

An Empirical analysis on the factors influences the wastage of Banana and Cherries: Cross sectional study of supply chain in UAE

Dr. Sameera Iqbal*, Ahmed Abdulsalam Alzarooni, Rashid Saif Alkaabi, Abdulaziz Ahmed Aljefri, Mohamed Saleh Aljabri, Abdullah Sultan Alrumaithi, Yousef Ahmed Alshamsi

Department of Engineering Technology & Science, Logistics Engineering, Higher Colleges of Technology, UAE

Abstract - The research highlights main critical points related to controlling wastage of banana and cherries. Above all there are: the limited shelf-life, packaging, delivery time sensor and costs that can influence the wastage. However, methodological framework suggests that Packaging under the influence of efficient sensors and cost, forces the supply chain to be shaped as both responsive to the market (by reducing the wastage) as well as efficient. The study uses a theory building approach which adopted a qualitative research method. The research strategy includes a preliminary desk research followed by a qualitative research composed by interviews with experts in the field. All interviews were constructed using open-ended questions either executed face to face or through phone calls. The questionnaire was also distributed among different retailer, wholesalers and manufactures.

Keywords: Banana and Cherries, Wastage, Packaging, Delivery time, Shelf Life, Cost, Sensors, Supply chain

INTRODUCTION

Food security throughout the world is a major concern for every living being (Verghese, Lewis, Lockrey & Williams, 2015). More of losses causes a nightmare to dealers who run their businesses with small profit margins (de Gorter, Drabik, Just, Reynolds & Sethi, 2021). Food loss can range from 25 to 50 percent due to improper processing and packaging (or a lack thereof), particularly in impoverished nations. Much of the losses is incurred during transportation and storage of especially perishable goods. The shipment of rotten perishable items to the European Union are abandoned owing to poor quality or rotting (AVETISYAN, 2021). Non-optimized handling throughout supply chain procedures is responsible for a large portion of such losses (Jedermann, Nicometo, Uysal & Lang, 2014). Consumer expectations for year-round availability of fresh fruit and vegetables have been driven by the expansion of infrastructure, facilities, and technology across the supply chain, as well as the deregulation of the global economy (Falagán & Terry, 2018). Customers expect fresh fruits to reach to the destination. In UAE, along with other fruits Bananas remained the most popular fruit and popular among consumers all around the world (Siddique, Shoaib & Jan, 2020). Fruit classified as superfoods, on the other hand, had the fastest growth rates. Especially cherries, which have all seen an increase in demand (Siddique, Shoaib & Jan, 2020; Abro et al., 2020). The major threats to the good state of these fruits are found to be ripening and delicate skin for bananas and cherries respectively due to packaging. Fruits, as we all know, are living organisms that continue to breathe even after harvesting and can only stay fresh for as long as normal metabolites are present (Malik 2017; Mukama, Ambaw & Opara, 2020). Bananas upon ripening produce their own threat i.e. ethylene which is responsible for their uncontrolled ripening. An injury/shock to any of the bananas makes the ripening more

*Corresponding author:

Email: sameeraiqbal786@hotmail.com (S.Iqbal)

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severe. Cherries on the other hand can only last for only a week especially if they are well handle and preserved. As per consumer purchasing behavior, they would not like to buy bitter and astringent taste of banana and cherries for the value of their money. In this article the study focuses on the most important aspects of the factors that influence the wastage of banana and cherries as well as how we can improve them based on the findings collected from the different businesses related to food industry across UAE.

Research Orientation

The goal of this study is to come up with a possible supply chain arrangement for the banana and cherries in UAE. The research is design-oriented since it attempts to systematically evaluate perishable fruits by putting the literature on supply chains to investigate the existing banana and cherries supply chain in UAE empirically.

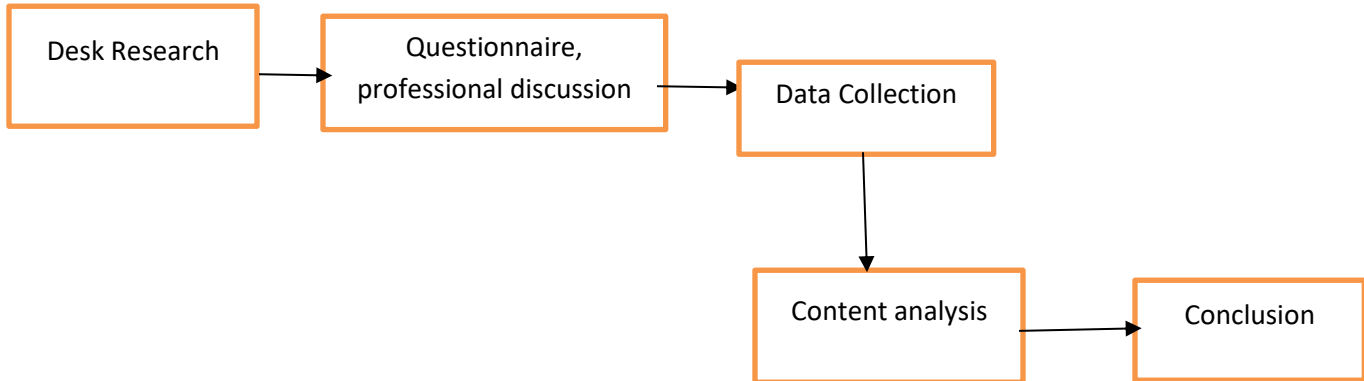


Figure 1: Research Orientation

Research objective

Following objective can be formulated after having analyzed the background and orientation of the research: “To provide recommendations on logistics and Packaging options for the Bananas and cherries supply chain by analyzing existing literature on fresh fruit supply chain behavior, by assessing the current practices on supply chain of banana and cherries and by investigating supply chains in the fresh fruit business”

Research framework

The research framework in Figure 2 shows a schematic overview of the research procedures. It is divided into four phases, each of which will be discussed.

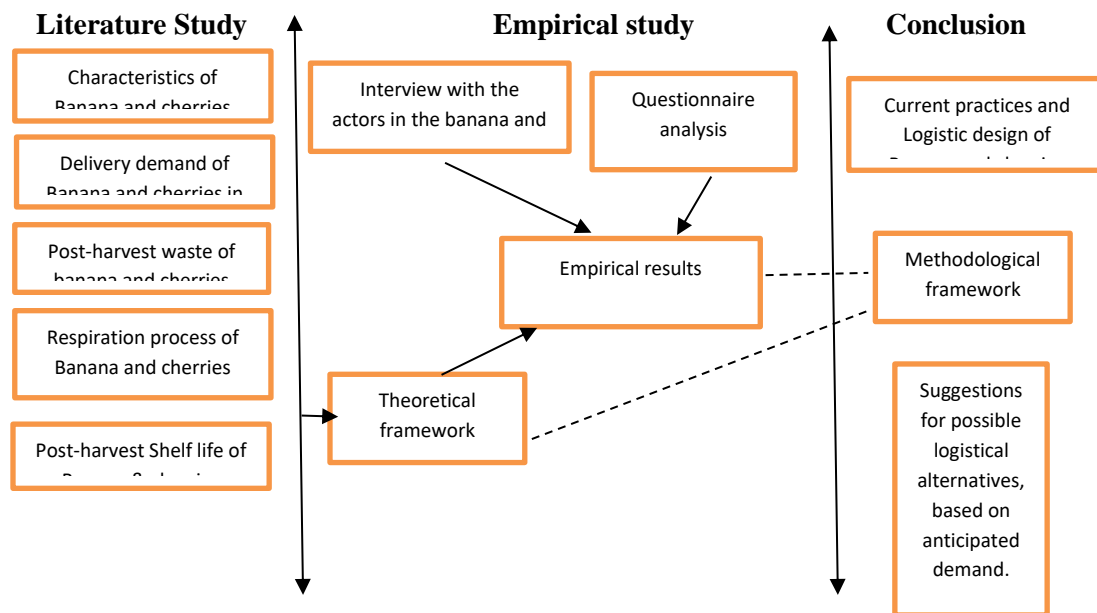


Figure 2: Schematic overview of the research procedures

LITERATURE REVIEW

Characteristics of banana and cherries

Bananas are a climactic fruit, ripening of bananas is caused by enzymatic reaction which when triggered tends to be very fast (Maduwanthi & Marapana, 2019). Ethylene and high concentrations of carbon dioxide cause bananas to ripen very fast. These compounds catalyze the enzymatic reaction. The green life of the bananas is thus reduced causing them to spoil before they can reach the market or any other processing facility. Damaged bananas are more lethal because they produce high amounts ethylene and this causes the ripening of other bananas in the same container to increase exponentially (Maduwanthi & Marapana, 2019; Khattak et al., 2020, October). Cherries on the other hand are non-climactic fruit and has more disadvantaged due to thin skin which tend to be very delicate (Abell, 2021). Poor handling is likely to cause injury to the fruit which leads to rapid spoilage. It is also important to understand the respiration of bananas and cherries to get better knowledge of packaging and handling.

Delivery Demand of banana and cherries in UAE

While the UAE is one of the world's wealthiest and most dynamic countries, with a GDP per capita rating of 13th in 2017 (Abdulaziz Alshareef, 2012). UAE is home to one of the world's most multicultural societies. In 2018, the UAE's overall population was 9.3 million, with yearly growth rates of roughly 1.5 percent predicted to reach 9.9 million by 2022 (Abdulaziz Alshareef, 2012). Overall, apparent consumption of imported frozen fruit and vegetables has slowed in recent years as customers have moved away from frozen goods in favor of fresh produce. Growing health consciousness has resulted in a desire to eat more natural foods, reducing demand for processed fruits and vegetables. The total proportion of consumer spending allocated to food and beverages (14 percent) and its share of the country's GDP (5 percent). Although it remained below the global averages (16 percent and 9 percent), respectively, in 2017. However, it is witnessed that purchases of fresh fruits including banana and cherries have increased especially after pandemic (Pandemic purchasing, 2021).

Post-harvest waste of banana and cherries

Studies revealed that 1.4 million bananas thrown away each year (1.4 million bananas thrown away each day reports Snact). One study reveal that \$65 billion a year in food waste happens which includes cherries and other fresh fruits (Kate Prengaman, 2019). Fruit quality is defined as the extent to which a set of natural traits meets the expectations of customers (2021). Damage to fruits can occur anywhere in the post-harvest supply chain (SC). Such as damage refer to vegetation from using equipment and from weather related events, damage during handling and packaging compression (2021). It was also discovered that damage could be caused due to vibration in transit and stack height of the package and stack position of the pallet (2021).

Respiration Process of bananas and cherries

Respiration of bananas and cherries increases when the ethylene production increases. Ethylene production increase when there is hot temperature (Gane, 1936). Studies revealed that if theses fruits are kept in a controlled environment where there is an increase of carbon dioxide and decrease of oxygen, then we can delay the process of respiration which in result will reduce the ethylene production (Gane, 1936). Intermediaries and production companies suffer a big loss if bananas overripe before they could reach the desired destination (market, wholesale or processing sites/companies). This is because once bananas start ripening the process cannot be stopped and current techniques of slowing it down are very expensive and less effective. Similarly, cherries have a very high spoilage rate and require care when handling. For Both fruits, spoilage cannot be delayed once it starts.

Post-harvest shelf life of banana and cherries

For direct consumption of cherries and bananas there is an extended post-harvest shelf life to facilitate long-distance transportation and ensure that the fruit arrives at markets in good condition (Habib, Bhat, Dar & Wani, 2015). Researchers have estimated the shelf life of cherries 7 – 14 days on cold atmosphere (Habib, Bhat, Dar & Wani, 2015; (Haq, Nawaz, Akram, & Natarajan, 2020). Whereas shelf life of bananas estimated to be 2-7 days at counter and 2-9 days in refrigerator ("How Long Do Bananas Last? Shelf Life, Storage, Expiration", 2021). The shelf life of cherries and bananas are highly influenced by a variety of factors such as harvest timing, correct handling and cooling techniques, and, above all, packaging (Habib, Bhat, Dar & Wani, 2015).

Logistics design of banana and cherries

The proposed solution to this problem would be more applicable to logistic companies who directly transport these produces for the intermediaries to the production, then to wholesalers. It will also be used by wholesalers, marketer, caterers and retailers for storing and ease movements within the store and transport over short distances.

Current practices

The currently available products which can perform similar functions involves the regulation of ethylene production, control of ethylene perception, suppression of polygalacturonate activity. This is done using Delayed Ripening

Technology (Maduwanthi & Marapana, 2019; Ul Haq, Malik, Akram, & Al Mutawa, 2020, December). Fridges are also being used to reduce ripening of bananas and for keeping cherries fresh. Cherries are currently being packaged in transparent plastic containers or small-sized cartons. This type of package does not guarantee safety of the cherries' delicate skin since they are kept under pressure from each other. Since the approach of reefer holders during the 1960s, they have reformed the manner by which transitory products are shipped and have supplanted conventional reefer ships as the dominating method of moving produce in controlled conditions. Reefer holders have just improved from that point forward as, after some time, enhancements in innovation have made reefers more proficient. This is particularly significant considering the way that the seaborne short-lived exchange is relied upon to develop by 5% every year among now and 2020. For organizations that manage short-lived merchandise, reefer holders will probably be a vital part in inventory network (Akram et al., 2020; Rana, Kumar and Prasad, 2021).

THEORETICAL FRAMEWORK

Three primary themes were studied through the literature review: Packaging, delivery time and storage. The researchers hypothesized that there is a link packaging, delivery time and storage on banana and cherries wastage.

The connection between those three ideas allows for the creation of some distribution scenarios that are based on time, cost, and sensor quality.

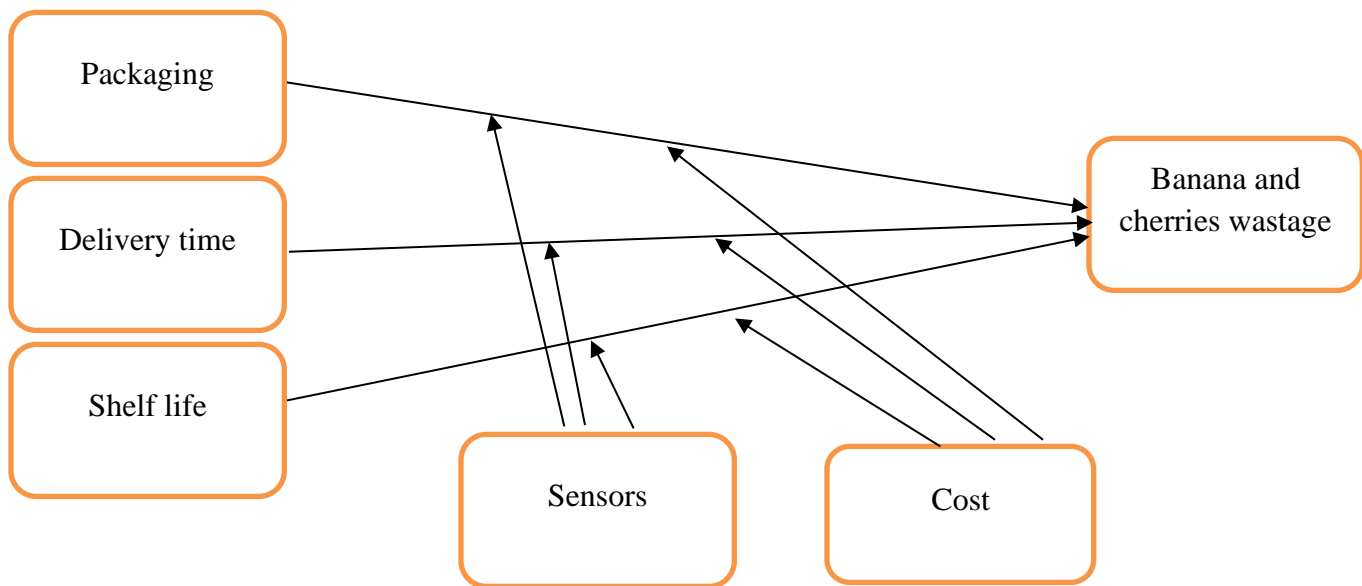


Figure 3: Theoretical Framework

Research Questions

First, the main research question was given. The main research question is then divided into 5 research framework phase. At last, the research questions per phase are divided into sub-questions. Those 5 research areas were banana and cherries wastage, time, storage, sensors and packaging. Likert scale, open ended and closed ended type of questions were designed to have interview and questionnaire from the retailers and wholesalers. The same set of question were asked in the interview as well. There were some categorical questions, also asked to get to know the information about demographic and types of businesses and activities.

PART A

Demographics

The survey study we report on took place in UAE and involved face-to-face, telephonic and online survey encounters with respondents in seven Emirates of UAE. These companies belong to either retail/grocery stores, warehouses or transporting perishable fruits. Because our findings apply equally across all states and companies, we do not make comparisons within the sample considerable amount of input from Dubai that is 57.1 %, followed by Abu Dhabi with 28.6% respondent's data.

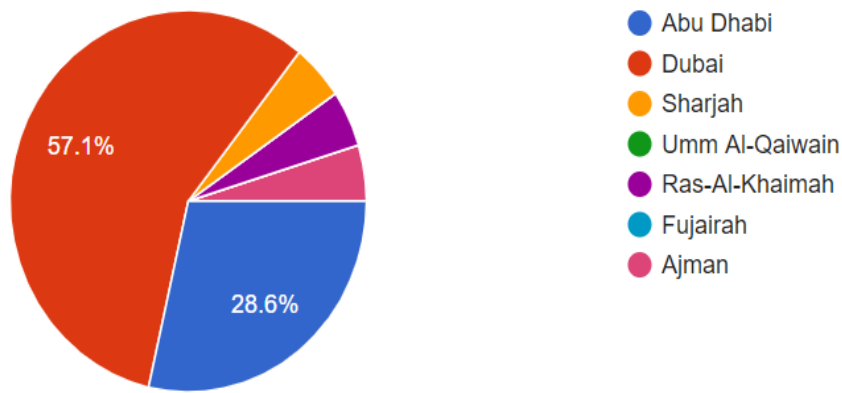


Figure 4: Demographics

Gender

Female contribution is observant in supply chain industry. Female contribution in supply chain is very minor and contains 14.3 percent of the proportion. Whereas, supply chain industry show more male contribution.

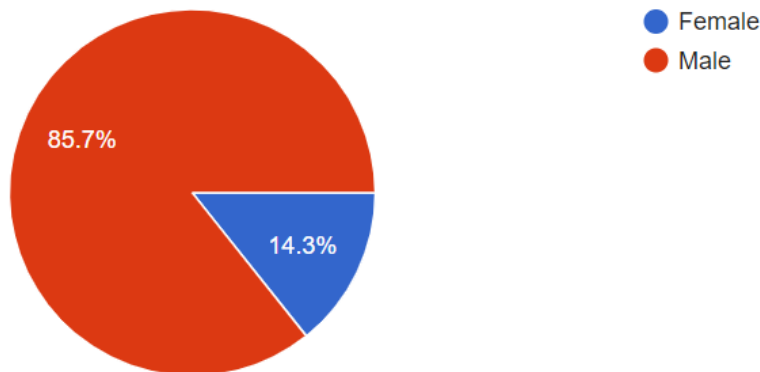


Figure 5: Gender

Time spent working in food industry

The Pie chart represents that 47.6% of respondents are in food industry more than 5 years and 52.4 % are in food industry less than 5 years. That shows that data collected is from experienced people which means data equals knowledge, hence it helps in validating the information and leads to make informed decisions because Knowledge is equal to data. While anecdotal evidence, assumptions, or abstract observation may provide incontrovertible evidence, taking action based on an inaccurate conclusion may result in a waste of resources.

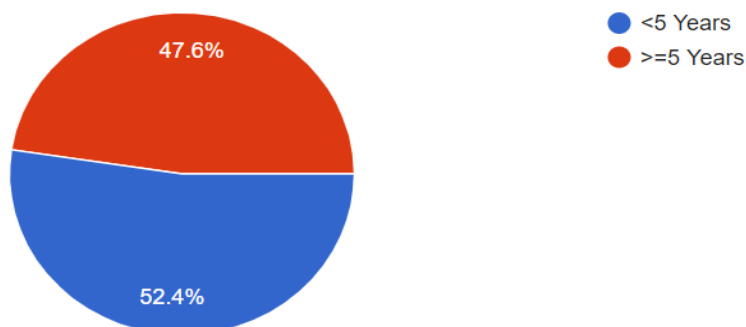


Figure 6: Time spent working in food industry

Type of Food industry that you are associated with:

It is evident from the surveys and face to face data collection that 47.6% were associated with grocery stores/retailers. 28.6% belongs to transporting perishable food and remaining 23.8% are connected to warehouses. This will give us prudent analysis about shelf life, because shelf life will vary for each type of food industry.

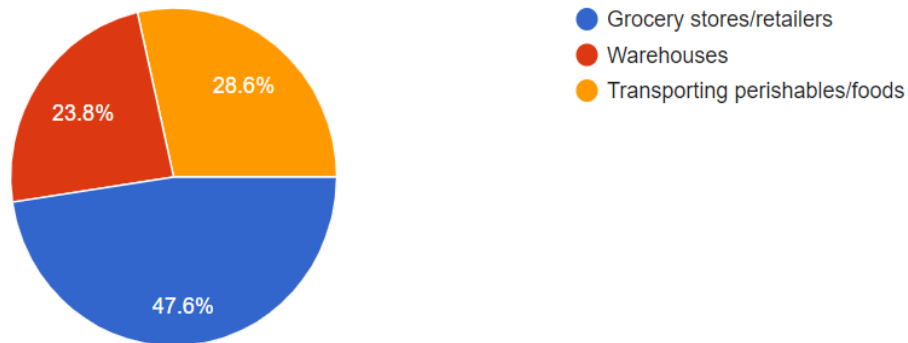


Figure 7: Type of Food industry that you are associated with

Do you know what post-harvest bananas are?

The below pie chart shows the huge proportions businesses aware of post-harvest knowledge of bananas. Whereas only 9.5% shows no understanding of post-harvest bananas.

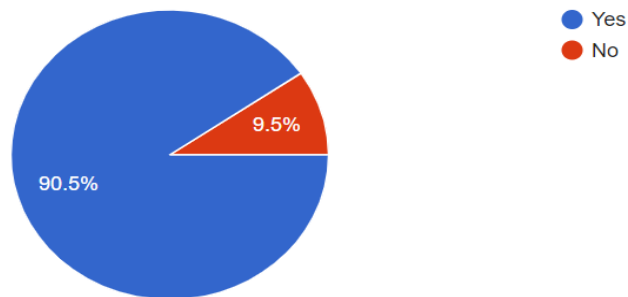


Figure 8: Business awareness of post-harvest bananas

Do you have experience in handling post-harvest bananas?

Majority if the businesses confirm their experience in handling post-harvest bananas whereby 23.8% shows no relevance towards the experience of handling post-harvest bananas but as per the statistics of previous question, some of them do have knowledge of post-harvest bananas.

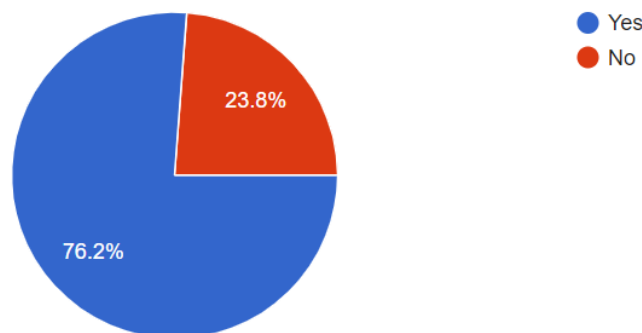


Figure 9: Experience in handling post-harvest bananas

Do you know the maturity stages for post-harvest cherries?

Huge amount of proportion indicates that the 71.4% businesses are aware of the knowledge of post-harvest cherries and 28.6% does not deal with post-harvest cherries.

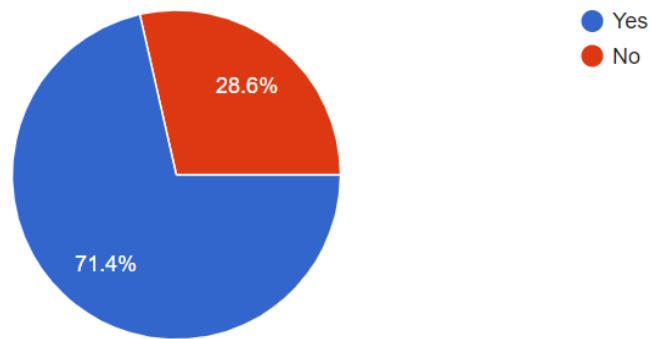


Figure 10: maturity stages for post-harvest cherries

Which maturity stages of cherries do you deal with?

There are total five maturity stages of cherries and bar graph shows that majority of the participants deal with cherries when they are at second maturity stage. After that, third and first maturity stages are common and dealt by the businesses.

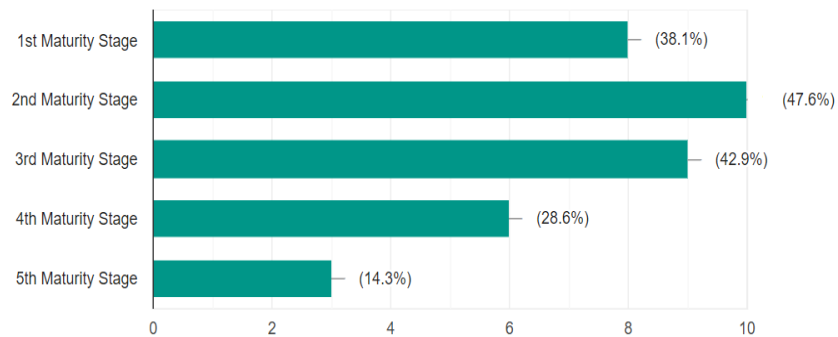


Figure 11: Dealing with maturity stages of cherries

INTERVIEW QUESTIONS

Why you think food waste occurs in your company due to manufacturing sector?

There is minor difference in the proportion of three categories. Over production scores higher followed by packaging and then wrong size.

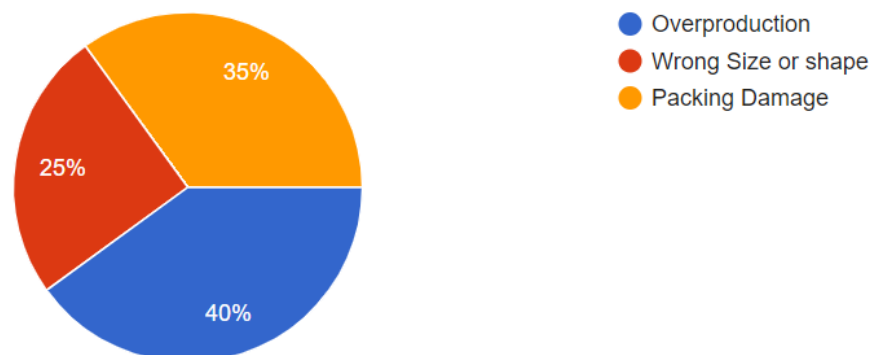


Figure 12 (a): Food waste in manufacturing sector

3.2 Why you think food waste occurs in your company due to retail sector?

Stock mismanagement indicates the biggest indicator of food loss which is related to packaging and handling. Marketing standards contributed 30% towards the wastage and marketing strategies have very low share.



Figure 12 (b): Food waste in Retail sector

What makes you buy a sensor?

It is evident from the results that companies and businesses are concerned with effectiveness and efficacy of sensors and considered it as a priority when they have to purchase it.

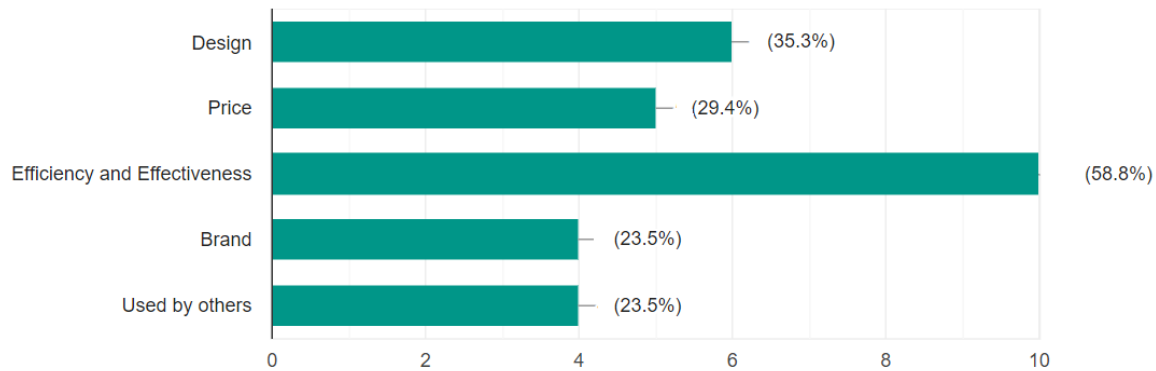


Figure 12(c): Purchase of sensors

CORRELATION RESULTS

We are using Correlation Coefficient indicator to check the strength of our variables. The table below shows the scale of correlation coefficient and its value. Correlation coefficient used to measure the relationship between two variables (Steven, 2021).

Table 1: Scale of Correlation

Scale of correlation coefficient	Value
$0 < r \leq 0.19$	Very Low Correlation
$0.2 \leq r \leq 0.39$	Low Correlation
$0.4 \leq r \leq 0.59$	Moderate Correlation
$0.6 \leq r \leq 0.79$	High Correlation
$0.8 \leq r \leq 1.0$	Very High Correlation

Correlation between dependent and independent variables

Based on the data collected we will check the strength of relationships of dependent and independent variables. Moreover, strength of relationship is also measured among independent variables and mediators. Correlation of independent variables with dependent variables:

Table 2: Correlation between dependent and independent variables

	Packaging	Delivery Time			Shelf life
		Within city	Within country	Out of country	
Banana and cherries wastage	0.636480633	0.004037	0.02354	0.36098	0.1157

Banana and cherries wastage shows high correlation with packaging because the value lies between $0.6 \leq r \leq 0.79$. These results indicate not a very strong relationship between the wastage of banana and cherries and delivery time within the city and delivery time within the country, however, low correlation identified between wastage and delivery time out of country. The coefficient correlation values are 0.004037, 0.02354 and 0.36098 respectively.

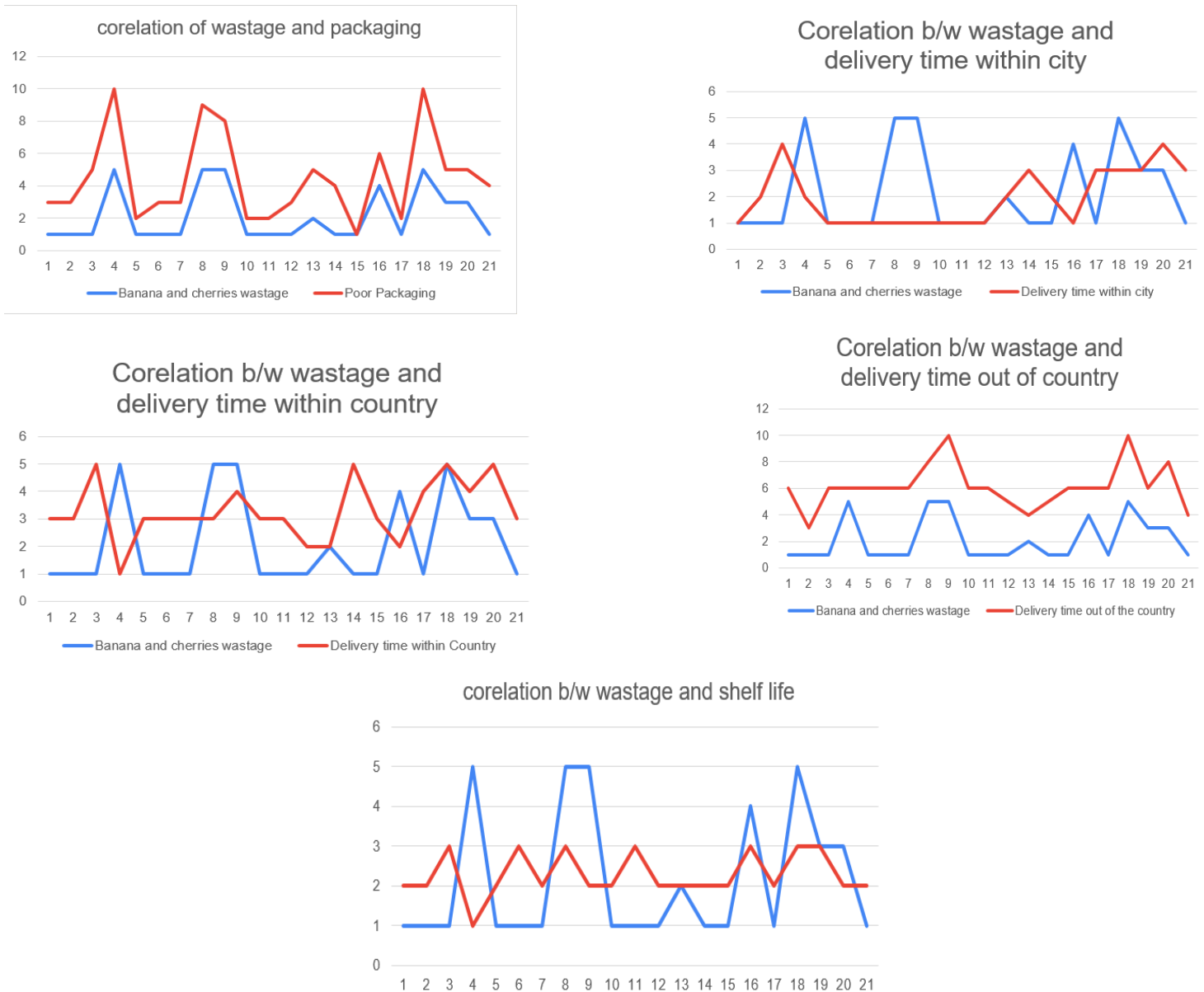


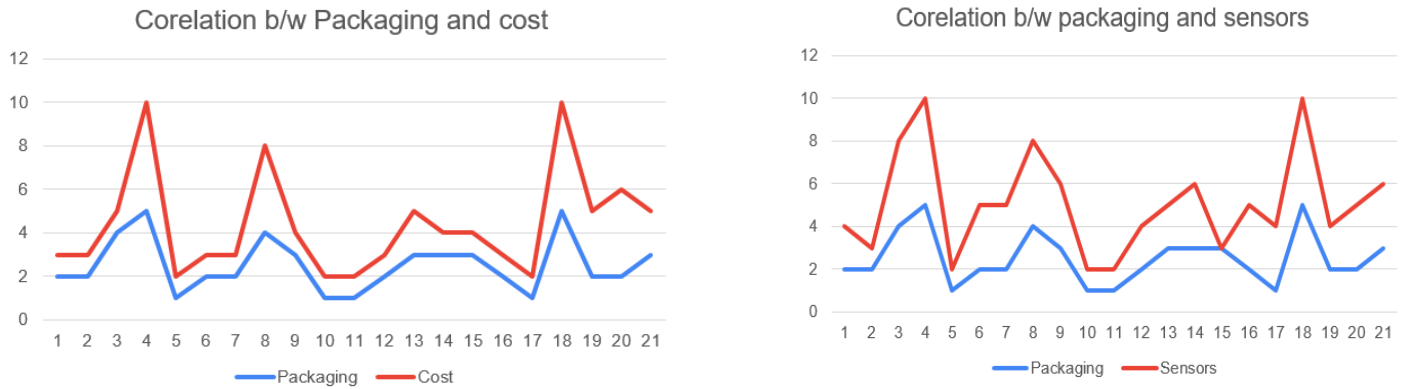
Figure 13: Correlation between dependent and independent variables

The results visible in figure 13 shows that wastage of banana and cherries is also in very low correlation with the shelf life.

Correlation between independent (packaging) variable with mediators**Table 3:** Correlation between independent (packaging) variable with mediators

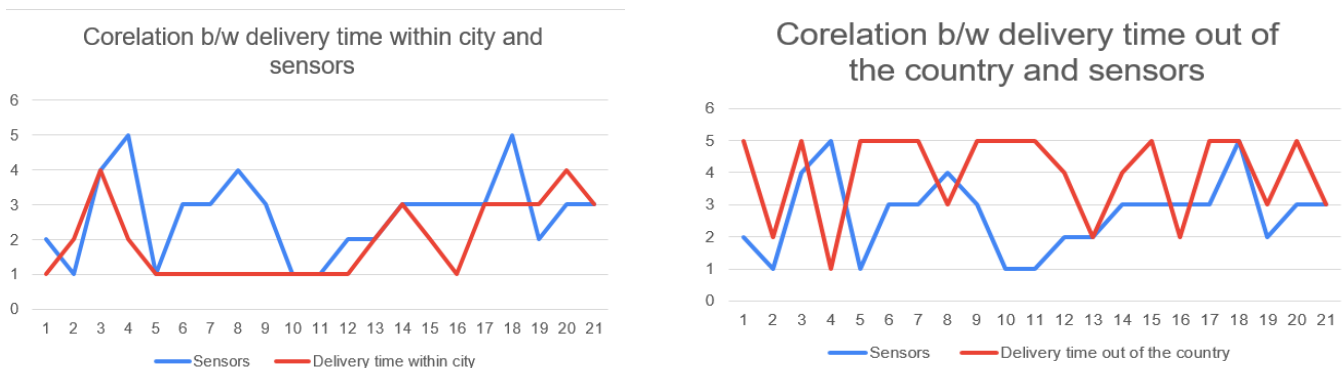
	Sensors	Cost
Packaging	0.839243	0.676997868

Packaging shows very high correlation with sensors and high correlation with cost which reflects that the quality of packaging increases with the durability and reliability of sensor increases. Similarly, investing more on packaging will increase the quality of packaging.

**Figure 14:** Correlation between independent (packaging) variable with mediators**Correlation between independent (delivery time) variable with mediators****Table 4:** Correlation between independent (delivery time) variable with mediators

	Sensors	Cost
Delivery Time within city	0.23918	0.355788192
Delivery Time within country	0.204459	0.059164299
Delivery Time out of country	0.345739	-0.340158989

Given data indicated very low correlation between delivery time within the city as well as within the country with quality of sensors throughout the distribution and storage process. However it does have low correlation with delivery time out of country and having good quality of sensors throughout the supply chain. Similarly, cost has low correlation with delivery time within the city. Cost has almost no relation with delivery time within the country and cost has negative low relationship with the delivery time out of the country. That means delivery time out of the country will increase if we decrease the cost in the supply chain process.



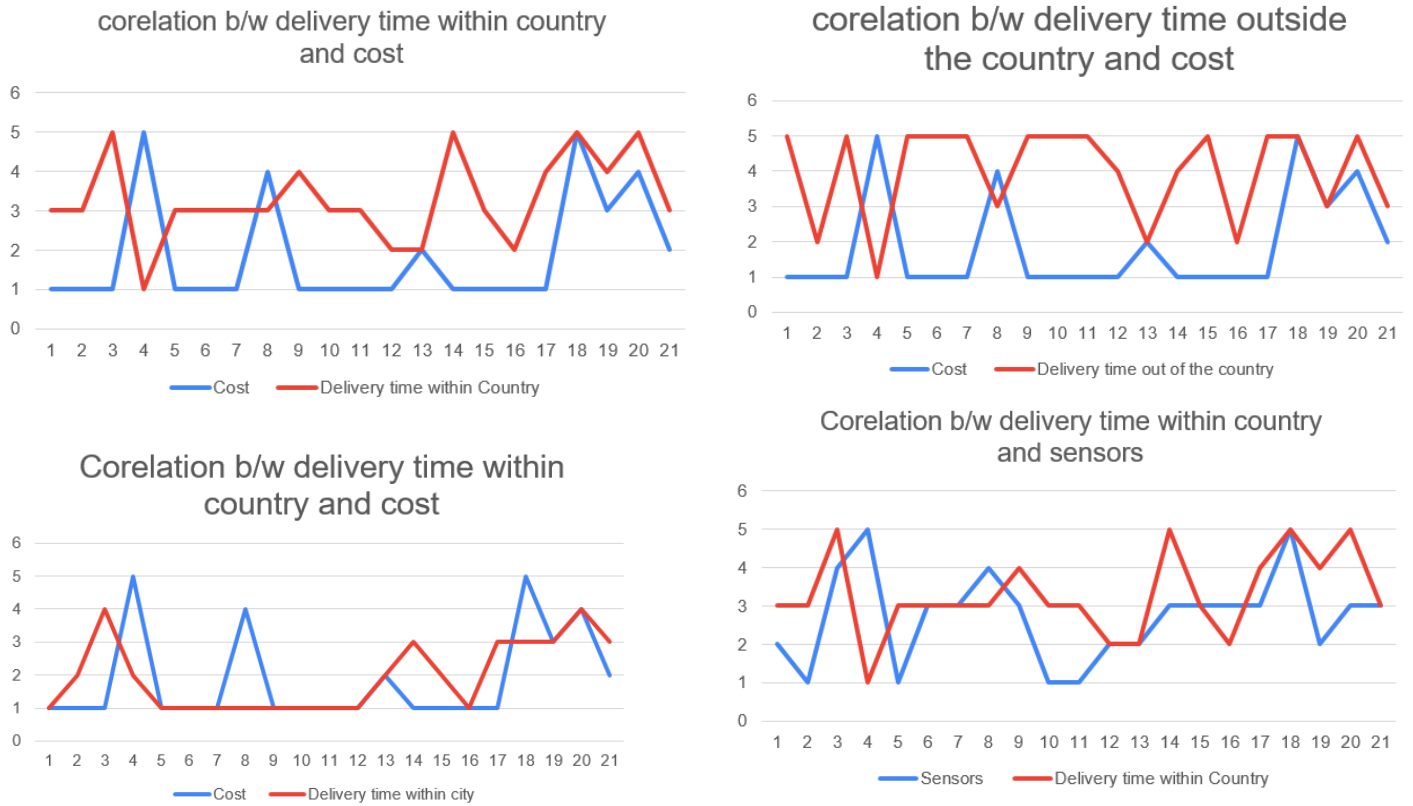


Figure 15: Correlation between independent (delivery time) variable with mediators

Correlation between independent (delivery time) variable with mediators

Table 5: Correlation between independent (delivery time) variable with mediators

	Sensors	Cost
Shelf Life	0.060502	-0.00895

As per given numbers shelf life has almost no correlation with sensors, however, cost has very low negative relation with shelf life. Negative relationship reflects that shelf life increases if cost in the supply chain process decreases.

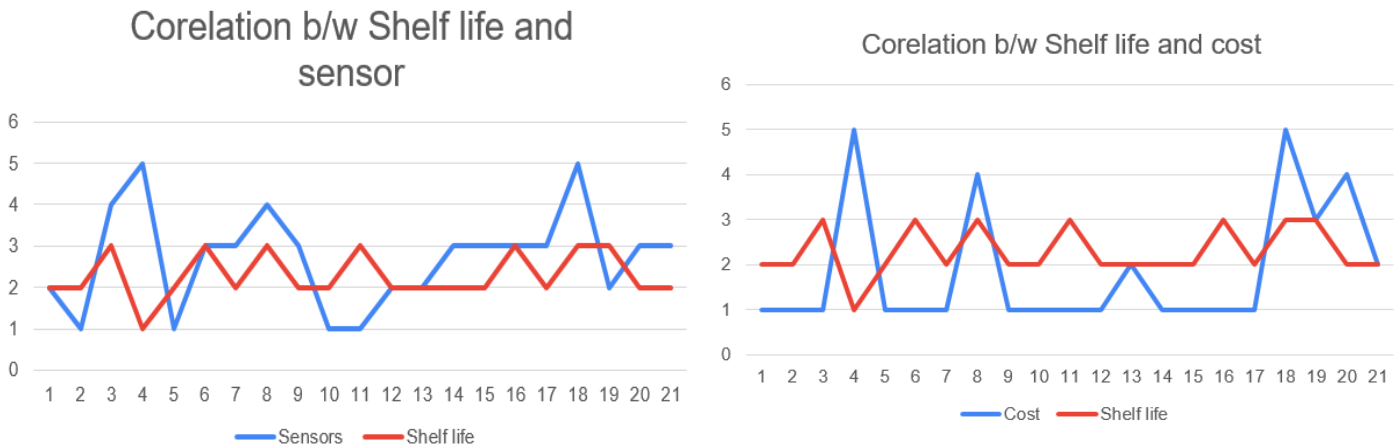


Figure 16: Correlation between independent (delivery time) variable with mediators

METHODOLOGICAL FRAMEWORK

The correlation analysis done in section 3 stresses on the factors that are playing crucial role in the wastages of banana and cherries which indicates packaging as the most important element with the correlation of 0.636480633. The finding further supports the effects of packaging with sensors and cost with the coefficient relation of 0.839243 and 0.676997868 respectively. Based on data analysis below methodological frame work can we evaluated.

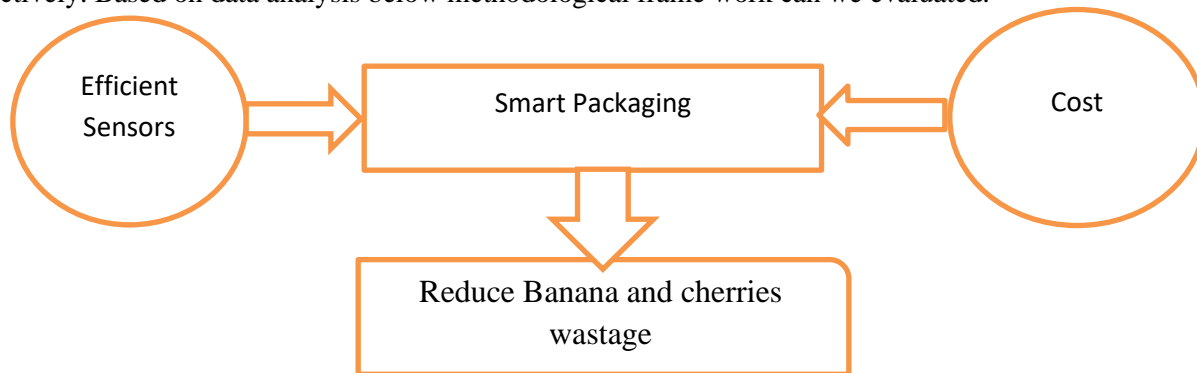


Figure 17: Methodological framework

CONCLUSION

Proposed Solution for smart Packaging

The designs proposed mainly deal with storage and handling of this fruits especially during transit. Special containers with specified number of fruits and their interactions are well explained for reduced fruit interaction and also putting in place new units which can help in easy handling during transportation. The well-known characteristics of these fruits help in the design. Special containers proposed for carrying the cherries are to have the capability of cushioning the fruits to avoid damage of the delicate screen. Bananas on the other hand have their containers accommodate sodium hydroxide and to absorb any carbon IV oxide gas which is as responsible for ripening of bananas as ethylene gas. Sensor will be used to detect the concentration of ethylene in the containers. If the critical value of ethylene concentration is reached, then it will mean that the bananas within that container are ripe. The sensor will sent a notification which will prompt the removal of the bananas since they can longer last long. Inner lining of the container, which will be wool, allows for soaking of sodium hydroxide to absorption of carbon IV oxide in the container. For both fruits, the containers will also have humidity and temperature sensors. Basically, reefer compartments are enormous coolers that are utilized to move temperature-controlled cargoes, for example, organic products, meat, fish, fish, and vegetables, dairy and furthermore additionally non-food items, for example, blossoms, drugs, and film across numerous miles and seas.

Some cargoes may should be sent chilled or frozen or in controlled temperatures. Reefer holders can keep up the load at the necessary temperatures for the term of the travel. Another important point which was observed during survey was sustainable packaging. There is huge market who is willing to pay for green packaging. Therefore, there is a need to find the sustainable packaging solution that makes use of materials and production techniques to save energy and lessen the environmental impact of packaging.

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