Assessing and Minimizing the Wastages in Perishable Cargo

Case of Vegetables Supply Chain in Sri Lanka

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ABSTRACT

Agriculture is the most common livelihood of Sri Lankans, and almost eighty (80) different varieties of fruits and vegetables are grown in Sri Lanka's in varied agro-climatic areas.Sri Lanka produces around 710,000 metric tons of vegetables and around 540,000 metric tons of fruits annually. Most of the population involved in agriculture is small producers or home garden growers whose individual extent of land does not exceed a hectare. Fruits and vegetables are damaged due to inappropriate methods of picking, packing, storage and transportation. A considerable portion of products are perished during this process. Insufficient information flow is another major handicap. Therefore, it is very important to study the whole supply chain and find out the necessary remedies to develop Sri Lankan fruit and vegetable industry. Agricultural wastage is a country wide issue in Sri Lanka. According to the past researches done, there are over 40% in fruits and over 30% in vegetables been wasted while passing through the supply chain from farm-gate to the final consumer. Common supply chain for fruits and vegetables can be identified in several stages in the traditional supply chain namely farm-gate to collector, collector to whole-seller and whole-seller to the retailer. The collection and distribution of vegetable in the country is largely based on several economic centers situated across the country which were established with intuitive judgments about the locations suitability interns of transport and distribution optimization attributes. Nevertheless, the mode of transport is mainly by trucks and fruits and vegetable are packed in to plastic sacks by the supplier or intermediaries. As a result of handling, transportation, and distribution, it is reported that there is a considerable portion of fruits and vegetables are wasted.

The present research focuses on assessing the wastage levels, due to transport, handling, and identify a strategy that will minimize the wastages in perishable cargo supply chain in Sri Lanka. Objectives of this research are, to identify the factors that lead to high wastage of vegetables, to assess the level of vegetable wastage in the perishable supply chain, and to identify strategies to minimize wastage during transport of vegetables in Sri Lanka.

This study identified sample of 100 retailers to examine the supply chain of fruits and vegetables in identical numbers. Samples were drawn from the Manning Market in Colombo, Welisara Economic Center, Meegoda Economic Center, Dabulla Economic Center, Narahenpita Economic

center and other vegetables Markets in Colombo and suburbs. The sample consisted the farmers, collectors, traders.

Primary data were collected by a questionnaire consisted of fifty questions and pocket discussions and interviews. Face to face interactions and other communicative channels were used to collect information on the vegetable supply chain.

According to the survey results, 65% of the supply is directly transported from farm gate to Colombo or city whole sale vendor. The average waste per Kilo of fruits and vegetables is higher in which comes through shops. Leafy vegetables total productions come from the farm gate. Higher proportion of the vegetable samples, were packed into net bags and poly sack bags. Loading method of the poly sack bags in the vehicle were identified as one poly bag on top of the other thus the ventilation to the cargo in the bags were minimal. Lowest wastage for fruits and vegetables were identified as packing into cardboard boxes. The study revealed that lowest wastage exits when vegetables come directly from farm gate. Further it was identified that the wastage levels will depend on the nature of vegetables. More wastage can occur for soft vegetables when transported in large Lorries. Distance is not a significant factor to the wastage in Sri Lankan vegetable supply chain.

Direct transportation from farm gate to the Colombo vendors is another advantage to reduce the wastage. When vegetables are transported through intermediate vendors, the wastage will increase. Number of additional handling will impact such wastage in this chain. Therefore, this research identifies the importance of introducing advanced handling methods and usage of new equipments main recommendations. Further the study discusses the importance of the effective use of the equipment, structural changes should be carried out inside the shops, store areas and loading & unloading bays to facilitate direct cargo loading process into the vehicles to minimize wastages.

Keywords: Post-Harvest, Perishable goods, Vegetable supply chain, Wastage, Distribution Centers, Packing, Transport

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LIST OF ACRONYMS

SCM : Supply Chain Management

EDB : Export development Board

EU : EuropeanUnion

FAO : FoodandAgriculture organization oftheUnitedNations

MT : Metrictons

DC : Distribution Centers

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CHAPTER 1

INTRODUCTION

This Chapter presents the global and Sri Lankan fruits and vegetable supply chain process with a focus on local production and distribution processes. Further the importance of SCM and trends and factors affecting the SCM are also described in this chapter.

1.1. Background of the Study

Agriculture is the most common livelihood of Sri Lankans, and almost eighty (80) different varieties of fruits and vegetables are grown in Sri Lanka's in varied agro-climatic areas. While identifying the opportunities in international and local market, the present development programs are targeted to establish small farm cluster companies merged with exporters or marketing enterprises to expand productivity, promote convenient products, increase sustainable farm income, etc. (Industry Capability Report, Sri Lanka Export Development Board 2013).

Fruits and vegetables are damaged due to inappropriate methods of picking, packing, storage and transportation. A considerable portion of products are perished during this process. Insufficient information flow is another major handicap. Therefore, it is very important to study the whole Supply chain and find out the necessary remedies to develop Sri Lankan fruit and vegetable industry. Agricultural wastage is a country wide issue in Sri Lanka. This is also a worldwide problem. There are lots of researches carried out by many expertises in this area. According to the past researches more than 40% of fruits and more than 30% of vegetables are wasted while travelling through the supply chain from farm-gate to final consumer. Vegetables are one of the valuable aspects in the agricultural sector. Many nutrients, vitamins, fibers and other important food components essential for human's health can be taken from vegetables.

This is the cause for a large percentage perishing, since this fruit and vegetable life time is short and if this time period is not managed properly it will cause problems. Integrated collection and transportation system to plan and manage by central unit is the answer, and then it could be arranged for daily collection and distribution network. In papaya supply chain, wholesalers' role is relatively small and because of their handling time of extra two days, it causes an increase in

the percentage of perishing and damage, adding further cost to consumer. If in the supply chain, truck buyers directly deal with the retailer, this damage percentage can be reduced and can also reduce transportation cost. Since individual retailers at present decide transportation which is costly, it is preferred for the truck buyer to develop integrated distribution network. This will reduce the transportation costs to a great extent. In all supply chains, the retailers keep the maximum profit margin. Then comes the wholesalers own high profit margins. Farmers take higher profit once they sell their products to the consumer at the fair, but quantity involved in this chain is comparatively low. Transportation and overheads cost component of the supermarket supply chain is comparatively high and the cost due to damage is low compared to the other supply chains. However, since supermarket supply chain manages quality of the fruit and vegetable, consumers who enjoy high living standard are willing to buy from them and pay an additional amount. When analyzing the price breakdown for supply chain process for fruits and vegetables in this research, the maximum portion was found to be the profit component, second came costs due to damage/ perishing and thirdly basic production cost. Around one fifth portion is only the amount for the cost of production for these 'fruit and vegetable items and the balance part of what the consumer pays consists of the profit, cost due to damage, transportation cost, packaging cost, loading unloading cost and overheads.

Supply Chain Management is at the heart of competitive advantage for any organization. Without Supply Chains, the hospitality Industry would quickly grind to a halt. There would be no fruit or vegetables in our restaurants, no beer or wine in our bars. Further there would be no recycling of glass or the disposal of food products. There would be no customers.

Sri Lanka produces around 710,000 metric tons of vegetables and around 540,000 metric tons of fruits annually. Most of the population involved in agriculture is small producers or home garden growers whose individual extent of land does not exceed a hectare. Table 1 and Table 2 present the annual fruit and vegetable production volumes against the land area used in Sri Lanka.

Table 1: Land area and Production volume of Major Fruit Crops in 2016

Crop	Area (ha)	Production (1,000 Fruits)
Banana	48,075	3310,600 Bunches
Cashew	21,218	1898,326
Lime	6,955	117,663
Mango	25,800	431,214
Orange	3,464	23,998
Papaya	3,476	26,874
Passion fruit	425	6,202
Pineapple	4,774	32,626

Source: Department of Census and Statistics. 2016

Table 2 : Land area and Production volume of Vegetables-2016

Crop	Extent(ha)	Production(mt)
Bean	7109	28939
Tomato	6729	42470
Capsicum	2812	10381
Cabbage	3244	40126
Radish	2244	19830
Carrot	2241	24374
Beetroot	2170	13301
Knol-khol	1487	12063
Leeks	1425	19830
Brinjal	1139	24374
Bandakka	9518	13301
Red pumpkin	7066	12063
Bitter gourd	6374	191484
Snake gourd	3597	15227
Cucumber	2615	68164
Ash pumpkin	2196	37330

Source: Department of Census and Statistics 2016

Supply Chain of Vegetable Industry

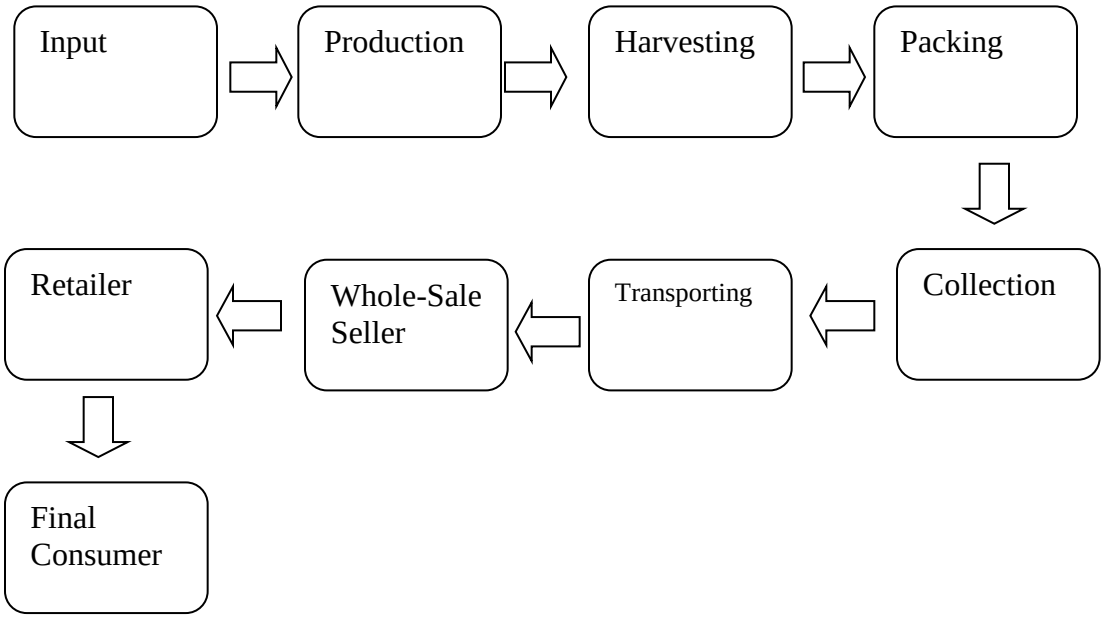

Figure 1: Common Supply Chain in Vegetable industry

Vegetable and fruit common supply chain can be identified in several stages in the traditional supply chain (Figure 1).

1. Farm-gate to Collector
2. Collector to Whole-sale agent
3. Whole-seller to retailer

There is also some other supply chain method presently exit such as supermarkets direct purchase from growers. But this supply chain does not have a considerable operation in Sri Lanka when comparing to the traditional SCM discussed above.

In many researches introduce many solutions for stage (a) and stage (b): Farm-gate to Collector and Collector to Whole-sale agent. Practically firms in this sector avoid using these solutions. Specially packing materials like plastic baskets are not in much use in the operation. In this research, we focus mainly on stage (c): wholesalers to retailer. It is expected to increase productivity of the total supply chain if stage (c) can be improved.

Majority of the aforementioned agricultural products grow in the upcountry areas. Sri Lanka's population density had been centered in the low country and mostly in Colombo and close to Colombo city. Colombo is one of the economically main important cities in Sri Lanka.
In here we examine vegetable fruits markets, geographical areas of vegetables and fruits growing, and people attitude in this sector. And, technical solutions expect such as equipment handling, structural development of stores and other areas, technical conditions for transportation.

1.2. Statement of the Problem

Population and food requirement is increasing as result of decreasing agricultural land and resources. The main challenge been faced is "how to manage the scarce food& reduce wastage of food during transportation in the supply chain". Supply chain management plays an integral role in keeping business's cost minimal thereby increasing profitability. There are many factors involved in SCM such as product flow, information flow and finance flow. The fruits and vegetables sector has grown substantially both in volume and in variety of output traded globally. Rising incomes, falling transportation costs, improved technologies, international trade and government involvement have all contributed to the level of growth. This increased level of fruits and vegetables production has not been matched by SCM. This has been happening in many developing counties. Large scale food and catering industries such as armed forces, hostels, prisons, hospitals, and tourism industry not take strategic advantages from SCM in the fruits and vegetables sector. Wastage during SCM process will have an impact on the final price of the product. Therefore, the price to the end consumer will increase if there are higher wastages.

Agricultural sector contributes approximately 21% to Gross Domestic Product in the Sri Lankan economy, out of which the vegetable production has been identified as the largest contributor. Production areas are largely located outside the main urban centers and daily transportation of vegetables from farm gate to the urban centers is a usual activity. Collection and distribution of vegetables in the country is largely based on several economic centers situated across the country which were established with intuitive judgments about the locations suitability interns of

transport and distribution optimization attributes. Nevertheless, the mode of transport is mainly using trucks and vegetables are packed in plastic sacks by most transporters. Considerable percentages of vegetables are wasted due to handling, transportation, and distribution, but there are no statistical data available to assess the wastage.

The present research focused on, assessing the wastage levels due to transport. Handling and identify causes contributing to wastage and, proposes a strategy that will minimize the wastages in perishable cargo such as vegetables supply chain in Sri Lanka.

1.3. Research Objectives

Sri Lanka is a producer of many fruits and vegetables but still there is a huge gap between per capita demand and supply. This is due to enormous wastage of commodities during post-harvest storage for the following reasons.

1. Handling caused by improper bagging without the usage of crates and other proper packaging
2. Lack of temperature-controlled vehicles
3. Unavailability of cold chain facilities in many parts of the country to preserve the produce

This results in immense losses to the economy. Hence a proper supply chain management in fruits and vegetables must be in place at all the stages of the supply by adopting best global practices in storage, packaging, handling, transportation, value added service to meet the country's demand of fruits and vegetables. As per this thesis important drawbacks of the current supply chain are high level of wastage, quality degradation, poor infrastructural facilities, and high cost. Government and private operators have to join hands to improve the physical infrastructure, information sharing, and the service required for quality improvement of the supply chain.

Therefore, the main purpose of this research is to study the whole supply chain of fruits& vegetable industry in Sri Lanka, to identify the weak links of the supply chain and to identify the

improvements to maximize profit for the growers and minimize cost (price) to the consumer. This research is also aimed at identifying the extent of fruits and vegetables damaged by the methods of inappropriate handling, storage and packaging.

The main objectives of this research are:

a) To identify the factors that leads to high wastage of vegetables

b) To assess the level of vegetable wastage in the perishable supply chain

c) To identify strategies to minimize wastage during transportation of vegetable in Sri Lanka

1.4. Scope of the Research

This research only focused on supply chain processes such as transport and logistics, packaging, and other relevant aspects of fruits and vegetables to economic centers and its related supply chain. Further the research also looked in to the management of the transport and logistics of fruits and vegetables to and from economic centers. The methodology of the study was via personal survey to staff members of the organizations in transport and logistics of fruits and vegetables to and from economic centers.

1.5. Significance of the study

This research is important for companies and firms (SMEs) especially those who engage in transporting fruits and vegetables to and from economic centers to know the role of logistics in its supply chain. Supply chain management plays a vital role for the performance of transport and logistics of fruits and vegetables to and from economic centers. Companies could apply cost reduction practices and proper managing of its supply chain while improving the vegetables supply chain performance. From this research, stakeholders will also know the benefits if use the supply chain in work activities.

1.6. Limitations of the Research

There are few constraints identified for this study. Descriptive analysis method was used to evaluate the findings. The low number of participants and samples, statistical analysis does not give more generalizable results. Farmers and Venders Lack of awareness and lack knowledge interference when answering questions were observed and precautions were taken to minimize mis-interpretations.

Measurements errors-Dehydrated volume may be a reasonable weight, but it is a difficult factor to identify. Soil weight packing bag weight also can include to the wastage portion.

CHAPTER 2

LITERAURE REVIEW

This chapter presents a review of the related literature on the subject under the study by various researchers, scholars, and authors. It discusses the historical background of the vegetables industry which provides a guide in conducting the research. The chapter provides the general economic situation, overview on global and local industry situation of the vegetables Industry which could affect the research data, information, and objectives.

2.1. Vegetables Supply Chain

Competition in the transport and logistics of vegetables supply chain industry continues as there are a large number of individual players engaged as intermediaries in the collection, transportation and distribution of vegetables. At present, many vegetables supply chain proprietors have started to understand that, to improve their performance, they should pay attention to the logistics and supply chain process to enable them to be more competitive to reduce cost. Literature review in this section will contain more details on the definition of logistics and supply chain management. Further it explains more details on how to implement logistics and supply chain management in the vegetables supply chain industry from a tactical, strategic and operational level. The review also discusses current practices used in vegetables supply chain and other businesses as well as the role logistics and supply chain management in a company's performance, particularly in the vegetables supply chain industry. Various measures to be implemented to improve product and service quality in the vegetables supply chain industry aims to make vegetables supply chain is capable to achieve a competitive advantage and this can be achieved by implementing the use of logistics and supply chain management. It is important for vegetables supply chain companies to focus on improving supply chain management efficiencies as well as reducing costs.

Supply chains are the glue that holds together the different stages of the process from the raw material at the start to delivering the right product in right Quantity, quality at right time to the

end user. They also consist of all parties who are either directly or indirectly trying to satisfy customer demands (Chopra and Meindl, 2013). It is a common perception that supply chain links manufacturers to their suppliers, but other variables need to be considered such as the customer, distribution, warehousing, and transportation (Chopra and Meindl, 2013). Christopher (2011) defines Supply Chain Management (SCM) as "the management of upstream and downstream relationship with suppliers and customers to deliver superior customer value at less cost to the supply chain as a whole" whilst Johnsen, Howard and Miemczyk (2014) state that SCM incorporates many business functions such as purchasing, operations, logistics and distribution. SCM consists of several firms cooperating to improve operational efficiency, thereby leveraging strategic positioning (Bowersox, Closs, Cooper and Bowerson, 2013). According to Crompton (2009), the goal of businesses operating a SCM model is to maximize profit through enhanced competitiveness which is achieved by having the lowest cost in the shortest time-frame possible whilst delivering the desired level of service.

2.1 Primary Activities

Inbound Logistics- involve relationships with suppliers and include all the activities required to receive, store, and disseminate inputs for the production process (Internet center for Management Business and Administration, Inc., 2010)

Its functions include,

- Receipts of Inputs
- Storage
- Stock Control
- Internal distribution of Inputs

Operation - are all the activities required to transform inputs into outputs (products and services). It is the process of manufacturing, assembling, packaging, and maintenance of the equipment and testing of inputs to produce the final product (Internet center for Management Business and Administration, Inc., 2010)

Its functions include,

- Transformation of inputs in to final products

- Usage of Labour
- Manufacturing Technology

Out Bound Logistics- Include all the activities required to collect, store, and distribute the output (Internet center for Management Business and Administration, Inc., 2010).

Its functions include,

- Distribution of Finished Goods
- Stock control and Inventory
- Distribution of final product to Buyers

Procurement -Procurement is not any more optional action in Supply Chain, Changes in the economy is critical amid most recent twenty years, not just information acquirement it is included to numerous routes in key administration. Finally, that is lined up with corporate strategy. And they are doing real part in inventory network the acquisition will be considered as an essential movement (Agboyi, 2014).

2.1.2 Secondary Activities

- Human Resource Management
- Marketing and Sales
- Service

2.3.Vegetables Supply Chain in Sri Lanka

2.3.1. The Global Supply Chain Factors and their Functions

According to the United Nations Industrial development organization, it has been identified the below factors and service providers who gets involved in the vegetables industry in the world. The households do not hire labors for their cultivation instead they use their own labour for the cultivation.

Farmers

Many households in Sri Lanka are involved in the cultivation. Number of large scale vegetable plantation owners, are also operating to get maximum output. The households are not hiring labors for their cultivation and they use their own labour for the cultivation (United Nations Industrial Development Organization, 2011).

Primary Corporative Societies

They provide the inputs and purchase supplies in bulk such as fertilizer, farm equipment on behalf of farmers. These cooperatives purchase raw vegetables from its members and sell to the buyers through warehouse system (United Nations Industrial Development Organization, 2011).

Cooperative Unions

Help the largest cooperative associations to buy materials in larger field quantities such as scrap and hull bags, loan purchases and transfers to headquarters, identification and registration of importers of raw beans into stock, as well as interaction with stock management systems. They also create a sales catalog for each shipment in the warehouse based on the information provided each week by the stock staff to the union (United Nations Industrial Development Organization, 2011).

Farmer groups and Individuals and Processing Groups

They have their own processing plant in addition to the vegetables plants. For such groups have legal status such as cooperatives or private company to sell vegetables to the export market (United Nations Industrial Development Organization, 2011)

Warehouses

All the Vegetables should be transported to certified standard warehouses that stock them separately in lot wise for each cooperative. The auction will be held here and various parties attend to the auction and money will be transferred to the bank accounts of the particular parties. This system is intended to eliminate or minimize the intermediate parties.

First Level Processors

The process of the vegetables up to the de-shelling before peeling will be done by the first level processors. This process is being out sourced at most of the time while carrying out the second level processing.

Second Level Processor/Exporters

They start the process while finishing the first level processing and do the job till sorting and packing. Sometimes they are carrying out both the first level processing activities as well as their regular job too. These processors can be categorized in to three types namely, small, medium and large. Small scale producers are producing vegetables for the local market while medium and large scale producers are producing for the regional and international market.

Customer

Customers are located locally as well as internationally. Main international markets are Europe, India, Middle East and USA whilst the raw vegetables are exported only to India.

Service Providers

Input Supplies

They provide and supply the input material for primary production. The inputs are privately licensed business. They provide the material to the local government within the context of subsidy voucher scheme.

Transporters

The job is delivering the raw vegetables from the cooperatives to the warehouses. In addition, the processed vegetables are delivered to local market as well as to the particular ports for international shipping.

Structural development

This topic explains the market places, stores, other transit places and buildings. Generally, in Sri Lanka this service developed by the local government. It is establishing economic centers in different parts of the country.

2.4. Current Practices in SCM

2.4.1. Vegetables Procurement Management in Sri Lanka

Procurement practices are used in the logistics and supply chain industry to support operational needs of the company by focusing on how purchasing is done, how the product is received from suppliers, building relationships with vendors and managing the procurement process by identifying opportunities and managing internal operations (Fantazy, Kumar, & Kumar, 2010). In today's procurement environment, importance has been placed on reducing costs during purchasing which leads to the best costs and value to its customers. Institutions such as dedicated economic centers, Cargill's who go straight to the manufacturer, are very strong when they negotiate their price with vendors and make sure no other company is getting their products at

the same low price. For example, Cargills supermarkets makes their procurement strategy transparent by spending a lot of time with vendors to better understand their pricing structure and their strategy to minimize costs. According to Lindsay (2012) vegetables supply chain purchasing is carried out on a two-week rotation using the company's master distribution plan philosophy which includes one to three vendors. They ask for the best price and promotions to help save on costs through the lower prices. In their procurement process they, try to stay within a 1 - 5% value as part of their product costs strategy (Lindsay, 2012). Due to the Venetian /Palazzo large structure and chain of events, a purchase must go through to get processed. A study was done on their purchase order strategy to evaluate the steps it takes to generate a single purchase order. The study showed it took $75 to process a single purchase order. They reversed their strategy to cut down on these processes which lead to few drops and fewer invoices to generate up the chain. The procurement process has also helped the Venetian /Palazzo, consolidate purchasing that has led to larger discounts and improved service from suppliers, increased speed in the flow of important information, and reduced the time necessary for ordering. Robert Lindsay has also seen improvements in the company's relationship with vendors and an increase in the accuracy of orders (R. Lindsay, personal communication, June 15, 2012). At the four economic Centers, the manager in charge of purchasing, Wayne Bach, mentions that with its procurement process it focuses on three bids for 90% of its products. He tries to use specific vendors, using a specific rotation and adjusts based on the value of the products. The Economic Centers uses procurement software which has helped them operationally match orders easily, improve auditing, and enable staff to more easily verify and track orders. The Economic Centers has also seen a reduction in inventory levels and the costs associated with inventory (W. Bach, personal communication, June 13, 2012). The Venetian/Palazzo and Four Economic Center, like many other vegetables supply chain companies, use procurement software called Stratton Warren to manage the whole procurement process via ecommerce. The change from the usual ordering process was because the previous system did not give accurate information on supply chain issues (Kothari, Hu, & Roehl, 2005). Stratton Warren has been integrated with other systems like warehouse management and financial systems to help gain better visibility and control of their procurement process and prevent any industry procurement challenges, like issues with purchases, deliveries, pricing, and

quality standards, as well as help suppliers spend more time creating value for the vegetables supply chains. For example, economic center vegetables supply chains changed their procurement strategy by combining buying into national contracts for its various brands and using local providers where it makes financial sense. Economic Center Vegetables supply chains makes sure they build strong relationships with suppliers for good deals, and then negotiate markups with the distributors that handle warehousing and delivery. Also as part of their strategy to control the whole supply chain process, they are making changes internationally by focusing on integrating their international procurement (Terry, 2007).

2.4.2. Distribution Management of Vegetables Industry

The role of distribution management is to get the right delivery of vegetables, to the right customer, at the right time in right quality. Distribution management is used as a strategy to minimize the transportation costs required to move delivery of vegetables from its network of suppliers to the company for consolidation, before being sent to the customer (Zhang, Song, & Huang, 2009). Retailers like Target Stores, continues to build distribution centers at strategic locations across the United States. Target Store uses its distribution management to supply a majority of its inventory to its stores, which helps provide replenishment faster (Tirschwell, 2008). At the Economic Center and Venetian /Palazzo properties in Las Vegas, vendors and suppliers ship directly to in-house property warehouses, which serve as their own distribution centers. The Venetian/Palazzo which is a convention driven property and the Four Economic Center which is an older and smaller property are sometimes faced with the challenge of a lack of space to store huge inventories, making them particularly vulnerable to stock-outs and other forecasting errors. The Four Economic Center vegetables supply chain has separate areas for full pallets, cases, and specific item picking of food orders.

According to Bach (2012), anytime products are moved in the warehouse, they make sure a transaction reflects the move. This helps prevent any integrity issues with the inventory, products available in the warehouse.

2.4.3. Transport and Logistics of Vegetables Industry in Sri Lanka

Logistics management practices focus on areas like transportation management and picking up of the orders. Effective logistics management operations lead to a higher revenue flow, cost structure improvements and reduction in transportation costs if all operations are streamlined correctly. In Sri Lanka dedicated economic centers and supermarket chain is the retail company with the best logistics management strategy because it uses its own trucks to service its stores from their distribution centers. The economic centers have a vendor compliance program, where they notify vendors about how their product should arrive. The integration of operations with suppliers has helped vegetables supply chain properties achieve the utmost throughput and highest efficiency, in the least amount of time. Another key factor working with suppliers has helped provide products designed for easy management within their facility due to issues like space and staffing. (Bach, 2012).

2.4.4. Inventory Management of Vegetables Industry

Inventory management practices help companies place orders accurately as well as maintain different assortments of products and supplies. Inventory management systems are used to create reports and track costs on which suppliers and vendors have the best costs as well as used to reconcile or adjust inventory after physical counts (Aluri&Munnang, n.d). Companies like Cargills Supermarkets have developed their inventory management strategy to focus on the needs of their customers. Cargills Supermarket gives store management the power to manage their unproductive inventories. Information technology plays a big part in inventory levels for Supermarkets, by making sure customers get the products they want. Supermarkets manage their inventory and their income through suppliers using automated ordering systems which connect vendor's computer with distribution centers and stores. When an item is identified as low in stock, a message is sent to the vendors to replenish the store or distribution center. This helps supermarkets focus on their inventory levels and know which products sold the most, while vendors were able to lower costs and pass on the saving to Centers through better prices.

Manufacturing requires products with low environmental impacts. In its distribution facilities they focus on packaging and space utilization in the warehouse and trailers to cut down on excessive handling.

2.4.5. Information Technology of Vegetables Industry

Information technology practices focus on the information available within the supply chain. Companies integrate and use multiple systems to distribute information about customer orders electronically which help to save costs. For example, information technology has changed the way businesses interact with suppliers and customers (Gunasekaran&Ngai, 2004). Today different information systems are integrated, like Point of Sales, to help forecast data, monitor inventory levels and sales trends, and in turn companies have seen cycle time reduction, quicker order filling, inventory at the right safety stock level, and customer service improvements.

CHAPTER 3

RESEARH METHODOLOGY

This chapter presents an outline of the research methods that were applied in the study in terms of answering the research problem and to fulfill the research objectives. Further the research strategy, method, approach, data collection, population, sampling, data analysis and research limitations had been discussed in each sub section.

3.1. Research Strategy

There are plenty of international and local studies related to perishable food industry. However, critical analysis of the Sri Lanka's vegetable wastetage has not yet taken place based on Supply chain perspectives. This research is a novelty and expected to contribute boarder knowledge to the field of supply chain management of Vegetable.

In many other research related to vegetable industry, analysis is carried out in four groups. Firstly, purchasing, inventory management, warehousing, customer relationship and service production processes in these enterprises are mainly being carried out by conventional methods. Secondly, internet is being used instead of multiple communication methods in the supply chain. Thirdly, respondents say that the use of information systems is reflected in the speed, reliability, easy access, low cost applications and time saving within the supply chain process. Finally, Netsis program is the most frequently used and the advantage of its ERP applications are also being used. In Sri Lankan context, the applications of advanced research strategies are not possible as the vegetable supply chain is informally organized and demonstrates a lack of use of technology. Therefore, the research strategy of this study is based on field surveys.

3.2. Research Method / Conceptual Framework

The study identified sample of 100 retailers and examines the identical number of vegetables. Samples were derived from The Manning Market Colombo, Welisara economic Center, Meegoda Economic Center, Dabulla economic center, Narahenpita Economic center and other vegetables markets located in Colombo and suburbs.

It is expected to validate past data of traditional supply chain wastage of vegetables. After that the study introduces a solution for improve the supply chain of vegetables in Sri Lanka.

Specially going to focus why past solutions fail in the market and how the new adoptions effect for the success.

In this paper, the supply chain structure in vegetables supply chains, and supply chain information systems are being examined through the interactions of the members. To achieve this goal, the relationship between information systems and the supply chain structure has been established and the role of information systems in SCM is determined with the help of corporate information systems.

Conceptual Frame Work

- Vegetable transport and logistics process
- Fruit transport and logistics process

This was included all the partners in supply chain.

Farm gate to final consumer

- Commodity Flow–This is a forward integration. Commodity collects by small vehicle from farm gate. These commodities unloading at collecting center/whole seller/distribution agent place at town. These commodities load in to large vehicles. These vehicle travels to main cities and unloading at commission agent/whole seller/distributors place at main city. Bulk purchases/retailers/purchase these commodities and transport by small vehicle to there are places. We assume this is the final consumption point.
- Information flow- This is a forward integration. Famers→ (collecting center/whole seller/distribution agent) → (commission agent/whole seller/distributors) → (bulk punchers/retailer)
- Finance flow - This is a backward integration. Price decided by demand and supply forces at commission agent/whole seller/distributors places in main city. Venders take 5% - 10% as commotion. And pay unloading charges, all transport charges. Balance money sends to the farmers.
- Time flow- Sri Lanka's common vegetable supply chain exits less than 24hrs.Farmers ready their harvest at 3 or 4p.m., collectors collect it and load to large Lorries around 5 or 6 p.m.These Lorries start to travel night at 8.p.m...These Lorries reach Colombo on the following day early morning at 3 a.m...Unloading of goods start at 5.a.m...

Vegetables selling start at same time and it close around 7 or 8 a.m...Fresh vegetables come to final consumer's place before 12 noon, and it's ready to eat before evening.

3.3. Data collection Method and Tools

3.3.1. Primary Data Collection Method

Primary data were collected by a questionnaire consisted of fifty questions, pocket discussions and interviews. Face to face interactions and other communicative channels were used to collect data.

Direct interviews and observations were very much fruitful hence main sample of the research did not possess a sound educational background and the others were mainly elders employed as part time workers. Research scope consisted by three main areas as functions, actors and service providers and was able to cover all three areas as planned by the researcher (Appendix 1:1).

The following data related to vegetable supply chain process were collected.

- Distance from farm gate to the final consumption point.
- Four types of vegetable (weights at the origin) – Carrot, Cabbage, Bean and Kankun
- Origin of vegetable transportation (farm gate)
- Packing type of vegetable – Poly sack bag, Net bags and cardboard boxes
    - Cardboard box is not a medium of packaging used in practice. The researcher added cardboard boxes into the questionnaire as an experiment and with the objective of comparing wastage level with conventional packing materials.
- Lorry type used in the transportation

Data were collected over a 31 days.

3.3.2 Secondary Data Collection Method

Secondary data collection mainly based on electronic sources such as web sites, publications, and reports from the department of census & statistics, ministry of agricultural and related departments. Previous researches had carried out by scholars, universities, and other institutions.

3.4. Sample Selection

The sample was selected mainly focusing the farmers, collectors, traders in areas, where the highest vegetables production are taking place in Sri Lanka according to whole seller's

records. Few whole sellers in Colombo also interviewed to gather more information regarding origins (Appendix 1:1).

3.5. Research Process

It visually illustrates the relationship between the business in the supply chain and other market players. A more sophisticated version shows that some businesses are different in size, some connections are more important than others, and they help identify bottlenecks and take advantage of points. Value chain helps you to quickly understand complex realities. For an example, it shows how transactions in the core of the Supply Chain are linked to market players in a close and wide business environment.

The basic objectives of a value chain map are;

- To see the basic picture of the Supply Chain to lead the full VAC (Supply Chain analysis)
- Identify the prevention and apply the best solutions in each level of the Supply Chain
- Identify the weak position and locations in the Supply Chain
- The network should be visualizing to understand and connect between actors and processors
- To show the interdependency between processors and actors in Supply Chain (Supply Chain)

The Sri Lanka Common Vegetable Supply Chain is presented in the Figure 2 below.

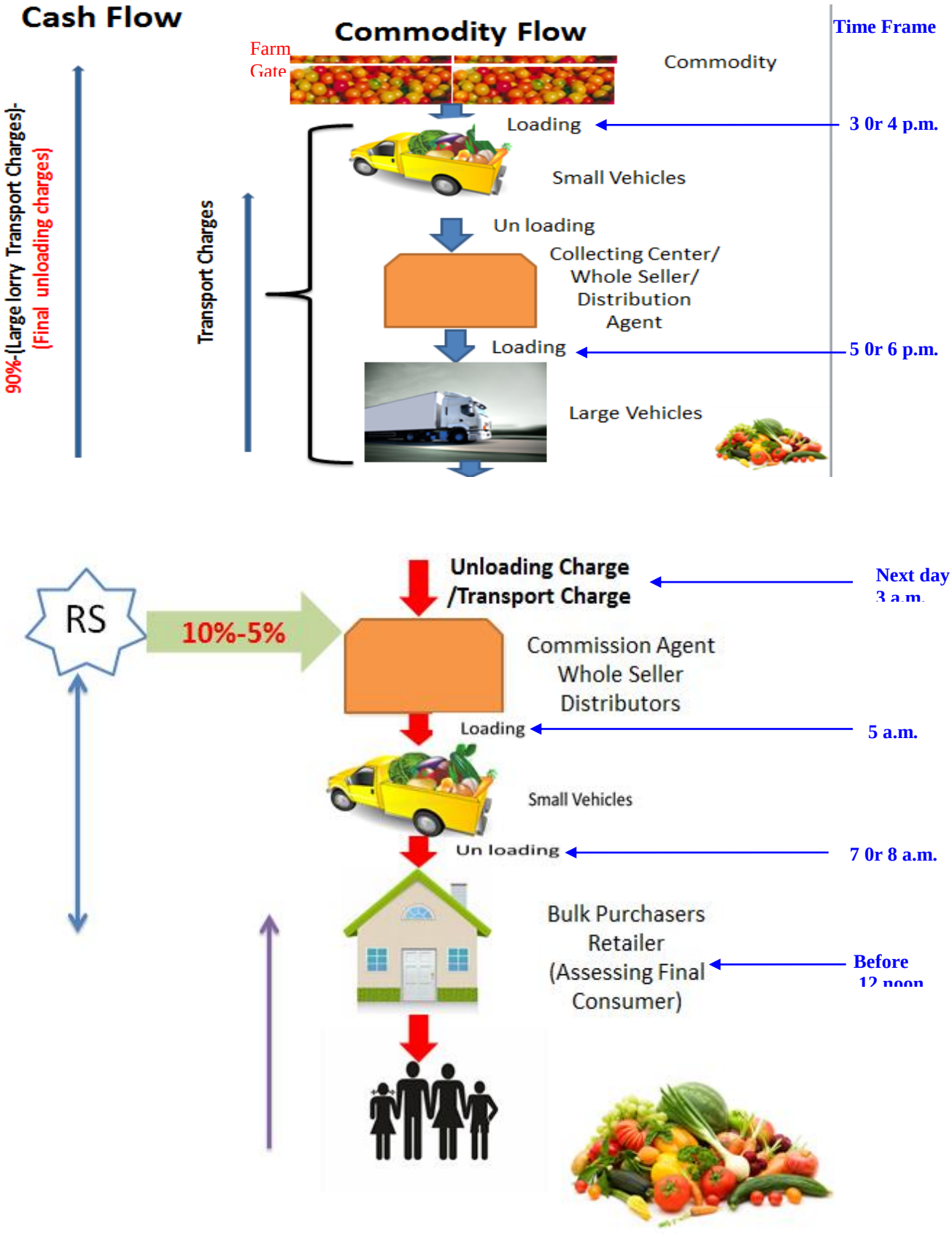

Figure 2: Sri Lanka Common Vegetable Supply Chain

3.6. Data Analysis

The data was analyzed according to the following procedure. First wastage was calculated using the following equation for each type of vegetable selected.

$$W_{Qij}=FG_{Qij}-FC_{Qij} \quad i = 1, 2, 3\ldots\ldots n \qquad j = 1, 2, 3\ldots\ldots n \quad \text{----------(1)}$$

$$\text{Average}W_{Qij}=\frac{W_{Qij}}{FG_{Qii}}$$

W – Wastage of *i*th vegetable quantity of in *j*th transporter

FG - Farm Gate Weight of *i*th vegetable quantity in *j*th transporter

FC - Final Consumable Weight

Qij – Quantity

Descriptive analysis techniques were used to analyze wastage. Further regression analysis method was used to derive factors affecting the wastage level. The equation is based on Ordinary Least Square Estimation method and shown in the form of:

$$\textit{Wastage} = \textit{constant} - b_1\ \textit{Distance} + b_2\ \textit{Origin} - b_3\ \textit{Packing type} - b_4\ \textit{Lorry type}$$

Where;

Wastage = Average Waste per kg

Distance = Distance from farm gate to the Location of Consume (End Customer) – 60 km, 120 km, 160 km, 180 km, 200 km ,300 km

Origin = Farm Gate (Direct Purchase), Shop (Indirect Purchase)

Packaging type = Net Bag, Poly Sack and Cardboard Boxes

Lorry type = Small Lorry and Large Lorry

Dummy variable used in the regression model

Origin		**Packing Type**		**Lorry Type**		**Distance**	
0	Farm Gate	0	Net Bag	0	Large	0	
1	Shop	1	Poly Sack Bag	1	Small	1	
		2	Cardboard Box				

3.6.1 Organize the Data

As a first step the collected data will be translated in to codes and clean them. Then structuring and familiarizing will label those data to run in a regression model.

3.6.2 Identify a Framework

The research and reference article read by the researcher to get a clear picture about the process and thereafter research framework will be identified. It was an exploratory (Guided by the data) and, accordingly to the framework (Coding plan), collected data were structured, labeled and defined lately.

3.6.3 Sort the Data

As the next step collected data coding process started. Accordingly, the framework was modified and understood the relationship between each actors and processes as well as sub processes.

CHAPTER 04

ANALYSIS RESULTS AND DISCUSSION

The chapter presents the results and findings obtained from the collected data of the Research. In today's competitive environment there is an increased interest in logistics and supply chain management practices since performance is not only determined by actions and decision, but also the improvements on return on investment and greater profitability. Even though logistics and supply chain is considered an operations management strategy in the vegetables and fruits supply chain and other service industries, they can use these strategies to help add value to their properties. The literature review has shown that for successful participation in the vegetables supply chain industry, logistics and supply chain collaboration and integration are important at all levels. Collaboration can help the vegetables supply chain industry gain competitive advantage by improving the overall performance through a group approach, rather than independently. Increased collaboration by logistics and supply chain partners will lead to an easy and synchronized approach that helps create lower costs and higher profits since there is better flexibility and improved utilization of resources. Logistics and supply chain integration helps with sharing benefits, resources, and risk which helps create complete process efficiency and effectiveness. Compared to a single company integration also allows faster delivery of products of good quality at a low cost which helps identify issues and solutions immediately, since integration adds information on new ideas (Naslund& Williamson, 2010). In vegetables supply chain logistics and supply chain management, supplier partnerships and relationships are very important. The long-term partnership helps the organization and its suppliers achieve major benefits through their direct, long-term union, and encourage joint planning and problem-solving efforts. These strategic relationships allow vegetables supply chains to work well with a small number of vital suppliers who are prepared to share accountability for the success of the products and work together to reduce inefficient time and effort. Relationships are used to improve customer satisfaction and prevent customers from going to the next vegetables supply chain. With changes to customization and personalized service for customers, building relationships has become important for corporate survival. The relationships allow vegetables supply chains to differentiate themselves from competitors, maintain loyalty, and in turn pass off value to its customers (Li, Ragu-Nathan, Ragu-Nathan &Subba Rao, 2006). Vegetables supply chain companies that use logistics and supply chain management strategies experience

a high level of information sharing based on the quality and quantity of information. This has to do with how information is communicated between the different partners (Yang, H & Fu, 2007). The level of information shared is used as a basis of competitive advantage, since together they understand the needs of the final customer better and can respond quicker to changes. The biggest issue with implementing logistics and supply chain management in the vegetables supply chain industry is its complex nature. As service levels can be improved to meet customer expectations, so can the nature of logistics and supply chain management (Vickers & Kodarin, 2006). Another issue with implementing logistics and supply chain strategies in the vegetables supply chain industry is change. Change can be very shaky which leads to intense, challenging, and uncomfortable situations since it is seen as a bad thing. In the vegetables supply chain industry there is resistance because people feel adopting logistic and supply chain strategies will lead to changes in their current employment status and possible fear of the unknown in the new job. Also, seasoned management has found it hard to play an important role in the change process since they feel the old strategy has worked in the past and no change is needed. (Fedele, n.d)

4.1: Achievement of objectives

In today's changing vegetables supply chain environment, it is important to apply costs saving strategies to the different logistics and supply chain functions such as inventory management and logistics management to optimize end-to-end costs and efficiency. Companies with low logistics and supply chain costs usually give managers the power to make changes to the whole process. Vegetables and fruits supply chain managers need to focus their attention on changing customer demands and should be able to identify the costs benefits that can be derived from utilizing logistics and supply chain management costs saving strategies. The implementation guide was broken down into three different levels from tactical to strategic to operational to make sure the different groups involved in implementation do not see the long-term goals in different ways. If the logistics and supply chain management guide above is executed correctly and adjusted based on the changes in the environment, the vegetables supply chain industry will be able to use these strategies as a guide to gain a competitive advantage.

4.2. Descriptive Analysis of the Sample

First descriptive analysis of four vegetables selected was carried out. The average per kg was calculated using the equation 1 and the results are presented in Table 3.

Table 3: Average waste per kg (kg)

Vegetable	Average of Waste Per kg
Beans	0.21
Cabbage	0.45
Carrot	0.25
Kangkong	0.28
Grand Total	0.30

According to Table 3, average wastage is highest for cabbage in the sample, while bean represents a low wastage. Average wastage per kg of vegetable in general is about 300g.

Descriptive Analysis of wastage in Carrot

The following Figure 4.1 presents the sample size representation of carrot, one selected vegetable to the analysis.

Origin points of carrot

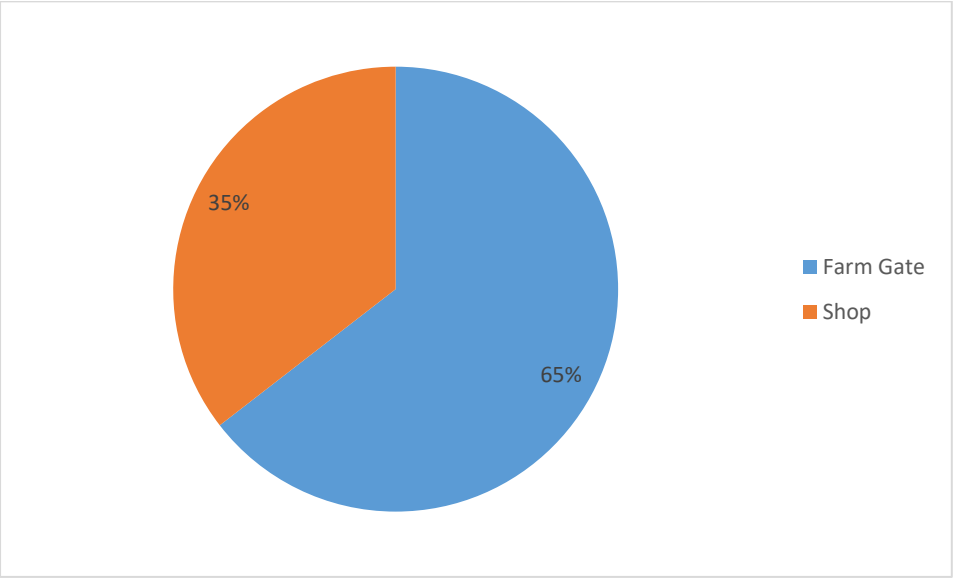

Figure 3 : The Origin point of Carrot

From the Sample 65% comes directly from farm gate. Other 35% come from intermediate vender's, that 35% faces to additional loading/unloading, transportation operations as the

process with intermediary vegetable transportation and distribution has more handling within SC process.

Lorry Typesin Carrot Transportation

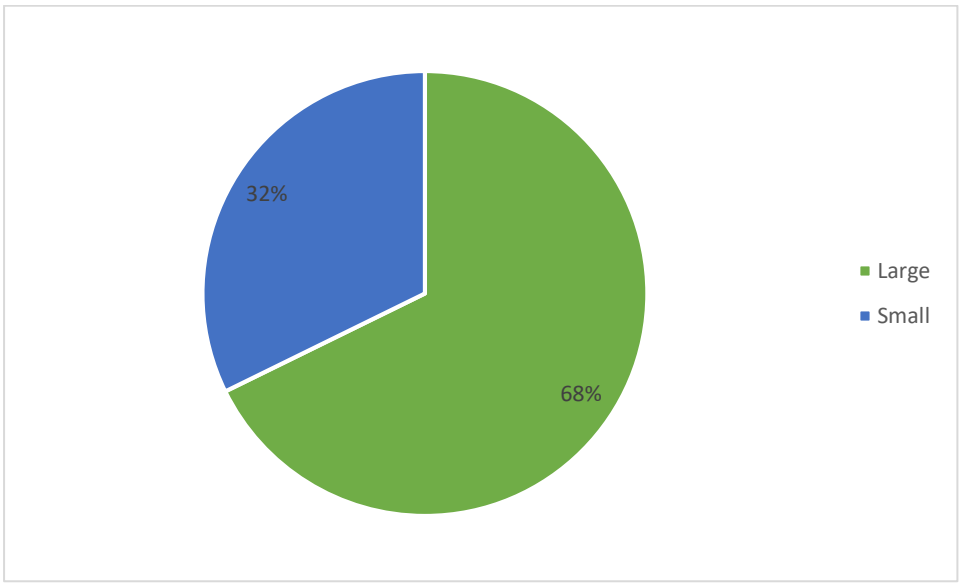

Figure 4: Lorry Type in Carrot Delivery

Large lorry of carrot delivery comes very packed environment in transportation and more load is packed inside the vehicle. Temperature and some exotics air can be circulating inside the storage area. 68% of the carrot in the sample are transported using large Lorries, while the rest is transported using small Lorries.

Packing Type of Carrot

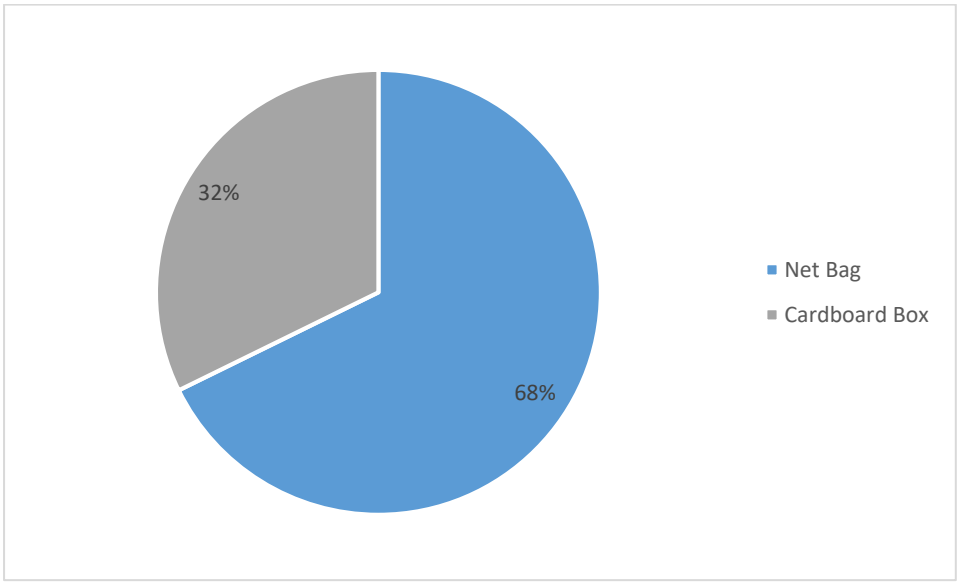

Figure 5 :Sample Size of the Packing Type of Carrot

In here Net bag means poly sack bags. Important thing is net bag can carry more than 50kg of weight of the goods that carry a load pressure to the bag stacked underneath it. Cardboard box weight does not transfer to next cardboard box and to the packed vegetables.

Distance of Carrot Delivery

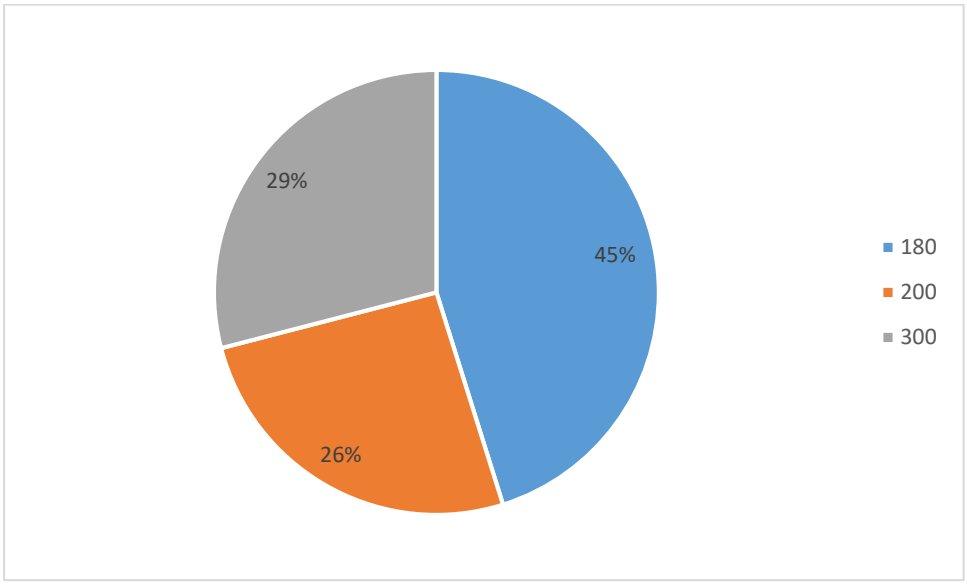

Figure 6: Distance of Carrot Delivery

In here the graph describes how far carrot transported from farm gate to final retailer or before the decupling point to the final consumer. Carrots in the samples are transported beyond 180 km or more to reach the final consumption.

Carrot Wastage per kg fluctuation

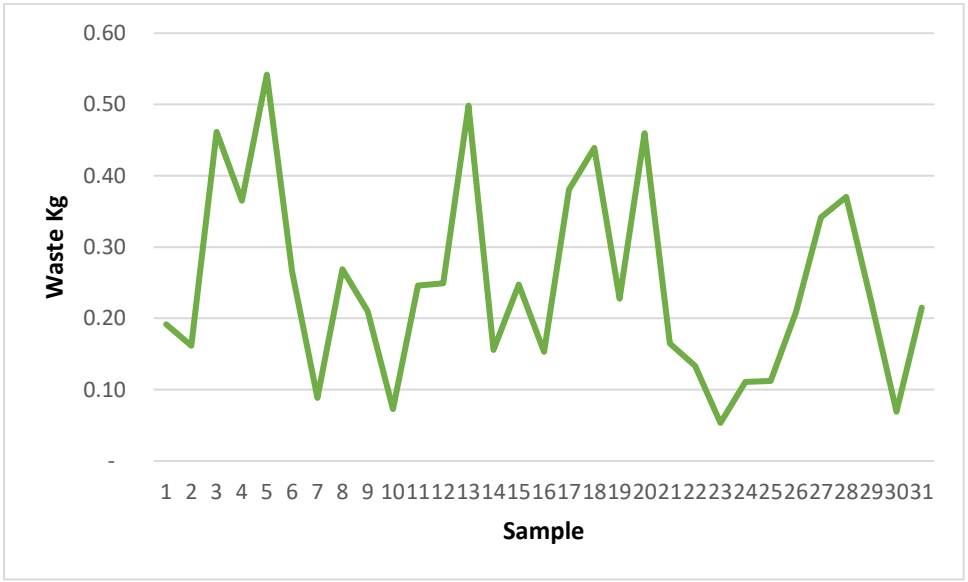

Figure 7: Carrot Waste per kg over 31 days

Wastage per kg of carrot for each sample gathered over a period of 31 days shows a high variability. It ranges from a maximum wastage of 500g per kg to 50g per kg.

Carrot Average Waste per kg Based on Origin

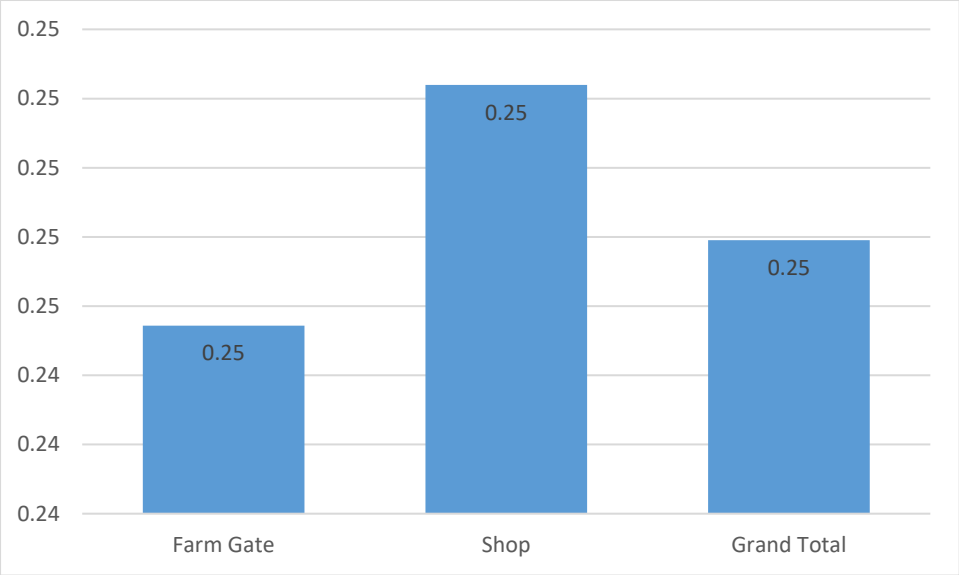

Figure 8: Carrot Average Waste per kg based on the origin

According to Figure 8, the wastage of carrot per kg is indifferent between the origins, that average wastage is about 250g per kg of carrot.

Carrot Average Waste per kg Based on Packing Type

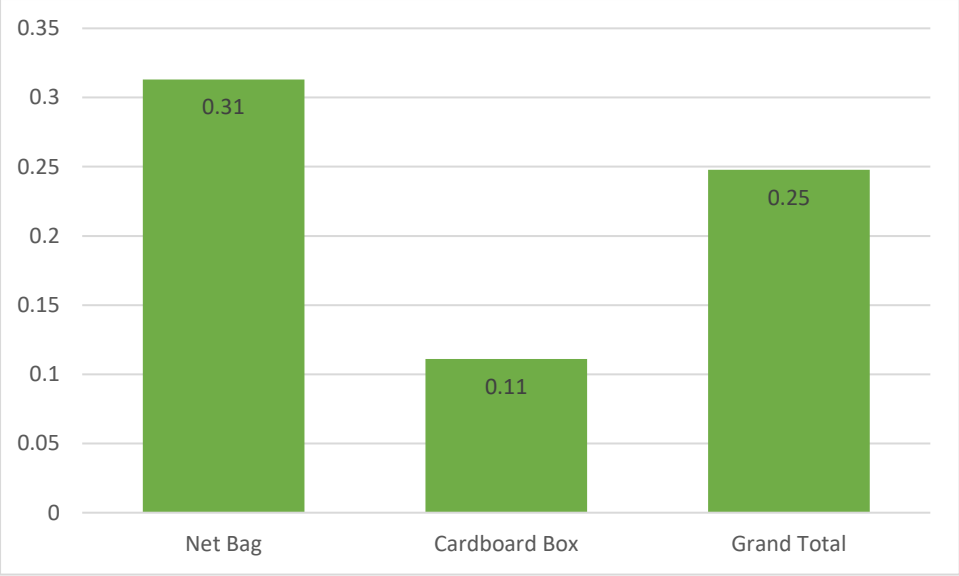

Figure 9 : Carrot Average Waste per kg Based on Packing Type

Figure 9 clearly shows that wastage of carrot packed and transported in net bags are relatively higher than using card board boxes. Net bags results in about average of 210g of loss per kg over cardboard boxes.

Carrot Average Waste per kg Based on Lorry Type of Delivery

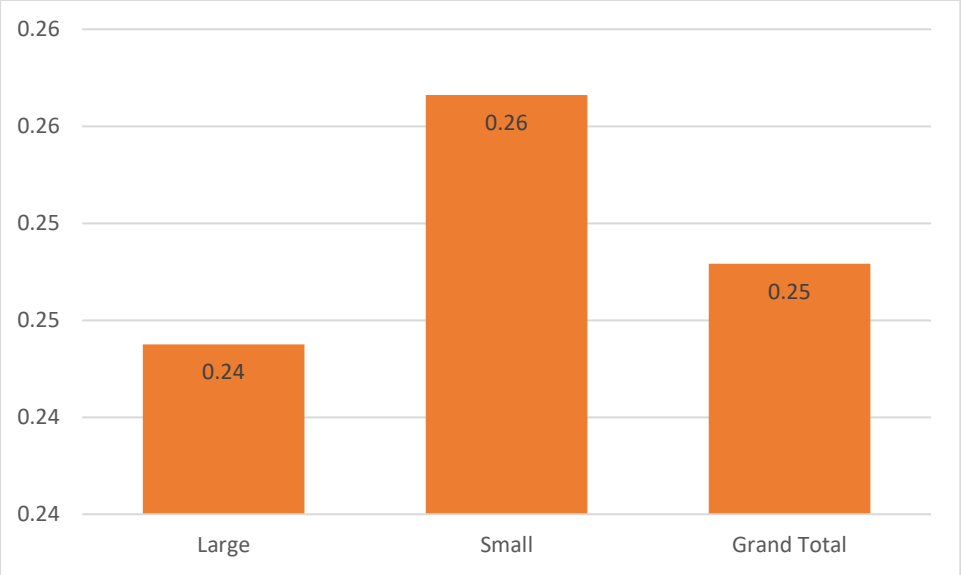

Figure 10 : Carrot Average Waste per kg Based on Lorry Type of Delivery

Carrots are mainly transported using Lorries. The samples collected include two lorry types – large and small. The results show that the average wastage per kg of carrot is indifferent between the lorry types, which range about 240g-260g of wastage per one kg of carrot.

Carrot Average Waste per kg Based on Distance of Delivery

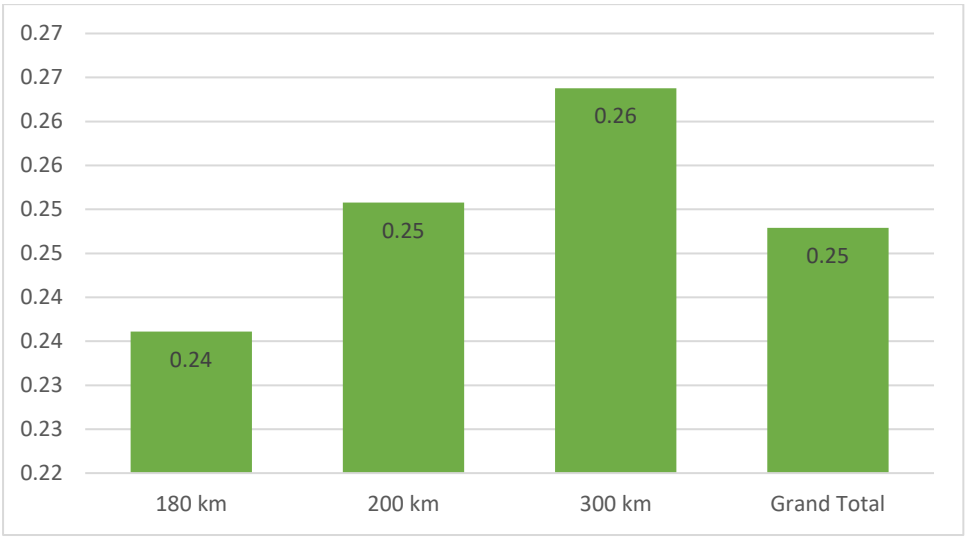

Figure 11 : Carrot Average Waste per kg Based on Distance of Delivery

The wastage tends to be slightly higher for long distance deliveries. This may be due to high exposure to vibration and sun and perhaps rain. In addition, as packed net bags are stacked on

top of each other, weight transfer from top to bottom for a long-time period results in higher wastage.

Descriptive Analysis of Beans

Distance of Beans Delivery

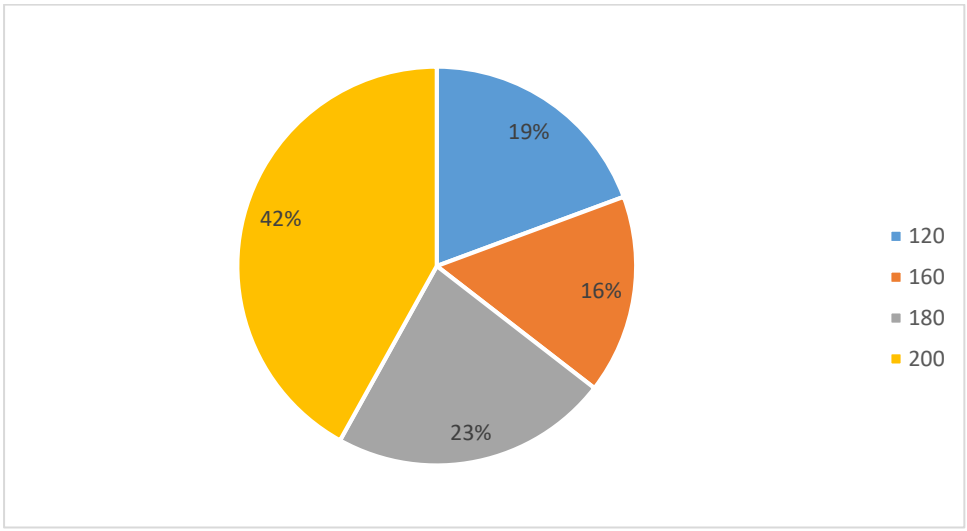

Figure 12 : Distance of Beans Delivery

In here the graph describes how far beans are transported from farm gate to final retailer or before the decupling point to the final consumer. All the beans in the sample are transported beyond 120 km or more to reach the final consumption.19% transport 120 km, 16% transport 160 km, 23% transport 180 km, 42% transport 200 km.

Descriptive Analysis of wastage in Beans

The following Figure 13 presents the sample size representation of beans, one selected vegetable to the analysis.

Origin points of Beans

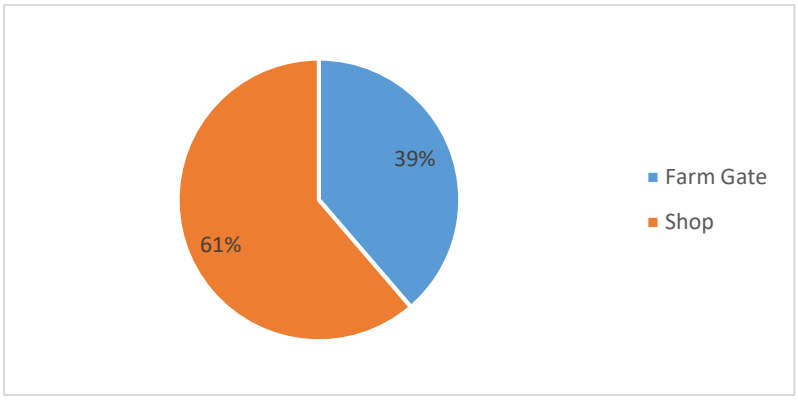

Figure 113 : The Origin point of Beans

From the Sample 61% comes directly from farm gate. Other 39% come from intermediate vender's, that 39% faces to additional loading/unloading, transportation operations as the process with intermediary vegetable transportation and distribution has more handling within SC process.

Packing Type of Beans

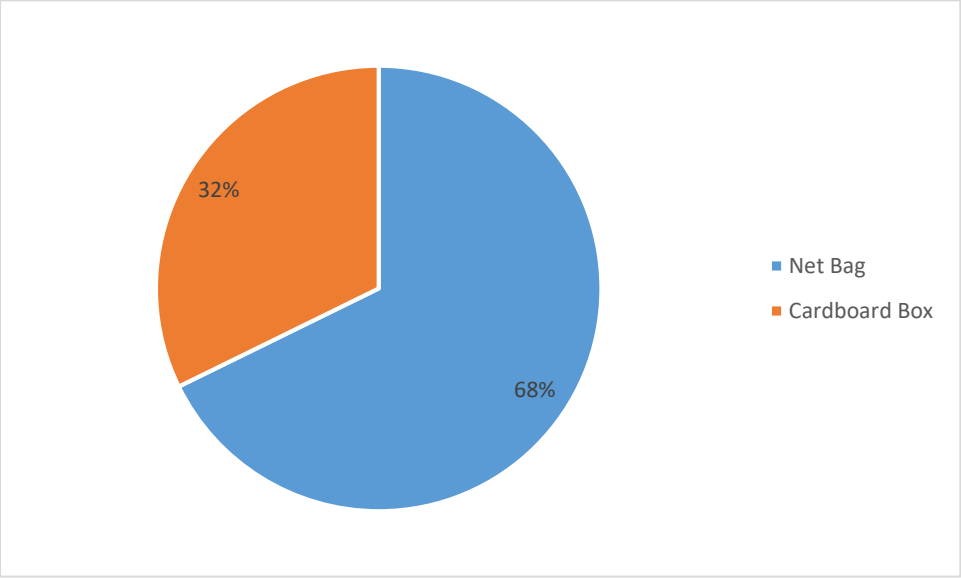

Figure 14 : Sample Size of the Packing Type of Beans

In here Net bag means poly sack bags. Important thing is net bag can carry more than 50kg of weight of the goods that carry a load pressure to the bag stacked underneath it. Cardboard box weight does not transfer to next cardboard box and to the packed vegetables.

Lorry Types in Carrot Transportation

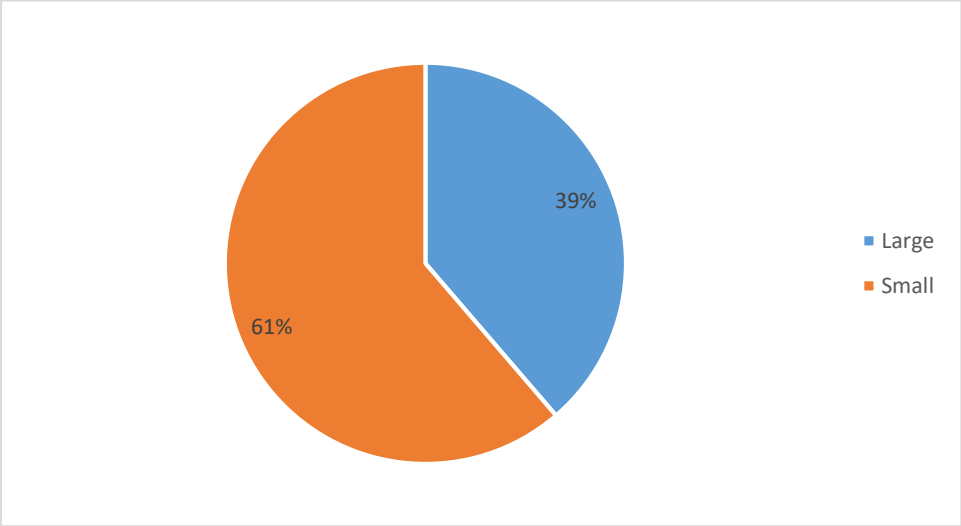

Figure 15: Lorry Type in Beans Delivery

Large Lorries of beans are delivery come very packed environment in transportation and more loads are packed inside the vehicle. Temperature and some exotics air can be circulating inside the storage area. 61% of the beans in the sample are transported using large Lorries, while the rest 39% is transported using small Lorries.

Beans Wastage per kg fluctuation

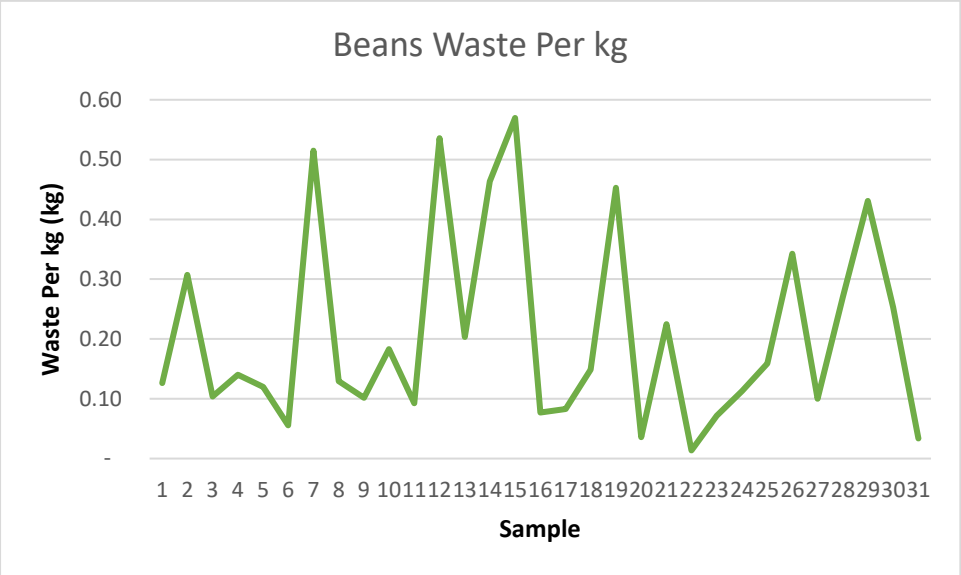

Figure 15 : Beans Waste per kg over 31 days

Wastage per kg of bean for each sample gathered over a period of 31 days shows a high variability. It ranges from a maximum wastage of 500g per kg to 50g per kg.

Beans Average Waste per kg Based on Distance of Delivery

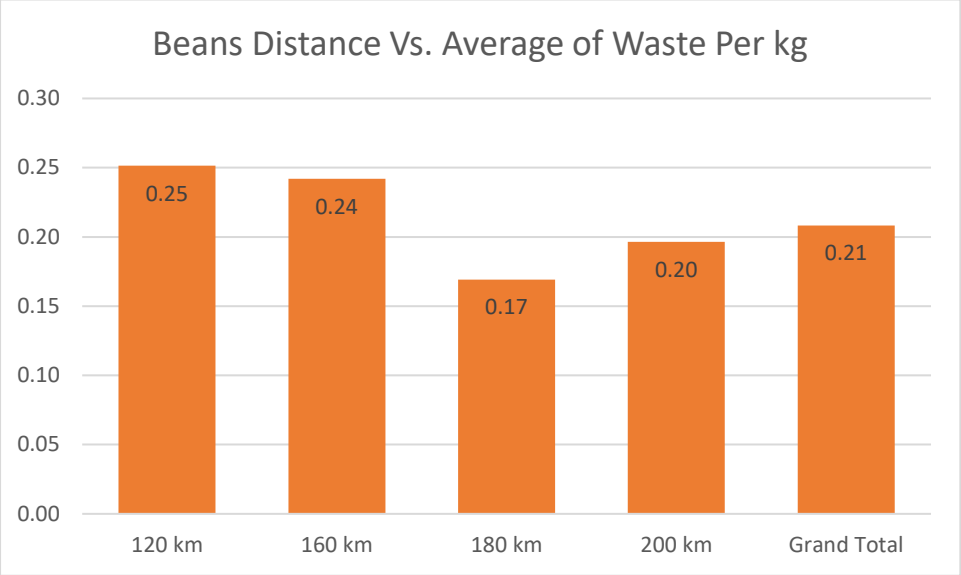

Figure 16: Beans Average Waste per kg Based on Distance of Delivery

The wastage tends to be slightly higher for long distance deliveries. This may be due to high exposure to vibration and sun and perhaps rain. In addition, as packed net bags are stacked on top of each other, weight transfer from top to bottom for a long-time period results in higher wastage.

Beans Average Waste per kg Based on Origin

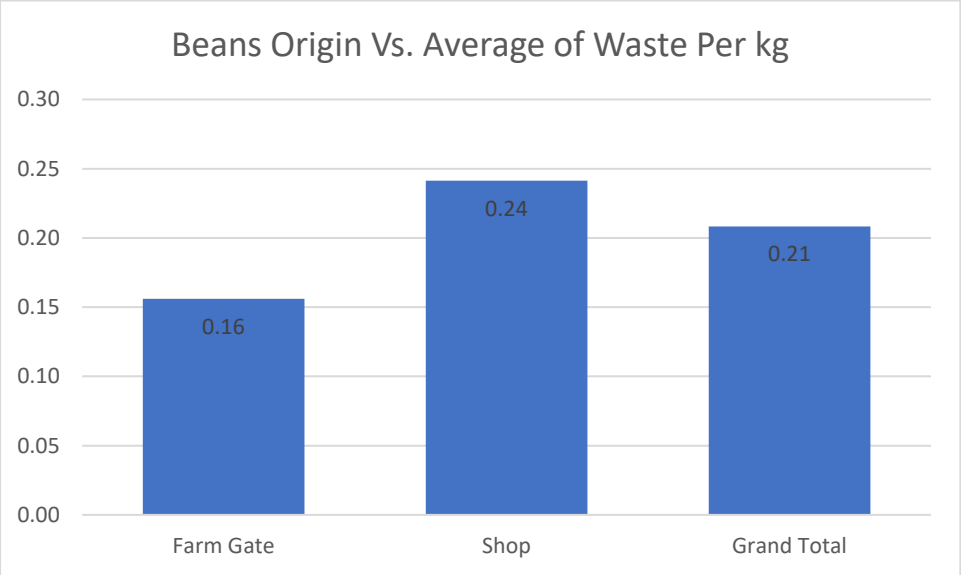

Figure 17: Beans Average Waste per kg Based on Origin

According to Figure 18, the wastage of bean per kg is indifferent between the origins, that average wastage is about 210g per kg of beans.

Beans Average Waste per kg Based on Packing Type

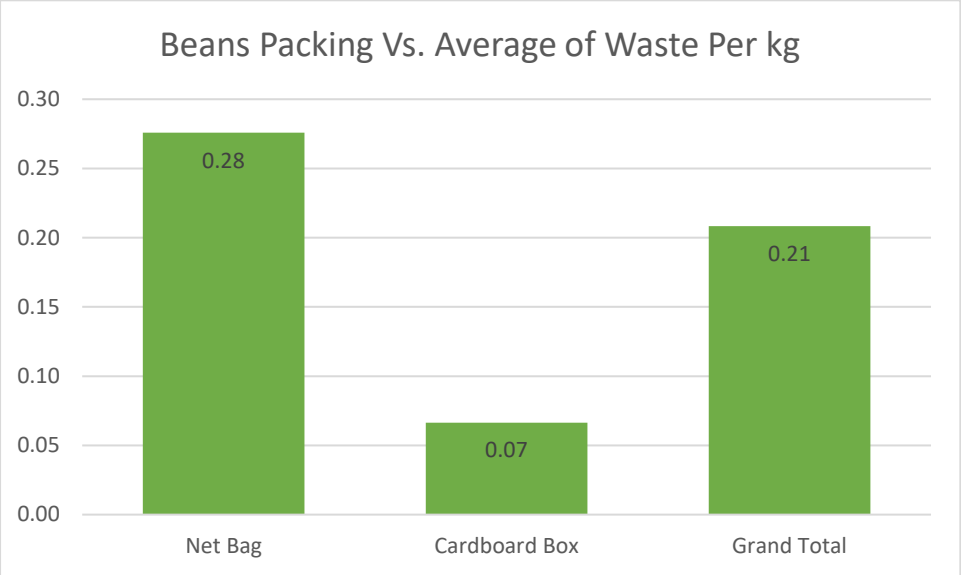

Figure 18: Beans Average Waste per kg Based on Packing Type

Figure 19 clearly shows that wastage of bean packed and transported in net bags are relatively higher than using card board boxes. Net bags results in about average of 210g of loss per kg over cardboard boxes.

Beans Average Waste per kg Based on Lorry Type of Delivery

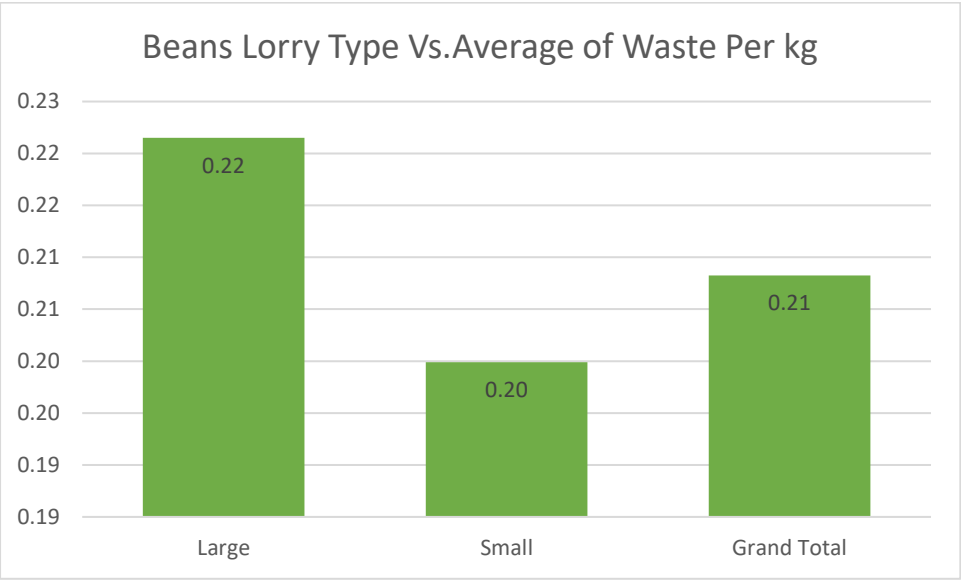

Figure 19: Beans Average Waste per kg Based on Lorry Type of Delivery

Beans are mainly transported using Lorries. The samples collected include two lorry types – large and small. The results show that the average wastage per kg of bean is indifferent between the Lorry types, which range about 200g-220g of wastage per one kg of bean.

Descriptive Analysis of Kangkong

Sample Size of the Distance of Kangkong Delivery

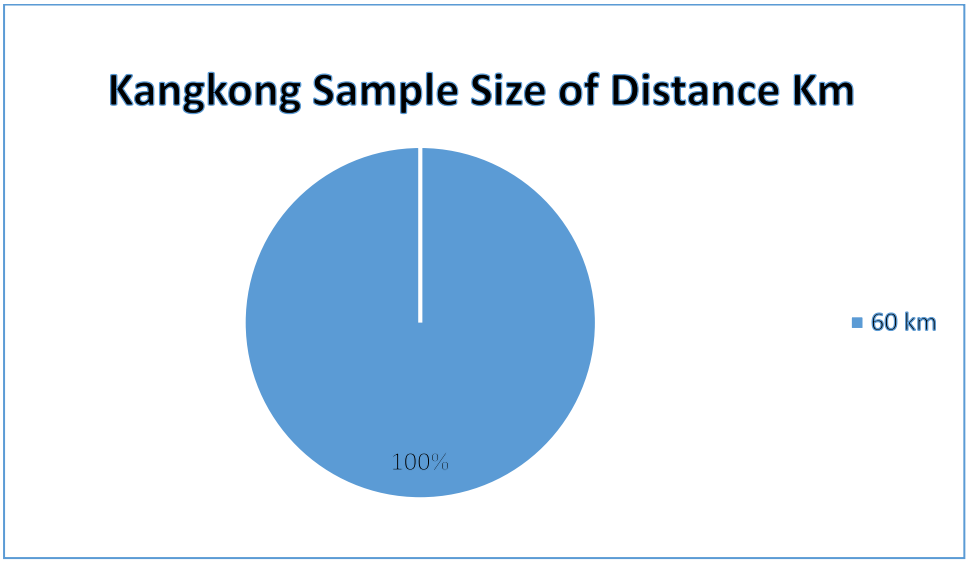

Figure 20: Sample Size of the Distance of Kangkong Delivery

Kangkong Average Waste per kg Based on Distance of Delivery

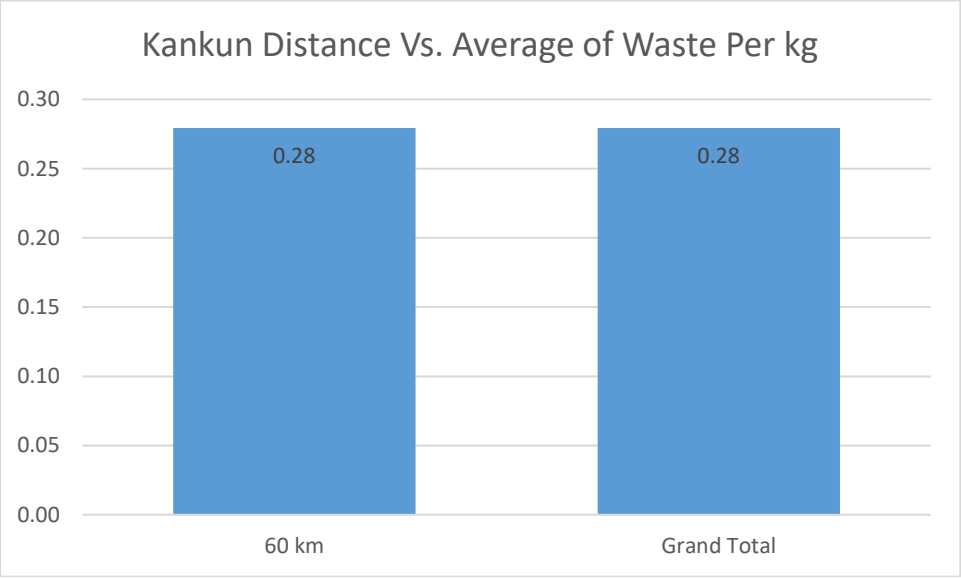

Figure 21 : Kangkong Average Waste per kg Based on Distance of Delivery

In Sri Lanka most of leafy vegetables come from close areas from Colombo city such as Chilaw, Wattala, Piliyandala. These places are less than 100 Km. this sample taken from some places in Puttlam and Chilaw. Therefore Distance is not a comparable factor for Leafy vegetables.

Kangkong Sample Size of the Origin

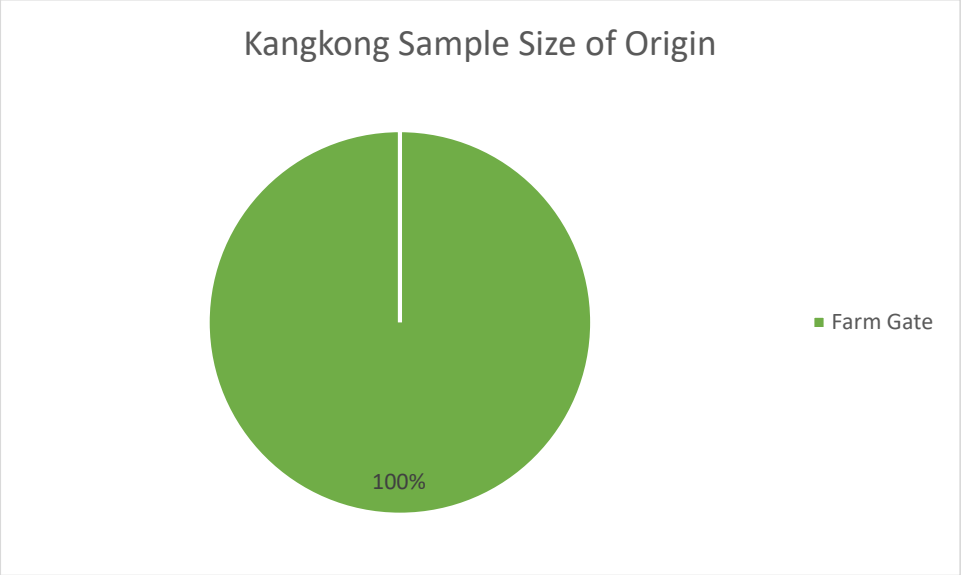

Figure 22: **Kangkong Sample Size of the Origin**

Kangkong Average Waste per kg Based on Origin of Source

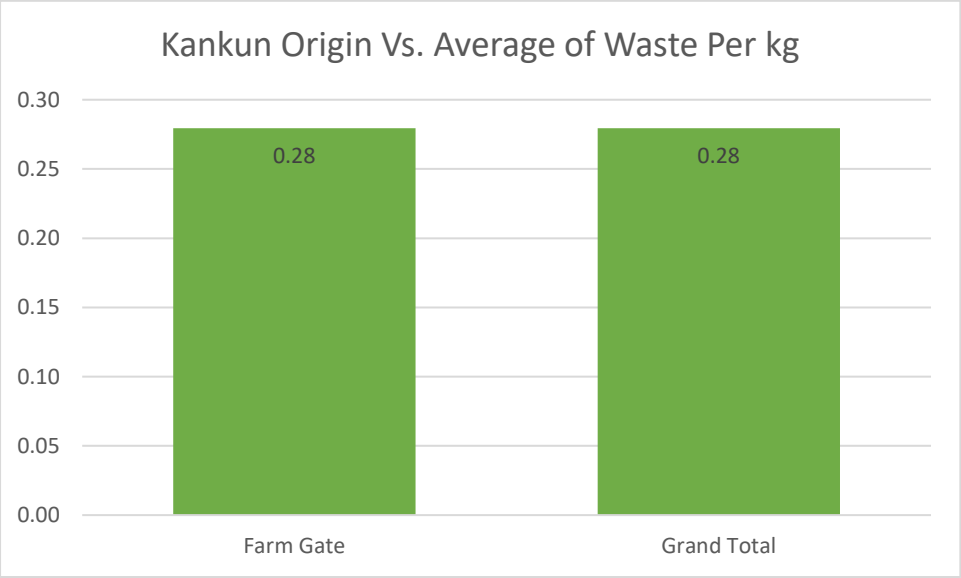

Figure 23 : Kangkong Average Waste per kg Based on Origin of Source

Practical situation is mostly Kangkong growers taken their harvest to the city market.

Packing Type of Kangkong

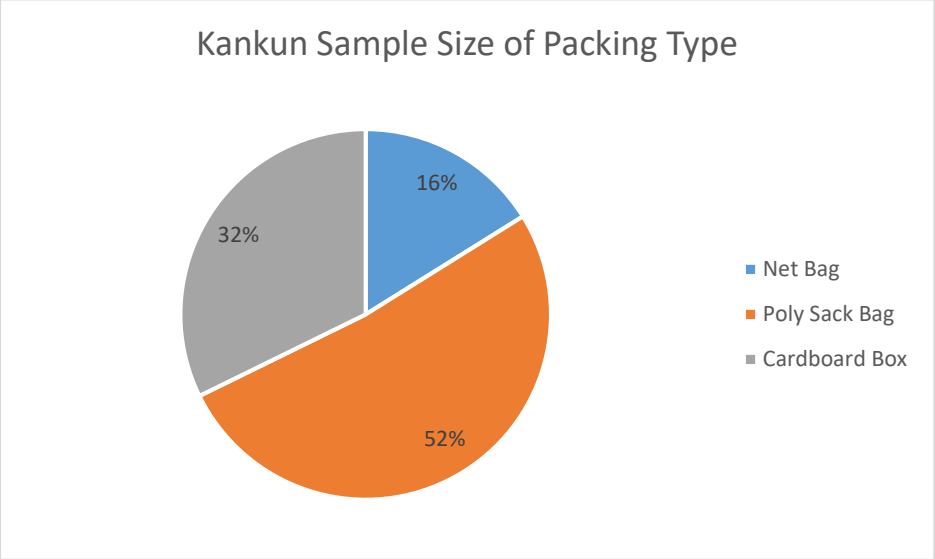

Figure 24: Sample Size of the Packing Type of Kangkong

Important thing is net bag and poly sack bag can carry more than 30kg of weight of the goods that carry a load pressure to the bag stacked underneath it. Net bags have better ventilation than full covered poly sack bag. Cardboard box weight does not transfer to next cardboard box and to the packed vegetables.

Sample Size of Lorry Type of Kangkong Delivery

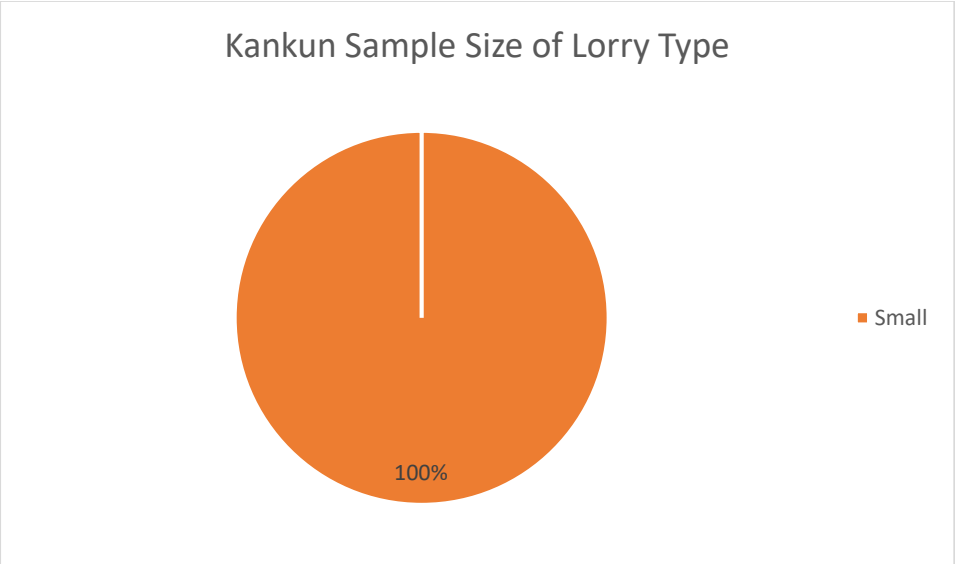

Figure 25: Sample Size of Lorry Type of Kangkong Delivery

Practical experience is most of the growers carried their Kangkong harvest by their private small Lorries.

Kangkong Average Waste per kg Based on Lorry Type of Delivery

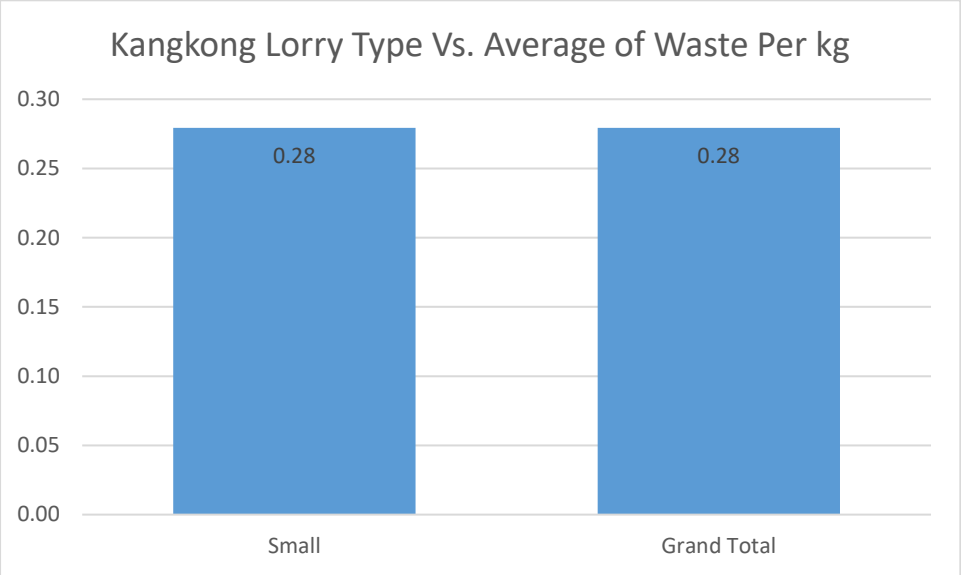

Figure 26: Kangkong Average Waste per kg Based on Lorry Type of Delivery

Kangkong Waste per kg Fluctuation

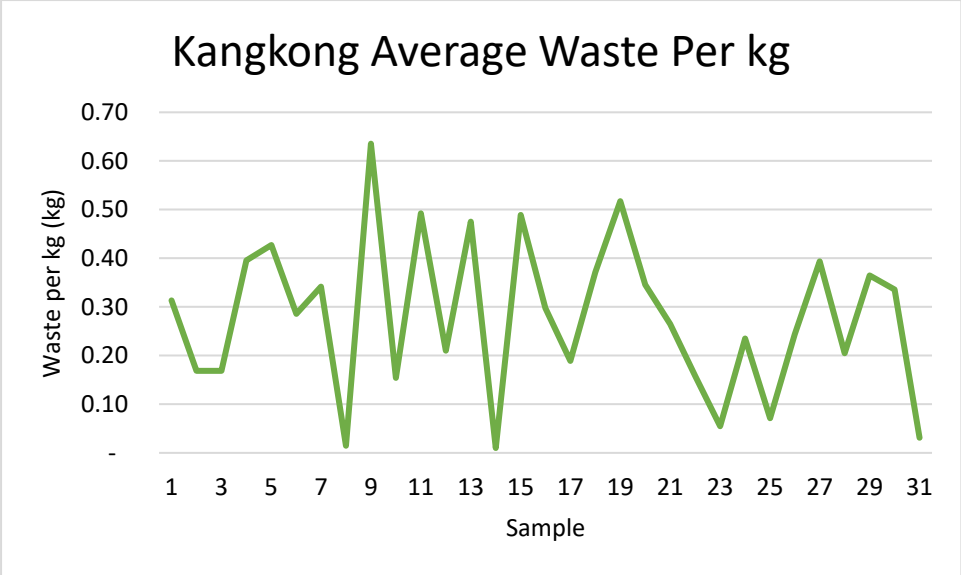

Figure 27 : Kangkong Waste per kg over 31 days

Kangkong Average Waste per kg Based on Packing Type

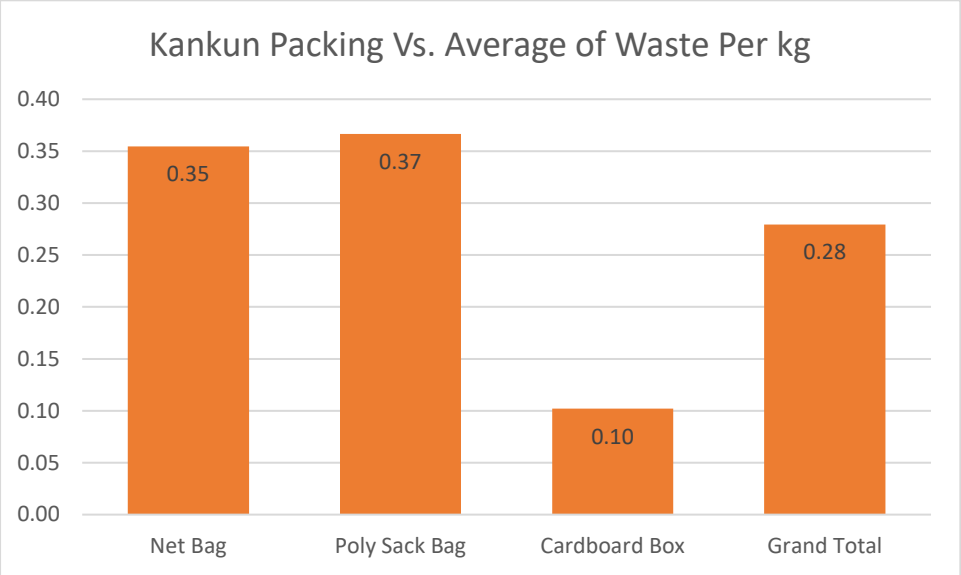

Figure 28: Kangkong Average Waste per kg Based on Packing Type

Figure 29 clearly shows that wastage of Kangkong packed and transported in net bags are relatively higher than using card board boxes. Net bags results in about average of 280g of loss per kg over cardboard boxes.

Descriptive Analysis of Cabbage

Sample Size of the Distance of Cabbage Delivery

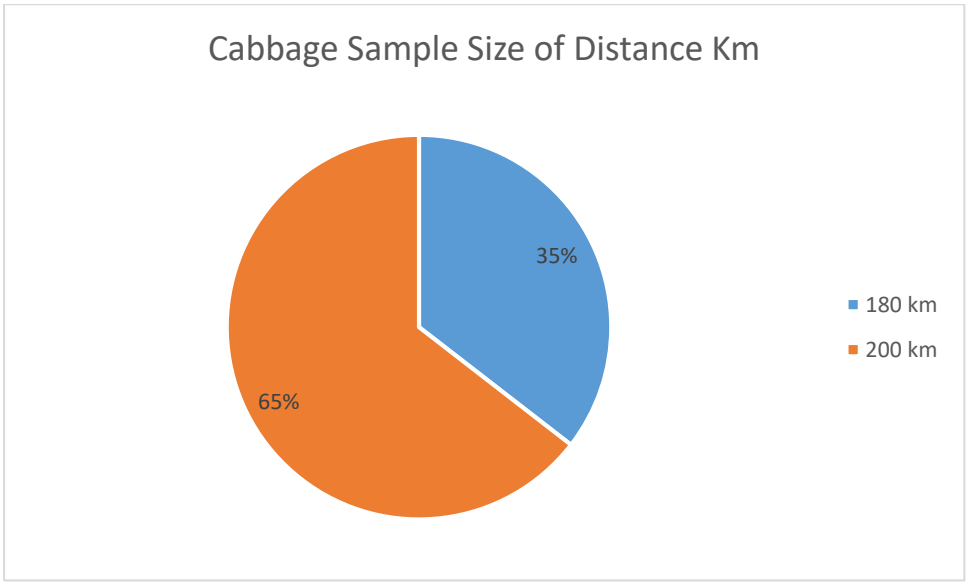

Figure 29: Sample Size of the Distance of Cabbage Delivery

Origin point of Cabbage

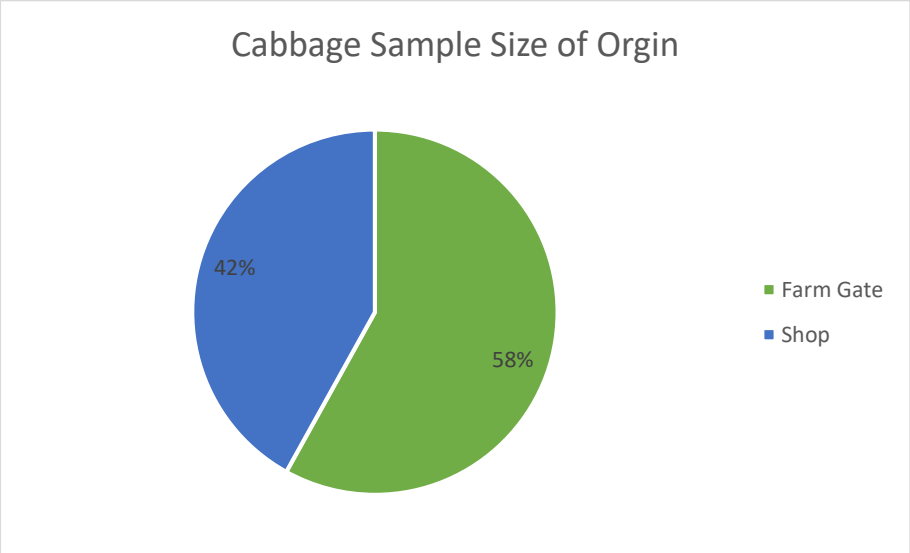

Figure 301: The Origin point of Cabbage

From the Sample 58% comes directly from farm gate. Other 42% come from intermediate vender's, that 42% faces to additional loading/unloading, transportation operations as the process with intermediary vegetable transportation and distribution has more handling within SC process.

Packing Type of Cabbage

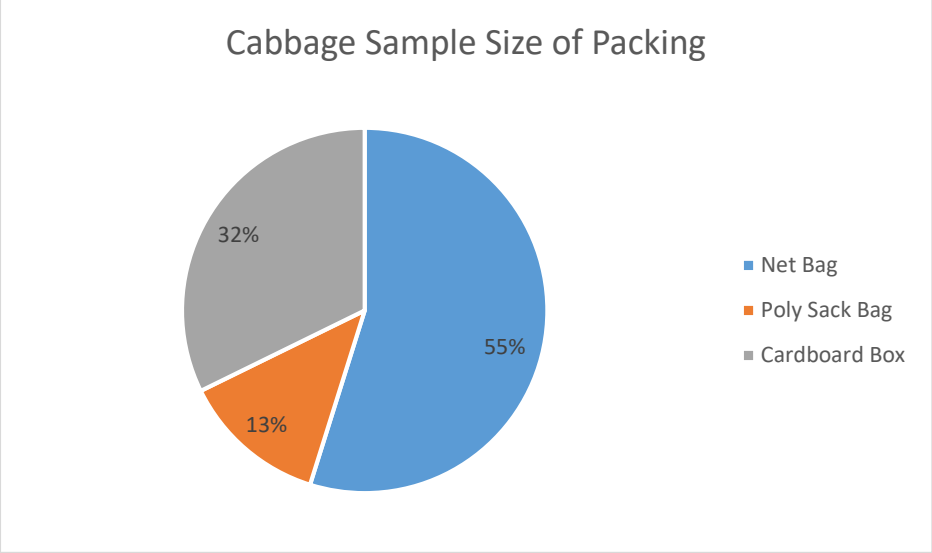

Figure 31: Sample Size of the Packing Type of Cabbage

Important thing is net bag and poly sack bag can carry more than 50kg of weight of the goods that carry a load pressure to the bag stacked underneath it. Net bags have better ventilation than full covered poly sack bag. Cardboard box weight does not transfer to next cardboard box and to the packed vegetables.

Lorry Type of Cabbage Delivery

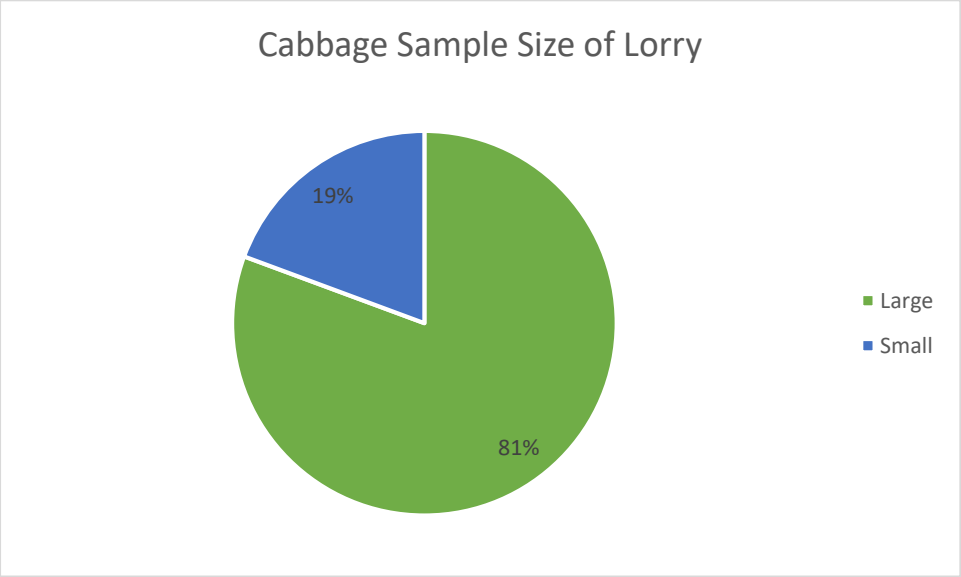

Figure 32: Lorry Type of Cabbage Delivery

Large lorry of carrot delivery come very packed environment in transportation and more loads are packed inside the vehicle. Temperature and some exotics air can be circulating inside the storage area. 81% of the cabbage in the sample are transported using large Lorries, while the rest is transported using small Lorries.

Cabbage Waste per kg Fluctuation

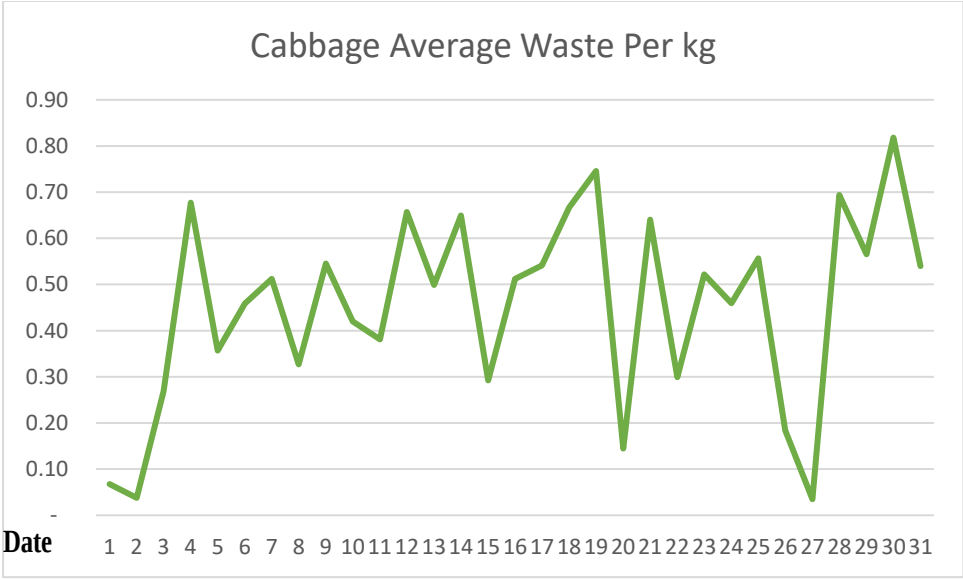

Figure 33: Cabbage Waste per kg over 31 days

Cabbage Average Waste per kg Based on Distance of Delivery

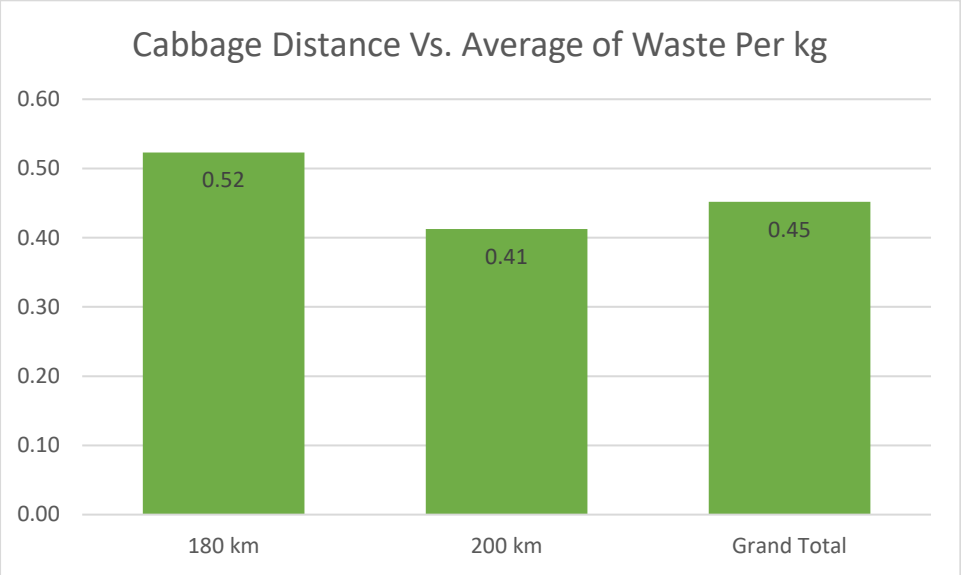

Figure 34: Cabbage Average Waste per kg Based on Distance of Delivery

The wastage tends to be slightly higher for long distance deliveries. This may be due to high exposure to vibration and sun and perhaps rain. In addition, as packed net bags are stacked on top of each other, weight transfer from top to bottom for a long-time period results in higher wastage.

Cabbage Average Waste per kg Based on Origin of Source

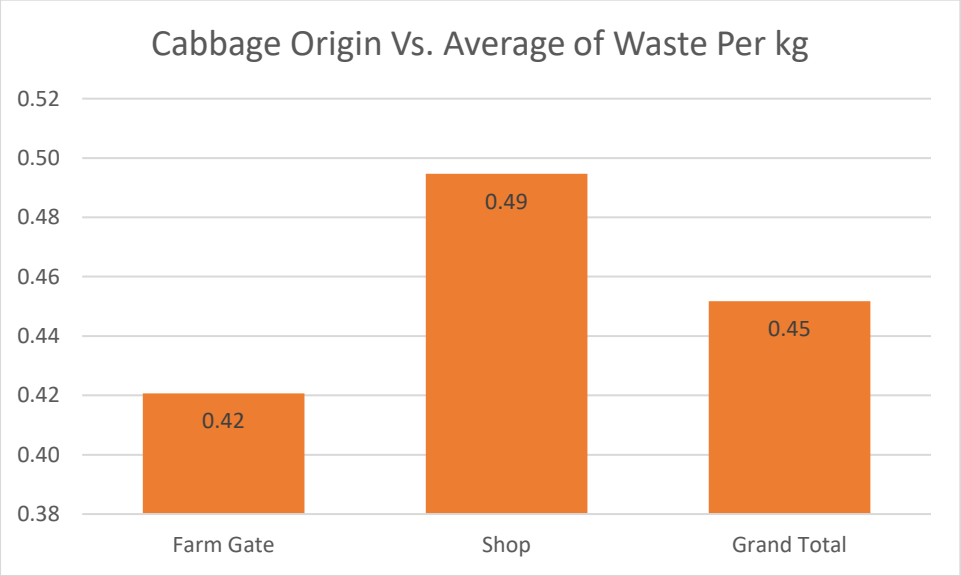

Figure 35: Cabbage Average Waste per kg Based on Origin

According to Figure 36, the wastage of cabbage per kg is in different between the origins, that average wastage is about 450g per kg of cabbage.

Cabbage Average Waste per kg Based on Packing Type

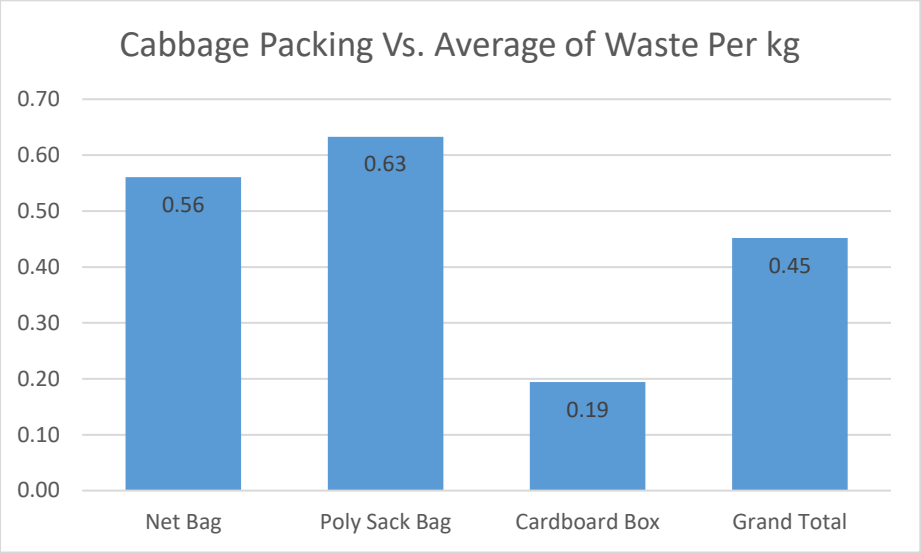

Figure 36: Cabbage Average Waste per kg Based on Packing Type

Figure 37 clearly shows that wastage of cabbage packed and transported in net bags and poly sack bags are relatively higher than using card board boxes. Net bags results in about average of 560g of loss per kg over cardboard boxes. Cardboard boxes loss is relatively lower than other packing methods. It is 190g per Kg.

Cabbage Average Waste per kg Based on Lorry Type of Delivery

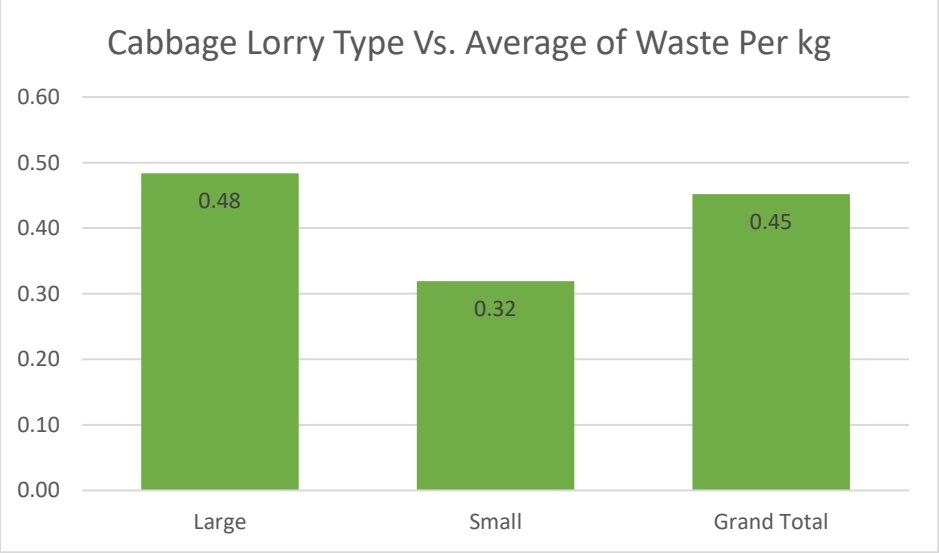

Figure 37: Cabbage Average Waste per kg Based on Lorry Type of Delivery

Cabbages are mainly transported using Lorries. The samples collected include two lorry types – large and small. The results show that the average wastage per kg of cabbage is different

between the lorry types. Its wastage ranges about 320g-480g of wastage per one kg of cabbage.

Comparison of Average Wastage between Packing Materials

Table 4: Comparison of Average Wastage between Packing Materials

	Average of Waste Per kg (kg)			
Vegetable	Net Bag	Poly Sack Bag	Cardboard Box	Grand Total
Beans	0.28		0.07	0.21
Cabbage	0.56	0.63	0.20	0.45
Carrot	0.31		0.11	0.25
Kangkong	0.35	0.37	0.10	0.28
Grand Total	0.37	0.42	0.12	0.30

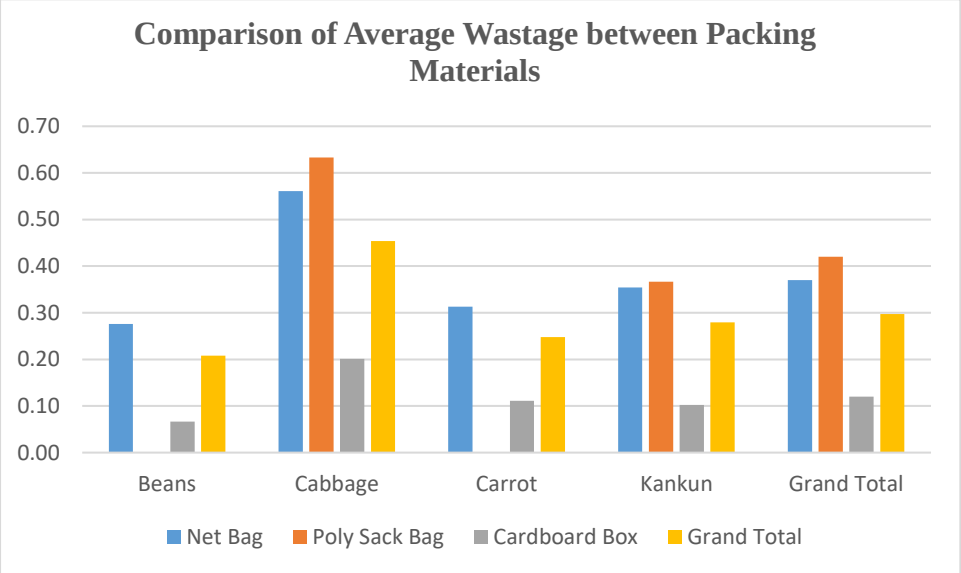

Figure 38: Comparison of Average Wastage between Packing Materials

In here we can see more wastage in cabbage. This could happen because of the nature of good. Practically cabbage most like to leafy vegetable. It has natural packing around its own leaves. In final consuming point, compulsory remove four leaves with covered around the cabbage. Also these matured leaves cannot eat. But these weights also include to the final wastage. That's why cabbage wastage is higher in all factors.

Comparison of Average Wastage between Vehicle Types

Table 5: Comparison of Average Wastage between Vehicle Types (average wastage in kg)

Vegetable	Large	Small	Grand Total
Beans	0.22	0.20	0.21
Cabbage	0.48	0.33	0.45
Carrot	0.24	0.26	0.25
Kangkong		0.28	0.28
Grand Total	0.34	0.26	0.30

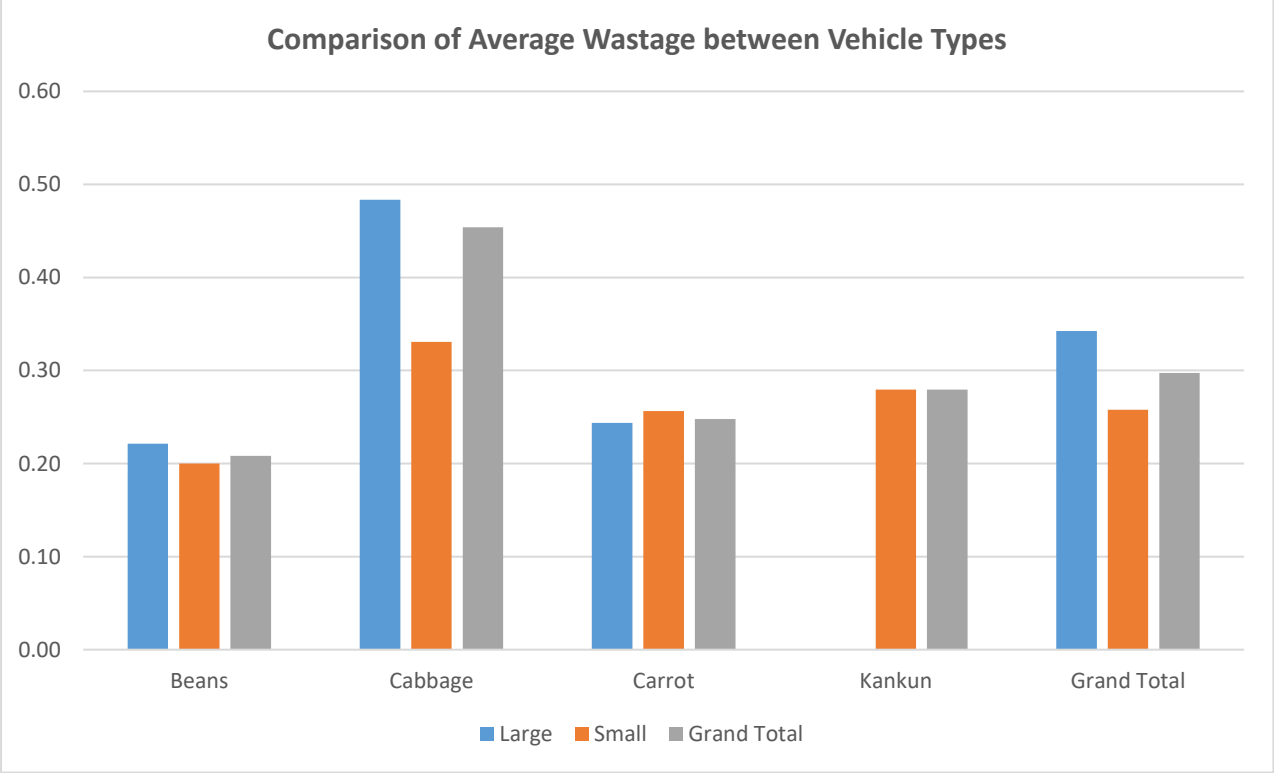

Figure 39 : Comparison of Average Wastage between Vehicle Types

Comparison of Average Wastage between Distances of Delivery

Table 6: Comparison of Average Wastage between Distances of Delivery (average wastage in kg)

Vegetable	60 km	120 km	160 km	180 km	200 km	300 km	Grand Total
Beans		0.25	0.24	0.17	0.20		0.21
Cabbage				0.52	0.42		0.45
Carrot				0.24	0.25	0.26	0.25
Kangkong	0.28						0.28
Grand Total	0.28	0.25	0.24	0.32	0.31	0.26	0.30

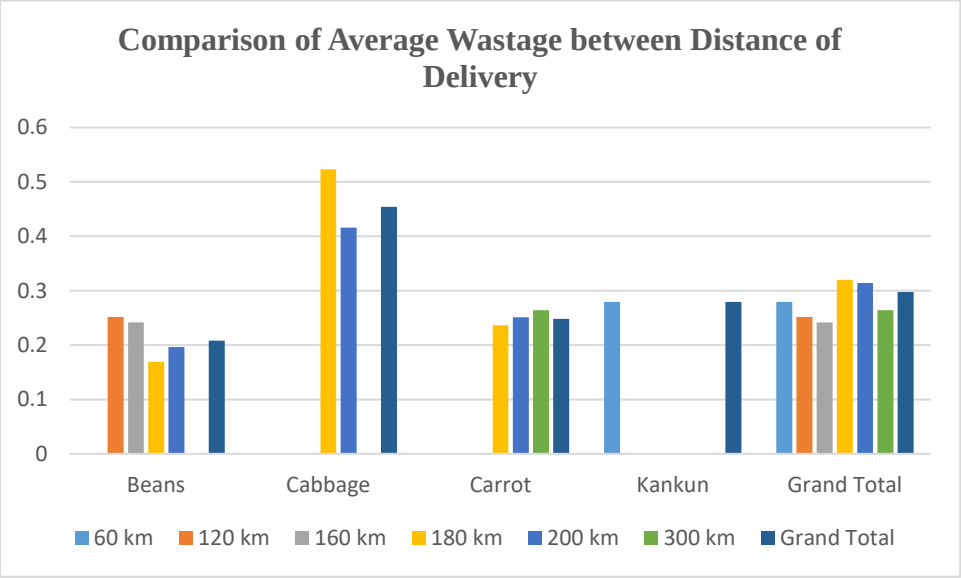

Figure 40: Comparison of Average Wastage between Distances of Delivery

Comparison of Average Wastage between Origins of Source

Table 7: Comparison of Average Wastage between Origins of Source (average wastage in kg)

Vegetable	Farm Gate	Shop	Grand Total
Beans	0.16	0.24	0.21
Cabbage	0.42	0.49	0.45
Carrot	0.25	0.25	0.25
Kangkong	0.28		0.28
Grand Total	0.28	0.32	0.30

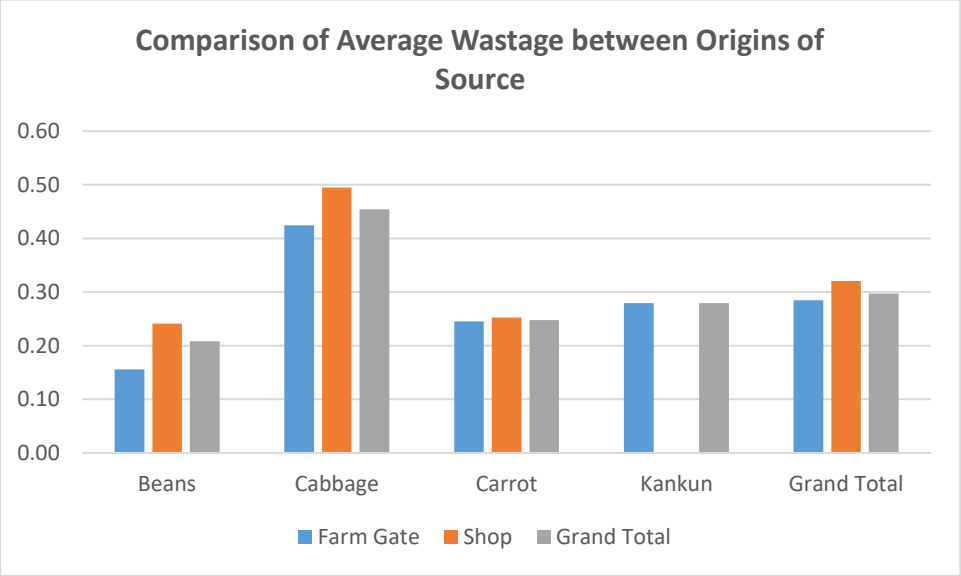

Figure 41: Comparison of Average Wastage between Origins of Source

4.2. Regression Analysis of the Sample

Regression analysis of factors affecting the wastage

Based on the data collected, the following regression equation was derived.

Wastage = 52.88 – 0.019 Distance + 11.25 Origin – 22.60 Packing type1 – 20.44 Lorry type1

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	**52.8744962**	14.87246834	3.555193	**0.000543**
Distance	-0.0192494	0.067532289	-0.28504	0.776109
Origin	11.2568666	8.354859351	1.347344	0.180429
Packing Type	**-22.59491**	8.226704871	-2.74653	**0.006959**
Lorry Type	**-20.43678**	8.658267731	-2.36038	**0.019883**

Regression Statistics	
Multiple R	0.41531918
R Square	0.17249002
Adjusted R Square	0.14467456
Standard Error	41.207801
Observations	124

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	4	42120.7977	10530.2	6.201228	0.000144
Residual	119	202071.8607	1698.083		
Total	123	244192.6584			

The overall model fit is significant (F = 0.000< 5%), all though R square value records about 17% of the modal variation.

Based on the significance level, only packaging type and the lorry type have an impact on the wastage level. When the packing type is (1/2) compared to packing type 0, the average waste would reduce by about 22 kg. Similarly, when the lorry type is 1 compared to other lorry type 0, the average wastage is reduced by about 20kg.Thus; results show that packaging type and the transporting lorry type significantly affecting the level of wastage.

CHAPTER 05

CONCLUSION AND RECOMMENDATIONS

5.1. Summary of Findings

According to the samples 65% of the produce was directly brought from the farm gate to Colombo or city wholesale vender. This portion has by passed the intermediate venders and collectors. Therefore, this part has less handling and less frequency of loading and unloading compare to intermediate shop venders. Average waste for kg is higher in vegetables which come through shops. These shops represent collectors and other intermediate venders presently exist in vegetable growing areas such as Nuwaraeliya, Bandarawela, Welimada, Dabulla, and Ebilipitiya. Generally, these shop venders purchase on cash. But Colombo wholesale vendors pay after they sell the goods on commission based. Because of that advantage some farmers send their crops to intermediate collectors. These collectors also send goods to main city wholesale venders on commission based or fixed price based.

Leafy vegetable like Kankun, Gotukola, Mukunuwenna production comes from farm gate. These vegetables grow in river banks which are very close to Colombo main city. Generally, growers carry these productions in small vehicles. As a result, wastages are low.

In the samples collected on carrot and cabbage, a higher percentage reaches the market through large Lorries. A higher portion of Beans arrive by small Lorries. Due to the heat and less air when loaded into the larger Lorries, conditions of vegetables are deteriorated. The results of cabbage and beans show a higher wastage during transportation in large Lorries, however carrots show a low wastage while transporting in large Lorries. It’s observed due to the carrots being a vegetable with hard roots in comparison to the soft vegetables such as beans and cabbages. Nature of the vegetables is also impacting in this situation for the wastage.

In the samples of Carrot, more portion come from long distance and their wastage is high. In sample of Beans, more portion come from long distance and their wastage is low. That means distance did not have a significant effect to the wastage.

A higher portion of all vegetable in the samples used net bags and poly sack bags. In poly sack bag ventilation to the ingredients is not sufficient and loading method and stacking method of both bag types is stacking on top of each other is not effective to vegetables.

Notable low wastage exited in the cardboard box packing and transportation. The result of the study shows that;

- Clearly low wastage exits in vegetables come directly from farm gate.
- Wastage depends on the nature of vegetables and lorry type. A more wastage is there in soft vegetable in big Lorries.
- Distance is not significant factor to the wastage.
- Cardboard boxes have a very low wastage compared to other packing types.

5.2. Conclusion of the Research

Logistics and supply chain a management practices which help to reduce costs and minimize the wastage and deliver high quality service to customers. This function is still underutilized in the vegetables supply chain industry. Even in vegetables supply chain private companies acting in isolated as individuals. Government or any other organized institutions do not involve in the Sri Lankan vegetable supply chain as a whole. Recently we have seen government's interference with vegetable supply chain networks in developing economic centers such as Meegoda, Narahenpita, Welisara, Nuwaraeliya, Dabulla, Weyangoda, Thabuthegama, Kilinothchi, Kalpitiya, Ebilipitiya etc. Thathelps to improve distribution network but it is not directly helping to improve vegetable supply chain in Sri Lanka.

The research has identified that efforts on eliminating waste in vegetables supply chain operations are valid and important ways to reduce costs through adopting logistics and supply chain practices, one area that vegetables supply chain managers overlook in their operating budgets. It is important that in today's competitive environment, vegetables supply chain companies need to make commitments to learn how these practices provide superior customer service and return on investment. Also governments or other organizations such as Universities, involvement is recommended.

The literature review also revealed a low level of understanding by the vegetables supply chain industry of how logistics and supply chain practices can be applied in the service industry. The use of logistics and supply chain management practices in the vegetables supply chain industry will teach managers the best mixture of practices to implement in the complex logistic and supply chain network. A lot of solutions need to be considered to guarantee that vegetables supply chains benefits from these practices to help catch up with the fast-growing competitive market. Factors like technology, skill sets, and capital

investment play a big role in the success of logistics and supply chain practices in the vegetables supply chain industry. Sri Lankan vegetable supply chain does not last for more than 24hrs. After collecting the harvest in the evening at farm gate, next day early morning it is arrived to the main city and before evening its goes for the cooking. Storage is not a valuable part in this chain.

Finally, this section focused on what the future holds for the vegetables supply chains and managers that adopt these practices in their operations and how logistics and supply chain management practices with a great degree of operational and costs efficiency will contribute to sustaining a competitive advantage.

There are many factors effect to the wastage in vegetable supply chain. According to the Regression method R value=.17. This research assumption factors only affect 17% for the wastage occur in supply chain according to the data collected.

Based on the significance level, only packaging type and the lorry type have an impact on the wastage level. When the packing type is (1/2) compared to packing type 0, the average waste would reduce by about 22 kg. Similarly, when the lorry type is 1 compared to other lorry type 0, the average wastage is reduced by about 20kg.

Thus, results show that packaging type and the transporting lorry type significantly affecting the level of wastage

5.3. Recommendations of the Research

The researcher has done an experiment of the use of cardboard boxes. It is recommended to use cardboard boxes very often for vegetable transportation as a package type.

Government had introduced plastic boxes for vegetable packing in transportation. And make compulsory regulations for plastic boxes. Plastic box is good packing type to reduce wastage in vegetable industry. But due to many practical issues it failed in vegetable supply chain process. They are high cost of the boxes, complexity in returning the box back to the original owner, difficulties in handling and many other reasons. Cardboard box can avoid these issues and it is more advantageous to reduce wastage in the vegetable supply chain.

Direct from farm gate to the Colombo vendor is another advantage to reduce the wastage. Vegetables arrive from intermediate vendors increase the wastage. More handling is impacting wastage in this chain. That is the main reason for more wastage. Therefore**,** introduce advance handling methods and equipment are the recommendations. And also, effectively use this equipment, structural changes and developments must do in inside the

shop, stores areas such as loading and unloading bays which can directly load and unload cargo inside the vehicles.

5.4. Future Research Directions

According to the research, identified more factors can affect the vegetable wastage in supply chain in Sri Lanka. To recognized these factors more data collection through a long period. If the can be collected over a one full year of climate changes, such as rainy and dry period, data will provide a higher reliability. Every researcher must consider the duration of the vegetable supply chain. It is not more than 24hrs thus the storage is not a very important part of the chain. However, storage will be a vital factor for seasonal items and during bad weather conditions.

The following areas can be considered for future researches.

- Handling frequencies in several supply chains, and how it impacts to the wastage?
- How is the temperature impacting wastage in vegetable supply chain?
- How is the climate effect impact wastage in vegetable supply chain?

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APPENDIXES

Appendix 1.1. Data Set of the Research

Vegetable	Date	Distance	Origin	Packing Type	Lorry Type	Original Weight	Consumable Weight	Wastage	Waste Per kg
Carrot	1	180	0	0	0	103	83.265	19.735	0.19
Carrot	2	180	0	2	0	143	119.895	23.105	0.16
Carrot	3	180	0	0	0	50	26.915	23.085	0.46
Carrot	4	180	0	0	0	183	116.216	66.784	0.36
Carrot	5	180	0	0	0	92	42.145	49.855	0.54
Carrot	6	200	0	0	0	101	74.215	26.785	0.27
Carrot	7	200	0	2	0	132	120.320	11.680	0.09
Carrot	8	200	0	0	0	124	90.635	33.365	0.27
Carrot	9	180	1	0	0	135	106.630	28.370	0.21
Carrot	10	180	0	2	0	55	51.005	3.995	0.07
Carrot	11	200	1	0	1	153	115.335	37.665	0.25
Carrot	12	300	1	0	1	115	86.350	28.650	0.25
Carrot	13	300	1	0	1	57	28.595	28.405	0.50
Carrot	14	300	0	2	0	85	71.760	13.240	0.16
Carrot	15	300	0	0	0	143	107.600	35.400	0.25
Carrot	16	200	0	2	0	85	72.000	13.000	0.15
Carrot	17	200	0	0	0	109	67.500	41.500	0.38
Carrot	18	200	0	0	0	181	101.560	79.440	0.44
Carrot	19	300	0	0	0	64	49.425	14.575	0.23
Carrot	20	300	1	0	1	161	87.000	74.000	0.46
Carrot	21	200	1	0	1	100	83.540	16.460	0.16
Carrot	22	180	1	2	1	165	143.000	22.000	0.13
Carrot	23	180	0	2	0	150	142.000	8.000	0.05
Carrot	24	180	1	2	1	80	71.148	8.852	0.11
Carrot	25	300	1	2	1	125	111.000	14.000	0.11
Carrot	26	300	0	0	0	100	79.135	20.865	0.21
Carrot	27	180	0	0	0	138	90.835	47.165	0.34
Carrot	28	180	1	0	1	130	81.845	48.155	0.37
Carrot	29	180	1	0	1	150	116.715	33.285	0.22
Carrot	30	180	0	2	0	130	121.000	9.000	0.07
Carrot	31	300	0	0	0	75	58.870	16.130	0.22

Beans	1	180	1	0	0	78.000	68.165	9.835	0.13
Beans	2	200	1	0	0	127.000	88.015	38.985	0.31
Beans	3	200	1	0	0	94.000	84.225	9.775	0.10
Beans	4	160	1	0	0	278.000	238.960	39.040	0.14
Beans	5	160	1	0	0	138.000	121.500	16.500	0.12
Beans	6	160	1	2	0	165.000	155.850	9.150	0.06
Beans	7	180	0	0	1	69.000	33.490	35.510	0.51
Beans	8	200	0	0	1	80.000	69.645	10.355	0.13
Beans	9	200	0	2	1	446.000	400.705	45.295	0.10
Beans	10	180	0	0	1	86.000	70.265	15.735	0.18
Beans	11	180	0	2	1	171.000	155.135	15.865	0.09
Beans	12	200	1	0	0	69.000	32.045	36.955	0.54
Beans	13	200	1	0	0	118.000	94.005	23.995	0.20
Beans	14	160	1	0	1	60.000	32.205	27.795	0.46
Beans	15	120	1	0	1	166.000	71.455	94.545	0.57
Beans	16	120	1	2	1	143.000	132.000	11.000	0.08
Beans	17	180	1	2	1	100.000	91.690	8.310	0.08
Beans	18	120	1	0	1	168.000	143.000	25.000	0.15
Beans	19	200	1	0	1	61.000	33.370	27.630	0.45
Beans	20	200	0	2	1	54.000	52.070	1.930	0.04
Beans	21	200	0	0	1	167.000	129.425	37.575	0.23
Beans	22	200	0	2	1	91.000	89.755	1.245	0.01
Beans	23	180	1	2	1	153.000	142.000	11.000	0.07
Beans	24	180	0	0	0	58.000	51.453	6.547	0.11
Beans	25	200	0	0	1	126.000	105.985	20.015	0.16
Beans	26	120	1	0	1	126.000	82.820	43.180	0.34
Beans	27	120	1	2	1	145.000	130.470	14.530	0.10
Beans	28	120	0	0	0	86.000	62.780	23.220	0.27
Beans	29	160	1	0	0	120.000	68.320	51.680	0.43
Beans	30	200	1	0	0	266.000	198.630	67.370	0.25
Beans	31	200	0	2	1	82.000	79.235	2.765	0.03
Kangkong	1	60	0	0	1	19.000	13.050	5.950	0.31
Kangkong	2	60	0	2	1	48.000	39.900	8.100	0.17
Kangkong	3	60	0	2	1	65.000	54.060	10.940	0.17
Kangkong	4	60	0	1	1	43.000	25.990	17.010	0.40
Kangkong	5	60	0	1	1	28.000	16.030	11.970	0.43
Kangkong	6	60	0	1	1	57.000	40.700	16.300	0.29
Kangkong	7	60	0	1	1	27.000	17.780	9.220	0.34
Kangkong	8	60	0	2	1	29.000	28.580	0.420	0.01
Kangkong	9	60	0	1	1	38.000	13.850	24.150	0.64
Kangkong	10	60	0	2	1	110.000	93.035	16.965	0.15

Kangkong	11	60	0	1	1	68.000	34.500	33.500	0.49
Kangkong	12	60	0	1	1	32.000	25.280	6.720	0.21
Kangkong	13	60	0	1	1	24.000	12.600	11.400	0.48
Kangkong	14	60	0	2	1	32.000	31.680	0.320	0.01
Kangkong	15	60	0	1	1	26.000	13.280	12.720	0.49
Kangkong	16	60	0	1	1	42.000	29.500	12.500	0.30
Kangkong	17	60	0	2	1	65.000	52.705	12.295	0.19
Kangkong	18	60	0	0	1	55.000	34.580	20.420	0.37
Kangkong	19	60	0	0	1	34.000	16.400	17.600	0.52
Kangkong	20	60	0	1	1	43.000	28.150	14.850	0.35
Kangkong	21	60	0	1	1	24.000	17.650	6.350	0.26
Kangkong	22	60	0	2	1	21.000	17.680	3.320	0.16
Kangkong	23	60	0	2	1	50.000	47.250	2.750	0.06
Kangkong	24	60	0	0	1	76.000	58.135	17.865	0.24
Kangkong	25	60	0	2	1	51.000	47.380	3.620	0.07
Kangkong	26	60	0	1	1	20.000	15.130	4.870	0.24
Kangkong	27	60	0	1	1	20.000	12.130	7.870	0.39
Kangkong	28	60	0	1	1	24.000	19.090	4.910	0.20
Kangkong	29	60	0	1	1	20.000	12.700	7.300	0.37
Kangkong	30	60	0	0	1	52.000	34.550	17.450	0.34
Kangkong	31	60	0	2	1	81.000	78.480	2.520	0.03
Cabbage	1	200	0	2	0	74.000	69.020	4.980	0.07
Cabbage	2	200	0	2	0	125.314	120.555	4.759	0.04
Cabbage	3	200	0	2	0	68.000	49.745	18.255	0.27
Cabbage	4	180	0	1	0	145.000	46.770	98.230	0.68
Cabbage	5	180	0	2	0	42.000	27.015	14.985	0.36
Cabbage	6	180	1	0	0	98.000	53.020	44.980	0.46
Cabbage	7	200	1	0	0	65.000	31.695	33.305	0.51
Cabbage	8	200	1	2	0	121.000	81.400	39.600	0.33
Cabbage	9	200	0	0	0	270.000	122.705	147.295	0.55
Cabbage	10	200	1	0	1	62.000	35.975	26.025	0.42
Cabbage	11	200	0	0	0	106.000	65.645	40.355	0.38
Cabbage	12	200	0	0	0	116.000	39.770	76.230	0.66
Cabbage	13	200	0	0	0	75.000	37.560	37.440	0.50
Cabbage	14	200	1	1	0	103.000	36.130	66.870	0.65
Cabbage	15	180	0	2	1	100.000	70.750	29.250	0.29
Cabbage	16	180	0	0	1	166.000	80.990	85.010	0.51
Cabbage	17	200	0	0	1	55.000	25.235	29.765	0.54
Cabbage	18	180	0	0	0	168.000	55.970	112.030	0.67
Cabbage	19	180	0	1	0	121.000	30.755	90.245	0.75
Cabbage	20	180	0	2	0	53.000	45.355	7.645	0.14

Cabbage	21	180	1	0	0	78.000	28.060	49.940	0.64
Cabbage	22	200	1	2	0	118.000	82.675	35.325	0.30
Cabbage	23	200	0	0	0	162.000	77.470	84.530	0.52
Cabbage	24	200	1	1	0	79.000	42.695	36.305	0.46
Cabbage	25	200	1	0	0	120.000	53.215	66.785	0.56
Cabbage	26	200	1	2	1	56.000	45.685	10.315	0.18
Cabbage	27	200	0	2	1	59.055	57.000	2.055	0.03
Cabbage	28	180	0	0	0	108.000	33.075	74.925	0.69
Cabbage	29	180	1	0	0	175.000	75.970	99.030	0.57
Cabbage	30	200	1	0	0	520.000	94.560	425.440	0.82
Cabbage	31	200	1	0	0	69.000	31.755	37.245	0.54

Appendix 1.2. Residual Output of the Regression Analysis

Observation	*Predicted Y*	*Residuals*	*Standard Residuals*
1	49.4096	-29.6746	-0.73212
2	26.81469	-3.70969	-0.09152
3	49.4096	-26.3246	-0.64947
4	49.4096	17.3744	0.428657
5	49.4096	0.445402	0.010989
6	49.02461	-22.2396	-0.54869
7	26.4297	-14.7497	-0.3639
8	49.02461	-15.6596	-0.38635
9	60.66646	-32.2965	-0.79681
10	26.81469	-22.8197	-0.563
11	39.8447	-2.1797	-0.05378
12	37.91975	-9.26975	-0.2287
13	37.91975	-9.51475	-0.23475
14	24.50476	-11.2648	-0.27792
15	47.09967	-11.6997	-0.28865
16	26.4297	-13.4297	-0.33133
17	49.02461	-7.52461	-0.18565
18	49.02461	30.41539	0.7504
19	47.09967	-32.5247	-0.80244
20	37.91975	36.08025	0.890162
21	39.8447	-23.3847	-0.57694
22	17.63477	4.365226	0.107698
23	26.81469	-18.8147	-0.46419

24	17.63477	-8.78277	-0.21669
25	15.32484	-1.32484	-0.03269
26	47.09967	-26.2347	-0.64725
27	49.4096	-2.2446	-0.05538
28	40.22968	7.925316	0.195531
29	40.22968	-6.94468	-0.17134
30	26.81469	-17.8147	-0.43952
31	47.09967	-30.9697	-0.76408
32	60.66646	-50.8315	-1.2541
33	60.28148	-21.2965	-0.52542
34	60.28148	-50.5065	-1.24608
35	61.05145	-22.0115	-0.54306
36	61.05145	-44.5515	-1.09916
37	38.45654	-29.3065	-0.72304
38	28.97282	6.537182	0.161284
39	28.58783	-18.2328	-0.44984
40	5.992919	39.30208	0.96965
41	28.97282	-13.2378	-0.3266
42	6.377907	9.487093	0.234063
43	60.28148	-23.3265	-0.5755
44	60.28148	-36.2865	-0.89525
45	40.61467	-12.8197	-0.31628
46	41.38465	53.16035	1.311558
47	18.78974	-7.78974	-0.19219
48	17.63477	-9.32477	-0.23006
49	41.38465	-16.3847	-0.40424
50	39.8447	-12.2147	-0.30136
51	5.992919	-4.06292	-0.10024
52	28.58783	8.987171	0.221729
53	5.992919	-4.74792	-0.11714
54	17.63477	-6.63477	-0.16369
55	49.4096	-42.8626	-1.05749
56	28.58783	-8.57283	-0.21151
57	41.38465	1.795349	0.044294
58	18.78974	-4.25974	-0.1051
59	50.56456	-27.3446	-0.67464
60	61.05145	-9.37145	-0.23121
61	60.28148	7.088524	0.174886
62	5.992919	-3.22792	-0.07964

63	31.28275	-25.3328	-0.625
64	8.68784	-0.58784	-0.0145
65	8.68784	2.25216	0.055565
66	8.68784	8.32216	0.205322
67	8.68784	3.28216	0.080977
68	8.68784	7.61216	0.187805
69	8.68784	0.53216	0.013129
70	8.68784	-8.26784	-0.20398
71	8.68784	15.46216	0.381478
72	8.68784	8.27716	0.204212
73	8.68784	24.81216	0.612159
74	8.68784	-1.96784	-0.04855
75	8.68784	2.71216	0.066914
76	8.68784	-8.36784	-0.20645
77	8.68784	4.03216	0.09948
78	8.68784	3.81216	0.094053
79	8.68784	3.60716	0.088995
80	31.28275	-10.8628	-0.268
81	31.28275	-13.6828	-0.33758
82	8.68784	6.16216	0.152031
83	8.68784	-2.33784	-0.05768
84	8.68784	-5.36784	-0.13243
85	8.68784	-5.93784	-0.1465
86	31.28275	-13.4178	-0.33104
87	8.68784	-5.06784	-0.12503
88	8.68784	-3.81784	-0.09419
89	8.68784	-0.81784	-0.02018
90	8.68784	-3.77784	-0.09321
91	8.68784	-1.38784	-0.03424
92	31.28275	-13.8328	-0.34128
93	8.68784	-6.16784	-0.15217
94	26.4297	-21.4497	-0.5292
95	26.4297	-21.6707	-0.53465
96	26.4297	-8.1747	-0.20168
97	26.81469	71.41531	1.761939
98	26.81469	-11.8297	-0.29186
99	60.66646	-15.6865	-0.38701
100	60.28148	-26.9765	-0.66556
101	37.68657	1.913435	0.047208

102	49.02461	98.27039	2.424501
103	39.8447	-13.8197	-0.34096
104	49.02461	-8.66961	-0.21389
105	49.02461	27.20539	0.671204
106	49.02461	-11.5846	-0.28581
107	37.68657	29.18343	0.720006
108	6.377907	22.87209	0.564294
109	28.97282	56.03718	1.382534
110	28.58783	1.177171	0.029043
111	49.4096	62.6204	1.544954
112	26.81469	63.43031	1.564936
113	26.81469	-19.1697	-0.47295
114	60.66646	-10.7265	-0.26464
115	37.68657	-2.36157	-0.05826
116	49.02461	35.50539	0.875979
117	37.68657	-1.38157	-0.03409
118	60.28148	6.503524	0.160453
119	17.24979	-6.93479	-0.17109
120	5.992919	-3.93792	-0.09716
121	49.4096	25.5154	0.629509
122	60.66646	38.36354	0.946495
123	60.28148	365.1585	9.009093
124	60.28148	-23.0365	-0.56835