



Using EPP Boxes in a Dark Store: A New Approach to Simplify Food Retail E-Commerce Deliveries

Eduardo Pintado

Instituto Superior de Contabilidade e Administração do Instituto Politécnico do Porto, Porto, Portugal

Lia Coelho de Oliveira

INESC TEC, Porto, Portugal, and Polytechnic Institute of Viana do Castelo, Portugal

Jorge Esparteiro Garcia

ADiT-LAB, Polytechnic Institute Viana do Castelo and INESC TEC, Porto, Portugal

Abstract

Background: E-commerce has emerged as a good response to the pandemic of COVID-19. However, the costs of providing a service, which includes a driver and a vehicle, in a regular vehicle that can transport goods that need positive cold (0° to 5°C) are very high. **Objectives:** This paper aims to investigate how a big Portuguese retailer company can reduce its dependence on refrigerated vehicles, simplifying operations and reducing the costs of transporting positive and negative cold food. **Methods/Approach:** This research was carried out in a food retailer Portuguese company, more precisely in a Dark Store dedicated to the online channel. The study was developed based on the AS-IS/TO-BE process analysis methodology, starting with the analysis of the current situation, giving rise to the so-called AS-IS model. **Results:** It was possible to reduce costs associated with transporting positive cold goods. As a result, there are 30% fewer costs associated with order transportation. With an additional 10% in space optimization with the gain of space within the galley of each vehicle. **Conclusions:** The costs of transporting positive and negative cold foods were decreased, and substituting vehicles with room temperature transport reduced the need for refrigerated vehicles.

Keywords: E-commerce; Transportation; Sustainability; Dark Store; Food Retail; Case study

JEL classification: L81, L91, Q56, L16

Paper type: Research article

Received: 02 Feb 2022

Accepted: 16 Oct 2022

Citation: Pintado, E., Coelho de Oliveira, L., Esparteiro Garcia, J. (2022), "Using EPP Boxes in a Dark Store: A New Approach to Simplify Food Retail E-Commerce Deliveries" Business Systems Research, Vol. 13 No. 3, pp. 130-143.

DOI: <https://doi.org/10.2478/bsrj-2022-0029>

Introduction

In the last decades' food retail structures have evolved rapidly, initially transitioning from traditional stores to supermarkets and, in a second phase, from supermarkets to the online market (Lu & Reardon, 2018). This evolution did not invalidate the other structures' existence; it required organizations to find new models of managing their supply chains that would allow hybrid structures between offline and online food retail channels (Wuang & Ng, 2020). Traditional food retail has been changing a lot in recent years, and this is due to new technologies such as smartphones and tablets, software such as apps, digital coupons, and mobile payments. Technologies enable an optimized interaction between the customer and the company. With this new scenario, it has been seen that cross-channel and multichannel models have been moving towards an omnichannel model, in which the full integration of the various channels shapes the service interface and creates a perfect experience for consumers (Alves et al., 2021). More evident in Western Europe and the United States, this evolution has been driven by consumer characteristics and the need to reduce infrastructure costs, enabling the offer of more competitive prices, as described by Oliveira et al. (2023).

Nowadays, people have less and less time and want everything as immediate and simple as possible. The food retail industry responds to this reality with a continuous effort to reduce the complexity and the number of actions required by the consumer from the moment the need arises to the purchase (Martins et al., 2020; Cosimato & Troisi, 2015). According to Deloitte (2017) in the Global Powers of Retailing 2017 study, four trends are crucial for the food retail sector, namely the development of value-added digital skills, combining channels to make up for lost time, creating unique and engaging store experiences; the reinvention of food retail with new emerging technologies (Deloitte, 2017). The advantages of shopping online are numerous since you no longer spend your precious time doing other more productive tasks than daily going to a supermarket and being bombarded with stimuli to purchase items that are unnecessary or waste time to be with the ones you care about most. It is safer in times of pandemic. However, there is a need for robots that have an algorithm in your automation that allows you to understand the intensity of touch they should exert when choosing a particular food, nor the color to be easy to associate with the taste registered in the system by the customer (more mature or greener). Today, they work daily to meet the needs of several people, and sometimes the article may not come out in ideal conditions or according to expectations. Or it may not be dispatched at all. Supply chains face recovery from the disruption caused by the 2020 pandemic event. At the end of 2019, the world was exposed to an unprecedented pandemic crisis that has cost high human losses characterized by a frightening speed of propagation. As the scientific community developed an answer, the economic impact was quick. Supply chains were in crisis because of the government restrictions, like social distancing, remote work, and restaurants and schools closed, as measures to control COVID-19. Additionally, the need for isolation and new human behaviour quickly influenced the nature of business (Bhatti et al., 2020). As a result, online commerce has increased rapidly, triggering problems along supply chains that have faced operational difficulties and the capacity to respond. Within days, the food retail sector began to feel pressure, increasing delivery times, reducing supply, and overloading its technological systems (Lone et al., 2021). In the first phase of the COVID-19 pandemic, we witnessed the purchase associated with panic; then, due to scarcity, the idea emerged that it was necessary to create stock, combining contradictory information. As a result, it was not difficult to observe the disruption of supply chains worldwide. The stockouts created even more stress on consumers as

supply chains looked for new solutions and faced problems caused by COVID-19. Many suppliers even went into production disruption (Campisi et al., 2021). With the evolution of the pandemic, and the perception of its infectious severity, customers favored online channels for security reasons. In this scenario, E-commerce emerges as a good response to this reality, offering a wider range of products (including products that are not available in stores) and providing an unimpeded offer in terms of access without the consumer having to worry about the crowd, decisions transportation, weather conditions, and parking (Bhattim et al., 2020). Also, the technological advances witnessed in recent decades have led to a growing recognition of the possibility of online shopping (Jiang et al., 2013). Before the pandemic, the market was already expanding; it is evident that the convenience for the consumer to be able to buy what they need for their home online. For instance, with the growth of solutions such as Alexa or Siri, linked to the refrigerators and cabinets themselves, in the future, with just voice recognition, it may be even easier to order the items that are missing for the nearest dinner. However, purchasing fresh items that lack a visualization and touch on the product still suffer some resistance when buying them. The food retail sector was expanding in a structured manner with a focus on customer satisfaction and increasing the information spectrum throughout the supply chain. In 2019, the sector followed the growth trend of previous years with an EU-wide average of 10%, but 2020 exceeded all expectations with an average of 50%. (McKinsey Company, 2021). In this context of the evolution of e-commerce in the retail sector, the present investigation arises. For instance, the food retail case study presented in this paper increased by 80% in 2020 versus 2019, only accounting for e-commerce. This combines the need to increase the offer in the distribution channel (reduction of lead time) at the lowest possible cost in association with high levels of service. During the first confinement, operations and the site were unprepared for the surge due to the Covid-19 pandemic. However, the case study company saw an opportunity related to the distribution of products packaged in the positive cold (0° to 5°). This distribution requires refrigerated road vehicles, resulting in higher diesel consumption and lower availability. If the costs of providing a service, which includes a driver and a vehicle, are three times higher when comparing a regular vehicle that can transport goods that need positive cold (0° to 5°C) compared to a vehicle that can only transport goods that are at room temperature. The focus on sustainability has increased over the years; the company's strategic plan aligns with the 2011 White Paper (Kallas, 2011) for the reduction of CO₂ emissions. The integration of a zero-emission vehicle is expected in the short term.

This paper aims to analyse how retailer companies reduced their dependence on refrigerated vehicles, reducing the costs of transporting products from online orders in vehicles. In doing so, aspects such as Savings in service provision costs with vehicles with EPP (Expanded Polypropylene) boxes; Savings on diesel costs (in refrigerated vehicles, diesel consumption is higher); Ensuring better product quality; Reducing waste products when the delivery is not made; Cost savings in trading on a larger scale with non-refrigerated vehicles (the number of non-refrigerated vehicles increase, so the price per vehicle decreases) were analysed in the light of the replacement of these regular vehicles. To meet these needs, delivery vehicles should have at their rear a truck body capable of receiving a refrigeration system directly linked to the vehicle's energy consumption, which in turn implies a greater diesel consumption during the trip (Margaritis et al., 2016). And a project that promotes sustainability improvement does not require an increase in costs. On the contrary, Competitiveness and Sustainability are sides of the same coin; as society strengthens the power of consumers, this relationship is a powerful weapon for innovation and

value creation (Cosimato & Troisi, 2015). As is well known, transport is one of the heaviest items in monetary terms of a supply chain manager, which involves the physical movement of a product from one point to another.

For this reason, food retailers and online commerce struggle daily to reduce their costs per unit of movement without penalizing product quality. These cost savings must be higher than the investment costs in thermal plates, EPP (Expanded Polypropylene), and BLE (Bluetooth Low Energy) sensors, as well as the manual work of placing the products in these same boxes, associating, and disassociating orders from the respective sensors to obtain temperature tracking per order box. The properties of EPP include good heat resistance, good chemical resistance, and good characteristics as a thermal insulator. EPP does not absorb water but is nevertheless permeable to water vapor and other gases. (Maier & Haber, 1998).

In related work, Casson et al. (2021) proposed investigating the environmental performance of the expanded-polypropylene (EPP) box production process to improve sustainability in catering services. Their work quantified the environmental benefit of using the EPP box instead of conventional packaging. Furthermore, in another related work, Mohebi et al. (2015) highlighted an overview of existing commercial sensors for monitoring meat stability and its shelf-life, discussing sensors that have been applied to monitor different kinds of meat, such as pork, fish, beef, and shrimp. In addition, they also reviewed the integration of these sensors into the meat packaging technology and compared their advantages and disadvantages in the meat industry. Alberto Lopes et al. (2019) demonstrated that heat treatment of semi-crystalline polymeric food contact cups in EPP boxes could lead to changes in the degree of crystallinity. Physical changes were also observed on the surface of the material. The variation in crystallinity affected the specific migration of several substances. However, they were only observed at temperatures above 40 °C.

The document comprises an introduction that addresses the investigation's context, description, and objectives. Subsequently, it is presented the methodology used in this research paper. Afterward, the Main Findings are presented, where it is possible to discover more about the company's dynamics and what led it to discover that it could innovate to reduce its ecological footprint and costs in your operating account. Then, a discussion of the main findings obtained during the development and implementation of this research is made. Finally, the last chapter considers this investigation, and the next steps for implementing the project at the company are presented.

Methodology

This investigation was carried out in a food retailer Portuguese company, more precisely in a Dark Store dedicated to the online channel. In this structure, orders are delivered daily to meet the requests of your online store. In these orders, all items must be transported at the required temperature (ambient, refrigerated, or frozen) not to lose the characteristics that give them quality or, in certain cases, the possibility of being consumed.

The study was developed based on the AS-IS/TO-BE process analysis methodology, starting with the analysis of the current situation, giving rise to the so-called AS-IS model. After its study and identification of inefficiencies, a set of improvements (translated into actions) are presented, thus exposing the desirable situation for the process, conceiving the so-called TO-BE model.

The opportunity identified in the context of this research is linked to the fact that it is necessary to increase the level of customer service at the lowest possible cost in a short period, which is why the refrigerated transport replacement project was created,

which allows for a reduction in dependence on this type of vehicle, increasing fleet availability associated with cost reduction, on delivery to the final consumer, ensuring that the temperature is maintained throughout the supply chain (Cosimato & Troisi, 2015; Deloitte, 2017).

For reasons of confidentiality, no cost will be disclosed. In the next chapter, the logistical process within the Dark Store will be presented to understand the changes that had to be made to implement the efficiency project. The development and implementation of this project took place between the first and second waves of confinement caused by COVID-19, allowing the company greater flexibility in its supply chain to avoid the disruption experienced in the first wave.

Main Findings

The Dark Store used for this case study has 6 000 square meters. This distribution center is very similar to a supermarket but without clients.

In stock, this has high and medium rotation products arranged in a practical layout to ensure that everything is accessible to the operators, minimizing distances and times required during the picking operation. Three times per day, an offline store (the same company's supermarket) sends the fresh product (e.g., meat, vegetables, fruit) and the long-tail items needed for orders. To satisfy the daily demand, the layout of Dark Store has six departments: reception, picking, consolidation, shipping, replacement, and quality control. In the first phase, an AS-IS analysis was carried out to identify gaps in the operational process; we mapped the product flow from the arrival of the order to the return of the vehicle to the Dark store.

The most obvious bottleneck was in the dispatch process created by the vehicle typology and the inherent characteristics of the whole process. Thus, we proceeded to develop the desirable situation through a TO-BE analysis, presenting a set of improvements obtained through a set of actions.

AS-IS PROCESS

As mentioned above, Dark Store consists of 6 functional departments, whose functions will be described below:

- Reception – is responsible for ensuring the reception of items sent to the Dark Store from the Azambuja Distribution Center and the Support store. This department registers all stock or order movement entries (parts of orders) in the system.
- At the end of the flow, the reception also acts on the return of empty boxes and their respective cleaning near the loading/unloading docks. This department is also responsible for recording all products that return from the customer (e.g., the customer was not at home and did not receive the order).
- If it is a temperature-controlled food item, it is recorded as broken since its quality cannot be guaranteed (e.g., frozen food, yogurt, vegetables).
- In cases of non-food items (e.g., broom or shower gel), this item is moved back into stock.
- The quality department inspects the remaining cases before being returned to stock.
- Picking - is responsible for ensuring the preparation of orders per customer in the following circuits: Sweet and Savory Grocery; Drinks (juices, water, wines, and spirits); Milk and eggs; DPH (Drug shop, Perfumery, and Hygiene); Non-food (ironing boards, dishes); Fresh (Fruits & Vegetables, Delicatessen, Butcher and Fishmonger); Frozen.
- Each of these circuits has its team that alternates its area of action as needed.

- Consolidation - At the end of preparation, the boxes of a given order, the CHEP boxes (boxes used for preparing items), are stacked by customer and route (the trip number defined by the router that aims to optimize the delivery of orders by different postal codes), in an area called expedition marshaling.
- Shipping - is responsible for ensuring that orders are loaded in the correct order and that the number of boxes shipped is equal to the number of boxes prepared for that route (it's a manual process - still).
- Replacement - is responsible for ensuring the replacement of items in the defined locations to avoid stockouts or process inefficiencies (example: return from stockout - order preparer returns to the position where the item was missing at the end of preparation or goes to another location of over, but that wastes more time in moving).
- Quality Control is responsible for ensuring that the items sent to the customer are in the conditions defined by the central quality control, within the required validity period, and at what temperature the cold transport vehicles leave and return.

Based on the process mapping and analysis, the following opportunities for improvement were identified:

- During the picking process, the products had a temperature rise, although the process ensured fast movement between the cold rooms and the vans;
- The contracted transport vans were prepared for the transport of positive cold items, making it also possible to transport products that only need room temperature (unnecessary), being necessary to place frozen orders in boxes with lining and eutectic plates to ensure the temperature;
- During the distribution process, the inside temperature changes due to the consecutive openings of the vans' doors during the stops at the customer's homes, which causes the loss of cold, the loss of quality, and customer dissatisfaction;
- The consultation of the temperature of the vans required a manual request to the carrier to obtain the temperatures at which the vans were at the beginning and end of the trip, not being possible autonomy in the control or tracking of temperatures along the route.

TO-BE PROCESS

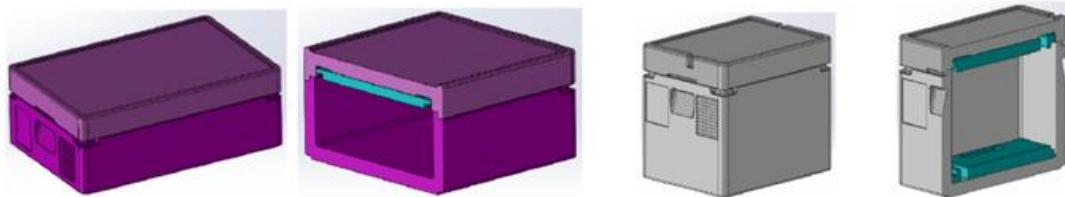
To reduce all costs inherent to the process, transport, and product quality inefficiencies, which includes the investment of two new tares (EPP boxes), it was necessary to create new functions/tasks within the Dark Store. Figure 1 shows the conceptual model of the EPP Boxes and the eutectic plate.

Figure 2 presents how the Dark Store layout is divided in a macro way, identifying the areas related to this new process. The final process this research implemented will be analyzed in detail throughout the explanation below. The processes presented will only refer to positive cold and negative cold goods.

These EPP Boxes are produced using expanded polypropylene (EPP). This material is resistant to touch, insulating, can be stacked on other boxes, and is extremely light. The characteristics that compose this product not only guarantee the quality required by the project at the insulation level but are also very useful in operational terms, being a light to facilitate handling. Resistant, because they will be transported on different types of equipment and platforms, and because they can be stacked on top of each other, they optimize the space between them throughout the logistic chain, as well as the possibility of being stacked on CHEP boxes (green boxes used for transporting fruits and vegetables), which are standard used worldwide through a pooling system. There

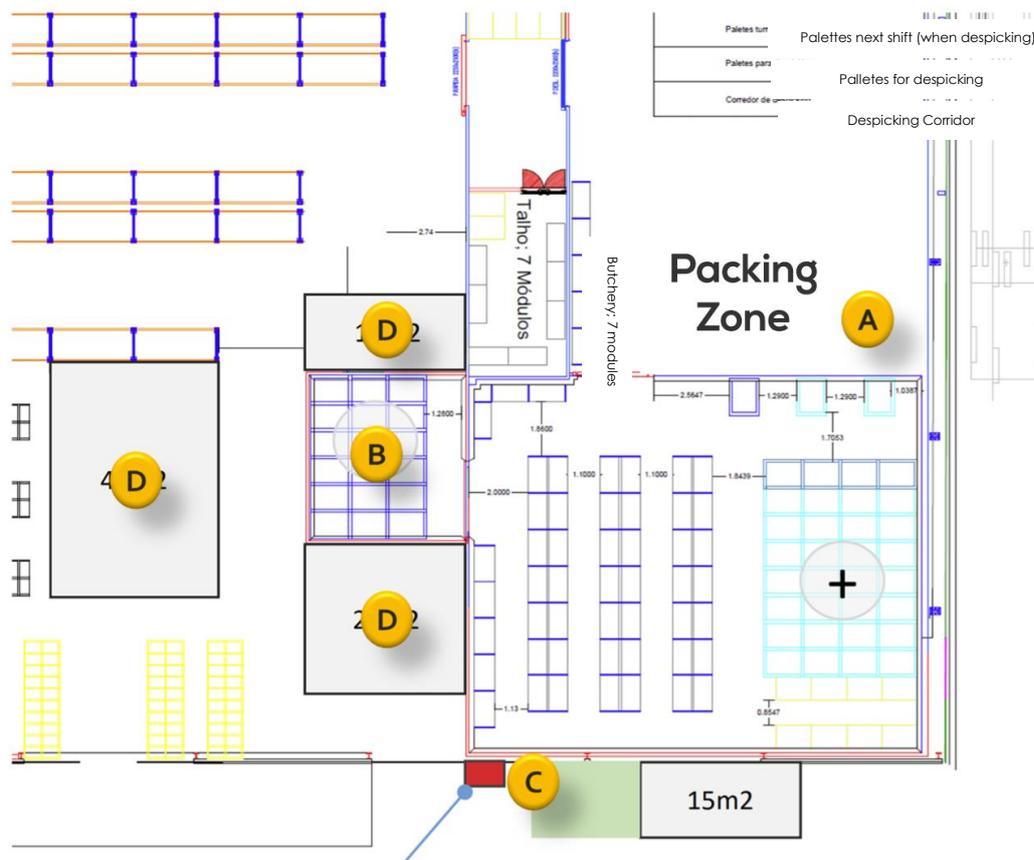
are two bins: EPP Refrigerated bins and EPP Frozen bins. The EPP Ref box measures 600x400x270mm, and the EPP Cong boxes measure 400x300x350mm. Each box allows the placement of 2 eutectic plates. One plate is fixed on the lid of the box, and the other box is on the base inside the box. The products are in the middle of the box. Eutectic plates contain a solution that mixes water with salts, whose melting point (or freezing point) is constant and lower than that of water. Two types of plates were purchased for this project.

Figure 1
EPP Boxes and eutectic plate



Source: self-elaboration

Figure 2
The layout of the process inside the Dark Store



Source: self-elaboration

An orange plate allows for reaching the freezing point at -12°C (B- refrigerated), and a blue plate with a higher freezing point, -21°C , for the frozen operation. The logistics of eutectic plates within Darkstore was one of the processes that were born with the implementation of this process. At the end of order preparation (positive cold), the orders are placed inside the respective EPP boxes together with the eutectic plates. This packaging is carried out in the identified zone A. The eutectic plates are supplied whenever necessary from zone B to zone A inside the Darkstore. In this packaging process, the process is as follows:

Step 1: Preparation of the EP Box - Opening the respective EPP box and place a eutectic plate corresponding to the box type at its interior and a plate on the lid.

As previously mentioned, these are very resistant to touch, are insulating, can be stacked, and are extremely light. The characteristics that make up this product not only guarantee the quality required by the project in terms of insulation but are also very useful in operational terms, being a light to facilitate handling. In the project, two types are used - Refrigerated and Frozen.

Step 2: Product Placement - Products from a particular order box (each order can have multiple order boxes) are placed inside the EPP box.

Step 3: Order Tag change location - The order box contains a label that identifies the respective order and associated route information in addition to its order box identification.

This label is taken from the old box where products are placed during preparation (green CHEP box) and placed in a plastic bag in the respective EPP box.

Step 4: Order Association to EPP box - The application created for this research follows the process of associating orders to the respective EPP boxes (using equipment ZebraZT57).

In this process, the employee must enter the cold box application, choose the option associate order, and then read the bar code of the EPP box (BLE Sensor) and prick the order box code.

After entering both codes, the employee must press the associate option.

Step 5: Shipping the boxes - Then, the boxes are taken to the dispatch marshaling to a position identified with its route number (see Figure 3). They are stacked in towers containing the three different temperatures for the same order (positive, negative, not refrigerated).

When leaving the Dark Store, the number of boxes is counted for future validation on its return.

This process also facilitates the driver's work when he arrives at the customer's house and must identify the respective order. Instead of visiting two spaces with different temperatures to collect order boxes, the same order is stacked in 1 or more columns. When the driver returns to the Dark Store with empty EPP boxes or with the product, they are placed in zone C.

Figure 3
EPP Boxes and eutectic plate



Source: self-elaboration

Now, at Zone C, it starts the inverse logistics process. The following steps are very important to support the daily supply of equipment and to reduce waste:

Step 6: Verification of number and exterior status - If any box is missing, an alert is triggered to inform the logistics partner.

Physical separation of Refrigerated EPP and Frozen EPP boxes to avoid storing different boxes in the same place.

Checking whether the box contains one or more undelivered items.

Step 7: Checking Current Temperature - If the box has a product, the employee carrying out this process must have a ZebraZT57 terminal with him to check if the temperature is within the correct temperature.

The app is used to perform this instant collection.

Step 8: Replacement of the item as in stock - In case it is at a temperature, according to this article, it returns to its stock position, avoiding food waste and breakdown costs.

Step 9: Placing the plates back into freezing - The eutectic plates are removed from the boxes and placed in the respective dolis of each type of plate. These, when full, are transported by the wheels that support them to the freezing chambers located in zone B.

Step 10: Disassociation of empty EPP boxes - the empty EPP boxes are stacked in EURO pallets and taken to a gantry equipped with Gateways that collect the temperature data (BLE Sensors), creating a history.

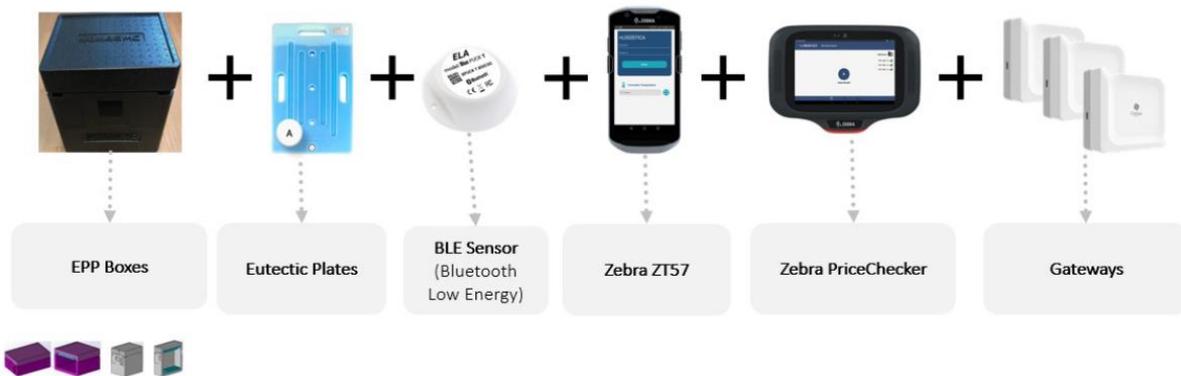
Afterwards they disassociate the box from the products it transported on the previous trip. These operations are triggered through a tablet at the entrance of the gantry (ZebraPriceChecker).

This pallet with the empty boxes is placed in one of the D zones for storage, depending on the type of tare.

This new process allows real-time traceability of any boxes transported, thus ensuring the legislative standards of health and hygiene in transporting perishable goods and controlled temperatures.

This is a cost-efficiency project, but it also has an innovation component for connecting several types of technological equipment to obtain the expected result. In Figure 4, it is possible to observe the several pieces of equipment mentioned above that allowed the process to be changed.

Figure 4
Process Equipment's



Source: self-elaboration

As mentioned in Step 1, the EPP boxes need the eutectic boards to ensure the correct temperature. Associated with these is a BLE sensor which consists of a Bluetooth low energy sensor (lower energy consumption and costs, ensuring similar communication and range) that allows autonomous temperature capture, being robust and waterproof.

This sensor is associated with the parcel at Step 4 to ensure information collection and disassociated at Step 10 with the help of Gateways. The sensors collect the temperature every 15 minutes. The Gateways collect the information from the sensors in 1 minute and can read 48 simultaneously. ZebraZT57 and Zebra Price Checker allow the insertion and access to the data in the developed app.

Discussion

The reduction in operational costs was achieved by reducing costs associated with transporting positive cold to customers' homes since it now only uses vehicles with room temperature transport. The macro estimate realized was 30% fewer costs associated with order transportation. With an additional 10% in space optimization (routes allocated to a given vehicle) with the gain of space within the galley of each vehicle.

The reduction in daily use from 30 refrigerated vehicles to normal vehicles directly impacts the ecological footprint reduction. However, the fact that more boxes requiring plates were purchased cannot be ignored, contributing to the increase in energy effort in the refrigeration chambers. Although the figures are lower, we do not have the ratio.

The Dark Store can now centralize over 300 more refrigerated and frozen items due to the loss of the need to ensure that the packaged product is inside the respective chambers. Today this product goes directly to the shipping marshaling without the

intervention of the supermarkets. This way, the intervention of the support stores was reduced, contributing to increasing the process's capacity and agility.

As explained in the definition of the receiving concept, the Dark Store, which continues to receive stock returning from orders that were not delivered for various reasons, now has a chance to check if the products conform (if the temperature and expiration date are met) and put them back in stock. This translates not only into an economic benefit, given the savings in the items that no longer go directly to the garbage, but also decreases the food waste index of the company.

Regarding the increase in food safety, this happens due to the tracking of the articles' temperature from the moment they leave the chambers until they arrive in the best conditions at the customer's house or return to stock.

This project involved an investment in the human process (packaging, association, disassociation, and management of containers), annual Capex of the project (amortization of technological devices), and increased consumption of consumables (boxes, plates) and electricity; however, in the end, the study proved that the direct economic benefits associated are greater than the costs and in the short term a different potential is expected due to the greater occupation of the routes.

Finally, it was possible to achieve a significant reduction in the loss of boxes and eutectic plates and a substantial reduction of losses with the recovery of refrigerated goods. In addition, with the elimination of distribution through refrigerated vehicles, there has also been a marked reduction in fuel consumption and much higher availability because refrigerated boxes are now used without the need for the specific use of this type of vehicle.

Conclusions and Future Research

The pandemic scenario we are currently experiencing has brought the acceleration of these types of solutions, not only because more online commerce is consumed in its chain with solutions identical to the ones we have seen throughout this paper but also in the backstage of the stores.

At the end of this research work and through the combination of new technologies that allow for collecting product information, it was possible to implement new products for Transportation (frozen and fresh). The replacement of vehicles was accelerated by the growth of the company's e-commerce channels, which allowed for a better level of service, increased operational capacity, and a reduction in financial and environmental costs. It is also possible to understand how products can be transported with quality and safety to all customers of the Dark Store.

This work allowed the identification and implementation of an opportunity for improvement in the distribution chain of the online store. With its implementation, it was possible to reduce operational costs, decrease the ecological footprint, increase the capacity and agility of processes, reduce food waste, and increase food safety.

This paper also presents a solution for monitoring temperatures during deliveries in a food retail supply chain to increase flexibility. The 80 percent growth in demand in the online market has created the need to implement new, more efficient processes. In this research was also possible to reduce costs associated with transporting positive cold to customers' homes since it now only uses vehicles with room temperature transport. The macro estimate realized was 30 percent fewer costs associated with order transportation. With an additional 10 percent in space optimization (routes allocated to a given vehicle) with the gain of space within the galley of each vehicle. Furthermore, because refrigerated boxes are now used instead of refrigerated vehicles, there has been a significant reduction in fuel consumption and a

considerably higher availability because of the elimination of distribution via this type of vehicle.

One of the limitations of this work was that it was not possible to use EPP boxes with all types of products, which would have allowed even greater cost savings. Due to the limitation of the box size, only some products can be transported in these conditions. In this study, it was also not possible to monitor all transports comprehensively, so it is expected in future studies that a more detailed analysis of cost reduction per delivery and type of product will be done.

As future work, we are investigating the possibility of integrating the temperature at which the item arrived at the customer's home to be visible on the order invoice. Also, it is intended to study how to print the boxes on a 3D printer to save the cost per EPP box further. Finally, we want to improve the Operational Efficiency (FTE Packaging and FTE Container) and pick directly from the EPP box.

References

1. Alberto Lopes, J., Tsochatzis, E.D., Robouch, P., Hoekstra, E.J. (2019), "Influence of pre-heating of food contact polypropylene cups on its physical structure and on the migration of additives", *Food Packaging and Shelf Life*, Vol. 20, June 2019, 100305
2. Alves, S., J. Serra da Fonseca, M., Esparteiro Garcia, J., C. de Oliveira, L., Teixeira, A. (2021), "The omnichannel strategy in portuguese companies: an overview", *The omnichannel strategy in portuguese companies: an overview*. In 2021 16th Iberian Conference on Information Systems and Technologies (CISTI) (pp. 1-6). IEEE.
3. Bhatti, A., Akram, H., Basit, H. M., Khan, A. U., Naqvi, S. M., Bilal, M. (2020), "E-commerce trends during COVID-19 Pandemic", *International Journal of Future Generation Communication and Networking*, Vol. 13, No. 2, pp. 1449-1452.
4. Bhatti, A., Akram, H., Muhammad Basit, H., Usman Khan, A. (2020), "E-commerce trends during COVID-19 Pandemic", *International Journal of Future Generation Communication and Networking*, Vol. 13, No. 2, pp. 1449-1452.
5. Burke, R. R. (1997), "Do You See What I See? The Future of Virtual Shopping", *Journal of the Academy of Marketing Science*, Vol. 25, No. 4, pp. 352-360.
6. Campisi, T., Russo, A., Tesoriere, G., Bouhouras, E., Basbas, S. (2021), "COVID-19's Effects over E-commerce: A Preliminary Statistical Assessment for Some European Countries". *ICCSA 2021: Computational Science and Its Applications – ICCSA 2021*. 12954, pp. 370-385. Italy: Springer.
7. Casson, A., Giovenzana, V., Tugnolo, A., Pampuri, A., Fiorindo, I., Beghi, R. and Guidetti, R. (2021), "Assessment of an expanded-polypropylene isothermal box to improve logistic sustainability of catering services", *Journal of Agricultural Engineering*, Vol. 52, No. 2., 111:1139.
8. Cosimato, S., Troisi, O. (2015), "Green supply chain management: Practices and tools for logistics competitiveness and sustainability", *The DHL case study*. *The TQM Journal*, Vol. 2.
9. Deloitte. (2017), "Global Powers of Retailing 2017: The art and science of customers". Deloitte. Available at: <https://www2.deloitte.com/content/dam/Deloitte/global/Documents/consumer-industrial-products/gx-cip-2017-global-powers-of-retailing.pdf> / 30th March, 2022
10. Jiang, Q., Tan, C. H., Chi, J., Phang, C. W., Wei, K. K. (2013), "Offline and online channels for customer relationship management: An investigation in the inter-organizational context". *Proceedings - Pacific Asia Conference on Information Systems, PACIS*, 150., Available at <https://aisel.aisnet.org/pacis2013/150> / 30th March, 2022
11. Kallas, S. (2011), "White Paper on Transport: Roadmap to a Single European Transport Area - towards a Competitive and Resource-efficient Transport System", Office for Official Publications of the European Communities. Available at: <https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2011:0144:FIN:en:PDF> / 30th March, 2022

12. Lone, S., Harboul, N., Weltevreden, J. (2021), "2021 European E-commerce Report", Hogeschool van Amsterdam. Available at: <https://ecommerce-europe.eu/wp-content/uploads/2021/09/2021-European-E-commerce-Report-LIGHT-VERSION.pdf> / 30th March, 2022
13. Lu, L., Reardon, T. (2018, July), "An Economic Model of the Evolution of Food Retail and Supply Chains from Traditional Shops to Supermarkets to E-Commerce", *American Journal of Agricultural Economics*, Vol. 100 No. 5, pp. 1320-1335
14. Maier, C., Haber, T. (1998), "Polypropylene : the Definitive User's Guide and Databook", Elsevier, Netherlands
15. Margaritis, D., Anagnostopoulou, A., Tromaras, A., Boile, M. (2016), "Electric commercial vehicles: Practical perspectives and future research directions", *Research in Transportation Business Management*, Vol.18, pp. 4-10.
16. Martins, M., Nabeiro, R., Pires, N., Tenreiro, S. (2020), "O Futuro é Hoje: Uma nova visão para Portugal", Lisbon, Cultura
17. McKinsey Company. (2021), "A year like no other for European grocery retailers: The state of the industry post 2020". Available at: <https://www.mckinsey.com/industries/retail/our-insights/a-year-like-no-other-for-european-grocery-retailers-the-state-of-the-industry-post-2020> /6th December, 2021
18. Mohebi, E., Marquez, L. (2015), "Intelligent packaging in meat industry: An overview of existing solutions", *Journal of food science and technology*, Vol. 52, No. 7, pp. 3947–3964.
19. Oliveira, LC., Pavlenko, O., Garcia, JE. (2023), "Reducing Environmental Impact Using Vehicle Route Planning", *Lecture Notes in Mechanical Engineering*, pp. 248-256.
20. Wang, X., Ng, C. T. (2020), "New retail versus traditional retail in e-commerce: channel establishment, price competition, and consumer recognition", *Annual of Operations Research*, Vol. 291, pp. 921-937.

About the authors

Eduardo Pintado has received an MSc in Logistics at the Porto Accounting and Business School of Polytechnic Institute of Porto. He has worked at companies like DHL Express, SONAE MC, Voltalia, and GKN Automotive. His main research interests are Logistics, Project Management, Product Management, Lean Manufacturing, and Business Development. The author can be contacted at eduardoluispintado@gmail.com

Lia Coelho de Oliveira is an Adjunct Professor at the University of Aveiro and an Adjunct Professor at the Polytechnic Institute of Viana do Castelo. She received her Ph.D. in Engineering Design and Advanced Manufacturing at MIT Portugal, a collaboration between the University of Porto, University of Lisboa, University of Minho, and Massachusetts Institute of Technology (MIT) with a thesis titled "Dealing with uncertainty in supply chain design in the automotive industry". Her main research interests are Logistics, Supply chain management, Warehouse Management, and Transportation. The author can be contacted at liaoliveira@esce.ipvc.pt

Jorge Esparteiro Garcia has been an Adjunct Professor at the Polytechnic Institute of Viana do Castelo (IPVC) since 2005/2006. He is a Researcher at ADiT-Lab of IPVC and an Affiliated Researcher at INESC TEC, Porto. Received his Ph.D. in Informatics Engineering from the Faculty of Engineering - University of Porto (FEUP) with a thesis titled "Requirements Change Management based on Web Usage Mining". He received his master's degree in informatics engineering from FEUP and his bachelor's degree in Computer Science from the Faculty of Sciences - University of Porto (FCUP). His main research interests are software engineering, requirements management, and logistics. The author can be contacted at jorgegarcia@esce.ipvc.pt