



PORTUGUESE CUSTOMER'S PERCEPTION AND INTENTION OF USE OF SMART LOCKERS

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Thesis submitted as partial requirement for the acquisition of Masters' Degree in MSc in
Management

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September 2023

Acknowledgments

I would like to express my sincerest appreciation and gratitude to the following individuals who have been instrumental in the successful completion of my thesis:

First and foremost, I would like to thank my thesis advisor, Henrique O'Neill for his support, guidance, invaluable feedback, and constructive criticism throughout the research and writing process. I am truly grateful for his mentorship and availability, without which this thesis would not have been possible.

Furthermore, I would like to acknowledge the participants who generously dedicated their time and efforts to participate in my study and provided me with valuable data.

To my dear friends, especially the ones who patiently listened to my complaints and frustrations when I couldn't fathom how to proceed, I will forever be indebted to you. Your unwavering support and encouragement have been a true blessing in my life.

To my beloved parents, Inês and Hugo, I want to express my profound gratitude for the unwavering love and support you have provided me with throughout my entire life. Without your guidance and encouragement, I wouldn't have reached this point in my academic journey. This thesis stands as a testament to your exceptional parenting, and I am eternally thankful.

To my siblings, nieces, and nephews, I hope that my achievements make you proud. Your presence in my life has been a source of motivation and inspiration.

Last but certainly not least, I extend my heartfelt appreciation to my extended family, friends, and loved ones. Your unwavering support, words of encouragement, and understanding have been my pillars of strength during this challenging journey.

I want to thank each and every one of you for contributing to my academic growth and for standing by me. This experience will forever hold a special place in my heart.

Abstract

In today's digital landscape, e-commerce has become increasingly prevalent, and the last mile problem has emerged as a significant challenge for businesses. Understanding the intricacies of the last mile problem and its dynamic relationship with evolving consumer behaviors is crucial for businesses to thrive. In this context, smart locker services emerge as a groundbreaking technological solution to tackle these challenges. While their utilization is expanding across Europe, their awareness and adoption within Portugal, a country with comparatively limited smart locker usage, warrant attention. This study aims to delve into the perception and intent of Portuguese consumers regarding the adoption of smart locker delivery services. It accomplishes this by integrating two key theoretical frameworks: the Innovation Diffusion Theory and the Resource Matching Theory.

Primary data was garnered through a web survey, drawing responses from 226 individuals residing in Portugal, all of whom were at least 18 years old. This research assessed various facets, including convenience, reliability, complexity, privacy security, compatibility, and relative advantage. The findings indicate that all variables, except complexity, exhibit a positive and statistically significant correlation with the intention to use smart lockers. Furthermore, the study reveals that consumers predominantly favor residential areas, supermarkets, and shopping malls as ideal locations.

This study not only bridges a gap in the existing literature but also offers valuable insights into consumer preferences that underpin their acceptance of smart locker services.

Keywords: smart lockers, parcel lockers, consumers, intention, acceptance, last-mile delivery, Portugal

JEL classification system:

- M19: Business Administration, Other

Resumo

No cenário digital atual, o comércio eletrônico tornou-se cada vez mais prevalente, e o ‘last mile problem’ surgiu como um desafio significativo para as empresas. Compreender as complexidades do problema e a sua relação dinâmica com os comportamentos em evolução dos consumidores é crucial para o sucesso das empresas. Neste contexto, os serviços de ‘smart lockers’ emergem como uma solução tecnológica inovadora para enfrentar esses desafios. Embora a sua utilização esteja a expandir-se por toda a Europa, a sua consciência e adoção em Portugal, um país com uma utilização comparativamente limitada de cacifos inteligentes, merecem atenção.

Este estudo tem como objetivo analisar a perceção e a intenção dos consumidores portugueses em relação à adoção dos serviços de entrega por cacifos inteligentes. Para o efeito, integra duas estruturas teóricas fundamentais: a Teoria da Difusão da Inovação e a Teoria da Correspondência de Recursos.

Os dados foram recolhidos através de um inquérito online, com respostas de 226 indivíduos residentes em Portugal, todos com pelo menos 18 anos de idade. Esta investigação avaliou vários aspetos, incluindo conveniência, confiabilidade, complexidade, segurança e privacidade, compatibilidade e vantagem relativa. Os resultados indicam que todas as variáveis, exceto a complexidade, apresentam uma correlação positiva e estatisticamente significativa com a intenção de utilizar cacifos inteligentes. Além disso, o estudo revela que os consumidores preferem predominantemente áreas residenciais, supermercados e centros comerciais como locais ideais.

Este estudo não só preenche uma lacuna na literatura existente, mas também oferece informações valiosas sobre as preferências dos consumidores que fundamentam a sua aceitação dos serviços de cacifos inteligentes.

Palavras chave: smart lockers, parcel lockers, consumidores, intenção, aceitação, Portugal

JEL classification system:

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1. Introduction

This study aims to identify the acceptance and perception of people towards new last-mile technologies, in this case, smart lockers, specifically among the Portuguese population. As part of the acceptance study, I will examine where smart lockers would be most successful in the Portuguese environment if Portuguese consumers view them as an added value to their lives and society, and what variables have the greatest influence on Portuguese consumers' perception, as well as making some recommendations on how smart lockers can be expanded in Portugal in a similar way to other countries in which they have been successful.

1.1. Theme

An issue that is currently gaining prominence and is expected to worsen with the expansion of e-commerce is the Last Mile Problem, as commonly referred to in the literature. The Last Mile problem summarizes a range of logistical and operational challenges associated with the inefficiency of delivering to individual homes and businesses as online shopping gradually replaces traditional shopping. Prior to the advent of online shopping, the last mile referred to the transportation of goods from warehouses to the final distributor. There are now individual home deliveries, which require more freight trips, more fuel consumption, less efficient use of truck space due to next-day delivery, more traffic congestion in cities, more cost for companies, the need for precise timing, and more (Iwan et al. 2016). Solving the last mile problem with the use of alternative methods is needed for the last mile to keep up with the modern marketplace and demanding consumers.

The inefficiency of door-to-door delivery is a relatively new last-mile logistics problem due to the growing popularity of online shopping. Much as smart lockers offer convenience and security in the last mile delivery process, there is still limited research on understanding the factors that might influence users' willingness to adopt the use of the lockers as their main delivery method. As part of the literature review, the study identified the following issues in areas that justify further exploration. A significant success factor is the willingness of customers to walk to the smart locker location. (Kahr, 2022).

In addition, there has been a limited discussion of consumers' inertia toward switching to self-collection services, along with how socio-cultural factors, including demographic characteristics, influence acceptance of smart lockers and can be used to tailor solutions to specific target groups.

1.2. Research questions and objectives

The research questions for this study are:

1. Are the Portuguese consumers using Smart Lockers as delivery method?
2. Is the attitude about using Smart lockers positive or negative?
3. What factors positively influence customers' intention to use smart lockers?
4. In which locations do Portuguese consumers express a preference for the placement of smart lockers?
- 5.

The research objectives are:

1. To describe the importance of adopting new last mile delivery methods.
2. To examine Portuguese customers' awareness and current use of smart lockers as a last mile delivery solution.
3. To identify the factors that influence customers' intention to use smart lockers.
4. To examine preferred locations for smart lockers and characteristics of a delivery service.
5. To synthesize the findings and if applicable make recommendations to promote their usage.

1.3. Structure

The study is organized in six chapters. Chapter one introduces the theme of the study, the topic context, the relevance of the study and research questions and objectives. In chapter two, the literature review delves into various aspects of the subject matter. It encompasses an exploration of e-commerce and last-mile delivery, providing a comprehensive overview of typical delivery services. The chapter also delves into the realm of smart lockers. Additionally, it examines the factors that shape customer perception and intention, drawing insights from the theories presented in the research framework, which will be detailed in Chapter 3 along with the presentation of hypotheses. The research methods will be discussed in chapter four under methodology. In chapter five the data results will be discussed and analysed. Finally, chapter six concludes the study by summarizing the findings and elaborating on future research challenges and recommendations.

2. Literature Review

2.1. Logistics and E-Commerce

Door to door delivery improves consumers' accessibility to the retail sector (Wang & Zhou, 2015), however, in research from Iwan et al. (2016) last-mile deliveries are one of the main causes of the high volume of commercial vehicle traffic throughout the urban area. The primary attributes of last-mile deliveries, significantly influencing the efficient operation of the transportation system, involve considerable fragmentation and limited cargo space within the vehicles. Moreover, Iwan et al. (2016) highlights that the importance of this delivery approach is on the rise due to the increasing interest in long-distance shopping, predominantly driven by the surge in e-commerce activities within the B2C market.

Retail e-commerce sales exceeded \$5.2 trillion globally in 2021 (*Global Retail E-commerce Sales 2026 | Statista, 2022*), accounting for nearly 19 percent of retail sales worldwide (*Global E-commerce Share of Retail Sales 2026 | Statista, 2023*). That figure is forecast to grow 56 percent over the next few years to reach about \$8.1 trillion by 2026. By 2022, China's ecommerce market is forecast to be the largest in the world, with Internet sales accounting for nearly half of the country's retail sales. The U.K. ranks second with the highest percentage of retail sales made online (36 percent), followed by South Korea (32 percent) and Denmark (20 percent) (*Global Retail E-commerce Sales 2026 | Statista, 2022*).

Taking a look at Portugal, the country has over five million digital buyers, which generate over four billion U.S. dollars in retail e-commerce revenue, according to 2021 estimates. Covid19 played a big role in encouraging Portuguese consumers to buy online. A historical first was reached in 2020 when more than 35 percent of e-commerce users bought something online in the previous three months. Nevertheless, these rates are usually lower than those in Europe (*Topic: E-commerce in Portugal, 2023*).

Kahr (2022) stated that the pandemic caused by the coronavirus also resulted in supply chain shocks at different levels. The demand for mail orders soared temporarily during lockdowns. Furthermore, Wang & Zhou (2015) noted that freight trips generated by residential units represent a significant portion of total freight demand.

2.2. Last Mile Logistics and Delivery Services

“We observe a great potential to investigate this area, mainly because in the new era of mobility, increasing efficiency for distribution of goods in cities is as significant as moving people, and a major source for sustainable development” (Ghaderi et al., 2022, p.2).

Urban logistics and urban transport are thematic complexes that include last-mile deliveries. In the last mile, concepts have been studied from various perspectives such as carriers, companies, customers, cities, and others, as well as from different perspectives such as logistics, transportation planning, traffic planning, supply chain management, and others, and finally with different focuses, efficiency, sustainability, environmental impact, or innovation level.

Last-mile delivery is defined as the “last stretch of business-to-consumer parcel delivery to a final consignee who must receive the parcel at home or retrieve it from a collection point” (Yuen et al., 2019, p.316). Due to the rise of e-commerce, customer preferences have become increasingly important in the parcel delivery market. Market players see the last mile as an important differentiator, as the variety of delivery options and the perceived quality of the delivery service strongly influence the decision criteria of online customers and have an impact on the market success of providers. (Joerss et al., 2020).

By 2025, same-day and instant delivery will account for 20% to 25% of the market (Joerss et al. 2020). As a result of increased delivery volumes, returns, customer expectations, and tougher marketing competition, home delivery is time-consuming and labor-intensive. (Vakulenko et al., 2018).

2.2.1. Delivery Services

With the purpose of coherence when defining delivery services, the author based most of this chapter on the article by Boysen et al., (2020) “Last-mile delivery concepts: a survey from an operational research perspective”.

The above-mentioned authors define last-mile delivery concepts as “a chain of storage and transport process steps, where each chain starts at the depot and ends with a handover element”. Due to the previously mentioned wake of e-commerce and its prominent diffusion in commercial activities, the last mile has seen many innovations in delivery concepts.

The authors distinguish concepts used today from near-future concepts, which have not yet been completely implemented in daily operations. Human-driven delivery vans, cargo bikes,

and self-service are among the former, while unmanned aerial vehicles (drones), autonomous delivery robots, and crowd shipping, combined with people transportation and alternative handover options are among the latter.

A human-driven delivery van is the standard delivery concept used throughout the world to process most shipments. A delivery van leaves a central depot and is driven by a delivery person, who goes through the homes of customers, handing over parcels directly (Boysen et al., 2020).

There are two types of *cargo bikes*, manual or electrical, which are very well-established delivery vehicles, contributing to sustainable last-mile delivery compared to conventional engines. (Boysen et al., 2020). According to the researchers, cargo bikes have a much smaller capacity than delivery vans, so they must be replenished repeatedly during the day with additional shipments, and given their small capacity, it remains unclear if mass markets can accommodate them.

Self-Service refers to the process of bringing multiple parcels to a single decentralized facility that is easily accessible by the customers (Boysen et al., 2020). This concept of selfservice will be further developed in the literature review that follows.

Drones for supplying shipments on the last mile have been widely discussed. A drone, also known as an unmanned aerial vehicle (UAV), is an aircraft equipped with sensors and transceivers that allow them to navigate and operate autonomously (Drones, n.d.). At most, they can only carry one shipment at a time, not too heavy. Drones are seen as a potential new mode of delivery for logistics organizations, however, factors like regulations, technology, and economics, have limited drone delivery to only a few isolated operations globally (Drones, n.d.).

Earth-bound *autonomous delivery robots* can transport significantly heavier packages up to 10 kg and are employed for service delivery. Due to their reliance on current roadways and delayed delivery, these robots cannot alleviate the time constraints associated with last-mile delivery (Boysen et al., 2020).

Crowd Shipping is the involvement of the “crowd” in the last-mile process. Uber and Airbnb are cited as successful examples of the crowd being involved in passenger transportation and overnight accommodations by Boysen et al., (2020). As an alternative to employing fixedterm delivery personnel, “Crowdsourced Logistics” (CSL) allows shippers to procure transportation

services via a smartphone or computer app directly from crowd members who provide those services on their own vehicles (Castillo et al., 2017).

An *alternative handover option* allows for parcels to be delivered unattended to customers' private areas. With the reception box, an electronic key or code can be used to open the box that sits outside the customer's home, so that parcels can be dropped off without the consumer being home. The delivery box, on the other hand, is a locked locker owned by the delivery company. Using a fixed locking device, the parcels are temporarily attached to the consumer's home once they have been filled at the distribution depot (Deutsch & Golany, 2018).

2.2.2. Consumer preferences

Due to constant changes in consumer behavior, consumer preferences are considered a major and complex criterion for selecting last-mile delivery. In the retail industry, last-mile delivery options are crucial to success and profitability, since they directly impact customer satisfaction and experience (Filiopoulou et al., 2022).

In their conference paper Filiopoulou et al., (2022) explored the preferences for last-mile delivery alternatives among 174 Greek consumers, analyzing their online shopping behavior, which delivery options they prefer, what challenges they face, and which factors influence their delivery decisions.

The results showed that, concerning last-mile delivery options, 81% of the respondents favored home delivery while click-and-collect delivery mode from the store or distribution point was less popular with 21%. In the study only 9.80% used parcel lockers "often" and 6.90% used them "always". Consumers also stated they preferred home delivery mostly due to timesaving followed by convenience. Concerning the factors behind choosing "Pick-up point" as a delivery option, 24/7 access to the locker was the most determinant factor followed by moneysaving.

2.3. Smart Lockers

One solution to support supply chain viability in last-mile delivery is the use of smart lockers (outdoors) that allow customers to pick up their packages 24/7 while maintaining a physical distance. The use of parcel lockers can support the profitability of the last-mile supply chain, as the relatively low investment costs deliver promising returns (Kahr, 2022).

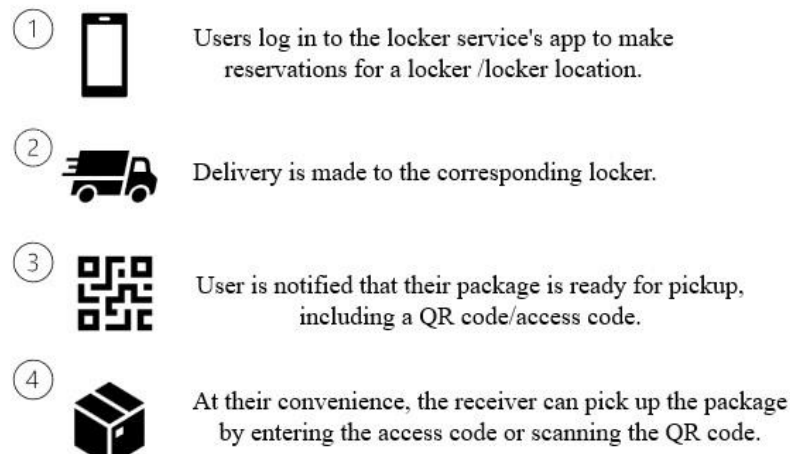
Smart-lockers can be defined as "scalable, customizable, electronic, and often cloud-based systems that give onsite and remote workers and users easily accessible space for the retrieval

of letters and parcels” (Yuen et al., 2019, p.316). They can also be identified as parcel kiosks, locker boxes, automated lockers, self-service delivery lockers, and intelligent lockers (Vakulenko et al., 2018).

2.3.1. How Smart Lockers Work

In most cases, home deliveries take place within a 2-hour time frame, and consumers need to wait at home for them. However, when self-collection deliveries are made, consumers are often notified when parcels are delivered to their service points. Consumers can pick up their parcels at their convenience. Waiting time is reduced which reduces customers' opportunity costs. (Yuen et al., 2018).

When defining smart lockers Iwan et al. (2016) add that to optimize usage, customers are not usually assigned their lockers (lockers have electronic locks with a variable opening code and can be used by different customers on different days). Customers can be notified by message when their delivery has arrived, the number and location of the locker, and the code to open it. With lockers, customers must make the final leg of the journey themselves. However, the lockers are located so that the detours for customers are as short as possible.



Source: Author's elaboration

Figure 2.1. _ The operational process of Smart Locker Delivery as experienced by the user

2.3.2. Predominant Sites for Smart Locker Installation

It is common for parcel locker facilities to be in public areas, making them easily accessible to both couriers and shippers. (Ghaderi et al. 2022). Research from Ghaderi et al. (2022), shows that enabling joint delivery can improve by up to 5% the success delivery rate, by placing a small number of parcel lockers in key locations. In the research, the authors hypothetically

considered supermarkets as the parcel location, demonstrating benefits for public places with high foot traffic for locating parcel lockers.

2.3.3. Benefits of Smart Lockers

According to Yuen et al. (2019), smart lockers benefit three different stakeholder groups. These being:

1. Operator; One of the main reasons contributing to the last-mile issue, making it more expensive and less efficient is delivery failure and redelivery (Ducret, 2014). Smart lockers eliminate this possibility and allow items that would otherwise be delivered to different locations to be delivered all at once, improving the utilization of vehicle assets and reducing delivery trips in the process, while reducing costs (Yuen et al. 2019).

2. Customers' perspective; parcel lockers offer customers advantages such as flexible opening hours for picking up the delivery, faster deliveries, avoidance of time pressure when picking up the parcel, and anonymity (Vakulenko et al., 2018).

3. Social perspective, Self-pickup delivery services enable consolidated shipments that reduce the number of road trips required to deliver to customers. This reduces congestion on the roads, the need for roadside parking, and greenhouse gas emissions, and improves the quality of life in cities (Chen et al., 2017).

When comparing five different last-mile delivery systems, these being: attended delivery; reception box; controlled access systems; locker-bank, and collection point, Iwan et al. (2016) consider lockers-banks as the most interesting solution since they favor the reduction of traffic and improve the use of cargo compartment by consolidating deliveries and making them more independent from the available time slots.

2.3.4. Adoption Costs of Smart Lockers

The use of parcel lockers is characterized by a variety of business models. Vertically integrated couriers invest in their locker network, while specialized operators offer locker usage on demand. Individuals and businesses can use lockers on demand through specialized operators (Ghaderi et al. 2022).

Kahr (2022) indicated that the anticipated ROI from employing parcel lockers holds promise, however, it diminishes with the upfront investment expenses.

The significant initial expenses associated with installing and integrating smart lockers in business premises and residential areas contribute significantly to the limited uptake of such technology. The total initial investment encompasses factors like tailoring and designing the system, costs of integration and installation, as well as expenses related to training (Automated Smart Locker System Market, n.d.).

2.3.5. Types and Features of Smart Lockers

As stated by Kahr (2022), parcel lockers offer several advantageous features. These include: (1) facilitating the practice of physical distancing, (2) are easy to build and maintain, (3) permitting the retrieval and sending back of mail orders at any time of day, (4) allowing adaptable and location-specific designs, (5) having the potential to be powered by batteries or solar panels, (6) remaining operational across diverse geographical and climatic conditions, (7) being available in versions suitable for storing frozen food, and (8) having the flexibility to be positioned at numerous locations within urban areas, such as parking lots.

As per Lopes (2023) of Bloq.it, a smart locker company with a presence in 11 countries, including Portugal, the category of smart lockers encompasses a wide range of models catering to various specific needs. In Portugal, specifically, you can find smart lockers designed for the following purposes:

1. Pharmacy Smart Lockers
2. Refrigerated Lockers
3. Modular Parcel Lockers

These diverse locker types are available in different sizes and equipped with various features. For instance, refrigerated lockers are designed to maintain a cool temperature to preserve grocery items, so they include a temperature control feature. On the other hand, standard smart lockers, typically used for package retrieval at locations like postal offices, are technologically advanced but lack the specialized temperature regulation found in refrigerated lockers.

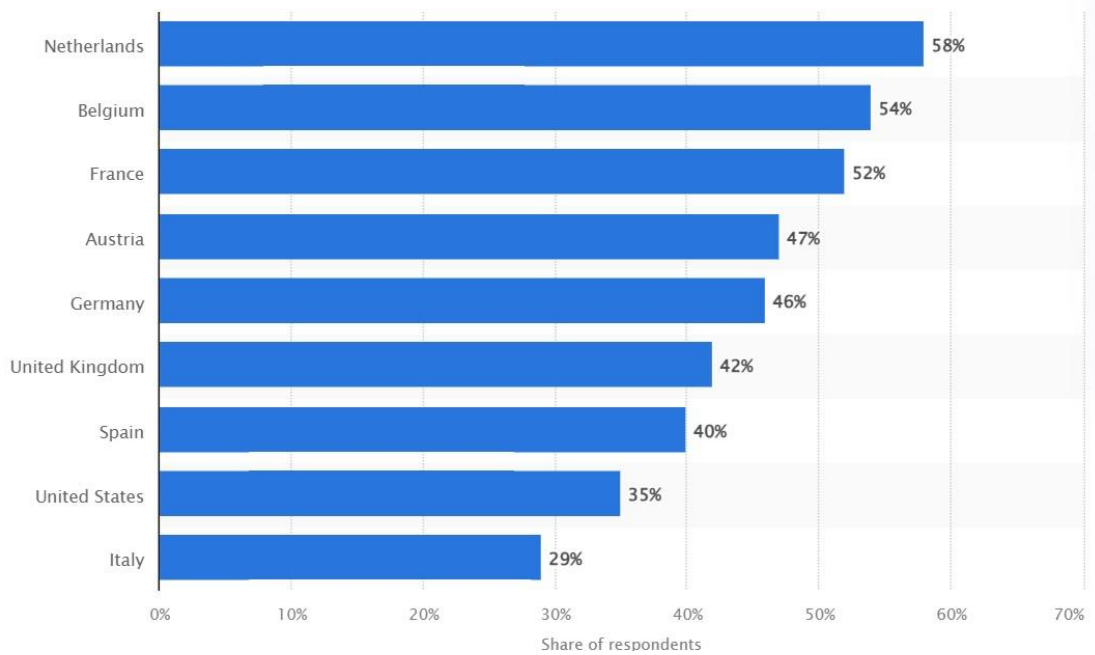
The Bloq.it website (Lopes, 2023) also provides insights into how the smart locker market operates. Beyond the physical locker itself, these companies primarily offer software systems. The essential components highlighted for a smart locker software solution include:

1. An intuitive public API (Application Programming Interface), which serves as the program that customers use to understand and interact with the service easily.
2. Cloud-based architecture, enabling remote management, seamless communication between services, and more.
3. An adaptable system designed to cater to the diverse needs of various services.
4. Plug-and-Play functionality, ensuring that the software can be easily installed and run on different configurations across various industries.
5. User-centric design, prioritizing the needs and preferences of end-users.
6. Scalability to accommodate growth and evolving requirements.
7. Customizability, allowing organizations to tailor the software to their specific needs and branding.

2.3.6. Market Landscape

The global market scope is classified across North America, South America, Europe, the Middle East & Africa, and Asia Pacific. In 2021 the smart parcel locker market amounted to approximately 722.1 million U.S. dollars and that figure is expected to surpass one billion U.S. dollars by 2024 (Statista, 2022).

A survey from 2022 showed the percentage of consumers from different European countries not willing to use out-of-home delivery options (Consumers Interest in Smart Lockers by Country 2022 | Statista, 2023).



Source: Statista 2023

Figure 2.2. – Share of consumers not willing to use smart lockers for out-of-home (OOH) delivery in 2022, by country

2.4. Factors influencing Customer Perception and intention

2.4.1. Cost

To remain competitive, all companies strive to maintain the highest quality of their products while maintaining the lowest costs. According to a study conducted by Joerss et al. (2020) about customer preferences of delivery models, 70% of consumers are pleased with the cheapest form of home delivery. Due to the high cost of home deliveries, companies can significantly reduce their costs through proper planning and execution of a delivery plan. As a result, companies can achieve substantial efficiencies. This can involve, among other options, redesigning the distribution network, creating more efficient routings, and /or changing delivery zones (Brown & Guiffrida, 2014).

Last-mile delivery usually involves one package per door, which prevents economies of scale. It is also costly because there are often failed deliveries because the customer is not home.

There may be a need to pick up the failed delivery from a collection point at an unsuitable location or time window (Lin et al., 2020). In their study on the operational challenges associated with public locker installation in a city following a smart initiative in Singapore (Lyu & Teo, 2022) noted that, in one day of deliveries, more than 20% of parcels could not be physically delivered to their destinations, and, among these failed deliveries, 40% were due to the customer not being present at the prearranged time window.

Bundling many individual points of customer demand into a single delivery point reduces distance- and time-based costs for the carrier. CDPs make it possible to avoid additional costs associated with multiple failed delivery attempts, especially for payment-on-delivery orders. The number and location of lockers play a crucial role in reducing the costs incurred by transportation (Janjevic et al., 2019).

By combining shipments by various service providers, smart locker services might also save customers money because logistic service providers may charge less to deliver to smart lockers. (Gundu, 2020)

2.4.2. Sustainability

Nowadays environmental sustainability is well recognized and taken into account in the business world including the operations and supply chain for organizations.

In research from Brown and Guiffrida (2014) when considering the supply chain, the delivery of goods to end consumers is one of the most polluting and expensive segments of the supply chain.

Brown and Guiffrida (2014) compare conventional shopping involving customer pickup with e-commerce-based online retailing involving last-mile delivery to customers' homes. The authors conclude that delivery to fewer customers than the break-even number results in higher carbon emissions than if customers picked up their purchases themselves (conventional shopping).

Pickup point networks are considered highly innovative and environmentally friendly B2C providers (Ducret, 2014). In research from Iwan et al. (2016) when suitable locations are selected, parcel lockers can not only offer significant economic benefits but also, or even

primarily, have a positive impact on reducing pollutants released into the environment by urban freight traffic.

Moreover, as self-collection services are considered greener alternatives to home deliveries, people with pro-environmental attitudes may be more likely to utilize them since they align with their values of protecting the environment. (Yuen et al., 2018).

Reduction of urban traffic and congestion

Throughout this literature review, we have noted that online shopping is closely associated with home deliveries and has a big impact on urban freight transportation. Since shopping trips are being replaced by home deliveries, traffic is increasingly flowing toward homes and less toward stores. (Francke and Visser, 2015)

2.4.3. User Experience

2.4.3.1. Consumers view of Smart Locker

Iwan et al. (2016) mention that the most important condition for the efficiency of parcel lockers is the willingness of Internet retailers to deliver goods to a place that does not coincide with the address of the buyer and, on the other hand, the willingness of customers of Internet stores to receive their goods from parcel lockers. For the buyer, the most important obstacle to the use of parcel lockers is the fact that he must make the last leg of the journey himself.

2.4.3.2. Relative advantage

The concept of self-service redefines roles in value creation by including the customer in the service algorithm. In the case of parcel lockers, consumers oversee creating value for both parties involved in the last-mile delivery process. Therefore, in contrast to traditional ecommerce, customer roles are reversed, changing the perception of the last mile (Vakulenko et al., 2018), thus the use of smart lockers for receiving parcels is only more beneficial than standard delivery if the users believe it to be. In the research ‘What’s in the parcel locker?’, Vakulenko et al. (2019) demonstrate that the last mile experience impacts customer satisfaction with online shopping significantly and Yuen et al. (2019) on their study on ‘The determinants of customers’ intention to use smart lockers for last-mile deliveries’ found that improving

attributes such as convenience, security, and reliability leads to the creation of value for smart locker users.

2.4.3.3. Compatibility

On the study ‘Customers’ intention to adopt smart lockers in last-mile delivery service: A multitheory perspective’ by Tsai and Tiwansing (2021), the authors define compatibility as the learners’ perspectives on the benefits they can gain from using smart lockers to receive parcels. Additionally, Gundu (2020) on ‘Smart Locker System Acceptance for Rural Last-Mile Delivery’ discusses how customers perceive the environment and how society perceives smart lockers, both of which will impact the decisions customers make.

Yuen et al. (2018) on their study ‘An investigation of customers’ intention to use self-collection services for last-mile delivery’ state that in the context of smart locker adoption compatibility needs to be distinguished from relative advantage, since relative advantage involves comparing self-collection services among them and with home deliveries, while compatibility is linked to the level of congruency that using self-collection services has with a consumers’ lifestyle, values, and needs.

Yuen et al. (2019) found that working professionals who spend most of their day at work may prefer self-collection services, so compatibility can be entwined with the question of employment effects on self-collection services.

2.4.3.4. Reliability and Security

Reliability is a crucial attribute of superior service quality, and when applied to a self-service technology is viewed as the capacity to deliver the service accurately. Reliable delivery is a source of customer value in e-commerce, accordingly, Vakulenko et al. (2019) states that a negative delivery will influence customer satisfaction and future relationship.

As stated by Tsai and Tiwansing (2021), one of the primary factors that leads consumers to use smart lockers is the lack of trust on the last-mile logistics standard delivery method while research done by Barua et al. (2017) titled ‘A perceived reliability-based customer satisfaction model in self-service technology’ finds that perceived reliability influences the perceived risk connected with self-service technologies. Furthermore, Barua et al. (2017) mentions that

customers can feel the absence of direct service employee support and that self-service technology can be dampened due to the lack of technical reliability.

On the topic of private security, Tsai and Tiwansing (2021) define it in the context of smart lockers as the extent to which users perceive self-pickup parcel lockers as private regarding their information and find that it is a key factor in the adoption of smart lockers for the respondents of their study. This is also touched on by Yuen et al. (2019) that view privacy security as a factor that increases the likelihood that consumers will use the technology since it gives them control over personal information and improves customers' trust in the technology.

Gundu (2020) identified through focus groups that customers also seem to have doubts regarding the physical security of the lockers stating that there is a need for service providers to address those concerns so that the uncertainty does not have a negative effect on smart locker acceptance.

2.4.3.5. Complexity and Convenience

Tsai and Tiwansing (2021) report that when it comes to parcel delivery, consumers expect the easiest and most convenient method possible and that this is a major consideration factor for consumers when choosing a delivery method, so if it is too complicated, consumers will choose another route.

As Gundu (2020) words, the effort expectation is based on the level of ease (complexity) associated with using smart lockers, which also implies that using smart lockers is dependent on resources such as money or time. As a result, a customer is more likely to use a smart locker if the resources required are less than those needed to travel to get the goods. Moreover, Gundu (2020) reported that smart lockers give customers greater control over the delivery process than standard deliveries, making them a more flexible option. As outlined by Yuen et al. (2019), the convenience attribute refers to the efforts consumers make in terms of factors such as geographical location, effort, and time convenience, which when aligned with consumer lifestyles can create excitement over new technology.

In their article, 'Why the little things matter: Exploring situational influences on customers' self-service technology decisions', Collier et al. (2015) discuss how situational variables may influence a person's preference for self-service technology or a standard approach. This article cites several reasons why a customer would fail to use self-service. One being that the location

may be inconvenient or difficult to find for the customer, or that the size order may not be suitable for self-service.

Yuen et al. (2018) discuss how self-collection occurs through the use of the delivery method, noting that innovations demanding users to acquire new skills tend to be embraced at a slower pace. Hence, in the context of smart lockers, individuals who perceive the use of these lockers as intricate are anticipated to exhibit greater resistance and scepticism, consequently leading a weaker inclination to adopt this delivery method.

2.4.3.6. Location

In research from Kahr (2022), ‘Determining locations and layouts for parcel lockers to support supply chain viability at the last mile’’, several challenges arise when planning distribution networks for parcel lockers, including deciding where to locate them. The location of parcel lockers is known to be the most important factor for success, considering that customers have limited willingness to invest travel time to pick up their packages. Deciding on the size and compartment structure of parcel lockers is also challenging, but critical to meeting customer demand for different goods.

Iwan et al. (2016) state that the best location is related to the availability of local hot spots within suburbs, high traffic pedestrian areas in city centres, shopping centres and supermarkets car parks, bus/underground stations, petrol stations, service stations and business centres. Participants in Lemke et al. (2016)'s study on Polish cities prefer smart lockers located near their homes, while those located on their way to work rank second. Shopping centres and public transportation stops were found to be the least attractive locations.

Another perspective on location is provided by Collier et al. (2015), which discusses the area itself where self-service technology is to be located. It is suggested that if customers are forced to work within a limited space, they might feel an extra sense of pressure to complete their tasks faster, and this could hinder the likelihood of using the technology for some individuals.

2.5. Relevance of the Literature Review

In summary, the literature review plays a pivotal role in contextualizing and grounding this study. Through a comprehensive examination of existing literature and scholarly work, the literature review provides valuable insights, that are emphasized and elaborated upon within the research framework, into the last-mile world and smart locker market and gives the author a

broader landscape of consumer behavior and technology adoption within the realm of smart lockers.

By synthesizing a range of studies and empirical findings, the literature review helps identify gaps in current literature and establishes a foundation upon which the thesis can build its research questions and hypotheses. It also allows the author to pinpoint key variables, and recognize patterns, trends, and discrepancies in the existing knowledge which contributes to the credibility and relevance of the study. The pivotal variables mentioned are consistent with those discussed earlier in the literature review. These variables encompass privacy security, reliability, convenience, location, compatibility, relative advantage, and complexity. Among these variables, the first four were derived from the selected theory for this thesis's analysis, the resource matching theory (Yuen et al., 2019). The remaining three variables were selected from the complementary theory, the innovation diffusion theory (Wang et al., 2012). Detailed explanations on both of these theories will be provided in the research framework.

3. Research Framework

Recently, the use of new technologies for last mile delivery, as previously mentioned has grown. Consequently, this topic has been the focus of various research in the past years on different fronts, including the adoption of Smart lockers. The perception, acceptance, and intention of use and behaviour of individuals regarding Smart lockers has been debated in several studies.

In these studies, on smart locker intention, researchers have applied several theories, such as resource matching theory, perceived value theory, innovation diffusion theory, theory of planned behaviour, and theory of transaction cost economics. These theories can be applied to the context of explaining intention of use by helping researchers understand the underlying factors and motivations that influence whether individuals or organizations intend to use a resource, technology, or innovation.

Perceived Value theory (Yuen et al., 2019) posits that people are more likely to utilize a product or service when they believe it offers substantial value. Consequently, this theory elucidates how effectively aligning customers' cognitive resources results in the generation of value.

The Theory of Planned Behavior (Ajzen, 1991) illuminates individuals' hesitancy in adopting new behaviors and the degree of effort they invest in carrying out these behaviors. This determination is shaped by their attitudes, the influence of subjective norms, and their perception of behavioral control. The theory of planned behavior places significant emphasis on an individual's intention to engage in a specific behavior.

Although Transaction Cost Economics (Wang et al., 2012) mainly centres on economic factors, it is still pertinent in elucidating usage intentions. When users adopt and use a service such as Smart Lockers, it can be viewed as a form of transactional behaviour. Yuen et al. (2019) highlight that when making decisions, all costs, including those associated with transaction execution, are considered. Therefore, this theory can clarify how the alignment of customers' cognitive resources reduces transaction costs and improves intention to use.

The resource matching theory is employed to comprehend how both individuals and organizations distribute and align their resources. This theory posits that choices or intentions come into play when the resources at a customer's disposal align with or surpass the perceived requirement of resources necessary for obtaining a particular service (Yuen et al., 2019). The resource matching theory can elucidate how reducing the effort in using smart lockers can enhance customers' perceptions of their usefulness and strengthen their inclination to use them.

When applying the resource matching theory to smart locker use, we can argue that variables like convenience, privacy security, reliability and location can reduce the perceived resources for smart lockers. (Yuen et. al, 2019).

On the other hand, resources are not the only concern when adopting new technology. Therefore, the author also applied Innovation Diffusion Theory in this study, proposed by Everett Rogers in 1962. The theory continues to stand as robust theory for forecasting how innovations spread within a societal context (Wani & Ali, 2015), and can assist in elucidating the process of making innovation-related decisions and analyse the concerns that potential adopters may harbour when considering adopting an innovation (Wang et al., 2012). The set of attributes used to explain the rates of adoption by users are relative advantage, compatibility, complexity, trialability, and observability. (Wang et al., 2012). In this study, the author did not consider trialability and observability since smart lockers are not well-known in Portugal, therefore, only relative advantage, compatibility and complexity are used to explain user adoption. The exclusion of trialability and observability seems to be quite common within the literature that uses Innovation Diffusion Theory, for example Wang et al. (2012) excludes these two attributes when studying the Determinants of user adoption of web “Automatic Teller Machines”, and Tsai and Tiwasing (2021) also excluded these two attributes in their study on customers’ intention to adopt smart lockers in last-mile delivery services in Thailand.

Several instances of authors utilizing these theories in their research on the intention of use include, Yuen et al. (2019) that analysed the determinants of customers’ intention to use smart lockers for last mile deliveries in China using the resource matching, perceived value, and transaction cost economics theories and concluded that perceived value has the strongest influence on customers’ intention followed by reliability and convenience. Yuen et al. (2018) employed Innovation Diffusion Theory to investigate customers’ intention to use self-collection services in Singapore, that showed that relative advantage, compatibility and trialability positively influence customers’ intention. In addition, Tsai and Tiwasing (2021) integrate resource matching theory, innovation diffusion theory, and theory of planned behaviour to understand the intention to utilize smart lockers by Thai consumers with all the nine hypotheses being supported with a significant correlation with attitude showing the strongest impact on intention.

Studies previously mentioned focused mostly on countries outside of the European Union. By examining Portuguese consumers' perceptions and intentions, the author provided a foundational understanding of this parcel delivery service's future in Portugal.

In the previously cited study by Tsai and Tiwasing (2021), the authors introduced an innovative framework that blends three key theories: resource matching, innovation diffusion, and planned behavior. This framework consists of two levels of latent variables, where attributes such as convenience, reliability, and privacy security are initially assessed through the second level of perceived behavioral control to understand their impact on intention. Simultaneously, factors like compatibility, relative advantage, and complexity are evaluated through the second level of attitude to gauge their influence on intention. When making recommendations for future research the authors suggest that these first-level variables may directly affect consumers' intention to use smart lockers, bypassing the need for a second-order latent construct. In this present study, the aim is to contribute to the literature by directly connecting two of these theories, namely resource matching and innovation diffusion, to elucidate consumers' intention to adopt smart lockers. Last, the study identifies whether a new technology like smart lockers can provide effective last-mile logistics delivery in Portugal and what location is preferred by Portuguese consumers.

To find answers to this research gap, it is crucial to identify what factors drive or hinder people to consider the use or not of smart lockers. A framework was created, and hypotheses were formulated to answer these questions within the Portuguese market. Thus, the main objectives of this study are to understand if the Portuguese consumers are using Smart Lockers as a delivery method (1), if the attitude of Portuguese customers' about using smart lockers is positive or negative (2), what factors positively influence customers' intention to use smart lockers (3), and in which locations do Portuguese consumers express a preference for the placement of smart lockers (4).

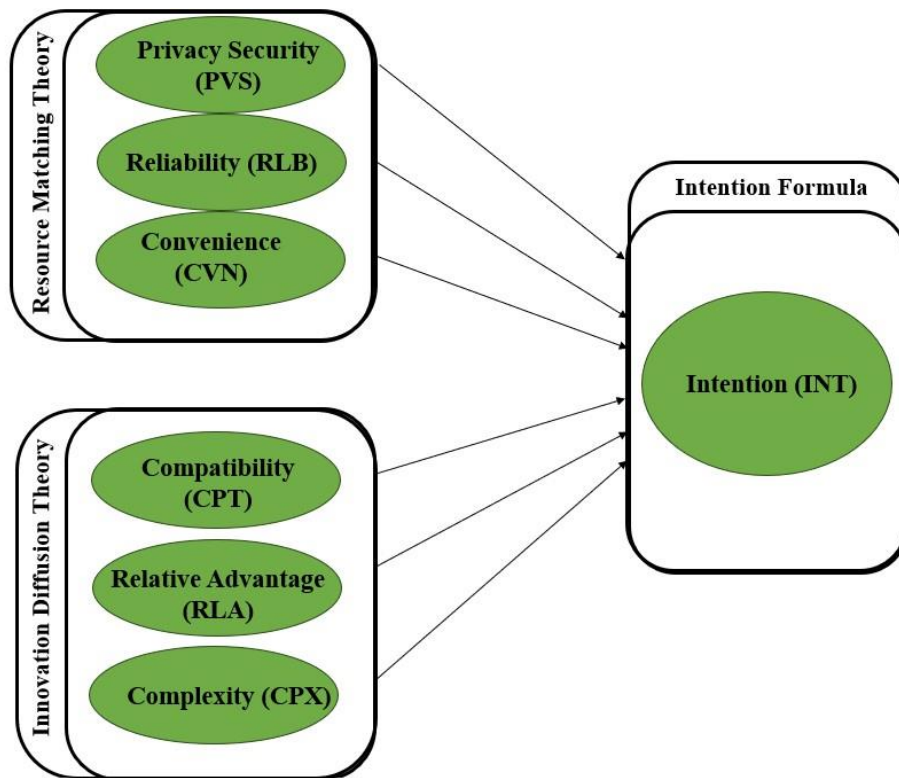


Figure 3.1. – Research Framework

Drawing from the variables examined in the literature review, we can put forward the subsequent hypotheses:

Hypothesis 1: Convenience has a positive effect on consumers' intention to use smart locker services.

Hypothesis 2: Reliability has a positive effect on consumers' intention to use smart locker services.

Hypothesis 3: Privacy security has a positive effect on consumers' intention to use smart locker services.

Hypothesis 4: Compatibility has a positive effect on consumers' intention to use smart locker services.

Hypothesis 5: Relative advantage has a positive effect on consumers' intention to use smart locker services.

Hypothesis 6: Complexity has a negative effect on consumers' intention to use smart locker services.

Table 3.1. - Constructs and measurement items

Construct	ID	Measurement items	Adapted Source
Convenience (CVN)	CVN1	Using smart lockers seems easy	Tsai and Tiwansing (2021) Gundu (2020) Yuen (2019)
	CVN2	Using smart lockers does not require much effort	
	CVN3	Using smart lockers allows me to pick up my packages when it's most convenient for me	
Reliability (RLB)	RLB1	Using Smart Lockers is more reliable than someone delivering my package at home	Vakulenko et al. (2019) Tsai and Tiwansing (2021) Barua et al. (2017)
	RLB2	Using Smart Lockers offers service accuracy	
Complexity (CPX)	CPX1	I feel smart lockers are difficult and frustrating to use	Yuen et al. (2018)
	CPX2	I feel using Smart lockers requires a lot of time and effort	
Privacy Security (PVS)	PVS1	I feel/ would feel secure using smart lockers	Tsai and Tiwansing (2021) Yuen et al. (2019) Gundu (2020)
	PVS2	I would not be concerned about the privacy and security of my items stored in smart lockers	
	PVS3	I can keep my information private by using smart lockers	
Compatibility (CPB)	CPB1	I believe receiving parcels by smart lockers is compatible with my lifestyle	Tsai and Tiwansing (2021) Yuen et al. (2018) Yuen et al. (2019)
	CPB2	I feel receiving packages by smart lockers is compatible with my needs	
Relative Advantage (RLA)	RLA1	Overall, I believe smart lockers are advantageous	(Vakulenko et al., 2018) Vakulenko et al. (2019)
	RLA2	Using Smart lockers is better than home delivery	
Intention (INT)	INT1	I intend to use smart lockers in the future	Collier et al. (2015)
	INT2	I would recommend the use of smart lockers to peers	
	INT3		
Construct	ID	Measurement items	Adapted Source

	INT4	I would be inclined to use Smart lockers if it was recommended to me by friends or family I am planning to use smart lockers often	Tsai and Tiwansing (2021)
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Source: Author's elaboration

It is important to note that the construct and measurement items were adapted from previously published studies that are mentioned in the 'Adapted Source' column of the table above.

4. Methodology

In this section of the study, the author will outline the research method used and go over the data collection, type of survey, sampling technique and research structure.

4.1. Data Collection

The data collection for research can be through primary data or secondary data. The latter concerns data that has already been collected for purposes other than the problem at hand and is readily available. The former is data collected by the researcher for the specific purpose of addressing the problem at hand when there is not enough secondary data available.

It is possible to collect primary data in a qualitative or quantitative manner. Research conducted quantitatively measures variables for individual participants to obtain numerical values, which are analysed statistically and interpreted. Research conducted qualitatively involves making observations that are summarized and interpreted in a narrative report.

This research was conducted using primary data as the main collection method of this research on customer perception and intention of use of the smart locker system, with the quantitative survey technique in a cross-sectional design, meaning it involves the collection of information from any given sample of population elements only once.

4.2. Type Of Survey

There are many ways to conduct a survey for research. The classification of survey methods are telephone interviews, personal interviews, mail interviews, mobile interviews, and electronic interviews. Considering the options, the survey choice for this study was a web-based survey spread through social media built with Google Forms. The choice was based on many factors considering that every method has its benefits and drawbacks. Some benefits that author identified for choosing this option were the wide reach of social media and its speed and efficiency, how quickly it is possible to gather responses from many participants within a short period of time.

4.3. Sampling Technique

The sampling shows the selection of participants that will answer the survey. The sampling technique that was used in this research is a non-probability sampling. This means that the sampling technique does not use chance selection procedures. Specifically, convenience sampling was employed, which means selecting participants who are readily available and accessible. The survey was publicized on social media via Instagram, WhatsApp, LinkedIn and

Facebook meaning they were distributed to individuals that have access to the Internet, with social media accounts and are more likely to come across the author's publication.

4.4. Structure

A structured survey was conducted with a self-administered internet questionnaire. The target population for this study is Portuguese customers who have encountered or have the potential to use smart lockers meaning people who may place orders and receive packages. Prior to completing the questionnaire, the participants were briefed on the study purpose, anonymity, and voluntary nature of participation, as well as a brief explanation of smart lockers. Afterward, they were asked to fill out a questionnaire to rate the perception, acceptance, user experience of the product and intention of use. The data collection period was based on availability of participants making the questionnaire opened for one month.

The questionnaire designed to gather data from the participants consisted of only closed-ended questions to simplify the data analysis and was pilot-tested on a small group of respondents to ensure clarity and validity. A filter question ("Have you understood the smart locker concept?") was added to the questionnaire so that the answers corresponded to the universe under analysis. Responses from participants who do not know what smart lockers are and who did not understand the concept prior to answering the survey were not considered as valid.

The questionnaire was divided into three parts. In the first part the researcher aimed to explore the demographics of the respondents. Information regarding, gender, age, living area, educational level, monthly income, employment status and choice of means of transport to work / university were collected.

The second part of the questionnaire includes information regarding shopping preferences, encompassing participants preferred method of shopping, frequency of shopping, how many packages they receive a month and what address they use to receive packages.

In the third and final part of the questionnaire, the participants' knowledge of Smart lockers is examined, along with their past utilization of the service. In addition, this part of the survey also covers the attitude towards the service and intention of use, willingness to pay, preferred location, and important characteristics of delivery services, as well as evaluating the variables identified in the literature review, which include convenience, reliability, complexity, privacy security, compatibility, relative advantage and intention.

The study's dataset includes 234 responses with 226 valid participant responses, of which 139 were female and 85 were male, and the average age was between 18 and 24 years old. The sample's demographic profile is presented in Table 5.1. and Table 5. 2..

5. Data Analysis and Discussion of Results

The author performed a statistical analysis on the gathered data using SPSS as the primary tool for analysis. Firstly, descriptive statistics were employed to present an overview of the participants' demographic characteristics. Subsequently, we delved into examining consumer habits to gain insights into consumer behaviour. Following this, we explored participants' preferences regarding location. Finally, we concluded by investigation consumers' perception and intentions regarding the use of smart lockers.

The questionnaire obtained a total of 234 answers; however, the research sample consists of 226 respondents. The author will not consider as valid responses those who checked "No" to the question "Have you understood the Smart Locker concept?".

5.1. Characteristics of the Sample

This section of the findings will cover the respondents' demographic information, which comprises gender, age, residential location, education level, monthly income, occupation, and their mode of transportation to work or university. Out of the 226 considered responses 139 participants are female, 85 are male and 2 checked "Other". Percentages wise, this means female have a share of 61,5%, males of 37,6%, and "Other" of 0,9%. Off this sample the range of the age of 18 – 24 had the greatest number of respondents (53,5%), followed by the age ranges of >45 (28,8%), 25-34 (15%) and 35-45 (2,7%). The majority of respondents were educated with a bachelor's degree (64,6%), followed by a master's degree (26,5%), High School (7,5%) and Doctoral Programme or other (1,3%). With regard to residential location, responses included Lisbon Metropolitan Area as the most chosen 150 (66,4%), Central Region (23,9%), Açores and Alentejo Region both with (3,1%), North Region (2,2%), Algarve Region (0,9%) and Madeira (0,4%).

Table 5.1. – Demographics of respondents (personal data)

Variable	N	Total	
			%
<i>Sex</i>			
Female	139		61,5
Male	85		37,6
Other	2		0,9
<i>Age Group</i>			
18-24	121		53,5

25-34	34	15,0
35-45	6	2,7
>45	65	28,8
<i>Education level</i>		
High School	17	7,5
Bachelor's Degree	146	64,6
Master's Degree	60	26,5
Doctoral Programme or other	3	1,3
<i>Residential Location</i>		
Lisbon Metropolitan Area	150	66,4
North Region	5	2,2
Central Region	54	23,9
Alentejo Region	7	3,1
Algarve Region	2	0,9
Açores	7	3,1
Madeira	1	0,4

Source: SPSS

Regarding occupation the author divided into 5 groups, with the results showing the highest results 'Homemaker, Student, Retired person' with 43,4%, employed (in-person job) with 31,4%, employed (hybrid work) with 19,0%, employed (work from home) with 4,0% and unemployed with 2,2%. Off the 226 respondents, regarding monthly income, 38,9% stated they were financially dependent, 26,5% earned between 1301€-2600€, 16,8% between 760€-1300€, 14,6% between 2601€-5000€, 1,8% more than 10000€ and finally 1,3% between 50001€-13000€. Finally, when it comes to transportation car placed first with 42,9%, closely followed by public transport with 41,6%, walk in third place with 11,5% and finally bike with 4%.

Table 5.2. – Demographics of respondents (occupation related)

Variable	N	Total
		%
<i>Occupation</i>		
Homemaker, Retired person, Student	98	43,4
Employed (in-person job)	71	31,4
Employed (hybrid work)	43	19,0
Employed (work from home)	9	4,0
Unemployed	5	2,2
<i>Monthly income</i>		
Financially dependent	88	38,9
760€-1300€	38	16,8
1301€-2600€	60	26,5
2601€-5000€	33	14,6
5001€-10000€	3	1,3
>10000€	4	1,8
<i>Transportation to work</i>		
Bike	9	4,0
Car	97	42,9
Public Transport	94	41,6
Walk	26	11,5

Source: SPSS

5.2. Consumer Habits and Behaviour

The latter section of the survey delves into consumer habits and attitudes regarding shopping and Smart lockers. A majority of respondents, specifically 67.7%, express a preference for inperson shopping, while 32.3% favor online shopping. In terms of shopping frequency, the data shows that 51.8% of consumers shop online once a month, 29.6% shop online only twice a year, 9.3% shop online every week, 6.2% shop online once a year, 2.7% shop online twice a week, and daily online shopping is the least common, with only 0.4% of consumers engaging in this behavior.

Regarding the quantity of packages received each month, 64,2% of consumers receive between 1 and 2 packages, 25,7% report receiving 0 packages monthly, 8,0% receive between 3 and 5 packages, and 2,2% receive more than 5 packages. As for the delivery location, 52,7% state that they consistently have their packages delivered to their home, while a significant 47,3% of consumers opt for an alternative delivery address.

Shifting our focus to questions related to Smart lockers, the data reveals that a majority of consumers (64,2%) were already familiar with the concept of smart lockers, while 35,8% learned about them when they participated in the questionnaire. Despite this awareness, only 13,7% of respondents reported using the service, with 86,3% indicating they had not.

Regarding cost of the delivery, when asked “ In addition to the delivery cost, how much would you be willing to pay for the use of the smart locker service”, 31,9% of respondents indicated a willingness to pay 1,0€. Following closely, 30,5% expressed their preference not to pay anything for the service. About 16,8% were open to paying 0,5€, while 1,5€ and 2,0€ both garnered 8,8% of responses. On the higher end, more than 2,0€ was chosen only by 3,1% of respondents. Interestingly, 92,0% of respondents stated that they would opt for this service if it were the most cost-effective delivery option.

5.3. Preferences regarding location and delivery services

When it comes to the preferred locations for smart lockers according to consumers, they were presented with seven possible options and could select multiple choices, following a "check all that apply" format. Therefore, the total percentages mentioned here will exceed 100%.

The top choice, selected by a significant majority, was having smart lockers located near their residential area, with 60.6% of respondents indicating this preference. In the second position, shopping malls garnered 46.0% of respondents' support, closely followed by supermarkets at 45.1%. Another notable consideration was office buildings, which ranked fourth with 30.1%.

Interestingly, transportation hubs received support from 20.4% of respondents, even though public transportation seemed to be a primary mode of commuting for 41.6% of the participants. Petrol stations and "other" locations occupied the last two positions, with 16.4% and 2.7%, respectively.

In Lemke et al. (2016)'s study on Polish cities, previously mentioned in the literature review, participants also expressed a preference for smart lockers located near their homes as

the top choice. However, shopping centres were not explicitly mentioned as preferred locations in their findings whereas in the present study it claimed the second position. Public transportation stops were found to be among the least attractive locations, which contrasts with our findings where transportation hubs received some support. These variations in location preferences highlight the importance of considering local context and cultural factors in the acceptance and placement of smart locker systems.

Table 5.3. – Descriptive statistics of preferences related to the attributes of smart locker locations

	N	Minimum	Maximum	Mean	Std. Deviation
Proximity to your residence	226	1	5	4,53	,828
Proximity to your workplace	226	1	5	4,10	1,089
Proximity to public transportation	226	1	5	3,12	1,333
Availability of parking nearby	226	1	5	3,73	1,352
Secure location	226	2	5	4,77	,579
High traffic Area	226	1	5	3,54	1,166
N (valid)	226				

Note: 5 very important, 4 important, 3 neutral, 2 mildly important, 1 Not important Source:

SPSS

According to Pimentel (2010), who utilized a five-point Likert scale recognized as an interval scale, the mean holds significant importance, as outlined below:

- Scores between 1 and 1.79 indicate that the attribute is "not important."
- Scores ranging from 1.80 to 2.59 signify that the attribute is "mildly important."
- In the range of 2.60 to 3.39, the attribute is considered "neutral."
- A score of 3.40 to 4.19 indicates that the attribute is "important."
- Finally, a score falling between 4.20 and 5 suggests that the attribute is "very important."

Using this framework to analyze the table above, we observe that for the first statement, with a mean score of 4.53, the majority of participants express that proximity of smart lockers to their residence is of great importance to them. Regarding the second statement about proximity to the workplace, most participants consider it important, as it has a mean score of 4.10. When it comes to proximity to public transportation, which is somewhat unexpected given the high

usage of public transportation among respondents, the majority rated it as "neutral," with a mean score of 3.12. Notably, this was the lowest mean among all the statements.

The availability of nearby parking was perceived as important by most respondents, with a mean score of 3.77, which aligns with the popularity of this mode of transportation. "Secure location" received the highest mean score of 4.77, signifying its paramount importance to the majority of respondents. It's noteworthy that this statement also had a minimum score of 2, rather than 1, indicating that no respondent considered a secure location "not important." Lastly, "High traffic area" received a mean score of 3.54, positioning it as important, possibly due to security considerations.

5.4.Importance of characteristics of a delivery service

When participants were requested to assess the importance of the specified delivery services using the aforementioned 1 to 5 scale, and with reference to the findings presented by Pimentel (2010), the outcomes are displayed below.

Table 5.4. – Descriptive statistics of preferences related to attributes of delivery services

	N	Minimum	Maximum	Mean	Std. Deviation
24/7 pick-up time	226	1	5	4,56	,788
Ecological transport/ lower emissions	226	1	5	3,85	1,079
Personal Information Security	226	2	5	4,73	,529
Lowest Cost	226	1	5	4,47	,778
Lowest Effort	226	1	5	3,49	1,216
Employee to help if needed	226	1	5	4,15	,961
N (valid)	226				

Note: 5 very important, 4 important, 3 neutral, 2 mildly important, 1 Not important

Source: SPSS

Utilizing the aforementioned framework, the attribute that garnered the highest mean score, signifying its significance to the majority of respondents, was personal information security, with an average rating of 4.73. It's noteworthy to mention that this was the only attribute with a minimum score of 2.

Following closely with a notably high mean score of 4.56 was 24/7 pick-up availability, which also fell within the realm of "very important" for most participants. Next in line, but still highly regarded, was the attribute of lowest cost, receiving a mean score of 4.47. This

observation aligns with the fact that 92% of consumers expressed a preference for smart locker delivery if it were the most economical choice.

Transitioning from the "very important" category, having an employee available to assist if needed was rated as "important" by most respondents, with a mean score of 4.15. As noted earlier in the literature review, Barua et al. (2017) discuss how customers may sense the lack of direct service employee support. These findings align with our respondents' views, as they emphasize the significance of this presence. Lastly, the last two characteristics, while still considered important, had slightly lower mean scores: ecological transport scored 3.85, and lowest effort scored 3.49, respectively.

5.5. Consumer's perception and intention of use and Hypothesis testing

In this section, we outline and evaluate the key assumptions that underlie the multiple regression analysis conducted in this study.

Assumption one: Linearity of Relationships

The relationship between the dependent variable and the independent variables is assumed to be linear. This assumption was evaluated by examining scatterplots (see Annex B), which did not suggest any significant non-linear relationships.

Assumption two: Absence of significant outliers

We assessed the presence of significant outliers in the data series by analyzing the residuals statistics table in Annex B. The Studentized residuals, with values ranging between 2.446 and 2.437, did not exhibit cases falling below -3 or above +3. Consequently, further investigation for significant outliers was deemed unnecessary.

Assumption three: Independence of errors

The assumption of independence of errors, implying no relationship between the independent variables and the residuals, was evaluated using the Durbin-Watson statistic. With a value of 2.063 (see the model summary table in Annex B), falling within the range of 1.5 to 2.5, this assumption is supported.

Assumption four: Homoscedasticity

The analysis affirms that the assumption of homoscedasticity holds. This is evident from the scatterplots presented in Annex B, where the X-axis represents the regression Standardized Predicted value, and the Y-axis represents the Regression Standardized residual. These scatterplots demonstrate a uniform distribution of values without the formation of clusters, thereby confirming the presence of homoscedasticity.

Assumption five: Normality of residuals

The assumption of normally distributed residuals was assessed in multiple ways. First, a histogram of the standardized residuals (Annex B) displayed only minor deviations from normality. Additionally, a normal P-P plot (also shown in Annex B) was used to assess normality by comparing observed residuals against those expected under the condition of normality. While some deviations from the regression line were observed, these deviations were minor and provided support for the assumption of normally distributed residuals.

Assumption six: Absence of Multicollinearity

We ensured that multicollinearity was not a significant concern by examining the coefficients table in Annex B. All tolerance values exceeded 0.1, and all Variance Inflation Factors (VIFs) were below 10, indicating the absence of strong multicollinearity among the independent variables.

These assumptions provide the foundation for our multiple regression analysis, and our thorough evaluation of each assumption ensures the validity and reliability of our results. In the subsequent sections, we present the findings and interpretations of our regression analysis.

Secondly, the reliability of the measurement items was examined as showed in Table 5.5.

Table 5.5. – Reliability Statistics

	Cronbach Alpha (α)
Convenience	,843
CVN1	
CVN2	
CVN3	
Reliability	,714
RLB1	
RLB2	
Complexity	,815
CPX1 CPX 2	
Privacy Security	,887
PVS 1	
PVS 2	
PVS3	
Compatibility	,853
CPB1	
CPB2	
Relative Advantage	,804
RLA1	
RLA2	
Intention	,917
INT1	
INT2	
INT3	
INT4	

Source: SPSS

The Cronbach's Alpha score evaluates internal consistency and reflects how effectively the items within a measurement instrument capture various aspects of the same underlying attribute or concept. A construct is reliable if the Alpha value exceeds 0.70. Upon careful examination of the Cronbach Alpha values for each variable, the author noted that all variables were found reliable as seen above.

When considering the Convenience variable's third question and the Privacy and Security variable, there was a possibility of excluding them during the Cronbach alpha analysis 'if item was deleted, as their removal could have resulted in a higher overall alpha value. However, given that the alpha value was already sufficiently high, the researcher made the deliberate choice to retain these questions in the analysis. It's crucial to emphasize that a value closer to 1 signifies enhanced reliability.

Table 5.6. – Model Summary

Model	R	R Squared	Adj. R Squared	Std. Error of the Estimate	Durbin-Watson
1	,787	,619	,609	,43777	2,063

a. Predictors: (Constant), RLA, CPX, PVS, RLB, CVN, CPB

b. Dependent Variable: Intention

Source: SPSS

The regression model demonstrates the following key statistics:

R: 0.787, indicating a strong positive linear relationship between the independent variables and the dependent variable.

R Squared (R^2): 0.619, implying that approximately 61.9% of the variance in the dependent variable is explained by the independent variables, signifying a substantial explanatory power.

Adjusted R Squared (Adj. R^2): 0.609, considering the model's complexity, and still explaining approximately 60.9% of the variance in the dependent variable.

Standard Error of the Estimate: 0.43777, indicating a low average deviation of the model's predictions from actual data points, suggesting a good fit.

These findings collectively indicate that the regression model provides a strong fit to the data, with a substantial portion of the variance in the dependent variable explained by the independent variables. The low standard error of the estimate further enhances the model's reliability.

Table 5.7. – Multiple Regression Analysis

Hypothesis	Regression Weights	Beta Coefficient	Std. Error	t-value	p-value	Hypothesis Supported
H1	CVN>INT	,145	,065	2,654	,009	Yes
H2	RLB>INT	,143	,049	2,927	,004	Yes
H3	PVS>INT	,170	,053	3,187	,002	Yes
H4	CPB>INT	,305	,054	5,196	<,001	Yes
H5	RLA>INT	,328	,054	6,446	<,001	Yes
H6	CPX>INT	,065	,041	1,308	,192	No

Dependent Variable: Intention

Source: SPSS

A multiple regression analysis was employed to examine the correlation significance of the hypothesis. The study aimed to understand the relationships between various independent variables (Convenience, Reliability, Privacy Security, Compatibility, Relative Advantage and Complexity) and the dependent variable, "Intention."

Hypothesis 1: Convenience > Intention

The analysis reveals that Hypothesis 1, which posited that "Convenience has a positive impact on Intention" is supported. The beta coefficient of 0.145 signifies a positive relationship between convenience and intention. Furthermore, the statistically significant p-value ($p = 0.009$) suggests that this relationship is not due to random chance but is indeed statistically meaningful. These findings imply that as convenience increases, intention is also likely to increase.

Hypothesis 2: Reliability > Intention

Hypothesis 2, suggesting that "Reliability positively affects Intention," is strongly supported. The beta coefficient of 0.143 demonstrates a substantial positive relationship between reliability and intention. The highly significant p-value (0.004) underscores the robustness of this relationship, indicating that reliability significantly influences Intention.

Consequently, an increase in Reliability is associated with a higher likelihood of intention.

Hypothesis 3: Privacy Security > Intention

The findings for Hypothesis 3, stating that "Privacy Security positively impacts intention," indicate a statistically significant relationship. With a beta coefficient of 0.170 and a p-value of 0.002, privacy security is deemed to have a positive influence on intention. These results highlight the importance of privacy security in shaping Intention, with higher privacy security scores corresponding to greater Intention.

Hypothesis 4: Compatibility > Intention

Hypothesis 4 posited that "Compatibility has a positive effect on intention," and the analysis strongly supports this claim. The beta coefficient of 0.305, accompanied by a highly significant p-value (<0.001), underscores the substantial impact of compatibility on intention. As compatibility increases, intention is also expected to increase, making compatibility a key driver of intention.

Hypothesis 5: Relative Advantage > Intention

The results for Hypothesis 5, which suggested that "Relative Advantage positively influences intention" are consistent with expectations. A beta coefficient of 0.328 and a highly significant p-value (<0.001) highlight the significant impact of relative advantage on intention. This underscores the significance of Relative advantage as a predictor of intention, with higher relative advantage values associated with increased intention.

Hypothesis 6: Complexity > Intention

In contrast, Hypothesis 6, proposing that "Complexity has a negative effect on Intention," does not find support in the analysis as the non-significant p-value (0.192) indicate that complexity does not have a statistically significant impact on intention.

In summary, the findings of this study reveal strong support for most hypotheses (H1 to H5), with convenience, reliability, privacy security, compatibility, and relative advantage all significantly influencing intention. However, Hypothesis 6, which focused on complexity, does not gain empirical support. These results provide valuable insights into the factors influencing intention and can inform decision-making in relevant domains.

It's not surprising that Relative Advantage and compatibility emerge as the most significant factors. Customers typically require a compelling reason to switch from their existing preferences, especially when home delivery remains the top choice. To bring about this change, customers need to be educated about the advantages of alternative delivery methods. Similarly, for compatibility, customers must perceive how smart locker services align better with their lifestyle and needs for them to consider switching. Moreover, relative advantage with the mean value of 3.9137 in Table 5.8 indicates that, on average, customers only slightly favor smart lockers over existing options.

Furthermore, there is a notable correlation between privacy and security and the intention to use smart locker services. This aspect holds significant importance for consumers who want assurance that their personal information and belongings remain safe. It is imperative for logistic service providers to educate customers about the workings of smart locker services, as it differs substantially from the conventional standard delivery method they are accustomed to.

Among all the characteristics considered, convenience and reliability rank the lowest while still exerting a predictive influence on intention. Smart locker providers can gain a competitive edge by presenting the delivery process as not only convenient but also user-friendly for consumers in their daily lives. They can market these convenience advantages when compared to other delivery methods, such as the 24/7 availability option. Regarding reliability, ensuring the accuracy and dependability of the service is pivotal for its success. Building trust with customers by consistently delivering on promises is essential in retaining them as long-term clients.

Table 5.8. – Descriptive Statistics

	Mean	Standard Deviation	N
Convenience	4,3289	,58582	226
Reliability	4,0088	,69756	226
Privacy Security	3,9454	,70796	226
Compatibility	4,3119	,76233	226
Relative Advantage	3,9137	,84925	226

Table 5.7 reveals that among the five characteristics demonstrating statistical significance, their impacts on customers' intention are not uniform. Yet, Table 5.8 demonstrates that the

majority of variables have mean values ranging from 3.9 to 4.3. This indicates that customers generally hold a viewpoint towards smart lockers that is fairly neutral to positive.

6. Conclusions

With the objective of gaining insight into the perspectives of Portuguese consumers regarding the adoption of smart locker technology—an innovation offering various benefits to individuals and logistic services while addressing the last-mile delivery challenge—this thesis delves into the willingness of Portuguese consumers to embrace smart locker systems. This research contributes to both theoretical comprehension and the practical management of self-collection services. A convenience sampling method was employed, resulting in 226 valid questionnaire responses.

From a theoretical perspective, this thesis augments existing literature by combining the Innovation Diffusion Theory and Resource Matching Theory. The study utilizes variables such as compatibility, relative advantage, and complexity from the Innovation Diffusion Theory and convenience, reliability, and privacy security from the Resource Matching Theory. The findings from the hypotheses support five out of six hypotheses, revealing significant correlations. Notably, complexity does not exert a statistically significant influence on the intention of Portuguese consumers, while Relative Advantage and compatibility emerge as the most influential factors shaping their intention.

6.1. Comparing results

When we compare the outcomes of the present study with those of prior research, significant distinctions come to the fore. Yuen et al. (2019) and Tsai and Twisang (2021) conducted separate investigations, with Yuen et al. (2019) focusing on consumers in China, while Tsai and Twisang (2021) centered their study on Thai consumers. Both studies explored the same factors—convenience, privacy security, and reliability—that were examined in our research and were found to significantly influence customer intention. However, it is essential to note that in both studies, latent variables were employed, and direct influence was not established.

Additionally, Yuen et al. (2018) identified that relative advantage and compatibility exerted positive effects on customer intention. Furthermore, similar to our findings, both studies did not find complexity to have a significant impact on intention, suggesting that consumers may already perceive smart lockers as straightforward and uncomplicated in today's digital age. Thus, the perceived simplicity of the process may not be a significant determinant of customers' intention to adopt the service.

In contrast, Tsai and Twisang's (2021) research among Thai consumers yielded contrary results, indicating that complexity does indeed play a substantial role in shaping intention.

6.2.Recommendations

The comprehensive findings presented in this thesis offer valuable insights into the prospects of smart lockers in the Portuguese market. Firstly, a notable observation is the limited awareness of smart lockers in the Portuguese market, with a substantial 35.8% of respondents indicating unfamiliarity with the concept, and an overwhelming 86.3% reporting no prior use of such services. This underscores the need for enhanced publicity and education regarding smart locker offerings.

The data further reveals a promising market for smart lockers, as 64.2% of consumers receive between 1 to 2 packages monthly, and 47.3% already utilize alternative delivery addresses aside from their residences. To encourage the adoption of smart locker services among Portuguese customers, offering the most cost-effective delivery option appears to be a compelling strategy, as a remarkable 92% of respondents expressed their preference for this choice when assured of its affordability.

Regarding the ideal locations for smart lockers, the study emphasizes the significance of situating them near residential areas. Additionally, shopping malls and supermarkets emerge as suitable options. However, it is crucial to highlight that petrol stations do not seem to align with the preferences of the Portuguese market for smart locker placement. Moreover, emphasizing the security aspects of smart lockers, particularly in terms of privacy and security, holds importance, considering their prominence in the consumers' perception of characteristics.

6.3.Research Limitations

While this research has made valuable contributions, it is essential to acknowledge certain limitations that warrant consideration in future studies. Firstly, the sampling method employed in this research could potentially result in a non-representative sample, as certain demographic groups may be disproportionately represented, while other may be underrepresented. Additionally, there is the possibility of self-selection bias inherent in web surveys, as participation is voluntary and primarily driven by individuals who are more likely to encounter the author's publications. Lastly regarding sample size of this research, 226 respondents is sufficient, but a larger sample size would be ideal to be sure the outcomes of this research truly represent the consumers.

Another important consideration is that smart lockers represent a relatively novel and unfamiliar service in Portugal. This novelty is reflected in the sample, where only 13.7% of

individuals have experimented with it, while a relatively substantial portion, 35.8%, were previously unaware of its existence. These numbers did not meet the criteria for statistical significance, with a resulting proportion of 86.3% who had not utilized the service and 13.7% who had. While this data may provide some insight into usage patterns, it may not be sufficient to draw meaningful and robust conclusions.

Ultimately, in designing the survey, particularly regarding the final question aimed at testing the hypothesis, the author made a deliberate decision not to allocate an equal number of questions to each variable. This choice stemmed from the researcher's concern that certain topics ended up with redundant questions, potentially leading to survey lengthening and a subsequent decline in participants' willingness to proceed with answering the survey. In hindsight, the author now believes that it would have been more precise to employ an equal number of questions for testing each variable. Moreover, concerning the assessment of reliability, it is worth noting that Cronbach's alpha is highly responsive to the quantity of items. In hindsight, if given the opportunity, the author would choose to include more items in their research to enhance the reliability of the analysis.

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Annexes

Annex A | Questionnaire structure

PORTUGUESE CUSTOMERS' PERCEPTION AND INTENTION OF USE F SMART LOCKERS

Dear Participant,

This survey is aimed at exploring the perception and intention of Portuguese customers on the use of Smart Lockers. This survey is part of a thesis project inserted in the Management Master at ISCTE, and aims to understand consumer attitudes towards the use of these technologies in the Portuguese market.

The survey will take approximately 3 minutes to complete and involves answering questions about your familiarity with Smart Lockers, your perceived benefits and concerns about their use, and your likelihood of using them in the future.

Smart lockers are similar to the traditional mailbox but with digital access, security cameras, and software. End users when online shopping select lockers as the delivery method and then receive access instructions. They can be placed anywhere, including heavy-traffic areas where they can be accessed by more users, are available 24/7, there is no staff involved, are fast to retrieve (10 seconds or less) and are safer since the final customer is the only with access to the locker.

Please note that your responses in this survey will be anonymous. Your answers will be kept strictly confidential, and no personally identifiable information will be associated with your responses. Your participation is voluntary, and the data collected will be used solely for research purposes. I sincerely appreciate your time and input, as your feedback will help me gain valuable insights.

Sincerely,

Maria do Carmo Machado

1. Have you understood the smart locker concept?

- Yes
- No

2. Gender

- Female
- Male
- Other

3. Age

- <18
- 18 – 24
- 25 – 34
- 35 – 45
- >45

4. Where do you live?

- Lisbon Metropolitan Area
- North Region
- Central Region
- Alentejo Region
- Algarve Region
- Açores
- Madeira

5. Education Level

- Elementary School
- High School
- Bachelor's degree
- Master's degree
- Doctoral programme or other

6. What is your monthly income

- 760€ - 1300€
- 301€ - 2600€
- 2601€ - 5000€
- 5001€ - 10000€
- >10000€

- Financially Dependent

7. What is your occupation?

- Employed (hybrid work)
- Employed (work from home)
- Employed (in-person job)
- Homemaker, Student, Retired person
- Unemployed

8. What is your choice of means of transport to work/school/university?

- Car
- Bike
- Public Transport
- Walk

9. Which method of shopping do you prefer?

- On-line shopping
- In-person shopping

10. How often do you shop on-line?

- Every day
- Every week
- Every 2 weeks
- Once a month
- Twice a year
- Once a year

11. Approximately, how many packages do you receive per month?

- 0
- 1 - 2
- 3 – 5
- More than 5

12. Do you ever use an alternative delivery address, other than your house, when ordering on-line?

- Yes
- No

13. Had you heard about Smart Lockers? (also known as intelligent lockers, parcel lockers, automated locker facilities)
- Yes
 - No
14. Have you used Smart Locker technology for package pickup?
- Yes
 - No
15. If you answered yes to the last question, would you recommend Smart Lockers to your peers?
- Yes
 - No
 - I have never used
16. In addition to the delivery cost, how much would you be prepared to pay:
- Nothing
 - 0.5€
 - 1.0€
 - 1.5€
 - 2.0€
 - >2.0€
17. If the delivery through smart lockers was the cheapest option, would you choose it?
- Yes
 - No
18. In which setting would you prefer a smart locker to be located?
- Residential Area
 - Office Buildings
 - Shipping Mall
 - Transportation Hubs (metro/train station)
 - Supermarkets
 - Petrol Stations
 - Other

19. From 1 (not important) to 5 (very important), please rate the following statements regarding the location of a Smart Locker:

- Proximity to your residence
- Proximity to your workplace
- Proximity to public transportation
- Availability of parking nearby
- Secure location
- High traffic area

20. From 1 (not important) to 5 (very important), how important are the following parcel delivery services to you?

- 24/7 pick-up time
- Ecological transport / Lower Emissions
- Personal Information Security
- Lowest Cost o Lowest Effort
- Having an employee to help if needed

21. From 1 (not important) to 5 (very important), how much do you agree with this information? Using smart lockers seems easy

- Using smart lockers does not require much effort
- Using smart lockers allows me to pick up my packages when it's most convenient for me
- Using Smart Lockers is more reliable than someone delivering my package at home
- Using Smart Lockers offers service accuracy
- I feel smart lockers are difficult and frustrating to use
- I feel using Smart lockers requires a lot of time and effort I feel/ would feel secure using smart lockers
- I would not be concerned about the privacy and security of my items stored in smart lockers
- I can keep my information private by using smart lockers I believe receiving parcels by smart lockers is compatible with my lifestyle
- I feel receiving packages by smart lockers is compatible with my needs

- Overall, I believe smart lockers are advantageous ○ Using smart locker is better than home delivery
- I intend to use smart lockers in the future
- I would recommend the use of smart lockers to peers
- I would be inclined to use Smart lockers if it was recommended to me
- by friends or family
- I am planning to use smart locker often

Annex B | SPSS Outputs for Multiple Regression Analysis

Model Summary:

Resumo do modelo^b

Modelo	R	R quadrado	R quadrado ajustado	Erro padrão da estimativa	Durbin-Watson
1	,787 ^a	,619	,609	,43777	2,063

a. Preditores: (Constante), RLA, CPX, PVS, RLB, CVN, CPB

b. Variável Dependente: INT

ANOVA:

ANOVA^a

Modelo		Soma dos Quadrados	df	Quadrado Médio	Z	Sig.
1	Regressão	68,247	6	11,374	59,351	<,001 ^b
	Resíduo	41,970	219	,192		
	Total	110,217	225			

a. Variável Dependente: INT

b. Preditores: (Constante), RLA, CPX, PVS, RLB, CVN, CPB

Coefficients:

Coefficientes^a

Modelo		Coefficients não padronizados		Coefficients padronizados Beta	t	Sig.	95,0% Intervalo de Confiança para B		Correlações			Estatísticas de colinearidade		
		B	Erro Erro				Limite inferior	Limite superior	Ordem zero	Parcial	Parte	Tolerância	VIF	
1	(Constante)	-,713	,317		-2,250	,025	-1,337	-,088						
	CVN	,173	,065	,145	2,654	,009	,045	,302	,538	,177	,111	,583	1,714	
	RLB	,143	,049	,143	2,927	,004	,047	,239	,465	,194	,122	,733	1,364	
	CPX	,054	,041	,065	1,308	,192	-,027	,135	-,233	,088	,055	,693	1,442	
	PVS	,168	,053	,170	3,187	,002	,064	,272	,572	,211	,133	,613	1,632	
	CPB	,280	,054	,305	5,196	<,001	,174	,386	,610	,331	,217	,504	1,984	
	RLA	,350	,054	,328	6,446	<,001	,243	,457	,632	,399	,269	,673	1,485	

a. Variável Dependente: INT

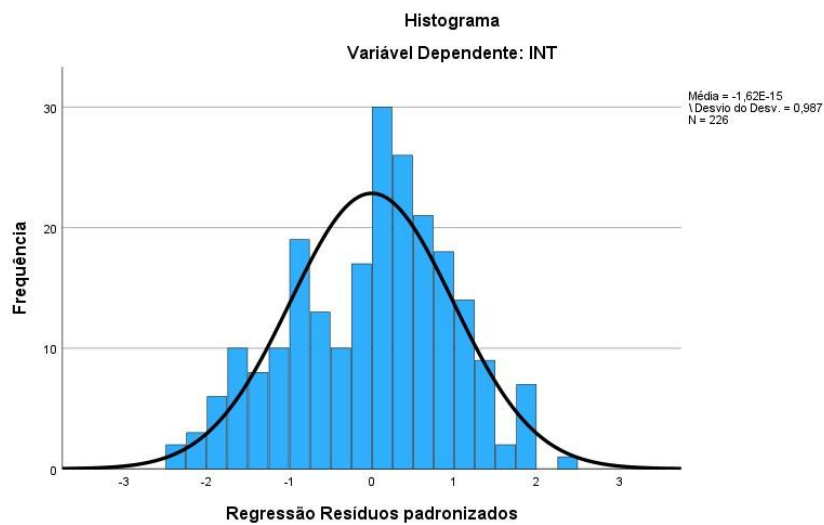
Residuals Statistics:

Estatísticas de resíduos^a

	Mínimo	Máximo	Média	Erro Desvio	N
Valor previsto	2,1934	4,9660	3,9646	,55074	226
Erro Valor previsto	-3,216	1,818	,000	1,000	226
Erro padrão do valor previsto	,036	,161	,074	,022	226
Valor previsto ajustado	2,1720	5,0002	3,9651	,55161	226
Resíduo	-1,05935	,99272	,00000	,43190	226
Erro Resíduo	-2,420	2,268	,000	,987	226
Resíduos Resíduo de Estud.	-2,446	2,437	-,001	1,005	226
Resíduos de Estud.	-1,08228	1,14696	-,00052	,44863	226
Resíduos de Estud.	-2,474	2,466	-,001	1,009	226
Mahal. Distância	,491	29,261	5,973	4,406	226
Distância de Cook	,000	,132	,006	,012	226
Valor de ponto alavanca centralizado	,002	,130	,027	,020	226

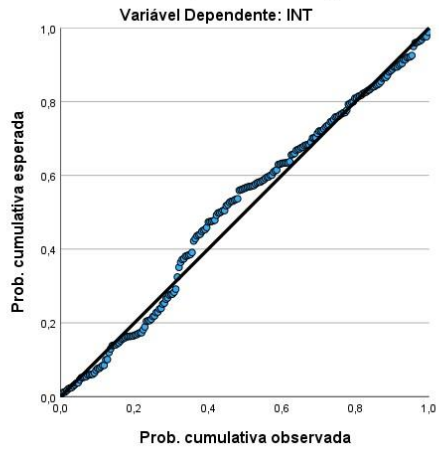
a. Variável Dependente: INT

Histogram:

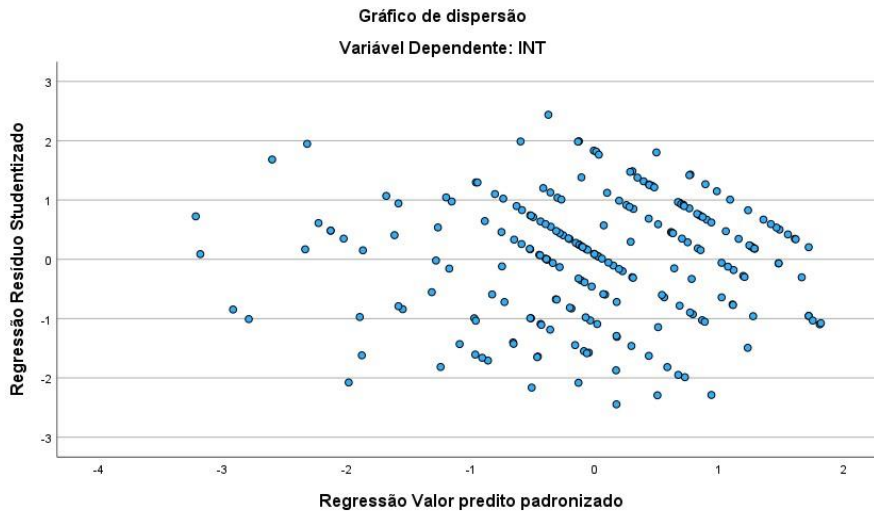


Normal P-P Plot of Regression Standardized Residual:

Gráfico P-P Normal de Regressão Resíduos padronizados



Scatterplot to check linearity:



Scatterplots to check Homoscedasticity:

