

**The Crucial Role of Technology in  
Business Supply Chain Sustainability:  
the Case of Lidl**



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## Abstract

**Background:** Supply chain refers to the processes from the initial raw materials to the final consumption of the final product connecting the supplier-user companies and to operations inside and outside a company that enable the value chain to produce products and provide services to the customer. The negative effect of the pandemic on global supply chain has lead to a significant interest for its sustainability and how it can be obtained. Technological advances, such as Universal Product Code, QR, blockchain and RFID, have literally transformed the global supply chain. The use of such technologies in supermarkets is of most importance for the sustainability of their supply chain system.

**Aim:** The aim of the study was the investigation of the crucial role of technology in sustainable chain management in Lidl.

**Methods:** This research was quantitative and involved a case study of Lidl Hellas. The data were collected from 21 Lidl workers through a self-reported questionnaire. Those participants worked in various positions. In particular, a total of 26 questions were used, which were divided into five main categories. These categories were 1) benefits of using technology in the sustainable supply chain 2) knowledge of the role of technology in the sustainable supply chain 3) attitudes towards a sustainable supply chain 4) the role of individual technologies 5) barriers to using technology in the sustainable supply chain. It is therefore a questionnaire that assesses individual parameters of employees' perceptions of the role of technology in Lidl's sustainable supply chain. Employees were asked to give answers from 1 (strongly disagree) to 5 (strongly agree). The analysis carried out by descriptive and inductive statistics. The sociodemographic variables were used as independent variables in the inductive analysis. The analysis of the data was carried out by SPSS.

**Results:** There was a highly positive perception for the benefits from the use of technology in supply chain, since the mean value was 29.61 and the potential range for this scale 7-35. The knowledge was high, since the potential range was 3-15 and the participants mean value 12.19. The perceptions for the role of sustainability in supply chain were positive, since the mean value was 28.85 (potential range 7-35). The perception towards the role of separate technologies was high, since the mean value was 20.76 (potential range 5-25). The barriers in the use of technology in supply chain were low (mean value 10.80-potential range 5-25). Those with higher work experience

at Lidl perceived the benefits to be higher ( $p=0.015$ ). In addition, work position had a significant relationship with benefits, with clerks having the less positive perception, followed by loaders, administrative staff and office workers ( $p=0.046$ ). Those with higher work experience at Lidl had more knowledge regarding the use of technology in supply chain ( $p=0.029$ ). Work experience in the current position was negatively related with the perception for the role of sustainability in supply chain, while total work experience was positively related ( $p=0.026$  &  $0.015$ ). Those with higher work experience in the current position had a less positive perception compared to the others for the role of separate technologies ( $p=0.049$ ). Finally, those with higher work experience in the current position perceived more barriers in the use of technology in supply chain ( $p=0.035$ ).

**Conclusions:** The perception regarding the use of technology to enhance sustainable supply chains is very positive. Employees were distinguished by competent knowledge and low perception of barriers. Since employees with longer tenure at Lidl had more knowledge, knowledge sharing programs could be implemented among employees to enhance the knowledge of employees with less tenure on the use of technology in the sustainable supply chain of this supermarket. Management could also promote job rotation along the career path, as employees who had been employed in the same position for many years seemed to have more barriers to using technology in the supply chain.

# 1. Introduction

Sustainability is a subject that has received considerable attention in recent decades. For centuries, humans have treated the environment in which they live as a given, i.e. assuming that the environment is not expected to change significantly in the future and that future generations are expected to take it over in the facility in which the previous ones found it. Indeed, progress was identified with technological and scientific advances, thus creating the illusion that humanity is in a constant state of improvement. However, in recent decades a significant concern has emerged due to climate change, leading to the realization that environmental sustainability is not a given (Morelli, 2011; Thiel and Masters, 2014).

In addition to sustainability with regard to the environment, a significant concern has also emerged with regard to social sustainability. In the last decades, an important reflection has developed regarding the rights of people belonging to vulnerable social groups. Ostensibly, in the modern world there is equality, at least in developed countries, without legal barriers that prevent equal participation in social life by people belonging to marginalized groups. In practice, however, there are too many structural mechanisms, such as education and the work environment, which promote, reproduce and ultimately justify social inequalities. Addressing these inequalities seems imperative to ensure social sustainability (Eizenberg and Jabareen, 2017; Schwab and Malleret, 2020).

Finally, in today's fragile society, there also seems to be an economic sustainability in crisis. The very high global debt and the vulnerability that the 6-Sigma model implies for supply chains are for example factors that call into question the economic sustainability of modern societies (Schwab and Malleret, 2020).

Based on major crises of the latest years, there is no doubt that modern businesses are faced with a multitude of significant and multi-dimensional challenges. The crises that modern businesses face are unprecedented, given that the COVID-19 pandemic was followed by the war in Ukraine, thus leading to problems such as high inflation, which pose significant issues for the sustainability and profitability of businesses. Thus, there is a need to systematically review the way modern business are



operating, in order to continuously improve their strategic position in the market (Ngoc et al., 2022).

Despite the unpredictability of these related crises, several scholars have for years pointed out the vulnerability of modern societies to as yet unforeseen threats. As Thiel and Masters (2013) point out, the rapid and unprecedented pace of modern life has now led in a sense to the shortening of historical time, i.e. to many unpredictable events taking place within far fewer years than in the past. The crises facing modern humanity in a single generation would therefore have required, as these scholars point out, many generations of people in the past. Historical time has therefore been shortened and the average human being is expected to face many more collective crises over the course of his or her lifetime compared to the human being of the past, which could experience few or no crises over a lifetime.

Currently, the rapid technological changes taking place in the Information Society are leading humanity into the 4th industrial revolution. This is an ongoing trend of automation and data sharing in production technologies, including cyber-physical systems, the internet of things, cognitive computing and cloud computing (Koh et al., 2019).

This trend represents a necessary response at a time when technology is called upon to play a pivotal role in addressing major problems facing humanity, the most important being that of climate change. It is expected that the COVID-19 pandemic crisis will lead to an increased awareness of future threats, with the result that the post-pandemic period will be a period of predominant focus on the issue of climate change. Modern technology is therefore expected to play a central role in this direction (Schwab and Malleret, 2020).

In light of the existing challenges, businesses have been called upon to undertake a revision of unquestioned assumptions that have been in place for several decades. Since the fall of the Berlin Wall, firms have shifted to a model of multiple suppliers from different regions of the world, with the aim of achieving the lowest possible cost. However, this situation led to particularly fragile supply chains, as the development of a final product depended on suppliers located in different parts of the world. In the pandemic period, this problematic situation became apparent, leading to

a major crisis in supply chains, especially during the first waves of the pandemic (Schwab and Malleret, 2020).

Based on the above, this study focuses on the investigation of the supply chain as a function of the issue of technology and sustainability. In particular, the case of the supply chain of the firm Lidl is examined. The overall aim of the study was to come to conclusions which could improve the supply chain of this supermarket.

Regarding the structure of the present study, a literature review of the concepts that will be discussed later in the research is carried out. Therefore, the concept of supply chain is introduced and analyzed, the development of interest in supply chain at academic and business level is presented, the basic principles of a competent supply chain are analyzed, the supply chain as a function of the pandemic challenge is examined, the role of technology in relation to the sustainability of a supply chain is analyzed, environmental management systems are analyzed and the way in which technologies are organized and their role in the relevant supply chains is presented. Based on this literature review, a research project is developed that focuses on the case of Lidl's supply chain. In particular, an empirical research was developed using a self-report questionnaire based on a quantitative approach. Since based on the relevant literature review it was found that the supply chain involves all stakeholders involved in the supply and transportation of a company's products, the relevant questionnaire was administered to employees of the company in general, in order to depict and present the views and perceptions of the individual stakeholders on the role of sustainability and technology in the supply chain of this supermarket. Followingly, based on the results of the statistical analysis that was performed, a discussion on the results of the research is carried out. In this part, a theoretical attribution of the findings is carried out, they are examined in contrast to previous literature, the limitations of the relevant study are highlighted and relevant recommendations for future research and for the supply chain of Lidl are made.

## 2. Background

### 2.1 The concept of supply chain

Various definitions of the supply chain can be found in the literature as the concept has gained popularity. Based on Cox et al. (1995), supply chain refers to:

- 1) the processes from the initial raw materials to the final consumption of the final product connecting the supplier-user companies; and
- 2) operations inside and outside a company that enable the value chain to produce products and provide services to the customer.

Another approach is that of Lummus and Alber (1997). These authors identified the supply chain as the network of entities through which a commodity flows. These entities may include suppliers, carriers, production sites, distribution centers, retailers and customers.

The Supply chain Council (1997) used the definition: *"supply chain - a term increasingly used by logistics professionals - includes any effort involved in the production and delivery of a final product, from supplier's supplier to customer's customer. Four key processes - plan, source, make, deliver-broadly define these efforts, which include supply and demand management, supply of raw materials and components, manufacturing and assembly, inventory storage and monitoring, order registration and management, distribution across channels, and customer delivery."*

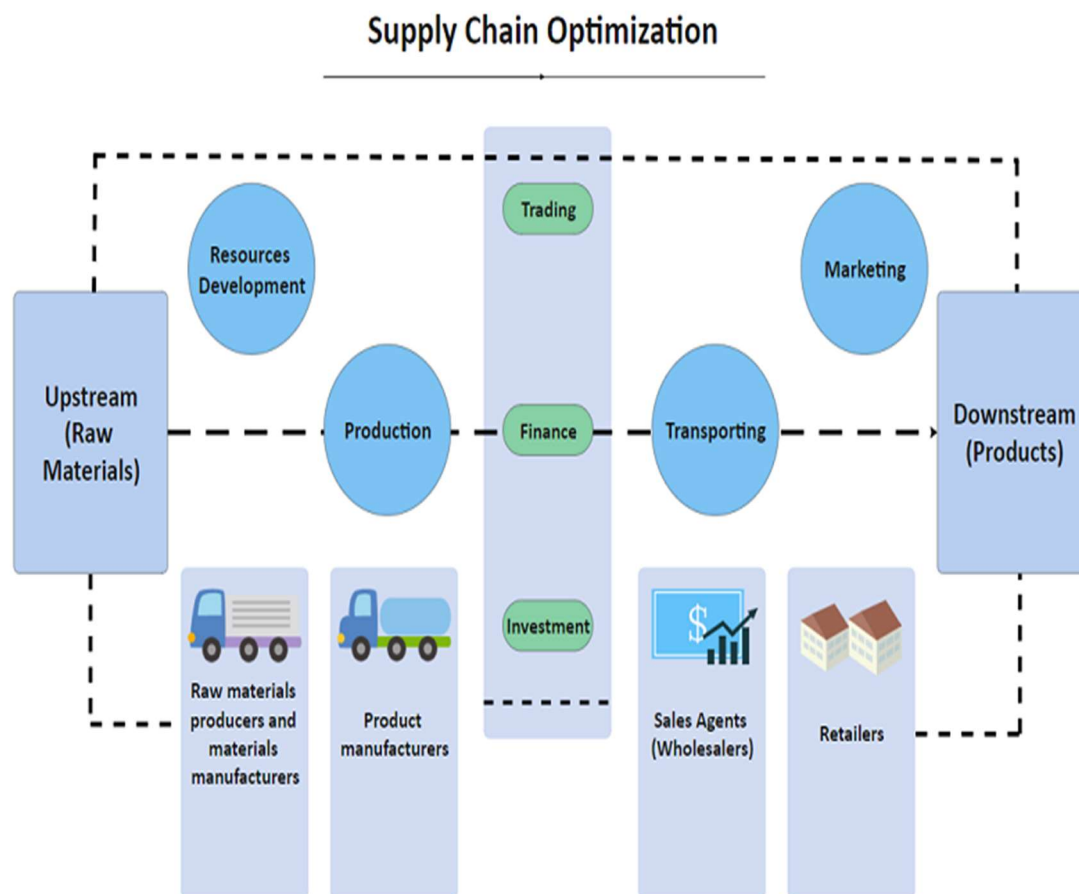
Quinn (1997) took a different approach, defining the supply chain as all the operations involved in moving commodities from the raw material stage to the final consumer. The supply chain comprises order processing, inventory management, transportation, warehousing, and customer support in addition to sourcing and production planning. It is crucial that the information systems required to keep track of all these activities are included in the supply chain.

Supply chain management is also of great importance, in addition to supply chain definition. Supply chain management is an integrated methodology for controlling the full flow of a distribution route from supplier to end customer, according to Cooper and Ellram (1993). In addition, Monczka and Morgan (1997) asserted that

integrated supply chain management entails controlling all of the activities required to bring value to the customer horizontally, starting with the external customer.

In light of the aforementioned, the supply chain refers to all processes involved in the delivery of a product, from the raw material to the customer, including the acquisition of raw materials and components, manufacturing and assembly, inventory storage and monitoring, order registration and management, distribution across all channels, delivery to the customer, and the information systems necessary to track all of these processes. All of these activities are coordinated and integrated into a single process by supply chain management. It links all participants in the chain, including internal organizational units and external partners like transporters and suppliers. Additionally, managers of businesses along the entire supply chain are concerned with the success of rival businesses. In order to make the entire supply chain competitive, they cooperate. They have access to market information, have extensive knowledge of the competitors, and coordinate their operations with those of their trading partners. This comprises the procedures required to produce, supply, manufacture, and distribute goods in response to demand. They communicate information between firms and collect data on market demands using technology. As a result, the entire procedure needs to be handled as a single system. When inefficiencies occur at any point along the supply chain (suppliers, production facilities, warehouses, customers, etc.), the procedure should be assessed and generally redesigned (Hugner and Wheelen, 2004).

**Figure 1.** Supply chain management optimization



Source: <https://www.edrawmax.com/article/what-is-supply-chain-diagram.html>

## 2.2 The growth of interest for supply chain management

Unquestionably, the pandemic has generated a great deal of interest due to the severe effects it has had on the world supply chain (Bonadio et al., 2021). However, the supply chain's scientific and research aspects have been ongoing for several decades, with the 1990s witnessing the peak in attention. Horizontal corporate integration was heavily emphasized during this time period, which led to a global desire for suppliers of low-cost, high-quality materials rather than for the companies themselves to own their source of supply. In order to maximize overall performance, it is crucial for businesses to manage the complete procurement network (Hugner & Wheelen, 2004).

A second reason relates in part to the increased national and international competition that arose as a function of the development of a global market in the post-Fall of the Berlin Wall era. Companies acquired multiple sources from which they could choose to meet demand. Positioning the product across the distribution channel for maximum customer accessibility at minimal cost became vital. Previously, companies were trying to solve the distribution problem through keeping inventory at various locations throughout the chain. However, the dynamic nature of the market made holding stocks risky and potentially unprofitable for a business. Customers' buying habits began to change rapidly in this decade and companies developed hypercompetition among themselves. Changes in demand therefore made it almost certain that the company would have stocks with not high market demand. The cost of keeping stocks also meant that most companies would not be able to provide low-cost products when funds have already been pooled in stocks (Hugner and Wheelen, 2004).

In this decade the supply chain has also been at the heart of business consultants. Advanced Manufacturing Research, a Boston-based consulting firm, developed a supply chain model that emphasized the flow of materials and information between manufacturers and their trading partners. They argued that the changes required by management are due to the following changes in the way manufacturers do business (Davis, 1995):

- Greater exchange of information between suppliers and customers.
- Horizontal business processes replacing vertical operations.
- Shift from mass production to personalized products.
- Increased dependence on purchased materials and external processing while reducing the number of suppliers.
- Greater emphasis on organizational and procedural flexibility.
- Need to coordinate procedures in multiple locations.
- Empowerment of employees and the need for real-time decision-making based on rules.
- Development of decision-making systems.
- Competitive pressure for faster introduction of new products.

The businesses streamlined their processes and reduced the amount of time required to provide customer service for their goods. These factors have made sophisticated supply chain management essential for the majority of businesses in this decade. "Winning the 1990s market will require a very different kind of relationship," said Ralph Drayer, vice president of product supply and customer service at Procter and Gamble. "The ultimate winners will be those who understand the interdependence of retailer / manufacturer business systems and who work together to seize opportunities to deliver superior value to the consumer" (Drayer, 1994).

More generally, it became commonly acknowledged in this decade that business executives are motivated by the success of rival businesses along the supply chain. Businesses are now cooperating to make the entire supply chain competitive as a result of these discoveries. They have access to market information, have extensive knowledge of the competitors, and coordinate their operations with those of their trading partners. They communicate information between firms and collect data on market demands using technology. Management of the connections between each chain node is essential to supply chain synchronization (Hugner and Wheelen, 2004).

## **2.3 Basic principles of an effective supply chain**

### **2.3.1 Fast response**

Due to intense competition in the textile and apparel industries globally, Kurt Salmon Associates in the United States was hired in 1985 to conduct supply chain analysis. As a result of globalization, various industries, including the textile industry, were largely redefined as a part of a new, global market. The study's findings revealed that the textile supply chain's delivery time, from raw materials to consumers, was 66 weeks, of which 40 weeks were spent in storage facilities or in transit. The long supply chain has resulted in heavy losses for the industry due to the freezing of funds due to inventories and the lack of the right product in the right place at the right time. The result of this study was the development of the Rapid Response Strategy (QR). QR is a partnership where retailers and suppliers work together to respond faster to consumer needs by sharing information (Fernie, 2023).

The industry's adoption of the UPC code, a set of standards for electronic data interchange (EDI) between businesses, was one of the study's most significant outcomes. To swiftly transmit sales data to distributors and manufacturers, retailers started implementing scanning systems at points of sale (POS). Based on point-of-sale data and sales history, it was discovered that QR maximized inventory profitability by locking up a company's funds when necessary. In the manufacturing and distribution plan, QR incorporates marketing data on promotions, discounts, and forecasts (Fernie, 2023).

### **2.3.2 Efficient consumer response**

A task force for the grocery sector known as the effective consumer response task force (ECR) was established in 1992 by a number of industry heavyweights. The committee was given the mission of examining the food supply chain to find ways to boost its level of competition. The group recruited Kurt Salmon Associates to examine the supplier-distributor-consumer value chain in the grocery industry and identify what cost and service improvements may be made through changes in technology and business processes. The study's findings demonstrated that enhancing performance only necessitated minor adjustments in technology. The study did, however, identify a number of best practices that have the potential to greatly enhance supply chain performance. As discovered by Kurt Salmon Associates in 1993, ECR enables suppliers and distributors to estimate future demand for a considerably longer period of time and with greater accuracy. They anticipated a 37% total decrease in supply chain stocks and a reduction of between \$24 billion and \$30 billion in industry expenditures through the adoption of best practices.

A manufacturer's ability to retain production flexibility, which enables it to balance supply and demand, is crucial to the adoption of the ECR. A process that tightly integrates demand management, production, planning, and inventory development is essential to this flexibility because it allows the business to make better use of data, production tools, and inventory (Weeks and Crawford, 1994).

A further development of the ECR was the concept of continuous replenishment (CRP). CRP is a move away from pushing products out of inventory kept on grocery



shelves based on consumer demand (ECR performance Measures Operating Committee, 1994). Transactions at the point of purchase are transmitted via computer to the manufacturer, allowing it to keep the retailer replenished and balanced just-in-time. CRP was rapidly adopted by several businesses. For example, General Mills soon began distributing about 10 percent of its products with CRP, gaining a significant competitive advantage over its competitors. Estimates of improvements in performance with CRP were calculated immediately after the implementation of this strategy to an increase in stock turnover from 10 to 50, a reduction in supply days from 30 to 5 and an increase in net profit margin from 5 per cent to 7 per cent (Garry, 1994).

The 1990s saw a number of successful initiatives to enhance supply chain efficiency, in addition to those from the grocery and apparel industries. Actions taken by companies like Hewlett-Packard, Whirlpool, Walmart, West Co., Becton Dickinson, Baxter, and Georgia-Pacific Corp. are a few of these (Garry, 1994).

### **Hewlett-Packard**

In the early 1990s, Hewlett-Packard, a manufacturer of computer components, methodically connected its manufacturing of computer terminals with its distribution operations. Changes were made to the product's physical distribution as well as a new system for planning distribution needs. (DRP). The DRP system links client orders with forecasts and acts as the chain's first bottleneck (Hammell and Kopczak, 1993).

### **Whirlpool**

The manufacturer of electrical appliances began implementing the supply chain with a team of executives in 1992, believing that the businesses that will succeed in the modern market will be those that are connected in a direct response mode, in a short cycle of distribution processes to the customer, and those that will come closest to achieving an inter-business traction system. As part of its supply chain management program, Whirlpool has established a new position of vice president of logistics,

assembled interoperable teams for important product categories, reached agreements with suppliers based on their dependability and capacity to contribute to product design, and placed an emphasis on regular communication with suppliers. As a result, product availability immediately increased to 90-95%, stocks fell by 15-20%, and delivery times were reduced to just five days (Davis, 1995).

### **Walmart**

By cooperating directly with important manufacturers, the business started its own supply chain initiative. Known as "vendor managed inventory," manufacturers were in charge of overseeing their goods' inventory in WalMart's warehouse (VMI). Walmart's international growth focused on VMI (Johnson and Davis, 1995).

### **West Co., Becton Dickinson & Baxter**

In the early 1990s, three companies collaborated on supply chain growth in the medical products sector. Becton Dickinson received rubber stoppers from West, and Baxter received medical supplies from Becton Dickinson. Becton Dickinson carried out the program by tasked a top executive with overseeing the supply chain's execution. The three businesses reduced time and expenses while enhancing quality and service by cooperating at all management levels. (Battaglia, 1994).

### **Georgia-Pacific Corp.**

Georgia-Pacific, a pioneer in building product distribution and construction in North America, started adopting supply chain management procedures as part of its company's decentralized operations. Previously, managers in each section were in charge of their unit's incoming and outgoing orders and shipments. A new centralized transport and logistics section was established to organize and streamline the distribution process in response to this system's insufficient efficiency. Every business

unit's requirements and priorities were examined by the new department, and new procedures resulted in annual savings of up to \$20 million. (Blackwell, 1994).

This is why supply networks are now being emphasized as a new strategy rather than just a new trend. As a novel tactic to increase their efficiency, businesses have begun to concentrate on the supply chain. In general, these major developments in the 1990s laid the groundwork for the future of supply networks (Fernie, 2023).

## **2.4 COVID-19 & supply chain**

As mentioned above, pandemic COVID-19 has had a significant impact on the global supply chain. Indeed, the pandemic led to an important contradiction, as on the one hand the global supply chain was affected, but on the other hand it was necessary not to be affected at such a critical time in order to ensure uninterrupted supply of medical equipment (Schwab and Malleret, 2020).

Taking the pandemic as a starting point, there are some undeniable trends for the modern supply chain. The first relevant trend relates to digitalisation. Information technologies that can connect the individual stakeholders in a supply chain and provide real-time updates on what is happening along it, helping to make the best possible decisions, both under conditions of normality and deviation from normality. Blockchain and the Internet of Things (IoT) are predominant initiatives that could contribute in this direction (Iftekhar and Cui, 2021).

A second trend concerns the shift from globalization to regionalization. As a function of the growth of the global market after the fall of the Berlin Wall, a doctrine of cheaper sourcing from many different regions of the world has dominated, creating fragile supply chains. The realisation of this problematic situation during the pandemic predictably leads to a shift to regional and more resilient supply chains (Schwab and Malleret, 2020).

A third trend concerns the rethinking of the concept of efficiency. The concepts of lean and just-in-time approaches may be efficient but hardly effective. These two concepts are philosophies more than methods or tools. The prolonged pandemic COVID-19 these approaches, as they seem to work particularly effectively under

normal conditions, but not when they need to quickly draw in more resources as a function of increased demand. It is therefore now becoming clear that a supply chain should be designed in a way that allows for easy and rapid transition from flexible to efficient strategies or vice versa, depending on the volatility or stability of the business environment (Schwab and Malleret, 2020).

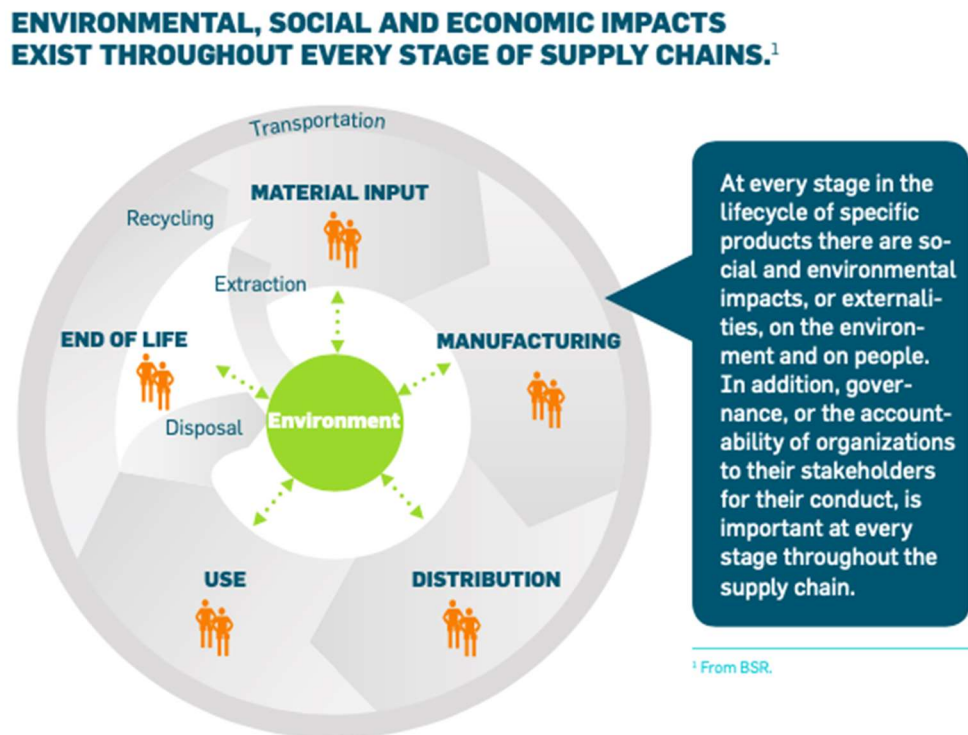
## **2.5 Technology & sustainability in the supply chain**

### **2.5.1 Basic information for sustainable supply chains**

Many scholars started to ponder in depth on the sustainability of the supply chain. In order to improve their environmental and business operations, firms today have devised a variety of environmental initiatives. Activities related to supply chain management have been used by corporations as an environmental strategy. An essential method that helps firms get an advantage over their rivals and enhance overall performance is sustainable system chain management (SSCM). According to Wagner et al. (2001), the outcomes of SSCM techniques could have either a favorable or negative impact on economic performance. To fully foresee the effects that SSCM adoption by enterprises could have, it is necessary to consider both the benefits and drawbacks of the technology.

The practice of managing supply challenges with environmental, economic, and social aspects in mind, focused on advancing the long-term economic objectives of the specific business and its supply chains, is the most widely accepted definition for SSCM. According to Koberg and Longoni (2019), a product's design, production, marketing, shipping, and purchasing all fall under the definition of a sustainable supply chain.

**Figure 2.** The sustainable supply chain



Available at: <https://wheelerblog.london.edu/sustainable-supply-chains-quantifying-impact/>

### 2.5.2 Sustainable product and package design

The creation of sustainable design strategies for the product and packaging is the first step in the application of SSCM. Designing items in a way that they can be recycled or remanufactured is another aspect of this activity. The first researcher to emphasize the need for a sustainable design to eradicate the consequences of waste products was Navin-Chandra (1991). Later, Baojuan (2008) stated that environmentally friendly design has a major impact on resources. In addition to operations, quality,

development cycle, and cost, he claimed that such a design will optimize key design factors. Sustainable design also leads to an effective recycling process.

Also, it aids businesses save money, create better products, and get the respect of their customers (Toupin, 2001). The use of environmentally friendly packaging, the selection of suitable raw materials in accordance with environmental standards, and attention to recycling were all popular in the middle of the 1990s (Hugner and Wheelen, 2004). Sustainable packaging, according to Baojuan (2008), can be done by employing sustainable design to use less packaging material.

### **2.5.3 Sustainable production**

The second activity crucial to the development of SSCM is production. In order to accomplish low input, high output, and low pollution, environmental production can be achieved by adopting clean production methods, innovative technology, and reduced raw materials and resources (Baojuan, 2008). The first production approach that fulfilled environmental goals and addressed environmentally friendly production was lean production, sometimes known as the "just-in-time" method (Farahani et al., 2009). According to Srivastava's argument from 2007, efficient production plays a significant role in lessening the production phase's negative environmental effects. By reducing waste and avoiding hazardous waste, for example, frugal production, according to Liang and Chang (2008), can help firms perform better in terms of the environment. King and Lenox (2001) also argued that frugal production leads to improvements in environmental application and helps organizations reduce the marginal cost of pollution.

Sustainable production can be achieved by recycling. Recycling helps enterprises present a better environmental image to their clients, according to Baojuan (2008). Sustainable products encourage the recycling of items and some of its components. Reverse logistics, or the acceptance of products by customers for purposes of remanufacturing and recycling, is a crucial activity in establishing sustainable production (Dowlatshahi, 2000). Reverse logistics adoption is influenced by economic variables, such as decreased production costs (Grabara et al., 2014).

#### **2.5.4 Sustainable marketing**

Marketing plays a crucial role in the creation and application of SSCM. Maintaining ecosystem balance and emphasizing environmental protection are two things that firms should do in order to practice sustainable marketing (Peterson et al., 2021). Rao (2008) argued that waste management can result in cost savings and increase competitiveness when used in conjunction with sustainable marketing. Additionally, it aids businesses in strengthening their connections with clients, partners, and suppliers.

#### **2.5.5 Sustainable transportation**

Another critical component in the development of effective SSCM is sustainable transport. Many elements, including fuel sources, mode of transportation, infrastructure, as well as operational and managerial procedures, should be taken into consideration while developing environmentally friendly transportation systems. The supply chain's logistics phase's environmental impact is determined by these variables and the dynamics that link them (Shokoohyar et al., 2022).

#### **2.5.6 Sustainable materials' use**

SSCM requires the implementation of sustainable market strategies. Liang and Chang (2008) argued that sustainable markets lead to the reduction of waste and hazardous materials through the use of environmental raw materials. Sustainable markets also play an important role in SSCM because they help organizations reduce pollution source and waste through the use of strategies such as recycling, withdrawal, disposal or sorting and the use of biodegradable packaging (Spaargaren, 2020).

## 2.6 Environmental Management System & supply chain

Making environmental choices has been aided by technology, which has streamlined the complexity of environmental management issues. The Environmental Management System (EMS), a new information system that can be used to enhance environmental and commercial success, has assisted in supply chain environmental decision-making (Prajogo et al., 2014). Every SSCM activity is impacted by EMS, and organizations can use EMS to reduce environmental harm quickly and with little effort. (Darnali et al., 2008). The advantages of EMS in managing environmental risk, assisting organizations in achieving their environmental goals, committing to environmental development, enhancing business performance, and enhancing relationships with the community have been reported by Florida and Davison (2001). The EMS leads to successful adoption of SSCM because it makes information sharing with various stakeholders, such as employees, suppliers, distributors, customers, and governmental organizations, simple. Additionally, it aids in the production of reports that enhance monitoring and assessment procedures. Massive databases and other technological advancements have made SSCM more effective at managing SSCM operations. Radio frequency identification (RFID) is the most current technology to be utilized in SSCM. (Izikki et al., 2022).

Environmental practices are incorporated into supply chain operations to the benefit of organizations in many ways. The benefits of SSCM are being studied by many experts. According to Carter and Rogers (2008), the application of SSCM would aid in lowering threats to the environment, reducing pollution, and enhancing environmental performance. According to Van Hoek (1999), organizations will gain marketing advantages and greatly enhance their corporate image with the implementation of SSCM. Cost savings are another undeniable benefit of implementing SSCM. (Rao, 2002). The advantages of using SSCM are enumerated by Carter and Easton (2011) as follows: packaging is reduced through the use of more efficient design for reuse and recycling, safety costs are decreased, turnover and workforce costs are decreased as a result of safer storage and transportation, product quality is increased, and disposal costs are decreased.

Despite these unquestionable benefits, there are substantial barriers to SSCM adoption. Numerous studies have looked into these obstacles. According to Min and



Galle (1997), the primary challenge in developing SSCM is the high expense of environmental programs. Additionally, unprofitable reuse and recycling, as well as a dearth of managerial and human resource commitment, have an impact on the creation of SSCM strategies (Farahani et al., 2009). Other significant barriers to the implementation of SSCM include inadequate environmental standards or company-level control programs, inadequate buyer and supplier knowledge, and a lack of state legislation. (Zimon et al., 2019). High levels of competition and erratic market demand, according to Hines and Johns (2001), are harming SSCM development. Additionally, according to Farahani et al. (2009), short-term strategies do not aid in the development of the SSCM. As a result, SSCM has a lot of potential advantages but also faces a lot of challenges as it develops.

### **3. Literature review for the supply chain in super markets**

#### **3.1 Major challenges for modern supermarkets**

Market saturation, extreme competition and demographic changes combined with the recent pandemic and the inflation crisis due to the war in Ukraine pose main challenges for supermarket businesses (Lewis et al., 2023). Supermarkets are being forced to adapt various operating strategies, expanding the range of services and products, increasing the loyalty of profitable customers, generating profits through private label and reaching customers through new delivery methods such as online shopping and home delivery (Stanton, 2018).

The growth in services has resulted in the proliferation of "combinatorial" stores and hypermarkets that provide consumers with a one-stop shopping experience. Although in Greece there are legal obstacles that prevent the compliance with certain international trends, in foreign countries for decades supermarkets offer multiple services, such as pharmacies, photo processing, bill payment, banking services etc., having as their primary tenet the economy of time for consumers. In other countries, however, where the relevant legal framework exists, supermarkets offering non-purely related to the traditional role of supermarkets have not met with relative success. In fact, there are countries in which the supermarkets themselves have a lower relative impact than Western societies. For example, in India consumers usually shop in neighborhood stores known as "kirana shops", where home delivery is free and bills are settled at the convenience of the customer, interest-free, although their popularity has definitely fallen from the same popularity two decades ago (Lupane, 2019).

In any case, the combined services have as their central goal the creation of organic growth. It is estimated that when a supermarket offers pharmaceutical services and beauty products, total sales benefit by 15-20% due to increased store traffic. Consequently, supermarkets provide high traffic products, with a high profit margin (Vorley et al., 2016).

Supermarkets are not only forced to expand the kinds of products they offer, but also have to respond to the varying tastes of consumers within categories. For example, some consumers are turning to organic and organic food, while others may be vegan,

needs to be met by modern supermarkets (Kantamaturapoj and Marshall, 2020; Mulee et al., 2017). Therefore, the modern supermarket is imperative to expand the types of products it offers and respond to the diverse preferences of consumers.

Customer loyalty and private label are two other crucial worries for contemporary supermarkets. Barcode cards are used by frequent shopper programs today to monitor consumer purchases, provide discounted prices, and modify offers based on prior usage. Customers are thus rewarded for their devotion, which encourages them to continue making purchases (Mallika, 2022).

Private label programs also increase company recognition and consumer loyalty. In the beginning, the tendency toward private label was an "American phenomenon." However, Tesco developed related programs in Great Britain very effectively in the early 2000s, which led to a successful introduction and imitation of this practice on the European continent (Kwon et al., 2008).

Finally, a particularly pivotal challenge for supermarkets concerns internet delivery markets. In this context, some critical success factors have emerged, such as brand recognition and stable and marketing-related supply systems (van der Vorst et al., 2002). The emphasis on selling over the internet also experienced great popularity due to the COVID-19 pandemic. The pandemic has indeed led to an unprecedented shift to the internet, thus making it imperative for supermarkets, and more generally, to have an effective strategy of selling products via the internet. The supply chain of supermarkets is therefore called upon to respond to the multidimensional challenges they face. To achieve profitability, supermarkets need to significantly improve efficiency, logistics, procurement and cost control (Gordon-Wilson, 2022).

### **3.2 Organizing super markets' supply chain**

Effective Customer Response, or ECR, is a popular method employed by supermarket chains to handle their particular position (Kurt Salmon Associates, 1993). The grocery industry's logistics trends are heavily influenced by this strategy. The consumer is the system's primary driver, according to ECR. In order to make improvements at every stage of the supply chain, it entails evaluating inefficiencies

throughout the chain. ECR was introduced in the US in 1992 as a result of intense consumer pressure, limited growth, and intense competition. In Europe in 1994, Asia in 1996, and Latin America in 1998, this strategy started to catch on. The system calls for collaboration and information sharing among supply chain participants, most frequently between suppliers who were previously unaffiliated. This approach became popular as a function of the realization that when products are on the shelves, customers are better served, supermarkets increase profitability and sales, and suppliers reduce transportation costs and increase sales (Corsten and Kumar, 2003).

Despite having its roots in the US, the ECR has grown even more rapidly in Europe, allowing European chains to beat their American counterparts much more swiftly. This is mostly because of space constraints and significantly higher shipping costs in Europe. American businesses frequently have enormous warehouses that have plenty of room for security barriers. Since security warehouses are rare in European supermarkets, particularly accurate inventory systems are used to prevent stockpiling and the need for additional inventory (Salvi, 2020).

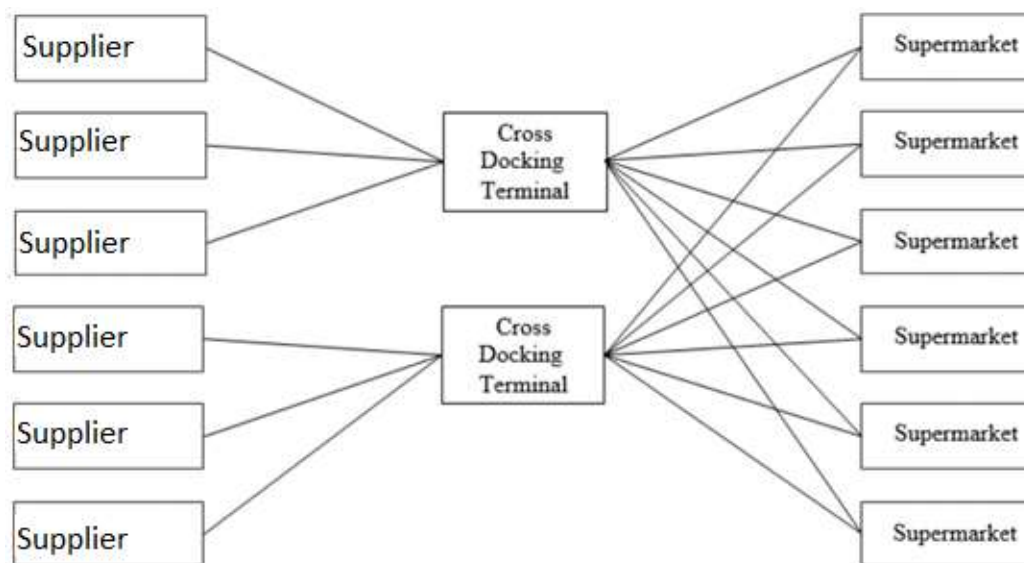
The size of the industry as a whole has an impact on the capabilities and necessity of an effective ECR system. For instance, a less complex structure was conceivable in New Zealand due to the size of the market there. However, India faces unique challenges as a result of its disjointed infrastructure and system, which makes it challenging for grocery chains to apply ECR. Due to transportation and infrastructure constraints, supermarkets in India are also have to hold goods for a far longer periods of time than in European states (Sahu and Rao, 2021).

A number of businesses have significantly improved the supermarket supply chain. The German grocery chain Metro-AG served as a notable example of this, demonstrating to logistics management how structural changes to logistics systems combined with efficient technology utilization may dramatically improve ECR performance. The procurement logistics report for the company described the logistics system that Metro-AG introduced in 1996 and for which it ultimately got the German Logistics Prize in 2002. This system focused on effectively centralizing product and connected thousands of retailers and suppliers (Reynolds et al., 2004).

Metro discovered that he was utilizing two separate logistics models while analyzing the problem he was then facing. Both were based on cross-docking, but one

was source-oriented while the other was target-oriented. Cross docking terminals are located close to suppliers using source-oriented cross docking, as seen in Figure 3. There is a primary terminal for each provider, which supports numerous branches. For very large suppliers who send their goods to very large branches via truck, the technique works well. However, in other instances, the system causes clogged branches and numerous frequent stops for delivery trucks (Reynolds et al., 2004).

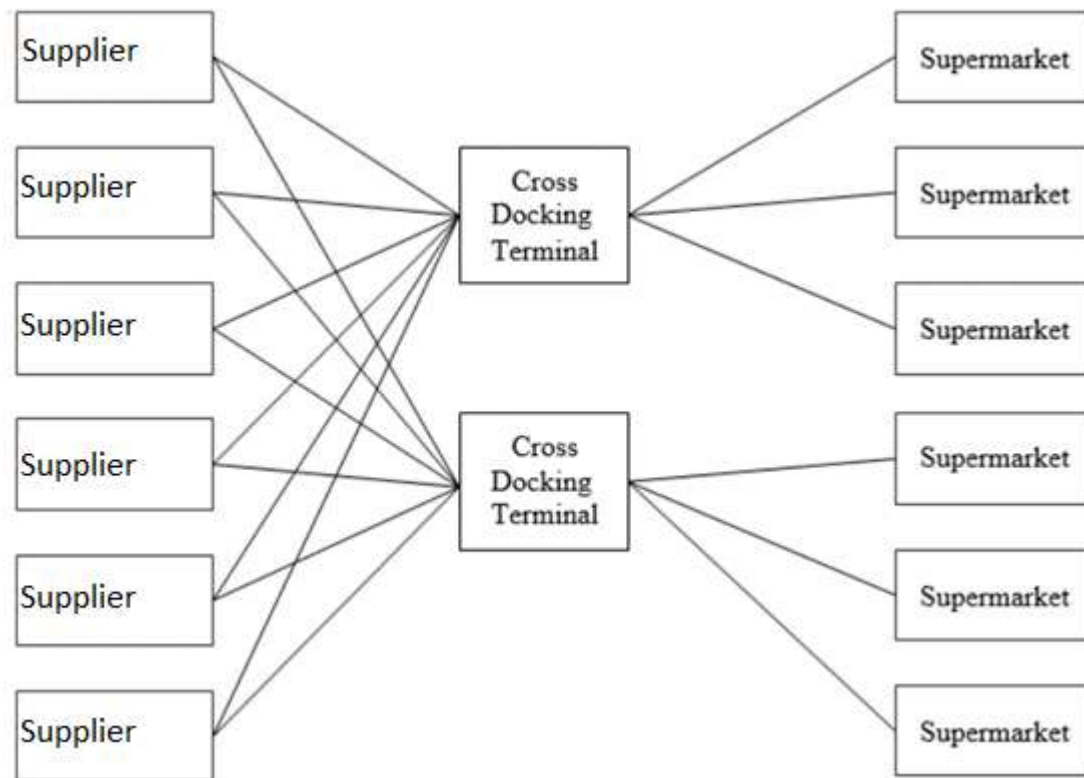
**Figure 3.** Source-oriented cross docking



**Available at:** Reynolds et al., 2004

The supermarket branch is the main focus of target-oriented cross docking (Figure 4). The branches are close to the junction terminals. A primary terminal that receives merchandise from numerous vendors supports each branch. This paradigm creates many stops for suppliers and idle trucks, despite being generally quite effective for branches (Reynolds et al., 2004).

**Figure 4.** Target-oriented cross docking

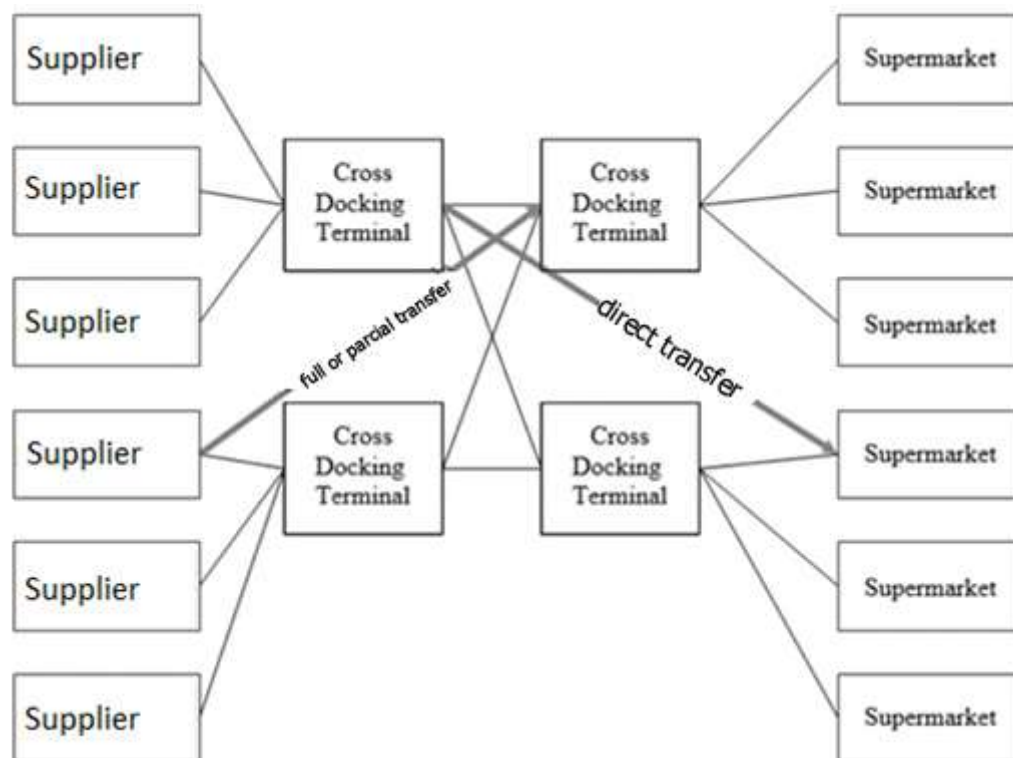


**Available at:** Reynolds et al., 2004

The new system he developed, shown in Figure 5, created a hybrid of the other two. It uses more terminals than traditional models and offers three distribution scenarios:

- (1) suppliers with sufficient daily consignments may dispatch complete or partial consignments directly to the terminal of a particular branch. The Associated send arrow in Figure 5 shows this situation.
- (2) branches with large square meters and high demand can receive shipments directly from the terminal of a particular supplier. The instant send arrow illustrates this situation.
- (3) in all other cases, the system allows the solution of the double transfer. Suppliers aggregate small deliveries to individual terminals in a particular branch, and vice versa, small branches aggregate deliveries to their respective terminals.

**Figure 5.** Hybrid cross docking



**Available at:** Reynolds et al., 2004

The resulting improvements were a 50% reduction in the number of trucks at Metro-AG's pick-up docks and an increase in the volume of deliveries per truck from just one pallet to up to 30. The system also significantly reduced the entire time of the process (Reynolds et al., 2004).

Progressively, the majority of multinational enterprises have started outsourcing the supply chain, in addition to the supermarkets' own significant development of supply systems. Supermarkets have the chance to separate transportation costs when logistics are handled by outside parties, seeking huge cost savings. The first to demand factory gate prices from suppliers were Norwegian businesses. With pricing at the factory gate, transportation costs were removed from supplier prices, enabling supermarket chains to choose the most effective method for transporting the items. Thus, retailers are in charge of logistics and transportation, but suppliers are also

involved in the design of logistics. Together, supermarkets and suppliers are creating mechanisms that are advantageous to both parties. These advancements range from figuring out the optimal packing and pallet height to developing effective ordering systems (Ziga and Martnez, 2016).

Reverse logistics is a significant problem for supermarkets and their supply chains. In fact, an increasing number of supermarket merchants are building reverse logistics systems with their suppliers, modeling them after major product retail chains like Walmart. Reverse logistics is sending damaged, spoiled, or slow-moving merchandise back to suppliers in order to make way for more profitable merchandise. According to Xu (2019), the approach is often utilized for non-perishable non-food items.

Also, achieving the goals of the ECR and overseeing increasingly complex logistics systems requires efficient use of technology in complex inventory management systems. All major retailers use wireless technology. This allows stores to constantly monitor what is on the shelves and what products are purchased, allowing each store to adjust inventory (Salvi, 2020).

About 50 % of supermarket sales are for perishable products. Species with a short lifespan are more difficult to manage. The lack of data makes it more difficult. Wireless inventory management systems that enabled huge improvements in managing categories of non-perishable groceries are not always an option for perishable products. Unfortunately, oranges don't have a barcode. Variations in size, weight and quality make it more difficult to manage items such as oranges and other fruits, vegetables, meats and fish. Supermarkets face the challenge by carefully monitoring the data based on this technology. These systems allow monitoring of certain perishable products, while accelerating the checkout and collection of data useful in customer loyalty programs. Scanners in the near future are expected to collect all the necessary information and eliminate the need for staff at the checkout. As labor costs make up half of a supermarket's operating budget, this technology entails a significant saving for supermarket chains (Tan and Ngan, 2020).

More generally, supermarkets face challenges that other businesses do not face in terms of inventory management (e.g. in the automotive industry). It was therefore imperative to improve technology, in order to improve the supply chain of



supermarkets. Global positioning systems allow senders to track products during transportation. Automated loading and unloading and packaging that allows efficient movement through transport systems create incremental improvements in the time needed to transport products from the producer or manufacturer to the market and, ultimately, to the customer (Gold et al., 2017).

The sophistication of transportation cooling devices has also greatly increased. Today, specially designed containers have the ability to precisely cool to within a quarter degree Celsius, monitor and regulate the concentrations of different gases in the air, and regulate humidity levels. These technologies changed the perishable product trafficking process when used in conjunction with better inventory and logistics planning (Wang et al., 2020).

For supermarket companies, maintaining quality, ensuring food safety, and enhancing energy efficiency are also top considerations. Supermarkets are getting better in each of these categories thanks to refrigeration technology in retail settings. Although not very well known, this technology has been in development for many years. For instance, a company called Hill PhoeniX in Georgia, United States, created a refrigerated showcase that prolongs the shelf life of meat three times longer than traditional showcases by reducing air circulation and maintaining uniform temperatures (Lewis, 2001).

Other changes are happening across the board. Multiple refrigeration units replace the large engineering rooms. These systems are more energy efficient, flexible and have lower manufacturing and operating costs. Also, there are companies that can now provide supermarkets with energy control and continuous monitoring of the HVACR, lighting and control systems of the building. Even tasks as simple as making and transporting ice are getting better. Also, ICE is now more easily distributed directly to the storefront, reducing the requirement for manual ICE transfer inside the store (Wang et al., 2020).

### 3.3 Technological development & super market supply chain management

The first major technological development that transformed the supermarket supply chain was the Universal Product Code (UPC). On June 26, 1974, a package of 10 Wrigley's Juicy Fruit chewing gum was scanned for the first time in a cash register of a supermarket in Ohio, United States. The fact that a barcode could be used to purchase a product was not enough to bring UPC into widespread use. Products had to be labelled (often manually) and retail systems had to be upgraded so they could scan items. What made UPC the de facto standard today was the need to address the slow, labor-intensive and often inaccurate customer checkout (Morton, 1994).

The adoption and use of the UPC, originally in the United States and then internationally, are attributed to Alan Haberman. In particular, it gathered sufficient manufacturers and grocery executives to accept the new coding method. Haberman joined the board of directors of the Uniform Code Council in 1973, which eventually evolved into Global Standards 1 (GS1), an organization that assists businesses in resolving supply chain issues by adopting and implementing accepted standards (Morton, 1994).

Radio Frequency Identification (RFID) is a second crucial technology with major applications in the supermarket supply chain. This system, which Charles Walton invented in 1983 and has since undergone significant development, is utilized in supply chain management as well as many other applications. In essence, RFID technology enables the marking of specific items with tags that contain a UPC and a serial number that uniquely identify each item. This label can be remotely read thanks to RFID technology. As a result, retailers can identify and follow products as they move through the supply chain (Nikolii et al., 2015).

Using this technology requires more skill than just scanning a UPC. The RFID system consists of a transmitter and a receiver. They operate similarly to a radio station that transmits a signal and a radio that picks up the signal. Today's RFIDs are made up of a tiny radio and an antenna that are attached to a price tag or built into a box. The radio employs a unique radio frequency pulse that is transmitted to power itself even though it has no internal power source. The radio broadcasts data on its side after being fed. The device that started the radio frequency pulse receives the transmission and

sends the data to a computer for processing. This data is called an electronic product code, or EPC, containing the UPC and serial number (Nikolić et al., 2015).

There were issues with RFID technology, but these were substantially resolved in later advancements. Because of interference from the metal, an RFID label placed on a can could not always pick up the radio frequency pulse. As bulky things can block radio frequencies, other examples include RFID labeling on liquor bottles and fresh meat packages. Better RFID tags, multiple antennas, ultra-high frequency radio waves, and other technologies that allow RFID tags to be read despite associated impediments have substantially solved these issues (Nikolii et al., 2015).

The third most important technology, which is expected to be applied to supermarket supply chains in the near future is blockchain technology. This technology has gained popularity relatively recently due to the intensive growth of cryptocurrencies in the global economy and was initially used to hide information about transactions. Blockchain technology is currently gaining rapid popularity: articles are written about it, it is discussed in industry forums and special conferences, and start-ups are introduced in various sectors of the economy based on it (Rocas-Royo et al., 2021).

Literally, the word "blockchain" refers to a chain of blocks where each block is connected to the one before it. A block is a collection of information that includes some new data as well as all the earlier information. The entire chain functions as a decentralized database that is dispersed across various segments. The information that makes up the block chain may include transactions, individuals, items, serial numbers, loans granted, etc. As a result, this tool's range of application can change (Rocas-Royo et al., 2021).

The foundation of blockchain technology is a sophisticated encryption scheme in which every block has a distinct key. This feature of blockchain databases almost eliminates the chance of a breach by requiring simultaneous access to a copy of the database on every computer in the network by hackers. Any further modifications to the original document or transaction will result in a new digital signature for the data, which will be incompatible with the system as a whole. This system is set up so that each member constantly checks the information coming in. Each exchange thereby verifies the reliability and accuracy of the data that has been saved on the network. This ensures that information is accurate and preserved. (Lysanikov et al., 2020).

By implementing blockchain technology, the management paradigm is changed from being hierarchical and "top down" to being "horizontal," where choices are made decentralized and the entire process is transparent to supply chain partners. In this case, the number of intermediaries is reduced, the information flow parameters are optimized, and the financial flow parameters are minimized (e.g., reduced processing costs and transportation costs) (Lysanikov et al., 2020).

In the case of supermarkets, a few businesses in the sector have so far incorporated the necessary technologies. One such division of Walmart makes use of technology to automate and improve its supply chain. To trace food from suppliers to retailers, Walmart now largely relies on this technology (Lysanikov et al., 2020). Nevertheless, it appears that the use of the pertinent technologies is not widely spread outside of Walmart. The adoption of this technology is constrained by its expense, the lack of a clear legal framework, the absence of international standards, and the low level of public knowledge of the technology (Rocas-Royo et al., 2021).

## **4. Materials and Methods**

### **4.1 Aim/ research questions**

The aim of the study was the investigation of the crucial role of technology in sustainable chain management in Lidl. Two specific research questions were set: 1) which are the attitudes of Lidl workers towards sustainable supply chain? 2) which factors determine these attitudes?

### **4.2 Methods**

This research was quantitative and involved a case study. Quantitative research refers to those conducted using measurement tools such as questionnaires. A prerequisite therefore of a quantitative research is the use of measurements which are analyzed and coded numerically (Robson, 2002). This research was also a case study. In a case study, a single case that relates to a wider phenomenon is examined in depth. The case does not necessarily have to refer to a single individual as it can refer to a unit, a town, a supermarket etc. (Babbie, 2013). This study therefore looked at Lidl as a case study, attempting a more general investigation into the role of technology in supermarket supply chain sustainability.

### **4.3 Participants**

The participants of this study were employees of Lidl. As mentioned above, the supply chain is an issue of central importance for supermarkets, which concerns the way they operate in general and not just a specific part of them. Potentially, the inclusion of participants could only be carried out with regard to senior managers of the company. However, the employees themselves may be effectively aware of the barriers, difficulties, opportunities and benefits of using technology in the supply chain. Consequently, it was considered preferable to include employees of the company

without inclusion and exclusion criteria in order to explore the awareness of all employees on this issue.

#### **4.4 Assessments**

The measurements of this study were carried out using a self-report questionnaire. The self-report questionnaires are completed by the participants themselves, i.e. they are not administered in any form of interview by the researcher. The relevant questionnaire is provided in the appendix. Initially, this questionnaire includes socio-demographic data, and then includes questions concerning issues of technology use in relation to the sustainability of the supply chain of Lidl.

As for the questions on the use of technology, these were conducted in Likert scale format. In particular, a total of 18 questions were used, which were divided into five main categories. These categories were 1) benefits of using technology in the sustainable supply chain 2) knowledge of the role of technology in the sustainable supply chain 3) attitudes towards a sustainable supply chain 4) the role of individual technologies 5) barriers to using technology in the sustainable supply chain. It is therefore a questionnaire that assesses individual parameters of employees' perceptions of the role of technology in Lidl's sustainable supply chain. Employees were asked to give answers from 1 (strongly disagree) to 5 (strongly agree).

#### **4.5 Process**

The administration of the measurements of this study was carried out in person. Given the researcher's employment at Lidl, the questionnaires were administered in physical form to colleagues during their breaks from work and in any case at times when neither the operation of the business was disrupted nor the participants' break time was abused. In order to ensure the latter, in the event that participants wished to do so, they completed their measurements at home and returned them on another day, after consultation with the researcher. It was stressed to all participants that their participation in the study was anonymous and confidential and that the data they

provided for the purposes of the study would not be used for other purposes. It was emphasized to participants that they could choose not to complete the study's, even if they had agreed to participate in the study in the first instance. Permission to conduct the study was obtained from managers of the stores where employees were included. The inclusion process in the study was terminated after the collection of 21 completed responses.

#### 4.6 Statistical analysis

Statistical analysis of the data of the present study was performed using SPSS for Windows. Initially, descriptive analysis was performed on the socio-demographic data of the participants, with the aim of detailing the profile of the study sample. These analyses were performed using absolute values and percentages in the case of categorical variables, and using means and standard deviations in the case of quantitative variables. The use of means and standard deviations was also carried out with respect to each of the questions of the measurement tool in order to determine the extent to which participants agreed with each statement. Similarly, the individual questions of each scale were added in order to derive an overall score and to obtain a mean and standard deviation for each variable as well. The reliability of these five subscales was also examined based on Cronbach's (1951) index. The relevant analysis can be found at the following table.

**Table 1.** The reliability for each of the study scales

Scale	$\alpha$
Benefits from the use of technology in supply chain	0.564
Knowledge towards the role of technology in supply chain	0.589
Perceptions for the role of sustainability in supply chain	0.276
The role separate technologies	0.552
Barriers in the use of technology in supply chain	0.747

Subsequently, the sub-variables obtained from the sum of the individual questions were examined in relation to all socio-demographic data of the participants.

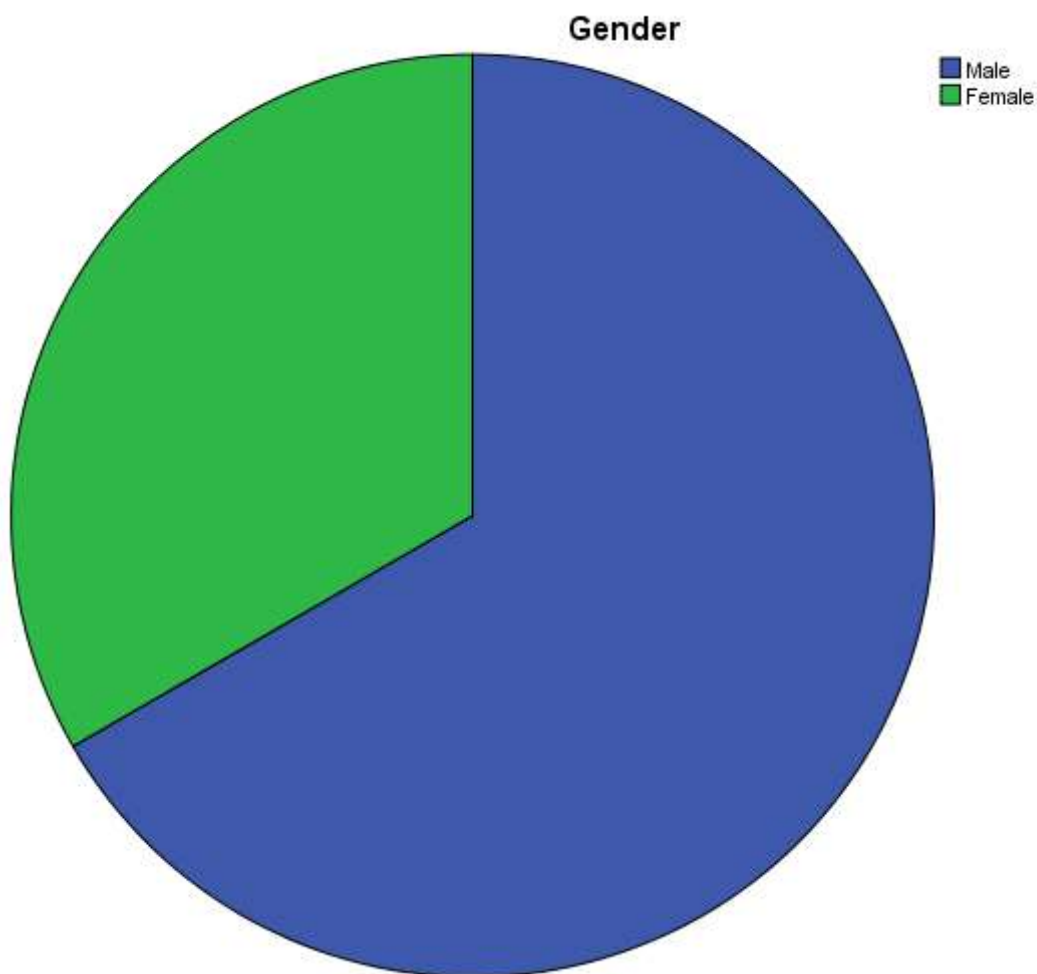
For each of these four variables, a multiple linear regression analysis was performed. The significance index was set at 0.05 for all analyses.



## 5. Results

The descriptive analysis for the participants' gender is presented at Figure 6. As indicated, the majority of the participants consisted of males (N=14, 66.7%), while 33.3% of the participants (N=7) were females.

**Figure 6.** The gender of the study participants



The participants' work experience is presented at Table 2. As indicated by the table, the mean value of work experience at Lidl was 7.90 years, of work experience in the current position 6.61 years and of total work experience 18.23 years.

**Table 2.** The participants work experience

	Work experience at Lidl	Work experience in the current position	Total work experience
Mean	7,904	6,619	18,235
N	21	21	17
Std. Deviation	3,520	3,930	7,369

The duties of the responders are presented at Table 3. As indicated by the table, almost half of the study participants were clerks (47.6%). A smaller proportion consisted of office workers (28.6%), loaders (14.3%) and administrative staff (9.5%).

**Table 3.** The work position of the participants

		Frequency	Percent
	Loader	3	14,3
	Office worker	6	28,6
	Clerk	10	47,6
	Administrative staff	2	9,5
	Total	21	100,0

The descriptive analysis for each of scales of the study is presented at Table 4. As indicated, there was a highly positive perception for the benefits from the use of technology in supply chain, since the mean value was 29.61 and the potential range for this scale 7-35. The knowledge was high, since the potential range was 3-15 and the participants mean value 12.19. The perceptions for the role of sustainability in supply chain were positive, since the mean value was 28.85 (potential range 7-35). The perception towards the role of separate technologies was high, since the mean value was 20.76 (potential range 5-25). The barriers in the use of technology in supply chain were low (mean value 10.80-potential range 5-25).

**Table 4.** The descriptive analysis for the scales of the study

	Benefits from the use of technology in supply chain	Knowledge towards the role of technology in supply chain	Perceptions for the role of sustainability in supply chain	The role of separate technologies	Barriers in the use of technology in supply chain
Mean	29,6190	12,1905	28,8571	20,7619	10,8095
N	21	21	21	21	21
Std. Deviation	2,43877	1,28915	2,08052	1,22085	2,92607

The analysis regarding the relationship between the independent variables of the study and the perceived benefits is presented at the following table. As indicated by the table, those with higher work experience at Lidl perceived the benefits to be higher ( $p=0.015$ ). In addition, work position had a significant relationship with benefits, with clerks having the less positive perception, followed by loaders, administrative staff and office workers ( $p=0.046$ ).

**Table 5.** The association between the sociodemographic variables and perceived benefits from the use of technology in supply chain

Model	Unstandardized Coefficients		Standardized Coefficients	t	P
	B	Std. Error	Beta		
(Constant)	29,348	2,334		12,575	,000
Gender	1,878	1,332	,385	1,410	,186
Work experience at LIDL	,779	,271	1,122	2,872	,015
Work experience in the current position	-,407	,253	-,629	-1,609	,136
Total work experience	-,142	,112	-,456	-1,271	,230
Work position	-1,242	,553	-,638	-2,247	,046

The effect of the overall model ( $F=2,273$ ) was insignificant ( $p=0.117$ ). The

adjusted R square was 0.215.

**Table 6.** The overall model for perceived benefits from the use of technology in supply chain

Model	Adjusted R Square	F	p
1	,215	2,273	0.117

The effect of sociodemographic variables regarding knowledge towards the role of technology in supply chain is presented in the following table. As indicated by the table, those with higher work experience at Lidl had more knowledge regarding the use of technology in supply chain ( $p=0.029$ ).

**Table 7.** The association between the sociodemographic variables and knowledge regarding the use of technology in supply chain

Model	Unstandardized Coefficients		Standardized Coefficients	t	p
	B	Std. Error	Beta		
(Constant)	10,570	1,308		8,080	,000
Gender	,639	,746	,228	,857	,410
Work experience at Lidl	,380	,152	,953	2,504	,029
Work experience in the current position	-,276	,142	-,740	-1,943	,078
Total work experience	,027	,063	,154	,439	,669
Work position	-,375	,310	-,334	-1,209	,252

The overall model had an effect ( $F=2,093$ ), which was non-significant ( $p=0.143$ ). The adjusted R square was 0.255.

**Table 8.** The overall model for knowledge regarding the use of technology in supply chain

Model	Adjusted R Square	F	P
1	,255	2,093	0.143

The analysis for the association between the sociodemographic variables and perceptions for the role of sustainability in supply chain is presented in the following Table. Work experience in the current position was negatively related with this variable, while total work experience was positively related ( $p=0.026$  &  $0.015$ ).

**Table 9.** The association between the sociodemographic variables and perceptions for the role of sustainability in supply chain

Model	Unstandardized Coefficients		Standardized Coefficients	t	P
	B	Std. Error	Beta		
(Constant)	29,590	1,609		18,389	,000
Gender	-1,978	,918	-,490	-2,154	,054
Work experience at Lidl	-,168	,187	-,293	-,900	,387
Work experience in the current position	-,450	,174	-,840	-2,582	,026
Total work experience	,222	,077	,863	2,885	,015
Work position	,614	,381	,380	1,610	,136

The effect of the overall model ( $F=3,678$ ) was significant ( $p=0.033$ ). The adjusted R square was 0.456.

**Table 10.** The overall model for perceptions for the role of sustainability in supply chain

Model	Adjusted R Square	F	P
1	,456	1,336	0.319

The analysis for the association between the sociodemographic variables and the role of separate technologies is presented at Table 11. As indicated by the table, those with higher work experience in the current position had a less positive perception compared to the others ( $p=0.049$ ).

**Table 11.** The association between the sociodemographic variables and the role of separate technologies

Model	Unstandardized Coefficients		Standardized Coefficients	t	p
	B	Std. Error	Beta		
(Constant)	20,495	1,475		13,899	,000
Gender	,502	,841	,175	,597	,563
Work experience at Lidl	,240	,171	,587	1,400	,189
Work experience in the current position	-,354	,160	-,928	-2,212	<b>,049</b>
Total work experience	,065	,070	,353	,917	,379
Work position	-,475	,349	-,414	-1,359	,201

The effect of the overall model ( $F=1,336$ ) was not significant ( $p=0.319$ ). The adjusted R square was 0.378.

**Table 12.** The overall model for perceptions for the role of separate technologies

Model	Adjusted R Square	F	P
1	,378	1,336	0.319

The association between the sociodemographic variables of the study and the perceived barriers in the use of technology in supply chain are presented followingly. As indicated by the table, those with higher work experience in the current position perceived more barriers ( $p=0.035$ ). No other significant associations were noted between the independent variables and the use of technology in supply chain.

**Table 13.** The association between the sociodemographic variables and barriers in the use of technology in supply chain

Model	Unstandardized Coefficients		Standardized Coefficients	t	P
	B	Std. Error	Beta		
(Constant)	13,851	2,805		4,937	,000
Gender	,123	1,601	,020	,077	,940
Work experience at Lidl	-,341	,326	-,401	-1,048	,317
Work experience in the current position	,729	,304	,918	2,398	<b>,035</b>
Total work experience	-,262	,134	-,687	-1,954	,077
Work position	,159	,664	,067	,239	,815

The effect of the overall mode ( $F=2,044$ ) was insignificant ( $p=0.150$ ). The adjusted R square was 0.482

**Table 14.** The overall model for perceptions for barriers in the use of technology in supply chain

Model	Adjusted R Square	F	P
1	,482	2,044	0.150

## 6. Discussion

### 6.1 Theoretical attributions

In this study, the role of technology in relation to sustainability was examined by examining the case of Lidl supermarkets. A first finding that emerges from the analysis of the study data has to do with the positive attitude of the research participants towards the use of technology in the supply chain of this company. The participants believe that there are significant benefits from the use of technology in the supply chain, they believe that it promotes sustainability, they have a positive attitude towards various individual technologies used, they believe that there are few barriers that hinder the use of technology in the supply chain and they perceive themselves as having competent knowledge of these technologies.

Through the inductive analysis of the study data, a number of other findings also emerge. Work experience at Lidl significantly differentiates the perceived benefits and knowledge of the participants regarding the use of modern technology in the supply chain. A second effect is that of having worked in the same position, which is associated with a more negative evaluation of the role of sustainability in the supply chain, a more negative evaluation of the use of individual technologies in the supply chain and a more negative evaluation of the barriers arising from the use of technology in the supply chain. These participants could therefore be considered to have a more negative evaluation in general compared to the others.

Finally, the relationship between job location and perceived benefits is also of interest. As mentioned above, clerks having the less positive perception, followed by loaders, administrative staff and office workers.

Based on the above, it seems that Lidl has a very positive view on the issue of sustainability and the use of modern technology in the supply chain. The supply chain makes use of modern technology, which is supported by a pool of employees with relevant knowledge and skills. The fact that there are low perceived barriers within Lidl to the use of technology also indicates an important priority of this business in terms of its use. Lidl therefore appears to have followed the trends that have been identified for decades in the global supermarket market to rapidly integrate and exploit advances in technology in the supply chain (Reynolds et al, 2004). At the same time, it seems to place considerable emphasis on sustainability issues, which is also considered



important in terms of the supply chain (Prajogo et al., 2014). It is therefore, according to the employees' assessment, a supply chain that is both efficient and in line with current trends in terms of sustainability.

Regarding the finding of a positive correlation between work experience and the variables considered, it seems that Lidl is a learning organisation and that along the time employees increase their knowledge and skills. Participants with more work experience therefore seem to be distinguished by more knowledge and skills. One might expect the opposite, given that individuals with longer work experience are also expected to be older, with older age being a problematic factor in increasing knowledge regarding modern technologies (O' Brien et al., 2012). In the case of Lidl, however, work experience is expected to lead to more knowledge regarding modern technology.

However, through this study a negative effect of working in the same position within the organization is also highlighted. It could therefore be argued that working in the same position leads to an increase in the degree of use of modern technology and significant benefits for the development of the participants, but reaching a stagnation at some point. From this point onwards, a change of job is required so that further benefits accrue.

## **6.2 Practical implications**

Based on the above, a related suggestion emerges about encouraging employees to change jobs within the organization in order to increase the richness of their experiences and to make multifaceted use of modern technology to promote the sustainability of the firm's supply chain. Therefore, a relevant suggestion for the management of the firm has to do with the job rotation of the participants.

A second proposal for the management of the business has to do with turning Lidl even more into a learning organization. As mentioned above, participants who have more experience are also distinguished by more knowledge regarding the use of modern technology in the supply chain. Consequently, a relevant suggestion could be made in terms of developing informal forms of knowledge management within the firm. Such modern forms of knowledge management are coaching and mentoring (Kalantzis and Cope, 2013). Within the firm, therefore, interventions based on coaching and mentoring could be developed with the aim of increasing employees' knowledge about the use of technology in the supply chain. Older employees could take on the role of trainers of

younger employees, accelerating their acquisition of knowledge on their part about the role of technology in the supply chain.

Finally, the fact that significant knowledge on the part of the company's employees in general has been established through this study should not lead to complacency. After all, a firm's staff has a central role in using modern technology to improve its strategic position (Hugner and Wheelen, 2004). These findings should therefore not lead to a complacency in the firm, especially since technological developments are rapid. On the contrary, the firm should place even greater emphasis on educating and training its staff on issues related to the use of technology in the firm's supply chain. In this way, cost-effective benefits for the firm could result, i.e. reducing the cost of the supply chain and increasing its efficiency. Lidl's emphasis on human resources training is therefore imperative.

### **6.3 Study limitations**

In any case, this study is distinguished by certain limitations, which should be pointed out. A first limitation has to do with the size of the sample considered. The sample of this study was small, consisting of only 21 participants. A small sample size increases the risk of type 1 error, i.e. incorrectly rejecting the null hypothesis and demonstrating statistically significant relationships in cases where they should not be (Robson, 2002). The findings of this study are therefore vulnerable to type 1 error.

A second limitation of the study has to do with the representativeness of the sample examined. From a methodological point of view, representativeness refers to the extent to which the participants in a study are typical members of the wider target population being studied. In the present study, the target population was generally Lidl employees in our country. However, the inclusion was drawn from the researcher's wider professional and interpersonal environment, thus constituting a convenience sample, an approach which has been criticized in terms of its potential for generalization to the wider target population (Robson, 2002). It could therefore be argued that there is a selection bias in this research, which therefore constitutes a significant methodological limitation.

A third limitation of the study has to do with the measurement tool that was used. A non-standardized instrument, such as the one used in the present study, is questioned as for its reliability (Robson, 2002). In this study the instrument used was

unweighted, which also leads to a significant limitation. However, the choice of an unweighted psychometric instrument was imperative, given that it addressed an issue that had not been studied by previous studies, namely to have a relevant study instrument. In addition, the  $\alpha$  level for all of its scales was low.

#### **6.4 Suggestions for future research**

Based on the above, some suggestions for future research can be made. A first relevant suggestion has to do with conducting a study that addresses the limitations of the present project. In particular, a study could be conducted on a larger and more representative sample size, so that more reliable conclusions and findings could be obtained.

A second suggestion is to conduct a study examining the issue of technology and its application in the sustainable supply chain and other supermarkets in our country. Therefore, it could be determined whether there is a central trend regarding the use of technology for supply chain sustainability in supermarkets or whether each supermarket applies its own approach.

Finally, it could be suggested to conduct a qualitative research, examining the perceptions of the participants as to the ways in which the sustainability of the supply chain in LIDL could be improved. In modern business the need for evolution is constant (Hugner and Wheelen, 2004). This research was quantitative and by their nature quantitative studies cannot lead to an in-depth exploration of participants' attitudes and perceptions regarding the issue under consideration, which is best carried out through qualitative research, particularly those using interviews (Robson, 2002). Therefore, it could be suggested that a study using interviews could be conducted in order to explore employees' perceptions of the ways in which the supply chain at Lidl could be improved.

## **7. Conclusions**

In conclusion, this study leads us to a very positive assessment on the use of supply chain technology to promote sustainability at Lidl. These findings should not lead to a complacency, but to a constant vigilance for the management of the company, so that it proceeds to the continuous improvement of the sustainability of the supply chain, utilizing the latest trends in modern technology.

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## Appendix

Φύλο: Άντρας

Γυναίκα

Άλλο

Έτη προϋπηρεσίας στα Lidl:.....

Έτη προϋπηρεσίας στη συγκεκριμένη θέση:.....

Συνολικά έτη εργασιακής προϋπηρεσίας:.....

Θέση εργασίας στην επιχείρηση:.....

	Διαφωνώ απόλυτα	Διαφωνώ	Ούτε συμφωνώ ούτε διαφωνώ	Συμφωνώ	Συμφωνώ απόλυτα
<b>Οφέλη από τη χρήση της τεχνολογίας στην εφοδιαστική αλυσίδα</b>					
Εξοικονομείται χρόνος					
Περιορίζονται οι αναγκαίοι χώροι αποθήκευσης των προϊόντων					
Τα προϊόντα δεν χαλάνε (π.χ. φρούτα)					
Περιορίζονται οι ελλείψεις προϊόντων					
Αναπτύσσονται καλύτερες σχέσεις με τους προμηθευτές					
Οι πελάτες μένουν πιο ικανοποιημένοι					
Βοηθάει η χρήση των τεχνολογιών στην επίτευξη των στόχων της παραγωγικότητας					
<b>Γνώσεις για το ρόλο της τεχνολογίας στη βιώσιμη εφοδιαστική αλυσίδα</b>					
Γνωρίζω αρκετά για την αξιοποίηση της τεχνολογίας με					

στόχο τη βιωσιμότητα της εφοδιαστικής αλυσίδας					
Η εταιρεία εκπαιδεύει τους εργαζόμενους στην αξιοποίηση της τεχνολογίας στην εφοδιαστική αλυσίδα					
Προωθείται μια κουλτούρα συλλογικής γνώσης για τη χρήση της τεχνολογίας στην εφοδιαστική αλυσίδα					
Αντιλήψεις για τη βιωσιμότητα στην εφοδιαστική αλυσίδα					
Η βιωσιμότητα πρέπει να αποτελεί κεντρικό πυλώνα των εφοδιαστικών αλυσίδων των πολυκαταστημάτων					
Μεταξύ της βιωσιμότητας και της εξοικονόμησης κόστους, η διοίκηση μιας επιχείρησης πρέπει να επικεντρώνεται περισσότερο στη βιωσιμότητα					
Στο μέλλον η βιωσιμότητα των εφοδιαστικών αλυσίδων θα απασχολήσει αναμενόμενα περισσότερο τη διοίκηση της επιχείρησης που εργάζομαι					
Θεωρώ μεγάλης αξίας τη βιωσιμότητα μιας εφοδιαστικής αλυσίδας					

Η κοινωνική βιωσιμότητα της εφοδιαστικής αλυσίδας πρέπει να είναι πρωταρχικής σημασίας					
Η περιβαλλοντική βιωσιμότητα της εφοδιαστικής αλυσίδας πρέπει να είναι πρωταρχικής σημασίας					
Η οικονομική βιωσιμότητα της εφοδιαστικής αλυσίδας πρέπει να είναι πρωταρχικής σημασίας					
Ο ρόλος των επιμέρους τεχνολογιών					
Το Universal Product Code έχει βελτιώσει καταλυτικά τη βιωσιμότητα της εφοδιαστικής αλυσίδας των Lidl					
Η τεχνολογία QR έχει τη δυνατότητα να βελτιώσει τη βιωσιμότητα της εφοδιαστικής αλυσίδας των Lidl					
Η τεχνολογία blockchain έχει τη δυνατότητα να βελτιώσει τη βιωσιμότητα της εφοδιαστικής αλυσίδας των Lidl					
Η τεχνολογία RFID μπορεί να βελτιώσει σημαντικά τη βιωσιμότητα της εφοδιαστικής αλυσίδας των Lidl					
Η τεχνολογία αυτόματων παραγγελιών autodispo των					

καταστημάτων βελτίωσε την βιωσιμότητα της εφοδιαστικής αλυσίδας των Lidl					
Εμπόδια στη χρήση της τεχνολογίας στην βιώσιμη εφοδιαστική αλυσίδα					
Οι εργαζόμενοι δεν διαθέτουν τις αναγκαίες γνώσεις					
Η διοίκηση δίνει μικρή έμφαση στη χρήση της τεχνολογίας με στόχο τη βιωσιμότητα					
Η ίδια η τεχνολογία δεν έχει ακόμα αναπτυχθεί στον αναγκαίο βαθμό					
Υπάρχουν προβλήματα στον συντονισμό του Lidl με τους προμηθευτές για την αποτελεσματική χρήση της τεχνολογίας					
Οι τεχνολογίες αυτές συνεπάγονται σημαντικό επιπρόσθετο κόστος για την επιχείρηση					

Δηλώνω ρητά ότι, σύμφωνα με το άρθρο 8 του Ν. 1599/1986 η παρούσα εργασία αποτελεί αποκλειστικά προϊόν προσωπικής εργασίας και δεν προσβάλλει κάθε μορφής δικαιώματα διανοητικής ιδιοκτησίας, προσωπικότητας και προσωπικών δεδομένων τρίτων, δεν περιέχει έργα/εισφορές τρίτων για τα οποία απαιτείται άδεια των δημιουργών/ δικαιούχων και δεν είναι προϊόν μερικής ή ολικής αντιγραφής, οι πηγές δε που χρησιμοποιήθηκαν περιορίζονται στις βιβλιογραφικές αναφορές και μόνον και πληρούν τους κανόνες της επιστημονικής παράθεσης.