	0	0	1.8	94.5	3.6	4.02	0.234
Using correct packaging will reduce spillage of vegetables and package failure along the supply chain	f	0	1	1	104	4		
	%	0	0.9	0.9	94.5	3.6	4.01	0.287
Ensuring the use of a suitable transport mode for vegetables can reduce wastage along the supply chain	f	0	0	1	105	4		
	%	0	0	0.9	95.5	3.6	4.03	0.212
Eliminating transportation delays can reduce the perishability of vegetables along the supply chain	f	0	1	1	104	4		
	%	0	0.9	0.9	94.5	3.6	4.01	0.287
Improving a transport network can reduce vegetable wastage along the supply chain	f	0	0	1	105	4		
	%	0	0	0.9	95.5	3.6	4.03	0.212
Using reliable transport vehicles can reduce vegetable wastage along the supply chain	f	1	0	1	104	4		
	%	0.9	0	0.9	94.5	3.6	4.00	0.358
Installation of proper storage facilities can reduce food waste along the supply chain of vegetables	f	0	1	1	104	4		
	%	0	0.9	0.9	94.5	3.6	4.01	0.287
Using transport vehicles with suitable storage facilities can reduce wastage of vegetables along the supply chain	f	0	0	2	104	4		
	%	0	0	1.8	94.5	3.6	4.02	0.234
Minimizing exposure to unsuitable temperatures can reduce wastage of vegetables along the supply chain	f	0	1	1	104	4		
	%	0	0.9	0.9	94.5	3.6	4.01	0.287
Using suitable storage can reduce loss of	f	0	0	2	104	4		

Measures to Mitigate Food waste		SD	D	N	A	SA	ME	S.DE
sales of vegetables along the supply chain	%	0	0	1.8	94.5	3.6	4.02	0.234
Linking vegetable producers and processors can reduce vegetable waste along the supply chain	f	1	0	1	104	4		
Enhancing the linkage with processing units can reduce food waste along the supply chain of vegetables	%	0.9	0	0.9	94.5	3.6	4.00	0.358
Entering in contractual arrangement with processing units can reduce vegetable waste along the supply chain	f	0	0	1	105	4		
Enhancing access to processing units can reduce food waste along the vegetable supply chain	%	0	0	0.9	95.5	3.6	4.03	0.212
Ensuring the supply of quality vegetables can reduce wastage along the supply chain	f	0	0	1	105	4		
Enhancing quality packaging of vegetables can reduce wastage along the supply chain	%	0	0	0.9	95.5	3.6	4.03	0.212
Improving quality storage along the supply chain can reduce wastage of vegetables	F	0	0	2	104	4		
Preventing quality failure can reduce loss of sales of vegetables in the supply chain	%	0	0	1.8	94.5	3.6	4.02	0.234
Improving regulations on packaging for vegetables can reduce wastage along the supply chain	F	0	0	1	105	4		
Enhancing regulations on vegetable transportation can reduce food waste along the supply chain	%	0	0	0.9	95.5	3.6	4.03	0.212
Implementing quality standards can reduce food waste along the vegetable supply chain	F	0	0	2	104	4		
Developing regulations on the linkage with processing units can reduce food waste along the vegetable supply chain	%	0	0	1.8	94.5	3.6	4.02	0.234
	%	0	0	0.9	95.5	3.6	4.03	0.212
Overall Average			0.16%	1.13%	94.80		4.02	

Source: Own Survey Results (2024)

Key: SD =Strongly Disagree, D = Disagree, N = True to some extent, A = Agree, SA = Strongly Agree, ME= Mean, S.DE= Standard Deviation

4.3.5 Summary of Descriptive Analysis for Each Variable

The summary of descriptive analysis in table 4.7 below presents summary statistics for each variable, providing an overview of the data distribution (Cohen et al., 2020). The results show that food wastage along the vegetable supply chain has a mean of 3.75, indicating a moderate level of food waste, with a relatively small standard deviation (0.510) and variance (0.260) (Hair et al., 2019).

Independent variables (Market information, Packaging, Transportation, Storage, Processing linkages, Quality, and Regulation) have means ranging from 3.7 to 4, indicating moderate to high values, with small standard deviations and variances (Kline, 2016).

Skewness values range from -2.530 to 2.530, indicating some variables are slightly skewed, but not severely (Tabachnik et al., 2007).

Kurtosis values range from -2.069 to 19.269, indicating some variables have heavier tails or outliers (Hair et al., 2019).

Table 4.7: Summary of Descriptive Analysis

Descriptive analysis of variables									
	Min	Max	Mean	Std. Dev	Var.	Skewness		Kurtosis	
						Statistic	Std. Error	Statistic	Std. Error
Food wastage along the vegetable supply chain	3	5	3.75	.510	.260	-.315	.230	-.231	.457
Market information	3	5	4.03	.212	.045	2.530	.230	19.269	.457
Packaging	1	5	3.67	.814	.663	-2.031	.230	4.398	.457
Transportation	3	5	4.04	.232	.054	2.519	.230	15.279	.457
Storage	2	5	4.01	.287	.082	-2.069	.230	27.100	.457
Processing linkages (units)	3	5	4.04	.232	.054	2.519	.230	15.279	.457

Descriptive analysis of variables									
	Min	Max	Mean	Std. Dev	Var.	Skewness		Kurtosis	
						Statistic	Std. Error	Statistic	Std. Error
Quality	3	5	4.03	.212	.045	2.530	.230	19.269	.457
Regulation	3	5	4.02	.234	.055	1.222	.230	15.913	.457

4.4 Normality Tests

Before proceeding with bivariate and multivariate analyses, the scale data underwent preliminary checks for missing values, outliers, and normality. Descriptive statistics showed that missing data absent 0.00% across variables and respondents, which is below the 10% threshold considered negligible for most analyses (Hair et al., 2019). Figures 4.7 and 4.8 shows boxplots and comparisons of actual means with 5% trimmed means revealed no extreme scores exerting significant influence on the means (Pallant, 2016). Normality assessments indicated that kurtosis and skewness values fell within the acceptable ± 1 range for psychometric tests, ensuring the data met the assumptions for further analysis (George & Mallery, 2016).

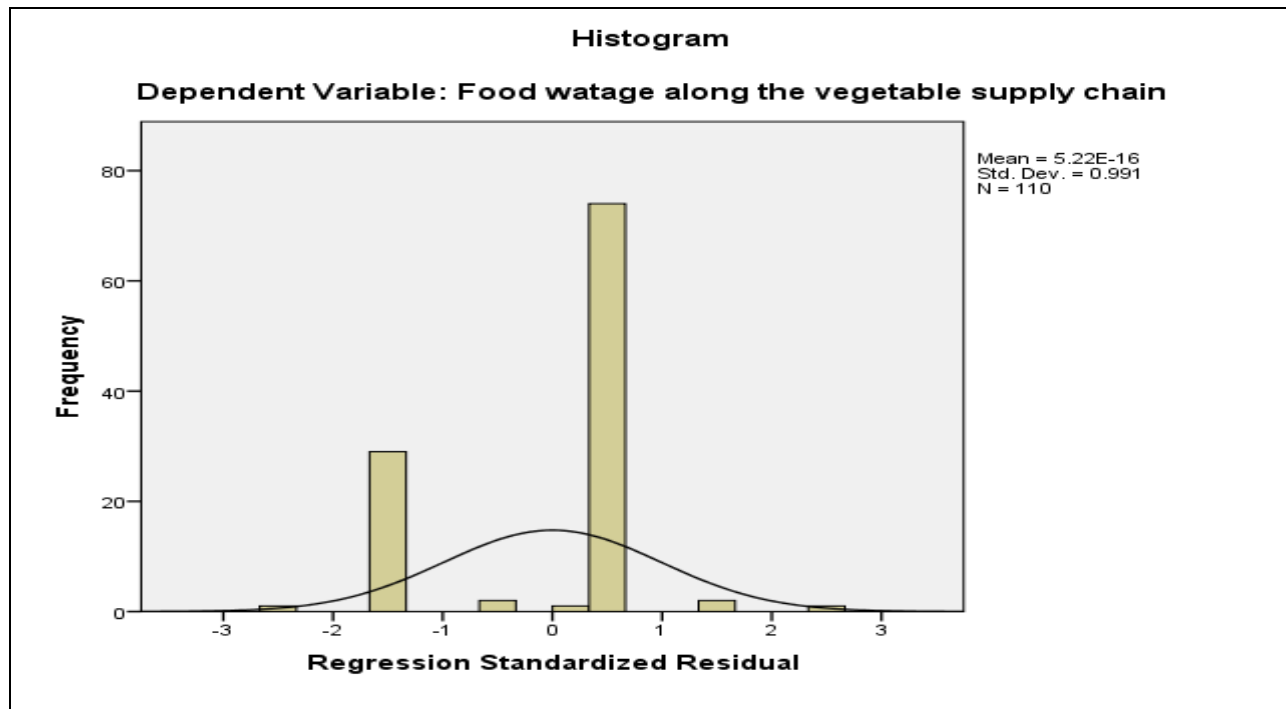


Figure 4.7: Regression standardized Residue (Source: Own Survey Results, 2024)

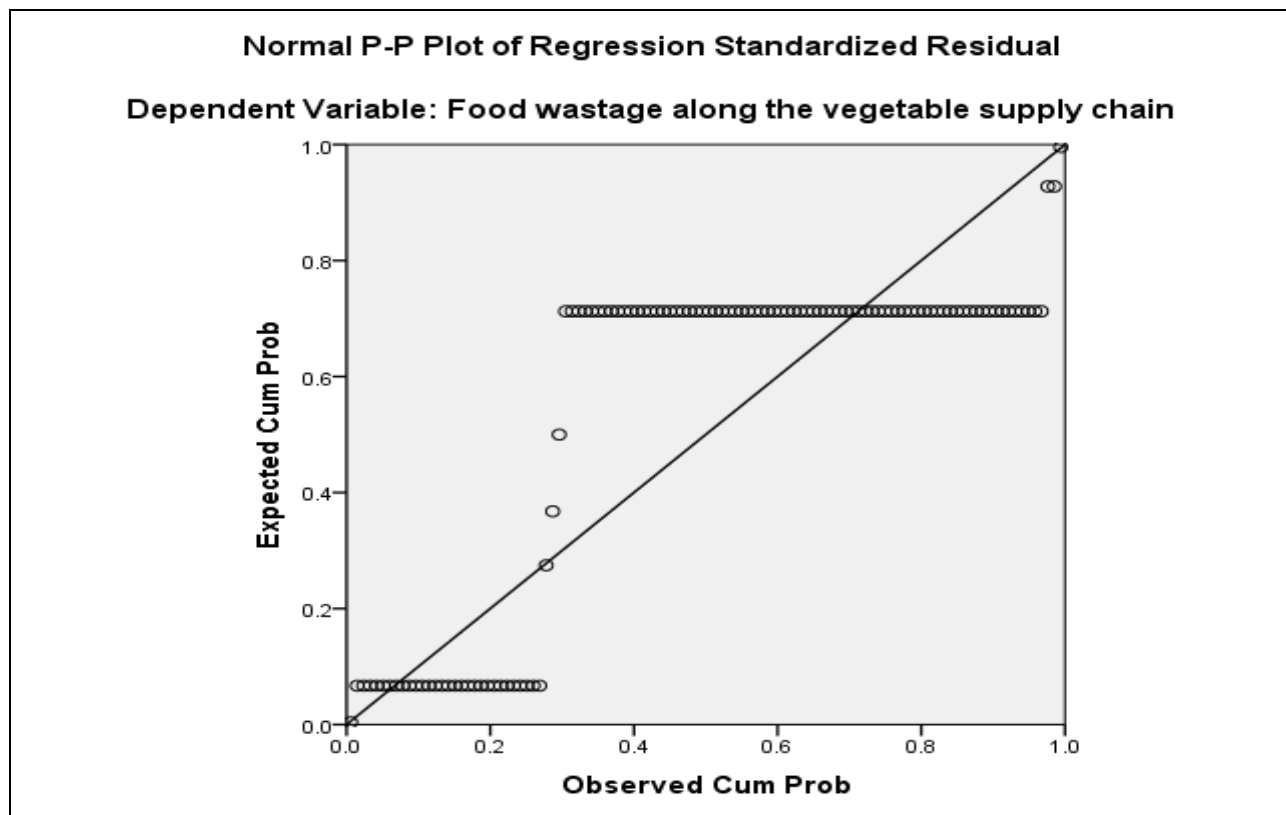


Figure 4.8 Normal P-P Plot of Regression Standardized Residue
(Source: Own Survey Results, 2024)

4.5 Reliability and Validity Analysis

To assure reliability and internal validity, the questionnaire comprised of items adapted from prior similar studies. The independent variables were *Market information*, *Transportation*, *Packaging*, *Storage*, *Processing linkage*, *Quality*, and *Regulation*. The dimensions required the respondents to rate on a five-point Likert scale ranging from 1= “strongly disagree” to 5= “strongly agree”. The questionnaire was pilot tested before final distribution to ensure that the questions were concise and where necessary and correctly rephrased.

4.5.1 Reliability

Reliability analysis of all the variables included representing all dimensions for the factors and food waste along the vegetable supply chain. Table 4.8 shows that all explanatory variables, except for ‘packaging’ had high Cronbach's alpha values above 0.8, indicating excellent reliability and internal consistency. The number of items for each variable is 4, which is a good number for a reliable scale.

The results in table 4.8 suggest that the variables *Market information*, *Transportation*, *Storage*, *Processing linkage*, *Quality*, and *Regulation* are reliable and suitable for factor analysis because the Cronbach's alpha > 0.8 (DeVellis, 2012). The KMO test values are > 0.8 and significant Bartlett's test of sphericity $p < 0.001$ indicate that the data is suitable for factor analysis (Kaiser, 1960).

Table 4.8: Reliability Analysis

Items	Components (Cronbach's Alpha)						
	1	2	3	4	5	6	7
Market Information	0.972						
Over supply of vegetables along the supply chain is due to market demand forecast failure	0.945						
Vegetable wastage along the supply chain is due to lack of access to market information	0.980						
Food waste along the vegetable supply chain is due to inaccurate market information	0.945						
Vegetable wastage along the supply chain is due to unreliable sources of market	0.984						

Items	Components (Cronbach's Alpha)						
	1	2	3	4	5	6	7
information							
Packaging		0.544					
Spillage of vegetables along the vegetable supply chain is due to packaging failure		0.412					
The frequency of pest and insect infesting vegetables is due to poor packaging		0.912					
Rotting along the vegetable supply chain is due to use of unsuitable packaging		0.423					
Food waste along the vegetable supply chain is due to use of unsuitable packaging		0.412					
Transportation			0.952				
Exposure of vegetables to abnormal temperatures is due to use of unsuitable transportation			0.913				
Perishable vegetables along the supply chain is due to transportation delays			0.913				
Vegetable wastage along the supply chain is due to poor transport network			0.913				
Non-reliable of transport vehicles lead to vegetable wastage along the supply chain			1.000				
Storage				0.959			
Selling at reduced price along the supply chain is due to non-existence of proper storage facilities				0.945			
Vegetable wastage along the supply chain is due to lack of proper storage facilities				0.918			
Exposure of vegetables to high temperatures is due to lack of cold storage facilities				0.945			

Items	Components (Cronbach's Alpha)						
	1	2	3	4	5	6	7
in the chain							
Loss of sales of vegetables along the supply chain due to lack of suitable storage causing				0.978			
Processing linkage					0.917		
Supply of vegetables will always be higher than demand due to absence of processing units					0.857		
Vegetables are wasted along the supply chain due to lack of linkage with processing units					0.834		
Food waste along the vegetable supply chain is due to lack of appropriate processing units					0.857		
Wastage of vegetables along the supply chain is due to limited access to processing units					0.986		
Quality						0.972	
Loss of sales of vegetables is due to quality failure						0.945	
Wastage of vegetables along the supply chain is due to diminishing quality						0.945	
Supply of poor-quality vegetables will always cause wastage along the supply chain						0.980	
Failure to sale vegetables on time leads to wastage due to reduced quality						0.984	
Regulation							0.988
Wastage of vegetables along the supply chain is due lack of market information regulations							0.978
Food waste along the							0.978

Items	Components (Cronbach's Alpha)						
	1	2	3	4	5	6	7
vegetable supply chain is due to lack of packaging regulations							
Wastage of vegetables along the supply chain is due lack of transport regulations							1.000
Food waste along the vegetable supply chain is due to lack of regulations on processing units							0.978

The factor analysis in table 4.9 below presents the results of the exploratory factor analysis (EFA) conducted on the variables (Cohen et al., 2020). Factor analysis was performed to establish the dimensionality of constructs and the validity of the dependent and independent variables. Specifically, exploratory factor analysis with principal components extraction and varimax rotation was conducted. The significant approximate chi-square values $p < 0.001$ suggest that the factors extracted from these variables are likely to be significant and explain a significant amount of variance in vegetable wastage (Y) (Tabachnick & Fidell, 2013).

The results in table 4.6 also show the dependent variable, Food wastage along the vegetable supply chain, has a high Cronbach's Alpha value (0.971), indicating excellent internal consistency (Hair et al., 2019). The independent variables (Market information, Packaging, Transportation, Quality, Storage, Processing linkages, and Regulation) have Cronbach's Alpha values ranging from 0.544 to 0.988, indicating varying levels of internal consistency (Kline, 2016). The KMO (Kaiser-Meyer-Olkin) test values range from 0.587 to 0.857, indicating moderate to high sampling adequacy for factor analysis (Tabachnik et al., 2007). The Bartlett's Test of Sphericity results show significant chi-square values $p < 0.001$ for all variables, indicating that the data is suitable for factor analysis (Hair et al., 2019). These findings supported the use of factor analysis to identify the underlying factors contributing to food waste along the vegetable supply chain.

Table 4.9: Factors Analysis

Factor analysis					
Variable Description	No. of items	Cronbach's Alpha	KMO Test	Bartlett's Test	
				Ap. Chi-square	Sig.
Dependent variable					
Y= food wastage along the vegetable supply chain	4	0.971	0.587	975.635	0.00
Independent variables:					
X ₁ = market information	4	0.972	0.820	300.767	0.00
X ₂ = packaging	4	0.544	0.856	332.850	0.00
X ₃ = transportation	4	0.952	0.850	362.218	0.00
X ₄ =quality	4	0.972	0.847	322.192	0.00
X ₅ =storage	4	0.959	0.845	340.145	0.00
X ₆ =processing linkages	4	0.917	0.833	315.336	0.00
X ₇ =regulation	4	0.988	0.849	329.224	0.00

4.6 Correlation Analysis

A Pearson correlation analysis was conducted to examine the direction and strength of relationships among all variables. Table 4.10 presents the correlation coefficients for the dependent variable (food wastage along the vegetable supply chain) and independent variables (market information, transportation, storage, process linkage, quality, and regulation). The results in Table 4.10 reveal relatively weak correlations below 0.8 between certain variable pairs, including (transportation and storage), (storage and market information), (storage and processing linkages), (regulation and storage), (quality and storage), and (regulation and processing linkages), indicating no multicollinearity issues (Cohen et al., 2020). However, strong correlations above 0.7 were observed between other variable pairs, such as (transportation and market information), (processing linkages and transportation), (quality and transportation), (regulation and market information), (regulation and processing linkages), and (regulation and quality), suggesting potential multicollinearity problems (Hair et al., 2019).

It may be noted that the correlation coefficient thresholds for determining multicollinearity vary among researchers. While some suggest 0.7 (Hair et al., 2019), others recommend 0.8 (Tabachnik et al., 2007) or even 0.9 (Kline, 2016).

Arising from the above, the alternative hypothesis that Processing linkage has a positive influence on food waste along the vegetables supply was proved. Also, it was clear that regulation had an influence on food waste along the vegetables supply thereby proving the

alternative hypothesis that Regulations has a positive influence on food waste along the vegetables supply chain. Whereas the alternative hypotheses that Market information, Packaging, transportation, storage and quality has a positive influence on food waste along the vegetables supply could not be proved.

Table 4.10: Pearson Correlation Analysis

Correlations among independent variables							
		Market information	Transportation	Storage	Processing linkages	Quality	Regulation
Market information	Pearson Correlation	1					
	Sig. (2-tailed)						
Transportation	Pearson Correlation	.911**	1				
	Sig. (2-tailed)	.000					
Storage	Pearson Correlation	.748**	.408**	1			
	Sig. (2-tailed)	.000	.000				
Processing linkages	Pearson Correlation	.911**	1.000**	.408**	1		
	Sig. (2-tailed)	.000	.000	.000			
Quality	Pearson Correlation	1.000**	.911**	.748**	.911**	1	
	Sig. (2-tailed)	.000	.000	.000	.000		.
Regulation	Pearson Correlation	.913**	.665**	.953**	.665**	.913**	1
	Sig. (2-tailed)	.000	.000	.000	.000	.000	
**. Correlation is significant at the 0.01 level (2-tailed).							

4.7 Regression analysis

The regression model summary table 4.11 below reveals that the model, including predictors such as Regulations and Processing linkages, explains a significant proportion of variance in Food wastage along the vegetable supply chain $R^2 = 0.110$, $F(2, 107) = 6.625$, $p = 0.002$ (Cohen et al., 2020). The adjusted R^2 value 0.094 indicates a slight shrinkage in the model's explanatory power, but still suggests a moderate fit (Kline, 2016). The standard error of the estimate 0.486 provides a measure of the model's precision (Hair et al., 2019). The significant F-change value $p = 0.002$ indicates that the addition of predictors significantly improved the model's explanatory power (Tabachnik et al., 2007).

Table 4.11: Model Summary for Multiple Regression Model – M1

Model Summary ^b									
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.332 ^a	.110	.094	.486	.110	6.625	2	107	.002
a. Predictors: (Constant), Regulations, Processing linkages (units)									
b. Dependent Variable: Food wastage along the vegetable supply chain									

The ANOVA results in table 4.12 below indicate that the regression model, which includes Regulations and Processing linkages as predictors, is significant $F(2, 107) = 6.625, p = 0.002$ (Cohen et al., 2020). This suggests that the predictors, as a group, explain a significant proportion of variance in Food wastage along the vegetable supply chain. The model accounts for approximately 11% of the variance Sum of Squares Regression = 3.126, Sum of Squares Total = 28.373 (Hair et al., 2019). The Mean Square values represent the average squared deviations for the regression model is 1.563) and residual is 0.236, respectively. The significant F-value indicates that the regression model is a better fit than a null model, and the predictors contribute significantly to explaining the dependent variable (Kline, 2016).

Table 4.12: Analysis of Variance for Multiple Regression Model – M1

ANOVA ^a						
Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	3.126	2	1.563	6.625	.002 ^b
	Residual	25.246	107	.236		
	Total	28.373	109			
a. Dependent Variable: Food wastage along the vegetable supply chain						
b. Predictors: (Constant), Regulations, Processing linkages (units)						

The coefficients in table 4.13 below presents the results of the regression analysis, showing the unstandardized (B) and standardized (Beta) coefficients for the predictors (Cohen et al., 2020). The results indicate that processing linkages (units) has a significant positive effect on Food wastage along the vegetable supply chain $B = 0.918, \text{Beta} = 0.417, p = 0.001$ (Hair et al., 2019). Regulations has a non-significant negative effect on Food wastage along the vegetable supply chain $B = -0.354, \text{Beta} = -0.163, p = 0.186$ (Kline, 2016). The collinearity statistics (Tolerance

and VIF) suggest that multicollinearity is not a significant issue, as the values are within acceptable ranges Tolerance > 0.5, VIF < 2 (Tabachnik et al., 2007).

Table 4.13: Model Coefficients for Multiple Regression for Model – M1

Coefficients ^a								
Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	1.474	.883		1.668	.098		
	Processing linkages (units)	.918	.269	.417	3.416	.001	.558	1.791
	Regulations	-.354	.266	-.163	-1.332	.186	.558	1.791
a. Dependent Variable: Food wastage along the vegetable supply chain								

The excluded variables in table 4.14 below presents the results of the regression analysis, showing the variables that were not included in the final model (Cohen et al., 2020). The results indicate that Market information, Transportation, Storage, and Quality were not significant predictors of Food wastage along the vegetable supply chain, as evidenced by their exclusion from the final model (Hair et al., 2019). The partial correlation values are not reported, indicating that these variables did not contribute significantly to the model (Kline, 2016). The collinearity statistics (Tolerance and VIF) are not applicable, as these variables were not included in the final model (Tabachnik et al., 2007). The minimum tolerance value is not reported, suggesting that multicollinearity was not a concern in the final model (Hair et al., 2019).

Table 4.14: Regression Analysis for Variables not Included in the Final Model

Excluded Variables ^a								
Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics		
						Tolerance	VIF	Minimum Tolerance
1	Market information	. ^b	.	.	.	.000	.	.000
	Transportation	. ^b	.	.	.	.000	.	.000
	Storage	. ^b	.	.	.	.000	.	.000
	Quality	. ^b	.	.	.	.000	.	.000
a. Dependent Variable: Food wastage along the vegetable supply chain								
b. Predictors in the Model: (Constant), Regulations, Processing linkages								

Generally, the findings have revealed that. Processing linkages have a significant positive effect on food waste, while regulations have a non-significant negative effect.

Given the revelations from the above findings where processing linkages is highlighted as a significant predictor of food waste along the vegetable supply chain, focus should be targeted on processing linkage as a key area when developing mitigation measures on food waste along the vegetable supply chain. Although the findings have clearly pointed out that addressing processing linkages is critical to minimize food waste, it is crucial to appreciate that Regulations together with other factors, though not significant, may still play a role in reducing food waste along the vegetable supply chain.

CHAPTER 5 - DISCUSSION OF RESULTS

5.0 Introduction

This chapter presents a discussion of the results. It begins by discussing the demographic characteristics and focuses on the study objectives.

5.1 Demographic Profile

The demographic section of the study was designed to establish the demographic profile of respondents and to assess the extent of involvement of smallholder Farmers in food waste along the vegetable supply chain. The results show that there was a 100% response rate because the survey questionnaire was self-administered (Belisario, et al., 2015) and there were more responses from Sales Managers who ranked first accounting for 48.18% of the total participants. 44.55% were Marketing Managers, 5.45% were Product Managers ranked third at while 1.82% were General Managers. Despite having more Sales Managers, it was interesting to learn that the 50% of the respondents were at secondary school qualification level. In a similar study conducted by Ndirangu et al, (2017) the level of education did not significantly influence the level of vegetable waste. Therefore, these results imply that most of the respondents had some formal education and were able to respond to study problem and variables.

5.2 Major types of food waste generated along the Soweto market vegetable supply chain

One of the objectives of the study was to establish the major types of food waste generated along the Soweto market vegetable supply chain. The study established the type of vegetables along the vegetable supply chain using the responses from the participants responses. The types of vegetables were identified and subjected to confirmation as to whether they are wasted along the vegetable supply chain. The findings on the types of food waste generated along the Soweto market vegetable supply chain indicated that tomatoes were a high-ranking food waste along the vegetable supply chain accounting for 36.4% similar to the findings by Sibomana, et al (Sibomana, et al., 2016) who indicated that postharvest waste in the fresh tomato supply chain is high in Sub-Saharan Africa (SSA) and occurs predominantly at the pre-consumer level. Onions and Cabbages ranked second at 24.5%, Okra ranked third at 8.2% and Carrots ranked lowest at 6.4% (Maina & MainaMwangi, 2008).

The findings on farm size show that 92% of participants who are smallholders had farms with a size of up to 5 hectares, 5% had farm size of up to 10 hectares, 2% had farms with a size of more

than 20 hectares and 1% had farms with a size of up to 20 hectares. These findings are similar to the study by Nagayets (2005) where it found that the majority of smallholder farmers occupy farms of less than 2 hectares. Therefore, the study collected reliable data from the right source considering that the 92% of the participants had farm sizes of up to 5 hectares with experience between two to five years as 58.2% confirmed to have been in the farming business up to 2 years. 31.8% confirmed to be between 3 to 5 years.

The study wanted to appreciate the aspect of demand because it had a bearing on the food waste along the vegetable supply chain. Hence, the participants were requested to state their average sales per day in the period of high demand to appreciate demand. The results showed that 55.5% of the smallholder farmers had their average sales oscillating between ZMW10,000.00 to ZMW50,000.00, 34.5% were at below ZMW10,000.00 whereas in the period of low demand results showed that 92.7 % of the smallholder farmers had their average sales below ZMW10,000.00, 5% were between ZMW10,000.00 to ZMW50,000.00 this result is similar to the general overview by (Paumgarten, et al., 2010) where they established that the sales of African indigenous vegetables were low in periods of low demand.

5.3 Study Variables

Besides analysing the demographic characteristics, the study also examined independent and dependent study variables. The results generated from the descriptive analysis for each variable, provided an overview of the data distribution as explained in the study by Cohen et al (2020).

5.3.1 Food wastage along the vegetable supply chain

Based on the scale of 1 to 5 where 1 was strongly disagree and 5 was strongly agree, the results showed that the dependent variable food wastage along the vegetable supply chain had a mean of 3.75, indicating a moderate level of food waste, with a relatively small standard deviation of 0.510 and variance of 0.260 (Hair et al., 2019).

5.3.2 Factors that influence food waste along the Soweto market vegetable supply chain

The study had an objective to determine the factors that influence food waste along the Soweto market vegetable supply chain. Based on the findings from the study, it showed that independent variables (Market information, Packaging, Transportation, Storage, Processing linkages, Quality, and Regulation) had means ranging from 3.7 to 4, indicating moderate to high values, with small standard deviations and variances (Kline, 2016).

Skewness values range from -2.530 to 2.530, indicating some variables are slightly skewed, but not severely (Tabachnik et al., 2007). Kurtosis values range from -2.069 to 19.269, indicating some variables have heavier tails or outliers (Hair et al., 2019).

Before proceeding with bivariate and multivariate analyses, the scale data underwent preliminary checks for missing values, outliers, and normality. Descriptive statistics showed that missing data absent 0.00% across variables and respondents, which is below the 10% threshold considered negligible for most analyses (Hair et al., 2019). In a similar study conducted by Adhikari and Herath (Adhikari & Herath, 2022), under inferential statistics, the study performed the tests regarding missing values at the very beginning and it resulted in zero missing values because the study considered the observations without missing values, and the observations with missing values were not considered when measuring the statistics. Then, the study considered the tests for outliers and there were no outliers found in the study which showed a better result. Therefore, the conclusion on this criterion was reliable. Further, the boxplots and comparisons of actual means with 5% trimmed revealed no extreme scores exerting significant influence on the means (Pallant, 2016). Normality assessments indicated that kurtosis and skewness values fell within the acceptable ± 1 range for psychometric tests, ensuring the data met the assumptions for further analysis (George & Mallery, 2016).

The independent variables for this study were *Market information*, *Transportation*, *Packaging*, *Storage*, *Processing linkage*, *Quality*, and *Regulation*. Reliability analysis of all the variables included representing all dimensions for the factors and food waste along the vegetable supply chain. The results showed that all explanatory variables, except for 'packaging' had high Cronbach's alpha values above 0.8, indicating excellent reliability and internal consistency. The number of items for each variable is 4, which is a good number for a reliable scale.

The findings further showed that variables *Market information*, *Transportation*, *Storage*, *Processing linkage*, *Quality*, and *Regulation* are reliable and suitable for factor analysis because the Cronbach's alpha > 0.8 (DeVellis, 2012). The KMO test values are > 0.8 and significant Bartlett's test of sphericity $p < 0.001$ indicate that the data is suitable for factor analysis (Kaiser, 1960). In a similar study conducted by Parimi and Chakraborty (Parimi & Chakraborty, 2022) Kaiser-Meyer-Olkin (KMO) measure of sample adequacy values and also the Bartlett's test of sphericity results were found to be significant at 0.1% level Total Variance explained was $> 60\%$ and KMO value > 0.8 , Bartlett's test of sphericity result significant at 0.000, and the Cronbach

Alpha values were above 0.8. Therefore, the instruments and results were reliable for factor analysis.

5.4 The influence of factors on food waste along the Soweto market vegetable supply chain

The study had an objective to assess how factors influence food waste along the Soweto market vegetable supply chain. Thus, an Exploratory Factor Analysis (EFA) was conducted on the variables (Cohen et al., 2020). Factor analysis was performed to establish the dimensionality of constructs and the validity of the dependent and independent variables. Specifically, exploratory factor analysis with principal components extraction and varimax rotation was conducted. The significant approximate chi-square values $p < 0.001$ suggest that the factors extracted from these variables are likely to be significant and explain a significant amount of variance in food waste along the Soweto market vegetable supply chain (Y) (Tabachnick & Fidell, 2013).

The dependent variable, food wastage along the Soweto market vegetable supply chain, had a high Cronbach's Alpha value of 0.971, indicating excellent internal consistency (Hair et al., 2019). The independent variables (Market information, Packaging, Transportation, Quality, Storage, Processing linkages, and Regulation) had Cronbach's Alpha values ranging from 0.544 to 0.988, indicating varying levels of internal consistency (Kline, 2016). The KMO (Kaiser-Meyer-Olkin) test values range from 0.587 to 0.857, indicating moderate to high sampling adequacy for factor analysis (Tabachnik et al., 2007). The Bartlett's Test of Sphericity results show significant chi-square values $p < 0.001$ for all variables, indicating that the data is suitable for factor analysis (Hair et al., 2019).

The analysis aimed to assess the instrument's validity and reliability to ensure accurate and consistent measurements. These findings supported the use of factor analysis to identify the underlying factors contributing to food waste along the vegetable supply chain (Y). The reliable and valid factors (except for packaging) were then used as predictors of vegetable wastage (Y) in a regression analysis, providing insights into the relationships between the variables and vegetable wastage (Cohen et al., 2013).

A Pearson correlation analysis was conducted to examine the direction and strength of relationships among all variables. The results presented the correlation coefficients for the dependent variable (food wastage along the vegetable supply chain) and independent variables (market information, transportation, storage, process linkage, quality, and regulation). The results

revealed relatively weak correlations below 0.8 between for certain variable pairs, including (transportation and storage), (storage and market information), (storage and processing linkages), (regulation and storage), (quality and storage), and (regulation and processing linkages), indicating no multicollinearity issues (Cohen et al., 2020). However, strong correlations above 0.7 were observed between other variable pairs, such as (transportation and market information), (processing linkages and transportation), (quality and transportation), (regulation and market information), (regulation and processing linkages), and (regulation and quality), suggesting potential multicollinearity problems (Hair et al., 2019). It may be noted that the correlation coefficient thresholds for determining multicollinearity vary among researchers. While some suggest 0.7 (Hair et al., 2019), others recommend 0.8 (Tabachnik et al., 2007) or even 0.9 (Kline, 2016). Further analysis revealed that the model, including predictors such as Regulations and Processing linkages, explained a significant proportion of variance in Food wastage along the vegetable supply chain $R^2 = 0.110$, $F(2, 107) = 6.625$, $p = 0.002$ (Cohen et al., 2020). The adjusted R^2 value 0.094 indicated a slight shrinkage in the model's explanatory power, but still suggested a moderate fit (Kline, 2016). The standard error of the estimate was 0.486 which provided a measure of the model's precision (Hair et al., 2019). The significant F-change value $p = 0.002$ indicated that the addition of predictors significantly improved the model's explanatory power (Tabachnik et al., 2007).

The ANOVA results indicated that the regression model, which includes Regulations and Processing linkages as predictors, is significant $F(2, 107) = 6.625$, $p = 0.002$ (Cohen et al., 2020). This suggests that the predictors, as a group, explain a significant proportion of variance in Food wastage along the vegetable supply chain. The model accounts for approximately 11% of the variance Sum of Squares Regression = 3.126, Sum of Squares Total = 28.373 (Hair et al., 2019). The Mean Square values represent the average squared deviations for the regression model is 1.563) and residual is 0.236, respectively. The significant F-value indicates that the regression model is a better fit than a null model, and the predictors contribute significantly to explaining the dependent variable (Kline, 2016). The coefficients presented the results of the regression analysis, showing the unstandardized (B) and standardized (Beta) coefficients for the predictors (Cohen et al., 2020). The results indicate that processing linkages (units) has a significant positive effect on Food wastage along the vegetable supply chain $B = 0.918$, $Beta = 0.417$, $p = 0.001$ (Hair et al., 2019). Regulations has a non-significant negative effect on Food wastage along the vegetable supply chain $B = -0.354$, $Beta = -0.163$, $p = 0.186$ (Kline, 2016).

The collinearity statistics (Tolerance and VIF) suggest that multicollinearity was not a significant issue, as the values are within acceptable ranges Tolerance > 0.5, VIF < 2 (Tabachnik et al., 2007).

The excluded variables presented the results of the regression analysis, showing the variables that were not included in the final model (Cohen et al., 2020). The results indicate that Market information, Transportation, Storage, and Quality were not significant predictors of Food wastage along the vegetable supply chain, as evidenced by their exclusion from the final model (Hair et al., 2019). The partial correlation values are not reported, indicating that these variables did not contribute significantly to the model (Kline, 2016). The collinearity statistics (Tolerance and VIF) are not applicable, as these variables were not included in the final model (Tabachnik et al., 2007). The minimum tolerance value is not reported, suggesting that multicollinearity was not a concern in the final model (Hair et al., 2019).

5.5 Hypothesis Test

5.5.1 Statistically ‘Supported’ Hypotheses

Based on statistical findings, the conclusion on the Statistically ‘Supported’ Hypotheses test development is as follows.

- I. Hypothesis Test Development number 5.0, the alternative hypothesis H_1 which stated that Processing linkage has a positive influence on food waste along the vegetables supply chain is accepted whereas the null hypothesis H_0 which stated that Processing linkage has a negative influence on food waste along the vegetables supply chain is rejected. Thus, the alternative hypothesis is supported. The hypothetical outcome justifies the empirical findings from the literature and the conceptual framework where processing linkage had a positive influence on food waste along the vegetables supply chain. Thus, the finding confirms the conceptual framework that processing linkage has a positive influence on food waste.
- II. Hypothesis Test Development number 7.0, the alternative hypothesis H_1 which stated that Regulations has a positive influence on food waste along the vegetables supply chain is accepted whereas the null hypothesis H_0 which stated that Regulations has a negative influence on food waste along the vegetables supply chain is rejected. Thus, the alternative hypothesis is supported. When compared to the conceptual framework, the hypothetical outcome confirms the literature and the conceptual framework where

Regulations was found to have a positive influence on food waste along the vegetables supply chain.

5.5.2 Statistically ‘Non- Supported’ Hypotheses

Based on statistical findings, the conclusion on the Statistically ‘Non-Supported’ Hypotheses test development is as follows:

- I. Hypothesis Test Development number 1.0, the alternative hypothesis H_1 which stated that Market information has a positive influence on food waste along the vegetables supply chain. is rejected whereas the null hypothesis H_0 which stated that Market information has a negative influence on food waste along the vegetables supply chain is accepted. Thus. the alternative hypothesis was not supported because there was no sufficient evidence. When compared to the conceptual framework, the hypothetical finding contradicts with that from the literature and conceptual framework where Market information was found to have a positive influence on food waste along the vegetables supply chain.
- II. Hypothesis Test Development number 2.0, the alternative hypothesis H_1 which stated that Packaging has a positive influence on food waste along the vegetables supply chain is rejected whereas the null hypothesis H_0 which stated that Packaging has a negative influence on food waste along the vegetables supply chain is accepted. Thus. the alternative hypothesis was not supported because there was no sufficient evidence. When compared to the conceptual framework, the hypothetical finding contradicts with that from the literature and conceptual framework where Packaging was found to have a positive influence on food waste along the vegetables supply chain.
- III. Hypothesis Test Development number 3.0, the alternative hypothesis H_1 which stated that Transportation has a positive influence on food waste along the vegetables supply chain is rejected whereas the null hypothesis H_0 which stated that Transportation has a negative influence on food waste along the vegetables supply chain is accepted. Thus. the alternative hypothesis was not supported because there was no sufficient evidence. When compared to the conceptual framework, the hypothetical finding contradicts with that from the literature and conceptual framework where Transportation was found to have a positive influence on food waste along the vegetables supply chain.

- IV. Hypothesis Test Development number 4.0, the alternative hypothesis H_1 which stated that Storage has a positive influence on food waste along the vegetables supply chain is rejected whereas the null hypothesis H_0 which stated that Storage has a negative influence on food waste along the vegetables supply chain is accepted. Thus, the alternative hypothesis was not supported because there was no sufficient evidence. When compared to the conceptual framework, the hypothetical finding contradicts with that from the literature and conceptual framework where Storage was found to have a positive influence on food waste along the vegetables supply chain.
- V. Hypothesis Test Development number 6.0, the alternative hypothesis H_1 which stated that Quality has a positive influence on food waste along the vegetables supply chain is rejected whereas the null hypothesis H_0 which stated that Quality has a negative influence on food waste along the vegetables supply chain is accepted. Thus, the alternative hypothesis was not supported because there was no sufficient evidence. When compared to the conceptual framework, the hypothetical finding contradicts with that from the literature and conceptual framework where Quality was found to have a positive influence on food waste along the vegetables supply chain.

CHAPTER 6 - CONCLUSION AND RECOMMENDATION

6.0 Introduction

This chapter sums up the research by providing a conclusion of the findings, research contribution, recommendations, and research limitations to be addressed by future research.

6.1 Conclusion

In Zambia, the overall vegetable primary production was 157,500 tons in 1972 while in 2021, the vegetable production was at 445,625 tons. However, food waste along the supply chain of vegetables at Soweto Market retail stage was averaging around 6.5% for rape, 1.5% dry onion and cabbage and 40 to 50 per cent for tomatoes. Hence, the study sought to assess the factors influencing food waste along the vegetable supply chain.

The first objective for the study was to establish the major types of food waste generated along the Soweto market vegetable supply chain. The study findings from descriptive statistics showed that tomatoes were a high-ranking type of food waste along the vegetable supply chain accounting for 36.4%, Onions and Cabbages ranked second at 24.5%, Okra ranked third at 8.2% and Carrots ranked lowest at 6.4%. Therefore, the major types of food waste generated along the Soweto market vegetable supply chain were established and confirmed through descriptive statistics.

The second objective was to determine the factors that influence food waste along the Soweto market vegetable supply chain. The study findings from the descriptive analysis of variables indicated that independent variables (Market information, Packaging, Transportation, Storage, Processing linkages, Quality, and Regulation) had means ranging from 3.7 to 4, indicating moderate to high values, with small standard deviations and variances. The findings from the data did confirm that Market information, Packaging, Transportation, Storage, Processing linkages, Quality, and Regulation were the factors influencing food waste along the Soweto market vegetable supply chain. Therefore, the study did ascertain the factors that influence food waste along the Soweto market vegetable supply chain.

The Third objective was to evaluate the influence of these factors on food waste along the Soweto market vegetable supply chain. The study findings from Pearson Correlation Analysis revealed relatively weak correlations below 0.8 between certain variable pairs. Further, the findings from Regression Model Summary revealed that predictors such as Regulations and

Processing linkages, explained a significant proportion of variance on food wastage along the vegetable supply chain ($R^2 = 0.110$, $F(2, 107) = 6.625$, $p = 0.002$). The adjusted R^2 value (0.094) indicates a slight shrinkage in the model's explanatory power, but still suggests a moderate fit. The significant F-change value ($p = 0.002$) indicated that the addition of predictors significantly improved the model's explanatory power. Whereas Market information, Transportation, Storage, and Quality were not significant predictors of Food wastage along the vegetable supply chain, as evidenced by their exclusion from the final model. Therefore, the study evaluated the influence of factors on food waste along the Soweto market vegetable supply chain and found that Regulations and Processing linkages had a positive impact on food waste along the Soweto market vegetable supply chain.

The study aimed to investigate the factors contributing to food waste along the vegetable supply chain. The results of the descriptive analysis indicate that food waste is a moderate problem, with a mean of 3.75. The independent variables, except for packaging, showed high reliability and internal consistency, indicating their suitability for factor analysis.

The factor analysis revealed that the data is suitable for factor analysis, and the extracted factors are likely to be significant. The Pearson correlation analysis showed weak correlations between some variable pairs, indicating no multicollinearity issues. However, strong correlations were observed between other variable pairs, suggesting potential multicollinearity problems.

The regression analysis revealed that the model, including regulations and processing linkages, explains a significant proportion of variance in food waste. Processing linkages have a significant positive effect on food waste, while regulations have a non-significant negative effect. The collinearity statistics suggest that multicollinearity is not a significant issue.

Based on these facts, the study concludes that processing linkages are a significant predictor of food waste along the vegetable supply chain. Regulations, although not significant, may still play a role in reducing food waste. The study highlights the importance of addressing processing linkages to minimize food waste. The findings support the use of factor analysis to identify underlying factors contributing to food waste.

6.2 Research Contribution

The study's contribution is in two aspects. Firstly, the study theoretically contributes to the current literature on food waste along the vegetables supply chain, and secondly, it provides practical implications to sales managers and policy makers in the vegetables supply chain.

6.2.1 Theoretical Contribution

The main theoretical contribution of the study is that the findings clarify the knowledge gap on using factor analysis to identify underlying factors contributing to food waste along the vegetable supply chain. Further, using regression modelling to ascertain the influence of each factor on food waste along the vegetable supply chain can be used to reduce food waste along the vegetable supply chain (Parimi & Chakraborty, 2022).

The study contributes to the Interpretive structural modelling (ISM) theory as it demonstrates that relationships among factors influencing food waste along the vegetable supply chain were identified and a problem or an issue was established. The Interpretive structural modelling (ISM) theory can be used to focus on the issue identified to reduced food waste along the vegetable supply chain (Attri, et al., 2013). Therefore, this approach provides a new perspective that provides much more detailed information for future use. Future researchers and academicians shall find this study and approach interesting.

6.2.2 Practical Contribution

In addition to the theoretical contributions, this study also provides practical contributions to sales managers, policy makers and generally smallholder farmers at Soweto Market.

Smallholder farmers, particularly Sales Managers should develop linkage with processing units as that would assure quality, timely delivery and good packaging because processing units would buy from them through agreed contracts with clear terms of reference and service. Developing linkage with processing units requires sales managers to reach out to processors and demonstrate capacity and ability to meet processing standards.

Policy makers should conduct a robust review of the Soweto Market regulations and develop regulations that will also play a key role in linking the smallholder farmers and processing units. Regulations would encompass transportation, packaging, storage and quality controls for all players to adopt. Policy makers can engage key stakeholders on the development of regulations for the vegetable supply chain at Soweto market. It is important to note that the vegetable supply chain at Soweto Market operations in a free for all without some form of regulations. The lack of regulations has made it challenging for processing units to engage with the sales managers.

Smallholder farmers should embark on self-regulation by adopting acceptable standard practices in quality, storage, transportation and packaging which would be very critical in linking them to processing units.

6.3 Recommendations

Based on the findings provided by the study, the following are the key recommendations.

- I. Supply chain stakeholders should focus on improving processing linkages to reduce food waste. Therefore, sales managers need to embark on promoting their products to processing units. Processing linkage will play a key role in reducing food waste along the vegetable supply chain at Soweto Market because it will create sustainable demand for smallholder farmers.
- II. Regulations should be revisited and strengthened to support food waste reduction efforts. Therefore, Policy makers need to revisit regulations on the vegetable supply chain at Soweto Market. Revisiting the regulations would provide an opportunity to develop more structured and effective guidelines that will standardise operations along the chain and ensure that players adhere to the guidelines. Regulations have a bearing on processing linkage because processors operate in a very formal way and are very keen in using contractual agreements that are binding on parties in the supply chain. Thus, revisiting regulations would bridge the exiting gap between processors and smallholder farmers.
- III. Further research should explore the impact of packaging on food waste. Future researchers need to explore the influence of package on food waste along the vegetable supply chain because the study could not establish the impact as evidence in the low Cronbach's alpha value. Further exploration will settle this question and set things clear on the whether packaging does influence food waste along the vegetable supply chain.
- IV. The study's findings should be disseminated to relevant stakeholders to inform food waste along the vegetable supply chain.

6.4 Limitations

Despite the contributions provided by the study, it is still limited in some ways and offers future research with research avenues

The following are the limitations of the study.

- I. The first limitation of the study is that the study's sample size was limited to 110 respondents and was not generalised as it focused on Soweto Market. Thus, future

research should consider a large sample size whose findings can be generalized at the industry and national levels.

- II. The second limitation of the study is that the study only focused on the vegetable supply chain which narrowed the source for information because most of the literature were looking at vegetables and fruits. Thus, future researchers should consider extending the focus to vegetables and fruits as one.
- III. The third limitation of the study is that it did leave other factors such as harvesting, infrastructure and many other. Thus, future studies should explore other factors contributing to food waste.

6.5 Future Research Directions

The future research directions could focus on the following.

- I. Investigate the impact of packaging on food waste.
- II. Explore other factors contributing to food waste.
- III. Conduct a longitudinal study to assess the effectiveness of food waste reduction strategies.

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APPENDICES

Budget

Item	Amount in Kwacha
Transport	3,000.00
Food	1,000.00
Printing	5,000.00
Other Cost	2,000.00
Total	11,000.00

Work Plan

Time Period	Week	Week	Week	Week	Week	Week	Week	Week	Week
Task	1	2-5	6	7	8	9	10-12	13	14
Proposal Defense									
Chapter 1-3									
Design Questionnaire and Interview Questions									
Review/ Validation of Questionnaires									
Administer Questionnaire									
Collection of Questionnaires									
Data Preparation, Analysis and Conclusion									
Proofread									
Submit Final Report									



GRADUATE SCHOOL OF BUSINESS

Survey Questionnaire

PROPOSAL TOPIC

AN ASSESSMENT OF THE FACTORS INFLUENCING FOOD WASTE ALONG THE VEGETABLE SUPPLY CHAIN - A CASE OF SOWETO MARKET IN LUSAKA

DEAR PARTICIPANT,

I am a Master of Science (MSc) student at the University of Zambia. As part of the requirement for the degree award, I am expected to undertake research in my area of study. I am working on research on “Assessment of the Factors Influencing Food Waste along the Vegetable Supply Chain- a case of Soweto Market in Zambia.” I wish to humbly request your assistance with certain information from your farming business to facilitate this research. Below is the research survey questionnaire designed to obtain information on Factors Influencing Food Waste along the Vegetable Supply Chain. Kindly answer all the questions as completely as possible. The information is intended for academic purposes only and will be treated with utmost good faith and confidentially. No specific reference will be made to your business, and only the summary of the result will be made public.

In case of any doubts that will require clarity, please contact me on the following contact details.

Name: Misael Tembo

Mobile contact: +260 976047303

Email: misael.tembo@gmail.com

SECTION 1: GENERAL INFORMATION

*Please answer the following questions about yourself and your company by ticking ✓ in the box
☐ where appropriate.*

State your Genda.

☐ Male

☐ Female

Indicate your age Group.

☐ 20-30 years

☐ 31-40 years

☐ 41-50 years

☐ Above 51 years

Which of the following most accurately describes your current title or position in your farming business?

☐ Sales Manager

☐ Product Manager

☐ Operations Manager

☐ Marketing Manager

☐ General Manager

☐ Other (please specify) _____

Please select your highest education qualification level.

☐ Certificate

☐ Diploma

☐ Bachelor's degree

☐ Master's degree

☐ Doctorate degree

☐ Other (please specify)

Please select the type of vegetable that you are specialized in as a farming business:

☐ Tomatoes

☐ Onions

☐ Carrots

☐ Okra

☐ Cabbages

What is the size of your farm.

☐ 0 – 5 hectares

☐ 6 – 10 hectares

☐ 11 – 20 hectares

☐ more than 21 hectares

Number of years you have been in framing business.

☐ 0 – 2 years ☐ 3 – 5 years ☐ 6 – 10 years ☐ 10 + years

What is your average sales in ZMW per day in the period of high demand

☐ Below 10,000 ☐ 10,000 – 50,000 ☐ More than 50,000

What is your average sales in ZMW per day in the period of low demand

☐ Below 10,000 ☐ 10,000 – 50,000 ☐ 50,000- 100,00

SECTION 2: FOOD WASTE ALONG THE VEGETABLE SUPPLY CHAIN

To what extent do you agree or disagree with the following statements concerning food waste along the vegetable supply chain?

Please rate each statement by ticking ☒ in the box ☐ appropriate: Strongly Disagree = 1, Disagree=2, Neutral = 3, Agree = 4 and Strongly Agree = 5.

Food Waste	1	2	3	4	5
1.Food goes to waste along the vegetable supply chain when demand information is not available	☐	☐	☐	☐	☐
2.Food goes to waste along the vegetable supply chain when not properly packaged	☐	☐	☐	☐	☐
3.Food goes to waste along the vegetable supply chain when not properly transported	☐	☐	☐	☐	☐
4.Food goes to waste along the vegetable supply chain when not in good quality	☐	☐	☐	☐	☐

Tomatoes	1	2	3	4	5
5.Tomatoes go to waste along the vegetable supply chain when demand information is not available	☐	☐	☐	☐	☐
6.Tomatoes go to waste along the vegetable supply chain when not properly packaged	☐	☐	☐	☐	☐
7.Tomatoes go to waste along the vegetable supply chain when not properly transported	☐	☐	☐	☐	☐

8. Tomatoes go to waste along the vegetable supply chain when not in good quality	☐	☐	☐	☐	☐
---	--------------------------	--------------------------	--------------------------	--------------------------	--------------------------

Onions

1. Onions go to waste along the vegetable supply chain when market demand information is not available	☐	☐	☐	☐	☐
2. Onions go to waste along the vegetable supply chain when not properly packaged	☐	☐	☐	☐	☐
3. Onions go to waste along the vegetable supply chain when not properly transported	☐	☐	☐	☐	☐
4. Onions go to waste along the vegetable supply chain when not properly stored.	☐	☐	☐	☐	☐

Carrots

1. Carrots go to waste along the vegetable supply chain when market demand information is not available	☐	☐	☐	☐	☐
2. Carrots go to waste along the vegetable supply chain when not properly packaged	☐	☐	☐	☐	☐
3. Carrots go to waste along the vegetable supply chain when not properly transported	☐	☐	☐	☐	☐
4. Carrots go to waste along the vegetable supply chain when not properly stored	☐	☐	☐	☐	☐

Okra

1. Okra goes to waste along the vegetable supply chain when market demand information is not available	☐	☐	☐	☐	☐
2. Okra goes to waste along the vegetable supply chain when not properly packaged	☐	☐	☐	☐	☐
3. Okra goes to waste along the vegetable supply chain when not properly transported	☐	☐	☐	☐	☐
4. Okra goes to waste along the vegetable supply chain when not properly stored	☐	☐	☐	☐	☐

Cabbages

- | | | | | | |
|--|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| 1. Cabbages go to waste along the vegetable supply chain when market demand information is not available | ☐ | ☐ | ☐ | ☐ | ☐ |
| 2. Cabbages go to waste along the vegetable supply chain when not properly packaged | ☐ | ☐ | ☐ | ☐ | ☐ |
| 3. Cabbages go to waste along the vegetable supply chain when not properly transported | ☐ | ☐ | ☐ | ☐ | ☐ |
| 4. Cabbages go to waste along the vegetable supply chain when not properly stored | ☐ | ☐ | ☐ | ☐ | ☐ |
-

SECTION 3: CAUSES OF FOOD WASTE ALONG THE VEGETABLE SUPPLY CHAIN

To what extent do you agree or disagree with the following statements concerning the causes of food waste along the vegetable supply chain?

Please rate each statement by ticking ☒ in the box ☐ appropriate: Strongly Disagree = 1, Disagree = 2, Neutral = 3, Agree = 4 and Strongly Agree = 5.

-
- | Market information | 1 | 2 | 3 | 4 | 5 |
|--|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| 1. Over supply of vegetables along the supply chain is due to market demand forecast failure | ☐ | ☐ | ☐ | ☐ | ☐ |
| 2. Vegetable wastage along the supply chain is due to lack of access to market information | ☐ | ☐ | ☐ | ☐ | ☐ |
| 3. Food waste along the vegetable supply chain is due to inaccurate market information | ☐ | ☐ | ☐ | ☐ | ☐ |
| 4. Vegetable wastage along the supply chain is due to unreliable sources of market information | ☐ | ☐ | ☐ | ☐ | ☐ |

Packaging

- | | | | | | |
|--|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| 1. Spillage of vegetables along the vegetable supply chain is due to packaging failure | ☐ | ☐ | ☐ | ☐ | ☐ |
|--|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|

- | | | | | | |
|--|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| 2. The frequency of pest and insect infesting vegetables is due to poor packaging | ☐ | ☐ | ☐ | ☐ | ☐ |
| 3. Rotting along the vegetable supply chain is due to use of unsuitable packaging | ☐ | ☐ | ☐ | ☐ | ☐ |
| 4. Food waste along the vegetable supply chain is due to use of unsuitable packaging | ☐ | ☐ | ☐ | ☐ | ☐ |

Transportation

- | | | | | | |
|---|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| 1. Exposure of vegetables to abnormal temperatures is due to use of unsuitable transportation | ☐ | ☐ | ☐ | ☐ | ☐ |
| 2. Perishable vegetables along the supply chain is due to transportation delays | ☐ | ☐ | ☐ | ☐ | ☐ |
| 3. Vegetable wastage along the supply chain is due to poor transport network | ☐ | ☐ | ☐ | ☐ | ☐ |
| 4. Non-reliable of transport vehicles lead to vegetable wastage along the supply chain | ☐ | ☐ | ☐ | ☐ | ☐ |

Storage

- | | | | | | |
|---|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| 1. Selling at reduced price along the supply chain is due to non-existence of proper storage facilities | ☐ | ☐ | ☐ | ☐ | ☐ |
| 2. Vegetable wastage along the supply chain is due to lack of proper storage facilities | ☐ | ☐ | ☐ | ☐ | ☐ |
| 3. Exposure of vegetables to high temperatures is due to lack of cold storage facilities in the chain | ☐ | ☐ | ☐ | ☐ | ☐ |
| 4. Loss of sales of vegetables along the supply chain due to lack of suitable storage causing | ☐ | ☐ | ☐ | ☐ | ☐ |

Processing linkage

- | | | | | | |
|---|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| 1. Supply of vegetables will always be higher than demand due to absence of processing units | ☐ | ☐ | ☐ | ☐ | ☐ |
| 2. Vegetables are wasted along the supply chain due to lack of linkage with processing units | ☐ | ☐ | ☐ | ☐ | ☐ |
| 3. Food waste along the vegetable supply chain is due to lack of appropriate processing units | ☐ | ☐ | ☐ | ☐ | ☐ |
| 4. Wastage of vegetables along the supply chain is due to limited access to processing units | ☐ | ☐ | ☐ | ☐ | ☐ |

Quality

- | | | | | | |
|---|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| 1. Loss of sales of vegetables is due to quality failure | ☐ | ☐ | ☐ | ☐ | ☐ |
| 2. Wastage of vegetables along the supply chain is due to diminishing quality | ☐ | ☐ | ☐ | ☐ | ☐ |
| 3. Supply of poor-quality vegetables will always cause wastage along the supply chain | ☐ | ☐ | ☐ | ☐ | ☐ |
| 4. Failure to sale vegetables on time leads to wastage due to reduced quality | ☐ | ☐ | ☐ | ☐ | ☐ |

Regulations

- | | | | | | |
|--|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| 1. Wastage of vegetables along the supply chain is due lack of market information regulations. | ☐ | ☐ | ☐ | ☐ | ☐ |
| 2. Food waste along the vegetable supply chain is due to lack of packaging regulations | ☐ | ☐ | ☐ | ☐ | ☐ |
| 3. Wastage of vegetables along the supply chain is due lack of transport regulations | ☐ | ☐ | ☐ | ☐ | ☐ |
| 4. Food waste along the vegetable supply chain is due to lack of regulations on processing units | ☐ | ☐ | ☐ | ☐ | ☐ |

SECTION 4: INFLUENCE OF THE FACTORS ON FOOD WASTE ALONG THE VEGETABLE SUPPLY CHAIN

To what extent do you agree or disagree with the following statements concerning the influence of the factors on food waste along the vegetable supply chain?

Please rate each statement by ticking ✓ in the box ☐ appropriate: Strongly Disagree = 1, Disagree = 2, Neutral = 3, Agree = 4 and Strongly Agree = 5.

- | Market information | 1 | 2 | 3 | 4 | 5 |
|--|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| 1. Demand forecast failure influences oversupply of vegetables along the supply chain leading to wastage | ☐ | ☐ | ☐ | ☐ | ☐ |
| 2. Access to market information influences sales leading vegetable wastage along the supply chain | ☐ | ☐ | ☐ | ☐ | ☐ |

- | | | | | | |
|--|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| 3. Inaccurate market information has an impact on food waste along the vegetable supply chain | ☐ | ☐ | ☐ | ☐ | ☐ |
| 4. Unreliable source of market information influences vegetable wastage along the supply chain | ☐ | ☐ | ☐ | ☐ | ☐ |

Packaging

- | | | | | | |
|--|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| 1. Packaging failure influence Spillage of vegetables along the vegetable supply chain | ☐ | ☐ | ☐ | ☐ | ☐ |
| 2. Poor packaging influence frequency of pest and insect infesting vegetables along the supply chain | ☐ | ☐ | ☐ | ☐ | ☐ |
| 3. Unsuitable packaging contributes to rotting along the vegetable supply chain | ☐ | ☐ | ☐ | ☐ | ☐ |
| 4. Unsuitable packaging influence food waste along the vegetable supply chain | ☐ | ☐ | ☐ | ☐ | ☐ |

Transportation

- | | | | | | |
|---|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| 1. Unsuitable transportation results into exposure of vegetables to abnormal temperatures | ☐ | ☐ | ☐ | ☐ | ☐ |
| 2. Transportation delays influence perishable vegetables along the supply chain | ☐ | ☐ | ☐ | ☐ | ☐ |
| 3. Poor transport network influence vegetable wastage along the supply chain | ☐ | ☐ | ☐ | ☐ | ☐ |
| 4. Non-reliable transport vehicles influence vegetable wastage along the supply chain | ☐ | ☐ | ☐ | ☐ | ☐ |

Storage

- | | | | | | |
|---|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| 1. Non-existence of proper storage facilities have an impact on sales at reduced price along the supply chain | ☐ | ☐ | ☐ | ☐ | ☐ |
| 2. Proper storage facilities influence vegetable wastage along the supply chain | ☐ | ☐ | ☐ | ☐ | ☐ |
| 3. Cold storage facilities in the chain influences exposure of vegetables to high temperatures | ☐ | ☐ | ☐ | ☐ | ☐ |
| 4. Lack of suitable storage influence loss of sales of vegetables along the supply chain | ☐ | ☐ | ☐ | ☐ | ☐ |

Processing linkage

- | | | | | | |
|---|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| 1. The absence of processing units has an impact on the supply of vegetables leading to supply being higher than demand | ☐ | ☐ | ☐ | ☐ | ☐ |
| 2. Linkage with processing units influences vegetable waste along the supply chain | ☐ | ☐ | ☐ | ☐ | ☐ |
| 3. Appropriate processing units influence food waste along the vegetable supply chain | ☐ | ☐ | ☐ | ☐ | ☐ |
| 4. Limited access to processing units influences wastage of vegetables along the supply chain | ☐ | ☐ | ☐ | ☐ | ☐ |

Quality

- | | | | | | |
|--|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| 1. Quality failure influences loss of sales of vegetables | ☐ | ☐ | ☐ | ☐ | ☐ |
| 2. Diminishing quality influences wastage of vegetables along the supply chain | ☐ | ☐ | ☐ | ☐ | ☐ |
| 3. Supply of poor-quality vegetables will always influence wastage along the supply chain | ☐ | ☐ | ☐ | ☐ | ☐ |
| 4. reduced quality influences failure to sale vegetables on time leads to wastage along the supply chain | ☐ | ☐ | ☐ | ☐ | ☐ |

Regulations

- | | | | | | |
|---|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| 1. Regulating market information can influence wastage of vegetables along the supply chain | ☐ | ☐ | ☐ | ☐ | ☐ |
| 2. Regulating packaging can influence food waste along the vegetable supply chain is due to lack of | ☐ | ☐ | ☐ | ☐ | ☐ |
| 3. Regulating vegetable transportation can influence wastage of vegetables along the supply chain | ☐ | ☐ | ☐ | ☐ | ☐ |
| 4. Regulating processing units influences food waste along the vegetable supply chain | ☐ | ☐ | ☐ | ☐ | ☐ |

SECTION 5: MEASURES FOR REDUCING FOOD WASTE ALONG THE VEGETABLE SUPPLY CHAIN

To what extent do you agree or disagree with the following statements concerning the measures for reducing food waste along the vegetable supply chain?

Please rate each statement by ticking ✓ in the box ☐ appropriate: Strongly Disagree = 1, Disagree = 2, Neutral = 3, Agree = 4 and Strongly Agree = 5.

Market information

- | | 1 | 2 | 3 | 4 | 5 |
|---|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| 1. Enhancing access to market demand information for vegetables can reduce wastage along the supply chain | ☐ | ☐ | ☐ | ☐ | ☐ |
| 2. Forecasting demand can reduce over supply and reduce food waste along the vegetable supply chain | ☐ | ☐ | ☐ | ☐ | ☐ |
| 3. Ensuring reliability of market information can reduce wastage of vegetables along the supply chain | ☐ | ☐ | ☐ | ☐ | ☐ |
| 4. Verifying the accuracy of demand information for vegetables can reduce wastage along the supply chain | ☐ | ☐ | ☐ | ☐ | ☐ |

Packaging

- | | | | | | |
|---|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| 1. Using a suitable package for a particular vegetable can reduce wastage along the supply chain | ☐ | ☐ | ☐ | ☐ | ☐ |
| 2. Adopting a robust packaging can prevent the frequency of pest and insect infesting vegetables along the supply chain | ☐ | ☐ | ☐ | ☐ | ☐ |
| 3. Enhancing packaging can prevent vegetables from rotting along the vegetable supply chain | ☐ | ☐ | ☐ | ☐ | ☐ |
| 4. Using correct packaging will reduce spillage of vegetables and package failure along the supply chain | ☐ | ☐ | ☐ | ☐ | ☐ |

Transportation

- | | | | | | |
|---|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| 1. Ensuring the use of a suitable transport mode for vegetables can reduce wastage along the supply chain | ☐ | ☐ | ☐ | ☐ | ☐ |
| 2. Eliminating transportation delays can reduce the perishability of vegetables along the supply chain | ☐ | ☐ | ☐ | ☐ | ☐ |
| 3. Improving a transport network can reduce vegetable wastage along the supply chain | ☐ | ☐ | ☐ | ☐ | ☐ |
| 4. Using reliable transport vehicles can reduce vegetable wastage along the supply chain | ☐ | ☐ | ☐ | ☐ | ☐ |

Storage

- | | | | | | |
|---|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| 1. Installation of proper storage facilities can reduce food waste along the supply chain of vegetables | ☐ | ☐ | ☐ | ☐ | ☐ |
|---|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|

- | | | | | | |
|--|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| 2. Using transport vehicles with suitable storage facilities can reduce wastage of vegetables along the supply chain | ☐ | ☐ | ☐ | ☐ | ☐ |
| 3. Minimizing exposure to unsuitable temperatures can reduce wastage of vegetables along the supply chain | ☐ | ☐ | ☐ | ☐ | ☐ |
| 4. Using suitable storage can reduce loss of sales of vegetables along the supply chain | ☐ | ☐ | ☐ | ☐ | ☐ |

Processing linkage

- | | | | | | |
|--|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| 1. Linking vegetable producers and processors can reduce vegetable waste along the supply chain | ☐ | ☐ | ☐ | ☐ | ☐ |
| 2. Enhancing the linkage with processing units can reduce food waste along the supply chain of vegetables | ☐ | ☐ | ☐ | ☐ | ☐ |
| 3. Entering in contractual arrangement with processing units can reduce vegetable waste along the supply chain | ☐ | ☐ | ☐ | ☐ | ☐ |
| 4. Enhancing access to processing units can reduce food waste along the vegetable supply chain | ☐ | ☐ | ☐ | ☐ | ☐ |

Quality

- | | | | | | |
|--|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| 1. Ensuring the supply of quality vegetables can reduce wastage along the supply chain | ☐ | ☐ | ☐ | ☐ | ☐ |
| 2. Enhancing quality packaging of vegetables can reduce wastage along the supply chain | ☐ | ☐ | ☐ | ☐ | ☐ |
| 3. Improving quality storage along the supply chain can reduce wastage of vegetables | ☐ | ☐ | ☐ | ☐ | ☐ |
| 4. Preventing quality failure can reduce loss of sales of vegetables in the supply chain | ☐ | ☐ | ☐ | ☐ | ☐ |

Regulations

- | | | | | | |
|---|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| 1. Improving regulations on packaging for vegetables can reduce wastage along the supply chain | ☐ | ☐ | ☐ | ☐ | ☐ |
| 2. Enhancing regulations on vegetable transportation can reduce food waste along the supply chain | ☐ | ☐ | ☐ | ☐ | ☐ |
| 3. Implementing quality standards can reduce food waste along the vegetable supply chain | ☐ | ☐ | ☐ | ☐ | ☐ |
| 4. Developing regulations on the linkage with processing units can reduce food waste along the vegetable supply | ☐ | ☐ | ☐ | ☐ | ☐ |

chain

Proof of Payment for Ethical Clearance

THE UNIVERSITY OF ZAMBIA
P.O. Box 32379, LUSAKA - ZAMBIA

RECEIPT No. 2021988

RECEIVED WITH THANKS FROM

Mr Misael Tembo

DATE 15-05-24

THE SUM OF

One thousand

POUNDS
KWACHA
DOLLAR

PENCE
NGWEE
CENTS

PARTICULARS

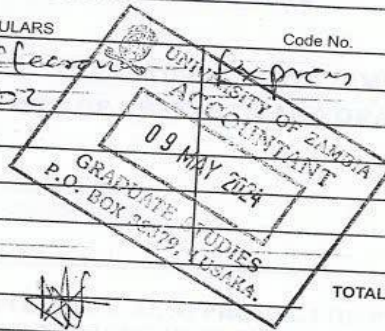
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UNIVERSITY OF ZAMBIA
ACCOUNTANT

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CASH / CHEQUE No.

FOR BURSAR

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HSSREC' 2024- MAY' 028

Approval of Study by the Supervisor

3b. **SUPERVISORS: FOR STUDENTS ONLY**

Name: Dr. Bupe Gertrude Mwanza
Qualifications: PhD, in Engineering Management
Present Appointment/Affiliations: Supervisor

Signature: 

3c. Co-Supervisor/Mentor in Zambia (This section is for all researchers outside Zambia)

Name: _____ Qualifications: N/A
Present Appointments/Affiliations: _____

Name: _____ Qualifications: N/A
Present Appointments/Affiliations: _____

4. **ARE THE PARTICIPANTS DEPENDENT ON ANY OF THE INVESTIGATORS**

As students: Yes ☐ No ☒ As employees: Yes ☐ No ☒
As patients: Yes ☐ No ☒ In other ways: Yes ☐ No ☒

If 'Yes' to any of the above, give details.

5. **POSSIBLE BENEFITS TO PARTICIPANTS:** The participants will benefit from this research as the questions will give them an opportunity to voice out on what is influencing food waste along the Soweto market vegetable supply chain. It will enable them to assess if understanding the factors influencing food waste would help them reduce wastage along the Soweto market vegetable supply chain.

Approval of Study by DRGS



THE UNIVERSITY OF ZAMBIA DIRECTORATE OF RESEARCH AND GRADUATE STUDIES

Great East Road Campus | P.O. Box 32379 | Lusaka10101 | Tel: +260-211-290 258/291 777
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APPROVAL OF STUDY

IORG No. 0005376
HSSREC IRB No. 00006464
REF NO. HSSREC-2024-MAY-028

24th May, 2024

Mr. Misael Tembo
The University of Zambia
P.O. Box 32379
LUSAKA

Dear Mr. Tembo

RE: “AN ASSESSMENT OF THE FACTORS INFLUENCING FOOD WASTE ALONG
VEGETABLE SUPPLY CHAIN - A CHAIN OF SOWETO MARKET IN LUSAKA.”

Reference is made to your submission of the protocol captioned above. The HSSREC resolved to approve this study and your participation as Principal Investigator for a period of one year.

REVIEW TYPE	ORDINARY REVIEW	APPROVAL NO. HSSREC:- 2024 - MAY- 028
Approval and Expiry Date	Approval Date: 24 th May, 2024	Expiry Date: 23 rd May, 2025
Protocol Version and Date	Version - Nil.	23 rd May, 2025
Information Sheet, Consent Forms and Dates	☐ English.	To be provided
Consent form ID and Date	Version - Nil	To be provided
Recruitment Materials	Nil	Nil
Other Study Documents	Questionnaire.	
Number of Participants Approved for Study		

Specific conditions will apply to this approval. As Principal Investigator it is your responsibility to ensure that the contents of this letter are adhered to. If these are not adhered to, the approval may be suspended. Should the study be suspended, study sponsors and other regulatory authorities will be informed.

CONDITIONS OF APPROVAL

- No participant may be involved in any study procedure prior to the study approval or after the expiration date.
- All unanticipated or Serious Adverse Events (SAEs) must be reported to HSSREC within 5 days.
- All protocol modifications must be approved by HSSREC prior to implementation unless they are intended to reduce risk (but must still be reported for approval). Modifications will include any change of investigator/s or site address.
- All protocol deviations must be reported to HSSREC within 5 working days.
- All recruitment materials must be approved by HSSREC prior to being used.
- Principal investigators are responsible for initiating Continuing Review proceedings. HSSREC will only approve a study for a period of 12 months.
- It is the responsibility of the PI to renew his/her ethics approval through a renewal application to HSSREC.
- Where the PI desires to extend the study after expiry of the study period, documents for study extension must be received by HSSREC at least 30 days before the expiry date. This is for the purpose of facilitating the review process. Documents received within 30 days after expiry will be labelled “late submissions” and will incur a penalty fee of K500.00. No study shall be renewed whose documents are submitted for renewal 30 days after expiry of the certificate.
- Every 6 (six) months a progress report form supplied by The University of Zambia Humanities and Social Sciences Research Ethics Committee as an IRB must be filled in and submitted to us. There is a penalty of K500.00 for failure to submit the report.
- When closing a project, the PI is responsible for notifying, in writing or using the Research Ethics and Management Online (REMO), both HSSREC and the National Health Research Authority (NHRA) when ethics certification is no longer required for a project.
- In order to close an approved study, a Closing Report must be submitted in writing or through the REMO system. A Closing Report should be filed when data collection has ended and the study team will no longer be using human participants or animals or secondary data or have any direct or indirect contact with the research participants or animals for the study.
- Filing a closing report (rather than just letting your approval lapse) is important as it assists HSSREC in efficiently tracking and reporting on projects. Note that some funding agencies and sponsors require a notice of closure from the IRB which had approved the study and can only be generated after the Closing Report has been filed.
- A reprint of this letter shall be done at a fee.

- All protocol modifications must be approved by HSSREC by way of an application for an amendment prior to implementation unless they are intended to reduce risk (but must still be reported for approval). Modifications will include any change of investigator/s or site address or methodology and methods. Many modifications entail minimal risk adjustments to a protocol and/or consent form and can be made on an Expedited basis (via the IRB Chair). Some examples are: format changes, correcting spelling errors, adding key personnel, minor changes to questionnaires, recruiting and changes, and so forth. Other, more substantive changes, especially those that may alter the risk-benefit ratio, may require Full Board review. In all cases, except where noted above regarding subject safety, any changes to any protocol document or procedure must first be approved by HSSREC before they can be implemented.

Should you have any questions regarding anything indicated in this letter, please do not hesitate to get in touch with us at the above indicated address.

On behalf of HSSREC, we would like to wish you all the success as you carry out your study.

Yours faithfully,



DR. J. I. Ziwa
CHAIRPERSON
THE UNIVERSITY OF ZAMBIA HUMANITIES AND
SOCIAL SCIENCES RESEARCH ETHICS COMMITTEE - IRB

CC: Director, Directorate of Research and Graduate Studies
 Assistant Director (Research), Directorate of Research and Graduate Studies
 Assistant Registrar (Research), Directorate of Research and Graduate Studies



An Assessment of the Factors Causing Food Waste along the Vegetable Supply Chain at Soweto Market in Lusaka

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Abstract

The food waste along the vegetable supply chain has become a major concern across the globe and measures are being sought to reduce its impact on food security, economy, environment and society. Soweto Market in Lusaka, Zambia is among the biggest markets where food waste along the vegetable supply chain is extensive. However, there is a significant research gap particularly on the causes of food waste along the vegetable supply chain at Soweto Market. To address this gap, this research aims to assess the factors causing food waste along the vegetable supply chain at Soweto Market. This research is envisioned to contribute to the existing body of knowledge on the reduction of food waste along the vegetable supply chain. The study adopted a deductive research approach and employed the descriptive research design. Empirical data were collected using survey questionnaires distributed to 110 smallholder farmers at Soweto Market who farm, package, transport, store and sale for themselves. Data analysis involved descriptive statistics, factor analysis and regression analysis using the Software Package for Social Sciences (SPSS). The study intended to establish the type of food waste and was restricted to understand how factors such as market information, packaging, transportation, storage, processing linkage, quality and regulations as independent variables cause food waste along the vegetable supply chain. The findings from descriptive statistics established that tomatoes, onions, carrots, okra and cabbages were among the types of food waste along the vegetable supply chain. It was also found that independent variables except for packaging showed high reliability and internal consistency. It revealed that processing linkage have a significant positive effect on food waste. These findings contribute to enhancing the reduction of food waste along the vegetable supply chain which ultimately improves food sustainability. It is recommended that stakeholders in the vegetable supply chain use the insights from this study to review processing linkages along the vegetable supply chain at Soweto Market.

Keywords: Food waste, Vegetable supply chain, Regulations, processing linkage, Supply chain management, Smallholder farmers, Wholesalers

1. Introduction

Food waste is discarded food that is fit to continue in the supply chain (Gustavsson, et al., 2011). Across the globe, 14% of the world's food valued at \$400 billion continues to be wasted after it is harvested (FAO, 2019). Food waste along the vegetable supply chain is a major problem across the globe with latest studies pointing to one third of the food produced wasted worldwide (Ribeiro, et al., 2018). The vegetable production forms part of the huge food crops cultivated and are a major source of livelihood (Idah, et al., 2007). In the agricultural sector, the vegetable supply chain constitutes of processes from farms where production takes place to final consumers (Negi & Anand, 2016). It is expected that players that include farmers, transporters, wholesalers, retailers, sales agents, processors among others would prevent food waste along the vegetable supply chain.

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In Zambia, vegetable production has increased from 157,500 tons in 1972 to 445,625 tons in 2021 (Kusuma, 2021). In Lusaka, there is heavy dependence on regional food networks for vegetable supplies as 75% of vegetables are from outside Lusaka while 27% are produced within the administrative boundaries of the city (Nyawali, 2018). Results show that out of a total of 4621.3kgs of vegetables produced from Lusaka, 1429kgs are transported to Soweto Market (ACLAR, 2023). Food waste occurs along the vegetable supply chain before reaching consumers or processors (Marisa & Toshiyuki, 2021).

1.2 Problem Statement

According to Hichambwa and Tschirley, the dominance of open-air market at Soweto Market is most pronounced in vegetables and holds close to 87% of vegetables produced in Zambia (Hichambwa & Tschirley, 2010). In the period between 2007 and 2008, Soweto Market Transacted over 50,000 metric tons of tomatoes, onions, rape per year valued over