ANALYSIS OF LAST-MILE LOGISTICS IN SHORT AGRI-FOOD SUPPLY CHAINS

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Abstract

The purpose of this paper is to analyse and describe empirically the practices of Last Mile Logistics (LML) in Short Agri-food Supply Chains (SASC) of fruit and vegetable sector in south-east Spain, and their contributions to sustainability.

For this objective, a case study methodology was used, to study a Agri-food Supply Chains (ASC) in the South Spain that has developed SASC with LML. The case study was focused in a successful SASC that commercialize a box of fruits and vegetables in collaboration with the LML operator. Their ecommerce and integration with their LML supplier were analyses through stakeholder meetings to develop a cocreation process. Semi-structured interviews were also conducted with LML operator to identify the requirements and particularities needed for successful deliveries, which add sustainability and proximity to the end market, helping towards healthier consumption, and avoiding food waste

The paper offers a novel perspective by identifying and analysing the positive and negative contributions of LML to each of the dimensions of sustainability of SASC. The limitations that can be found in the study derive from the fact that it was focused on a fruit and vegetable cluster with very particular characteristics. The specificity of the context may restrict the generalization of LML recommendation in other Food Supply Chains such as meat, fish, oils and fats, and dairy products. On the other hand, this study analyses LML in an unexplored sector due to the novelty of the business model recently implemented in SASC.

Keywords: last mille logistics, e-commerce, sustainability, agri-food short supply chain

1. INTRODUCTION

Traditionally, Agri-food Supply Chain (ASC) has been considered as separate models from Short Supply Chain (Chi Ffoleau and Dourian, 2020). While the first ones are usually oriented towards mass distribution, the second ones tend to focus on distributing agricultural products directly to consumers on a small scale. Recently, advances in information and communication technologies, as well as the development of economic, social and environmental sustainability practices, have driven the evolution of these models so that they can take advantage of synergies between them (Thomé *et al.*, 2021). Along these lines, in Spain (Navarro-del Aguila and de Burgos-Jiménez, 2022) have identified synergies between the two in the distribution of fruit and vegetables using a box model.

Spain is the main European exporter of vegetables, with a high concentration of agricultural companies in south-east Spain. This has led to the development of a strong Agri-food cluster with specialized research and transfer centers. In this agri-food cluster of fresh fruit and vegetables in south-east Spain traditional agri-food chains have a structure of farmers' associations that perform the functions of handler and marketer (Perez-Mesa and Galdeano-Gomez, 2010). In the last decade, some fresh fruit and vegetable producer organizations have created parallel short channels through which they also sell their products directly to the final consumer by their ecommerce. Deliveries to the consumer by short chains require specific capabilities that traditional marketer do not have developed yet and rely on specialised LML operators. However, the development of the SASC of fresh fruits and vegetables is constrained for the LML of these products. LML have to adapt to working with highly perishable, refrigerated (positive cold) and fragile products.

According to (Peppel and Spinler, 2022), LML refers to logistics operations at the final part of the delivery between the recipient and the final processing location, i.e. warehouses, depots, sorting centers or dark stores. This LM sector, including courier and parcel companies and new operators, has experienced tremendous growth, driven by the rise of e-commerce, which has also accelerated during the COVID-19 pandemic. LML is considered to be a resource-intensive process that requires continuous coordination between stakeholders. In addition, LML can also suffer from problems such as urban congestion and unattended deliveries by the consumer. In some cases they can lead to high returns, which can have environmental consequences (Mangiaracina *et al.*, 2015). There is also a perception that there are sometimes safety risks in this sector, and low labor wages (Verheyen and Kołacz, 2022).

In SACs, this type of logistics can contribute to healthier consumption by bringing the product to the final consumer faster and in better conditions. In this article it was analyzed the characteristics and contributions of LML to SASCs integrated in large exporting traders in the agri-food sector, thus providing a new perspective on the development of LML, which contributes with solutions that solve some of the problems that appear when operating in other sectors.

During the study, it was tried to answer the research question on how LML practices associated with the delivery of fresh fruit and vegetables are configured to improve the sustainability of SASC.



Sustainability is understood in this paper as an extension of the concept of sustainable development (WCED, 1997) which encompasses three dimensions (Munasinghe, 1993): social (including aspects such as culture, poverty or quality of life), economic (efficiency, growth, profitability) and ecological/environmental (natural resources, pollution, carbon footprint).

Although in these ASCs the volume of business in their short channel is very low compared to the traditional channel, they are developing the strategic capabilities necessary to meet the needs of the final consumer of fresh fruit and vegetables.

The characteristics and peculiarities of the LML operation are of special interest because they should have to facilitate the emergence of hybrid chains (conventional supply chains of fresh fruit and vegetables which are developing a SASC).

The SASC allow consumers' needs to be addressed in a more direct way without the need for many intermediaries that increase the prices paid by customers and reduce farmers' margins. The customer wants a variety of fresh products (fruit and vegetables) from the greenhouses. However, direct delivery from the farmer to the consumer presents a number of difficulties: food safety controls, the variety of products the customer wants, and the match between farmers' production and consumer demands. For all these reasons, a grouping of several farmers/producers is required, to which conventional chains respond (Jiménez-Guerrero *et al.*, 2018). The provisioning of the SASC have been resolved by conventional chains with a network of establishments close to the farmer where agricultural products are received and prepared for marketing (washing, calibration, packaging, residue analysis, etc.). However, the customer delivery logistics are required to enable the development of the SASCs, in which integration with the LML provider plays a fundamental role.

It was reviewed the growth of this paradigm in the sector within the specific fruit and vegetable agri-food cluster in which it was located, exploring whether this trend could be replicated in the rest of the agri-food industry and thus extrapolated to other agri-food clusters

2. MATERIALS AND METHODS

2.1 Theorical Background

Improved agricultural production and transport systems have shaped the current ASC model, characterized by mass production and distribution. The dominant ASC model is an extensive network of interconnected operators comprising specialized farmers, warehouses, handling companies, intermediaries, wholesalers and retailers that bring the product to the final consumer. This has led to the development of local agglomerations of enterprises, known as agri-food clusters (Simboli *et al.*, 2015).

Supply Chain (SC) according to (Flynn *et al.*, 2010) can be defined as a series of operations that ensure the production and distribution of goods in the right quantities, delivered to selected locations at the required time, to meet the needs of consumers.

In traditional ASC, large-scale distribution exercises a dominant position, which leads to a narrowing of margins at source and a distancing from the consumer (Thomé *et al.*, 2021). In order to provide a solution to this ASC model in which there is an

inadequate distribution of added value, ASSC are being developed in these organizations, giving rise to Hybrid Supply Chains (Navarro-del Aguila and de Burgos-Jiménez, 2022).

SASC can be defined as a ASC made up of a limited number of economic actors committed to cooperation, local economic development and socio-economic relations between producers and consumers in a close geographical area (Elghannam *et al.*, 2017), and with as few intermediaries as possible. This achieves greater sustainability and interaction between farmers and consumers and changes the relationship in the construction of value in these chains.

According to (Navarro-del Aguila and de Burgos-Jiménez, 2022) the hybrid fresh fruit and vegetable SCs that are emerging in south-east Spain on the supply side can benefit from economies of agglomeration, scale and scope that contribute to the sustainability of the agricultural model. These chains facilitate the fight against food waste by providing an outlet for sizes or products that at a given moment do not meet certain standards (e.g. size, color) established by the large distributor in the long chain but which are in perfect nutritional and physical condition.

Concentration in agricultural production allows effective and efficient access to advanced technologies. Mass production for large export-oriented SCs requires homogeneity and compliance with standards, which facilitates the reduction of production costs. However, SASCs are better adapted to the variability of agricultural production, as their product specifications can be more flexible and change rapidly. The flexibility and agility of short chains allows access to customer segments that particularly value certain product attributes (freshness, taste, smell, size). Most use ecommerce with deliveries made by LML operators with systems such as food boxes.

This new paradigm of hybrid chains in which short and long fruit CSs coexist is a sustainable innovation and is starting to set a clear trend in long fruit and horticultural CS, as there are clear advantages from synergies in common processes.

In order to realize the SASC objective, there has to be close collaboration and coordination with the LML provider, as well as coordination with the other stakeholders in the SC.

LML takes place from the point of order penetration (referring to an inventory location (e.g. cooperative handling center) where a fulfilment process is triggered by a consumer order to the final recipient's preferred destination point.

Due to the difficulty of service differentiation in the LML sector, prices are similar, margins are low, and competition is often achieved through improving cost efficiency (Peppel *et al.*, 2022). Innovation is central to this process, allowing them to improve processes and develop new tools. To do so, they can employ different methods by first trying to increase delivery factors (number of parcels delivered) per stop, while minimizing consumption, delivery time and kilometers travelled. In addition, they try to minimize the stop factor by grouping many parcels per route. Secondly, digitization allows a higher level of automation to be achieved, thus reducing personnel costs. Thirdly, using new AI functions to optimize both routing and internal processes in sorting centers. The last dimension is quality. Finally, it is essential to take care of security as it is crucial to maintain the quality of LML services. This is also where the packaging used plays an important role, as it can improve the performance of the supply chain, helping to avoid food waste, and



enabling efficient logistics and transport operations, as well as reducing packaging waste. It is important to avoid lost or damaged packages, and to take care to manage personal data such as location and preferred delivery options.

It should be noted (Hjort *et al.*, 2019) that one of the aspects that remains to be resolved in the LML is the management of reverse flows of products. However, in agri-food chains, especially for highly perishable products such as fresh fruit and vegetables, returns are not appropriate due to the very nature of the products themselves, thus reducing the reverse flow of products.

2.2. Research methodology

2.2.1 Context of the study

The Fresh Fruit and Vegetables sector in Spain accounted for 11.4% of the total agri-food industry in 2022 (Subdirectorate General, 2022). Spain, especially the south-east, on which was focus our study, is currently the main horticultural supplier to Europe through important horticultural supply chains, with a 40% share of fresh vegetables in recent years (Pérez-Mesa et al., 2021). The largest concentration of greenhouses in the world is located in this area (Aznar-Sánchez, Velasco-Muñoz, García-Arca, 2020). Its productivity is 30 times higher than the European average. The Almeria agricultural model is based on the use of simple but efficient technologies, such as plastic greenhouses or crops grown on sandy soils in small family farms of an average size of 2.5 ha. This paradigm has been evolving, concerned with sustainability, improving water use, biodiversity, circular economy, image and identity, focused on technology and knowledge transfer and largely digitized (De Witte et al., 2023). It focuses on vegetable production which takes place mainly in winter, specializing in the cultivation of peppers, tomatoes, courgettes, cucumbers, aubergines, green beans, watermelons and melons (Navarro-del Aguila and de Burgos-Jiménez, 2022). Approximately 80% of fruit and vegetable production is exported (Servicio de Estudios Agroalimentarios de Cajamar, 2022).

The marketing of fruit and vegetables is carried out through handling-marketing companies (usually cooperatives) with which the farmers usually have stable relationships. These marketing companies also carry out basic product preparation tasks such as residue analysis, washing, sizing and/or packaging for delivery to their customers (Navarro-del Aguila and de Burgos-Jiménez, 2022).

2.2.2 Methods

In order to carry out our study, it was conducted a search for fruit and vegetable ASCs that have developed a SASC with home delivery by LML in the selected study area. These chains found were hybrid chains, since they were initially conventional supply chains and have developed a SASC that coexists with the traditional chain (Navarro-del Aguila and de Burgos-Jiménez, 2022), relying on LM operators to develope these new deliveries.

The main hybrid supply chain (in terms of turnover, market share, product variety) of the 9 SASCs identified by (Navarro-del Aguila and de Burgos-Jiménez,

2022) was selected to analyse in detail the LML organisation through a case study. This SC is characterised by its innovative orientation, it is a second-tier cooperative that is interested in studying the improvement of its supply chain in the short term and sustainability, which leads it to participate in research projects on the subject.

It was analysed its e-commerce and its integration with its stakeholders and especially with the LML operator. To this propouse, personal interviews were held in January 2022 with the middle managers appointed by the company's management to organize the study. The first task was to create a working group in which stakeholders involved in all the phases of the value chain were represented. There were 15 stakeholders including 4 suppliers (LML operator, seed supplier, packaging and agricultural technician) 2 consumers, 2 employees, 2 farmers and 5 intermediate managers (logistics, Information technologies, plant, customer service and quality). These stakeholders received methodological co-creation training in order to conduct the group meetings successfully. The first working group meeting of 15 stakeholders from the whole value chain was scheduled for March 2022.

They were previously informed of the required time availability and the content of the process in which they were going to participate in order to foster the collaborative work environment necessary to carry out a cocreation process. During this process, they used techniques proposed by (Nanclares, 2014) to add value, collaboratively design and create innovative and sustainable ideas for products and services, through a group of "experts", in our case belonging to the stakeholders of the value chain composed of customers, suppliers, business or product developers, marketing, last mile logistics operator among others, in order to achieve a high degree of acceptance in the market with their contributions. During the meeting, techniques were used to stimulate the generation of ideas through a Swot process on strengths, weaknesses, opportunities and threats in SASCs. To this culmination, working subgroups were formed consisting of 2 or 3 people with related functional areas, who were asked to draw up an outline that they would discuss during a word café in which they sought to integrate, share and understand proposals on a given topic. This was followed by a meeting in which the contributions proposed by each working group were synthesised.

Subsequently, from April 2022, telephone interviews were managed with the 9 chains in the sample that have developed a short chain to find out more about the details of the LML operator they work with. Curiously, almost all of them worked with the same operator that offers an affordable level of costs (these are basic products that form part of the shopping basket, not premium products) and speed of delivery, due to the fact that the products are delicate and perishable and if the necessary care and quickness (less than 24 hours) is not taken, the food spoils. In fact, one of the long chains that had developed this short channel with e-commerce has abandoned the activity, due to te inconveniences and complications it was causing, as it was not dedicating the necessary resources and attention to the process of preparing and delivering orders to the short chain.

It was prepared a guide notes with 16 questions. At the beginning of January 2023, a personal meeting was held with the branch manager of the logistics operator in charge of our case study, which is considered the most established in the Agri-food sector. A semi-structured personal interview was conducted on the following topics:



- how the delivery of vegetable crates is carried out with the SASC,
- the procedure followed by the logistics operator,
- challenges and opportunities of fruit and vegetable delivery systems,
- their innovation strategies,
- requirements to be met, internal protocols.
- the company's internal policies to be more sustainable,
- new technologies to be used,
- the role of governments and regulations,
- what is your direct competition.

The details provided about their competitors were used to try to cross-check the information obtained. Telephone interviews were conducted with two of these operators. It was verifye that only one of them actually operates with a certain frequency in the fresh fruit and vegetable sector.

From February 2023, it was analysed the details obtained on the operations necessary to carry out successful deliveries, their interaction with the hybrid chain and the rest of the stakeholders, and the measures they take as a company policy to improve sustainability.

3. RESULTS, DISCUSSION AND LIMITATIONS

3.1 Aspects for improvement in sustainability of SASC

Through our case study, it was verify how this fruit and vegetable ASSC represents an improvement in the sustainability of traditional supply chains by helping to fight food waste through appropriate and innovative logistics supported by LML (Peppel and Spinler, 2022) integrating with its logistics provider. This finding is aligned with the assertions of (Neutzling *et al.*, 2018) on the need for collaboration between SC stakeholders which includes knowledge integration and cooperation that empowers firms to create unique organisational capabilities. Integrated and synergetic collaborative relationships can be developed as in the case study that enables knowledge exchange and the generation of innovative capabilities that lead to improved sustainability throughout the SC.

The contributions proposed by each working group in the Swot process implemented by the selected stakeholders have been synthesised. It can be seen how all members of the short supply chain have to work in close coordination. The main contributions have been schematized in figure 1:

Figure 1 Swot Agrifood Short Supply Chain



Source: Own elaboration

Once the Swot has been analysed, there was a starting point as an overview of the strengths and weaknesses as well as the opportunities and threats that SASC is facing. It can be seen that there is a lot of stakeholder concern in ensuring that the product arrives fresh and with a sustainable delivery to the consumers, as well as that the purchasing and receiving experience were easy and positive.

To continue with the cocreation procedure, the phases of the supply chain defined by (Navarro-del Aguila and de Burgos-Jiménez, 2022) were used to organise the working subgroups.

Figure 2, shows the phases of the CSA in which all stakeholders are involved. It starts with the supply of inputs such as seeds, packaging, etc. by suppliers. These materials are used in the following phases, in primary production, where the farmer produces fruit and vegetables in greenhouses. And subsequently in the processing, e.g. packaging, which is carried out in the handling cooperatives, where the products are processed, prepared for sale and stored in cold storage. Finally, the chain is bifurcated at the marketing level. On the one hand, the traditional chain (ASC) can be seen in the upper part of figure 2. In the ASC, packaged fruits and vegetables are sent to a varied



set of intermediaries that use different channels to bring their products directly or indirectly to the final consumer. These intermediaries include wholesalers, brokers, large supermarkets, retailers and other types of stores.

On the other hand, the supply chain is shortened by selling the products through Ecommerce and delivering it directly to the end consumer through the LML (SCSA) This short part of the hybrid chain, which no longer involves intermediaries to reach the consumer, is shaded in the bottom of Figure 2.

Figure 2 Phases in Agri-food Supply Chain (ASC / SASC)



Source: Own elaboration

The special characteristics of highly perishable products (Pérez-Mesa and García-Barranco, 2019) must also be taken into account in order to successfully deliver the vegetable boxes to the final consumer. This particularity marks from the beginning of the phases of how operations will have to be carried out in the chain, for example in the selection of seed varieties, which have to possess certain qualities, not only in terms of taste, appearance and nutrition, but also resistance to transport, the type of packaging used that allows the product not to hit each other, its cold storage in warehouses and its e-commerce and LML.

These results can be seen in figure 3. The left side of figure 3 shows the phases of the SASC from the selection of inputs through primary production (farmers), Processing, Transport & Logistics, and Marketing & Information Technologies to the final consumer. The right hand side shows the contributions to sustainability proposed by the key stakeholders in each of the phases of the SASC.



Source: Own elaboration

Studying the summary of interactions in the phases that each stakeholder has developed, it could be seen how important was that sustainable actions and innovations were coordinated for successful delivery to consumers. According to (Neutzling *et al.*, 2018), these collaborative relationships between organizations can be sources of competitive advantage, enabling the creation of value for the entire chain.

It also highlights the importance that consumers attached to delivery logistics and the improved sustainability provided by the delivery of these products, thus also helping to avoid food waste. This allows them to consume local produce, through deliveries in less than 24 hours with information available digitally on the status of the delivery. This LML allows them to take advantage of the facilities provided by digitalization and online commerce for direct interaction with the end consumer. It also provides a solution to the need to create value in SC by increasing trade margins and achieving a better distribution (Pérez-Mesa *et al.*, 2021), by reducing the number of intermediaries, and providing a solution to the distance between the consumer and the producer. It is a shortening of the traditional chain by eliminating the figure of the retailer and carrying out the function of supplying the end consumer directly by the SASC.



In this type of chain, the last mile delivery operation requires specific and differential characteristics to adapt to this sector of perishable and delicate products in the fresh fruit and vegetable sector (Wang *et al.*, 2019).

The characteristics of the products handled introduce a novel perspective for the development of LML (Lim and Winkenbach, 2019), which require solutions that solve some of the problems that affect the sustainability of this logistics (Peppel *et al.*, 2022).

3.2. Specific characteristics of the LML of SASC

It was studied in depth how last mile logistics was organized in the case study what considerations need to be considered for it to function correctly. It was reviewed how, in general, these characteristics coincide with the rest of the cases found in our sample of traditional supply chains that are developing a short-term chain (hybrid).

The interviews and group meetings have provided us with a detailed description of the operations between the SC and the LML operator.

It starts with the collection usually by truck from the LML operator, depending on the volume of the goods at the facilities of the ASC processing center at the agreed time, usually fixed and in the afternoon, of the vegetable crates. The boxes are premarked with the logistics operator's labels, palletized and suitably refrigerated. Here the boxes are grouped with goods from other customers (of the logistics operator) according to the destination of the package on domestic routes. For this purpose they employ the cross-docking in LML operator's facility (crossdocking warehouse) in which according to (Mejia *et al.*, 2017) the materials are received by the suppliers of the distribution center and are not stored, but are managed for their next shipment reducing unproductive inventory, shipping times and distribution costs. This type of practice shortens the handling time and extends the shelf life of the products, which is why it is widely used for perishable products. In other words, transport is optimized according to the destination, not according to the product (looking for cost efficiency).

These boxes of vegetables are loaded (along with the rest of the goods from other customers of the logistics operator) in conventional vans, not refrigerated, as at the moment, the incorporation of refrigeration is not viable and would entail a high cost in places, although they do try to keep the products in cool places for better preservation. The boxes travel at night to each destination, thus avoiding crowded hours and maintaining a better temperature. They must be at the destination delegation of the LML operator at first time of the morning, then, the vegetables boxes are unloaded. Finally, the boxes are prepared for dispatch, normally together with third party goods, to be delivered to the end customer before 2 p.m. on the day after collection. In this way, delivery is made in less than 24 hours after collection of the product (time without refrigeration). This delivery will be made according to the characteristics of the local delegation, and the destination requested by the customer, and can be made in a normal delivery van, electric, or walkers.

The sale of boxes is concentrated in the cooler months, which facilitates the possibility of transporting the boxes without refrigeration with little loss of product quality, since in the summer, which are the hottest months of the year, the marketing of boxes is suspended because there is no local production.

In addition, the LML operator has to comply with an internal protocol with this very delicate merchandise that is treated as a priority delivery and fragile product, which helps to avoid food waste (Yetkin Özbük and Coşkun, 2020) by always placing the boxes on the top, without knocking them or turning them upside down. Packaging (Pålsson and Sandberg, 2021) also plays a fundamental role in this good preservation of the product, which must be appropriate and sustainable, for which they must be resistant, ventilated, insulating, recyclable and reusable, with the minimum possible presence of single-use plastics, normally cardboard is used. In addition, with the possibility of compartmentalization, so that fruit and vegetables are not mixed or moved, which is already prepared from origin with the heaviest products at the bottom and the most delicate ones on the surface or in specific compartments.

This process of LML of boxes of fresh agri-food products by specialised operators allows the geographical scope of product delivery to be extended, but also involves an adaptation to conventional LML.

The use of this type of logistics is more efficient than individual deliveries, as it allows groupings in logistics platforms, and organizes the start of deliveries during off-peak hours (at night), avoiding congestion problems.

These are outsourced services, carried out by specialized companies, with infrastructure, a fleet undergoing renewal and electrification, digitized, offering shipment traceability, normally contracted in advance or with a work agreement framework, which allows shipments to be planned. They are able to meet demanding consumer expectations (speed, flexibility, traceability and digital communication, geolocation of the parcel, home delivery) at competitive prices.

They share a concern for sustainability and the environment, with policies to reduce CO2 emissions (consumption of green energies, electrification of fleets, etc.) and offsetting of emissions (Peppel *et al.*, 2022).

Figure 4 shows a summary of the specific characteristics of in SASCs, detailing the differences with respect to conventional LML.



Figure 4 Specific characteristics of LML in SASCs

Source: Own elaboration

These specialized external logistics operators are committed to sustainability and the use of green energies, with a fleet of hybrid and electric vehicles, bicycles and walkers for foot delivery in the most environmentally friendly delegations, and even CO2 emission compensation programs (e.g. financing projects in some countries to carry out climate protection measures by reducing their resource consumption and associated emissions, or the use of renewable energies in developing countries).

Political markers also have a very important role to play in encouraging and supporting this improvement of sustainability in LML, by making regulations aimed

at encouraging investments in green energy consumption, and replacing existing fleets with electric vehicles and installing energy charging points (Galati *et al.*, 2021).

3.3. Limitations and possible extensions

The limitations that can be found in our study derive from the fact that it focuses on a fruit and vegetable cluster with very specific characteristics in terms of agricultural production (small and high-tech greenhouses) and marketing organization (farmers' cooperatives). The specificity of the context may mean that the model of LML use is not directly replicable in other food supply chains such as meat, fish, oils and fats and dairy products (possibly because they are not concentrated, less frequent consumption, more or less demanding preservation systems (meat and fish more, oils less,,,,).

On the other hand, this study analyses LML in a very little explored sector due to the novelty of the business model recently implemented in ASCs (many processes and procedures are not standardized because not enough experience has been gathered yet).

The in-depth interview has been done only with 2 logistics operators who deal with fresh fruit and vegetables on a regular basis. Other (5) LML operators indicated that they only ship on a one-off basis due to the actual unattractiveness and restrictions associated with this type of perishable (agri-food) products. The Spanish case study may work differently in other countries or contexts (all road vs. multimodal...).

It should be noted, however, that this study analyses LML in a sector that has been little explored due to the novelty of the hybrid chain business model recently implemented in ASCs and is therefore subject to natural evolution.

Future research will explore the application of this model to other food products distributed in boxes, such as eggs, pre-prepared and pre-cooked convenience foods and some cold meats. Its development could generate economies of scale and scope in the distribution of fresh food products, both in terms of collection (establishing coordinated routes) and, above all, in terms of delivery to the end consumer (delivering several boxes simultaneously).

Additionally, the incorporation in LMLs of refrigerated areas in their storage and distribution facilities would allow the incorporation of other fresh products that are more sensitive to cold, such as meat, fish and dairy products.

4. CONCLUSION

The characteristics and contributions of LML to SASC (hybrid) have been analyzed showing how they enhance sustainability and proximity to the consumer. LML may facilitate healthier consumption of fresh products through direct product deliveries and helping to avoid food waste.

They provide a solution by bundling existing mobility patterns for parcel delivery with the fresh fruit and vegetable boxes. LML integration in SASC giving



rise to new innovative and collaborative business models. Organizations develop capabilities to reduce the negative impact of LML and, at the same time, achieve a sustainable competitive advantage, which offsets the negative impacts of LML practices with the demand for cost-effectiveness and competitive service that encourages the consumption of fresh and healthy products.

LML contributes to the three main pillars of sustainability. On the economic side, it reduces the time and cost of distributing boxes of fresh fruit and vegetables, adapting the infrastructure and distribution systems of conventional products to these fresh products; it provides value to fruit and vegetables that are in perfect condition but do not meet the size or appearance specifications required by large distributors. On the negative side, the lack of refrigeration of the goods leads to an increased risk of deterioration of the fruit and vegetables. Working with perishable fresh produce requires stringent handling protocols (fragile and perishable goods) in LM to avoid complaints and loss of goods; non-compliance with these protocols incurs high claims costs that have caused some LM operators to give up working with this type of goods. In addition, the customer wants a variety of produce in the fruit box, which requires more handling and increases the risk of spoilage. There are climacteric fruits (e.g. avocado) that in certain environments (presence of ethylene) can ripen very early or spoil. For all these reasons, 8% more weight of goods than agreed is included in the box at origin.

In the social dimension, it contributes positively to several aspects: by reducing intermediaries, it simplifies and makes traceability more accurate; by shortening the delivery period to the customer, it facilitates the consumption of healthy products in a better state of conservation; it also reduces food waste and losses both by reducing storage time and by facilitating the marketing of products that are not in demand by wholesalers or large distribution chains. On the other hand, the delivery of the product by a company specialised in LML makes it lose the perception of local product and proximity to the consumer that a short food distribution channel provides. In addition, employment generation in the LML sector tends to have poor working conditions (Kougiannou and Mendonça, 2021)

In the environmental dimension, positive contributions have been identified, such as the fact that the LML carries out logistics operations for the distribution of fruit and vegetables in a more energy-efficient way than the average consumer, as it carries out operations in a grouped way and with specialised fleet and facilities; moreover, thanks to a more accurate information system, it adjusts transport at times with less traffic, avoiding traffic jams and reducing pollution; they also tend to have carbon footprint compensation programmes. Among the negative effects on environmental sustainability, the main problem is the need for the consumer to receive the goods at the agreed place and time of delivery, which causes delivery delays that increase product damage and food waste. In addition, it has been found that packaging material, in order to protect transport and to allow the compatibility of fruit with other goods, is a source of waste. The reuse of packaging in the same circuit presents logistical difficulties, even if it is in a good state of conservation, and other less environmentally sustainable options are used (such as alternative uses or recycling).

Finally, it should be noted that the increase in demand for home-delivered vegetable boxes can also help the sustainability of the LML: on the one hand, by increasing the traffic of goods and enabling the development of economies of scale and scope, and on the other hand, by incorporating values that favour a rational use of the LML (the cost of transport is usually included in the price of the final product but the delivery is not free of charge).

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