CBI for Artificial Intelligence

Final Report

Challenged based Innovation for Artifical Intelligence

Team Fruit Ninjas

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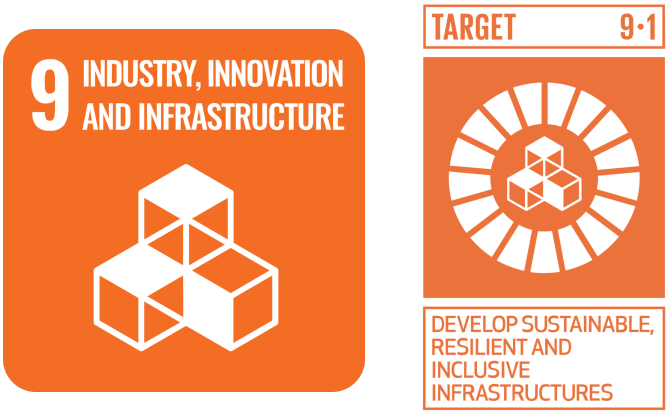
1. Understanding the problem

1.1. Our Challenge: SDG 9.1

For our group challenge, we chose the Sustainable Development Goal 9.1. This target aims to develop quality, reliable, sustainable and resilient infrastructure, including regional and transborder infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all. Infrastructure provides the basic physical systems and structures that enable the delivery of goods and services that are essential for modern society. Infrastructure also supports innovation and industrialization by facilitating the movement of people, materials, and information. However, many parts of the world still lack adequate infrastructure or face challenges in maintaining and upgrading their existing infrastructure. Therefore, SDG 9.1 calls for increased investment and cooperation in infrastructure development, especially in developing countries and rural areas.

We decided to tackle the issue of food waste in exports from Egypt, focusing on citrus fruits as a case study. We believe that this issue is relevant for SDG 9.1 because it involves improving the quality and efficiency of infrastructure in the food sector, such as storage facilities, transportation systems, and cold chains. By reducing food waste in exports, we can also support economic development and human well-being by increasing income and food security for farmers and exporters.



1.2. Desk Research

We then conducted desk research to gather relevant information and data about our topic. We used reliable sources, such as academic articles, reports, statistics, and news articles, to support our arguments and findings. We searched for information on the following topics:

- Food waste in the world: According to the UNEP Food Waste Index Report 2021 , around 931 million tonnes of food goes to waste each year. This represents about 17 percent of total global food production. Food waste occurs at different stages of the food supply chain, from production to consumption. Food waste has negative impacts on the environment, society and economy. It contributes to greenhouse gas emissions, biodiversity loss, water scarcity, land degradation, and food insecurity. It also represents a loss of resources, income, and opportunities for farmers, businesses, and consumers.

- Food waste in developing countries: Most of the food waste in developing countries occurs at the production and post-harvest stages of the food supply chain. This is due to various factors such as poor infrastructure, inadequate storage facilities, lack of cold chains, inefficient transportation systems, low quality standards, limited market access, and weak institutional support. Food waste in developing countries not only affects the environment but also undermines food security and livelihoods for millions of people who depend on agriculture.

- The percent of Egypt's agricultural exports to total exports: According to the Export Council for Food Industries , agriculture accounts for about 12 percent of Egypt's total exports . The agricultural sector is the third-largest economic sector in Egypt but its share in the total exports has declined from 16 percent in the 1990s.

- Fruits and vegetables export segment brought more than $700 million in export revenue. Citrus fruits make up 1/3 of Egypt’s fruits and vegetables exports, maily oranges. citrus fruits, reached about 1.7 million tons in exports in 2022. This alone generated about $566 million in revenues for Egypt.

- The percentage of rejected citrus fruits exports from Egypt: Not all citrus fruits exports from Egypt meet the quality standards of the importing countries, especially those in the European Union (EU), which is one of Egypt's main trading partners. According to a study by the Egyptian Center for Economic Studies , the percentage of rejected citrus fruits exports from Egypt ranged from 0.5 to 3 percent between 2016 and 2019.

Based on our desk research, we hypothesized that the rejection of fruit exports is mainly caused by the quality of the fruits, which can be affected by various factors such as harvesting, packaging, transportation, and storage conditions.e exporter

1.3. Our Problem

Through our research, we identified the main problem that we want to address: the rejection or return of citrus fruits exports from Egypt due to quality and safety issues. One of the factors that affects the quality of citrus fruits is the storage facility. If the storage facility is not well-equipped or maintained, citrus fruits may overheat or get damaged during storage or transportation. This may cause the shipment to be rejected by the importing country, which is a huge loss for the exporter and the farmer. Therefore, we want to find ways to improve the storage facility and reduce food waste in exports.

The quality of citrus fruits depends on several factors such as cultivation practices, harvesting methods, post-harvest handling, transportation, and storage. Among these factors, storage is one of the most critical ones because it affects the shelf life and freshness of citrus fruits. Citrus fruits require proper temperature and humidity control during storage. If the storage facility is not well-equipped or maintained, citrus fruits may overheat or get damaged during storage or transportation. This may lead to deterioration of quality attributes such as color, flavor, texture, juiciness, and nutritional value. These quality issues may cause the shipment to be rejected or returned by the importing country, which is a huge loss for the exporter.

Therefore, our challenge is to find innovative solutions using AI to reduce food waste in exports from Egypt by improving the storage facility for citrus fruits. We aim to identify the main challenges and opportunities for improving the storage facility; analyze the current practices that affect it; and propose feasible and sustainable interventions that could improve its quality and efficiency. We hope that our challenge will contribute to achieving SDG 9.1 by enhancing Egypt’s infrastructure and industrialization through reducing food waste in exports

1.4. Interviews

After conducting desk research, we decided to proceed with in-depth interviews with our personas to understand the actual causes and consequences of the rejections they can face. This method allowed us to gain a deeper insight into their experience and pain points.

We used a purposive sampling method to select four interview participants who have relevant experience and knowledge in the fruit export industry. We interviewed two fruit exporters, a farmer who grows fruits, and an employee of a supply chain and logistics company that handles fruit shipments. We contacted the interview participants through our personal and professional connections in the fruit export industry. We sent them explaining the purpose and scope of our research and asking for their consent to participate. We scheduled the interviews at their convenience and conducted them via audio call using an interview guide.

The main topics we covered in the interviews were: the types of fruits they grow or export, the reasons for the fruits not meeting the specifications during quality control and getting rejected,

the technologies they use in cooling systems to preserve the fruits, and the economic impact of rejection on their livelihood. The main objectives of our interviews were to understand:

- What is the process of of exporting from beginning to end
- What are the reasons for the rejection of fruit exports?
- How does fruit overheating contribute to the rejection problem?
- What are the consequences of rejection for the fruit exporters, farmers, and logistics workers?
- How can the rejection problem be prevented or mitigated?

Interview Findings

The Process:

21. The farmer harvests the oranges from the trees and sorts them according to size, quality and variety. The farmer may use machines or manual labor for this task. This is the initial sorting that happens in the process.
22. The farmer packs the oranges in cartons or crates and labels them with the origin, destination, variety and weight and transports them to a local collection center or a packing house, where they are inspected, graded and stored in cold rooms. The collection center or packing house may sort the oranges based on external and internal quality parameters such as color, shape, size, weight, and defects. This is the second sorting that happens in the process.
23. The exporter or trader buys the oranges from the farmer or the collection center and arranges for the shipment to Europe. The exporter or trader may sort the oranges before loading them into refrigerated containers (trucks) to ensure that they meet the quality standards of the importing country. They may sort the oranges at their own facility or at the collection center or packing house where they buy the oranges from. (meaning that the second sorting can be done either by the farmer again or my the exporter of both)
24. The exporter or trader hires a supply chain transport company to provide trucks, trains or planes to transport the oranges to the port of departure. The transport company may also offer services such as loading, unloading, tracking and insurance of the cargo.
25. There may be another custom sorting that happens at the port of departure depending on the specific requirements and regulations of each country involved (quality control).
26. The exporter or trader ships the containers by sea to the port of arrival in Australia for example. The shipping time may vary depending on the distance, weather and availability of vessels. The average shipping time from Egypt to Australia is about 27 days.

27. The importer or distributor receives the containers at the port of arrival and clears them through customs. The importer or distributor may also inspect the quality and quantity of the oranges and pay any duties or taxes imposed by the importing country. There may be another sorting that happens at the port of arrival depending on the specific requirements and regulations of each country involved.

One of the main findings from the interviews was that fruit overheating is a major cause of rejection, which can occur at different stages of the production and export process. The participants identified three common sources of overheating: poor handling by farmers, direct sunlight exposure, and glitches in storage facilities during the pre-cooling phase. They explained how overheating can affect the quality and shelf life of the fruits by accelerating ripening, increasing water loss, or inducing browning or decay. For example the logistics worker said: ‘When this happens it’s a disaster for the exporter because he either has to throw away the fruits or sell it for much less to local vendors.’ Participant 4.

1.5. User Persona

Name: Ahmed Karim

Age: 38 **Location:** Cairo, Egypt

Occupation: Citrus fruits exporter mainly exports to Australia

About

Ahmed Karim is a 38 year old male who lives in Cairo and exports citrus fruits to Australia. He is ambitious, confident, reliable, and loyal. If a shipment get rejected in quality control he loses a lot of money and and might have to throw away the entire shipment

Painpoints

- Losing money and reputation when a shipment is rejected in quality control
- Having to deal with the hassle and stress of finding another buyer or disposing of the rejected shipment.
- Having to face the dissatisfaction and complaints of the customers who ordered the rejected shipment.
- Having to pay extra fees and penalties for the delay or cancellation of the shipment.
- Not finding a reliable and affordable way that can help him predict the spoilage of his fruits and vegetables

Goals

- Saving money and reputation when a shipment passes quality control.
- Having a smooth and hassle-free shipping process.
- Having satisfied and loyal customers who order regularly.
- Having competitive prices and profits for the shipments.
- Having no issues with the quality control due to overheating or spoilage of the fruits.

2. Conceptual development

2.1. Problem Statement

Significant financial losses, totaling approximately 1 billion dollars annually, are being incurred by Egyptian exporters and supply chain transporters as a result of fruit and vegetable rejection or devaluation in international markets. This issue can be divided into two key aspects: the ecological and social impact of food waste, and the economic implications of monetary loss.

In light of these challenges, the objective of our project is to find effective solutions to reduce food waste and mitigate financial losses caused by the overheating of fruits within storage facilities.

2.2. Ideation phase

Once we had found the exact problem we wanted to focus on, we had to start with the ideation phase. As the problem evolves around the overheating of fruits before reaching the exportation port, our first and most intuitive approach was to ideate some kind of device which was able to detect the spoilage of the fruit and avoid it during the supply chain and transportation.

During the initial phase, we explored various possibilities for implementing our system considering different stages of the supply chain. However, after careful evaluation, we encountered challenges with each option.

1. **Ship containers:** Initially, we considered developing a device that could monitor and detect anomalies throughout the entire journey of the fruits inside the containers. However, we faced difficulties in terms of device retrieval by exporters. Additionally, we realized that the primary problem lies in the early stages of the supply chain, specifically during harvest and storage. Therefore, this option proved to be unviable.
2. **Harvest bags:** Another approach involved integrating our system into the harvest bags themselves at the early stage of the supply chain. However, we encountered challenges in visualizing a system that could effectively prevent overheating after the detection implemented in this stage. The deployment of such an intelligent system would be complex and impractical.
3. **Storage facilities:** After thorough consideration, we realized that improving the storage conditions in the facilities where the fruits spend the most time before export was the optimal choice. Implementing our system in these storage facilities would be scalable and comparatively easier than the other two approaches.

Based on the assessments, we concluded that focusing on enhancing storage conditions in facilities would provide the most feasible and effective solution to address the food waste and overheating issues in the supply chain.

2.3. Our solution

To address this challenge, we developed a region-based cooling system.
Our device incorporates temperature, humidity, and ethylene sensors, which are placed inside the orange boxes, one in each corner of the facility. When an anomaly in temperature is detected by the sensors, a signal is sent to the central management system. This system then activates the closest ventilators to redirect refrigeration to the specific region of the facility affected by the anomaly. Once the sensors detect that the temperature has returned to normal levels, the ventilators automatically turn off.
To predict the spoilage of oranges and enable smart ventilator control, we utilize an AI model that utilizes data collected by the sensors in real-time. This model generates a spoilage profile and aids in controlling the ventilators accordingly.

Our How Might We Statement

How might we reduce food waste due to overheating of fruits in the storage facilities?

2.4. Attract technology: ULTRARAM

The problem called for a technology designed to be power-efficient compared to other flash memories, optimizing energy consumption and extending the battery life of the device.

We found this characteristics in the ULTRARAM technology:

- ULTRARAM is a non-volatile computer memory that combines the performance of DRAM with the non-volatility of flash.
- It uses a patented triple-barrier resonant tunneling structure to deliver an unmatched combination of speed, non-volatility, endurance and energy efficiency.

2.5. Benefits

Reduced Energy

Smart

Accuracy

Our solution offers several advantages over existing competitors in the market:

1. **Accuracy:** Unlike standard general refrigeration systems, our solution is region-based, allowing for precise temperature control and storage of products in specific zones of the facility where it is needed. This targeted approach ensures optimal conditions for each type of fruit, minimizing spoilage and maximizing shelf life.
2. **Smart solution:** Our solution incorporates AI models to predict fruit spoilage before it occurs. By analyzing various factors such as temperature, humidity, and other environmental conditions, our system can proactively adapt the ventilation system to meet the specific needs of the moment. This intelligent approach helps prevent fruit from overheating or getting spoiled, further reducing waste.
3. **Reduced energy consumption:** Our ventilation system operates on a dynamic basis, activating and deactivating based on the specific storage requirements of the products. This targeted ventilation approach significantly reduces energy consumption by only providing cooling when and where it is necessary, leading to cost savings and environmental benefits

By combining these advantages, our solution offers a more efficient and effective approach to mitigating food waste and reducing financial losses caused by overheating in storage facilities

3. Final Solution

3.1. Proposal

We are presenting the Frutech device. We have designed a prototype device to track the oranges quality inside the storage facilities and to manage the ventilation system smartly and efficiently in order to control the environment and avoid food spoilage wherever possible.

How does it work?

Step 1:
A group of Frutech devices are placed inside the orange boxes preferably at each corner of the storage facility that can cover the most remote parts of it.

Step 2:
Those devices collect data in real time of the ambient conditions of the nearest oranges. These data contain measurements of the temperature, humidity and ethylene gas. When conditions in one region are not optimal for proper storage, the nearest Frutech device predicts a high degree of risk of spoilage.

Step 3:
If the levels reached are critical, the device sends an alert to the central management system of the storage facility and this one identifies those ventilators that are closest to the problematic area and activates them to circulate the air and reverse abnormal conditions that may damage the oranges.

3.2. AI controlled region-based ventilation

In our mission to develop a smarter ventilation system that adapts to demand, we faced a challenge: identifying areas in the storage facility where oranges are at risk of spoiling. This is where Artificial Intelligence comes into play. Our solution integrates a powerful machine learning algorithm that uses real-time sensor data to predict the likelihood of spoilage. By harnessing the potential of AI, we can take proactive measures to address spoilage risks and optimize the usage of our ventilation resources. In this section, we explore how AI improves our ventilation system, making it more efficient and effective in preserving the freshness of our oranges.

Method

In our mission to incorporate AI into our demand-based smart ventilation system, we identified three main phases: data collection and preparation, model development, and prediction and ventilation control. In the following sections we give more details of each of them.

Data Collection and Preparation

Any machine learning model before it can make predictions needs to be trained with data from real scenarios. Since our goal is to predict the risk of spoilage of the fruit we needed to train our model with a dataset that contained the features we will use in the detection phase and a target feature which we want to predict in the prediction phase.

We investigated possible existing datasets that could be useful to train our model and we found some interesting studies: https://www.frontiersin.org/articles/10.3389/fpubh.2021.816226/full, https://www.mdpi.com/2304-8158/11/12/1777 . Many of them aimed to detect the food spoilage using computer vision approaches with image datasets containing fresh and spoiled fruit. However, since our device is placed inside the boxes and cannot take images of all the fruits but can monitor the environment conditions using its built-in sensors. This is the reason we decided that in order to train our model we needed to collect the data ourselves by recreating different ambient conditions and monitoring the temperature, humidity and gas levels using the sensors.

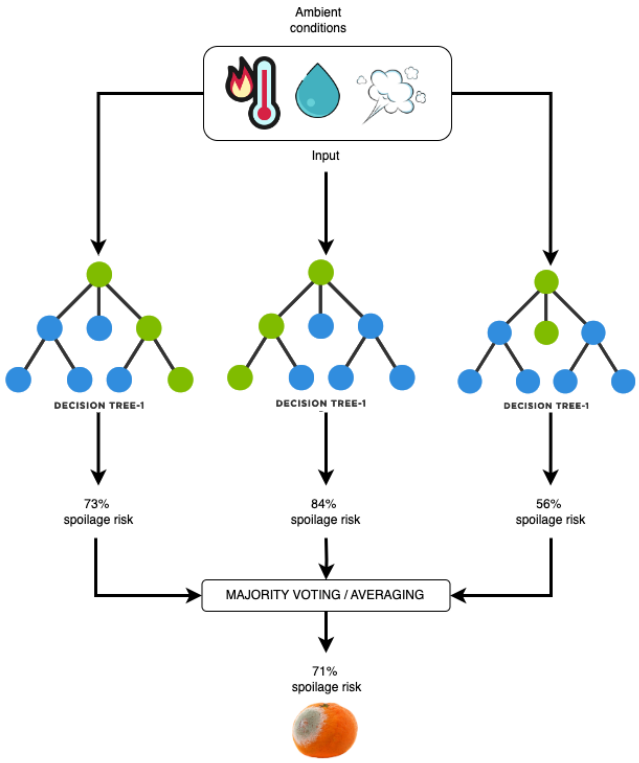
The idea here was to also generate the target variable we want to predict called spoilage risk based on the images and colors of different levels of fruit spoilage and apply a simple equation that outputs a percentage indicating the degree of spoilage.

Model Development

Once having the dataset we could think in which machine learning model we could use to train and predict the degree of spoilage. Since the target variable is numeric it was a case of regression problem instead of classification (spoiled yes or spoiled no). For this reason and because there are many articles that show its great predictive power we decided to use a Random Forest Regression model.

A random forest model is a powerful machine learning technique that combines the predictions of multiple decision trees to make accurate predictions. Decision trees are a machine learning algorithm that uses a flowchart-like structure to make predictions or decisions based on input features. Each node represents a feature, branches represent possible outcomes, and leaf nodes represent final decisions.

If we look inside our random forest model, during the prediction phase, each decision tree independently processes the input ambient condition data, and their predictions are averaged to obtain the final prediction. This ensemble approach helps to improve the accuracy and robustness of the predictions.



Random forests offer a good Interpretability by providing feature importance rankings. This indicates the relative importance of ambient conditions in predicting fruit spoilage risk. This can also help identify which factors have the most significant impact on spoilage and provide insights into the underlying mechanisms.

Model training

Once the data is preprocessed and fed to the model the training of the model starts and there it is able to learn the patterns of the ambient conditions that makes the fruit spoil.

Prediction

All the Frutech devices measure and store the ambient conditions data of the oranges that are placed next to them using the built-in temperature, humidity and ethylene gas sensors.

Then we utilize the trained Random Forest Regressor to estimate the spoilage risk based on current ambient conditions. The model analyzes the input data and generates a predicted spoilage risk value, indicating the likelihood of fruit spoilage.

Ventilation Control

To determine when to activate the ventilation system, we establish a spoilage risk threshold. This threshold serves as a reference point for decision making. If the predicted spoilage risk exceeds the threshold, it indicates an elevated risk of fruit spoilage, triggering the activation of the ventilation system.

3.3. Prototype

The solution we present is a 3d-printed orange-shaped device with a compact size that can easily fit inside any box.

The Frutech device is designed with a violet color to stand out from the oranges. This makes it easy to locate and pick them from the storage facility.

To ensure accurate data recording, it was also crucial to select appropriate materials for the Frutech device that enable optimal sensor performance. The chosen materials should possess properties that allow for reliable data collection by the sensors. Materials like ABS (Acrylonitrile Butadiene Styrene (“Acrylonitrile butadiene styrene”)), PET (Polyethylene Terephthalate (“Polyethylene terephthalate”)), or polycarbonate commonly used in 3D printing applications were investigated by us because can provide suitable characteristics for sensor data recording.

The main components included in the device are the following ones:

Sensors

Food spoilage can be caused by a variety of factors, including humidity and temperature fluctuations. As a result, it is important to provide a measurement device that can measure humidity and temperature differences during food storage. We have incorporated the following sensors in our solution:

1. Temperature sensor: DHT11 Temperature sensor for Arduino.
2. Humidity sensor: Also included in DHT11 Arduino sensor.
3. Ethylene gas sensor: ME3-C2H4 Winsen Electrochemical Ethylene Gas Sensor.

Attract UltraRam

The data collected from the Arduino-based sensors will be stored in the UltraRam memory unit. We have chosen this technology because it is designed to be power-efficient compared to other flash memories, optimizing energy consumption and extending the battery life of the Frutech device.

Battery

The battery is an essential component of the Frutech device. It provides the necessary power for the device to function and collect data in real time. A specific battery type, such as a rechargeable lithium-ion battery, has been chosen for its advantages in terms of performance and reliability.

Bluetooth module

This component enables wireless communication between the device and the central management system of the storage facility. It facilitates the transmission of collected data and reception of commands or alerts, ensuring real-time monitoring and analysis. The module's range and compatibility with the chosen Bluetooth version provide reliable coverage and seamless integration with the system.

In the ideation of the Frutech device, we considered Zigbee and other wireless communication technologies. Zigbee is a low-power, mesh networking protocol designed for IoT applications. It offers advantages such as long-range communication, low data rate requirements, and robustness in environments with multiple devices. It is important to note that all potential solutions, including Zigbee, require extensive testing to ensure their effectiveness and compatibility with the Frutech device and the central management system.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4. Business Plan

Frutech is an innovative device designed to address the challenge of fruit spoilage during transportation in emerging economies. By effectively monitoring and controlling ambient conditions, Frutech ensures the preservation of fruits, reducing waste and maximizing market value. This business brief outlines the key aspects of taking Frutech to the market and highlights its potential impact on the fruit supply chain.

4.1. Target Maret

Frutech primarily targets stakeholders involved in the fruit industry, including growers, distributors, and transporters in emerging economies. These regions often face infrastructure limitations and dysfunctional distribution networks, leading to substantial food waste. Frutech aims to provide a cost-effective solution to mitigate fruit spoilage during transit, thus enhancing market availability and profitability.

4.2. Product Features

- Real-time Monitoring: Frutech devices collect data on temperature, humidity, and ethylene gas levels, enabling precise tracking of ambient conditions.
- Predictive Analytics: The device utilizes advanced algorithms to identify potential spoilage risks based on collected data, allowing proactive intervention.
- Centralized Management: A central system receives alerts from Frutech devices and triggers appropriate actions to maintain optimal storage conditions.
- Scalable and Customizable: Frutech can be deployed in various storage facilities, with devices strategically placed to cover critical areas.

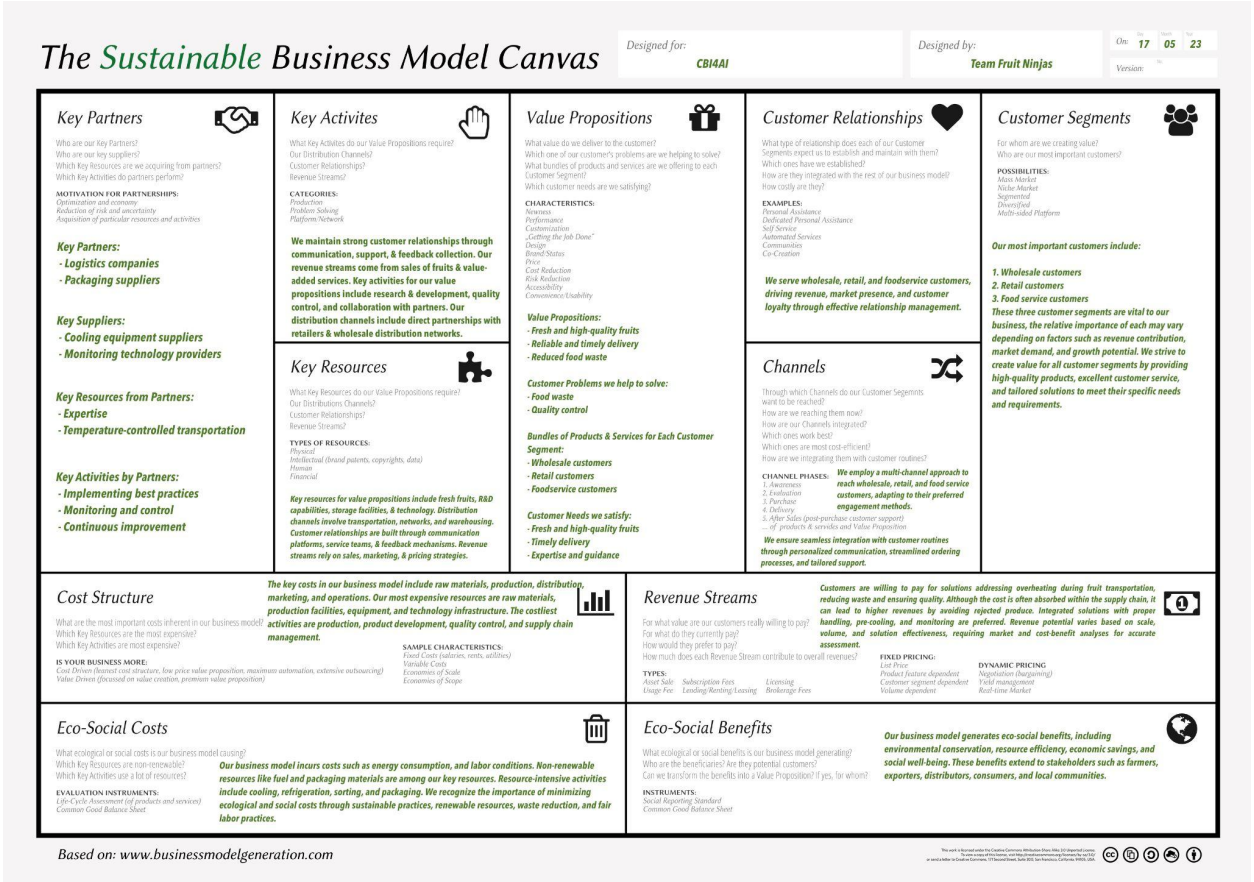
4.3. Value Proposition

1. Minimize Food Waste: By preventing fruit spoilage during transportation, Frutech significantly reduces food waste, improving economic and environmental sustainability.
2. Enhanced Market Availability: With preserved fruit quality, suppliers can deliver fresh and market-ready produce, meeting consumer demand consistently.
3. Cost Savings: Frutech eliminates revenue loss associated with damaged fruits, optimizing profitability for all stakeholders involved in the supply chain.

4.4. Go-to-Market Strategy

1. Partnerships: Collaborate with fruit industry players, logistics providers, and government agencies to integrate Frutech into existing supply chain processes.
2. Pilot Programs: Conduct pilot programs in selected regions of Egypt to showcase Frutech's effectiveness and gather valuable feedback for further product enhancements.
3. Marketing and Awareness: Launch targeted marketing campaigns to create awareness among key stakeholders, emphasizing the value proposition and positive impact of Frutech.
4. Support and Training: Provide comprehensive support, including technical assistance and training, to ensure smooth adoption and utilization of Frutech devices.

4.5. Sustainability Business Model Canvas



4.6. Impact

- Reduced Food Waste: Frutech's implementation can lead to a substantial reduction in fruit spoilage during transportation, effectively combating food waste and promoting sustainable practices.
- Economic Advantages: By minimizing revenue loss associated with damaged fruits, Frutech enables growers, distributors, and transporters to optimize profitability and enhance economic stability in emerging economies.
- Environmental Sustainability: The reduction in food waste achieved through Frutech contributes to a more sustainable food system, conserving resources and minimizing the ecological footprint.

4.7. Future Scope

Frutech holds immense potential for expansion and development:
- Technological Advancements: Continuous innovation in monitoring capabilities, data analytics, and predictive algorithms can further enhance Frutech's ability to prevent spoilage and optimize storage conditions.
- Market Penetration: Scaling Frutech's adoption in emerging economies worldwide, alongside forging partnerships with key stakeholders, will pave the way for a comprehensive transformation of the fruit supply chain.
- Diversification: Frutech's success can inspire the development of similar solutions for other perishable products, expanding its reach and impact beyond the fruit industry.

5. Conclusion

Frutech represents a groundbreaking solution that revolutionizes the way fruits are transported and preserved in emerging economies. By harnessing cutting-edge technology, Frutech empowers stakeholders to combat food waste, improve economic viability, and promote environmental sustainability. With its potential for future advancements and broad market penetration, Frutech stands as a catalyst for positive change in the fruit supply chain, ultimately benefiting communities, businesses, and the planet. Together, let us embrace Frutech and embark on a transformative journey towards a more efficient, sustainable, and prosperous future.

6. References

(1) SDG indicator metadata - UNSD. https://unstats.un.org/sdgs/metadata/files/Metadata-09-01-01.pdf.

(2) Goal 9: Sustainable Development Knowledge Platform. https://sustainabledevelopment.un.org/SDG9.

(3) Infrastructure and Industrialization - United Nations Sustainable https://www.un.org/sustainabledevelopment/infrastructure-industrialization/.

(4) Chapter 9 - SDG 9: Industry, Innovation and Infrastructure https://www.cambridge.org/core/books/sustainable-development-goals-their-impacts-on-forests-and-people/sdg-9-industry-innovation-and-infrastructure-anticipating-the-potential-impacts-on-forests-and-forestbased-livelihoods/C925D10F6738A9682EE883A6EAA5652C.

(5) SDG Indicators — SDG Indicators - UNSD. https://unstats.un.org/sdgs/metadata/?Text=&Goal=9&Target=9.1.

(6) Food Loss and Waste | FAO in Egypt | Food and Agriculture Organization .... https://www.fao.org/egypt/programmes-and-projects/food-loss-waste-reduction/en/.

(7) EU trade relations with Egypt. https://policy.trade.ec.europa.eu/eu-trade-relationships-country-and-region/countries-and-regions/egypt_en.

(8)Export Council for Food Industries. (n.d.). About us. https://www.ecfi-egypt.com/about-us

(9)Egyptian Ministry of Agriculture and Land Reclamation. (2022, January 4). Egypt's citrus exports reach 1.7 million tons in 2021. Retrieved from https://www.agr-egypt.gov.eg/NewsDetails.aspx?NewsID=1000

(10) El-Haddad, A., & El-Shennawy, A. (2020). The impact of non-tariff measures on Egyptian agricultural exports: The case of citrus fruits. Egyptian Center for Economic Studies Working Paper No. 203.

https://eces.org.eg/Publication.aspx?Id=1033

(11)Egyptian Ministry of Trade and Industry. (2022, January 5). Egypt bans export of wheat, flour, pasta, beans and lentils for six months. https://www.mti.gov.eg/English/MediaCenter/News/Pages/NewsDetails.aspx?Source=1&newsID=11967

(12)Exports of fruits and vegetables from Egypt may rise sharply in 2023 .... https://east-fruit.com/en/news/exports-of-fruits-and-vegetables-from-egypt-may-rise-sharply-in-2023/.