



Food Loss Prevention Container System-An Experimental Research of Heat Insulator Coating on Innovative Shelves

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Abstract - There is virtually little information available to consumers on the issues of supply chain management. Transporting food, and other perishable commodities while retaining their integrity is a Herculean challenge. This research propose and analyses a critical logistics operations that are being faced globally which leads to losses in both pallets & fruits. The study has been conducted with all the trials in different conditions and methods. The project design proved its functionality & competitiveness in the market & can be upgraded to end up being distributed and used globally.

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

INTRODUCTION

The Two fruits which are bananas and cherries have their cold chains for case study. The major threats to the good state of these fruits are found to be ripening and delicate skin for bananas and cherries, respectively. An injury to any of the bananas makes the ripening more severe. Cherries on the other hand can only last for only a week, especially if they are well handled and preserved. The designs proposed mainly deal with storage and handling of these fruits especially during transit (Iqbal et al., 2022a).

Intermediaries and production companies suffer a big loss if bananas overripe before they can 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 remarkably high spoilage rate and require care when handling. For Both fruits, spoilage cannot be delayed once it starts (Iqbal et al., 2022b). The proposed solution to this problem would be more applicable to logistic companies who directly transport these products from the intermediaries to the production, then to wholesalers. It will also be used by wholesalers, marketers, caterers, and retailers for storing and ease movements within the store and transport over short distances (Iqbal et al., 2022b).

Some cargoes may 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 (Trendova et al., 2022). Food security is a critical problem for all living things on the planet. Dealers who operate their operations with minimal profit margins face an increasing number of losses, which is a nightmare. The majority of the losses occur during the shipping and storage of perishable items. This challenge has increased during pandemic and management is more pressurized to come up with the more relevant solutions (Iqbal, 2021).

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CURRENT PRACTICES

A) *Refrigerators:*

Fridges are 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 (Abass, 2014). 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 between now and 2020 (Abass, 2014).

B) *Packaging:*

Packages help us store food and keep them as fresh as possible, they do that by sealing all the airways that could come and affect the food. Which would result in the decomposition. Furthermore, some foods require more than one type of package, for example refers.

The control unit on the compartment considers the setting and change of boundaries, for example, temperature, stickiness, ventilation, and air. The settings utilized will differ contingent upon the sort of freight being moved. Most should be put away at an unmistakable temperature (Alreshidi, 2019)

What is being used in the market:

Consumers currently have adopted the use of cartons, which were made for packaging of other products, to package bananas during transportation to the market. Consumers are using paper towels to keep cherries fresh (Abass, 2014; Alreshidi, 2019).

DESIGNS & APPROACHES:

A) *Shelves:*

The original idea was improved upon, by the implementation of central shelves where the boxes can be inserted into. This allows for easier maintenance and quality control, via making the shelves provide cooling to the boxes. Thereby, a user would only have to look after the shelf for cooling, and simply insert the boxes to provide the benefit of keeping the contents fresh for longer. The design of the shelves is a simple and modular rectangular shape, where a compartment in the middle houses dry ice, and boxes are placed on each side of it.

The shelf design prioritizes ease of manufacturing, and ease of handling. As both of those qualities are vital to aiding all logistical operations. Depending on the available space, a shelf can have few box compartments, or more can be stacked and placed as needed. Therefore, the shelves can be customized and fitted to the user's needs and means.

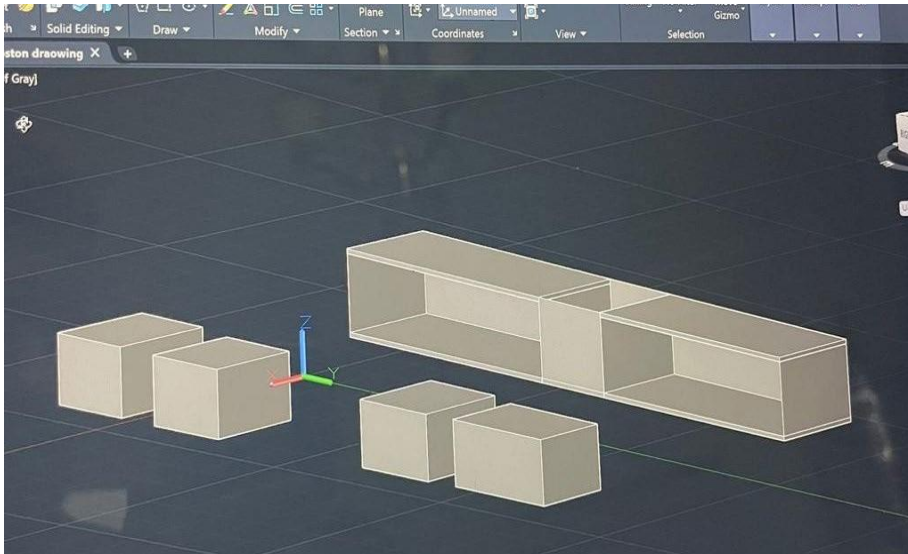
Additionally, the shelves would cool the boxes via implementation of a central dry ice compartment. The dry ice compartment would be in the middle, along the spine of the shelves. As dry ice goes from the solid form to the gas form immediately, we do not have to worry about liquid spillage problems. Additionally, with the right means, procuring dry ice is not too costly. Not only because it is easy to manufacture or purchase, but also because the shelf takes care of the cooling process by containing the dry ice, and the boxes. When the dry ice sublimates and becomes gas all that is necessary to replace it, is simply inserting more dry ice from the top. After consulting with industry, there were improvements made on the design which can be more cost effective and easy to use while loading and unloading.

B) *Initial design:*



C) 3D design:

After consulting with industry, there were improvements made on the design which can be more cost effective and easy to use while loading and unloading.

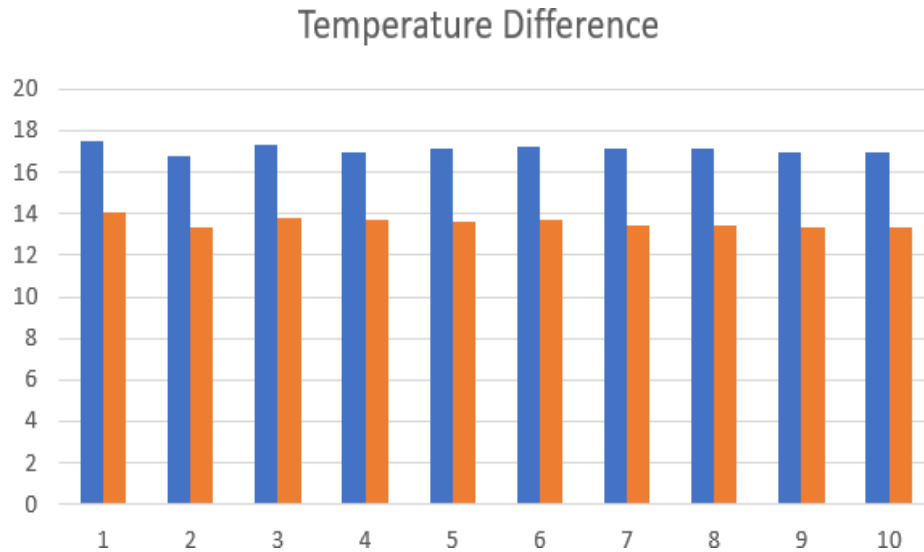
**D) Final Design:****E) Transportability:**

The container is designed with effective and easier transportability in mind. It's modular and simple shape allows it to fit and be picked and moved around easily. It does not require special installations or spaces to be made available for it to be placed or moved. When it is necessary for the box to be loaded into a transportation vehicle, it is as easy as stacking boxes in the back of a truck. What that helps with, is reducing time, cost, and effort in transporting the containers. And to mention another strong feature of the containers, is that they do not need electricity to work before, during, or after transportation. As long as there is dry ice in the compartment, the container can keep doing its job and keep the food inside fresh for longer.

Another important distinguishing feature of the container is its eco-friendliness. It runs on only ice to keep the content fresh and requires little to no cleaning. After use, the containers are not designed to be disposed of. They are reusable time and time again. It is also made of materials that are not damaging to the environment like plastic that cannot degrade. While the aluminum in use is a necessary component for heat insulation and other factors. It is only one of the materials used that are much friendlier to the environment.

FINDINGS:**A) Trial 1:**

To sum up everything we researched and found out during this project, the time for theories is long past, and we decided to do some experiments to test our researched knowledge by applying these theories into practice, one of our major goals was to have them as accurate as possible, no pristine conditions, just tried and true customer-based conditions. So, our plan was to conduct 2 experiments and compare their results, the first experiment was with Ice, in room temperature and with no heat insulating materials or paint. The second experiment is the same experiment however we introduce Heat Insulation materials to the container.



- Condition: room temp, normal ice
- Technical error: no heat insulation
- Human Error: ice was melting and was not filled on time.

As shown in this figure, that is the result of the first experiment with no heat insulation paint applied to the container. When applied properly it can decrease temperatures up to 10 degrees Celsius.

Right Side of shelve	Left Side of shelve
17.5	14.1
16.8	13.3
17.3	13.8
17	13.7
17.1	13.6
17.2	13.7
17.1	13.4
17.1	13.4
17	13.3
17	13.3
17.11	13.56

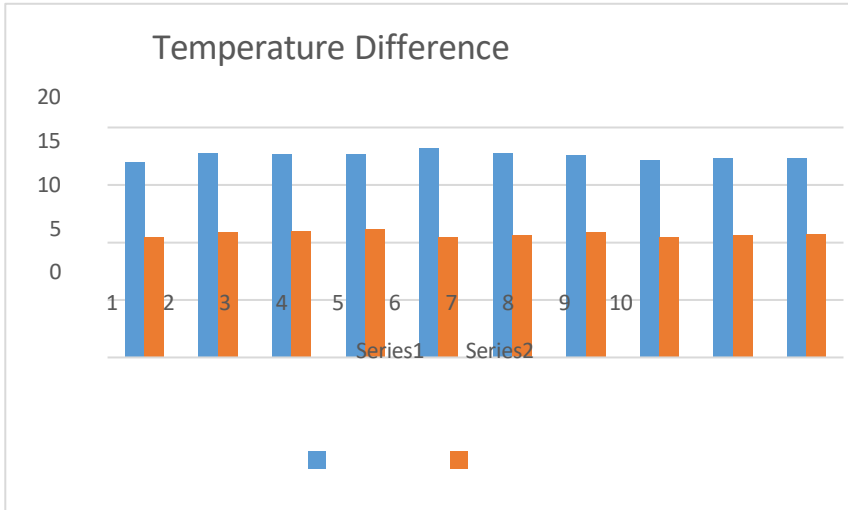
Left side = Cherries Right side = Bananas

The goal of these experiments is to increase lifespan for both bananas & cherries vary stating that their requirements are different, they have varying needs. One fruit needs to be cool while the other is harmed through cold temperatures. That's why in the container designed has two designated areas for fruits, the farther one from dry ice compartment is the one for higher-temp needed fruits. Comparing both experiments has shown that a thermal solution applied can greatly increase lifespan of the fruits by an additional 5 days. It is a necessity that can prove vital when

transporting products of strict temperature requirements. The figure indicates how different the farther side from the cooling compartment handles the fruits, while the closer one is almost to 5 degrees Celsius cooler.

B) Trial 2:

Here we conducted the 2nd experiment, and the results will be compared with the first Trial results, the first experiment was with Ice, in room temperature and with no heat insulating materials or paint. However in this trial we implemented Heat Insulation paint coat to the container.



- Condition: room temp, heat resistant coat, normal ice
- Technical error: heat insulation coat was missing in the bottom of the shelf + the insulation was not perfect and can be improved
- Human Error: ice was melting and was not filled on time

Series 1 indicates banana compartment temperature, series 2 indicates cherries compartment temperature

Right Side of shelf	Left Side of shelf
17.0	10.5
17.8	10.9
17.7	11
17.7	11.2
18.2	10.5
17.8	10.6
17.6	10.9
17.2	10.5
17.4	10.6
17.3	10.7
17.57	10.74

Left side = Cherries Right side = Bananas



In this temperature readings it showed a significant improvement in lowering the temperature which would improve the lifespan of the bananas & cherries in addition to other fruits. This can be significantly improved if there were no technical and human error involved while getting the readings such as getting a better coating and maintain the shelf by providing it by ice the entire time. This might have affected & raised the temperature by 2 degrees Celsius. Moreover if dry ice was used in this shelf the temperature would be stable in an extremely cold place and most importantly there would be no need of filling the shelf with ice on short periods of time.

Conclusion:

This experimental research focuses on the most important aspects of preventing banana and cherry waste. There are several factors that might impact wastage, including shelf life, packaging, delivery time sensors, and pricing. However, one of the important factor which has been observed during the experiment is heat insulating coating on shelves. Industries can increase the shelf life of perishable items by painting the shelves with heat insulator which are cost effective and at the same time can save significant energy in their warehouses.

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