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Estimating e-commerce demand for last mile delivery optimization through parcel locker

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To my family…

TABLE OF CONTENTS

ABSTRACT

The widespread diffusion of the online channel in the retail marketplace is impacting considerably modern society in recent years. Given the growing demand, Business to Consumer (B2C) e-commerce entails a much higher complexity of the delivery process due to significant fragmentation of parcel shipments in the "last mile", especially in urban areas, where traffic and congestion problems are arising together with environmental issues. All these aspects are of high interest not only for companies - that want to maintain a high target service level for their customers - but also for public administrations, that aim to foresee the implications of this phenomenon and how to manage it properly.

In this context, the purpose of the study is to investigate the potential of an alternative solution to the traditional home delivery, a self-collection service called "parcel locker". The research study is based on data gathered from an online survey submitted to a sample of residents living in the metropolitan area of Turin, Italy. An estimation of the willingness to buy online among different population segments will be provided by taking into account the main drivers arising from an extensive literature review. Then, e-commerce demand will be expressed in terms of quantity and spatial distribution. To conclude, the parcel locker's potential to capture the actual demand will be assessed to determine the feasibility of the delivery solution under consideration.

LIST OF TABLES

LIST OF FIGURES

1 INTRODUCTION

1.1 BACKGROUND

1.1.1 E-commerce

The past century has experienced the development of different retail solutions in the marketplace in terms of in-store shopping. However, during the last decades, thanks to the development of the World Wide Web, IT systems and IT tools (such as laptops, smartphones and tablets) a new retail channel came up: the online channel. From being almost a novelty in 1995, online retailing has steadily and dramatically increased its popularity among consumers over the past few years, thanks to the several advantages it can offer (Bhatnagar, Misra, & Rao, 2000; Morganti, Seidel, Blanquart, Dablanc, & Lenz, 2014).

Online retailing represents a form of electronic commerce (e-commerce). More specifically, e-commerce refers to the use of the Internet to perform diverse commercial activities which can be broken down into two main segments: *Business to Business* (B2B) and *Business to Consumer* (B2C) (Mokhtarian, 2004). The former refers to transactions between companies, while the latter involves transactions between a company and consumers. In this research work the terms "online retailing", "B2C e-commerce" and "e-commerce" will be used as synonyms.

Nowadays, 4.3 billion people worldwide have access to the Internet, 6% more than last year. In 2018, more than 2.8 billion people have bought online at least once and e-commerce's turnover has been estimated at 2875 billion dollars, with an increase of 12% compared to the previous year (Casaleggio Associati, 2019).

Europe is the area with the highest internet penetration (79.6%). Among internet users, 69% have purchased something online in 2018 (Casaleggio Associati, 2019).

The European countries with the highest percentage of the population purchasing online are UK (93%), Netherlands (91%), Germany (88%) and France (84%) (PostNord, 2018).

Compared to those countries, Italy is lagging, and digital development represents one of its biggest challenges. Italy is following the EU's plan for extending the Internet infrastructure to make the World Wide Web accessible to more people, with better and faster connection. As access increases, there will likely be more Internet users over the next few years, thus more Internet consumers (PostNord, 2018).

In December 2018, internet users in Italy were on average 42.3 million people (70% of the population). During 2019, B2C e-commerce in Italy has reached a turnover of 31.6 billion

euros, with the biggest increase ever, compared to the previous year (+15%). As in the past, consumers buy online more products than services (products accounted for 18.1 billion euros). (Casaleggio Associati, 2019; Osservatorio eCommerce B2c, 2019)

According to a case study carried out in the UK in 2018 by Allen et al. (2018), five factors will play an important role in the future growth of online shopping:

1. Older people are becoming more comfortable with online shopping
2. Young people, the new generations, have grown up with the internet and for most of them the favourite way to do shopping is through the online channel
3. Lots of physical shops closed because unable to cope with competition
4. Increasing penetration rates of online shopping in the grocery sector
5. The growing use of smartphones that makes much easier to shop online

1.1.2 Last-mile delivery

As pointed out by the previous data on online retailing, B2C e-commerce plays a crucial role in the profitability for most of the worldwide companies, in both mature and emergent markets.

B2C e-commerce entails, however, much higher complexity of logistic activities in the supply chain. Companies must face new challenges and strive to find new solutions to stay ahead from competitors and provide, at the same time, the highest customer satisfaction. Among the several logistic steps, many scholars agree that the most critical logistic process is the last mile delivery (Mangiaracina, Perego, Seghezzi, & Tumino, 2019). As the most complicated segment of the logistic chain, last-mile delivery seems to account for about 30 percent of total transport costs (up to 50 in some cases) (Xiao, Wang, & Liu, 2018).

Last-mile delivery is defined as the last segment of a delivery process, which involves a series of activities that are necessary to deliver the product from the last transit point to the final drop point of the delivery chain (K.F. Yuen, Wang, Ng, & Wong, 2018).

Concerning physical goods, the rapid and constant growth of online shopping has generated not only an increase in parcel delivery but also a significant fragmentation of parcel shipments in the “last mile”, considering that consumers usually buy small volumes when they order online (Figure 2).

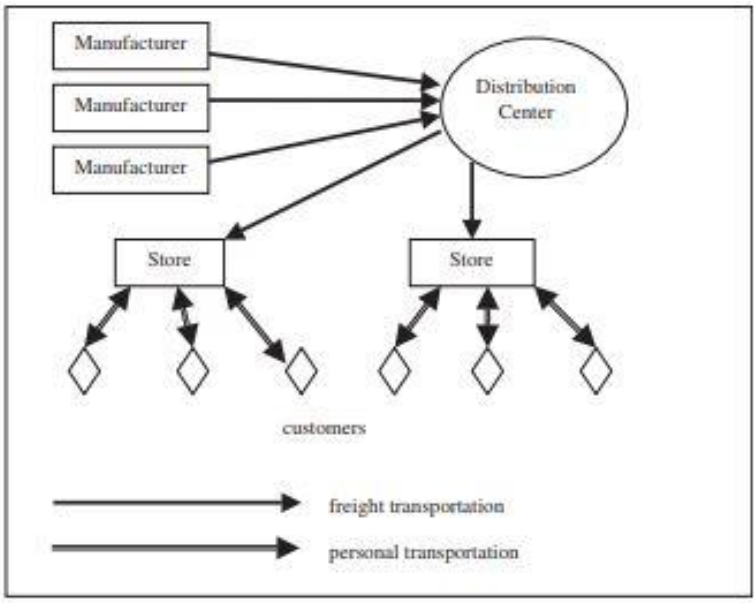

Figure 1:In-store shopping delivery model (Anderson et al., 2003)

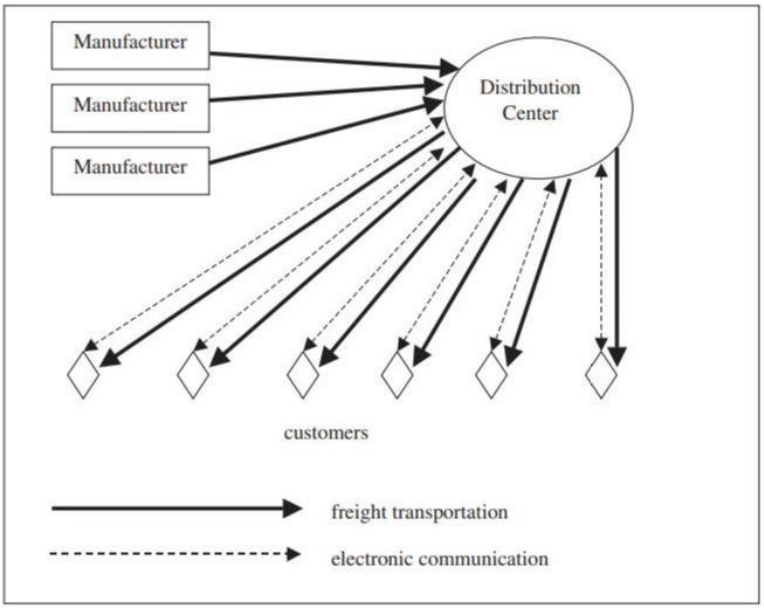

Figure 2: E-retailing delivery model - Home delivery (Anderson et al.,2003)

Therefore, in order to deliver the packages to consumers' home, the number of vehicles in residential areas has grown considerably in the last years. Moreover, failed deliveries represent one of the main problems of home delivery service because often consumers are not at home to collect the parcel from the courier. This aspect entails a rise in delivery cost from the carrier's

point of view because the package needs to be redelivered or returned to the distribution centre, but also a reduction in customer's service level (failed delivery problem).

It is well known that the last mile delivery experience plays a crucial role in shaping consumer's impression about his/her e-shopping experience, hence dissatisfaction in this last step might imply losing market share for retailers (Xiao, Wang, & Liu, 2018).

1.1.3 A self-collection delivery service: the parcel locker

As stated before, companies are striving to find alternatives to the traditional home delivery able to deal with the modern fast-changing business environment, which is characterized not only by growing volumes of delivered and returned parcels, but also an increase in customer expectations and a market competition intensification (Vakulenko, Hellström, & Hjort, 2018).

As the competition in the retail industry is getting more and more intense, every company tries to provide the highest service level to customers, with special attention to time performances in terms of punctuality (receiving the product within the predicted delivery time-lapse) and delivery speed (time interval between the customer order and the delivery). Companies usually consider service level targets as the constraint they necessarily need to meet to stay competitive in the market. Given that, they try to reach the service level by optimizing the delivery process to minimize costs (Mangiaracina, Perego, Seghezzi, & Tumino, 2019).

In this direction, the most popular solution is the Collection-and-Delivery point (CDP), which provides consumers with a self-collection delivery service. Self-service technologies (SST) are dramatically changing the way how businesses are conceived because this solution entails several benefits when compared to home delivery (Wang, Yuen, Wong, & Teo, 2018).

From the operators' perspective, a CDP can improve order fulfilment by reducing failed deliveries, the biggest problem related to home delivery. Furthermore, from the consumers' perspective, this service allows them to exploit time more efficiently since they do not need any more to stay at home waiting for the delivery. With self-collection delivery, a notification is sent when the parcel has been delivered to the CDP and the consumers can choose at their own convenience when to pick it up.

Moreover, from a social and environmental point of view, self-collection delivery services allow to consolidate shipments and reduce the road trips necessary to fulfil customers' orders (Figure 3). This entails less greenhouse gas emissions but also a reduction in road congestion, with better urban liveability (K.F. Yuen, Wang, Ng, & Wong, 2018).

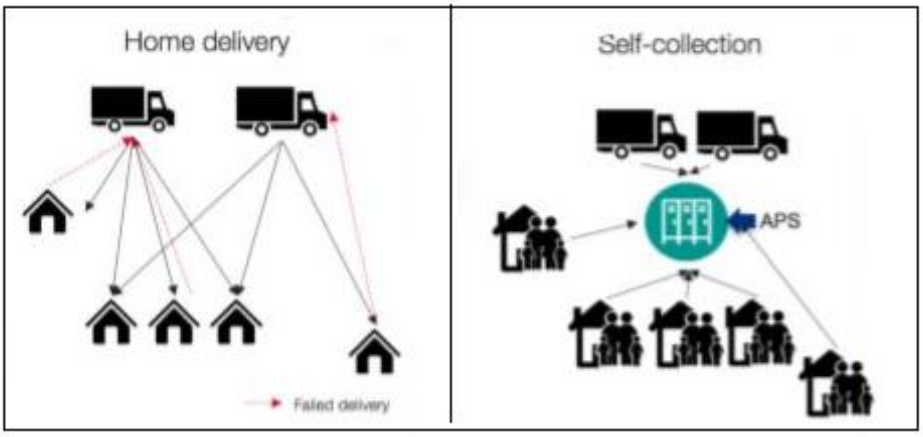

Figure 3: Comparison between home delivery and unattended self-collection delivery model

When it comes to self-collection service, a clear distinction needs to be made between two options: attended and unattended.

Attended self-collection option follows the concept of "shop-in-shop": the courier delivers the parcels to a post office, a store, a petrol station or a convenience store, where the consumer can go, pay and collect (or return) his/her package. This solution is better known as Pick-up-Point.

On the other hand, unattended self-collection service is based on an automated locker system: a notification is sent to consumer when the parcel has been delivered to the locker and the customer can collect it at any time, when he/she prefers, by opening the locker with the password or QR code received by e-mail or SMS. This solution is known as Automated Parcel Locker (Wang et al., 2018).

Figure 4: Picture of a parcel locker

The Automated Parcel Locker solution can also be found under various names such as Parcel Locker, Locker Box, Automated Parcel Station (APS), Automated Locker, Self-service Delivery Locker, etc.

	Pick-up Point	Parcel Locker
Service Hours	Opening hours	24h/24h
Queues for customers	Probable	Improbable
Queues for couriers	Probable	Improbable
Limitation on parcel dimensions	No	Yes
Limitation on number of parcels	No	Usually 1 parcel per box
Limitation on withdrawal time	5-7 days	3 days
Cost	Less expensive	More convenient with economies of scale
Human interaction	Yes	No
Couriers training	No	At the beginning probably needed

Table 1: Comparison between Pick-up Point and Parcel Locker (Zenezini et al, 2018)

From the operational standpoint, parcel locker solution results to be simpler and more rapid for both customers and couriers. It allows both to respectively collect and deliver parcels around the clock (during lunchtime, early in the morning or late in the evening), without facing any queue. However, it is likely that couriers need training, in the beginning, to perform the operations fast and smoothly, while some consumers still perceive a technological barrier towards this delivery service. They prefer sometimes to have human interaction in collecting the parcel.

When compared to the pick-up point, the parcel locker entails a limitation on the size of the parcel because it cannot exceed the dimension of the box.

Moreover, there are many issues related to the installation of the locker boxes. To what concerns location, on the one hand, they need to be installed in places accessible and convenient for customers but on the other hand, there are bureaucratic barriers related to the license to occupy public land. In this regard, a special role in the proper development of parcel lockers is played by public authorities, who should collaborate to make it easier for stakeholders the implementation of such environmentally friendly delivery solutions.

Furthermore, it needs to take into consideration the activation/installation cost. While a pick-up point involves only the cost to sign the partnership with the store, a parcel locker implies a much higher cost (cost of the physical structure, land tax, ICT system, etc.). Nevertheless, with high volumes (economies of scale), the unattended delivery solution seems advantageous, since it allows to get rid of indirect costs related to delivery such as delays, queues, closing days (Zenezini et al., 2018; Iwan, Kijewska, & Lemke, 2016).

In order to summarize every aspect of this innovative solution, the SWOT analysis (Strengths, Weaknesses, Opportunities, Threats) of parcel locker is displayed in Table 2.

Strengths	Weaknesses
• Possibility to collect parcels 7 days per week, 24 hours per day • Reduction of freight transport trip per km in comparison with attended delivery (reduction of emissions, noise and energy consumptions) • Low delivery costs	• Parcel lockers are result of private initiatives and public authorities have little information about the impact • The final leg of the journey must be made by customers
Opportunities	**Threats**
• Efficiency gains for logistic providers • Transferable to other cities	• E-commerce is expected to grow further in future and this might cause a higher freight mileage due to high number of parcel lockers

Table 2: SWOT analysis of parcel locker solution (Iwan et al., 2016)

1.2 PROBLEM DEFINITION

Already in the early 2000s, policymakers acknowledged the potential of CDPs as a means to reduce freight transport in residential areas caused by e-commerce. In 2003, the Organization for Economic Co-operation and Development (OECD) stated that "governments need to coordinate actions with the private sector in developing necessary logistics facilities including local pick-up points and parking places in order to restrain the expected growth of transport in urban areas due to B2C e-commerce".

According to Ecommerce Foundation (2019), only 8.9% of online buyers in Italy have declared in 2018 to prefer CDP as a delivery solution, against 76.4% of preferences for home delivery. These findings clearly highlight that there is still strong inertia in consumers' acceptance of these new last-mile solutions. Furthermore, as previously stated, the Italian online marketplace has great potential, it is growing year-by-year. This will presumably need adjustments even from public administrations in order to find solutions to what concerns social and environmental aspects.

In this direction, the following research project is part of an agreement protocol between Politecnico di Torino, Links Foundation (on behalf of Compagnia di San Paolo), Regione Piemonte and Confindustria Piemonte.

Public administration aims to foresee the implications of constant growth in e-commerce purchases in the Piedmont area and how to manage this phenomenon properly.

The goal of the thesis is to estimate the current e-commerce demand (B2C) of goods (not services) between different population segments (in terms of quantity, spatial distribution and socio-economic characteristics) in order to investigate the parcel locker's potential as a solution to optimize the last-mile delivery.

The second part of the research project, not part of the thesis, will focus then on exploiting the information gathered in this first step in order to implement a Capacity Facility Location Problem, aiming to get an optimal positioning solution of Locker Boxes in the area, according to demand estimation.

1.3 RESEARCH QUESTIONS

Coherently with the above premises, the following research questions and have been formulated:

RQ1: Who is the online shopper? Why do consumers choose to buy or not to buy online?
The first research question aims to investigate online consumers' characteristics, trying to determine the explanatory variables of consumers' behaviour towards e-shopping. In particular, the goal is to test if there is a correlation and to what extent between socio-economic variables and habits of respondents and their choice to buy products online.

RQ2: Given the e-commerce demand, who is willing to use the parcel locker as a delivery solution? Why?
The goal is to define the consumers' adoption behaviour of self-collection via parcel lockers in order the estimate its potential as a delivery solution. In other words, the most important variables that affect the decision to adopt this new self-collection delivery solution are investigated and how the lockers are perceived by users and non-users.

RQ3: How much and what kind of products do e-shoppers purchase online? How many products are currently collected from a parcel locker? Among parcel locker users, what variables affect the number of parcels ordered online?
First, the focus is on estimating the e-commerce demand in terms of the average number of orders and the number of products for each order. Once the e-commerce demand is known, we

want to investigate how many orders are currently delivered to parcel lockers and what factors affect the number of products ordered online by the users of this innovative solution.

1.4 CONTRIBUTION IN THE FIELD

So far, plenty of studies have been conducted worldwide to explore the online consumers' characteristics and their behaviour when it comes to deciding whether to buy online or in-store. However, there are currently only a few studies that explore those aspects in Italy. By answering to RQ1, this study aims to investigate whether previous findings concerning the role of socio-economic and spatial variables in the variability of e-commerce demand also hold in Italy. The goal is to give a contribution to the field by discussing similarities and differences in comparison to previous studies conducted in other countries in the past.

As concerns RQ2, Wang et al. (2018) and Vakulenko et al. (2018) highlighted that, despite receiving significant attention in the industry, there is a general lack of studies with a specific focus on the customers' adoption behaviour of self-collection delivery through parcel locker. Scarce research contributes to explain the customer's viewpoint regarding this solution. Hence, the aim is to make a contribution to the scarce existing literature about the topic, by providing insights on the uptake of parcel locker in Italy.

In addition, RQ3 provides interesting insights about consumers' shopping preferences related to product categories, but more important, in terms of e-commerce demand estimation and utilization of parcel locker as a delivery solution.

2 LITERATURE REVIEW

2.1 RESEARCH METHOD

As previously stated, to better understand the problem, the first step of my research work consisted of undertaking a systematic literature review, following a methodology in line with recent literature reviews on similar topics (Mangiaracina et al., 2019). In particular, two main stages were performed: literature search – papers were collected and selected; literature analysis – literature was reviewed.

Literature search

Four main steps (in alignment with Mangiaracina et al. (2019)) were followed to collect and select the most suitable papers:

1. Classification context: the focus of the research work is to investigate socio-economic and spatial variables in the variability of e-commerce demand and the consumer's intention to use a self-collection delivery service, such as parcel locker, for last-mile delivery.
2. Unit of analysis: it involves the single scientific paper. Given the considerable time needed for an article to be published and the novelty of the theme, the papers were taken not only from international journals but also from conference proceedings (faster way of making the results available).
3. Collection of publications: papers were collected mainly by looking on Scopus (and Google Scholar) with keywords such as "e-commerce drivers", "online shoppers", "e-shopping demand", "parcel lockers' drivers", "shopping behaviour", "last-mile delivery self-collection", "B2C e-commerce", "locker box". The keywords were selected and combined in order to investigate the papers whose contents lie at the intersection of two main areas: the online consumers' characteristics and the intention to adopt a parcel locker as a last-mile delivery solution.

   The papers were collected not only according to their relevance to the topic but also by taking into consideration their contribution to the field.
4. Field delimitation: the process followed three main steps. A first selection was based on the title; a second evaluation was made by looking at the abstract; ultimately, if the abstract was not enough to determine the alignment with the research scope, the article

was read. Considering the scarce existing literature on customer's intention to use parcel locker solution, papers focusing more in general on CDPs were taken into consideration..

Literature analysis

The analysis was conducted following three steps (Mangiaracina et al., 2019). First, a descriptive analysis was carried out to evaluate the main characteristics of the article in terms of content and year of publication. Second, the articles were classified according to the research methods adopted. Third, they were sorted according to the significant results and outcomes achieved by each research work.

To sum up, the articles considered suitable for my research work are categorized as follows:

1. Classification according to the content
2. Classification according to the methodology adopted to collect and analyse data
3. Classification according to results and conclusions

In total 48 articles have been analysed.

Moreover, also interesting reports by consultancy companies and logistic service providers were considered, especially to better understand (in numbers) the magnitude of e-commerce phenomenon in recent years together with parcel locker potential as a delivery solution.

2.2 CLASSIFICATION OF RESEARCH PAPERS

2.2.1 Classification according to the content

The first classification of research articles was based on the topic they focus on. More specifically, all articles focus mainly on 4 main topics:

1. E-commerce
2. Online shopper
3. In-store shopper
4. Collection-and-Delivery Points (CDPs)

RESEARCH ARTICLE	DATE	E-COMMERCE	ONLINE SHOPPER	IN-STORE SHOPPER	CDPs
(J.W.J. Weltevreden, 2008)	2008		✓		✓
(Beckers, Cárdenas, & Verhetsel, 2018)	2018		✓		✓
(Lemke, Iwan, & Korczak, 2016)	2016		✓		✓
(Clarke, Thompson, & Birkin, 2015)	2015		✓		
(Morganti, Seidel, Blanquart, Dablanc, & Lenz, 2014)	2014	✓			✓
(Bhatnagar, Misra, & Rao, 2000)	2000		✓	✓	
(Vakulenko et al., 2018)	2018				✓
(Soopramanien & Robertson, 2007)	2007		✓	✓	
(Farag, Krizek, & Dijst, 2006)	2006		✓	✓	
(Kau, Tang, & Ghose, 2003)	2003		✓	✓	
(Farag, Weltevreden, van Rietbergen, Dijst, & van Oort, 2006)	2006		✓		
(Farag, Schwanen, Dijst, & Faber, 2007)	2007		✓	✓	
(Lachapelle, Burke, Brotherton, & Leung, 2018)	2018				✓
(Rohm & Swaminathan, 2004)	2004		✓	✓	
(Forsythe & Shi, 2003)	2003		✓	✓	
(Liu & Forsythe, 2011)	2011		✓		
(Ng, 2013)	2013		✓		
(Comi & Nuzzolo, 2016)	2016		✓	✓	
(Valarezo, Pérez-Amaral, Garín-Muñoz, Herguera García, & López, 2018)	2018	✓	✓		
(Zenezini et al., 2018)	2018				✓
(Ghajargar, Zenezini, & Montanaro, 2016)	2016	✓	✓		✓
(Cagliano, De Marco, Mustafa, & Zenezini, 2014)	2014				
(Iwan et al., 2016)	2016				✓
(Rai, Verlinde, & Macharis, 2018)	2018	✓			
(Crocco, Eboli, & Mazzulla, 2013)	2013		✓	✓	
(Anderson, Chatterjee, & Lakshmanan, 2003)	2003	✓			
(Salomon & Koppelman, 1988)	1988	✓			
(Chang, Cheung, & Lai, 2005)	2005		✓		
(Oliveira, Morganti, Dablanc, & Oliveira, 2017)	2017		✓		✓
(Manerba, Mansini, & Zanotti, 2018)	2018	✓			
(Jarvenpaa & Toad, 1996)	1996	✓	✓		
(Carotenuto et al., 2018)	2018				✓
(Jesse W.J. Weltevreden & Rotem-Mindali, 2009)	2009	✓	✓		
(Mokhtarian, 2004)	2009	✓	✓	✓	
(Raman & Annamalai, 2011)	2011		✓		
(Morganti, Dablanc, & Fortin, 2014)	2014	✓			✓
(K.F. Yuen et al., 2018)	2018		✓		✓
(Wang et al., 2018)	2018		✓		✓
(Song, Wang, Liu, & Bian, 2016)	2016				✓
(Rotem-Mindali, 2010)	2010		✓	✓	
(Xiao et al., 2018)	2018		✓		✓
(Lin, Han, Yan, Nakayama, & Shu, 2019)	2019		✓	✓	✓
(Buldeo Rai, Verlinde, & Macharis, 2019)	2019	✓			
(Lian & Yen, 2014)	2014	✓	✓		
(Kum Fai Yuen, Wang, Ma, & Wong, 2019)	2019		✓		✓
(Chaparro-Peláez, Agudo-Peregrina, & Pascual-Miguel, 2016)	2016	✓	✓		
(Teo, 2002)	2002	✓	✓		
(Clemes, Gan, & Zhang, 2014)	2014	✓	✓		

Table 3: Classification according to the content of the article

2.2.1 Classification according to the research method

To better understand which methodology is more suitable to conduct the research, the literature review has been particularly useful. The following classification provided a good overview of the best practices related to data collection methodology and data analysis tools applied in the past for similar research purposes.

RESEARCH ARTICLE	DATA COLLECTION	DATA ANALYSIS
(J.W.J. Weltevreden, 2008)	From CDP companies Nationwide Online survey	Binomial logistic regression
(Beckers et al., 2018)	Online survey	Logistic regression Analysis of Variance
(Lemke et al., 2016)	Online survey	Confidence intervals, Bar charts
(Clarke et al., 2015)	Paper-based survey	Binary logistic regression
(Morganti, Seidel, et al., 2014)	Literature review, Available data	
(Bhatnagar et al., 2000)	Online survey	Factor analysis
(Vakulenko et al., 2018)	4 focus group interviews (26 participants)	Two-stage coding process
(Soopramanien & Robertson, 2007)	Postal survey	Factor analysis Logistic regression
(Farag, Krizek, et al., 2006)	Face-to-face interview Online survey	Chi-square tests Logistic and Ordinary Least-Square regressions
(Kau et al., 2003)	Online survey	Factor analysis and Cluster analysis Chi-square tests Stepwise discriminant analysis
(Farag, Weltevreden, et al., 2006)	E-shopping dataset from online market research agency	Binomial logistic regression Ordinary Least Squares regression
(Farag et al., 2007)	Shopping questionnaire (online and paper-and-pencil) and two days travel diary	SEM analysis
(Lachapelle et al., 2018)	Information collection about 45 locker sites from Australia Post	Micro and macro level analysis Logistic regression
(Rohm & Swaminathan, 2004)	Survey (online and offline sample)	Cluster analysis ANOVA Chi-square tests
(Forsythe & Shi, 2003)	Online survey	Multiple regression analysis
(Liu & Forsythe, 2011)	National online survey	Theory of Acceptance and Use of Technology model (UTAUT) Exploratory factor analysis MANOVA test
(Ng, 2013)	Online survey	Covariance Based Structural Equation Modelling (CBSEM) Confirmatory Factor Analysis
(Comi & Nuzzolo, 2016)	Online survey	Logit model New purchase choice model
(Valarezo et al., 2018)	Online survey	Discrete choice model Logistic regression
(Zenezini et al., 2018)	Semi-structured interviews to CEP (Courier, Delivery and Parcel) delivery companies	"Open coding" process to organize data into higher-level concepts
(Ghajargar et al., 2016)	Online survey	Descriptive statistics
(Cagliano et al., 2014)	Collection of data from the company at issue	Linear regression analysis
(Iwan et al., 2016)	Data from InPost Company and online survey	Not specified

(Rai et al., 2018)	Annual reports and new articles related to LSP	Document analysis
(Crocco et al., 2013)	Online survey	z-test Logistic regression (backward Wald procedure)
(Anderson et al., 2003)	Literature review	
(Salomon & Koppelman, 1988)	Literature review	Exploratory research
(Chang et al., 2005)	Extensive literature review	Classification of findings from each article
(Oliveira et al., 2017)	Online surveys according to stated preference and revealed preference methods	Multinomial logit model
(Manerba et al., 2018)		Mixed Integer Linear Programming (MILP)
(Jarvenpaa & Toad, 1996)	Survey	Qualitative data from surveys was coded Multiple regression
(Carotenuto et al., 2018)	Dataset about population	Heuristic and meta-heuristic (Multi Depot Capacitated Vehicle Routing Problem)
(Jesse W.J. Weltevreden & Rotem-Mindali, 2009)	Large online survey	Quantitative representation of the results from the survey
(Mokhtarian, 2004)	Literature review	
(Raman & Annamalai, 2011)	Survey	Pearson chi square and multiple regression analyses
(Morganti, Dablanc, et al., 2014)	Literature review and survey activities (face-to-face interviews)	Use of spatial data and descriptive statistical variables
(K.F. Yuen et al., 2018)	Pilot survey and formal street-intercept survey	Confirmatory Factor analysis Hierarchical regression analysis
(Wang et al., 2018)	Random street intercept survey, preceded by a three round pre-testing	SEM analysis (Confirmatory Factor analysis Harman's single-factor test Hypothesis testing)
(Song et al., 2016)	Database of 200 residents in Beijing	Genetic Algorithm-Ant Colony Algorithm (GAAA)
(Rotem-Mindali, 2010)	Face to face interview	Ordinal logit (mode of purchase as dependent variable) ANOVA
(Xiao et al., 2018)	Survey through self-reported questionnaire	Mixed structural equation model (SEM model)
(Lin et al., 2019)	Online survey	Two-step floating catchment area (2SFCA)
(Buldeo Rai et al., 2019)	Six focus groups (49 respondents in total)	Computer-assisted qualitative data analysis software
(Lian & Yen, 2014)	Survey	Integration between UTAUT (Unified Theory of Acceptance and Use of Technology) model and innovation resistance theory
(Kum Fai Yuen et al., 2019)	Online survey (with QR code)	SEM analysis
(Chaparro-Peláez et al., 2016)	Online survey	Fuzzy-set qualitative comparative analysis (fsQCA)
(Teo, 2002)	Online survey	Chi-square test
(Clemes et al., 2014)	Face-to-face survey	Regression analysis

Table 4: Classification according to the methodology adopted to collect and analyse data

Data collection methodology

As displayed in Table 4, the survey methodology is a widespread methodology to collect data from consumers. It was carried out in 34 research papers and in 23 of them, the survey was conducted online.

Regarding the size of the sample taken into consideration by each research work, there is no evidence of any trend: some articles considered samples with less than 200 people, others focused on samples with around 3000 people. The two surveys with the least participants

considered respectively 164 valid responses (K.F. Yuen et al., 2018) and 170 valid responses (Wang et al., 2018).

Data analysis methodology

As regards data analysis, different statistical tools were adopted. However, there is a statistical model implemented with much higher frequency: the regression analysis, more specifically the logistic regression analysis (or logit model). From the classification, it turns out that that regression analysis was implemented in 18 articles and 15 of them based their conclusions on the results generated from a logit model.

2.2.2 Classification according to results and conclusions

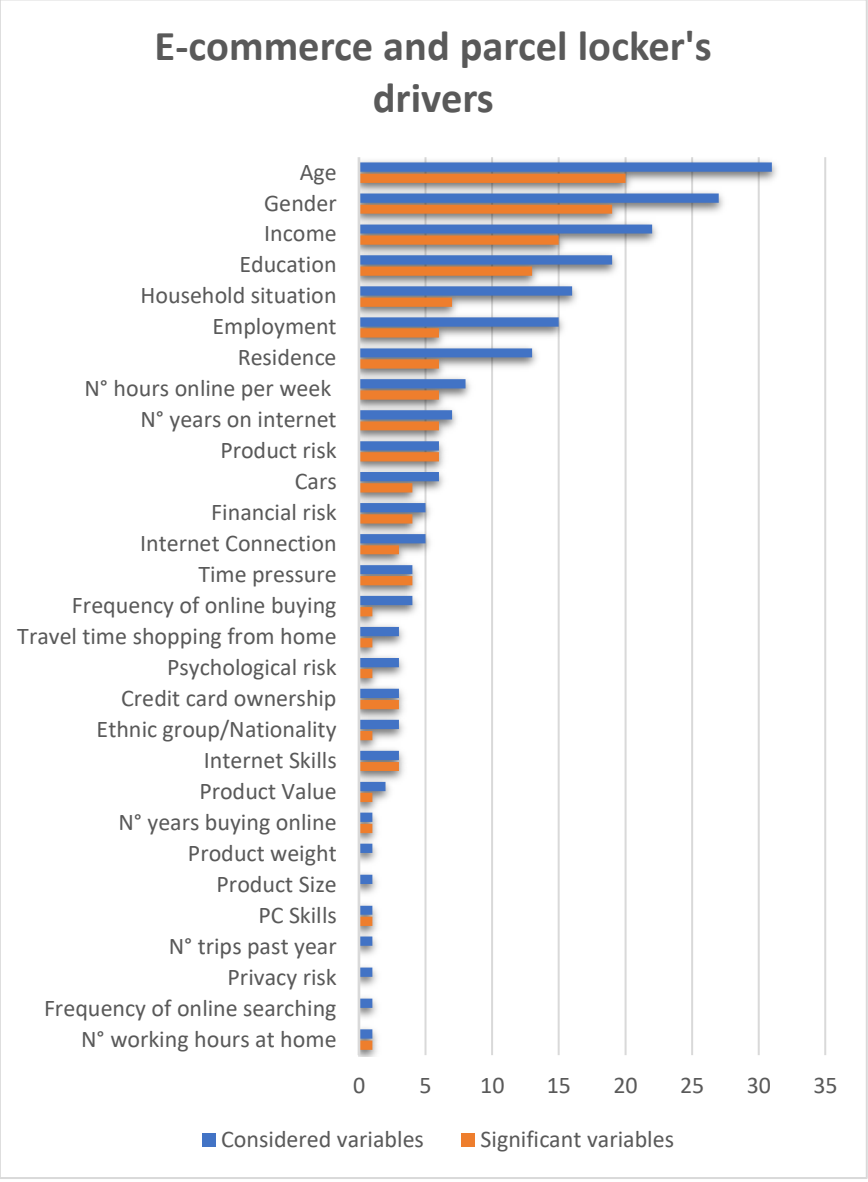

Figure 5: Potential variables affecting e-shopping and parcel locker's adoption

Different online consumers' aspects have been analysed by each research study in order to understand what consumers' variables are able to explain the decision to shop online and the utilization of parcel locker as a delivery solution.

However, by implementing statistical tools, each study has highlighted that among the different variables some of those are not really significant (Figure 5).

2.3 FINDINGS

Coherently with the above premises, this paragraph focuses on illustrating and clarifying similarities and differences in conclusions from different articles.

2.3.1 Variables affecting online purchasing

2.3.1.1 Socio-economic variables

By carrying out the literature review, it came out that although several variables have been considered in different articles when it comes to describing the consumer's decision to buy online, socio-economic variables are never missing in the analysis. Thus, a special focus on those aspects of consumers is following in this section.

Age

According to the existing literature in the field, the typical online consumer is young (Beckers et al., 2018; Clarke et al., 2015; Clemes et al., 2014; Comi & Nuzzolo, 2016; Crocco et al., 2013; Farag et al., 2007; Raman & Annamalai, 2011; Rotem-Mindali, 2010; Jesse W.J. Weltevreden & Rotem-Mindali, 2009; Xiao et al., 2018).

For instance, Beckers et al. (2018) stated that the highest percentages of online shoppers are found in the age groups between 25 and 40 years old, while according to Clarke et al. (2015) age is an important socio-economic discriminator for e-commerce because young people between 16-24 years old are used to access the internet much more often than those aged 75 or more, thus youngers are more frequent online shoppers.

According to Lemke et al. (2016) the people between 25 and 34 years old use the internet every day, thus they do not have any mental or technological barrier concerning online shopping.

However, some studies came to different conclusions. Bhatnagar et al. (2000) stated that older people find online shopping more attractive because they are more time constrained.

While others considered the variable age not significant to explain the internet usage (Soopramanien & Robertson, 2007; Farag, Krizek, et al., 2006; Jarvenpaa & Toad, 1996).

Forsythe & Shi (2003) stated that age is a predictor of the amount of time spent on the Web, but it does not explain anything more.

Liu & Forsythe (2011) investigated socio-demographic variables from another perspective. They stated that the success of online shopping channel does not really depend on the initial decision to use it to buy online, while it depends more on post-adoption decision to use the channel for purchasing a wide range of products. Thus, their research focused on analysing post-adoption behaviour by testing whether the drivers behind the initial adoption of the online channel can explain and predict post-adoption purchase intensity. Specifically, they concluded that there is no difference in age between early adopters and late adopters.

Gender

When it comes to determining the correlation between the gender of consumers and their willingness to buy online, most articles highlighted that males buy online more often than females (Beckers et al., 2018; Clarke et al., 2015; Farag, Krizek, et al., 2006; Farag, Weltevreden, et al., 2006; Farag et al., 2007; Comi & Nuzzolo, 2016; Crocco et al., 2013; Jesse W.J. Weltevreden & Rotem-Mindali, 2009).

On the other side, some studies came up with the conclusion that gender is not a significant variable able to explain consumers' different behaviour towards e-shopping (Soopramanien & Robertson, 2007; Forsythe & Shi, 2003; Jarvenpaa & Toad, 1996).

Xiao et al. (2018) analysed the impact of the variable "gender" on e-shopping spending and frequency by consumers: they pointed out that gender is significant, more specifically women are used to purchasing online more often, while men usually spend more.

An interesting study has been conducted by Clemes et al. (2014), who came to a different conclusion compared to the previous articles; they stated that actually, females buy more often online. However, in their study, they made clear that a limitation that could affect the final result is that the analysis has been carried out in China, where there is a majority of female internet users.

Additionally, Lian & Yen (2014) studied how gender and age affect online shopping. They noted that older adults show no gender differences related to online shopping attitude.

Valarezo et al. (2018) analysed if the variable "gender" is related to cross-border e-commerce, highlighting that being a male is positively correlated, while Bhatnagar et al. (2000) concluded that the significance of this variable on e-purchasing depends on products categories, some products are bought more by men, others by women. For example, Rotem-Mindali (2010) stated that gender is not significant to determine e-buyers' attitude to purchase electronic products.

Chang et al. (2005) performed an extensive literature review to describe which consumers' characteristics have an impact on purchasing online and highlighted that three studies found that males purchase more online, five did not find any difference.

Income

In general, existing literature has highlighted that consumers with high income are more willing to buy online (Beckers et al., 2018; Clarke et al., 2015; Soopramanien & Robertson, 2007; Farag, Krizek, et al., 2006; Farag et al., 2007; Forsythe & Shi, 2003; Crocco et al., 2013; Raman & Annamalai, 2011).

Clarke et al. (2015) pointed out the income as an important driver: the households with a very high income are 10 times more likely to buy online than their low-income counterparts.

Farag, Weltevreden, et al. (2006) came to an interesting conclusion: people with medium income buy less frequently than people with low or high-level income. They clarified this interesting result by saying that people with low income (students, for example) probably buy more often online to get products at a cheaper price, while people with high income utilize the online channel as a supplement of in-store shopping, to buy more frequently.

Other studies pointed out that income has not a significant effect on the decision to buy online. (Jarvenpaa & Toad, 1996; Rotem-Mindali, 2010; Xiao et al., 2018; Clemes et al., 2014)

Education

According to different papers, well-educated people are more willing to buy online (Beckers et al., 2018; Farag, Weltevreden, et al., 2006; Farag et al., 2007; Rotem-Mindali, 2010; Xiao et al., 2018; Clemes et al., 2014).

Valarezo et al. (2018) conducted a study in Spain and stated that education is positively correlated to Cross-Border e-commerce in the European Union, while it seems insignificantly in other cases.

Jarvenpaa & Toad (1996) stated that education level is not significant to explain attitude towards online shopping, while it is significant to explain the perception of risk associated with online shopping.

Household situation

The household situation is a variable that sometimes has been interpreted by several articles with slightly different meanings: some of them focused on analysing the number of children or the total number of households, others focused on the marital status of the respondent.

Beckers et al. (2018) concluded that the number of children has no impact on e-commerce adoption, supported by Farag, Weltevreden, et al. (2006) and Rotem-Mindali (2010), who stated that household type has no significant effect on e-shopping.

However, Farag et al. (2007) suggested that households with children most often have a fast internet connection, thus they are more likely to buy online; in contradiction with Farag, Krizek, et al., (2006), who stated that in the Netherlands, dual-income households with children prefer online shopping the least.

Bhatnagar et al. (2000) noted that marital status has no significant effect on e-purchasing, while Clemes et al. (2014) and Xiao et al. (2018) came up with different conclusions. The first stated that single individuals are those more willing to buy online, while the other two pointed out that married people are those who shop more frequently and spend more online.

Besides, Comi & Nuzzolo (2016) mentioned that the probability of making purchases online decreases when the number of household members raises.

Employment

Clemes et al. (2014**)** and Farag, Weltevreden, et al. (2006) noted that occupation has a positive impact on the adoption of online shopping. However, the number of years of employment seems not to be a significant variable able to explain the likelihood to purchase online (Jarvenpaa & Toad, 1996).

Other studies highlighted that not workers, but students are those more likely to shop online (Comi & Nuzzolo, 2016), in particular university students (Crocco et al., 2013). These results seem to be related also with the age, confirming the findings mentioned above.

Rotem-Mindali (2010) came to a different conclusion, pointing out that the type of employment is not a variable able to affect e-shopping's adoption by consumers.

Residence

Over the years, several articles have focused on analysing if there is a significant difference in the adoption of the online channel between residents in urban and rural areas. Thus, in this case, residence as a variable indicates the distinction between urban and rural residents.

In this matter, Clarke et al. (2015) mentioned that people living in rural areas are more willing to buy online because they live further from shops. Quite the contrary, Farag, Weltevreden, et al. (2006) and Farag et al. (2007) concluded that urban residents are more likely to buy online, especially because urban areas have a faster internet connection, thus consumers are more inclined to search and buy products online.

Besides, according to Beckers et al. (2018), "Residence" is not a significant variable: consumers living in urban and rural areas have the same willingness for e-commerce adoption.

2.3.1.2 Other variables

Number of years on internet

With regard to the correlation between e-commerce adoption and the number of years online, all studies agree that the likelihood of purchasing online increases as consumers' web experience increases (Bhatnagar et al., 2000; Farag, Krizek, et al. 2006; Farag, Weltevreden, et al., 2006; Farag et al., 2007; Chang et al., 2005; Xiao et al., 2018)**.**

Valarezo et al. (2018) did not consider the number of years on the internet, but another similar variable called "internet skills", meaning the consumer's expertise in online navigation. According to his analysis, to what concerns cross-border e-commerce, this variable is mostly significant and with a positive sign.

Number of hours online per week

According to literature, the daily frequency of internet usage is highly correlated to online shopping: frequent internet users are more likely to buy online (Farag, Krizek, et al., 2006; Farag, Weltevreden, et al., 2006; Farag et al., 2007; Chang et al., 2005).

Product risk

Product risk refers to the risk of a product ordered online not to meet customer's expectations. In particular, past studies highlight a negative correlation between product risk and e-commerce adoption. It represents one of the main risks preventing customers from buying online,

especially for certain product categories, especially when the price is high, the product is technologically complex or if it satisfies ego-related needs (products whose consumption is observable by others) (Bhatnagar et al., 2000; Forsythe & Shi, 2003; Chang et al., 2005; Crocco et al., 2013).

In general, according to the study conducted by Liu & Forsythe (2011), early adopters and late adopters perceive the same degree of product risk.

Time pressure

The literature review has highlighted that time pressure seems to be a significant variable affecting online purchasing. Farag, Krizek, et al. (2006) focused on a Dutch case and concluded that time-pressured people are more likely to buy online. On this topic, also Farag et al. (2007) and Chang et al. (2005) came to the same conclusion.

Financial risk

Financial risk refers to consumers' concern about losing money via credit card fraud. In particular, consumers are not particularly worried about the monetary amount involved in the transaction, but essentially because of the online transaction itself. As expected, the financial risk seems to have a negative impact on the likelihood to purchase online (Bhatnagar et al., 2000; Forsythe & Shi, 2003; Chang et al., 2005).

In particular, according to Crocco et al. (2013), the risk concerning credit card has the most negative impact on the propensity to purchase online.

Cars

The variable "Cars" groups together different aspects arising from literature, especially the correlation between owning a car and consuming online.

Farag, Krizek, et al. (2006), by focusing on a case study in the USA, stated that owning two cars or more for a household reduces the likelihood to buy online. While Farag et al. (2007) stated that owning a car has a slightly negative impact on the frequency of online buying.

On the other hand, Crocco et al. (2013) concluded that it is less likely that an e-shopper uses a car.

Internet Connection

According to Farag, Krizek, et al. (2006) and Farag et al. (2007) a fast internet connection enhances the likelihood to buy online for consumers.

Credit card ownership

As expected, all three studies concluded that owning a credit card positively affects the likelihood to buy online (Chang et al., 2005; Farag et al., 2007; Farag, Weltevreden, et al., 2006)**.**

Travel time for daily and non-daily shopping trips from home

Farag, Krizek, et al. (2006) came to a counterintuitive conclusion to what regards the relationship between e-shopping and in-store shopping: people with a short travel time to shops for non-daily goods are more likely to buy online, while to what concern the travel time for daily trips seems not to have a significant impact on the likelihood to buy online.

Ethnic group/Nationality

The nationality resulted particularly significant only in the analysis carried out by Valarezo et al. (2018), who focused on cross-border e.-commerce. They concluded that being a foreigner increases the likelihood of becoming a cress border e-Buyer.

Frequency of online searching

Farag et al. (2007) stated in their research article that the frequency of online searching positively affects the frequency of online shopping.

Psychological risk

According to Forsythe & Shi (2003), there is no psychological risk able to negatively impact online consumption. While Valarezo et al. (2018), in his research related to cross-border e-commerce, concluded that trust on the internet seems to be relevant and positive for becoming a cross-border e-Buyer especially in the case of higher levels of trust.

Number of holiday or business trips past year

According to Farag et al. (2007), people with an active lifestyle in terms of holidays or business trips have a lot of home shopping experience.

Product Value

Product value has a significant positive impact according to the literature review conducted on four articles by Chang et al. (2005).

2.3.2 Variables affecting parcel locker's utilization

2.3.2.1 Socio-economic variables

As previously stated, a general lack of literature has been noticed in trying to investigate variables affecting consumer's decision to adopt the parcel locker as a delivery solution.

A general overview of the conclusions from reviewed articles about each variable will be provided.

Gender

K.F. Yuen et al. (2018) investigated customers' intention to use self-collection services for last-mile delivery: they concluded that gender is not a significant variable. Similarly, Lin et al. (2019) focused on the usage behaviour of parcel pick up stations and came to an identical conclusion. They stated that there is no significant difference in reception frequency between genders. On the other hand, J.W.J. Weltevreden (2008) analysed service point users' characteristics: he concluded that females are more likely to adopt this solution.

Age

In relation to the variable "Age", K.F. Yuen et al. (2018) concluded that it is not significant. However, they stood out from the crowd since all the other studies stated that in general, younger people are those more willing to adopt this solution. Lin et al. (2019) stated that the average weekly reception decreases as age increases and that in general the service offered by parcel pick up stations is preferred by younger people. Lachapelle et al. (2018) analysed the presence of parcel lockers in Australia in relation to socio-demographic characteristics of the population and he concluded that areas with a high share of younger people should be targeted. In particular, Lemke et al. (2016) defined the most likely age range of parcel locker users, which according to them is between 25 and 34 years old. Similarly, J.W.J. Weltevreden (2008) stated that the average age of a service point user is 38.4 years old.

Residence

According to the analysis performed by Lachapelle et al. (2018), lockers are usually located in suburbs or areas with higher population density. Thus, it seems that the decision related to parcel locker positioning is a strategic choice influenced by where people live and the population density of each area. This seems coherent with the intention to offer a service to as many people as possible. With this regard, Lemke et al. (2016) and Lin et al. (2019) focused on studying the willingness in minutes to move from home to collect the parcel from an automated locker box. The first study concluded that consumers are willing to spend at most 5 minutes by car to go and collect their parcel; the second one stated that preferences are in a range between 2 and 5 minutes on foot from home.

Education

About this variable, J.W.J. Weltevreden (2008) concluded that the target user has a medium education, while Lachapelle et al. (2018) stated the university students are those more willing to parcel locker's utilization. For this reason, the second study considers locating lockers in or near universities a very good strategy.

Income

To what concerns the income, J.W.J. Weltevreden (2008) and Lachapelle et al. (2018) came to different conclusions in their articles. The first stated that people with higher income are more likely to use service points: the higher the income is, the more frequent they are likely to use this delivery solution. On the other hand, Lachapelle et al. (2018) noticed that lower-income neighbourhoods seem to attract lockers slightly more.

According to Kum Fai Yuen et al. (2019), the income seems to have a significant positive effect on consumers' attitudes towards this delivery solution. He explains that this outcome is expected since consumers with high incomes are usually working professionals who spend lots of hours away from home, not having the possibility to collect parcels with home delivery. Thus, parcel lockers would be more compatible with their working lifestyle.

Type of employment

The type of employment seems to be relevant in terms of the number of hours worked at home (J.W.J. Weltevreden, 2008).

In particular, employment-rich areas are more likely to attract lockers, since people are inevitably more time-pressured and spend less time at home (Lachapelle et al., 2018).

2.3.2.2 Other variables

Cars: according to Lachapelle et al. (2018), analysing car utilization in the different urban areas might be important for strategically locating the parcel lockers. In residential areas with low car ownership, it might be worth offering proximity access to lockers.

Internet connection: areas with higher shares of households with Internet access are more likely to have lockers (Lachapelle et al., 2018).

***Number of hours online per week*:** using the internet on a daily basis is correlated with the adoption of parcel locker as a delivery solution (Lachapelle et al., 2018).

Number working hours at home: as previously stated when discussing the variable "type of employment", the fewer hours a person spends at home, the more likely she will use service points (J.W.J. Weltevreden, 2008).

***Frequency of online buying*:** there is a strict correlation between the frequency of online shopping and the likelihood a person collects the parcel in a service point. As we can expect that the consumers is more open to the adoption of this new technology (J.W.J. Weltevreden, 2008)**.**

***Number of years buying online*:** similarly, with the previous variable, this one is also positively correlated with parcel locker's usage. If a consumer is more experienced in online shopping, he will be more familiar with new delivery solutions (J.W.J. Weltevreden, 2008)**.**

***Time pressure*:** time-constrained households more likely to use service points (J.W.J. Weltevreden, 2008).

3 METHODOLOGY

3.1 DATA COLLECTION

3.1.1 Survey structuring

The survey structuring was carried out according to the following steps:

- **Information gathering through literature review**

  In order to structure the questionnaire properly, information gathered from the literature review was particularly useful as a starting point, in order to understand how past studies designed surveys related to this topic.

- **Brainstorming activities**

  Several brainstorming activities were performed during the designing phase of the survey, in order to shape a smooth questionnaire able to respond to research objectives on the one side and to avoid unnecessary questions on the other side (by taking into consideration respondents' perspective).

- **Pilot survey**

  After designing a preliminary questionnaire, a pilot survey was conducted on a small group of 20 respondents. They were asked to fill in the questionnaire and provide feedback and suggestions for improvements, if necessary.

- **Final adjustments**

  As last step, a final revision of the questionnaire was carried out by taking into consideration respondents' feedbacks and suggestions. Small adjustments were performed, and the final version defined.

To what concerns the final version of the survey, it is divided into three main sections:

- Section 1: questions to investigate socio-economic characteristics (gender, age, income, type of employment, etc.) and some daily behavioural aspects of respondents (travel mode for daily trips, number of hours spent on internet daily, number of hours away from home on average).
- Section 2: questions focusing on consumers' attitude towards e-commerce, hence whether they are used to buy online and to what extent, what type of product categories and what delivery service.

- Section 3: focus on parcel locker's potential as a last-mile delivery solution, differentiating between those who already used it and those who never used it.

The survey was carried out on Google Forms. All the questions were marked as mandatory to respond.

3.1.2 Survey submission and data cleaning

The questionnaire was submitted to respondents on the internet, mostly by e-mail or through Facebook.

The Google Form stayed open for about one month, from 16/01/2020 to 21/02/2020**.**

The total amount of respondents was equal to 1446.

After closing the questionnaire, we carried out accurate data cleaning in order to discard the incorrect or inappropriate answers.

During this phase, submissions from respondents who have answered questions with checkboxes by choosing mutually exclusive options were discarded. An example is the question "Which means of transport do you own?", when the was fully discarded.

Moreover, respondents who provided inconsistent postal codes of their place of residence and workplace, have not been taken into consideration for the analysis.

Apart from quality checks, another important discriminator according to which responses were discarded is the residence of respondents. To make the analysis coherent with the further goal of the overall research project, only respondents currently living in the metropolitan city of Turin were taken into consideration.

After data cleaning according to the highlighted criteria, the total amount of remaining responses for further analysis were equal to 1140. This is very much in line with the observation from Beckers et al. (2018), who stated that any study analysing shopping behaviour should not work with less than 1000 data points because this would restrict too much statistical significance of the outcome.

3.2 DATA ANALYSIS

3.2.1 Stratification of the sample

The first step of analysis consisted in stratifying the sample. We investigated if the distribution of respondents in the metropolitan city of Turin is representative of the overall population. For the sake of clarity, it must be said that there is a huge difference between "Metropolitan area" and "Metropolitan city". The "Metropolitan area" around Turin involves the city of Turin plus 31 small municipalities around it. While the "Metropolitan city", after the Decree-Law in 2014, stands for the province of Turin, so it is wider than the "Metropolitan area".

	Population		Sample	
	Residents	% of total	Respondents	% of total
Turin	872,367	38.8%	688	60.3%
31 municipalities	639,327	28.4%	255	22.3%
Metropolitan Area	1,511,694	67.3%	943	82.7%
Between MA - MC	736,086	32.7%	197	17.3%
Metropolitan City	2,247,780.00	100.0%	1140	100.0%

Table 5:Stratification of the sample

As we can notice from Table 5, there is an over over-representation of residents living in Turin at the expense of those living outside the metropolitan area. This fact is a consequence of the submission bias; the questionnaire has been submitted mostly to people that are currently living in Turin or in the metropolitan area.

Nevertheless, the geographical area object of the study remains the metropolitan city of Turin, since the aim of the study is to study this area as a whole, not clustering people in sub-samples according to their geographical distribution.

In Figure 6 and Figure 7, the geographical distribution of respondents is illustrated according to their home postal code. Figure 6 displays an overall view, highlighting that the share of respondents to the questionnaire covers only the area we decided to focus on, the metropolitan city of Turin, not taking into consideration respondents from other regions. Within the study area, as previously mentioned, Figure 7 shows that the share of respondents is not equally distributed; it is more concentrated in the dark-coloured areas.

Figure 6: Geographical distribution of respondents - Comprehensive picture

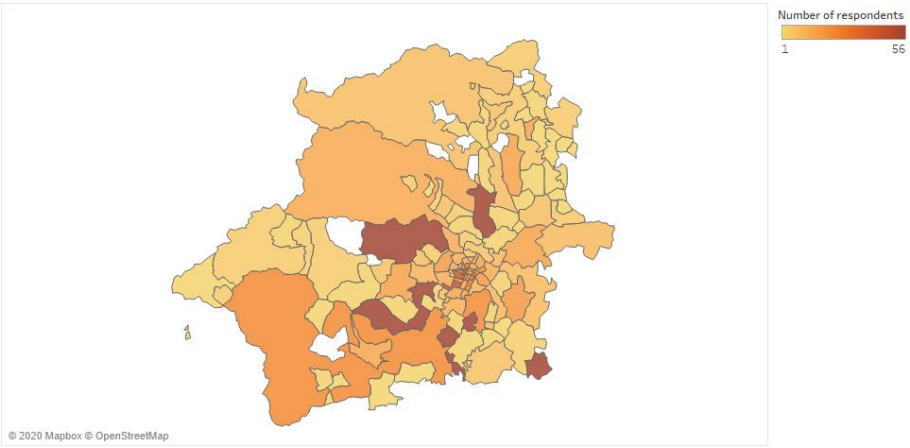

Figure 7: Geographical distribution of respondents - In-depth picture

When filling in the questionnaire, together with the residence postal code, respondents currently working or studying had to mention also the postal code of their workplace or university campus. This is particularly useful for the second part of the research project, not part of this thesis, I mentioned in paragraph 1.2. Nevertheless, it is indicative to display how most of the people, even though living outside of Turin, are working in the main town (Figure 8). Most likely, this implies for them daily commuting in most of the cases, a crucial aspect when considering the optimal positioning of parcel lockers.

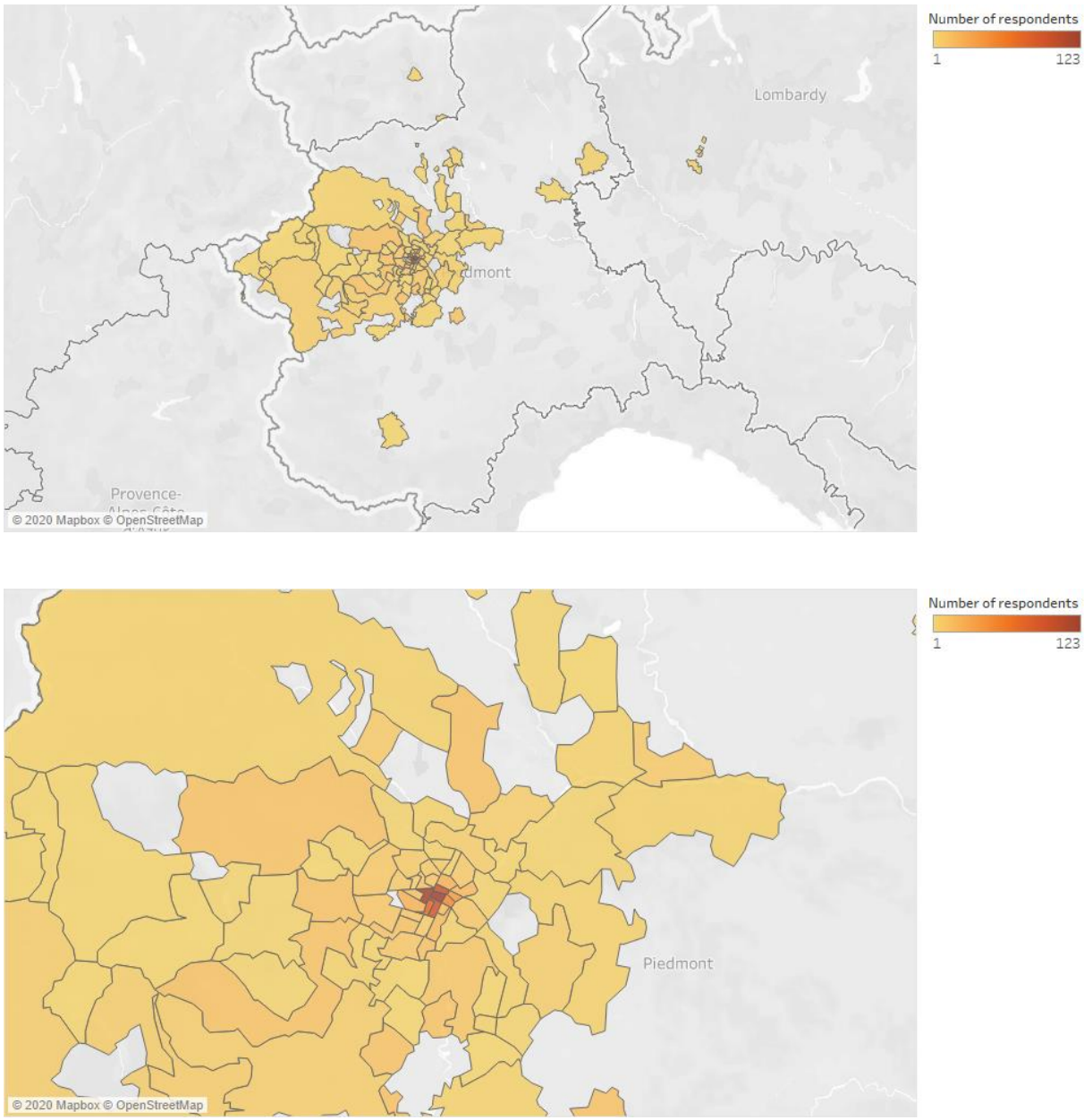

Figure 8: Workplace or place of study of respondents – Comprehensive and in-depth picture

3.2.2 Description of the sample

In the following table, the sample distribution of respondents is illustrated.

Variable	Characteristics	Total respondents	
		N (1440)	%
Gender	Male	392	34.4
	Female	748	65.6
Age	18-30	313	27.5
	31-50	445	39.0
	51-65	352	30.9
	Over 66	30	2.6
Education level	Secondary school	53	4.6
	High school	365	32.0
	Bachelor's degree	206	18.1
	Master's degree	368	32.3
	Post-graduate specialization	93	8.2
	PhD	55	4.8
Tenants	Live alone	158	13.9
	1 person	260	22.8
	2 people	294	25.8
	3 people	288	25.3
	4 people	100	8.8
	More than 4 people	40	3.5
Job	Student	248	21.8
	Employed	819	71.8
	Unemployed	34	3.0
	Retired	39	3.4
Income	No income	215	18.9
	Less than 1000 €	107	9.4
	1000 – 1500 €	245	21.5
	1500 – 2000 €	282	24.7
	2000 – 2500 €	181	15.9
	More than 2500 €	110	9.6
Means of Transport used	No one (by foot)	346	30.4
	Public transport	601	52.7
	Bike	161	14.1
	Motorbike	38	3.3
	Car	543	47.6
	Car sharing	41	3.6
	Bike sharing	39	3.4
	Electric kick scooter	8	0.7
Hours Online	Less than 1 hour	154	13.5
	1 – 3 hours	562	49.3
	3 – 6 hours	291	25.5
	6 – 10 hours	112	9.8
	More than 10 hours	21	1.8

Table 6: Sample distribution according to socio-economic variables

As we can notice, the gender proportion between males and females is not representative of the population (the real proportion for residents in the metropolitan city of Turin is equal to 48.35% for males and 51.65% for females).

The share of respondents is almost evenly distributed between the first three age ranges (18-30, 31-50, 51-65), while it is clear an under-representation of older people over 66.

To what concerns the education level, respondents have been asked to state the last qualification achieved. This means that it is likely that most of the respondents with a Bachelor degree are currently pursuing a Master degree or similarly some with high school diploma are enrolled in the first or second year of university. Besides that, the sample of respondents is generally well educated. Only 4.6 percent does not have a high school diploma, while more than 63 percent holds a university degree.

Students account for 21.8 percent of the sample, while employed people represent the biggest share (71.8%).

The income distribution is consistent with the above characteristics of the sample. The percentage of respondents with no income (18.9%) is similar to the share of students, while the income is overall medium-high. Among people with an income, 62 percent earn more than 1500 euros.

The variable “Means of Transport used” refers to the usual means of transport respondents use for daily trips to go to their workplace or university. It looks clear that respondents mainly use public transport or they go by car, alternatively by foot or by bike.

Concerning the variable “Hours online”, it involves the hours spent on web browsing or social networks from all devices (PC, smartphone, tablet). About half of the sample declared they spend between 1 and 3 hours, while a bit more than a quarter spends between 3 and 6 hours. More than 10 percent are heavy internet users with more than 6 hours spent online (1.8 percent more than 10 hours).

The distribution of average hours spent away from home by each respondent is somehow similar to a normal distribution (Figure 9). However, the mean does not coincide with the median. People spend on average 8.7 hours away from home, with a standard deviation equal to 3.04 hours. The median is equal to 10 hours, as well as the mode.

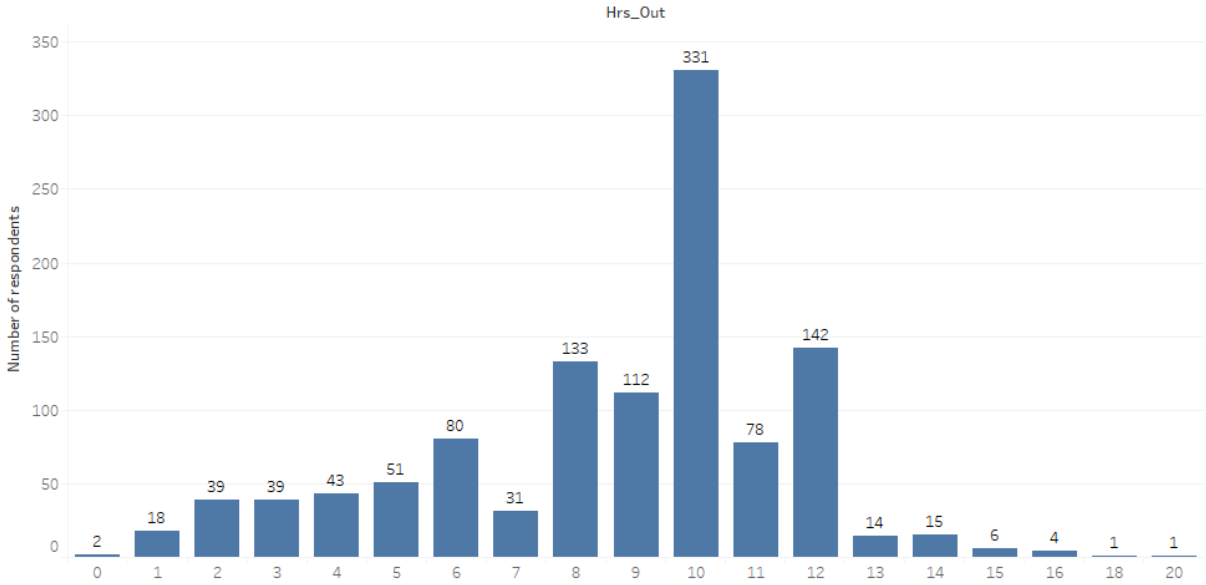

Figure 9: Average hours spent away from home daily

4 RESULTS

4.1 ESTIMATING CONSUMER'S INTENTION TO PURCHASE ONLINE

4.1.1 Descriptive statistics

Descriptive statistics represents an important step of the analysis. In this paragraph, a quantitative description of the sample's features will be provided. For the sake of clarity, in this study we decided to consider "Online shoppers" those respondents who declared they purchased online at least one product in the last twelve months. We decided to ask two questions:

1. "Have you bought online at least one product in the last month?"

For those who answered NO, we asked a second question:

2. "Have you bought online at least one product in the last year?"

Thus, those who responded YES at one of the previous questions have been considered online shoppers, while those who responded NO at both questions have been considered in-store shoppers. In the sample under analysis, 1053 respondents out of 1140, declared to be e-shoppers (92,3%). Furthermore, the great majority of e-shoppers (85%) stated that they purchased online at least one product in the last month. However, it is important to consider that the questionnaire has been submitted between January and February, thus right after the Christmas period and this might inflate the last result mentioned.

As shown in Table 7, the model takes into consideration the most important socio-economic variables mentioned in chapter 2 (Gender, Age, Education level, Income, Job) together with some other variables that we considered interesting to analyse (Tenants, Means of Transport Used and Hours online), even if less relevant according to the literature review.

For the sake of clarity, "Tenants" refers to the question "How many people are you living with?", while "Means of Transport Used" refers to the question "What means of transport do you usually use for daily trips?". As regards "Hours online", it involves the average number of daily hours of web browsing, including social network.

Variable	Characteristics	Online shoppers		In-store shoppers	
		N (1053)	%	N (87)	%
Gender	Male	361	92.1	31	7.9
	Female	692	92.5	56	7.5
Age	18-30	310	99.0	3	1.0
	31-50	426	95.7	19	4.3
	51-65	296	84.1	56	15.9
	Over 66	21	70.0	9	30.0
Education level	Secondary school	44	83.0	9	17.0
	High school	335	91.8	30	8.2
	Bachelor's degree	200	97.1	6	2.9
	Master's degree	331	90.0	37	10.0
	Post-graduate specialization	89	95.7	4	4.3
	PhD	54	98.2	1	1.8
Tenants	Live alone	139	88.0	19	12.0
	1 person	229	88.1	31	11.9
	2 people	271	92.2	23	7.8
	3 people	281	97.6	7	2.4
	4 people	93	93.0	7	7.0
	More than 4 people	40	100.0	0	0.0
Job	Student	247	99.6	1	0.4
	Employed	747	91.2	72	8.8
	Unemployed	29	85.3	5	14.7
	Retired	30	76.9	9	23.1
Income	No income	212	98.6	3	1.4
	Less than 1000 €	97	90.35	10	9.35
	1000 – 1500 €	226	92.2	19	7.8
	1500 – 2000 €	255	90.4	27	9.6
	2000 – 2500 €	161	88.95	20	11.05
	More than 2500 €	102	92.7	8	7.3
Means of	No one (by foot)	321	92.8	25	7.2
Transport Used	Public transport	555	92.35	46	7.65
	Bike	151	93.8	10	6.2
	Motorbike	35	92.1	3	7.9
	Car	505	93.0	38	7.0
	Car sharing	41	100.0	0	0.0
	Bike sharing	37	94.9	2	5.1
	Electric kick scooter	8	100.0	0	0.0
Hours Online	Less than 1 hour	133	86.4	21	13.6
	1 – 3 hours	528	93.95	34	6.05
	3 – 6 hours	269	92.4	22	7.6
	6 – 10 hours	104	92.9	8	7.1
	More than 10 hours	19	90.5	2	9.5

Table 7:Sample distribution between online and in-store shopper according to socio-economic variables

Relevant considerations can be drawn from Table 7. First of all, it looks clear that, despite the sample's disproportion between males and females, the percentage of in-store and online shoppers between the two genders is almost the same.

Moreover, it is interesting to underline the growing percentage of in-store shoppers positively correlated with the increasing age of respondents. Despite the share of old consumers is not representative of the population (it is only a small percentage of total respondents), it is evident their lower intention to purchase online than others. This fact is in line with findings from the literature review highlighted in the first chapter. It is important to underline the very high percentage of online shoppers in the age range 18-30 and 31-50 (respectively 99.0% and 95.7%). Especially for the youngest ones, it is indicative that only 3 out of 313 respondents stated that they have not purchased any product online in the last twelve months.

To what concerns the variable "Education", the highest percentage of in-store shoppers refers to the people with poor education (secondary school). This confirms conclusions from many articles according to which the typical online consumer is well-educated.

The variable "Tenants" seems not to be very relevant to explain the differences between in-store and online shoppers since all categories present very high percentages of online shoppers. However, it seems that people living alone or with just one person are those less likely to purchase online, while consumers living with more tenants, especially those living with 3 people are more likely to adopt e-commerce.

On the other hand, important conclusions can be drawn from variable "Job": it is emblematic that 99.6 percent of students have bought at least one product in the last twelve months. This remarks the propensity of younger consumers to buy online. Moreover, it is important to mention, on the other side, the high percentage of in-store shoppers among unemployed people (14.7%) and retired people (23.1%). For the former category, this might be a consequence of reduced economic possibilities, while for the latter category it might be due to higher technological barriers because of the age.

To what concerns the economic means of consumers, it is worthwhile to mention that a very high percentage of respondents with no income (98.6%) declared to be online consumers. The explanation lies in the fact that most of the respondents in this category are students, those who are very used to e-commerce but at the same time, in most cases, buy with money from family.

Besides, respondents do not present relevant differences in percentage between the two shopping modes adopted in relation to the usual means of transport used for the daily commute. While it is interesting to draw attention to the new solutions offered by sharing mobility. It is emblematic that, despite the low number of users of car sharing (41) and electric kick scooter (8), 100 percent of them are e-shoppers.

Looking at the variable "Hours online", the highest percentage of in-store shoppers involves those who spend the least time online, less than one hour (13.6%). However, there is no evidence of a remarkable trend, since people spending lots of hours online (more than 10), is the category with the second-highest percentage of in-store shoppers.

The same happens observing the hours spent away from home. The intention was to check if people spending more hours out, thus theoretically more time-pressured, are more likely e-shoppers. In Figure 10, differences in the shopping mode are presented in terms of percentages of total respondents: this aspect does not seem significant. Apart from the option "0 hours" which is not representative to draw conclusions, since it has been selected by only two respondents, there is not any significant trend that provides relevant insight. On the other side, it is counter-intuitive that the highest percentage of in-store shoppers (35.7%) involves those who spend quite a lot of hours out (13 hours).

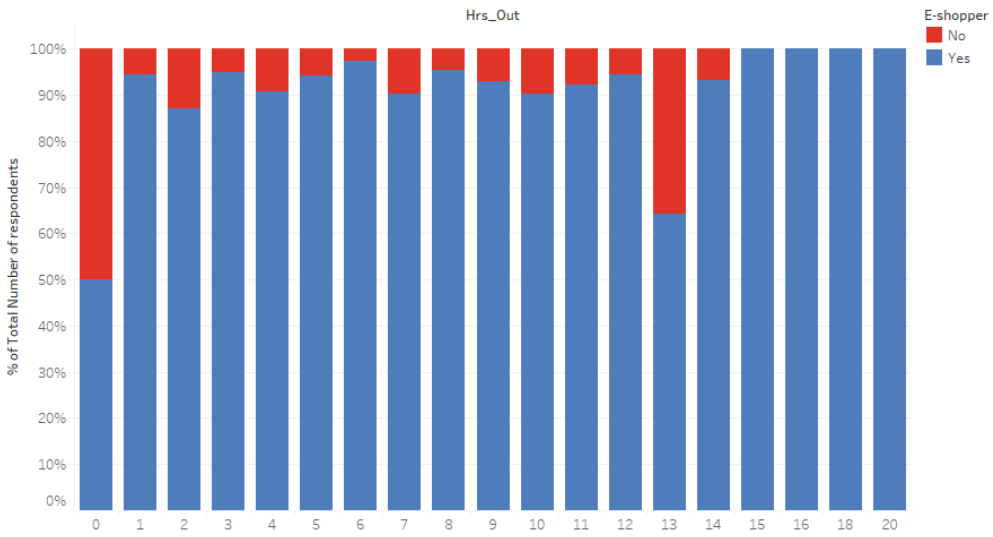

Figure 10: Percentage of in-store and online shoppers according to hours spent away from home

As discussed in the previous paragraph, the option "10 hours" is the mode, the most selected option by respondents. It has been declared by 331 respondents, of which 299 are online shoppers and 32 are in-store shoppers.

4.1.1.1 In-store shopper

After discussing the sample's share between in-store and online shoppers according to the different socio-economic variables, the following step is to describe the reasons why people choose whether to adopt e-commerce or buy in a physical store.

Reason for in-store shopping	N (Total=87)	% of total
I am concerned that the product does not reflect my expectations	13	14.9
I do not trust online payments	12	13.8
I do not like the online shopping experience	52	59.8
I am not willing to wait for product delivery	19	21.8
Others	12	13.8

Table 8: Reasons for in-store shopping

First of all, it is interesting to underline that consumers' main reason to keep buying products in a physical store is that they do not like the online shopping experience. When it comes to estimating the appeal of in-store shopping, there are aspects may be incidental to the main purpose of purchasing a product, thus important to take into consideration when analysing shopping behaviour. Doing shopping in a physical store involve *social interaction, entertainment* and *movement,* meaning that it might serve as an antidote to isolation, a recreational activity, a reason to get out of the house. Even among those not really interested in the social aspect of store shopping, some simply prefer having an interaction with the salesman (Bhatnagar et al., 2000).

Furthermore, the second most important reason is that people are not willing to wait for the product to be delivered, they want to take advantage of the product immediately, they look for instant gratification. "Immediate possession" has been pointed out by Mokhtarian (2004) as one of the dimensions which make store shopping still competitive with the online channel. Companies, being aware of this fact, keep investigating new solutions enhance the service level by shortening the lead time. For this reason, in order to increase online sales, retailers in the UK started offering faster and faster delivery services without covering the additional costs. This led between 2013 and 2015 to an increase of 50% of next-day delivery service for non-food (Allen et al., 2018).

To what concerns the other two risks preventing consumers from buying online, they correspond to the two types of predominant risks identified by Bhatnagar et al. (2000) related to internet shopping: *product category risk* and *financial risk*.

Product category risk is associated with the product's characteristics, in particular with the consumer's concern whether the products would function according to her expectations. For this reason, this risk is greatest for high tech products or for products that satisfy ego-related needs, where feel and touch are crucial to choosing whether to buy or not (such as perfumes, clothes, etc.).

On the other hand, financial risk is not related to a specific product category, while it involves concern about conducting financial transactions on the internet. Many studies highlighted that consumers are quite worried about communicating credit card information over the internet. The risk is not mainly related to the amount of money involved in the transaction, but it refers more to the consumer's risk to lose money because of credit card fraud. In this regard, there is a segment of the Italian population (usually older people) that is still comfortable only with cash transactions (Osservatorio eCommerce B2c, 2019).

In this regard, more than half of the in-store shoppers in the sample (62.1%) stated that they would be willing to buy online in future (Figure 11). This evidence confirms the increasing trend in B2C e-commerce turnover year by year and suggests it will likely keep growing in future.

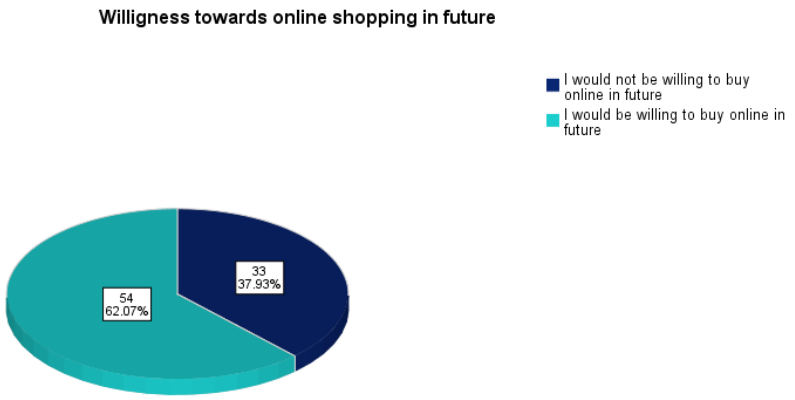

Figure 11: Willingness to adopt e-commerce in future

4.1.1.2 Online shopper

As well as we did for in-store shoppers, though the questionnaire we tried to investigate the grounds on which people decide to shop online. The most frequent reasons are displayed in Table 9.

Reason for online shopping	N (Total=1053)	% of total
Lack of time for in-store shopping	308	29.2
It is cheaper	560	53.2
More product variety online	558	53.0
It is more convenient, easier	637	60.6
Possibility to compare prices	473	45.0

Table 9: Reasons for online shopping

It is interesting to mention that the three main reasons that drive consumers to purchase products online are very much in line with the conclusions from the report issued by Osservatorio eCommerce B2c (2019) on this topic. The above mentioned three factors have been underlined as the most important determinant of e-commerce growth in Italy in the last years.

The main reason why consumers buy online is the convenience, meaning that e-commerce represents a practical solution, a very comfortable way to do shopping. Specifically, the biggest advantage is that online shopping allows customers to get over temporal and spatial constraints: buying products becomes possible at any time (24/7) in any place (Mokhtarian, 2004). In particular, e-shoppers prefer the online channel because they perceive and weight much more than in-store shoppers the aspects related to the convenience of e-retailing (Soopramanien & Robertson, 2007).

On the other hand, the lack of time seems to be the last reason why consumers decide to purchase products online.

As stated by Anderson et al. (2003), the web site is a very efficient means of conveying information and this makes much easier for the shopper to find details about products able to help him to take a more conscious decision (significant reduction in search costs). As pointed out by Table 9, consumers really appreciate electronic retailing because they can find whatever they want and compare prices much more efficiently online, even on a broad geographical scale. Consequently, this allows them to take advantage of discounts and buy products at a cheaper

price. Furthermore, with online shopping the inventories of all internet retailers are available to consumers, that can take advantage of basically unlimited selection (Mokhtarian, 2004).

Most frequent delivery services

Unlike in the past, when the only option to collect a parcel ordered online was through home delivery, nowadays when a consumer places an order online he can usually choose between several delivery services. Table 10 displays the preferences of respondents on this topic, more specifically what is the most frequent delivery service usually adopted.

Most frequent delivery services	N (Total=1053)	% of total
Home delivery (my home)	630	59.8
Home delivery (somebody else's home)	244	23.2
Delivery to my workplace	271	25.7
Delivery to others' workplace (relatives)	11	1.0
Pick-up point	192	18.2
Locker box	147	14.0

Table 10: Most frequent delivery services currently adopted

It looks clear that online consumers still collect their parcels with home delivery or receiving them at the workplace. This is in line with findings from Weltevreden & Rotem-Mindali (2009). Nevertheless, we can notice that solution like Pick-up Points (18.2%) and Locker boxes (14%) are becoming more and more popular among consumers, which is encouraging because this fact highlights a positive attitude of consumers towards innovative delivery solutions.

Factors affecting the delivery solution choice

After investigating what is the preferred delivery service of consumers, we tried to get insights into what factors have the highest impact on consumers' delivery solution choice. Each factor has been evaluated by respondents on a five-level Likert scale (1 = "Not important", 5 = "Very important"). The following factors are those considered most important among those discussed in several articles.

- Problem to carry the parcel from the delivery point to home
- Possibility to choose the exact time when to collect the parcel
- Interaction with the courier
- Price of the delivery service
- Sustainable impact of the delivery solution

In order to have a good understanding of the consumers' opinions related to the above-mentioned factors, in Figure 12 results are displayed in a bar chart in terms of percentage of the total number of online consumers, while in Figure 13 the same results are illustrated in boxplots[1], really good to have a more comprehensive interpretation of the data.

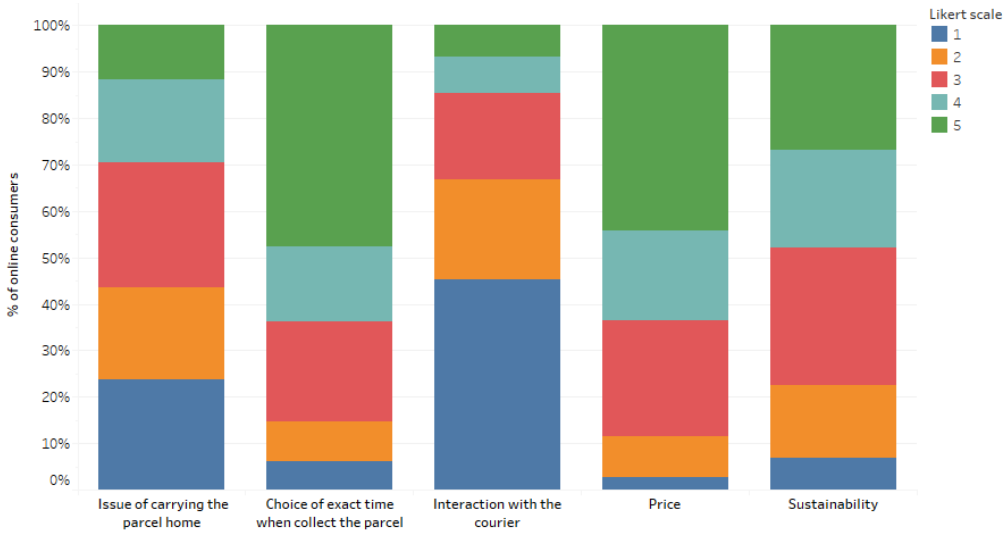

Figure 12: Bar chart- Factors affecting the choice of delivery service

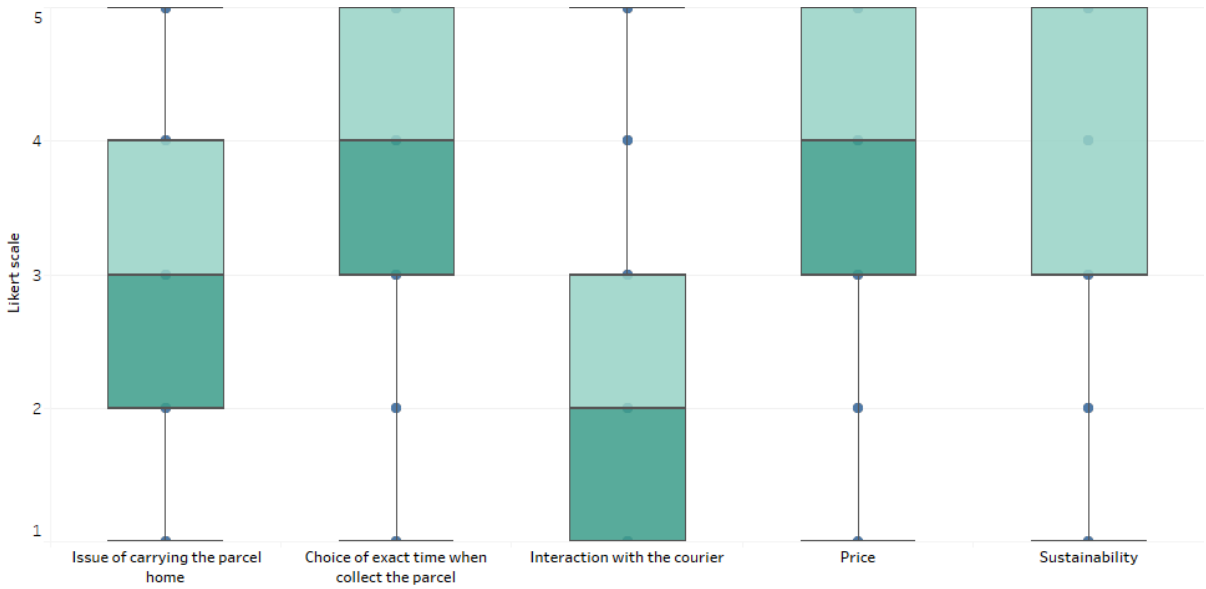

Figure 13: Boxplot - Factors affecting the choice of delivery service

[1] Boxplot: it is a standardized way of displaying the dataset based on five indicators (the minimum, the maximum, the sample median, and the first and third quartiles).

➢ *Problem to carry the parcel from the delivery point to home*

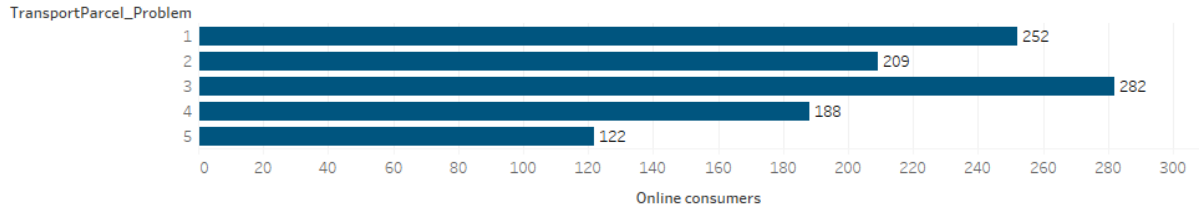

Figure 14: Evaluation by online consumers - problem to carry the parcel

Evidently, this problem arises only with the new self-collection delivery services offered to customers, like pick-up points and parcel lockers. It represents one of the main drawbacks of those services compared to home delivery, much more convenient from this point of view.

As displayed in Figure 14, the distribution of responses highlights that this factor has not a huge impact on consumers' choice, it is a medium importance factor. Only 10.6 percent of online consumers attributed a 5 on the Likert scale.

The previous considerations are confirmed by the alternative representation of the same data in the boxplot from Figure 13, which highlights that the sample median[2] is equal to 3.

➢ *Possibility to choose the exact time when to collect the parcel*

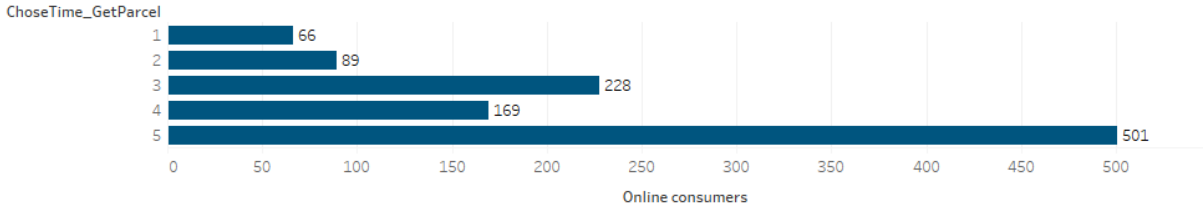

Figure 15: Evaluation by online consumers - Choice the exact time when collect the parcel

The great majority of online consumers consider this factor highly important (Figure 15). It is symptomatic that 501 respondents out of 1053, thus 47.6 percent of them choose the 5th level. It seems that this factor is even slightly more important than the price of the service (the other really important aspect) (Figure 12). This result seems to underline a customer need that corresponds with one of the strengths of parcel locker delivery solution, thus a promising outcome for the future implementation of this innovative service.

[2] Median: is the value separating the higher half from the lower half of a data sample, a population or a probability distribution.

This preference is highlighted also by Figure 13, which highlights that the sample's responses are allocated between 3rd and 5th level, with a median equal to 4.

- *Interaction with the courier*

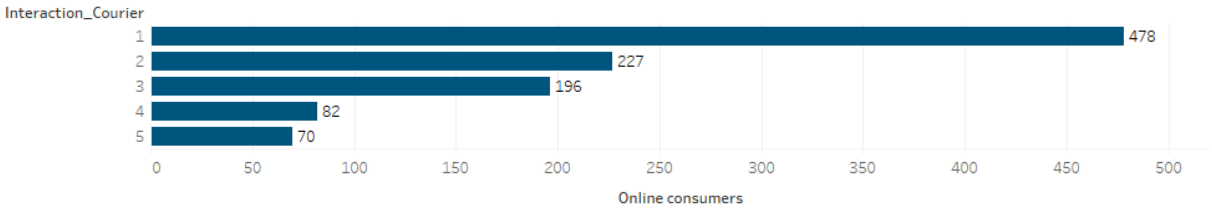

Figure 16: Evaluation by online consumers - Interaction with the courier

It looks clear that interacting with the courier (physical interaction) is not really important to customers. About 67 percent of online consumers rated this factor below 3 (Figure 12). As we can see from Figure 13, the "interaction with the courier" seems to be the least important factor for online consumers. This is, of course, encouraging for the adoption of the innovative last-mile delivery technologies from consumers that are characterized by lack of physical interaction with the courier.

- *Price of the delivery service*

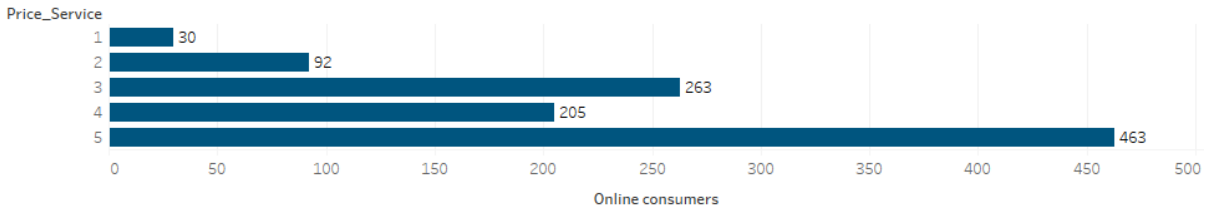

Figure 17: Evaluation by online consumers - Service price

As expected, the price is a very important factor for consumers when it comes to choosing the delivery service. As stated before, together with the possibility to choose the exact time when to collect the parcel, it is the most important factor (Figure 13). About 44 percent of online consumers rated the price with the maximum score equal to 5 (Figure 12).

The outcome is in line with findings from Lemke et al. (2016), who concluded that the price is the most important criterion in selecting the service provider.

According to Allen et al. (2018), there is a mismatch between what consumers are willing to pay for the delivery and the cost of providing the delivery service. This seems to be one of the main reasons why achieving good profitability with e-commerce is really challenging for logistic service providers and retailers. Usually, many retailers choose not to price explicitly the delivery services offered for online shopping orders, while they prefer to incorporate it in

the final product price. In this way, however, consumers are not aware of the delivery service price, being unable to make a comparison between different solutions. Moreover, this makes them perceive the delivery cost in some way non-existent and their service level expectations more and more challenging, which retailers strive to fulfil in order to maintain the market share and stay ahead of competitors. Assuming to change this situation and reveal the delivery prices, it is symptomatic that 83% declared they would choose the cheapest delivery option and only the remaining 17% would be willing to pay more for home delivery. Moreover, 81% stated that increased delivery or collection costs would put them off ordering online (Allen et al., 2018).

- *Sustainable impact of the delivery solution*

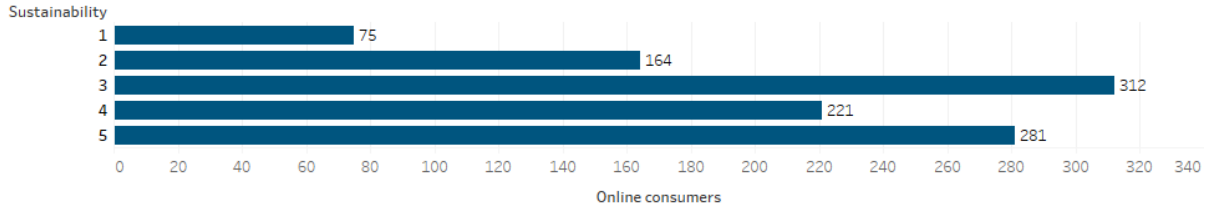

Figure 18: Evaluation by online consumers - Sustainability

From Figure 13, we can notice that the median is equal to 3. However, about 48 percent of respondents scored the sustainability aspect of the delivery solution above 3 (Figure 12). Again, this outcome is positive when estimating the potential of innovative delivery solutions (such as the parcel locker), because the focus on sustainability is one of the reasons why stakeholders are working on their implementation.

Moreover, the results are in line with other studies. According to Osservatorio eCommerce B2c (2019), young Italian online consumers started weighing much more the sustainable aspects when purchasing online. 39 percent of those between 16 and 24 declared to prefer ordering products with sustainable packaging.

4.1.2 Inference statistics

As previously stated (2.2.1), the choice of the best approach to analyse data was based on the literature review, which pointed out the logistic regression as the best-suited methodology.

In order to differentiate respondents between e-shoppers and in-store shoppers, a vector has been created as follows 1 = “e-shopper”, 0 = “in-store shopper”. In order to answer the RQ1, this vector has been considered as the dependent variable, while all the socio-economic characteristics (Part 1 of the survey) have been considered as independent variables.

Before running the logistic regression to investigate what variables are significant in explaining online consumer's characteristics, a variable inflation test has been performed to make sure there is no multicollinearity among the independent variables. The test is based on Variance Inflation Factor (VIF), which estimates how much the variance of a coefficient is "inflated" because of linear dependence with other predictors.

In literature, academics differ on how high the VIF must be to constitute a problem. We followed a rule of thumb commonly used which considers that there is high multicollinearity between variables when VIF is above 10.

After making sure the lack of high multicollinearity between the variables involved in the model, we run the logistic regression. More specifically we run a weighted logistic regression. We applied relative weights to the variable "Gender", being aware of the disproportion between males and females in the sample, in order to balance them and make the sample more representative of the actual population in the metropolitan city of Turin (Males = 48.35 %, Females = 51.65 %). This is a widely used methodology to convey an approximate sense of the precision of sample statistics.

In Figure 19 it is shown on the left the disproportion between males and females before weighting the cases, taking as discriminator the output ("online shopper" = 1; "in-store shopper" = 0), and the balanced ratio representing the overall population on the right.

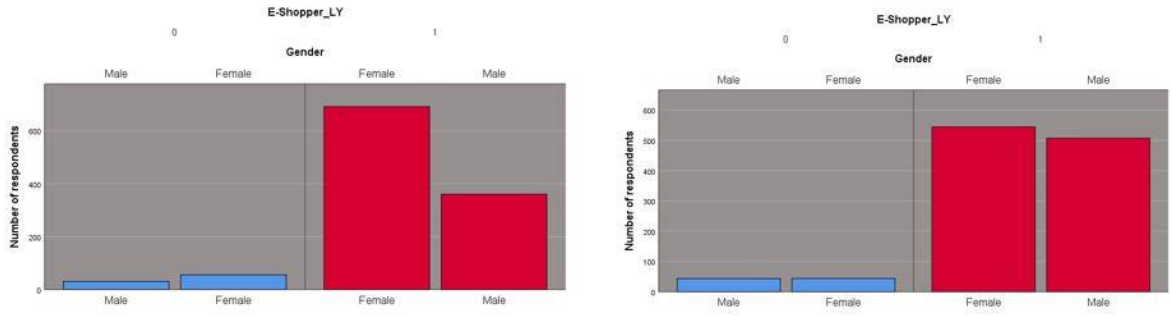

Figure 19: Gender disproportion balanced by weighting cases

We applied relative weights to cases because the two clusters of males and females were large enough to be statistically representative of the population with a 95% confidence level and a 5% margin of error.

4.1.2.1 Logistic regression

Variable	ß	Exp(ß)	S.E.	Wald	Sign.
Male	-.421	.656	.263	2.552	.110
18-30					
31-50	-.929	.395	.760	1.493	.222
51-65 (**)	-2.289	.101	.758	9.122	.003
Over 66 (**)	-2.924	.054	.983	8.847	.003
Secondary school					
High school	.043	1.044	.495	.007	.931
Bachelor's degree	.134	1.144	.667	.041	.840
Master's degree	-.329	.720	.525	.392	.531
Post-graduate specialization	.315	1.370	.716	.193	.660
PhD	1.014	2.757	1.018	.993	.319
Live alone					
1 person	-.107	.899	.347	.095	.758
2 people	.148	1.160	.360	.170	.680
3 people (**)	1.440	4.220	.484	8.838	.003
4 people	.320	1.377	.486	.434	.510
More than 4 people	18.178	78415877.514	5554.330	.000	.997
Student					
Employed	-.903	.405	1.212	.556	.456
Unemployed (*)	-2.689	.068	1.197	5.043	.025
Retired	-.438	.645	1.360	.104	.747
No income					
Less than 1000 € (*)	-2.088	.124	.956	4.766	.029
1000 – 1500 €	-.875	.417	1.009	.752	.386
1500 – 2000 €	-1.295	.274	1.003	1.667	.197
2000 – 2500 €	-.864	.421	1.000	.746	.388
More than 2500 €	-.614	.541	1.054	.340	.560
No one (by foot)	-.027	.973	.294	.008	.927
Public transport	-.259	.772	.284	.834	.361
Bike	.170	1.186	.371	.211	.646
Motorbike	.110	1.117	.643	.030	.864
Car	.281	1.325	.287	.962	.327
Car sharing	17.891	58880552.043	5391.351	.000	.997
Bike sharing	.300	1.350	.798	.142	.707
Electric kick scooter	17.636	45642513.371	11432.813	.000	.999
Less than 1 hour online					
1 – 3 hours online	.445	1.560	.325	1.871	.171
3 – 6 hours online	.290	1.337	.361	.647	.421
6 – 10 hours online	.566	1.761	.480	1.390	.238
More than 10 hours online	.278	1.320	.891	.097	.756
Hours Out	-.005	.995	.056	.007	.932
(Constant) (***)	5.525	250.983	1.346	16.851	.000

#p < 0.10, *p < 0.05, **p < 0.01, ***p < 0.001

Table 11: Logistic regression: who is the online consumer?

The results of the logistics regression are shown in Table 11.

SPSS software has been used to determine the significance and the impact of predictor variables on the output. For the category variables encoded in dummy variables, the reference categories are: 18-30 (Age), Secondary school (Education), Live alone (Tenants), Student (Job), No income (Income), Less than 1 hour (Hours online). The Enter procedure has been implemented since it provided the best goodness of fit for the model. Specifically, R-squared of Nagelkerke is 0.264 and the model stands the Hosmer-Lemeshow's test, with a significance level of 0.304.

As we can notice from Table 11, the gender of consumers seems not to be significant to explain their intention to purchase online. This result is in line with the findings from other studies from the past (Soopramanien & Robertson, 2007; Forsythe & Shi, 2003; Jarvenpaa & Toad, 1996).

The age results to be highly significant on the output, specifically to what concerns the age range 51-65 and over 66. Both are negatively correlated with the intention to purchase online. Hence, the older the consumers are, the less likely they will purchase online. This is in line with the outcome of the great majority of articles highlighted in paragraph 2.2.1, which describe the typical online shopper to be young.

Unlike the widespread opinion according to which the typical e-shopper is well educated, in this case, education level results not to be significant to explain attitude towards online shopping, in line with findings from Jarvenpaa & Toad (1996). This might be a consequence of the widely discussed pervasive diffusion of the Internet and consequently e-commerce, among all strata of society.

Findings related to the number of tenants reveal that consumers who live with two or more people are more likely to buy online than those living alone. More specifically, only living with 3 people seems to have a significant impact on the decision to purchase online. This is partly in line with the outcome of the research work carried out by Xiao et al. (2018), who stated that married people are those who shop more frequently and spend more online. In this regard, the mentioned variable coincides more than likely with the scenario of two married individuals with two children.

Being unemployed seems to reduce significantly the intention to purchase online, which is well aligned with conclusions from Clemes et al. (2014**)** and Farag, Weltevreden, et al. (2006)**,** who noted that occupation has a positive impact on e-commerce adoption.

In accordance with the widespread outcome from the reviewed articles, it results that having a low income, more specifically less than 1000 €, has a significant negative on consumer's intention to buy online (Beckers et al., 2018; Clarke et al., 2015; Soopramanien & Robertson, 2007; Farag, Krizek, et al., 2006; Farag et al., 2007; Forsythe & Shi, 2003; Crocco et al., 2013; Raman & Annamalai, 2011).

Not using a private means of transport, hence moving by foot or with public transport seems to be negatively correlated with the output, while using a private means of transport results to be positively correlated. Nevertheless, all these variables are far from having a significant impact on the output.

Similarly, also the hours online and the hours away from home turn out not to have a significant influence on consumer's attitude towards e-shopping.

4.2 USABILITY OF THE PARCEL LOCKER FROM CUSTOMER PERSPECTIVE

As described in the beginning, the last part of the questionnaire has been structured on gathering important information about consumers' opinions related to the parcel locker solution. This paragraph involves all relevant insights and outcomes of analysis related to this innovative delivery service.

4.2.1 Descriptive statistics

First of all, we differentiated consumers according to two discriminant factors: their current experience on collecting parcels from parcel lockers (if they already used it or not) and their willingness to use it in the future. In Table 12, the results of this first analysis are illustrated.

	N (Total = 1053)	% of total
I have tried it and I would like to use it again	257	24.4
I have tried it and I would not like to use it again	11	1.0
I have not tried it and I would like to use it	731	69.4
I have not tried it and I would not like to do it	54	5.1

Table 12: Experience of e-consumers with parcel locker solution

When looking at the results of the survey is interesting to underline a symptomatic result: the very high percentage of e-shoppers who potentially might take into consideration in the future to adopt the parcel locker as a delivery solution.

On the one side we can notice that, among those who already collected a parcel through this solution, 257 out of 268 (96%) would be willing to do it again. This remarks the very high customer satisfaction related to this solution, with only 4 percent of consumers that regretted their choice.

On the other side, we must underline the great potential of this innovative delivery service even among those who have not tried it yet. They represent the majority of the population according to Table 12 and these results should be encouraging for stakeholders investigating lockers' potential.

To conclude, it is symptomatic that potentially 93.8 percent of the sample might be parcel locker users in the next future.

In the next table (Table 13), the main socio-economic differences between potential adopters and non-adopters are shown.

Variable	Characteristics	Potential adopters		Non-adopters	
		N (988)	%	N (65)	%
Gender	Male	343	95.0	18	5.0
	Female	645	93.2	47	6.8
Age	18-30	301	97.1	9	2.9
	31-50	395	92.7	31	7.3
	51-65	276	92.2	20	6.8
	Over 66	16	76.2	5	23.8
Education level	Secondary school	40	90.9	4	9.1
	High school	313	93.4	22	6.6
	Bachelor's degree	193	96.5	7	3.5
	Master's degree	308	93.05	23	6.95
	Post-graduate specialization	83	93.3	6	6.7
	PhD	51	94.4	3	5.6
Tenants	Live alone	129	92.8	10	7.2
	1 person	211	92.1	18	7.9
	2 people	262	96.7	9	3.3
	3 people	266	94.7	15	5.3
	4 people	82	88.2	11	11.8
	More than 4 people	38	95.0	2	5.0
Job	Student	239	96.8	8	3.2
	Employed	696	93.2	51	6.8
	Unemployed	27	93.1	2	6.9
	Retired	26	86.7	4	13.3
Income	No income	205	96.7	7	3.3
	Less than 1000 €	92	94.85	5	5.15
	1000 – 1500 €	213	94.25	13	5.75
	1500 – 2000 €	235	92.2	20	7.8
	2000 – 2500 €	145	90.1	16	9.9
	More than 2500 €	98	96.1	4	3.9
Means of Transport Used	No one (by foot)	303	94.39	18	5.6
	Public transport	529	95.3	26	4.7
	Bike	141	93.4	10	6.6
	Motorbike	33	94.3	2	5.7
	Car	470	93.1	35	6.9
	Car sharing	37	90.2	4	9.8
	Bike sharing	36	97.3	1	2.7
	Electric kick scooter	7	87.5	1	12.5
Hours Online	Less than 1 hour	125	94.0	8	6.0
	1 – 3 hours	494	93.6	34	6.4
	3 – 6 hours	255	94.8	14	5.2
	6 – 10 hours	97	93.3	7	6.7
	More than 10 hours	17	89.5	2	10.5

Table 13: Sample distribution according to willingness to adopt parcel locker solution

Looking at the percentage of non-adopters, it seems there is no remarkable difference in the attitude towards parcel locker between males and females.

While e-consumers between 18 and 30 years old have the highest willingness to adopt this innovative delivery service (only 9 out of 310 stated not to take into consideration this solution), older respondents reveal to have a different attitude, especially 23.8 percent of those over 66 do not take into consideration to use the parcel locker.

Even though if there is not any significant difference in non-adopters' share according to education level, online consumers without a high school diploma are those more diffident to this solution. Similarly, to what concerns the household situation, only respondents living with 4 people show less willingness towards the parcel locker.

In line with findings related to "Age", on the one side, students are those with the highest share of potential adopters (96.8%), on the other side retired people are those with the least (86.7%).

It is interesting to mention a general negative correlation between income and parcel locker adoption for categories from "No income" (only 3.3% of non-adopters) to income range 2000-2500 € (9.9% of non-adopters). This trend does not apply to people with the highest income, with more than 2500 €: they reveal to have a more positive attitude towards the delivery solution under consideration (only 3.9% of non-adopters).

In relation to the means of transport used, there is a higher share of non-adopters among those using car-sharing (9.8%). This might be due to the rising cost of the mobility service while the consumer stops to collect the parcel.

Moreover, it seems that people spending the most hours online have the least intention to adopt parcel lockers (10.5% of non-adopters). However, critically looking at numbers, this means only two non-adopters out of nineteen. Apart from that, there is not any important evidence of what concerns the relation between hours spent online by consumers and the output.

As we can see from Figure 20, the same happens for the variable "Hours Out": it seems there is not any relevant trend in explaining the output variable. The highest share of non-adopters spends 6 hours away from home.

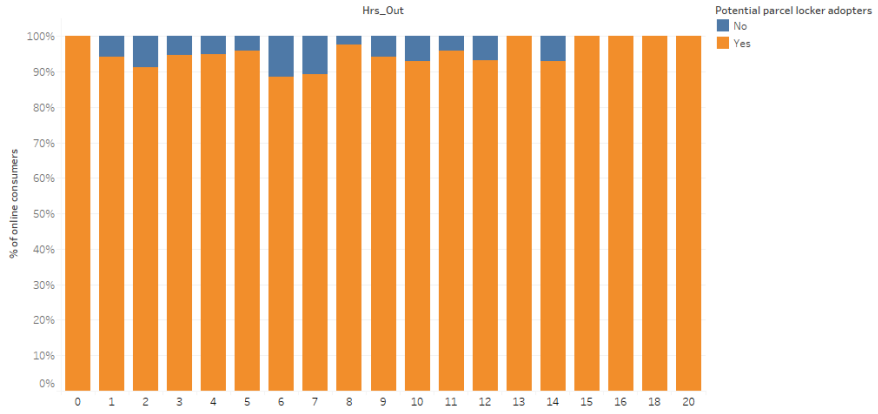

Figure 20: Relationship between hours away from home and intention to adopt parcel locker

Reasons not to adopt parcel locker as delivery solution

As above mentioned, the great majority of online shoppers expressed curiosity and a positive attitude towards this unattended delivery solution. However, a more in-depth analysis of reasons why others disregard this service is following.

From the analysis (Figure 21), it came up that most of the respondents (56%) do not consider the parcel locker a comfortable delivery solution. They pointed out that they prefer receiving the parcel to their homeplace, not willing to move to collect the parcel. Some of them stated that if they had to move, they would prefer to buy the product in a store.

The second main reason why e-consumers are not disposed towards this delivery solution is that they do not trust it (26%). They highlighted their concern about the risk of theft and the risk of damage to the parcel. The remaining respondents did not provide a valid motivation, just general reasons such as “I do not like this solution” or “I am not interested in this solution”.

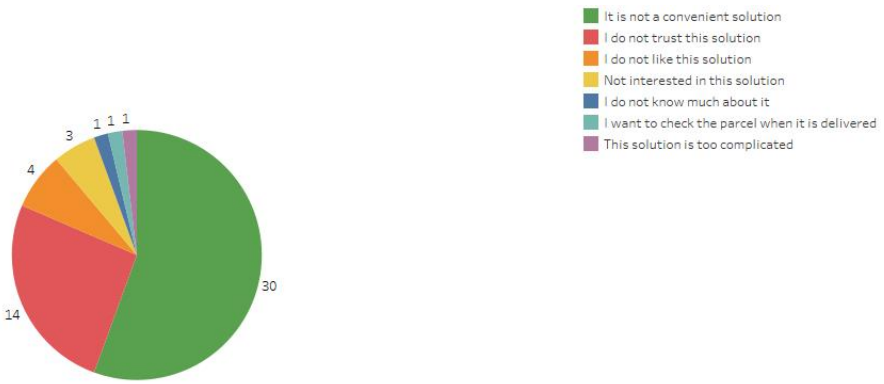

Figure 21: Reasons from non-adopters about not considering parcel locker solution

Furthermore, through the questionnaire we collected the location preferences among those willing to adopt the parcel locker as delivery solution (Table 14).

	N (Total = 988)	% of the total
Close to home	791	80.1
Close to the workplace	381	38.6
In front of a supermarket	366	37.0
At a gas station	56	5.7
In a parking area	38	3.8
In a shopping centre	219	22.2
In a university campus	164	16.6
Other	19	1.9

Table 14: Location preferences for parcel lockers

To what concerns the preferred location for a parcel locker, there is no doubt that consumers would like to have it available close to home (80.1%). This result is very much in line with findings from the research study conducted by Lemke et al. (2016) on a sample of respondents in Poland. He pointed out that 79 percent out of the total of 2933 respondents declared their preference for a parcel locker located close to home.

The second most preferred location for a locker is close to the workplace. Weltevreden & Rotem-Mindali (2009) pointed out that most online purchases are delivered at home or work (78%) because this does not require personal travel by consumers to collect the parcel. The outcome seems to emphasize that the majority of consumers would be willing to adopt the parcel locker and exploit the benefits of this innovative solution. However, they would prefer not to change their routine.

Nevertheless, a good share of respondents is considering also to integrate the parcel collection in their daily routine for example while performing another activity, such as doing grocery. The favourite locations are close to a supermarket and in a shopping centre. In a similar study, Oliveira et al. (2017) asked respondents in Belo Horizonte (Brazil) to state their location preference without providing them with the choices “Close to home” and “Close to the workplace”. Respondents ranked the supermarket and the shopping centre as their favourite locations by far, hence the results are very much in line.

Finally, consumers do not seem enthusiastic about parcel lockers located in a parking area (3.8%) or at a gas station (5.7%). This might be due to their concern related to safety risk when collecting the parcel.

To complete the analysis related to parcel locker's location preferences, we asked respondents to state the how many minutes they would be willing to deviate from usual daily trips (home-workplace or home-university, for instance) to collect a parcel in a locker box.

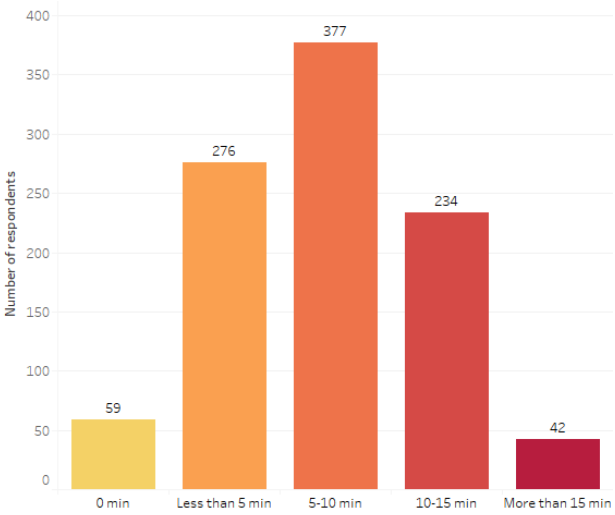

Figure 22: Maximum deviation (in minutes) to collect a parcel in a locker box

Of course, the distance covered during that time depends on the means of transport adopted, it changes considerably between moving on foot or by car, for example. Nevertheless, this data is a good indicator of the consumers' elasticity towards this unattended parcel delivery service.

We can notice from Figure 22, that out of the 988 potential adopters only 6.0 percent are not willing to deviate at all, which means that they would like to have the parcel locker right in front of their home place or workplace, for example, not to do any additional effort. On the other side, the majority of e-consumers (38.2%) are disposed to deviate between 5 to 10 minutes to collect their parcel.

4.2.1.1 Discriminant features of delivery services

Before performing a more in-depth analysis of what are the discriminant factors that lead consumers to adopt parcel locker solution, it is interesting to highlight how the factors described in the beginning (4.1.1.2) are perceived differently by potential adopters of locker box solution in comparison with the others (Figure 23 and Figure 24). The factors under consideration are the same above mentioned:

- Problem to carry the parcel from the delivery point to home
- Possibility to choose the exact time when to collect the parcel
- Interaction with the courier
- Price of the delivery service
- Sustainable impact of the delivery solution

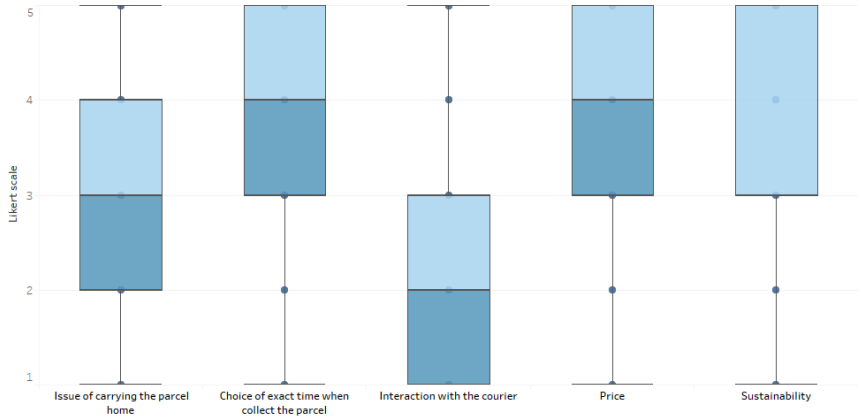

Figure 23: Discriminant features of delivery services - potential adopters of parcel locker

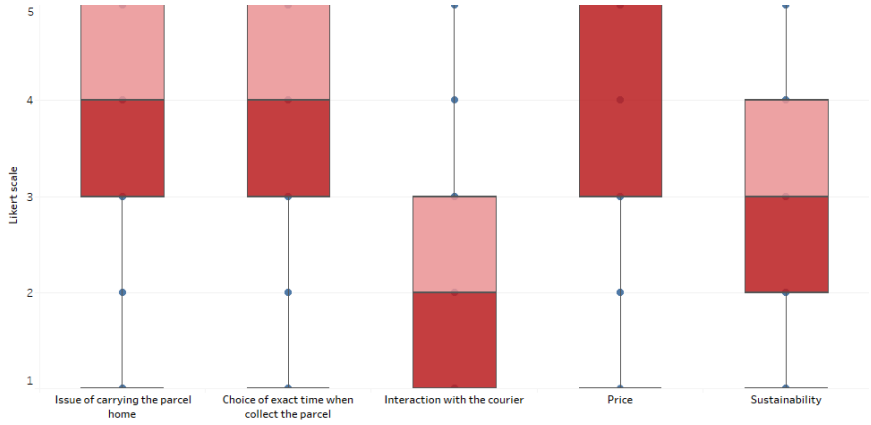

Figure 24: Discriminant features of delivery services – non-adopters of parcel locker

It looks clear that among online consumers, the two groups with different opinions towards parcel locker, think differently.

Those not willing to use parcel locker, weight more the issue related to carrying the parcel on their own (median is equal to 4, and most of the respondents scored this problem between 3 and 5) (Figure 24). While, Figure 23 shows, as expected, that people with a positive attitude toward parcel locker are less affected by the problem to carry the parcel.

It results that the physical interaction is not important; this is the least important factor for both groups. Besides, the possibility to choose the exact time when to collect the parcel is perceived in the same manner by the two groups of e-consumers. It seems to be a really important aspect. Since this delivery service's feature is one of the strengths of locker boxes, the result we got is quite in line with expectations for potential adopters, who might like the unattended solution for this reason. On the contrary, unexpected results for non-adopters underline that they really appreciate this feature in parcel delivery service, but they probably still do not want to use the parcel locker for other reasons which prevail over this one.

As expected, the price of the service is important for all consumers. However, it appears to be slightly more important for parcel locker's non-adopters. More than 50 percent of them gave to "Price" 5 points on the Likert scale, thus the median is 5. While among potential users, "only" 43.4 percent of consumers ranked this aspect with the highest score.

Furthermore, an evident difference results in the opinion related to the importance of the delivery service's sustainability. As discussed in the first chapter, parcel locker is an environmentally friendly solution for several reasons. Consequently, potential adopters seem to weight much more this aspect in the choice of the delivery solution than non-adopters. Among the former ones, 78 percent ranked it with a score of 3 or above; while among the latter ones only 67.7 did the same.

So far, we analysed five explanatory factors mainly related to differences between the traditional home delivery and the innovative delivery methods (Self-collection delivery services such as Pick-up Points and Locker boxes). To make a step forward, we identified four discriminant factors of the two self-service delivery solutions just mentioned, to better understand how they are perceived by potential adopters and non-adopters of the unattended solution. The four factors under consideration are:

- Privacy in collecting the parcel
- Parcel collection 24h/24h
- Safety risk
- Technological barrier

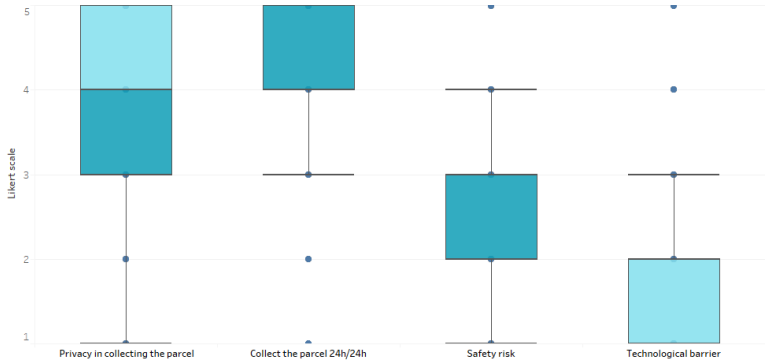

Figure 25: Specific factors related to parcel locker solution - potential adopters

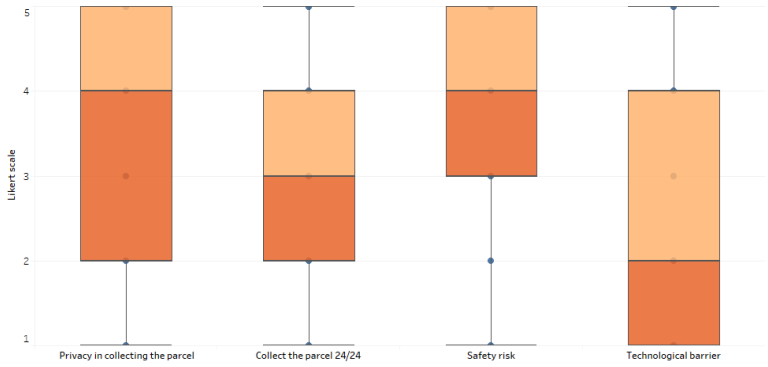

Figure 26: Specific factors related to parcel locker solution – non-adopters

The first aspect related to privacy refers to the consumer's preference not to make others aware of their online purchasing activity. It is more difficult to keep discretion when you receive your parcel to your home place or when you self-collect it in a Pick-up Point like a post office. It is in some way inversely correlated with the previous factor "Interaction with the courier" and it is in general about not having interaction with people when collecting the parcel, in order to keep confidentiality. As we have seen in the beginning, this aspect is one of the strengths of an unattended delivery solution like the parcel locker. In fact, from the comparison between Figure 25 and Figure 26, it results that potential adopters appreciate more this aspect than those who do not like automated locker boxes.

Similarly, the possibility to collect the parcels around the clock, even during the night, is one of the biggest motives of differentiation from all the other delivery services. As a confirmation, potential adopters of this unattended solution value much more this opportunity: it seems to be the most valued factor. Respondents rated it almost only with scores equal to 4 and 5 on the five-level Likert scale. More specifically, the median is equal to 5, hence more than 50 percent assigned the highest score. On the contrary, it turns out that for non-adopters this opportunity

is less relevant, maybe simply because their daily routine does not prevent them from collecting the parcels during the day, during the usual opening hours of the shops. The median is equal to 3, thus at least fifty percent of non-adopters value this feature 3 or less.

To what concerns the safety risk, it might be outlined as one of the drawbacks of locker boxes. They are installed on the streets and this fact might prevent people from adopting this solution because concerned about the risk of theft while collecting the parcel, especially if it is about a high-value item. It must be said that parcel lockers are provided with cameras to reduce this risk and to avoid acts of vandalism, the two main reasons why non-adopters do not trust this solution. As confirmation, we can see that the safety risk is quite prominent for them. The median is equal to 4 and about 50 percent scored it with a 5 on the Likert scale (Figure 26). On the other side, most of the potential adopters ranked this aspect between 2 and 3 (Figure 25), almost nobody gave it a score equal to 5 (it is an outlier). This comparison is symptomatic to highlight extremely different attitudes by consumers.

To conclude, the technological barrier refers to the utilization of the locker box. Being automated, it needs the customer to interact with a touch screen either to enter an alpha-numeric code or to scan a QR code received by e-mail. This procedure requires consumers to be comfortable with this kind of technology. However, the potential users of locker boxes are online consumers, people used to with Internet and e-shopping, thus it should not represent a relevant obstacle. As we can notice from the comparison between Figure 25 and Figure 26, parcel lockers' potential adopters do not perceive the technological innovation as a barrier. It is indicative that the median is equal to 1, meaning that at least 50 percent of them gave to this factor a score equal to 1. On the contrary, non-adopters are more concerned about the technological requirements of the solution under consideration.

4.2.2 Inference statistics

In order to answer to RQ2, we performed another logistic regression since the output is again dichotomous (0 = "I would not be willing to adopt or use again the parcel locker", 1 = "I would be willing to use the parcel locker as delivery solution"). The analysis involves only the online shoppers, thus 1053 respondents. As previously, we balanced the disproportion between males and females applying relative weights before running the logistic regression.

4.2.2.1 Logistic regression

Variable	ß	Exp(ß)	S.E.	Wald	Sign.
Male	.487	1.627	.301	2.609	.106
18-30					
31-50	-.825	.438	.858	.924	.337
51-65	-1.046	.351	.887	1.392	.238
Over 66 (*)	-3.649	.026	1.472	6.145	.013
Secondary school					
High school	.272	1.312	.653	.173	.677
Bachelor's degree	.536	1.710	.759	.499	.480
Master's degree	.212	1.236	.662	.103	.749
Post-graduate specialization	.361	1.434	.786	.211	.646
PhD	.653	1.921	.863	.572	.449
Live alone					
1 person	-.136	.873	.453	.090	.764
2 people	.756	2.131	.526	2.069	.150
3 people	.221	1.247	.468	.223	.637
4 people (*)	-1.001	.368	.489	4.184	.041
More than 4 people	.136	1.146	.814	.028	.867
Student					
Employed	.273	1.314	1.171	.054	.816
Unemployed	.934	2.544	1.270	.540	.462
Retired	2.580	13.203	1.761	2.147	.143
No income					
Less than 1000 €	.039	1.040	.810	.002	.962
1000 – 1500 €	.045	1.046	.947	.002	.962
1500 – 2000 €	-.629	.533	.917	.472	.492
2000 – 2500 €	-.656	.519	.940	.487	.485
More than 2500 €	.567	1.762	1.060	.286	.593
No one (by foot)	-.135	.873	.335	.163	.686
Public transport	.433	1.542	.323	1.799	.180
Bike	-.290	.748	.376	.597	.440
Motorbike	-.018	.982	.698	.001	.980
Car	.095	1.100	.336	.081	.776
Car sharing (#)	-1.114	.328	.573	3.778	.052
Bike sharing	1.228	3.414	1.198	1.051	.305
Electric kick scooter	-1.558	.211	1.000	2.425	.119
Less than 1 hour online					
1 – 3 hours online	-.620	.538	.484	1.636	.201
3 – 6 hours online	-.338	.713	.536	.397	.529
6 – 10 hours online	-.497	.608	.588	.715	.398
More than 10 hours online (#)	-1.500	.223	.849	3.123	.077
Hours Out	.077	1.080	.056	1.865	.172
(Constant) (*)	2.691	14.739	1.123	5.741	.017

#p < 0.10, *p < 0.05, **p < 0.01, ***p < 0.001

Table 15: Logistic regression: who is willing to adopt parcel locker as delivery solution?

Again, SPSS software has been used for the analysis, implementing the Enter method. For the category variables encoded in dummy variables, the reference categories are: 18-30 (Age), Secondary school (Education), Live alone (Tenants), Student (Job), No income (Income), Less than 1 hour (Hours online).

To what concerns the goodness of fit of the model, the Nagelkerke's R-squared resulted equal to 0.127 and the model passed the Hosmer-Lemeshow's test with a significance of 0.858.

By testing variables on a 95% confidence level, the outcome of the analysis draws attention on two variables. The most significant variable seems to be "Over 66" (Age), which is negatively correlated with the intention to adopt parcel locker as a delivery solution. This means that the older group of respondents point out a significantly different attitude towards parcel lockers when compared with the youngest (reference category is 18-30). Similarly, the other two categories (31-50 and 51-65) are less inclined to this delivery solution than the youngest ones, but not in a significant manner. These results are in line with expectations since older people are generally less receptive to trying new technologies. Moreover, they are consistent with findings from Lin et al. (2019), Lachapelle et al. (2018) and Lemke et al. (2016), who stated that automated locker boxes are preferred by younger people. Besides, Lemke et al. (2016) defined the most likely age range of parcel locker users (25-34), which is very close to the output of our analysis (18-30).

The other significant variable is "4 people" (Tenants). It seems that online consumers who live with 4 people have a significantly negative attitude towards parcel locker adoption if compared to those living alone (reference category). This interesting outcome may be a consequence of the different risk of failed delivery faced by the two categories of customers: an online consumer living alone probably is more inclined to adopt parcel locker because (if he works or goes to university) during the day there is nobody at home, thus his situation and daily routines are not in line with home delivery. On the contrary, the scenario is different for a worker/student living with many people (specifically 4 people): it is likely that even if the one who placed the order is not at home, there will be someone living with him to pick the parcel up and avoid the failed delivery. This fact presumably lowers consistently the intention to adopt self-collection delivery services such as the parcel locker, because consumers can exploit the convenience of home delivery solution.

If we extend the confidence level to 90%, the other two variables result to be significant. The first is related to the means of transport used. It seems that using car-sharing for daily trips has

a negative effect on consumers' intention to use automated locker boxes. This is in line with expectations because, more likely, individuals paying for a car-sharing are not willing to stop and collect their parcel on the street, since this would increase the cost of the mobility service the consumer is paying for. The other significant variable seems to be related to the hours spent online. Spending 10 or more hours online has a significant negative impact on the willingness to adopt a parcel locker solution. This might be due to a specific lifestyle of consumers in this category. For example, consider a scenario where people work from home and spend several hours online, they would prefer the home delivery, more convenient and in line with their lifestyle.

Furthermore. it is important to mention that all the other variables are not statistically significant on the output; this fact is interesting. According to the analysis, gender does not affect the intention towards this delivery solution and this is line other two recent articles on the same topic (Lin et al., 2019; K.F. Yuen et al., 2018). Similarly, education seems not to be relevant, which is someway unexpected since individuals with higher education could possess more knowledge about parcel locker's functioning and the positive implications on the environment and society. However, the findings are in line with Kum Fai Yuen et al. (2019). To what concerns the income, it is interesting to mention the non-significant effect on customers' intention to use the parcel locker, which differs from the results of other articles (Lachapelle et al., 2018; J.W.J. Weltevreden, 2008; Kum Fai Yuen et al., 2019).

4.3 E-COMMERCE DEMAND AND PARCEL LOCKER UTILIZATION

4.3.1 Estimating e-commerce demand

Before estimating the e-commerce demand in terms of the average number of orders per year and the number of products per order, online consumers' shopping preferences about product categories were explored. The results are displayed in Table 16.

Product category	N (Total=1053)	% of total
Clothes	444	42.2
Jewellery	150	14.2
Food	127	12.1
Furniture	139	13.2
Home Appliances	316	30.0
Consumer electronics	552	52.4
Books, DVDs	673	63.9
Body care products	328	31.1
Toys	245	23.3
Others	117	11.1

Table 16: Product categories purchased online

Considering only the categories that require a physical delivery, it seems that e-consumers mostly buy Books and DVDs, Consumer electronics and Clothes. These findings are very consistent with results from a report carried out by PostNord (2018) and are in line with Morganti et al. (2014), who stated that e-commerce for fashion and entertainment is getting more and more popular in Europe.

Besides that, it results that a considerable share of respondents buys online also products such as Body care products (31.1%), Home Appliances (30%) and Toys (31.1%).

Overall, the results are also quite in line with the recent analysis carried out by Osservatorio eCommerce B2c (2018), who stated that Consumers electronics and Clothing are the two main product categories bought online in Italy and ranked the other categories as follows: Furniture & Home living , Food & Grocery, Publishing, Toys and Beauty Care. They highlighted that Furniture & Home living and Food & Grocery are the two categories facing major growth, respectively +30% and +42%.

As a next step, we asked online consumers to declare the average number of online orders per year and the average number of products involved in each order. The results are displayed in Table 17.

	N	Minimum	Maximum	Mode	Median	Mean	Standard deviation
Orders per year	1053	1	300	10	10	17.74	25.33
Products per order	1053	1	30	1	2	1.91	1.8

Table 17: Average orders per year and products per order

By performing descriptive statistics on the number of orders declared by online consumers, it came out that they place on average 17.74 orders each, per year. However, as we can notice, there is high variability since the minimum is 1 but the maximum number of orders placed is 300. It is also indicative that the median is 10, so fifty percent of consumers are used to place 10 or fewer orders. Figure 27 offers a better insight into this fact, pointing out also that 75 percent of respondents stated that they place a maximum of 20 orders per year. Furthermore, it looks clear the presence of many outliers, which is confirmed also by the remarkable difference between the mean and the median (considering also the limited number of cases in the dataset, the outliers have a higher impact on misleading the mean value). The existence of outliers highlights the presence of a group of a small number of respondents, who place remarkably more orders than most consumers.

Similarly, to what concerns the number of products per year it turned out that on average consumers buy 1.91 products with one order. The median is equal to 2 (is very close to the mean, so outliers have a lower impact), while the mode is 1 product per order. As illustrated by the boxplot in Figure 27, 75 percent of respondents declared to place usually orders with a maximum of 2 products. There are some outliers, some respondents who declared to buy many more products in one time: the maximum is equal to 30.

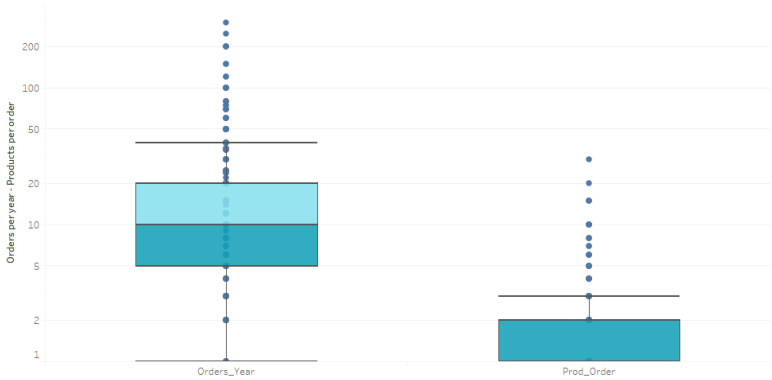

Figure 27: Boxplot - Average number of orders and products per order by online consumers

So far, we have analysed the average number of orders and the number of products per order separately. In this way, it is not possible to draw conclusions on the total amount of products ordered by each consumer yearly. It happens often that items involved in the same order are sent separately, in two different packages. This depends, for instance, on the size of the products or whether the products come from the same distribution centre or not. For this reason, we are more interested in the analysis of the total amount of parcels ordered by each consumer, which is the result of the following formula:

$$Total\ number\ of\ parcels\ per\ year = N°\ orders\ per\ year * N°\ products\ per\ order$$

The total number of parcels ranges from a minimum of 1 to a maximum of 2000. The mean is equal to 36.05 with a standard deviation of 86.77. The median is equal to 18, fifty percent of respondents buy online at most 18 parcels; while the mode is equal to 20 (133 respondents, 12.6 % of online consumers) (Figure 28).

The high value of the standard deviation together with the remarkable difference between the mean and the median, highlight the high variability on the number of total parcels ordered by the sample. There is a small group that orders significantly more than most of the respondents.

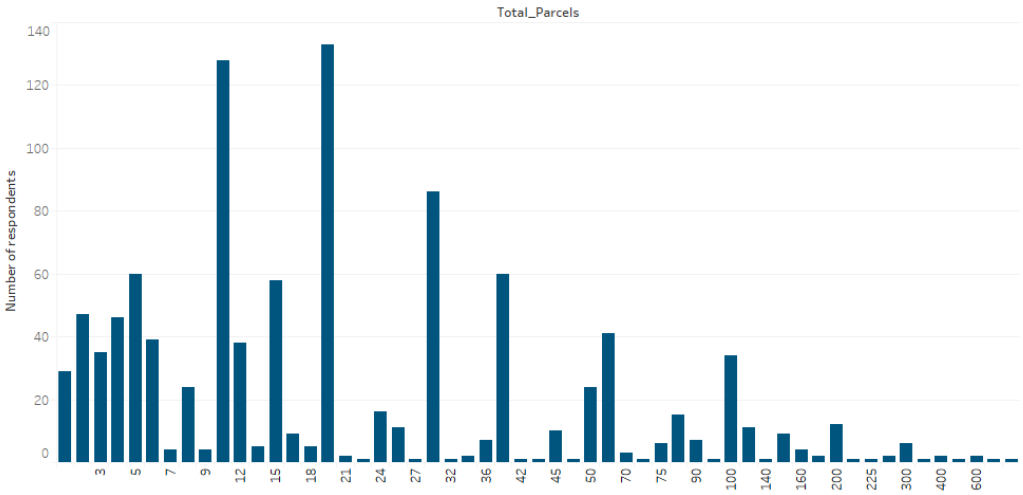

Figure 28: Total parcels ordered online on average by e-consumers

4.3.2 Parcel locker utilization

Respondents who have already utilized the parcel locker have been asked the number of parcels they picked up last year with this solution. To provide a comprehensive view, in Figure 29, it is illustrated the comparison between the total parcels ordered by all online consumers in the

sample and the total number of parcels collected from a parcel locker by current users of locker boxes.

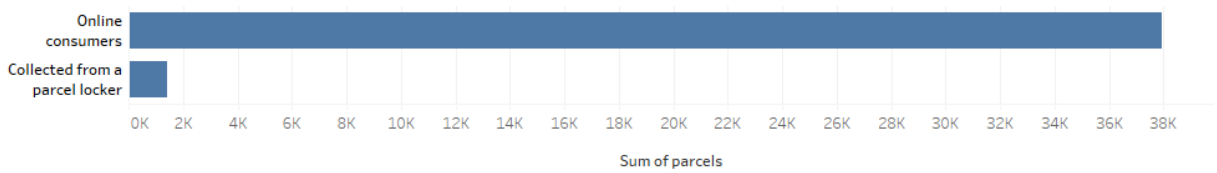

Figure 29: Online consumers – Total parcels ordered vs parcels collected from a locker box

All consumers ordered in total 37958 parcels online, while only 1406 have been collected through a parcel locker (3.7%). This confirms the current low utilization of this solution by the overall population of online consumers. This can be partly due to the reasons extensively explained in the previous chapter; however, it must be said that this solution is not well-established yet in the metropolitan city of Turin. Most likely, with a growing number of lockers boxes in strategic locations around the city, the utilization will grow.

Hence, in order to have a better estimation of current utilization of existent parcel lockers in the metropolitan city of Turin, we took into consideration only parcel locker adopters, those online consumers who already adopted this innovative delivery service. We performed the same comparison between total parcels ordered and those collected from a locker box (Figure 30).

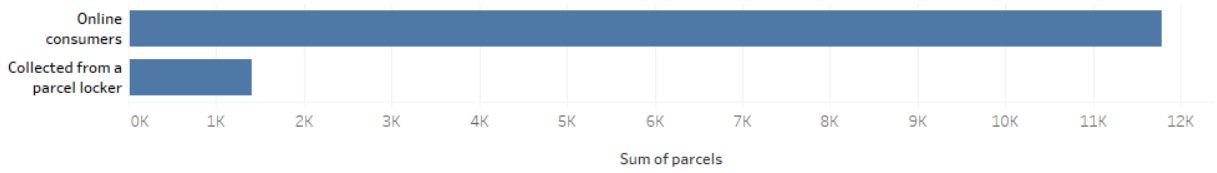

Figure 30: Parcel locker adopters - Total parcels ordered vs parcels collected from a locker box

Of course, the parcels collected from locker boxes remain the same (1406), while the sum of parcels ordered online only by parcel locker adopters is 11793. Among current adopters, the utilization share is now equal to 11.9 %. This is an indicative value, but it is the result of looking at the overall number of parcels, not utilization rate of the single person.

In Figure 30 the comparison we just discussed is displayed on the map. The distribution of total packages purchased online by parcel locker adopters for each postal code is shown in blue, while the sum of parcels collected through a parcel locker is displayed in circles on a colour scale from yellow to red, according to the utilization intensity of the parcel locker (yellow stands for lower utilization, red stands for higher utilization).

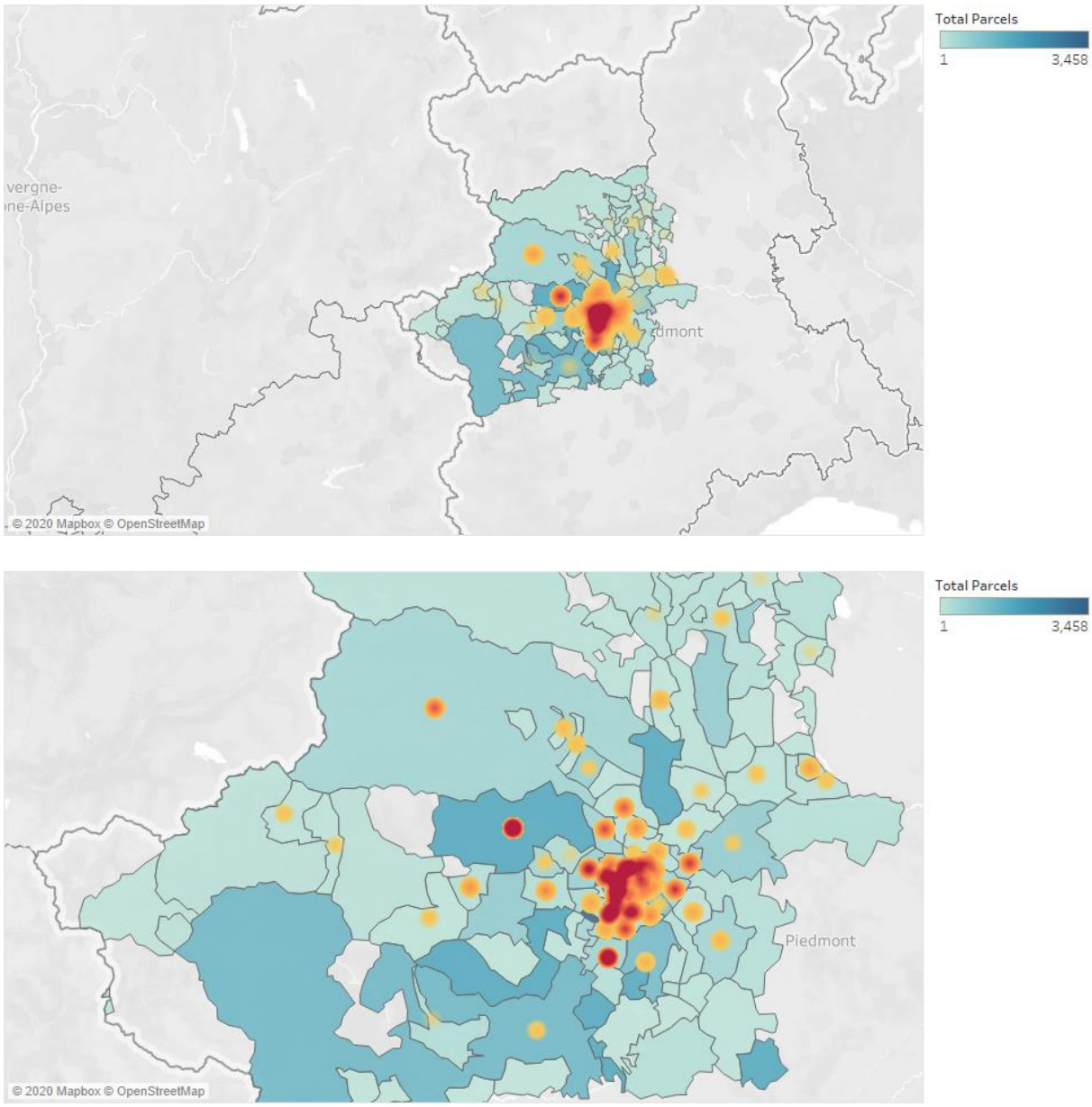

Figure 31: Total parcels compared to parcels collected from a parcel locker – Comprehensive and in-depth picture

As highlighted by the two maps, most of the parcels collected from a locker box has been collected in the urban centre of Turin. This might be due to the fact that a high share of respondents is from Turin. However, it is also indicative of unavailability of parcel lockers outside Torino. For instance, by analysing the locker boxes installed by Amazon (the biggest player in the e-commerce market), it came out that only three automated lockers are currently installed in Turin, which is the biggest urban centre in Piemonte.

In the following analysis, the group under consideration is the same, the current parcel locker adopters. We consider them individually by investigating the number of parcels ordered and collected by each online consumer in the group. As we can notice from Figure 32, the median relative to total parcels is equal to 20, thus this subgroup of online consumers seems to buy a bit more if compared to all online consumers. Moreover, to what concerns the parcel locker utilization, the median of parcel collected is equal to 4, hence at least 50 percent collected 4 parcels, while 75 percent collected maximum 7 in the last year.

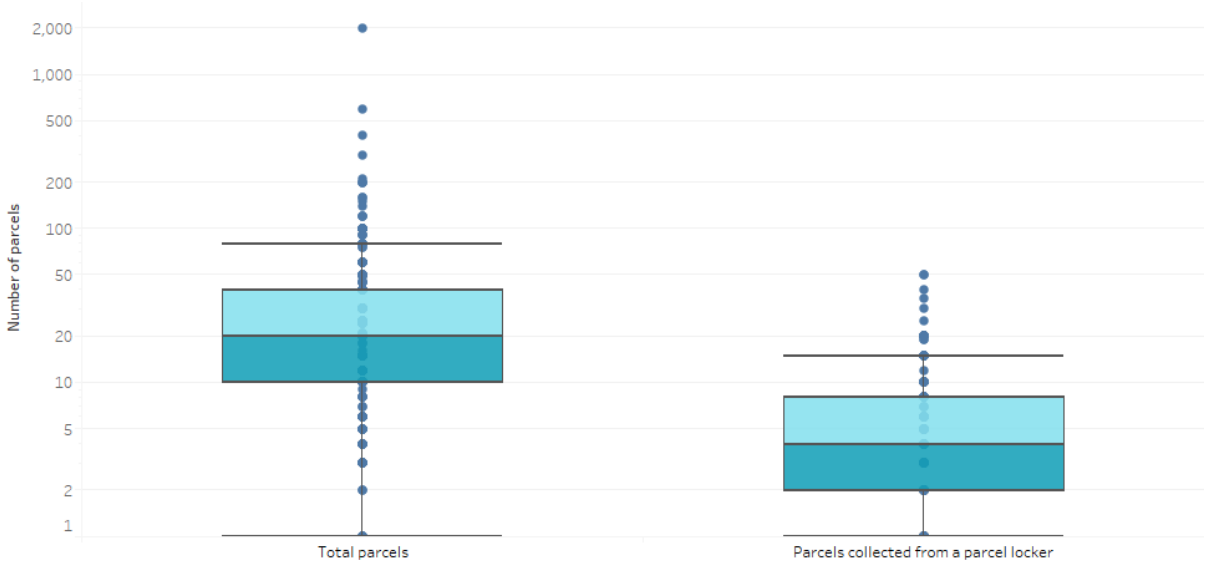

Figure 32: Comparison between total parcels and parcels collected from a parcel locker

To conclude, the individual utilization rate of parcel locker solution for each current user *j* has been calculated as follows:

$$Utilization\ rate_j = \frac{N°\ parcels\ collected\ from\ a\ parcel\ locker_j}{Total\ parcels\ purchased\ online_j}$$

The utilization rate takes values between 0 and 1. Zero stands for no utilization of parcel locker solution; one stands for maximum utilization, meaning that all packages purchased online are collected by addressing this service. To have a better understanding of utilization rates among parcel locker adopters, they are displayed in Figure 33. The results confirm the above-mentioned findings related to low utilization of the unattended delivery service. The minimum is equal to 0.005, while the median is equal to 0.2. This means that out of 10 parcels, at least 50

percent of respondents picked a maximum of 2 parcels up from a locker box. There is only one case with utilization rate equal to 1, it represents an outlier.

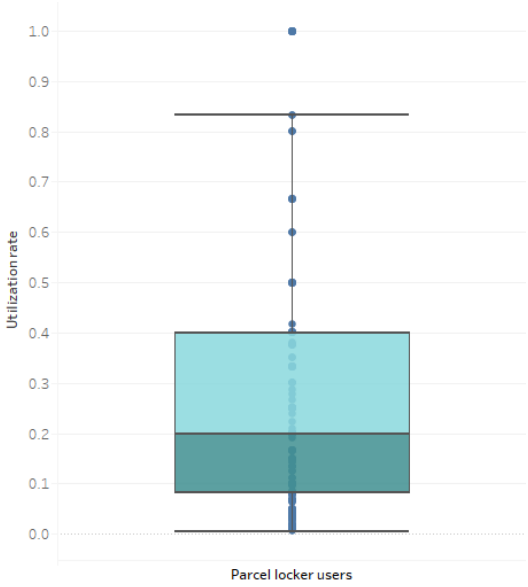

Figure 33: Parcel locker's utilization rate

4.3.3 Linear regression

To have a better understanding of the explanatory variables affecting the number of parcels ordered yearly, we performed a linear regression. The independent variables are the same described previously (since we want to get insights about consumers' characteristics), while the dependent variable is the total amount of parcels ordered. Since we are particularly interested in the potential of parcel locker solution as delivery service, we included in the analysis only the responses from online consumers willing to adopt the locker box in future. We weighted them as usual to balance the disproportion between males and females. The results of the linear regression are displayed in Table 18.

As usual, to avoid the dummy variable trap (a scenario in which two or more variables are highly correlated; in simple terms, one variable can be predicted from the others), SPSS excluded automatically from the analysis the biggest group of each category. Thus, the level which is not coded is the reference level for that category. The excluded levels are: 31-50 (Age), Master degree (Education level), 3 people (Tenants), Employed (Job), 1500-2000 € (Income), 3-6 hours (Hours online).

	Unstandardized coefficients		Standardized coefficients			
Variable	ß	S.E	B	t	Sign.	VIF
(Constant) (**)	61.762	18.036		3.424	.001	
Male	8.705	6.732	.044	1.293	.196	1.172
18-30	-12.005	14.461	-.056	-.830	.407	4.655
51-65	-11.016	8.466	-.049	-1.301	.194	1.460
Over 66	-43.468	34.706	-.057	-1.252	.211	2.172
Secondary school (#)	30.566	18.327	.058	1.668	.096	1.232
High school	-3.976	8.925	-.018	-.445	.656	1.746
Bachelor's degree	-9.018	10.997	-.036	-.820	.412	2.015
Post-graduate specialization	-19.255	12.526	-.053	-1.537	.125	1.226
PhD (#)	-24.725	14.535	-.058	-1.701	.089	1.209
Live alone	-11.381	10.528	-.040	-1.081	.280	1.383
1 person	-11.288	9.368	-.046	-1.205	.229	1.508
2 people	-1.042	8.771	-.005	-.119	.905	1.503
4 people	-13.648	12.497	-.038	-1.092	.275	1.235
More than 4 people	-6.322	16.625	-.013	-.380	.704	1.138
Student	-21.081	20.441	-.092	-1.031	.303	8.165
Unemployed	-42.791	26.593	-.065	-1.609	.108	1.667
Retired	-14.496	29.433	-.024	-.493	.622	2.350
No income	22.267	18.352	.092	1.213	.225	5.895
Less than 1000 €	6.955	15.519	.020	.448	.654	2.029
1000 – 1500 €	-6.606	9.936	-.027	-.665	.506	1.642
2000 – 2500 €	10.869	10.859	.039	1.001	.317	1.559
More than 2500 € (**)	39.396	11.973	.126	3.290	.001	1.509
No one (by foot)	1.104	7.401	.005	.149	.881	1.216
Public transport	-10.837	7.405	-.054	-1.463	.144	1.413
Bike	12.137	9.206	.044	1.318	.188	1.136
Motorbike	-15.418	16.985	-.030	-.908	.364	1.113
Car (∗)	15.781	7.666	.079	2.059	.040	1.514
Car sharing	4.352	16.366	.009	.266	.790	1.082
Bike sharing	-11.316	16.409	-.023	-.690	.491	1.132
Electric kick scooter	13.600	33.232	.013	.409	.682	1.057
Less than 1 hour (**)	-31.610	11.401	-.102	-2.773	.006	1.408
1 – 3 hours (**)	-23.111	7.634	-.116	-3.027	.003	1.508
6 – 10 hours (#)	-20.033	11.997	-.059	-1.670	.095	1.284
More than 10 hours	20.173	23.163	.029	.871	.384	1.111
Hours Out	-.021	1.287	-.001	-.016	.987	1.620

#p < 0.10, *p < 0.05, **p < 0.01, ***p < 0.001

Table 18: Linear regression on total parcels ordered by parcel locker's potential adopters

The model stands the ANOVA test, meaning that it is statistically significant, and presents an R-squared equal to 0.074. R-squared indicates the percentage of the variance in the dependent

variable that the independent variables explain collectively. In this case, it is not particularly high, thus only part of the variation in the number of products purchased online can be attributed to the variables included in the model. However, it is not unusual to find in social and behavioural sciences relatively poor values of R-squared, because it is difficult to include all the relevant predictors to perfectly explain the outcome variable. (see Farag, Weltevreden, et al., 2006 and Farag, Krizek, et al., 2006). Moreover, the VIF for each variable is indicated in Table 18 to underline the absence of very high correlation among variables (only the variable "Student" presents a pretty high VIF but it is still below 10, thus not particularly causing issues).

To what concerns the results, the most significant variable is income. As expected, having a high income (in this case more than 2500 €) has a significant positive impact on the number of parcels purchased online. It is interesting to mention then, even if not significant, also having no income at all or very low is positively correlated if compared to the reference category 1500-2000 € (medium income), probably because of young consumers, who purchase mostly with money from family.

Then, another remarkable variable affecting e-commerce demand is the hours spent online. It seems that spending less than 1 hours and between 1 and 3 hours, has a substantial negative impact on the number of parcels ordered yearly. This is in line with expectations since those categories describe individuals less familiar with the internet, people who do not spend a lot of hours online and thus less exposed to online advertisements, for example on social networks, that have a remarkable impact on consumers' purchasing behaviour. The interpretation is consistent with findings from Osservatorio eCommerce B2c (2019), who stated that 48 percent of Italians declared they buy online products seen on social networks.

It means that consumers spending less than 3 to 6 hours (reference variable) purchase online considerably fewer parcels. Moreover, if we extend the confidence level to 90%, it results that also spending online between 6 and 10 hours has a negative impact on the output. It turns out that only spending more than 10 hours enhances the online consumption, however not significantly in terms of confidence level. Thus, it seems that not necessarily if an individual spends more hours online, he/she always buys more.

Another significant variable, on a 95% confidence level, is related to car utilization for daily trips, to go to work or university. It is positively correlated with online consumption. This is somehow unexpected. Since owning a car and using it daily represents a remarkable cost, it is more likely that those individuals are consumers with medium-high income: this might be an

explanation of the significant positive correlation. Meanwhile, the other means of transport appears to be not significant.

The last significant variables, even though with a 90% confidence level, are related to education level. It seems that consumers with the lowest educational level (secondary school) are positively correlated with online consumption while holding a PhD is negatively correlated.

This outcome is quite unexpected, especially because people with a PhD are working professionals, with a high income.

However, an interesting insight can be found in the study carried out by Hyuncheol Bryant Kim (2018), assistant professor of policy analysis and management at Cornell University. He stated that education has an important role in enhancing the individual's economic decision-making quality or economic rationality. Thus, it seems that people with higher education are likely to be more careful and rational in their expenses, while less educated people seem to be more irrational in purchasing activities. This is likely to be one of the main reasons why consumers with the lowest education level seem to buy the most.

It must be taken also into consideration that the group under analysis is made by online consumers that are potentially willing to adopt parcel locker, hence all of them are at ease with online shopping, regardless of their education level.

5 CONCLUSIONS AND DISCUSSION

The steep growth of e-commerce in the last years has led to a remarkable increase of home deliveries, which is widely acknowledged as one of the main problems of city logistics to what concerns urban mobility and sustainability. Consequently, this fact accelerated the interest of public administrations to implement city logistics measures. Despite the cultural and social differences between residents in different cities, parcel volumes and sustainability concerns are developing consistently throughout Europe.

With this research, we studied the significant socio-economic and behavioural variables that affect the decision to purchase online and to adopt the parcel locker as a delivery solution, providing insights related to current utilization of this innovative delivery solution in the metropolitan city of Turin.

The first step consisted of an extensive literature review to have a good understanding of what are the remarkable variables on this topic and the most common implemented methodologies according to articles from the past. This was the starting point for the survey structuring. The intention was to structure a smooth survey, able to provide powerful insights to carry out the research study. In total, 1140 have been taken into consideration for further analysis. Data has been analysed through descriptive statistics and inference statistics (logistic regression and linear regression). The results are displayed in Table 19.

Now we can answer the research questions defined at the beginning (1.3) as follows:

RQ1: it seems that the typical online shopper is between 18 and 50 years old (the younger he is, the more likely he will choose to buy online). He is not unemployed, thus either an employee or a student and he lives with 3 people. If he has an income, it must be above 1000 €. It seems that the lack of time (to do in-store shopping) is the least important factor to explain e-commerce adoption. The consumers prefer online shopping mainly because of the convenience. Not only, the possibility to exploit discounts (buying products at a cheaper price) and to find a wider product variety easily, having the possibility to compare prices, are well-appreciated features of online shopping.

RQ2: according to the outcome of the analysis, among online consumers, the parcel locker user has age below 66 and he does not live with many people (4 people). He does not use car-sharing and he usually spends online less than 10 hours per day. The online consumer mainly adopts the parcel locker because he appreciates above all the possibility to collect the parcel around

the clock. Moreover, he considers sustainability as a really important feature in the delivery service. He does not perceive interacting with an automated solution as a technological barrier and he does not consider that the safety risk related to this solution is significant.

RQ3: according to the analysis, there is remarkable variability among online consumers regarding the number of parcels ordered on the internet yearly. On average, people place 17.74 orders per year (median equal to 10) with 1.91 products per each order (median equal to 2). It seems that consumers mainly purchase online Books and DVDs, Consumer electronics and Clothes. Considering all online consumers of the sample, only 3.7 percent of the total parcels ordered have been collected from a parcel locker. This is because only 24.4 percent of them have declared to be parcel locker adopters. By performing the same comparison only among locker users, the share of total parcels collected through this innovative solution raises to 11.9 percent but, individually, the utilization rate is quite low (it is equal or below 0.2 for at least 50 percent of them). Considering locker potential users, regression analysis highlights that age has no significant effect in explaining the number of products ordered online. Those who buy the most have high income (more than 2500 €) and use the car for daily trips. Consumers with low education (secondary school) buy more than those with high education (PhD). Spending below 3 hours online reduces significantly the online purchase intensity, but not necessarily spending more hours online enhance the number of products ordered.

To conclude, to make you appreciate the potential of this innovative delivery solution, it is important to mention two striking facts. More than 90% of respondents have purchased at least a product in the last twelve months and among them, more than 90% consider the parcel locker an interesting opportunity which they would be willing to use, or at least to try. These results are symptomatic to draw attention to possible tremendous positive implications if lockers were implemented efficiently in terms of numbers and optimal positioning. This would make potential users become actual users. Considering the remarkable share of people interested in the solution, this fact must be taken into consideration when evaluating opportunities for city logistics improvement.

Limitations

Despite the contribution of this research study, there are some limitations. The limitations related to this research work involve the nature of the sample and the procedures followed.

Due to the survey submission on the internet (on Facebook and by e-mail), the random sampling has not been performed consistently, because respondents self-selected themselves to answer

or not to the questionnaire. Moreover, some people may not have had an equal chance to participate in the survey. For this reason, the power of collected data to generalize results to the entire population is reduced.

However, it is important to underline that to what concerns the submission channel of the questionnaire, the online channel adopted for this study is consistent with the great majority of research works on similar topics (Teo, 2002).

As regards the sample distribution, it is predominantly made by female respondents. There is a gender disparity which is the most likely consequence of the submission of the questionnaire online. An interesting study on this topic called "Does Gender Influence Online Survey Participation? A Record-Linkage Analysis of University Faculty Online Survey Response Behaviour" has been carried out by Smith (2008). He reported the existence of gender bias in online survey response behaviour, and indeed, a difference in the online survey response rates of female and male members of a selected sampling frame. There is wide literature related to this topic; one interesting explanation provided by the author of the article is that gender discrepancy in response rate might be the consequence of differences in the way females and males make decisions and value actions in the online environment. Females seem to be more likely to possess or value more characteristics such as emotional closeness and empathy, thus more inclined than males to fill in the questionnaire.

Moreover, another limitation might be that only 8 percent of respondents are in-store shoppers, so the sample is skewed towards online shoppers. This might be a consequence of the age distribution within the sample, in particular to what concerns the low share of respondents in the age over 66, those consumers who according to literature seem to have lower intention to purchase online. The small share of old people in the sample seems to be a common problem because they represent a category much more difficult to involve in the survey, especially when the survey is conducted online and not face to face (Wang et al., 2018).

As regards the analysis of parcel locker adoption, the behavioural intention instead of actual behaviour is modelled as the dependent variable. Although it is a widely adopted practice to use behavioural intention as a predictor of behaviour, it is argued that pure intention is often different from actual behaviour. This happens when the actual behaviour is affected by factors not directly under the control of the individual, which implies he will not act even if he would like to (Wang et al., 2018). In the case of parcel locker, this means that a consumer might have

a strong intention to adopt the parcel locker, however, this might not be translated in actual adoption of the service because not conveniently accessible, for instance.

Concerning the adoption of the parcel locker as a delivery solution, the analysis has been conducted on a sample made by a small share of online consumers with a negative attitude towards this delivery service (6.2 %): this is an aspect to take into consideration.

Significant variables	Online shopping intention	Parcel locker adoption	Online shopping demand
	Odds ratio	Odds ratio	B
Age 18-30			
Age 31-50			
Age 51-65	.101**		
Age over 66	.054**	.026*	
Secondary school			.058#
PhD			-.058#
Less than 1000 €	.124*		
More than 2500 €			.126**
Unemployed	.068*		
3 Tenants	4.220**		
4 Tenants		.368*	
Car			.079*
Car-sharing		.328#	
Less than 1 hour online			-.102**
1-3 hours online			-.116**
6-10 hours online			-.059#
More than 10 hours online		.223#	
Constant	250.983***	14.739*	
Regression analysis	Logistic regression	Logistic regression	Linear regression
Dependent variable	1 = Online shopper 0 = In-store shopper	1 = Potential adopter 0 = Non-adopter	Number of total parcels ordered online
Number of cases	1140	1053	988
R^2			0.074
Adjusted R^2	0.264	0.127	
#p < 0.10, *p < 0.05, **p < 0.01, ***p < 0.001			

Table 19: Summary of the results from regression analysis

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