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Assessing the environmental sustainability of the clothing market: from the consumption habits to the operations

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Abstract

Apparel products are the ones most commercialized online. Despite all the environmental problems associated with the supply chain that is common to other sectors, apparel also has a larger amount of waste, smaller life cycles, and higher return rates. New trends are constantly emerging, and the products are purchased more often. This results in a large circulation of vehicles to transport the products.

Despite some efforts from companies to make the delivery more sustainable, this is not enough. The circular economy is also emerging through the commerce of articles in second hand. However, it is essential to understand consumer habits of customers to know how to improve environmental sustainability.

This work focuses on understanding consumer habits and how socio-demographic factors influence them. Also, the study aimed to understand the customers' preferences when buying online and conclude what their environmental impact is. For this purpose, first, a systematic literature review where was explored the business type was conducted, and then a survey to understand the customers' habits and how are they related to the business types was designed and applied.

Based on a sample of 356 respondents it is possible to observe that the factor with more influence on consumer habits of apparel products is gender as well as age. Factors like education or residence place have less influence. To test this influence was used a statistical test, Cramer's test measures the association between two variables.

Many consumers make their travel to the store using their own car, which results in a higher emission production. When asked for the reason to use their vehicle the most common response was that by using it, customers are independent of third parties, like the schedule of the public transportation. On the other side, a considerable number of customers have used second-hand commerce which helps to decrease one of the largest problems of the fashion sector, the short life cycle of the products. The results of this work may be used by decision-makers for the application of more sustainable practices.

Resumo

Os produtos de moda são um dos produtos mais comercializados online. Apesar dos problemas ambientais associados à cadeia de abastecimento comuns a outros sectores de actividade, este sector apresenta ainda outros como uma elevada produção de resíduos durante o processo de fabrico, ciclos de vida curtos e taxas de devolução muito elevadas. Há constantemente o aparecimento de novas tendências, e os produtos são adquiridos com elevada frequência. Isto resulta numa enorme e intensa cadeia de abastecimento.

Apesar dos esforços das empresas para tornar o abstecimento de produtos de moda mais sustentáveis, isto não tem sido suficiente. Novos conceitos surgem para promover a sustentabilidade dos artigos de *fast-fashion* como o de economia circular que promove o comércio de artigos em segunda mão. No entanto, é essencial compreender os hábitos de consumo dos clientes para melhorar a sustentabilidade ambiental do sector.

Esta dissertação foca-se na compreensão dos hábitos de consumo e na forma como os factores sócio-demográficos os influenciam. Pretendeu ainda também compreender as preferências dos clientes quando compram em lojas *online* e analisar qual é o seu impacto ambiental. Para isso foi realizado uma revisão sistemática da literatura onde foi abordado o tipo de negócio e foi criado um inquérito para perceber como os hábitos do consumidor estão relacionados com os tipos de negócio.

Com base em uma amostra de 356 respostas foi possível verificar que o fator com mais influência nos hábitos de consumo de moda é o género assim como a idade. Fatores como a educação e o local de residência têm menor influência no consumo deste tipo de bens. Para testar esta influência foi usado um testes estatístico, teste de Cramer que mede a associação entre duas variáveis. Apesar da larga variedade de tipos de entrega que as lojas tendem a oferecer para maximizar o valor para o cliente, a mais escolhida por este é o método de envio para casa em tempo normal.

Em relação à sustentabilidade ambiental, existem muitos consumidores que fazem a sua deslocação para as lojas em carro próprio o que acaba por ser mais prejudicial para o meio ambiente. Quando são perguntados pela razão para fazerem esta deslocação com veículo próprio a resposta mais comum é por questões é o facto de ficarem independentes de terceiro. Por outro lado um número razoável de consumidores usam comércio em segunda mão o que ajuda a reduzir um dos grandes problemas do sector da moda, o curto ciclo de vida dos artigos. Os resultados deste trablho podem ser usados como fatores de decisão para a aplicação de práticas mais sustentáveis.

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I would not be able to accomplish this work without the help of my family and friends, that do not let me forfeit, and for their constant support.

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Pedro Aidos

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"When you're backed against the wall,
break the goddamn thing down."

Harvey Specter

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Abbreviations and Symbols

DC   Distribution Center
QR   Quick Response
STS   Ship-to-Store
EEA   European Environmental Agency
EU   European Union
BOPS   Buy online, pickup in store

Chapter 1

Introduction

The fashion sector covers a lot of different types of businesses, from manufacturing to distribution to customers, including design and marketing. Retail in most cases acts as a fashion buyer and is focused on logistics and operation, while e-commerce offers services through electronic platforms. In the case of haute couture e-commerce, brands and designers offer high-end fashion items, which are built by hand from start to finish [4].

This chapter presents a first approach to the theme and it is divided into four sections. First, section 1.1 contextualizes the theme, the model business that uses e-commerce, and the market value relative to the fashion sector in some countries. Next, section 1.2 presents why this work has significant importance, due to the growing concern about the environment. Then, section 1.3 describes what this work pretends to accomplish. Last, section 1.4 outlines how this document is organized.

1.1 Context

With the rise in internet use, products from a foreign country can be easily bought. As a result, retailers find there a place to expand their business, to gain brand knowledge, and to increase sales and internationalization. The retailers see in an omnichannel model a solution to improve the user experience, to vanish the boundary between online and offline shopping [5]. In 2020, the global parcel shipping was 131.2 billion (10^9) parcels shipped, and is predicted that this number increase to 266 billion in 2026 [6].

The apparel market is one of the biggest sectors of consumption. This market includes from sportswear to businesswear, and from value clothing to statement luxury pieces, shoes, and hats. The big players in this market are China (284.4 billion dollars in revenue), the United States of America (126.5 billion dollars in revenue), the United Kingdom (32.5 billion dollars in revenue), Japan (23.9 billion dollars in revenue), and Germany (22.5 billion dollars revenues) [7].

In 2021, the value of the global fashion industry was estimated to be 1.5 trillion (Exp12) dollars [8], while e-commerce represents 751.5 billion dollars [7]. After a global decrease in the sector during the coronavirus pandemic (in 2020), estimates expect that the global demand for clothing

and shoes will rise again. By 2025, the e-commerce fashion industry expects to grow 7.2% annual [7]. In 2019, before the coronavirus pandemic, the sales are only 22.8% made online while the other 77.2% represents offline sales in markets and physical stores. In 2020, the year in which appears the pandemic, online sales have grown almost 10% settling in the 31.6% off all sales, and it is expected that this value will reach 40.3% in 2025 [7].

During the COVID-19 lockdown, 27% of U.S. consumers planned to spend less money in the fashion sector [9]. Despite this, brands like Zalando reported a 32% to 34% growth during the second quarter of 2020. Also, Shein had increased its valuation to double, with 30 billion dollars. Other examples like Nike and Amazon also have reported growth during the pandemic [10].

In addition to the COVID-19 pandemic, the constant growth of social media presence, from brands and people who promote brands also enhances online sales. Customers are influenced by social media publications, and have numerous platforms too, in which they can inspire, with a direct link to buy such things. This easiness in share trends creates a more volatile demand and shorter product life cycles for fashion items [11].

European consumers are more likely to buy fashion products online like clothes and shoes (48%) than electronic equipment (31%), the second sector that is most used to buy online. After this comes music and films (24%), household equipment (23%), and books (22%) [12]. Also, according to a survey conducted by Statista, in the United States of America between 2018 and 2019, 58 % of the respondents purchased clothes online, 47% books and films, 45% shoes, and 38% consumer electronics [13].

1.2   Motivation

Fast fashion companies have short product cycles, have poor product quality and refresh, and are responsible for a large number of waste [14]. Besides the poor quality of some products, they are not used as long as they could be, and the fashion trends are constantly changing. For instance, Zara offers 24 new clothing collections yearly; H&M offers 12 to 16 and refreshes them every week [14]. Besides the amount of waste produced by the production, there are also the gases emissions during the supply chain, namely during transportation.

Transportation planning and management are essential to increase the environmental sustainability of fashion companies. The adverse effects are due to inefficient deliveries like failed deliveries, the growing consumers' demand for next-day delivery, and retailers that need to offer better options to increase their value. Furthermore, the fashion parcels have great return rates that, depending on the country and store analyzed, range between 25% and 40% [15, 16]. This results in a large delivery vehicle flux, consequently leading to a more considerable influence on air pollution.

Despite the high quantity of air pollution produced by transport associated with last mile deliveries, air transportation is the worst. Furthermore, it is expected that the emissions due to international trade will increase by 400% in 2050 [15]. Freight vehicles represent about 6-18% of the total urban transport. However, in cities, they cause between 21% and 55% of the total

transport emissions [17]. Road freight vehicles emit a more significant portion of CO_2 and certain pollutants than other motor vehicles.

To face the environmental problems related to greenhouse emissions and pollutant emissions, the European Union (EU) has announced new regulations and actions related to gas emissions in the transport sector. According to European Environmental Agency (EEA), the EU intends to decrease CO_2 emissions by 20% by 2020 and 40% by 2030. Therefore, the need to reduce pollution and intensive urban freight traffic emerge as a priority for cities. This could be accomplished through managing logistics processes more efficiently and reducing the use of high emission vehicles [17]. To help in this reduction and accomplish the EU goals, it is necessary to have a better understanding of parcel deliveries.

1.3 Objectives

With the increase of e-commerce, it is important to ensure more sustainable ways to go shopping. Among many sectors of retail, this study focuses on fashion retail, the largest in European countries and USA [12, 13]. It pretends to respond to the following questions:

- For which channels, in physical stores and online platforms, do consumers have a preference?

- How do customers usually pick up their deliveries, and which are the typical delivery method used? How does this behavior change based on the residential area?

- How does the environmental awareness of customers influence their consumer habits?

In order to answer these questions, first, a systematic literature review was conducted focused on parcel deliveries and the environmental sustainability in the fashion sector. This makes it possible to examine possible lack of information that may lead to future investigations. To understand how customers' habits can influence operations, a survey was applied to characterize the population.

1.4 Document structure

This document is organized into five chapters.The first one, the introduction, allows us to contextualize the theme of study, understand the motivations for the development of the work and the goals, and define what has to be done in the following chapters. Chapter 2, the literature review, presents the research about the theme and explains the related work that has been done in the field. Complementary, a bibliometric analysis is presented. Chapter 3, the methodology, explains how the study was conducted, presents the hypothesis, how the survey was designed, the defined target population, and the evaluation method of the survey. Chapter 4 presents the results of the survey and provides a discussion of the results. In the last chapter, the conclusion aims to

synthesize the results previous presented and discussed, and explain some limitations of the work as well as future work.

Chapter 2

State of the Art

The literature review allows for developing knowledge about the theme of study, as well as for identifying the lack of studies in a certain area, leading to future research areas.

In order to conduct this review, first, a methodology (section 2.1) is defined to identify relevant publications and to explain how the analyses of that relevant publications are analyzed. After that, a bibliometric analysis (section 2.2) provides an overview of the evolution of studies done in this field, using quantitative analysis to illustrate publication distribution standards. Last, a literature review is presented (section 2.3), which includes the various studies identified in the previous sections that were analyzed.

2.1 Research methodology

The state of the art was conducted following a systematic literature review. This type of review differs from a classic narrative-based review because it follows a guideline based on a replicable and transparent process [18]. The review follows the guideline proposed by Denyer & Tranfield [19]. The process followed is illustrated in Figure 2.1.

The first stage identifies the objective of the research. The main goal is to formulate the research questions and understand in which fields the research is going. Therefore, the review questions for this systematic literature review are:

- RQ1: How the online fashion retail connects with physical retail?

- RQ2: How can the online market be characterized?

- RQ3: What could be done to make fashion retail more sustainable?

In the second stage, named identification, the main goal is to obtain a large list of references that are related to the study, which will be refined in a later stage. The WoS (Web of Science) was chosen as the research platform since it offers an extensive database of publications about the theme in question. Additionally, a research query was created to obtain publications related to the theme. This query was created based on specific keywords and their synonyms (e.g. fashion

or apparel). The query was refined using an iterative method, in which the results were analyzed with keyword maps. If the results match the research questions, the query used is the final query, otherwise, the query was changed and the results were tested again. The final search query used in Web of Science was:

- ("sustainab* retail*" or "fashion retail*" or "fashion industry" or "fashion supply" or "fashion business*" or "fashion apparel" or apparel or "fashion operation") and ("last-mile" or "last mile" or deliver* or distribution)

This search query was directed to the publications' titles, keywords, and abstracts. The search resulted in a preliminary sample of 445 publications. In the third stage, eligibility is intended to refine the research sample in order to only select scientifically and thematically relevant studies. For this purpose, objective and subjective criteria were defined. In the first one, exclusion and inclusion criteria were defined, while in the second one several screening levels were considered.

Regarding the exclusion criteria, the following ones were considered: (i) not written in English; (ii) early access publications; (iii) publications written in 2022; and (iv) with an average citation number per year less than or equal to two if published before 2021, and for articles after 2021, the number of citations had to be greater than or equal to 1. The application of these criteria allows reducing the initial sample of 445 articles to 161.

Additionally, inclusion criteria were defined. For this purpose, only the research areas more adequate to the theme in the study were taken into account, which were *Transportation, Business & Economics, and Operations Research & Management Science*. This screening resulted in a sample of 90 articles.

In the subjective analysis, firstly an abstract screening was done, in which the 90 articles were classified into Good(1), Bad(0), and Doubt(9) based on their abstract and title. This classification, performed by two individuals, was made with the goal of making it less biased as possible. Each person made their separate classification and in the end, the coincidence of the classifications was verified. If the article was classified as good, the article was considered for further analysis. Otherwise, if it was classified as bad the article was excluded. In the cases where it was classified as doubt or in which the two classifications were different a full-text screening was made. In this case, the article was analyzed and received a new classification. This screening resulted in a sample of 31 articles.

The following stages provide quantitative and qualitative insights into the studied field. A bibliometric review was developed to quantitatively evaluate the reviewed publications considering several characteristics. Due to the heterogeneous nature of the themes, and to further assess each article, a thematic analysis based on the bibliometric analysis was conducted.

2.2   Bibliometric analysis

Bibliometric analysis is a rigorous method for exploring and analyzing a large volume of scientific data. It helps to describe the evolutionary nuances of a specific field and also, shows

Stages	Objectives	Tool/Criteria	Sample
Stage 1 Question Formulation	Identify the questions to the literature research		
Stage 2 Identification	Define the database	Web of science	
	Define the search query	("sustainab* retail*" or "fashion retail*" or "fashion industry" or "fashion supply" or "fashion business*"or "fashion apparel" or apparel or "fashion operation") and ("last-mile" or "last mile" or deliver* or distribution)	445
Stage 3 Eligibility	Objective Analyze — Exclusion criteria	Not in english publications | Early Access | Publications from 2022 | Only articles and reviewed articles | Citations Per Year ≤ 2, If Published Before 2020 Citations Per Year ≤ 1, If Published After 2021	161
	Inclusion criteria	Transportation | Business & Economics | Operations Research & Management Science	90
	Subjective Analyze — Abstract Screening	Classification through abstract if it fits the theme or not Done with two people	71
	Full-text Screening	Classification through full-text if it fits on the theme or not Done with two people	31
Stage 4 Analysis	Bibliometric analysis	Temporal analysis | Geographic analysis | Cluster analysis	
Stage 5 Article Characterization	Systematic Literature Review		

Figure 2.1: Search diagram methodology (developed by the author).

some emerging areas [20].

The bibliometric analysis was made with the 31 resultant articles. It was conducted using the VOSviewer [21], this software is a tool that creates and shows bibliometric networks. These networks are built based on research authors, journals, or simply databases from search engines like Web of Science. This software also allows the creation of network maps of co-occurring keywords from titles, abstracts, and bodies of researched articles.

2.2.1 Distribution of publications

Since 2010, a growing trend is observed in the number of studies conducted related to the environmental component of delivery in the fashion sector (Figure 2.2). The maximum number of publications was reached in 2019. After that, the number of studies published has raised. This is coincident with the growth of e-commerce, which make this area of research possible due to the existence of more data and required due to the increase of environmental problems.
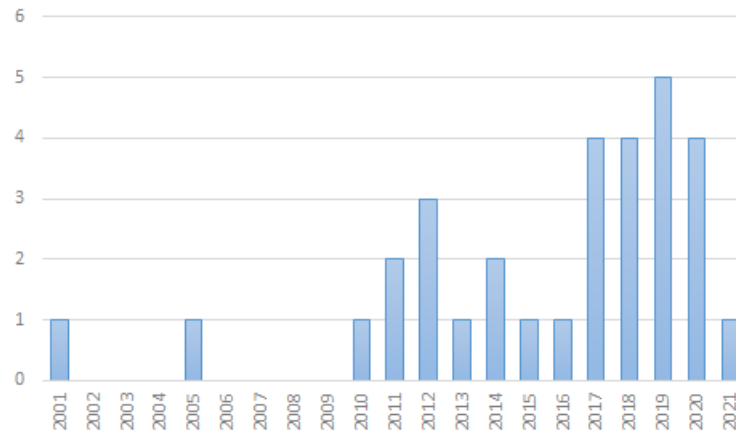
Figure 2.2: Distribution of the number of publications over the years (developed by the author).

The studies analyzed were developed for researchers from 7 countries. Figure 2.3 shows the countries with the number of research associated with each one. The most active ones in this research area are China (N=7), the United States of America (N=6), and Italy (N=5). China has huge commerce and industry and is one of the countries that contribute with more CO_2 emissions followed by the United States of America, which justifies the bigger amount of research [22].
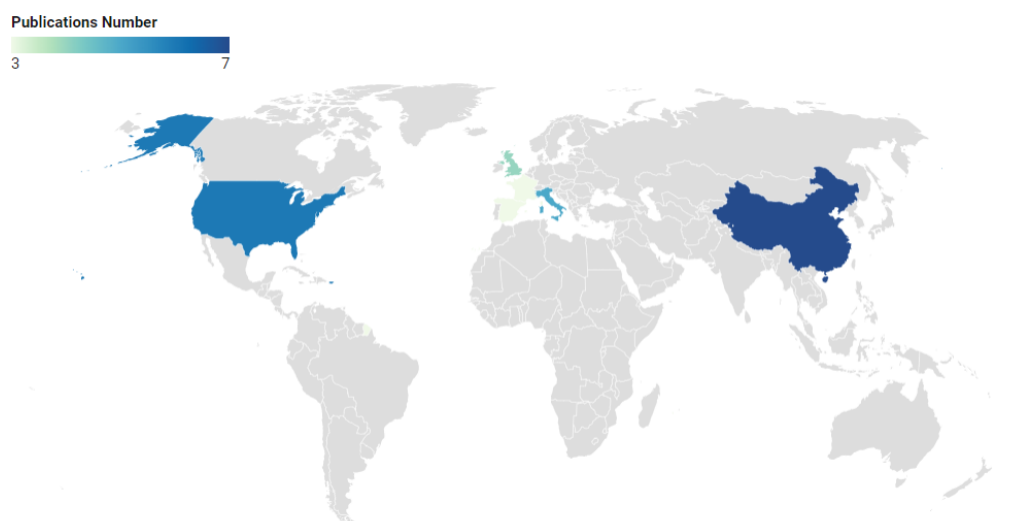

Figure 2.3: Distribution of the number of publications per country (developed by the author).
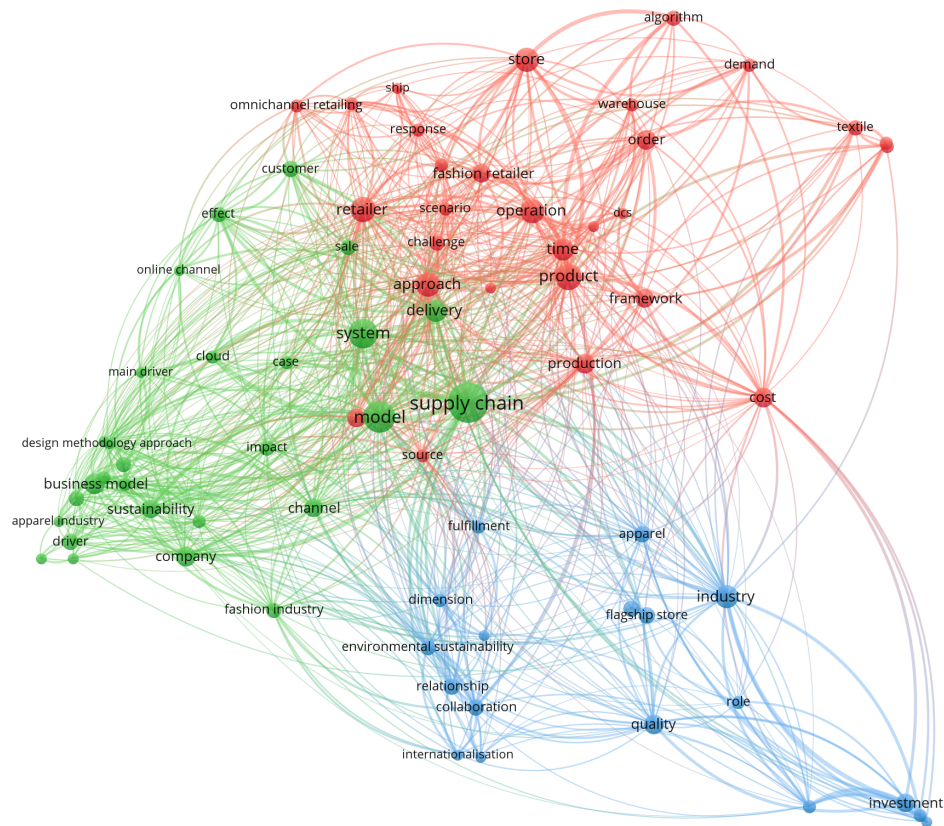
2.2.2 Identification of clusters

Figure 2.4: Cloud of terms that resulted from the analysis of co-occurrence of all keywords listed in the papers identified in the literature review (developed by the author).

For a preliminary analysis of the main areas of research in this area, a topic analysis focused on the data from the title and abstracts was conducted. Full counting was used with a minimum number of occurrences of three terms. Of the 822 terms identified, 85 met the threshold defined. From this 85, some non-useful terms were removed, like *study, level, data, research, author, article, paper, use, ahp, and term*. From this analysis, was found terms that have the same meaning, so was create a synonym dictionary.

As observed in Figure 2.4, three clusters are identified. The popular terms in the green cluster are *supply chain, model, and delivery*, in the red cluster is *product, retailer, store*, while in the blue are *industry, environmental sustainability, and quality*. Supply chain (N=30) and model (N=19) are the terms with more occurrences. These three different clusters will lead the literature on three main topics. The cluster in red to the topic is the integration of an omnichannel into the retailers' business since the terms are focused on the retailers, products, and omnichannel retailing. The green cluster which has the term with the most occurrences will lead to a topic about supply chain optimization to increase the retailer value. Lastly, the blue cluster where terms like environmental sustainability and industry will originate a topic about sustainability applied to the fashion industry.

2.3   Systematic literature review

During the last years, as the pursuit of sustainable fashion industry has emerged, it appears a large number of academic research about the subject but most of them focuses on supply chain logistics. Sustainable retailing could be divided into two practices, green transportation which is related to the movement of the products, and store operation which helps to save energy, waste reduction, and recycling [23].

This literature review is focused on three main points; the first one is the online business adopted by fashion retails, in particular the omnichannel model, which is the more used and is an evolution of the retail business that aims to follow the society's evolution and the increase costumers daily use of technology. Here the last mile is not approached due to the lack of literature that joins the fashion sector with the last mile, which happens due to the outsourcing of the last mile logistics. In the second section, the focus is on the supply chain and how this could improve to increase the business value. At last, this literature review focuses on the environmental issues and practices in fashion retail.

2.3.1   Integration of an online channel into business

To offer a different service to customers, in response to societal pressures, an increasing number of retailers who have at least one physical store also known as brick-and-mortar (B-n-M) retailers have recently started to integrate their traditional physical sales channel with their digital one [24]. Moving towards an omnichannel retailing approach, this model turns the "retail world into a showroom without walls." [5]. This business model has become more and more the norm of commerce [25].

At [5] is shown that the adoption of an omnichannel helps brands to gain brand awareness. The adoption of this business model brings growth in product sales and helps companies, in the long run, to build stronger brand recognition. The omnichannel solution contributes to breaking the traditional barrier between retailers and their suppliers and increases transparency for all parties in the supply chain. The technology innovations associated with information transparency give businesses the ability to offer more personalized services and products, which also is a way to increase their brand competitiveness [5]. For perishable and/or seasonal products, such as those from fashion apparel, maintaining this link between production and distribution are more crucial to achieving on-time delivery [26].

Internet is a path to help in the brands' internationalization as an alternative to a physical presence, it enhances the exportation but the adoption of an omnichannel is not easy, and there are several challenges and risks [25, 5]. In [5] the challenges are classified into two main levels, one strategy-related like organizational problems and cultural barriers, and the other one, development-related, like information systems and customer relationship management areas. Last-mile order fulfillment represents a significant challenge due to the high fixed costs of setting up a fulfill-ment center and no integrated inventory or capacity management across the channels. These challenges have a strong relationship with their contextual factors. For example, they are influenced by

population density, retailers' specifics like capability for cross-channel integration, and consumer behavior [5]. There are three main risks identified by Guercini *et al.* [25]; The first one is the traditional risk of internationalization unrelated to the online presence; The second one, operational risks which could affect both ways, brick and mortar companies, and online firms; And lastly, online risks relating to the use of online channel as the way of entry in a foreign country.

Some studies show that the omnichannel business is becoming more used and have more significance in luxury fashion companies. They intend to increase sales in different markets, gaining value from a cross-channel interaction. However, this value is not the same and has not the same importance in all countries because of state filtering or restrictions [25]. The internet was mostly used to increase brand visibility and interactively. According to the literature review performed by Guercini *et al.* [25], some authors considered that it works better as an advertising channel than a selling channel. However, Guercini *et al.* shows another perspective. Several brands focus their attention on expanding their online business. The two ways of selling could be to distinguish the motivational factors that lead a person to choose the different channels. In the online luxury seller, shoppers are price-conscious, appreciating the enhanced availability of online products. They have trust in e-commerce and customers' reviews of the products. On the other hand, in-store shoppers consider that it is crucial to see the product before purchasing them and appreciate the human interaction [25].

For example, the Chinese market has some differences, it represents one of the largest retail markets in the world but unlike developed markets such as America, the market is highly fragmented, dynamic, and mainly composed of small and medium-sized retailers [5]. These markets suffered a high transformation due to the rise of technological e-commerce companies such as Alibaba, Taobao, and Tencent [5]. In China, the most common strategies applied to transform offline into online involve launching mobile apps and offering in-store mobile payment options combined with click and collect or ship-to-store integrating inventory and logistics systems with e-commerce [5].

2.3.2 Value seeker through the supply chain optimization

The quick advance of service standards in e-commerce to fulfill the customer's demands can be demonstrated by the emergence of delivery services of two hours or less, which is becoming increasingly challenging from an operational point of view, especially in metropolitan areas. In these areas, the impact is more accentuated due to the high concentration of customers, which has a relevant impact on the cost and complexity of the last-mile logistics. This advance brings an advantage to the retailers that raise the customer's expectations and may become a key factor for competitiveness. According to Fisher *et al.* [27] "many retailers have identified speed as an important service quality metric." Fisher *et al.*[27] shows a study where it was estimated that the average online store delivery in the United States decreased from 8.3 days in 2014 to 5.1 in 2016 across all shipments made by 238 retailers. However, the delivery cost increases with the reduction of the delivery time. Furthermore, the lack of optimized layouts in the store's fulfillment increases

the picking cost and the risk of being out of stock. This could happen due to the simultaneous output to fulfill the online and in-shop orders [24].

A supply chain is a system responsible to produce and deliver a product or service, from the beginning stage of sourcing the raw materials to the delivery of the final product to the customer. "The supply chain lays out all aspects of the production process, including the activities involved at each stage, information that is being communicated, natural resources that are transformed into useful materials, human resources, and other components that go into the finished product or service" [28].

Supply chain management is a multidimensional concept that includes supply chain innovation, optimization, visibility, flexibility, collaboration, and agility. For the fast fashion business and reducing lead times is most crucial for collaboration and agility [29].To reduce delivery time, some lean management practices strategies can be applied. However, supply chains are generally not prepared to satisfy the requirements of short lead times needed by lean strategies. With the evolution of information technology and real-time information, there is an increasing awareness that supply chain performance could increase. This will lead to the adoption of cloud solutions [30]. Successful companies and the implementation of online channels rely on the skills of supply chain management to avoid overstock and keep the goods and services flowing efficiently and as much as possible cost-efficiently [26].

For a fast fashion supply chain to be competitive, it must be flexible, agile, cost-effective, and responsive [29]. Supply chain management success depends on coordination and cooperation among the different channels like suppliers, manufacturers, intermediaries, third-party service providers, and costumers [29].

Faster deliveries make the retailer distinguish from the competition and consequently increase their online sales, but retailers have to consider at what cost they can lower the delivery time. One option is opening a new distribution center, which is easy to quantify its cost. However, it is not so easy to quantify the benefits to see if pay of [27].

Order deliveries could also be optimized through an integrated channel fulfillment process, and systems like advanced distribution and warehouse management systems [5]. The distribution center is a crucial component in the supply chain. It is responsible for obtaining materials from different suppliers and fulfilling customer orders [31]. So due to this vital function of the DC (distribution center), the way the process is managed has a significant impact on the final lead time and company value. For example, the article [32] developed a model of a warehouse to assess operational efficiency.

The study conducted by Fisher *et al.* [27], was intended to quantify the benefits of opening a new DC in one specific retailer that operates with only one DC in the eastern United States and starts to operate with two openings, another one in the western United States. Approximately 20% of the sales were from online commerce, and with only one DC, there was a significant variation in delivery time from two or four business days in the close locations using the standard shipping method to seven days in some distant locations also using the standard shipping option [27]. This

addition increased online store sales by 3.79%, on average, in the western US zone. This happened due to the value-added to consumers by the delivery time reduction. For each business-day reduction was estimated that the sales increased by 1.45% [27]. After adding a new distribution center and reducing the delivery time, people with less online experience tend to increase their orders faster in the short run. However, customers who use more times the online store show a more significant increase in their orders. These results suggest customer learning as the main driver of the observed dynamics in the short run, but brand enhancement as the main driver of the observed dynamics in the long run [27]. Furthermore, the increase in online commerce and offline stores have increased their sales. The brand enhancement is explained by faster deliveries. More and better experience in online commerce increase brand reputation in both channels and consequently leads customers to make more orders also in both channels [27]. There is large importance in cross-channel effects. Online and offline satisfaction interact to influence customers' behavioral intentions [33].

The retailer analyzed by Difrancesco *et al.* [24] has over 1300 retail stores worldwide and seeks to leverage its physical retail presence for ship-from-store fulfillment of its online orders. This is one of the best ways to deal with online shopping in urban centers. To increase their value, they offered this ship-to-store method and home delivery made by electric bikes, due to their easiness in moving faster into traffic [24].

According to Difrancesco *et al.* [24] there are four different ways for retailers to fulfill customers' orders which are:

- Existence of a warehouse that fulfills the demand of a physic store and the online orders, called distribution center (DC);

- Direct-to-consumers centers (DTCs) which only fulfill the online orders;

- Retail stores that besides selling direct to clients also fulfill the online orders;

- Vendors, which directly fulfill online orders without the need for store inventory.

The first two options have some advantages in operations efficiency due to the economy of scale and the most advanced automation. This will imply less cost to employees and a more significant product assortment. On the other hand, fulfillment from existing stores allows to use of the already existing network facilities by the flexible adaption of the stores, reduces the price markdowns, and decreases delivery time, and cost [24].

In the case study analyzed by Guercini *et al.* [25], about eight luxury brands were researched in different markets and analyzed their online market, if they have a website or not, and other characteristics. Several different markets have adopted the omnichannel business and offered, like in [24], the two different delivery options, ship to store and home delivery. In this article, the responsible for last-mile transportation is not mentioned but in general, it was provided by third-party logistics like in the studies conducted by Giannakis *et al.* [30] and *Y*e et al.[5].

Ship to store is an initiative adopted by fashion retailers to better integrate with online orders and physical stores [24]. This initiative allows consumers to place orders online and pick them up

in the store. In this method, the shipping comes from a warehouse to a store where the consumer will after pick them up. This method differs from the BOPS (buy online, pick up in-store). The main difference is that in the BOPS, the product is already available in the store like in [24], which is one of the four fulfillment methods [34]. "A 2017 UPS study on online shoppers reveals that 5% of respondents have used STS options; furthermore, of these consumers, 41% intend to utilize STS more frequently in the following year" [34]. Fisher*et al.*[27] shows that the implementation of the BOPS program decreases online store sales but increases offline store traffic and sales.

While adopting the omnichannel operation, companies from fast fashion are also adopting QR (Quick Response). QR includes features like (i) reducing lead time through the use of IT, (ii) responding fast to consumer demand, (iii) achieving high inventory service level, (iv) utilizing market information to drive the supply chain operations [35]. The use of information and technologies allows to reduce lead time and enhance supply chain flexibility and agility [36]. Due to global competition and increased consumer demand, the survival of textile companies depends on their quick response to unpredictable changes in consumer tastes [26]. The QR strategy interacts with omnichannel operations. They work together to influence consumers' shopping choices. QR affects consumers' expectations of product availability in the store, leading to online buying instead of offline since the lead time is short. The introduction of omnichannel operations also impacts customers' shopping options. For instance, STS provides shoppers with a new shopping path and a possible more convenient way to pick the order [34].

Besides all the pollution associated with fashion products production, there are the CO_2 emissions related to transportation across the distribution network. To measure this impact Lagoudis *et al.*[37] has developed a model to calculate the amount of emissions. This gains relevance in companies because carbon auditing has become a key aspect of corporate social responsibility and there is an increasing awareness of sustainability.

The industry perception is that transportation with the lowest cost would be the most economical choice but the lowest cost is subject to higher lead-time and higher emissions. The literature review made by Lagoudis *et al.* [37], showed a study that compares the California High-Speed Rail with other urban transportation modes. The results demonstrate that when public subsidy for capital is used none of the projects appear to have an advantage over the other. Furthermore, was conducted a carbon emission cost study in the airline industry through a model that calculates carbon emission in individual phases during cargo transportation. That results in a variation in the amount of emissions due to unit carbon emissions per aircraft, aviation emission allowances per airline, and carbon trading prices.

2.3.3   Environmental Sustainability

Companies main focus has been on decreased final product price and lead times. However, in recent years the industries have changed their focus and have discussed how they could reach sustainability from both points of view, environmental and social [1]. The sustainable topic that was discussed as if the company should or not take a position and change to a more sustainable

way and how this will influence the economic performance, become in how to adopt a sustainable way along with improving the economic performance [38].

The fashion supply chain is known to create all kinds of pollutants [35]. The fashion sector has a considerable negative environmental influence due to the high energy consumption, production of synthetic fibers, tanning of leather, use of toxic chemicals, water pollution, and CO_2 emissions [1]. Waste related to clothes and textiles production is estimated to be the one with the fastest growing. During the period 2005 to 2010, Britain produced approximately two million tonnes per year [39]. Due to this negative influence and the increasing preoccupation with environmental sustainability, the interest in studies related to sharing and/or circular economies has been growing. These concepts are not mutually exclusive but are different. Sharing relates to the consumption of a specific product, that is, access on-demand without ownership, while circularity relates to different manufacturing systems based on maintenance, reuse, remanufacturing, and recycling, reducing as much as possible the environmental impact [40]. Furthermore, companies have to develop business models that also consider sustainability; they could do it by changing the production process or/and through the product design, adopting new technologies that have a smaller impact. For this happens is essential to develop a collaboration with external stakeholders to achieve sustainability on a system-level [40]. Moreover, the literature demonstrates that sustainable issues are often related to the degree of internationalization of a brand because it could modify the results obtained through sustainable practices [39].

In order to reduce and influence companies to decrease the outsourcing in far countries which will result in long shipping distances, that are responsible for a large emissions release, Choi [35] show a measure named carbon footprint tax. This is applied to long shipping distances. The goal is that the retailers choose nearby manufacturers.

Sustainability management is not confined to a firm's internal process, and all the supply chain has to be considered. If that could be reached, the retailer and all the suppliers would follow a sustainable model, and the companies will be very competitive. Their strategies can be more challenging to replicate thanks to the development of specific assets [1]. Although the adoption of sustainable supply chain management brings advantages and is seen as a driver to the adoption of these sustainable standards, there are some barriers faced by companies. They are summarized in the figure 2.5.
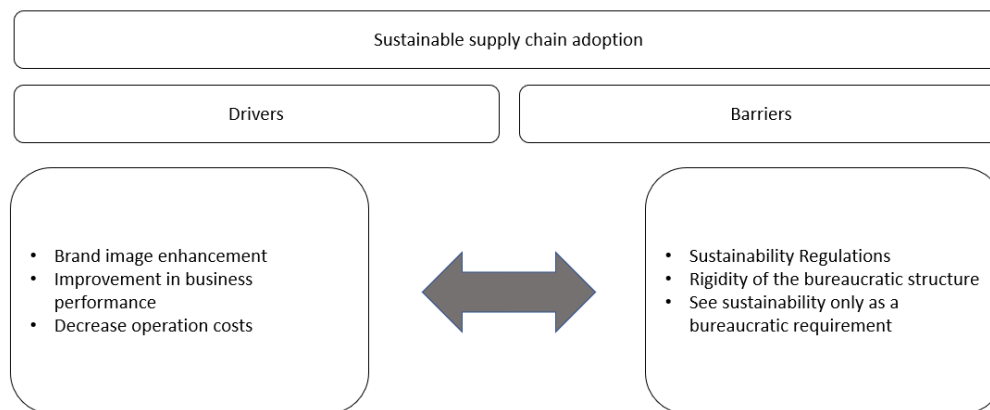
Figure 2.5: Drivers and Barriers in the adoption of a sustainable supply chain [1]

The delivery activities represent a particular problem because fashion suppliers are mostly located in the Far East to reduce the production costs, this situation leads to a large distance to travel to fulfill the retailers [1, 36]. Moreover, if fashion companies are often worldwide, the goods transportation process is extremely relevant. Here is relevant the setup of logistics practices, such as the choice of low-emissions transportation and the cargo optimization [1]. Furthermore, according to the consumer needs, and to reduce lead times, have been shipping more smaller packets which result in more amount of transport [37].

Chapter 3

Methodology

This chapter intends to investigate consumer behavior when they buy fashion goods as well as understand how consumer habits impact environmental sustainability. For this purpose, a methodology was defined to confirm the hypothesis created in the previous chapter and meet the goals of the document.

To test the hypothesis created a survey was applied. This research method allows a sample representing a specific population and deduces conclusions after the data analysis. The survey consists of a set of questions created based on the literature review and other similar surveys applied in the area of fashion retail. It was chosen to do a survey through the web due to its convenience, and efficiency, and is more indicated to reach a large sample size within a small time frame [41]. The research methodology is summarized in Figure 3.1.
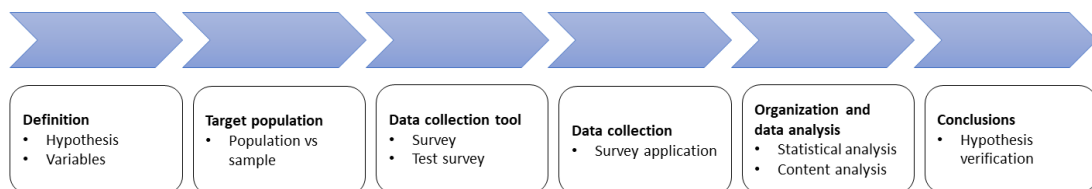
Figure 3.1: Methodology overview (adapted from [2]).

3.1 Hypothesis definition

Online shopping is a competitive environment where the number and diversity of consumers have been increasing, and the importance of understanding key factors that drive consumers to shop online [33].

Customers view online shopping as a way to shop efficiently. The more that the internet has to offer more satisfied the consumers will be [42]. They see benefits like convenience, greater access to information, ease of search and comparison, competitive pricing, and broader selection in online

shopping. Literature also cites holiday crowd avoidance, low shipping costs, timely delivery, tax-exempt status, avoidance of bad weather, improved security of information, improved customer service, and speedy e-mail response as key aspects of the large increase in online shopping [42].

On the other side, some aspects lost in transitioning from a brick and mortar business to an omnichannel and despite the evolution in this aspect still let the costumers reluctant are security and privacy concerns and the suitability of products to be sold [43] [42].

Shopping motivations are divided into experience, service, price, convenience, and brand orientation. Experience orientation is characterized by an emotional and sensational stimulus while shopping, customers see shopping as an experience. This is found to a limited degree when online shopping. Experience-orientated consumers are less interested in online shopping. In contrast, in a physical store, the consumer can touch, see or smell the product. In an online channel, the stimulus has limited the image, and a description [43]. The stimulus refers to triggers that encourage consumers and are of two types. These could be external, which are the brand, social and environmental stimulus, and the internals is stimulus like consumers motivations, sustainable knowledge, or awareness [44]. Some authors defend that online shopping will not replace the experience for many shoppers of browsing through the store [42].

Service orientation is characterized by seeking advice from sales personnel, is about the customer service provided by the retail, the human contact. This, like the previous one, is more relevant in physical stores and the online commerce could be only by email or chat in the website [43].

Convenience orientation is present when trying to reduce time and effort in shopping. Online shopping is the best channel to improve convenience. The internet provides consumers with more convenient access to a wide variety of items[45]. Also, price orientation is more likely to influence customers in online shopping through exclusive discounts, and the easy search for better prices [43]. All of this will affect consumer behavior and decision-making phases, such as how, where, and when consumers search for and compare products [45].

Lastly, brand orientation describes the extent to which customers prefer some brands rather than others. Through online shopping, it is easy to find their favorite brands even if they are only available in other countries[43]. The large variety of brands and merchandise represent strong criteria in shaping consumers' decisions to shop on the internet, offering good quality and reasonable prices, the most important attributes of online retailers. The brand has a positive effect on consumer influence. The brand trust and image influences consumer and have a more favorable perception of sustainable fashion products [44].

In fashion retailing, e-commerce offers consumers low prices, easy access to a wide range of product categories, and a convenient shopping experience, which are components of an attractive value proposition for consumers [45].

Research has shown that product attributes affect consumer behavior, such as product price, production, and quality [44]. In developing markets, consumers are more price-sensitive about sustainable fashion marketing [46]. The literature supports a positive relationship between environmental concerns and favorable attitudes towards green products.

Online shopping allows all the people with internet access to buy their products. Small community consumers would be likely to do their shopping online due to the small number of retailers with physical stores [42].

In the apparel market the growth of online channels and lenient return practices have reduced people's fear to buy online due to the size problems [16, 45]. Consumers due to this easiness in returns often order several sizes and styles of the same product, and after trying at home they return those which do not want [47]. According to the literature 17% of total returns in online shopping are related to fit issues [48]. Good fitting is a crucial factor that leads to physical and psychological comfort [48]. This makes fashion products more vulnerable to subjective opinions.

A survey conducted by McKinsey [16] prior to COVID-19 pandemic in North American show that the return rates in apparel e-commerce were from 25% compared to 20% overall [?].

After the literature review and the support text about consumer behavior has been created the hypothesis shown in Table 3.1.

Hypothesis	Description
H1	The frequency of consumption is influenced by the urban-rural environment of the residence place, as well as the channel and type of store for shopping
H2	The environmental awareness of consumers are influenced by the urban-rural environment

Table 3.1: List of hypotheses to assess.

3.1.1 Target population

The target population of the survey was the population in general. As the survey's main focus was fashion product buying, the only restriction to the population is that respondents should do the shopping for this type of product and must have sixteen years old or more. This age limit was defined because people under that age, in general, are dependent on other people and do not do their shopping. The population was essentially young people, students from university, and other members, like professors and researchers. These ages tend to buy more products due to their large tendency to have the last trends.

The distribution of the questionnaire was made by institutional email for the students and university members of Porto University, for a total of 36 910 people, and from members of the research institute INESC TEC. To get a large and diverse sample also was used social networks to share the survey, through the personal page and in groups formed to answer surveys and the social forum Reddit Inc. Also, was adopted a "spreading the word" strategy through friends and colleagues. The goal was to get answers from a wide diversity of people of different ages and different places to have a sample from all of the population. The platform was active to collect samples from 18/7/2022 through 12/8/2022.

It is wanted to maximize the sample size to conduct better analysis and be representative of the population. Through an investigation of the literature that used surveys, was established that

a good sample will have above 300 participants. The survey applied to consumer[49] used 104 participants, a survey about delivery services [50], have used 181, a survey about online shopping [51] used 248 respondents, and in [52] used 500 participants. All these surveys were made to the consumer and distributed through different means, like social networks and universities.

3.2   Design of the survey

The survey A was created in the platform Google Forms and disseminated online. The survey was created with a google account, subscribed by Porto University which ensures data protection. Another advantage of this platform is the easiness of creating the survey and collecting the answers, which will after the data collection phase be analyzed with the software IBM SPSS and Microsoft Excel. To start was analyzed some surveys like [53] and [49] and surveys that other colleagues have done to be used as a starting point and reference to developing a new survey.

The survey was divided into four main sections with a total of 27 questions, as follows:

- Consumer characterization: 8 questions

- Physical store purchases: 8 questions

- Online purchases: 6 questions

- Deliveries and returns: 5 questions

All of them were created to avoid biased answers, with a defined order, and are from three types: (i) multiple choice, (ii) combo box, (iii) and select box. The open-answer questions are minimized due to the possible errors that could bring and result in numerous invalid questionnaires. To minimize the error in this type of question was created some input checks that the platforms allow to do, like if it is a number and the range of numbers that the user could write.

The questions are created as uniformly as possible to facilitate the analysis. To do that was used five points Likert scale [54]. A Likert scale typically provides five or seven possible answers to a statement where the respondent indicates their positive or negative agreement with something. Despite this level of agreement this scale could be applied to other fields, like frequency which is also used in this survey, Figure 3.2, quantity, importance, and others.

In order to introduce the main goal of the survey, how it will contribute to the investigation, and where were made the research work, a preliminary section (A.1) was defined. This intends also to give the respondent the estimated time that will take them.

3.2.1   First section: Consumer characterization

The first section, (Appendix A.2), is used to make the consumer characterization. It is made of questions about the respondent like age, gender, residence, education, and employment status. These questions have as their purpose to understand the sample and relate with other questions and see if this characterization has influenced consumer habits.

Figure 3.2: Example of a five points Likert scale used (developed by the author).

3.2.1.1 Second section: Physical stores purchases

The second section aims to understand the customers' habits when they do their shopping in the physical stores and why they choose this channel to do them. this section is shown in the appendix A.2.1.

This section contains questions about the frequency, quantity, traveled distance, and transportation mode for the three physical stores, the shopping center, the local commerce, and fairs and markets. Furthermore is questioned about the use of the car and its motives, and also the advantages of buying in physical stores.

3.2.2 Third section: Online purchases

The third section, (Appendix A.2.2), has as its main goal to study consumer behavior when they want to do their shopping online, what motivates them and how they prefer to do their shopping. The question is similar to the questions in the previous section of the survey, due to the importance in compare physical store purchases with online purchases.

3.2.3 Fourth section: Delivery and returns

The fourth section, (Appendix A.2.3), focuses on the delivery action and returns. It asks about the type of delivery, and return most used, the return rate, and how customers prefer to do the returns. These questions intend to classify the habits of customers relative to the method chosen to do their orders.

The return process could be done in three different ways:

- At the physical store. This only is allowed in the multichannel business, where the retailer has a physical store and the online store. Using the store as a drop-off point has some advantages like the travel to the store could result in new shopping [48], and also if the clients make the travel by foot or using public transportation, it could improve the environmental sustainability.

- At a pickup point. The pickup points used to get the products when the client does the order usually could be used in the reverse direction. The customer drops the products in these specific places and then they are collected by a carrier and delivered to the retailer [48].

- At costumers house. In this case, the carrier picks up the product at costumers address, and then they are delivered to the retailer [48].

3.2.4 Survey evaluation

Before a large-scale survey distribution, it is important to make a pre-test to assess its consistency. This was made with a small group of people (3 people), all of them researchers in the fieldwork. These researchers fill out the survey and give feedback about the questions, and the results are used to see if the survey is adequate to the goals that are defined [2].

Given the preliminary feedback obtained, some questions were changed to fill some possible gaps in the analysis of the results. Other questions were merged to make the survey shorter and more accessible for the respondent. Another suggestion that was considered was to change the questions that allow multiple choice changes to five points Likert scale. The adoption of this scale for the generality of questions was made to turn the analyzing process possible since the questions will have the same scale.

The validation phase was also used to estimate how much time was needed to answer the survey, which was initially estimated as seven minutes. The feedback was that a ten minutes estimation would be more precise.

3.3   Data analysis

The database with the answers was created in Microsoft Excel. The analyses were made through graphs and some descriptive statistics.

To test the association between the variables could be used several association measures. This association allows detecting if the relations between variables are not random. The measure used is based on the chi-square distance. This measure the difference between the observed and expected frequency [55]. The measure used was Crammer's V. This test is used when it is pretended to know the relation between two variables. The variables have to be categorical which means that describe a category that is not related to numbers [56]. This value varies between 0 and 1 and could be interpreted following Table 3.2.

Crammer's V	Interpretation
>0.25	Very strong
[0.15, 0.25]	Strong
[0.10, 0.15]	Moderate
[0.05, 0.10]	Weak
[0, 0.05]	Null

Table 3.2: Interpretation of Cramer's V (adapted from [3]).

Chapter 4

Results and discussion

After the data collection, it is shown in this chapter the obtained results. The first section will be used to summarize the data through charts and tables, and after that, the next chapter will show the results of a statistical analysis using a model of structural equations.

4.1 Sample characterization

The survey was answered by 357 persons. One of these answers was considered invalid and removed from the data sample. This action was made after screening the data and registering that one of the items answered was not in agreement with the other answers.

Of the 356 analyzed respondents, 351 answered part two of the survey about shopping in physical stores A.2.1. The other five do not do shopping in physical stores. Part three was responded by 276 people, and also in this section, the remaining respondents do not buy products online.

Figure 4.1 represents the sample distribution by age. The distribution mode was 22 and 23 years, and the mean value of respondents was 27.6 years. How the sample is mostly built by young people was expected that the number of dependents of the majority of the respondents was zero or a low value. The most frequent was 0 with 306 respondents, 21 with 1 dependent 23 with 2.

The consumers could be divided into gender, and the results are shown in Figure 4.2.a). This means that 45.2% of the population sample collected was male and 53.9% was female, and the remaining 0.9% have answered the option "other". How the values are similar, the samples are representative of the male and female population.

Relatively to the education of the respondents (Figure 4.2.c), there is a large set of customers with graduation, about 39.2% followed by a master's degree with 32.8%, then high school with 18.2%, post-graduation with 6.2% and 3.4% of the respondents have a doctors degree. The distribution of the survey methods justifies these results.

Figure 4.2.b gives an overview of the spending that the respondents spent in a year, the most common is between 101 and 250 €with 32.9% of the sample and a few people, 9%, spend less than 50 euros.
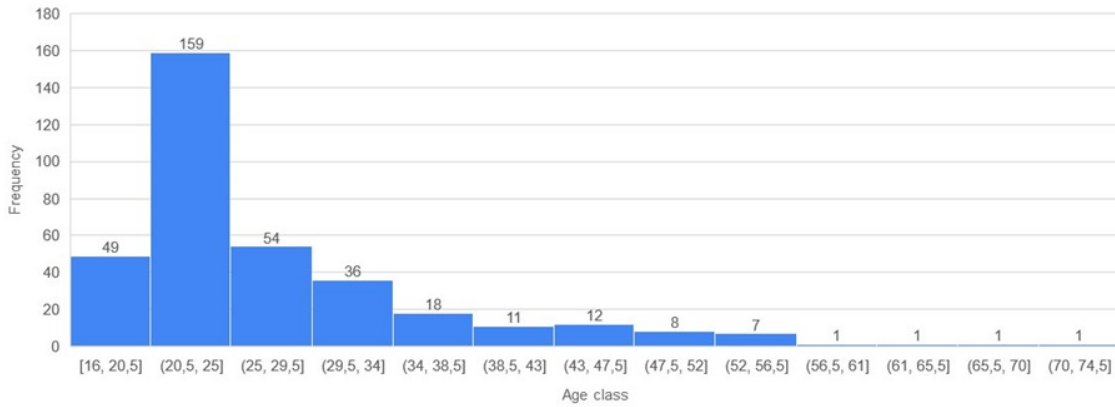
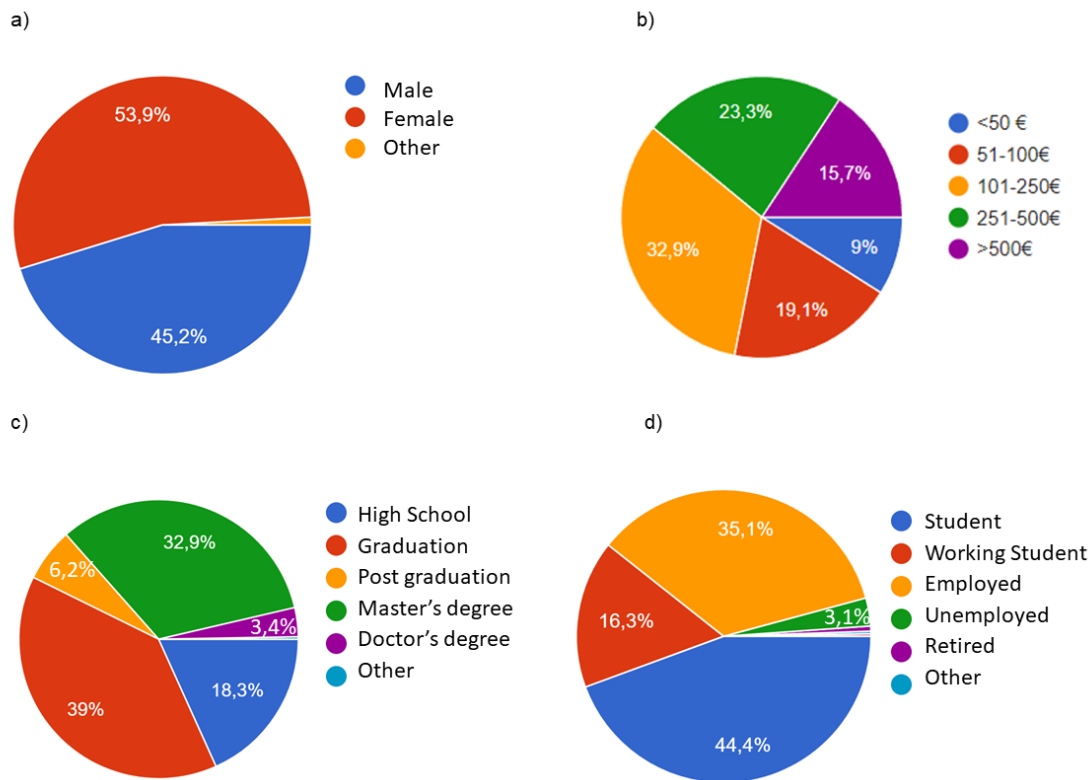Figure 4.1: Sample distribution by age (developed by the author).

Figure 4.2: Socio-demographic characterization: (a) Sample distribution by gender, (b) Sample distribution by spends on apparel products, (c) Sample distribution by education, (d) Sample distribution by the professional situation (developed by the author).

The sample has data from several places in the country but with the most incidence in the north region. There were more respondents from the Porto region, 17.7% of the respondents were from Porto, 7% from Vila Nova de Gaia, 4.8% from Matosinhos, 3.9% from Paços de Ferreira, due to the large distribution in the Porto university. It is also worth mentioning that 7.6% of respondents were from Lisboa, and the others were distributed in the country.

4.2   Socio-demographic influence in consumer behavior

It is pretended to explore how socio-demographic factors influence the quantity and frequency of consumption. Figure 4.3 shows how the quantity and frequency of buying second-hand products in physical and online shopping, vary due different factors.
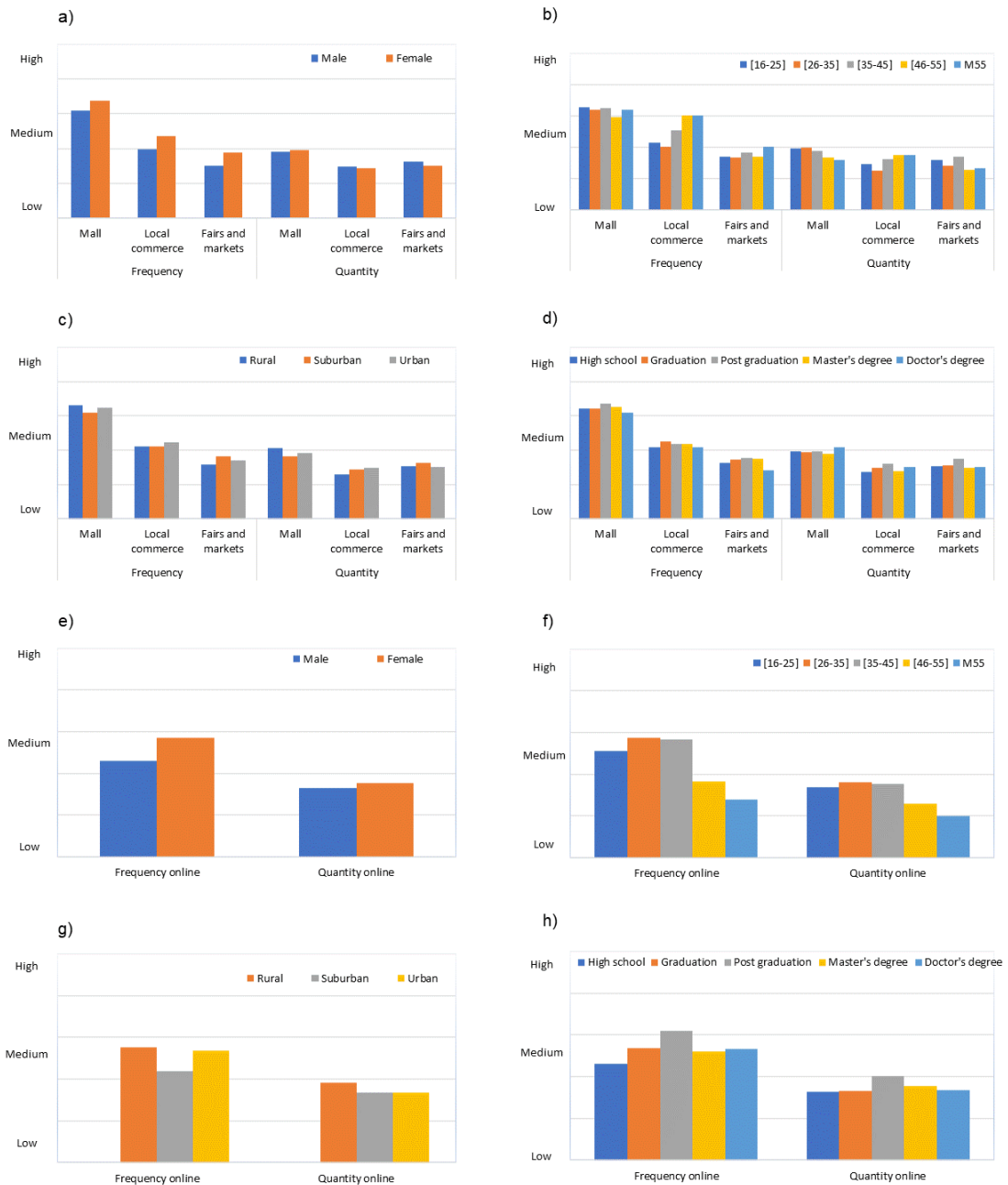

Figure 4.3: Impact of socio-demographic factors in shopping (developed by the author).

Figure 4.3.a shows the influence of gender. The sample is divided into 162 people from gender male and 192 females. The graphic shows that they tend to use physical stores more often. The

	Frequency			Quantity		
	Mall	Local commerce	Fairs and markets	Mall	Local commerce	Fairs and markets
Gender	0.21	0.18	0.19	0.11	0.09	0.08
Age	0.10	0.16	0.10	0.09	0.18	0.12
Residence	0.09	0.12	0.10	0.12	0.13	0.12
Education	0.10	0.11	0.10	0.11	0.11	0.17

Table 4.1: Cramer's V value for the physical store shopping. (green: strong association, yellow: moderate association, red: weak association)

Cramer's V value shown in Table 4.1 is bigger than 0.15, indicating a strong association between the variable gender and frequency. However, the association between gender and quantity is moderated for shopping centers and weak for local commerce, fairs, and marks. These results mean that gender appears to influence the frequency but not quantity.

Figure 4.3.b demonstrates the influence of age in consumption habits. The sample was grouped into five different sets. They are: (i) from 16 to 25 years old, with 207 respondents, (ii) from 26 to 35 years old with 92, (iii) from 36 to 45 years old with 35 respondents, (iv) from 46 to 55 years old with 17 respondents and (v) older than 55 with 5 respondents. The chart shows a small variation between the frequency and quantity except for the frequency and quantity in local commerce. Comparing these results with the result from Table 4.1, confirms that exists only a strong association between age and the frequency and quantity of local commerce.

Figure 4.3.c shows the impact of the urban and rural context of the place where people live. Through the chart, it is visible that the differences are minor. Using Table 4.1 the values indicate only a moderate association and a weak association in two of the frequencies. The residence appears not to have significance in the consumer behavior of the physical stores.

Figure 4.3.d explains how the education of the customers affects their habits. Also, education appears not to have a significant influence, which is corroborated by Table 4.1 in which all the associations are classified as moderated except the quantity in fairs and markets.

Figure 4.3.e shows a significant difference in the frequency but not in quantity. This is confirmed by Table 4.2 which contains Cramer's value for the association between the socio-demographic variables and the frequency and quantity of online shopping. The one related to age suggest that exists a strong association between gender and frequency but not with quantity.

In Figure 4.3.f are represented the mean frequency and quantity for the different sets of ages

	Frequency online	Quantity online
Gender	0.18	0.08
Age	0.16	0.11
Residence	0.14	0.15
Education	0.14	0.13

Table 4.2: Cramer's V value for online shopping. (green: strong association, yellow: moderate association, red: weak association)

also used for the physical stores' analyses. The charts show a higher frequency in the youngest people, from 26 years old to 45. The statistics test suggests a strong association between these factors, age, and frequency; however, the association for quantity is only moderate.

In Figures 4.3.g and 4.3.h, which study the influence of residential zones and education level, the differences do not seem to be very significant, which is confirmed by the association values, suggesting only a moderate association.

	Disagree	Neutral	Agree
See the product and feel it is crucial to do the purchase	3%	13%	84%
Try the product make me choose to buy in physical stores	9%	9%	82%
The customer care is valuable when I do shopping	51%	29%	19%
The possibility of having the product on time makes me choose physical stores shopping	22%	22%	56%
I am satisfied with the experience of do shopping in physical stores	7%	25%	67%

Table 4.3: Agreement classification about physical stores shopping.

	Disagree	Neutral	Agree
I have access to products that does not exist in physical stores	14%	11%	75%
Do not need to move to the store	12%	15%	74%
I have access to exclusive discounts	20%	17%	62%
It is easy to find specific products, for example, through search and filters in the websites	7%	14%	79%
It is easy and fast to know the products' prices	17%	19%	64%
The online search and easiness to do the order makes the shopping process faster	15%	19%	66%
I am happy with the online purchases that I already did, if there was any problem was easy to solve	11%	27%	62%
I trust in online purchases, in all the process like payment, delivery and returns	18%	21%	61%

Table 4.4: Agreement classification about online shopping.

4.2.1 Delivery and returns

The delivery method could be made from different methods as the return process. The respondents' preferences are in Figure 4.4. After the data research is possible to see that the method that customers most use when doing their orders is the standard delivery at home, chosen by 76.1% of the 276 respondents that do shopping online. From the home deliveries, 86.2% of the customers use their home as a delivery local, and a significant portion of 8% prefer their workplace. After the home deliveries, the delivery at the store is more used with 11.2% and 8.3% of the respondents prefer to collect their products at a pick-up point. The delivery in-store was approached by the

literature as a way to improve the business but did not have many expressions between the respondents analyzed. If the analysis is made based on the residential place, the tendency is the same, the standard delivery is the most used method as is possible to see in Table 4.5.

The literature identifies the online channel and the speed of deliveries as crucial factors in improving the business value [27]. The sample collection corroborates this. Of the 356 respondents, only 81 never used online commerce. And when they used it the preferential channel was the store sites. Moreover, from the 275 respondents, 62 % demonstrate trust in the buying process, like payment delivery and return, and only 18 % demonstrate the opposite. To add to the trust of the process is the happiness and the problem solving, only 11 % were not satisfied with the buying like it is possible to see in the Table 4.4. Also, in this table is possible to see that the people value the ease of finding the products, and the comfort of purchasing in any place and the order arrive at home.

Despite the significant tendency to choose the delivery at home when customers buy their products when they need to return them, 35.9% of the surveyed chose to return in the store. 21,7% to deliver them to a pick-up point, 14,1% make the return through the courier, 14,8% made the return through the postal mailbox, 4% made the return when receiving another product, and the remaining 6.5% or did not have to return any product or try to sell them or offer to another people.
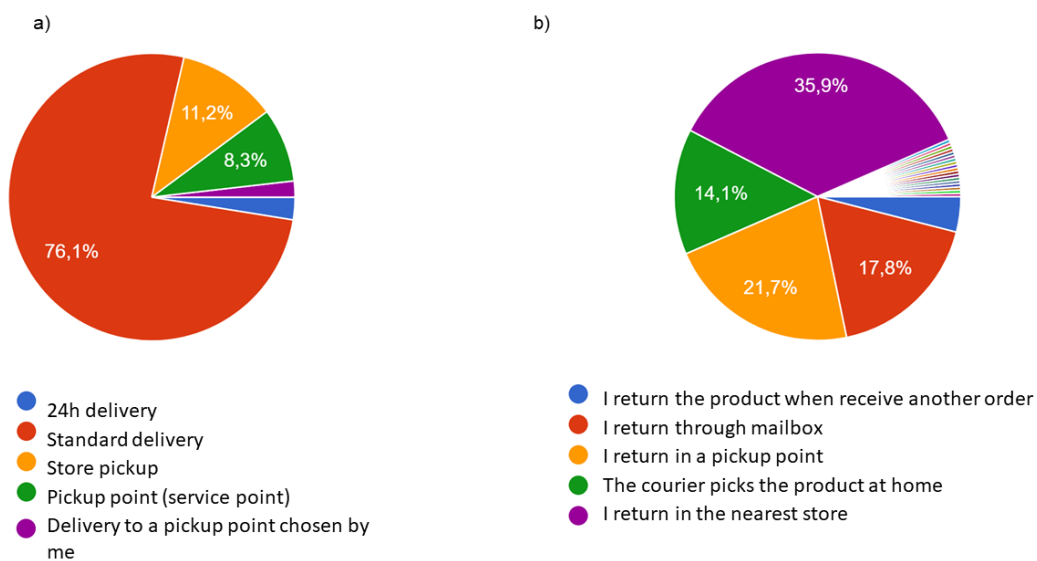

Figure 4.4: Different methods of: a) Delivery, and b) Return (developed by the author).

	24h delivery	Standard delivery	Pick-up store	Pick-up point	Delivery point (Ex:neighbor)
Rural	2%	91%	5%	2%	0%
Suburban	0%	78%	8%	8%	5%
Urban	3%	73%	13%	9%	2%

Table 4.5: Delivery methods by residential zone.

The literature review points out that packing management has a solution to decrease the number of travels to deliver an order [1]. In Table 4.6 is possible to see that only 11% of the 275 respondents responded that when they buy more than one product they arrived in more than one package. Also, the time windows defined are accomplished and the delivery is made at the right address.

The pick-up points not always are easily accessed on foot, in spite of the strong commitment to giving more delivery options and more pick-up points, the fact that they are not easily accessed on foot makes that the environmental impact is still significant due to the transportation used to reach the pick-up point.

	Disagree	Neutral	Agree
When I order more than one product, they usually arrive in a fractional form	67%	23%	11%
The orders are usually delivered in the previous defined time windows	4%	12%	83%
The order usually are not delivered in the given addresses	81%	12%	8%
The pick up points are easily accessed on foot	37%	32%	31%
The pick up points allows parking nearby	37%	36%	27%

Table 4.6: Agreement level for some aspects of the deliveries.

4.3 Sustainability of apparel business

It is expected that due to the lack of transportation in more rural areas, the customers use their own cars. This is verified by the sample collected. Figure 4.5 is represented the relationship between the local place and the mode of transportation used. Comparing all three locations analyzed, traveling to the shopping center stands out, where more than 90% of the respondents from rural areas use a car. Crossing the distances traveled, the most chosen option was more than 20 km. In the urban area, the car use rate drops down to 65%. In this case, the distance usually is less than 5 km.

When considering the travel to the local commerce, the car remains the transportation mode more used, but in the urban zones, the use drops to under 50%. While the walking option stands out at a rate under 10% in rural areas, 24.4% in suburban areas, and 35.8% in urban. To the local commerce, the distance traveled by the majority of the respondent was less than 5 km.

To travel to fairs and markets, 76.7% of respondents from a rural environment use the car, and 23.3% go on foot, while in a suburban zone, 71.4% uses the vehicle and 20% go on foot, and in an urban area, 54.3% uses the car and 26.7% walking. In all three different places, public transportation is not used very often. However, it is more significant for the urban area, where the concentration and regularity are higher.

Figure 4.5.a answers why people use the car, and the reason with more agreement is the possibility of being independent of third parties and the convenience of transporting the products. Table 4.7 allows us to understand if these reasons are equal to the three different zones. In all the zones, the reason with more strength agreement is the independence from third parties and the commodity. However, the impossibility of using public transportation has relevance in suburban zones and is even more prominent in urban areas. On the other side, the question about the car giving advantages to saving time has a significant disagree level for all the zones.
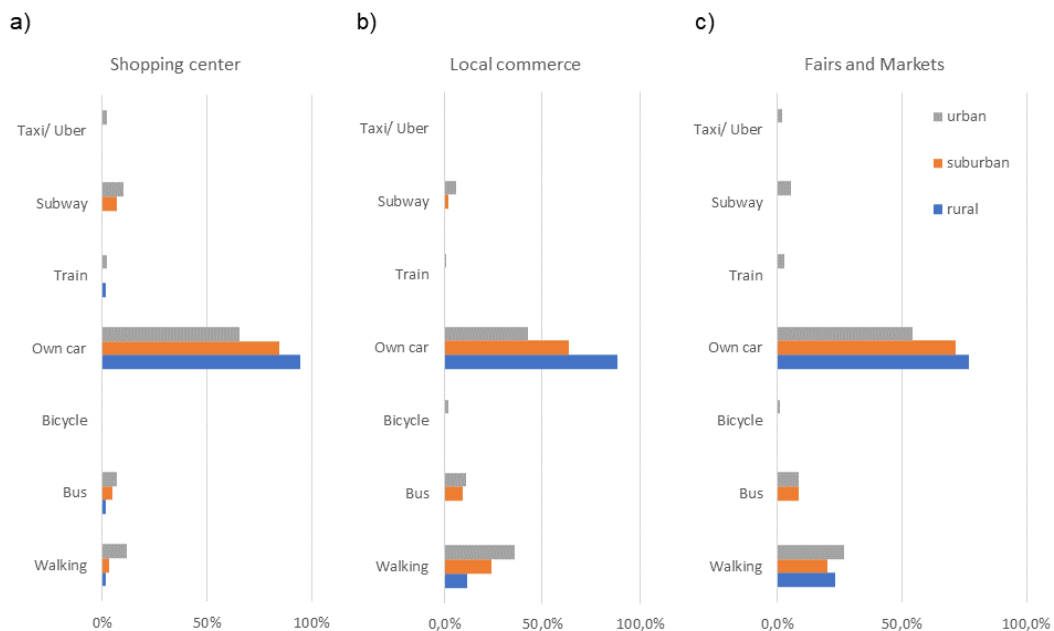

Figure 4.5: Relation between the local area and the mode of transportation (developed by the author).

		Disagree	Neutral	Agree
Rural	Time	35%	22%	43%
	Commodity	11%	11%	78%
	Impossibility	30%	7%	63%
	Independence	7%	11%	81%
	Price	24%	17%	59%
Suburban	Time	48%	30%	22%
	Commodity	16%	18%	67%
	Impossibility	30%	14%	56%
	Independence	25%	16%	59%
	Price	20%	25%	55%
Urban	Time	49%	21%	31%
	Commodity	11%	13%	76%
	Impossibility	55%	17%	28%
	Independence	17%	11%	72%
	Price	28%	19%	54%

Table 4.7: Level of agreement for the motives to use the car by residential area.

The literature review shows that despite the environmental problem through the supply chain, apparel produces much waste [39]. New trends constantly emerge in a sector, and customers tend to buy more products. A possible solution is the use of a circular economy, like the use of reuse articles. In Figure 4.6, there is a frequency in how people buy second-hand products. It started to have a significant amount of customers, but the most common answer was that they never purchased a second-hand product, for physical stores 66.3% and in online stores 66.7%. The values are close for the two different channels.

Figure 4.6: Frequency of second-hand products purchases in: a) Physical stores, and b) Online stores (developed by the author).
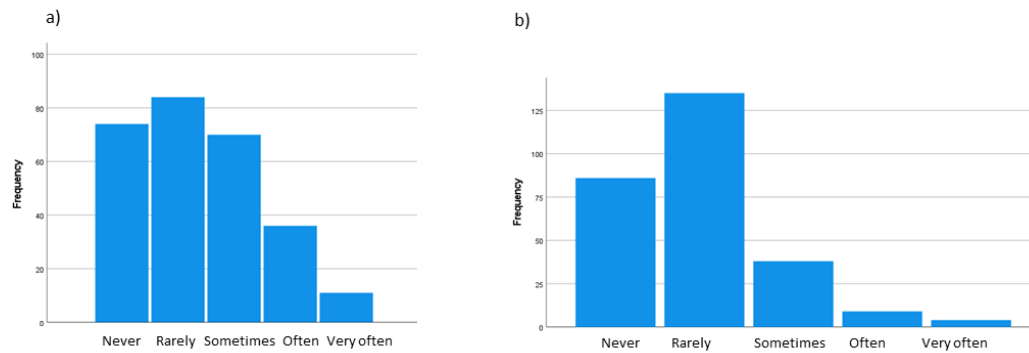
Figure 4.7: a) Customer's awareness of products' origin, b) Returns frequency (developed by the author).

Not only does the use of second hands products evidence the environmental awareness of the population, but also the returns have an impact on that. A significant portion of the respondents, indicated in Figure 4.7b) or never have returned any item or rarely have returned it. Although the literature suggests a high rate tax for the apparel market, the sample collection does not provide evidence. A justification from the literature is that when people buy more than one product to try and then return. The survey indicates that only 7% of the respondents usually do that. In addition Figure 4.7a) shows that customers usually do not pay attention to the origin of the products, which is a negative impact for a more sustainable approach.

Chapter 5

Conclusion and future work

In this work, a systematic literature review was conducted in order to study the environmental impacts of parcel deliveries on the apparel market and how the habits of consumers affect them. After the application of a screening based on a set of exclusion criteria to refine the research, the sample ended up with 31 articles on which the literature review was based. Complementary, a bibliometric analysis was made. Then, a survey was designed to study consumer habits and preferences for online and physical buying. The survey was made through a web app, using Google forms. In order to understand if the survey had some aspects that may seem confusing a pre-test was conducted, by a group of investigators of the theme of study.

The literature review focuses on the type of business and the sustainability of the supply chain in the apparel sector. This review highlight that the apparel sector has a large part of its business in the online and physical channel, using a multi-channel approach. The pursuit of the improvement of the business value leads to faster delivery and with that a need of adoption of sustainable supply chain.

The survey reached 356 respondents, mostly under 30 years old, and with these answers was possible to conclude that the physical store more used was the shopping center. In all factors analyzed, the shopping center was the channel more used. However, the factors influence the frequency of how they use them. The analysis through gender shows that it influences the three physical stores considered, the shopping centers, the local commerce, and fairs and markets, the application of Cramer's test show an association of 0.21, 0.18, and 0.19 respectively. The female gender tends to buy more frequently in these stores. Also, in online commerce, gender is associated with purchase frequency. Like in physical stores, the female gender tends to buy more often. Considering age, this did not have a stronger association with the frequency, like gender in physical stores. However, online commerce has a strong association. People between 26 and 45 years old tend to buy more frequently than others. The residence place and the education have less significance in the frequency and quantity of products purchased in physical stores and online stores. The values of Cramer's test did not exceed 0.15.

The literature evidence that the companies try to gain value through fast deliveries, like delivery in two hours, and want to give their customers the maximum amount of choices like the option

of shipping to the store. After the survey, it is possible to conclude that the most used delivery method was standard shipping, and they usually prefer that their order are delivered at home. The client sees online commerce as an easy way to buy and search for their products.

The use of second-hand products demonstrated environmental awareness; despite the large population not buying them, there is a portion that prefers to buy them. This helps to reduce the growing tendency of fast fashion and control waste production. Also, some costumes have concerns about the origin local of the products. As was studied in the literature review, online commerce enhances brand internationalization, and with the products factories all localized in east Asia, the transport is very prejudicial to the environment. If the customers' purchase products of national origin, these emissions in transport will go lower. Despite these concerns when they buy online, a significant portion of the sample who wants to go to a shopping center uses their car, even with distances less than 5 km.

One of the more significant limitations faced was the difficulty of sharing the survey with more customers from different residential zones. Due to these reasons, the survey had more incidence in people from urban zones.

On the retailers' side, as future work, could be made an analysis of the emissions produced by a single package and compared to the emissions if the customer uses different transportation modes to go to stores, from private to public transportation modes. Additionally, this analysis could be also conducted in order to compare different business models from e-commerce to brick-and-mortar.

In order to understand the overall impact in a city, simulation tools could be used to analyze the impact of the patterns and trends identified on emissions. These tools allow decision-makers to better understand the environmental impacts of these trends (or a policy) and therefore select the best strategy of consumption for a specific place. This will allow supports the development of more sustainable societies.

Appendix A

Survey

A.1 Introductory section

The purpose of this survey is to understand the environmental impact of the population's consumption habits regarding purchasing fashion items, such as clothing, footwear, accessories, and home textile.

This survey has as its target population all those who make purchases of this type of product, either through physical stores or through online commerce.

This data collection will support a Master's thesis at the Faculty Engineering University of Porto (FEUP) and is part of the e-LOG research project led by INESC TEC.

All data will be used only for the mentioned research, guaranteeing all anonymity of the answers given.

Filling out this survey takes approximately 10 minutes. We thank you for your cooperation and request to share this survey.

A.2 Consumer characterization

1. Gender

   (_) male

   (_) female

   (_) other

2. Age
3. How many dependent people have? (Ex: children, seniors...)
4. Residence place (where the respondent spends most of the time)
5. How would you classify the residence location(the location where the respondent spends most of the time)?

```
            1     2     3     4     5
Rural     (_)   (_)   (_)   (_)   (_)     Urban
```

6. Education

(_) ≤ 12º year

(_) degree

(_) post-graduation

(_) master degree

(_) doctor degree

7. What is your professional situation?

(_) Student

(_) Work-student

(_) Worker

(_) Unemployment

(_) Retired

8. On average, how much spend on this kind of product in a year?

(_) <50 €

(_) 51-100 €

(_) 101-250 €

(_) 251-500 €

(_) >500 €

A.2.1   Part II - Physical stores purchases

Considering your residence place (the place where spend most of the time), answer the following questions:

1. Do you buy fashion products in physical stores?

(_) Never

(_) Rarely (1 time year)

(_) Sometimes (half-yearly)

(_) Often (quarterly)

(_) Very often (>1 time month)

1. Indicate with which frequency do shopping in physical stores:

	Never	Rarely (1 time year)	Sometimes (half-yearly)	Often (quar-terly)	Very Often (>1 time month)
In second hand (in physical stores)	(_)	(_)	(_)	(_)	(_)
In shopping centers	(_)	(_)	(_)	(_)	(_)
In local commerce (proximity commerce, traditional commerce, except fairs and markets)	(_)	(_)	(_)	(_)	(_)
In fairs and markets	(_)	(_)	(_)	(_)	(_)

2. How many fashion products do you usually buy on each travel to the following locations?

	Not attending/ not applicable	1(1 product)	2	3	4	5 (>10 prod-ucts)
In shopping centers	(_)	(_)	(_)	(_)	(_)	(_)
In local commerce (proximity commerce, traditional commerce, except fairs and markets)	(_)	(_)	(_)	(_)	(_)	(_)
In fairs and markets	(_)	(_)	(_)	(_)	(_)	(_)

3. Indicate which distance, approximately, travel to reach the following locations:

	Not attending/ not applicable	1(<2 Km)	2	3	4	5 (>20 Km)
In shopping centers	(_)	(_)	(_)	(_)	(_)	(_)
In local commerce (proximity commerce, traditional commerce, except fairs and markets)	(_)	(_)	(_)	(_)	(_)	(_)
In fairs and markets	(_)	(_)	(_)	(_)	(_)	(_)

4. Indicate which are the transportation mode that, usually use to reach the following locations:

	Not attending/ not applicable	Walk	Bicycle	Own car	Taxi/Uber	Bus	Subway	Train
In shopping centers	(_)	(_)	(_)	(_)	(_)	(_)	(_)	
In local commerce (proximity commerce, traditional commerce, except fairs and markets)	(_)	(_)	(_)	(_)	(_)	(_)	(_)	
In fairs and markets	(_)	(_)	(_)	(_)	(_)	(_)	(_)	

5. Classified on a scale of 1 to 5 the motives to use your own car in your travels to physical stores? (In the case that you use your own car)

	1(Totally disagree)	2	3	4	5 (Totally agree)
Usually I have a few time to do the shopping	(_)	(_)	(_)	(_)	(_)
It is more convenient for transporting the purchases	(_)	(_)	(_)	(_)	(_)
Do not exist public transportation to go to the stores	(_)	(_)	(_)	(_)	(_)
With the car I am independent from third parties	(_)	(_)	(_)	(_)	(_)
For the transport of all family it is more cheap than public transportation	(_)	(_)	(_)	(_)	(_)

6. Classified on a scale of 1 to 5 the following statements relative to the purchases in physical stores:

	1(Totally disagree)	2	3	4	5 (Totally agree)
See the product and feel it is crucial to do the purchase	(_)	(_)	(_)	(_)	(_)
Try the product make me choose to buy in physical stores	(_)	(_)	(_)	(_)	(_)
The costumer care is valuable when I do shopping	(_)	(_)	(_)	(_)	(_)
The possibility of having the product on time makes me choose physical stores shopping	(_)	(_)	(_)	(_)	(_)
I am satisfied with the experience of do shopping in physical stores	(_)	(_)	(_)	(_)	(_)

A.2.2   Part III - Online purchases

1. Do you use to buy fashion products in online stores?

(_) Never

(_) Rarely (1 time year)

(_) Sometimes (half-yearly)

(_) Often (quarterly)

(_) Very often (>1 time month)

1. How often buy second-hand fashion products in online stores?

	1	2	3	4	5	
Never	(_)	(_)	(_)	(_)	(_)	Very often (>1 time month)

2. Do you have the care to choose national articles?

	1	2	3	4	5	
Never	(_)	(_)	(_)	(_)	(_)	Very often

3. Which channel do you usually use to buy fashion products?

(_) Store website (Ex: Zara, H&M...)

(_) Stores operating only online (Ex: Amazon, Shein...)

(_) Online stores of second-hand articles (Ex: Vinted...)

(_) Selling online platforms (Ex: OLX, eBay...)

(_) Social networks (Ex: Instagram, Facebook...)

4. On average how many units of this type of product buy in each time?

	1	2	3	4	5	
1 product	(_)	(_)	(_)	(_)	(_)	>10 products

5. Classified on a scale of 1 to 5 the following statements relative to the purchases in online stores:

	1(Totally disagree)	2	3	4	5 (Totally agree)
I have access to products that does not exist in physical stores	(_)	(_)	(_)	(_)	(_)
Do not need to move to the store	(_)	(_)	(_)	(_)	(_)
I have access to exclusive discounts	(_)	(_)	(_)	(_)	(_)
It is easy to find specific products, for example, through search and filters in the websites	(_)	(_)	(_)	(_)	(_)
It is easy and fast to know the products' prices	(_)	(_)	(_)	(_)	(_)
The online search and easiness to do the order makes the shopping process faster	(_)	(_)	(_)	(_)	(_)
I usually buy more than one product to try out	(_)	(_)	(_)	(_)	(_)
I am happy with online purchases that i already did, if there was any problem was easy to solve	(_)	(_)	(_)	(_)	(_)
I trust in online purchases, in all the process like payment, delivery and returns	(_)	(_)	(_)	(_)	(_)

A.2.3   Part IV - Delivery and returns

1. Considering the type of delivery, choose the option that is commonly used.

   (_) 24h delivery

   (_) Standard delivery

   (_) Pick up at the store

   (_) Delivery at a pick-up point

   (_) Delivery at a pick-up point chosen by me (ex: neighbor, coffee shop...)

   (_) Other

2. Which is the place that you usually choose for the delivery of your orders?

   (_) Residence place

   (_) Workplace

   (_) Relatives' house

   (_) Other

3. If you need to return, how usually do you proceed?

   (_) I return the product when receiving another order

   (_) I return through the mailbox

   (_) The courier picks the product at home

   (_) I return to the nearest store

4. How often do you return fashion products?

             1   2   3   4   5
   Never   (_)   (_)   (_)   (_)   (_)   Very often

5. Classify the following statements on a scale from 1 to 5:

	1(Totally disagree)	2	3	4	5 (Totally agree)
When I order more than one product, they usually arrive in a fractional form	(_)	(_)	(_)	(_)	(_)
The orders are usually delivered in the previous defined time windows	(_)	(_)	(_)	(_)	(_)
The order usually are not delivered in the given addresses	(_)	(_)	(_)	(_)	(_)
The pick up points are easily accessed on foot	(_)	(_)	(_)	(_)	(_)
The pick up points allows parking near by	(_)	(_)	(_)	(_)	(_)

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