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Changes in online shopping behavior after the coronavirus pandemic in Munich and solutions with low environmental impact on the delivery's last mile

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Summary

During the coronavirus pandemic, online shopping grew at a rapid speed [1], due to the different travel measures, business closures and more people working from home. This has changed the way people shop online, what, how often, when and, from where they do it.

The increasing demand has a direct impact on the last mile delivery. At the same time this has effects on the environment, since light cargo is the second most CO_2-intensive transport sector [2]. For many years, research and development projects have focused on making the logistic sector more efficient and greener, while also satisfying the increasing demand [3]. Unfortunately, it has been challenging to acquire detailed data about the deliveries and customer preferences since that data is kept private by the delivery companies.

Therefore, this study focused on creating a survey to collect data regarding the needs and preferences of the customer, their online shopping behavior (frequency, size of parcels, etc.), the changes during and after the pandemic and, their perspective regarding environmentally friendly deliveries.

The survey was answered by 160 people in the Munich area. This study presents a descriptive analysis of the data collected, as well as responding to different hypotheses raised by the research.

Some of the main findings of the survey were that the mean frequency on which people receive packages is about 7 packages per month. Also, that the most common size of packages people receive is medium (~38cm x 30 cm x 15 cm). As for the impact on online shopping after the pandemic, 42% of the people agreed or strongly agreed that they shop online more than before the pandemic. Regarding the importance of environmentally friendly deliveries, 58% of the people considered it important. Although, they are not willing to pay more than 2 euros for making the delivery more environmentally friendly.

Then a Multi-criteria Analysis (MCA) of the different solutions for the last mile was performed. The analysis allowed the author to recognize the best performing solutions within the framework established. In this case the best solutions identified were electrification of the fleet, bike couriers, and lockers at strategic locations for delivery. Further analysis will be needed to know how to improve the solutions and the possibilities of combining them.

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Abbreviations

Abbreviations	Full description
AGV	Autonomous ground vehicles
BIEK	German Parcel and Express Logistics Association
B2C	Business to Customer
CEP	Courier, express and parcel
CO_2	Carbon dioxide
COVID-19	Coronavirus disease
DIN	German Institute for Standardization
EU	European Union
EUR	Euro
FADR	First Attempt Delivery Rate
GDP	Gross domestic product
GHG	Greenhouse gas
GLS	General Logistics Systems B.V.
ITF	International Transport Forum
MCA	Multi-Criteria Analysis
OECD	Organisation for Economic Co-operation and Development
TUM	Technical University of Munich
UPS	United Parcel Service
ZIP Code	Postal Code
ZIP	Zone Improvement Plan

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1. Introduction

During the coronavirus pandemic online shopping grew at a rapid speed, due to the different travel restriction measures, business closures and more people working from home. This has changed the way people shop online what, how often, when and, from where they do it.

A study of the German Parcel and Express Logistics Association (BIEK) shows that the courier, express and parcel (CEP) market in Germany grew 10.9% in 2020. The volume of shipments rose by around 400 million shipments, with a total of more than 4 billion shipments being transported [1].

The Business to Customer (B2C) shipments increased by 19.7% in 2020 [1]. The main reason for these developments is the dynamically growing online trade, which received a further boost from the corona pandemic.

At the beginning of the corona pandemic, an annual growth in shipments of around 4% was forecasted [1]. Currently, until 2025 a growth rate of 7 % per year is expected. Thus the demand expected for 2025 (4.7 billion shipments) will probably be reached in 2022 [1].

The increasing demand has a direct impact on urban logistics, especially, on the last mile delivery. Moreover, light cargo is the second most CO_2-intensive transport sector in regard to CO_2 emissions per volume of transported good [2]. For many years research and development projects are focusing on making the logistic sector more efficient and greener. The last mile is often claimed to be the sector that is the most inefficient out of the entire supply chain [3]. There are various ideas and approaches to target a more ecological last mile delivery, also to satisfy the increasing demand [3]. Examples include cargo bikes, automated delivery vehicles, parcel locker stations and parcel shops [2].

Unfortunately, it is difficult to have detailed data about the deliveries and customer preferences since that data is kept private by the delivery companies. Thus, planning solutions is more difficult and could present inaccurate findings.

Creating concepts that adapt to the customer's needs and in relation to a more sustainable delivery system is needed. Therefore, a survey can help to collect the data regarding the needs and preferences of the customer, as well as their online shopping behavior (frequency, size of parcels, etc.). This will allow the sector to develop useful solutions for the time to come.

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The following chapters include the literature review, the design of a survey, as well as the results and, analysis of the data obtained. Then different solutions from the literature will be evaluated in a qualitative manner with the aim of knowing which one would satisfy the needs of the customer in a better way.

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2. Literature Review

For the literature review first an outline regarding online shopping and its development during the past years is presented. Following this, it is explained how the pandemic affected online shopping. Furthermore, the impacts of online shopping on the last mile delivery are presented, as well as how the last mile impacts the environment.

Finally different solutions for the last mile delivery, found in the literature, are introduced and described. Then a conclusion of the literature review is shown and how the findings justify this research.

At the end of the chapter, the objective and hypotheses are formulated, and their importance is explained.

2.1. Online shopping and its development during the past years

Today online shopping in Germany is growing rapidly along with the consumer behavior [1]. Consumer behavior is impacted fundamentally by the usage of online shopping. Online shopping provides many benefits compared to stationary shopping, for example multimedia support of product information, 24-hours availability of online stores, more choices (many vendors and products) and, relevant and detailed information in seconds [4].

In Germany during 2020, the volume of parcel, express, and courier shipments was expected to grow by 10.9% to reach 4.05 billion. Being the first time in the last twenty years that shipment growth is higher than 10% [1].

The rising share of parcel shipments is primarily due to the higher growth rates of online retailing in the B2C segment. This trend is intensifying once again. In addition, international parcel shipments have increased significantly over the past ten years (B2B and B2C) [1].

The trend since 2020 of above-average growth in parcel and national shipments in particular is likely to continue and the parcel shipments are expected to grow by 7.5% per year up to 2025 [1].

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The CEP market is growing twice as fast as other sectors of the economy. Only the construction industry has a slightly higher rate of growth, 5.3% per year [1]. It also exceeds the growth of the logistics market of around 2 % per year [1].

Importance of the sector

It was estimated that in 2020, Business to Client (B2C) online retail would create a total of around 13.1 billion euros in value added in Germany, which is a share of 12.7 percent of the value added by the retail sector [5].

In addition, online retailing activities create occupations and jobs [5]. The number of online retailers is growing exponentially in recent years. Studies show that "the growth rate has doubled in the last two years alone and the number of online retailers now amounts to 39,632 in 2020 (from 22,279 in 2018)" [5]. "E-commerce has thus become a firm pillar in the economy and in the retail sector" [5].

2.2.1   What, how often, when and from where people buy (Europe)

Sociological, situational, and psychological influences are among the most impactful for online shopping behavior of consumers [6]. Sociological influences are for example gender, age, culture, or lifestyle. Men and women are almost head-to-head regarding online purchasing frequency although differences in product categories can be identified [6]. Age has result to have a stronger impact on online shopping behavior than gender. There exists a considerable difference between age groups [6].

A survey from the European Commission in 2021, showed that Clothes, shoes, and accessories were the most common online purchase among European countries (ordered by 68% of online shoppers). They were followed by "deliveries from restaurants, fast-food chains and catering services (31%), furniture, home accessories or gardening products (29%), cosmetics, beauty or wellness products (27%), followed by printed books, magazines or newspapers (25%), sports goods (excluding sport clothing) (24%), computers, tablets, mobile phones or their accessories (23%) and children's toys or childcare items (20%)" [7].

The participants were asked regarding the purchases in the three months prior the survey. About 33 % bought goods or services for private use once or twice and three to five times. Only 15% of the participants made online purchases over 10 times was the lowest.

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Figure 1 Eurostat survey results: Number of times people shopped online, EU, 2021

The *Figure 1* shows the number of times people shopped online by age group. "The largest proportion of people buying online once or twice is found among those aged 55-74 (40 %)" [8]. The age group from 16-24 years old together with those aged 55-74 were the largest groups to shop three to five times (both 34 %), although the youngest group tends to shop more online one to two times (35 %) [8]. People between 25 and 54 years, were making more frequent purchases, 35% of them made more than 6 purchases during the three months period [8].

While the online shopping sector is increasing, some customers still prefer to shop in person to see the products before purchasing them, out of loyalty to the store or simply out of habit. The people encountered difficulties during purchasing online due to slower delivery than indicated, also technical problems on the website while ordering or paying and receiving wrong or damaged goods or services.

Overall the e-commerce sector expects a definitive growth in product sales and this will also result in a growth of the industry, which is increasingly reaching the customer by diverse channels (omnichannel) [9].

2.2. The effects of the pandemic on online shopping

Online shopping is continuing to grow in the EU. The mobility restrictions due to COVID-19, and changes in habits and preferences had consequences on e-commerce.

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E-commerce "has provided customers with access to variety of products from the convenience and safety of their homes, and has enabled firms to continue operation in spite of contact restrictions and other confinement measures" [10].

The COVID-19 crisis has enhanced dynamism in the e-commerce industry, across expanding its scope, including new firms, consumer segments (e.g. elderly) and products (e.g. groceries) [10]. "Meanwhile, e-commerce transactions have partly shifted from luxury goods and services towards everyday necessities, relevant to a large number of individuals" [10].

Online shopping has become the norm in Germany making it Europe's largest online market [11]. The digitalization trend was further accentuated by the COVID-19 pandemic. *Figure 2* shows the trends on google search during the pandemic, for the word "delivery" or its equivalent in the language of the country. In the case of Germany, the highest number of searches for "delivery" (*Lieferung*) was on April 7th, 2020 (~91). The number of searches at that time was around 3 times higher than it was around February 23rd, 2020.

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Figure 2 Google search interest in "delivery", selected OECD countries (February to April 2020)[1]
Source: OECD [10]

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[1] Note: Axis represents search interest for the term "delivery" for a given date and country, *relative* to the highest search interest for the term "delivery" (value of 100) observed in the considered period and country. Rolling 3-day averages.

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Impact of the pandemic in Germany

The pandemic affected Germany's economy. The GDP in 2020 was around 5% lower than in 2019 [12]. The service sector was the most affected, such as retail, transportation, hospitality, food, and leisure, decreasing their productivity by 6% during the same time period [12].On the other hand, e-commerce increased significantly in 2020 (around 23%) and was able to profit from the accelerating digitization [6].

In March 2020 many retail stores had to close as a measure to stop the spread of the virus [6]. Many stationary retail stores were in crisis and had to adapt to the situation. As a consequence e-commerce businesses had an unprecedented increase of consumer demand [6].

Although specific data is not yet available, there have been market studies and research regarding the increment of online shopping in Germany. For example, *Figure 3* shows the results of a survey conducted in April 2020. It shows the percentage of consumers who shop online more since COVID-19 in Germany 2020 [13]. As shown in *Figure 3*, 18% of consumers in Germany who never previously made online fashion purchases stated that they have increased their online shopping in that category since the outbreak of the pandemic [13]. From the respondents who did buy fashion items online before, around 31% were buying them more often [13]. There was a significant increase (41%) in new customers for the food category [13].

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Figure 3 Share of consumers who shop online more since COVID-19 in Germany 2020, by cate-gory. Source: Statista [13]

The direct impacts of COVID-19 on e-commerce, might involve long-term changes, for example, the elderly consumers who started to engage with e-commerce as a means to enhance physical distancing might in part stick to their newly acquired routines [10]. Many operators of physical stores, are now considering e-commerce a complimen-tary or alternative sales channel [10]. This is particularly the case for larger retailers, that have invested in their own sales and distribution infrastructure. However, smaller sellers, might decide to turn their established online identity and experience into a long-term asset [10].

After all the COVID-19 pandemic also had its positive outcomes for the transportation and delivery sector. "It experienced the acceleration of innovation and the emergence of new trends in logistics, such as process robotization and automation, remote work, dig-itization, and ecommerce. These developments have the potential to transform the in-dustry" [14].

2.3. Impacts of online shopping on the last mile delivery

Online shopping is rapidly growing. The reasons for this are the larger selection and specialization possibilities of the offer, lower prices, the possibility of shopping from home. However, the wide selection offered to consumers.

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The "last mile" of the delivery is the final step in the process of the final journey from a product to the customer's front door [15]. Last-mile delivery is one of the main causes for the high volume of traffic generated by commercial vehicles throughout the urban area [16]. As online shopping is rapidly growing it increases the pressure on delivery: customers prefer fast and free deliveries.

For reasons of convenience, customers mostly opt for direct delivery to their home, which is carried out by external courier services [16]. The emerging demand for transport services brings with it various challenges: many customers with different locations, individual customers buying small quantities of products (sporadically delivered), and the expectation of fast delivery [16].

The last mile has become a problem due to its inefficiency and large costs. It accounts for between 28% and 58% of the total transport costs [17].

Challenges of the last mile delivery

Some of the challenges for the last mile are:

- On-time deliveries. Planning last mile delivery might turn difficult due to the dynamics of logistics, the wide range of variables and unforeseen circumstances of the day to day [3]. This can lead to a delay of the expected delivery time. [3]

- Route planning. Due to the many variables considered, planning the driver delivery routes is difficult. A mistake can lead to operational delays then impact many final mile deliveries. [3]

- Real-time tracking. Technology can be a tool to update the last mile delivery, and allow better communication with the customer [3]. Outdated technology can also pose problems in last mile delivery. "Customers expect real-time follow-up and full transparency during the whole delivery" [3], so they can know when their package will arrive with accuracy.

- Consumer demands. "Consumers want faster and more frequent deliveries" [18]. Consumers want same-day deliveries and that the parcels are delivered as expected [3]. Consequently there is a dilemma to keep last mile delivery profitable while also guaranteeing customer satisfaction [3].

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- Low profitability. The decision of many retailers to provide 'free' delivery options to attract custom has resulted in low pricing models that create financial difficulties for retailers as well as their logistics providers [18].

- Failed First-time delivery attempt. "A failed delivery attempt means that the courier driver tried to deliver a parcel to a customer, but the delivery was not successful" [19]. The main reasons are the recipient is not at home, the address was incorrect, or the courier cannot access the delivery location [19]. After that the package will be delivered on the next working day or left at a different location [19]. A study from Hermes, a German delivery company, showed that only 61 percent of the packages reach consumers at home [20]. And that "from Monday to Friday, from morning to early afternoon, only about 30 percent of recipients are at home when the delivery comes" [20].

Side effects of the last mile delivery include increased traffic congestion from delivery trucks and the associated exhaust and noise pollution [17]. Moreover, the delivery staff working conditions are being affected due to the time pressure [17]. That is why innovative solutions that increase efficiency to the last mile, while adapting to the customer needs and, protecting the workers of the field, are needed.

2.4. The last mile and impact on the environment

In 2015, The International Transport Forum (ITF) estimated that "international trade-related freight transport accounted for around 30% of all transport related CO_2 emissions from fuel combustion, and more than 7% of global emissions" [21]. Their projection was that these emissions will be almost four times higher by 2050 [21]. From the total international trade, the road freight share was around 53% in 2010 and will increase to 56% by 2050 [21]. Additionally, the share of emissions generated by domestic trade freight is around 30%, because goods are moved from ports to consumption centers predominantly by road, a CO_2-intensive transport mode [21].

The freight and logistics sector has been growing because of the growing ecommerce sector. Due to an increase of online shopping and therefore an increase in shipping volumes, it is predicted that in the future the need for delivery vehicles will rise drastically [22]. This therefore increases the CO_2-emmissions especially in city centers [22]. Increased traffic could lead to a 25% increase in carbon dioxide emissions in city centers, according to the McKinsey report [22].

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Moreover, with the purpose of satisfying customer needs, online shopping platforms offer diverse shipping options, for example fast delivery [23]. Although this may have a negative impact on the environment [23].

Another source for an increase of emissions is the cross-border e-commerce due to the long hauling distance travelled [21]. An implication of which the consumers that are using these services, might not be aware of [23].

In a case study for the last mile delivery in Singapore, it was shown that the emissions generated for home delivery are greater than delivery to a collection point [23]. Although the difference is only 0.012 kg CO_2e per parcel [23]. In that case the small difference was a result of the low first-attempt delivery failure rate.

In Germany the first attempt delivery seems to have a high failure rate (around 40%), as reported by the delivery company Hermes [20]. Thus, collection points can be a valuable resource for decreasing emissions. A previous study, showed that with the current share of parcel lockers in Munich there is potentially savings up to 0.062 kg CO_2e per parcel [24]. This is around 10% of the emissions a parcel generates [25].

Pereira, et al. [26] suggest that for decreasing the impact of the fast delivery all stakeholders should be brought to work together. The customer: by showing and giving awareness of the carbon footprint of their online delivery choices, as well as the environmental impact of fast deliveries. Then the delivery companies, making their operation more efficient, which means not only cost savings, but also mitigation of their environmental impact. Moreover, public policies to regulate urban logistics to bring the society towards the reduction of environmental effects and the mitigation of GHG emissions through adequate logistics.

2.5. Solutions for the last mile delivery problem

Currently subject to significant disruption, last-mile delivery, especially of parcels, is getting a great deal of attention in the media and from investors [27]. The need of new business models and new technologies is imperative to react to the disruption while addressing the customer demand for ever faster deliveries.

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Suguna et al. (2021) [28] identifies ten key factors to focus when developing last-mile delivery projects. The ten factors are as follows: customers' expectations; health considerations; delivery density; cost of last-mile delivery; types of goods; achieving routing efficiency; infrastructure; issues from customers' side; unpredictability in transit; and meeting fulfillment timelines. The most important factors identified are types of goods, achieving routing efficiency, and meeting fulfillment timelines [28].

Based in those needs and factors, the literature suggests different solutions and approaches for the last mile delivery. Some examples of these solutions are as follows:

1. Click & Collect services. The customer orders online and selects the option to "Collect" their order. Then they can pay for the goods online. Next, the seller confirms the sale and provides the details necessary for collection. The goods are prepared to be collected. Once they're ready to be collected, the seller informs the customer. The customer picks up the goods within an agreed time frame from the designated location. [29]

   These services are popular with store-based online retailers as they can avoid performing last-mile delivery operations and can also result in consumers undertaking more shopping in-store while collecting goods [30].

2. Collection points. In the same way as the associated collection points, it is possible to choose a post office as a delivery point or a local shop that is associated with the online shop [31]. When the package is available, the customer will receive a notification allowing him to pick it up [31]. Normally they are located in accessible (e.g. near parking or public transport) and/or residential areas (e.g. in local convenience stores), where consumers can pick-up their ordered products [32].

3. Personal deliveries to the workplace. It is a delivery option for people who would not otherwise be at home to receive the parcels during a working day [30]. While this helps to reduce delivery failure rates, it has disadvantages, like negative impact on companies' loading bays, internal building logistics and post-rooms [30].

4. Parcel box. Instead of a normal mailbox, a parcel mailbox, with enough space for your letters as well as parcels (e.g. size M and DIN A4 items) [33]. It has a security lock so that the deliveries are protected from access by third parties [33].

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5. Parcel locker. They are lockers placed in strategic locations in residential areas, workplaces, parking lots, train stations, etc. [34]. The lockers have electronic locks with a variable opening code so they can be used by different customers on different days [34]. Usually, they can be reserved for one delivery company but could also be used by many [34]. Customers are informed when their delivery has arrived, the number and location of the locker and, the code to open it. Here the customer does the last part of the delivery route. [34]

6. Delivery day. The customer can group the deliveries together into one, save on packaging, and cut down on delivery trips and emissions [35]. Packaging efficiency also drive reductions in landfill waste [35].

7. Delivery time window. This is generally done after an order is placed on a mobile application or online store, before the check out, where "the customer can enter its preferred delivery time or choose from the available time slots" [36]. Some of the benefits are performing logistics in an efficient manner, reducing the number of missed or failed deliveries achieving higher First Attempt Delivery Rate (FADR), it also improves customer satisfaction [36].

8. Electrification of the fleet. Given their low annual mileage and predictable schedules, electric delivery trucks are feasible to use in the last mile. The CO_2 emissions (due to the electricity consumption) of electric vans are almost half than diesel vehicles [37]. Combined with other solutions the electrification of the fleet is a good solution to reduce emissions [38]. Studies also show that electric trucks are economically viable today, given the currently available purchase premiums [39].

9. Autonomous ground vehicles (AGVs) with lockers. This would be a mobile parcel locker. The parcels are delivered without human interaction. Customers are notified of the arrival time. Upon arrival at their door, customers are asked to pick up the parcel from the specified locker mounted on the van or truck" [27]. It is still a technology in development, and it is in the horizon of the next ten years as a solution for the deliveries [27].

10. Last-mile collaboration. Parcel carriers working together in making deliveries of online shopping orders to reduce infrastructure requirements and enhance the efficiency of their operations [30]. This proposes centrally located depots to make the final step of the delivery in certain areas of dense cities [30].

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11. Logistics depots in central urban areas. It is a concept where a municipality works with the partners of the sector to create multi-user logistics depots in central urban areas [30]. The municipality of Paris is developing these in order to reduce freight vehicle journey distances in the urban area and to transfer goods to cleaner, alternatively-fueled vehicles for final delivery [30].

12. Crowd shipping. Anyone who has signed up as a driver to the network can complete a specific delivery order. "The advantage of this model is its flexibility in supply, covering peaks and troughs, the multipurpose use of certain assets such as cars, as well as the low investment requirements for parcel companies" [27].

13. Drones. Autonomous aircrafts, that carry parcels (up to 15 kg) to their destination along the most direct route and at relatively high average speed. The disadvantage is that they need to be supervised (up to 8 drones per supervisor) [27].

14. Bike couriers. Couriers employed by the parcel service provider deliver a small number of parcels by bike [27]. Normally they are implemented for groceries, food or document shipping [27].

15. Compensation of CO_2 emissions. Different delivery providers offer their customers to have climate-friendly shipping. The price is already included in the customer agreement [40]. This service might include environmentally friendly transport of parcels, support of climate protection projects and the expansion of a sustainable energy supply [41].

16. Provide better information and educate customers. Customers expect real-time follow-up and full transparency during the whole shipping process. The tracking information can improve to announce the customer the delivery time and secure they are at home when the package comes [3]. Also, there is a high rate of delivery failure due to incorrect address so the customer could help top provide better information if they know how to use and fill the required data in the online platforms.

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2.6. Conclusion of the literature review

There exist several restrictions to evaluate the new and innovative solutions for making deliveries more environmentally friendly. This is due to an uncertainty of the demand of packages (frequency, size, type of goods) and lack on information on customer preferences, which cause a difficult simulation of different scenarios to evaluate the consequences of innovative approaches for delivering.

Therefore, it is difficult for researchers, new market players, as well as governments and local administration, to make changes or improvements in the branch since they cannot predict whether their solution is going to be able to fulfill the demand and how it is going to be received by the customers.

A solution to this problem is the performance of surveys, that could help to estimate demand as well as the needs of the customers, regarding the parcels they receive.

From the surveys found in the literature, regarding online shopping and the coronavirus pandemic, there were no results specifically for Germany, nor only for Munich. Also, most of the studies have focused on the changes while the pandemic was in its highest and several mobility restrictions were imposed, thus a further study on how the online shopping has changed after the pandemic has not been yet performed.

A survey performed in Germany by "PwC" in 2017, got results regarding the customer opinions on the last mile solutions, and the opinions regarding some environmental measures [42]. Although there was still additional information from the customer missing, for example the feelings of the participants regarding making the deliveries more environmentally friendly, their willingness to pay for doing it and the roles of responsibility for it. An up-to-date study is still needed, as online shopping has been growing and has suffered from changes during and after the pandemic. The present study aims to research the opinions from the customers in Munich in the current year (2022), regarding online shopping, their changes during and after the pandemic, as well as the importance they give to environmentally friendly deliveries and their role towards them. Also, relate their opinions with their demographic data, which has not yet been presented in the literature. Furthermore, perform an analysis of the different solutions for the last mile delivery considering the answers of the participants.

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2.7. Objective and Hypotheses

The goal of the study is to know the needs of the customers as well as their online shopping behavior. A survey is a useful tool for doing this because it can examine how the people buy online. Through the survey it is also possible to investigate the main changes after the pandemic. It also allows to analyze the parcels people receive (frequency, size), and the changes within different demographic groups. Finally, it allows to formulate situations regarding environmentally friendly deliveries, with the purpose of knowing if this topic is a priority for the customers.

The specific objectives are as follows:

- To know what services are the most important for the customers.

- To know the frequency on which people receive parcels.

- To determine the most common size of packages people receive.

- To recognize the changes in online shopping during and after the pandemic.

- To study the importance given to environmentally friendly deliveries by the customers

- To find out whether the demographics of the people play a role in how they shop online.

The hypotheses on this research are as follows:

Ha: People agree that their online shopping increased permanently due to the pandemic.

Hb: People changed to online shopping during the pandemic

Hc: Older people (50-69 years old) kept buying in physical stores during the pandemic

Hd: Most of the deliveries people receive are extra small, small, and medium size

He: People between 20 and 59 years old buy more frequently online than older people (60+)

Hf: Environmentally friendly deliveries are not a priority for the customers

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Hg: People do not think that the customer should be responsible of making the deliveries more environmentally friendly

Hh: People with higher income would be willing to pay more for making the delivery more environmentally friendly

2.7.1. Justification of the Hypotheses

In the *Table 1* it is explained why each hypothesis is relevant for the study and to examine further options in online shopping and solutions in the last mile delivery.

Table 1 Justification of the Hypotheses

Hypothesis	Importance
Ha	To know whether the pandemic had a long-term impact on the growth of online shopping. If it increased permanently, it implies more stress on the last mile delivery and the need to adapt to a higher demand.
Hb	For knowing the impact of the pandemic in online shopping. And to find out if new groups were brought to online shopping that were not interested before.
Hc	To find out if people of older age groups were brought to online shopping or they were not interested to change. This is to know who the main customers of online shopping were during the pandemic.
Hd	It is important to know the size of the parcels people receive to measure in what extent deliveries can be made by light vehicles or even by non-motorized modes.
He	To know who the main customers of online shopping are. Then for further studies have a smaller target population and have more specific results.
Hf	To find out how much customers consider environmentally friendly deliveries against other services.
Hg	To find out how much customers are aware of the environmental issues from online shopping and parcel delivery. Thus, to suggest solutions to inform the customer regarding the impact of the delivery.
Hh	To investigate how much money could be collected for making a delivery more environmentally friendly and whether this has a relationship with the income of the customer or not.

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3. Methodology

A survey was chosen as a tool for this research in order to analyze how the people buy online and the main changes after the pandemic. In the following chapter the methodology for designing the survey is described. Afterwards it is described how the results of the survey are analyzed. Finally, a method to analyze the different solutions for the last mile based on the results of the survey is presented.

3.1. Data collection: Survey

"A survey is defined as the act of examining a process or questioning a selected sample of individuals to obtain data about a service, product, or process" [43]. They gather information from a targeted group of people about their opinions, behavior, or knowledge [43]. They can be written questionnaires, face-to-face or telephone interviews, and electronic surveys [43].

First it the objectives of the survey were determine as well as the information that it was needed from the participants. Also, to determine who should be surveyed by identifying the population group.

Finally, a description of the way of studying the results and how to use them for further analysis was also part of the process.

3.1.1. Survey Design

Two surveys were created. The first a general survey, which asked information about the packages people receive, as well as their preferences and opinions about issues such as environmentally friendly deliveries and the pandemic. This survey created was distributed through google forms and was distributed in different channels (students and professors of TUM, social networks, employees of different industries and acquaintances), and in two languages (English and German) with a target population of Munich.

The general survey has 25 questions, and it is divided into four parts. The first part has eleven questions asking information about the deliveries people receive, the frequency, the size of the parcels, as well as their delivery preferences (place and services). The second part has three questions regarding environmentally friendly deliveries, its importance, who should be responsible for it and the willingness to pay for contributing to it.

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The third section has questions regarding the pandemic, the measures the people took regarding shopping and how their shopping has changed after the pandemic. The last section has questions concerning the demographic information of the respondents on such as age, gender, occupation, household structure and income. For Further details of the full survey, see *Appendix.*

The last question asked if the people would like to participate in the weekly survey. The weekly survey included questions regarding the products received by the participants in the previous week. The questions were regarding the frequency and place of the deliveries, the size and weight of the packages, the type of product, the reasons to buy the product online and the delivery company. To further details see *Appendix.* Here, only 40 people (25%) of the participants wanted to take part of the weekly survey and at the end only 36 people participated.

3.1.2. Target population and sample size

Because the goal of the research was to know the changes in online shopping behavior in Munich, the target population was the inhabitants of Munich, focusing on the people 20 years old and over. Considering they are the people that mainly perform the shopping from their household.

The total population of Munich is 1,562,128 as of 2021 [44]. And the population from 20 years old and over is 1,294,632 [44].

To avoid sampling errors or biases, a random sample needs to have the adequate size [45]. There are different approaches for calculating the sample size for categorical data. Bartlett et al. (2001) proposed the following formula [46]:

$$n = \frac{(P(100 - P) * Z^2)}{E^2}$$

The formula considers the levels of precision and risk willing to accept in the research [45]. E is the margin of error, normally in social research a 5% margin of error is acceptable [45]. "Z related to the level of confidence that the results revealed by the survey findings are accurate" [45]. This is the degree to which the characteristics of the population have been accurately estimated by the sample survey [45]. "Z is the statistical value corresponding to level of confidence required" [45].

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The second component is the estimation of the variance or heterogeneity of the population (P) [45]. P is the percentage of a sample with certain characteristic, for example, the 80% of the respondents agree, and 20% lack the characteristic or thought. Bartlett et al. (2001) suggest that researchers should use 50% as an estimate of P, as this produces the maximum variance and sample size [46].

The following table shows different calculations for a sample size for different values for P, Z and E.

Table 2 Sample size for different statistical values

P	Confidence level	Z	E	$n = \dfrac{\left(P(100-P) * Z^2\right)}{E^2}$
0.5	95%	1.96	0.05	384
0.6	95%	1.96	0.05	369
0.8	95%	1.96	0.05	246
0.5	99%	1.99	0.05	396
0.6	99%	1.99	0.05	380
0.8	99%	1.99	0.05	253
0.5	95%	1.96	0.08	150
0.6	95%	1.96	0.08	144
0.8	95%	1.96	0.08	96
0.5	95%	1.96	0.1	96
0.6	95%	1.96	0.1	92
0.8	95%	1.96	0.1	61

3.2. Data adjustment: weighting of the answers

The Foundation for Economic & Industrial Research indicates that "a sample must reflect the population it comes from and be representative with respect to all variables measured in a survey" [47]. Although when non-response problems occur, some population groups might be over- or under-represented in the sample [47]. Therefore, no reliable conclusions can be drawn from the survey data, unless there is a correction of the representativeness [47].

One technique to do the correction is weighting adjustment, "a processing through the assignment of a certain weight to each survey respondent" [47]. "The weights are the "corrective" values assigned to each one of the sample responses of a survey" [47].

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The most common types of weights are design weights, post –stratification or non – response weights and, population size weights.

Design weights

These are used: a) the survey statistics needs to be representative of the underlying population or b) when compensation for over- or under-sampling of specific cases or when disproportionate stratification is needed [47]. For calculating the weights, we must know the sampling fraction (over- or under-sampling) for a given group or area [47].

Non-response weighting

"It is used to compensate for the fact that persons with certain characteristics are not as likely to respond to the survey and for this reason it is used for handling unit non-response in surveys" [47]. It requires further information about the underlying population of the sample and other different variables must be taken into account (demographics) [47].

Population size weighting

"It is used when examining a combination of survey data from two or more and it corrects for the fact that most countries taking part have very similar sample sizes, no matter how large or small their population is" [47]. To reflect the population size of each country, the data is adjusted [47].

Weighting design

"The non-response weighting involves "post-stratification", that has two steps:

1.- Identify a set of "control totals" of the population that the survey ought to match.

2.- Calculate weights to adjust the sample totals to the control totals. Post-stratification compares an N-way table from the population with an equivalent N-way table from the sample. A weight is calculated per cell of the table to adjust each observation to the population" [47]. The default weight is equal to 1.

In the case of the present survey there was low representation of diverse population groups (stratification by gender and age). Thus, an adjustment of the data, with non-response weightings was needed. Therefore, different weights were assigned to each response depending on the gender and age group of the respondent. This had the purpose of having data that represents the real distribution of the population, according to the Munich census of population (as of 31/12/2021) [44] display in *Figure 4*.

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Image removed due to copyright.
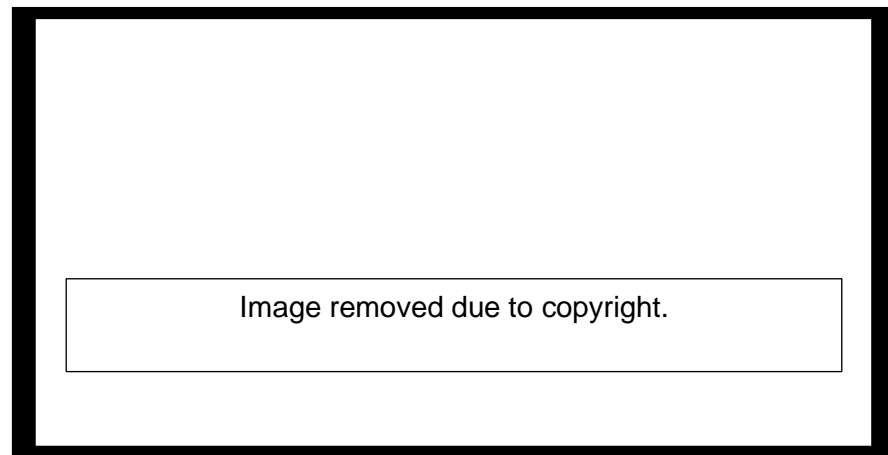
Figure 4 "Bevölkerung 1) am 31.12.2021" / Population distribution in Munich till 12/31/2021 [44]

3.3. Analysis of the data

An analysis of the data collected with the survey was performed. The next sections describe the methods used for the analysis, being it quantitative and qualitative analysis.

3.3.1. Analyzing the results of the survey questions

After adjusting the data with the weights, as explained in the previous section, the data was plot and then analyzed. For plotting the results, the program R was used.

"R is a language and environment for statistical computing and graphics" [48]. One of the advantages of R is the well-designed publication-quality plots that can be produced and that it can handle big quantity of data [48]. Thus, R was used as a tool for creating plots based on the frequency tables and respective percentages of the data from each survey question.

Once having the plots, a descriptive analysis of the data was done. A "descriptive analytics is the process of using current and historical data to identify trends and relationships" [49]. Its purpose is to "identify trends and relationships between variables, and visually display information" [49]. A descriptive analysis is useful for analyzing survey results because it stands out insights from the survey and allows to find trends [49].

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"Measures of central tendency or measures of variability, also known as measures of dispersion, are used for descriptive analysis of statistics" [50]. "Measures of central tendency focus on the average or middle values of data sets, whereas measures of variability focus on the dispersion of data" [50]. These measures use graphs, tables, and discussions to understand the meaning of the analyzed data [50].

Measures of central tendency will be used in the study to describe the distribution of the data. Analyzing the frequency of each data point and describing the distribution using the mean, or mode, for analyzing the patterns of the results.

3.3.2. Analyzing questions by income

The question referring to the willingness to pay was analyzed by the income of the respondents. Because the respondents had different household structures it was needed to have equivalence scales for each household type in proportion to its needs to be able to compare them [51]. The factors commonly considered to assign these values are the size of the household and the age of its members (number of adults or children) [51].

Equivalized income

It is a measure that takes account of the differences in a household's size and composition [52]. It is calculated using the modified OECD equivalence scale. This scale attributes a weight to all members of the household:

- 1.0 to the first adult

- 0.5 to the second and each subsequent person aged 14 and over

- 0.3 to each child aged under 14 [52].

The equivalent size is the sum of the weights of all the members of a given household [52].

Calculating the household equivalized income

For calculating the household equivalized income, first the midpoint of every class (net income range) was calculated by dividing the sum of the lower-class limit and the upper-class limit by 2. Then this value was given to each participant, depending on their answer for the net income.

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The second step was to calculate the size of the household with the OECD equivalence scale. Next, the midpoint of the net income was divided by the equivalent size of the household. In this way obtaining the household equivalize income for each respondent.

This result was then again categorized in classes of 1000 euros for further analysis and comparisons.

3.4. Qualitative analysis of the different solutions for the last mile delivery

As shown in the literature review there exists different options as solutions for the last mile. An analysis is needed with the purpose of knowing which might have better outcomes.

An analysis of options is the process of evaluating different options to decide on the best course of action. It is widely used in projects, to ensure that all the possible options are considered before the best one is chosen [53].

3.4.1. Analysis methods

Various decision-support techniques are based on monetary valuation of the impacts of options. The most known techniques are:

- "Financial analysis. An assessment of the impact of an option on the decision-making organization's own financial costs and revenues". [54]

- "Cost-effectiveness analysis. An assessment of the costs of alternative options which all achieve the same objective. The costs need not be restricted to purely financial ones". [54]

- "Cost-benefit analysis. An assessment of all the costs and benefits of alternative options". [54]

An applicable tool when a problem presents conflicting objectives and when these objectives cannot be easily expressed in monetary terms a single-criterion approach (such as cost-benefit analysis) might fall short, especially where significant environmental and social impacts involved is a Multi-Criteria Analysis (MCA) [55].

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Multi-Criteria Analysis (MCA)

"It is an analytical technique to prioritize options. This technique can deal with situations that involve uncertainty as well as the preferences of many stakeholders" [55].

It is an assessment of the expected performance for each option against a number of criteria or objectives [55]. "It provides an explicit relative weighting system for the different criteria" [54]. Then assigning a score for how alternatives perform under each criterion [55]. Thereafter, a weighted average of scores is calculated, which corresponds to an overall indicator of performance of each option [55]. A higher score would mean an option is better. This can be represented in a score's matrix [55].

The British Department for Communities and Local Government has defined the steps for the MCA, as follows:

1. "Establish the decision context. What are the aims of the MCA, and who are the decision makers and other key players?

2. Identify the options,

3. Identify the objectives and criteria that reflect the value associated with the consequences of each option,

4. Describe the expected performance of each option against the criteria. (If the analysis is to include steps 5 and 6, also 'score' the options, i.e., assess the value associated with the consequences of each option.),

5. 'Weighting'. Assign weights for each of the criteria to reflect their relative importance to the decision,

6. Combine the weights and scores for each of the options to derive and overall value,

7. Examine the results,

8. Conduct a sensitivity analysis of the results to changes in scores or weights" [54].

Due to the number of stakeholders and due to the data input to be collected by the survey, a Multi-Criteria Analysis has been chosen to carry out the analysis of the different solutions proposed in the literature review.

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4. Analysis

The survey had 160 responses, which for the targeted population of Munich (1.2 million), would represent a sample with a confidence interval of 95% and a margin of error of 8%, as presented in the methodology section in *Table 2*. The survey was answered by people between 20 and 69 years old. From the respondents 44 all of them were men and 116 were women.

During data collection, there were several limitations in terms of the number of responses obtained and the demographic distribution of responses. In the case of gender distribution, there was a bias due to the low participation of the male population (18%). In addition, there was a low representation in the age group over 60 years old. The data had a distribution as shown in the *Table 3 Distribution of the sample of the survey*:

Table 3 Distribution of the sample of the survey

Age group	Female	Male	% From total population
20 to 29 years old	52,6 %	47,4 %	23,75 %
30 to 39 years old	77,2 %	22,8 %	35,63 %
40 to 49 years old	85,7 %	14,3 %	21,88 %
50 to 59 years old	78,3 %	21,7 %	14,38 %
60 to 69 years old	57,1 %	42,9 %	4,38 %

The second survey was set up to follow participants one week each month for 3 months where they would provide information on packages received from a previous week. Unfortunately, participation was low and only 36 responses were obtained, which is lower than the calculated value for a sample size with confidence level 95% and a marginal error of 10 (see *Table 2*). Therefore, the sample is not representative of the population and this study presents only a brief analysis of it.

4.1. Data adjustment: weighting of the answers

Due to low representation of the male population as well as the age group for people over 60 years old, an adjustment of the data was generated.

For making that the distribution of the data corresponds to the distribution of the Table *Bevölkerung 1) am 31.12.2021*, the weights assigned to the responses were calculated. The *Table 4 Weights for the data of the survey* shows these weights.

After this adjustment the analysis of the weighted data continues in the next section.

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Table 4 Weights for the data of the survey

Age/Gender	Female	Male
20 to 29 years old	0,8584	0,9537
30 to 39 years old	0,4740	1,5475
40 to 49 years old	0,5409	3,1181
50 to 59 years old	0,9090	3,0451
60 to 69 years old	2,5279	3,7253

After the weighting of the responses, the age and gender distribution (corresponding to question 17 and question 18) of the survey is as follows:

Table 5 Weighted age and gender distribution of the survey

Age/Gender	Female	Male
20 to 29 years old	17	17
30 to 39 years old	21	20
40 to 49 years old	16	16
50 to 59 years old	16	15
60 to 69 years old	10	11
Total	81	79

4.2. Descriptive analysis of the survey responses

An analysis of the results of every question will be presented. The answers of the public in general will be examined, and it would be specified whether there were differences between distinct groups (by gender and by age). Also, these differences will be discussed and analyze in the following section.

Question 1 "How many packages do you generally receive per week?".

The plot in *Figure 5* shows the answers for the question 1. Thirty-four percent of the respondents of the survey (34%) answered "[0-1] – less than one". The second most common answer (31%) was "[1-2] – one to two". Then 16% responded "[2-3] - two to three" and 10% were in "[3-4] three to four" packages per week. The options "[4-5]", "[5-6]" and "[10-11]" were the less selected options, with less than 5% each. Therefore, in general receiving more packages is less popular. When calculating the mean from the frequency table in general people receive **1.8** packages per week.

There were differences by gender and by age group.

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The differences by gender are shown in *Figure 5*. We can observe that from the male respondents, most selected the option "[0-1) – less than one", and the percentage of receiving more packages decreases, and no one answered more than 6 packages. When calculating the mean from the frequency table the male group has a mean value of **1.7** packages per week.
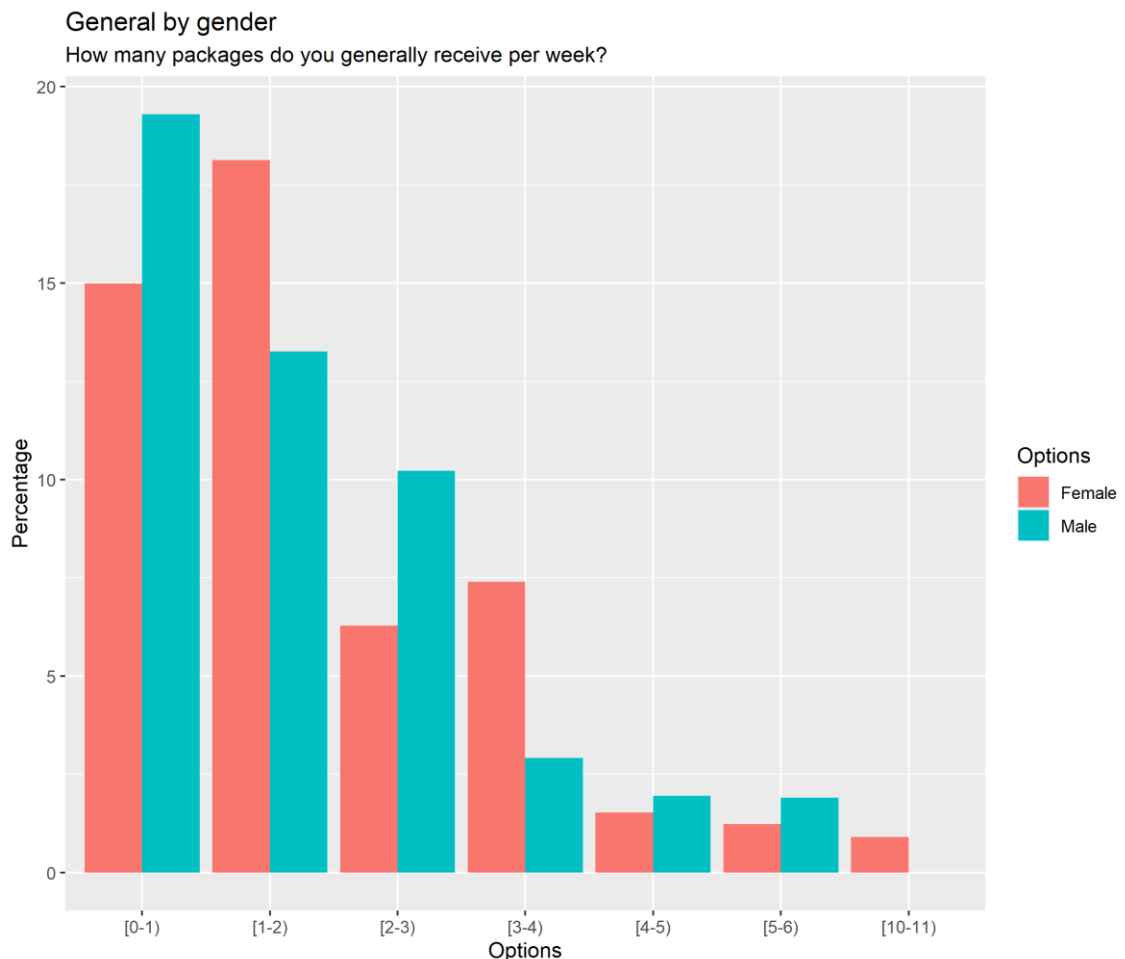
Figure 5 Results question 1 "How many packages do you generally receive per week?" by gender

On the other hand, women selected "[1-2) – one to two" the most. Followed by the options "[0-1) – less than one" and "[3-4) – three to four" packages per week. This group has a mean value of **2** packages per week. This means that in general women receive more packages per week than men.

When inspecting these results by age group, as portrait in *Figure 6*. We can observe that the age groups "20-29 years old", "30-39 years old" and "60-69 years old" have a very similar pattern, corresponding to the distribution of the general population, where most of the respondents selected the options "[0-1)" (48%, 32% and 53% respectively), and then the percentage of receiving more packages decreases.

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When calculating the mean from the frequency table the age group "20-29 years old" has a value of **1.2** packages per week. Then the age group "30-39 years old" has a mean value of **1.9** packages per week. And the age group "60-69 years old" has a mean value of **1.1** packages per week.

General with age
How many packages do you generally receive per week?
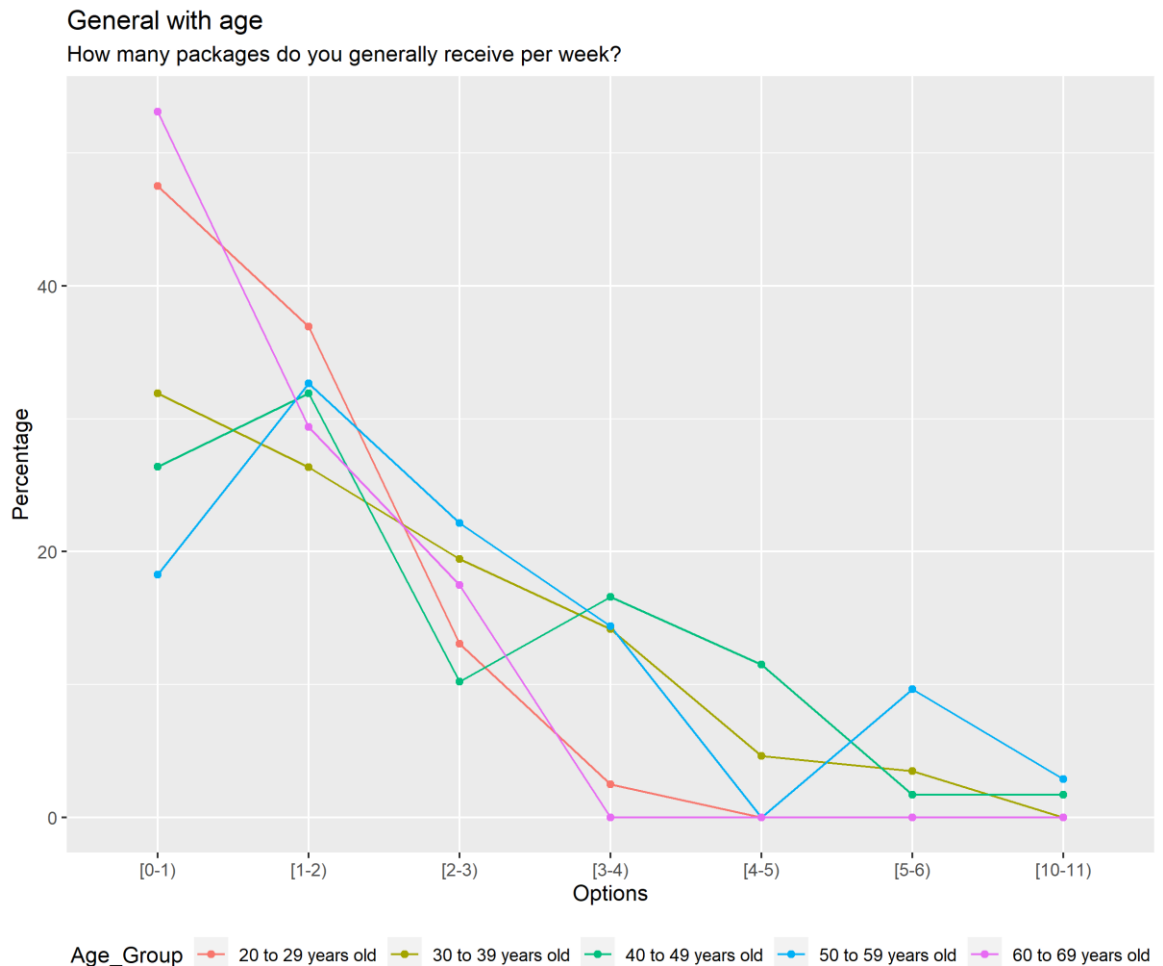
Figure 6 Results question 1 "How many packages do you generally receive per week?" by age group

Whereas the age group "40-49 years old" has its own pattern, where the most selected option (32%) was "[1-2]" packages per week, followed by "[0-1]" (26%), and the third place "[3-4]" (17%), which means, the frequency of packages received is higher, than younger age groups. This data has a mean value of **2.2** packages per week.

For the age group "50-59 years old", the most selected option (33%) was "[1-2]" packages per week, followed by "[2-3]" (22%), and the third place "[0-1]" (18%), which means, the frequency of packages received is higher, than younger age groups. Also, around 10% of the people in this age group answered "[5-6]" being the age group that selected

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this option the most. The corresponding mean for this age group is **2.5** packages per week.

Finally, the age group "60-69 years old", also has a similar distribution to the general population and to the plots for the age groups "20-29 years old" and "30-39 years old", where most of the respondents selected the options "[0-1]" (53%), and then the percentage of receiving more packages decreases. This age group has a mean value of **1.1** packages per week.

The results of the survey showed that the age groups "40-49 years old" and "50-59 years old" were those that have the highest frequency of received packages per week. This behavior might be attributed to the use of online shopping platforms or a higher income of the mentioned groups.
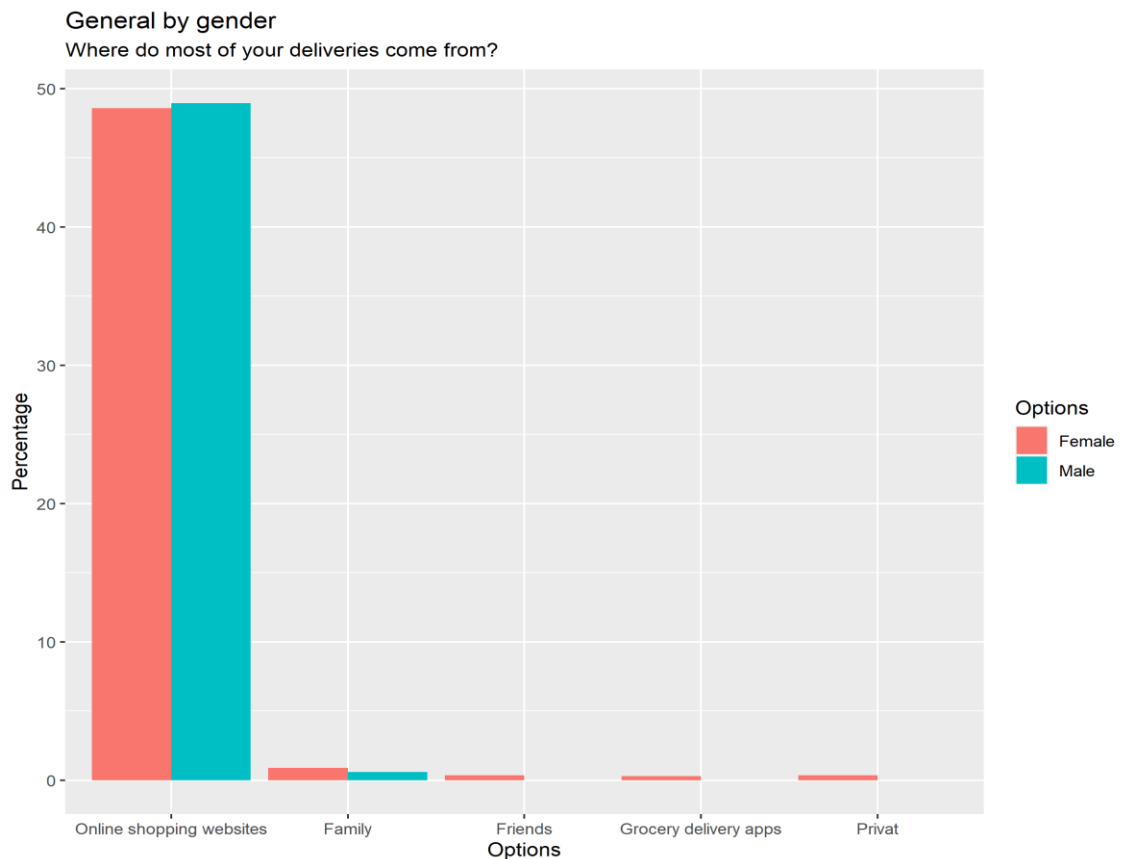
Figure 7 Results question 2 "Where do most of your deliveries come from?" by gender

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Question 2 "Where do most of your deliveries come from?"

The plot in *Figure 7* shows the answers for the results question 2 divided by gender. In general, the most popular option was "Online shopping websites" (selected 98% of the participants). Family was the second selected option with only 2%.

While the options "Friends", "Grocery delivery apps" and "Privat" were the least selected options (only 1% in total). It is to observe that only female participants selected these last. In contrast, these delivery sources are not common within men.

This shows that nearly all the deliveries a person receives come from online shopping.

There were no significant differences by age group. This can be seen in the plot from *Figure 8*.
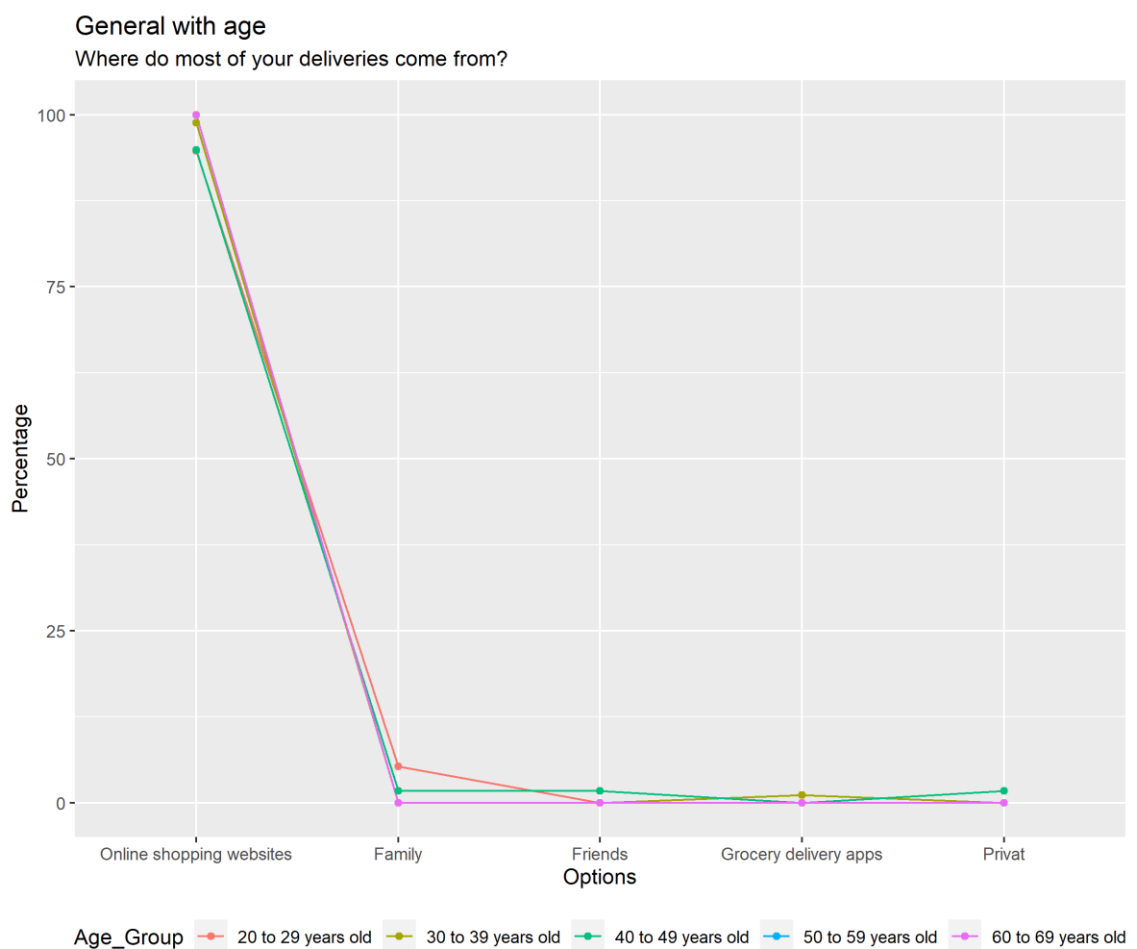
Figure 8 Results question 2 "Where do most of your deliveries come from?" by age group

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This means that most of the deliveries come from ecommerce rather than from non-economic activities. This is important for knowing the participants in the delivery process. It also implies that the deliveries are a part of the service offered by online suppliers thus it is subject to customer demands.

Question 3 "In a typical month how many different online stores do you order from? (Marketplace stores count as one)"

Figure 9 is the plot for the results of question 3 divided by gender. Most of the people (58%) buy in "[2-3]" different online stores. While 33% of the people buy from only "[1-2)" online stores. Only 6% of the participants answered "[4-5)" and the other options had a very low percentage of selection (3% in total). There were not big differences in the distributions by age or gender. The mean value for men was 2.2 online stores per month, and for women 2.6, thus both are between 2 and 3 different online stores per month. Although women selected options with more stores, they were not extremely popular.
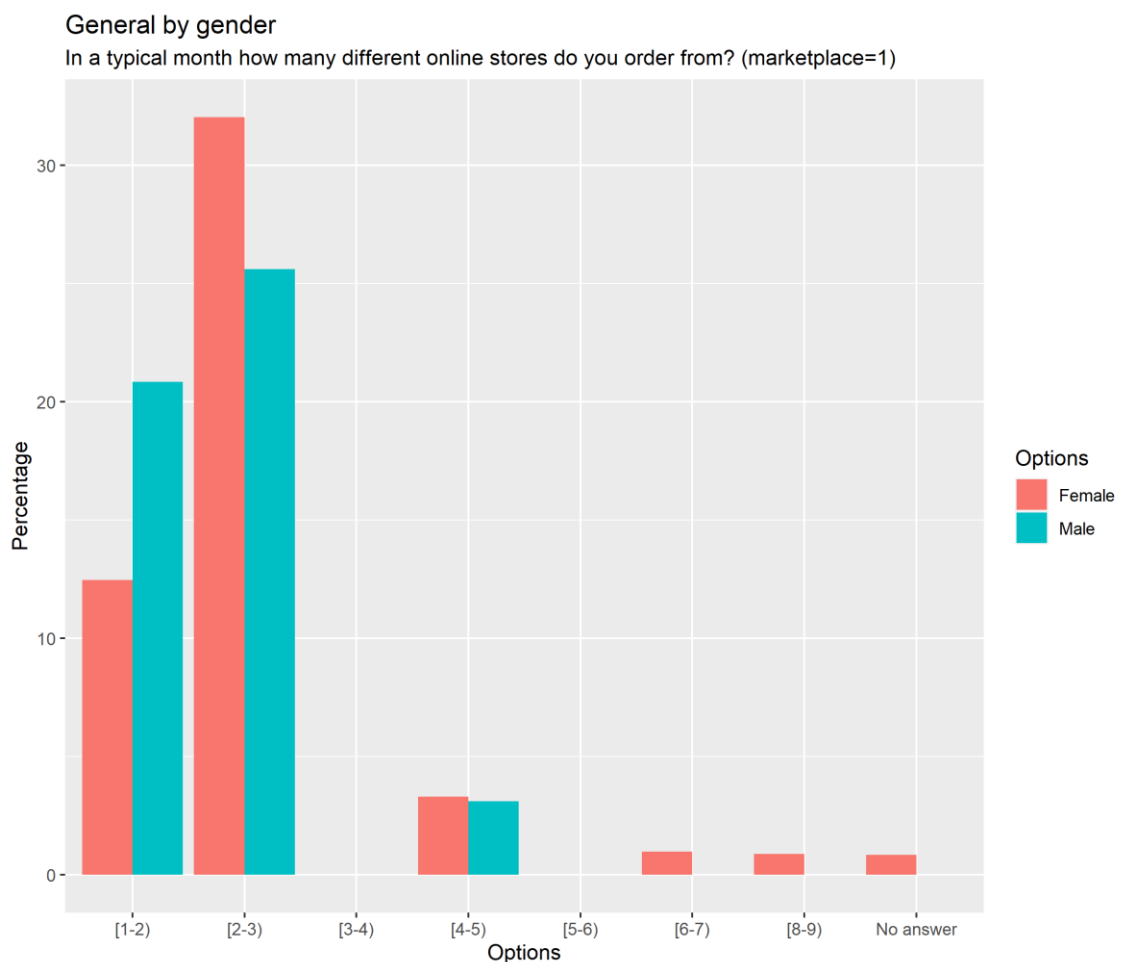
Figure 9 Results question 3 "In a typical month how many different online stores do you order from? (Marketplace stores count as one)" by gender

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Differences between age groups were minimal. They can be seen in the plot from *Figure 10*. Hence, it is to conclude that most people buy in 2 to 3 different online stores. The people are loyal to few stores that might offer what they need.
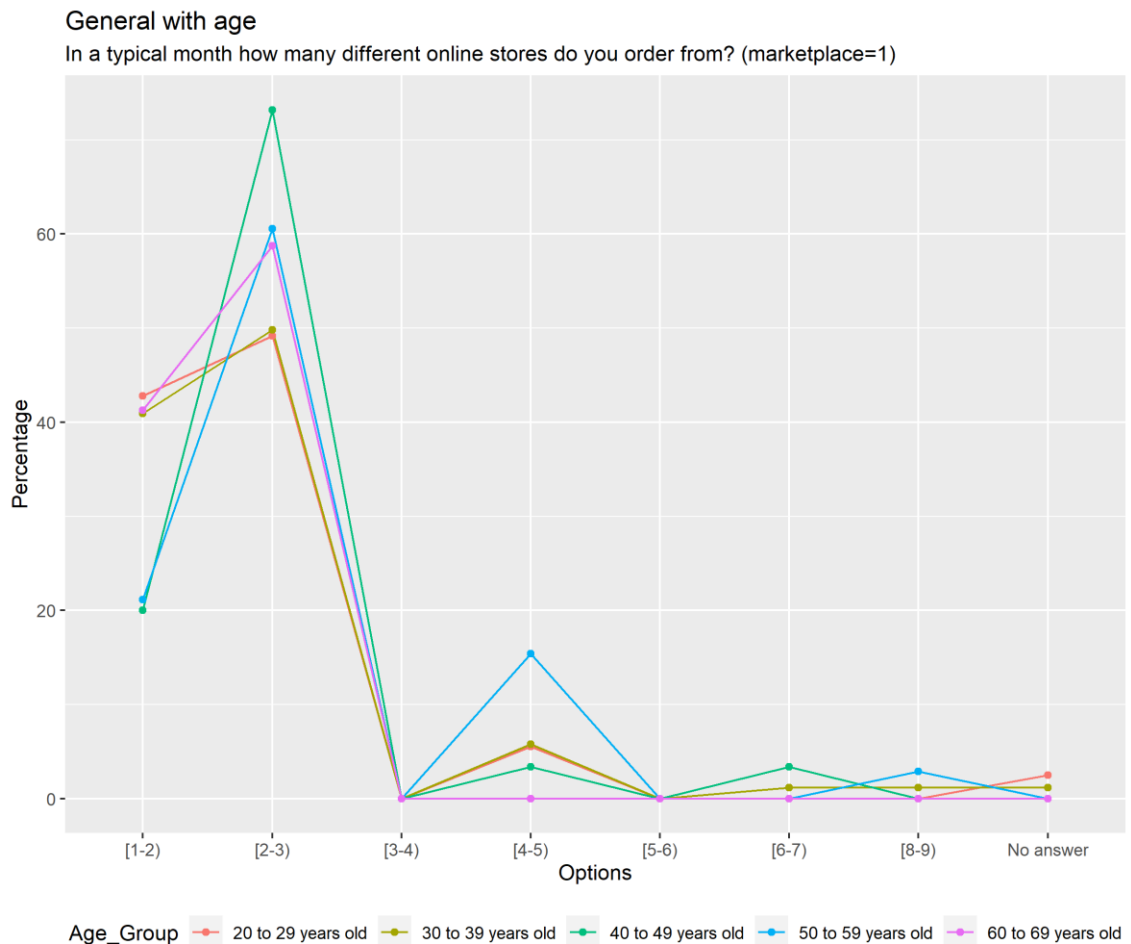
Figure 10 Results question 3 "In a typical month how many different online stores do you order from? (Marketplace stores count as one)" by age group

Question 4 "What are the most frequent sizes of the parcels you receive?"

The following plot represents the answers for the question 4 "What are the most frequent sizes of the parcels you receive?" The most frequent size of parcels people receive is "Medium", representing 58% of the answers, as indicated in *Figure 11*¡**Error! No se encuentra el origen de la referencia.** The second is "Small" with a 28%. And the third one is "Extra Small" with 8%, followed by "Large" with 5% and "Extra Large" with 1%. In this way, we can conclude that most of the deliveries people receive are "Medium" and "Small" size (86% of the total deliveries).

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This question was also analyzed by age groups and gender, as shown in the following plots. As *Figure 11* shows, when comparing the total population by gender there is a majority in the group sizes "Small" and "Medium", although there was a difference; by the male population the sizes "Large" or "Extra Large" were not selected at all.

General by gender
What are the most frequent sizes of the parcels you receive?
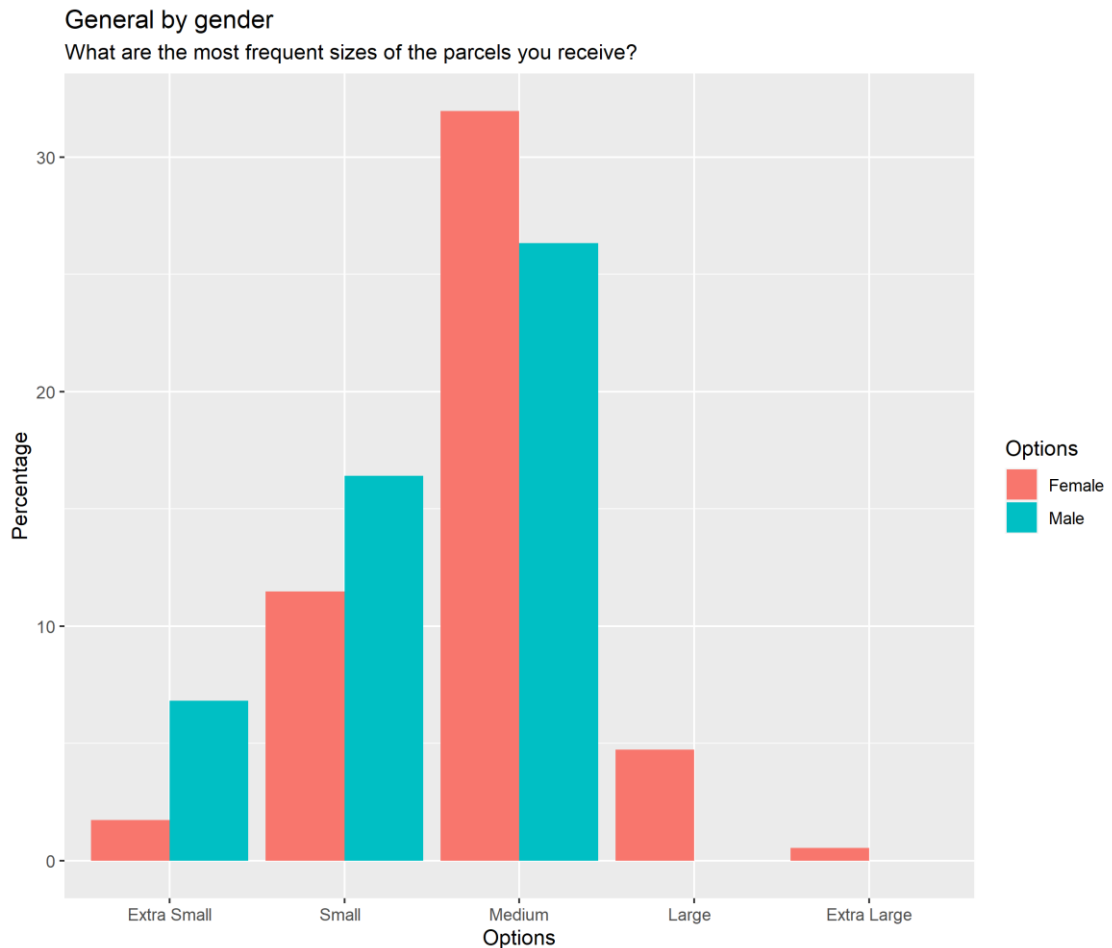
Figure 11 Results question 4 "What are the most frequent sizes of the parcels you receive?" by gender

When the question was analyzed by age groups, as shown in *Figure 12*, the age groups 20-29, 30-39 and 40-49 years old, had a very similar pattern. The main difference was that for the age group from 50-59 years old, the "Small" size was more frequent than the "Medium" size. Moreover, for the age group from 60-69 years old after "Medium", "Extra Small" was the most selected option, which differs from the younger age groups.

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In the case of the female population there was not a difference of the size distribution within age groups, compare with the answers of the general population. Although in the male population the age groups 50-59 years old and 60-69 years old, the most frequent size was "Small" and the second most frequent "Medium" while the other sizes had zero percent of representation. See plot for female population in the *Figure 13* and the plot for male population in the *Figure 14*.

In conclusion most of the people choose medium or small size of packages. This is important when planning the deliveries and the vehicles needed to distribute the packages. Smaller vehicles can be used when the packages are not big.
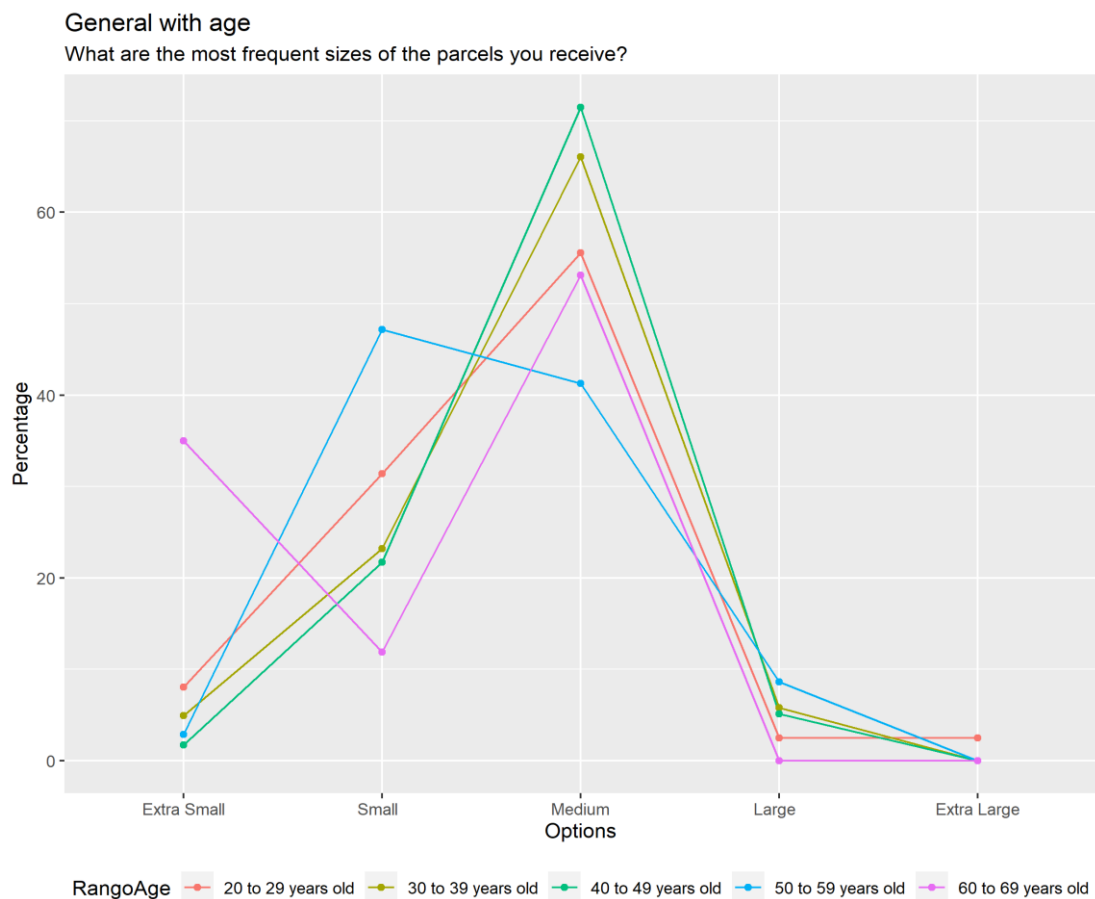
Figure 12 Results question 4 "What are the most frequent sizes of the parcels you receive?" by age group

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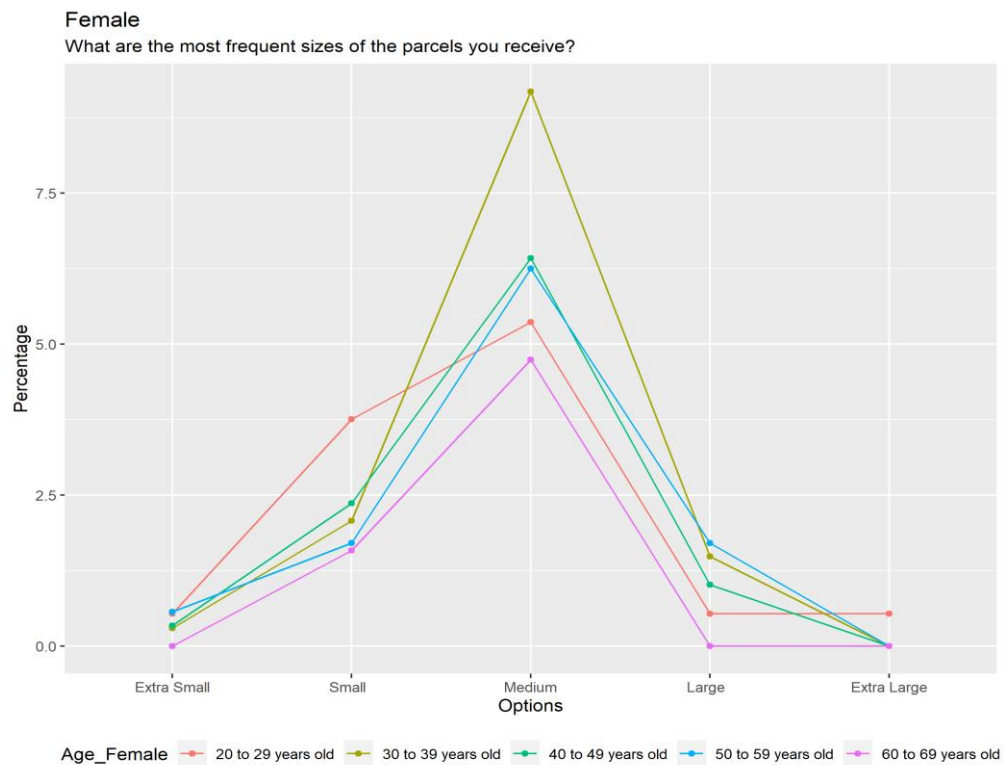
Figure 13 Results question 4 "What are the most frequent sizes of the parcels you receive?" female population
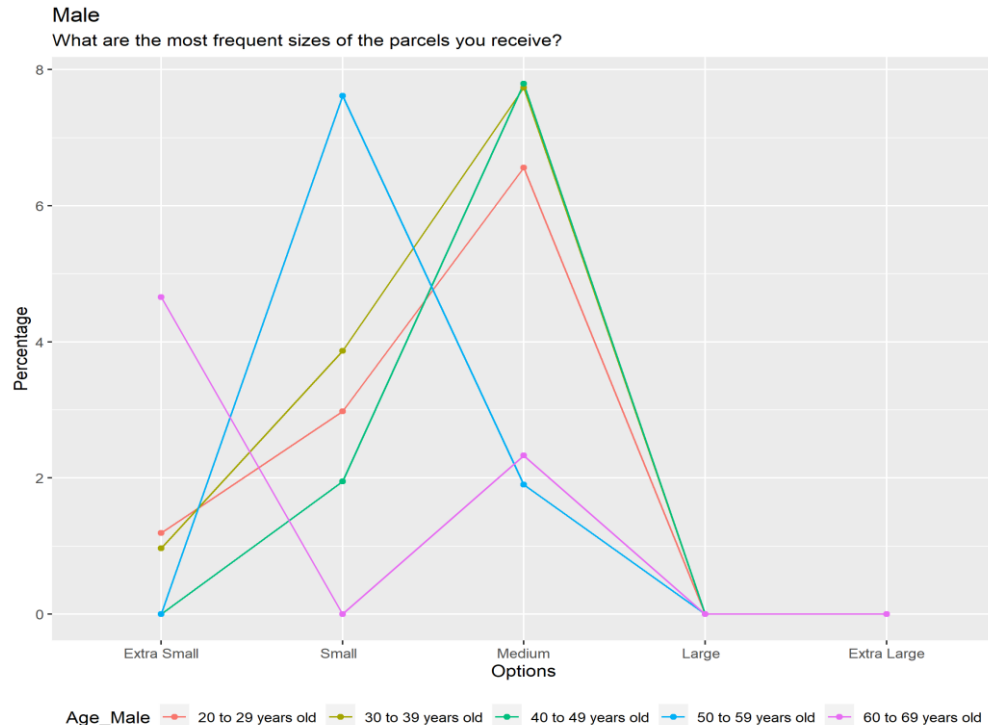
Figure 14 Results question 4 "What are the most frequent sizes of the parcels you receive?" male population

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Question 5 "Where are your packages generally delivered?"

The plot in *Figure 15* represents the answers for the question 5 "Where are your packages generally delivered?" divided by gender. Most of the people (88%) get home delivered. Only 9% get delivered to a parcel station, 2% to a parcel shop and only 1% to their office. This means that while delivery at parcel stations is getting more popular people still prefer to get their parcels delivered at home. There was a difference between men and women. The disparity is that only 3% of the women chose a parcel station, while 16% of the men chose this option.

There were some differences between age groups, as shown in *Figure 16*. People between 20 and 29 years old, chose parcel station with 11%. The people from "50 to 59 years old" chose this option in a 10%, and 35% of the people from "60 to 69 years old" selected this option. Though the age groups between 30 and 49 years old were less willing to choose "parcel stations" (around 1%).
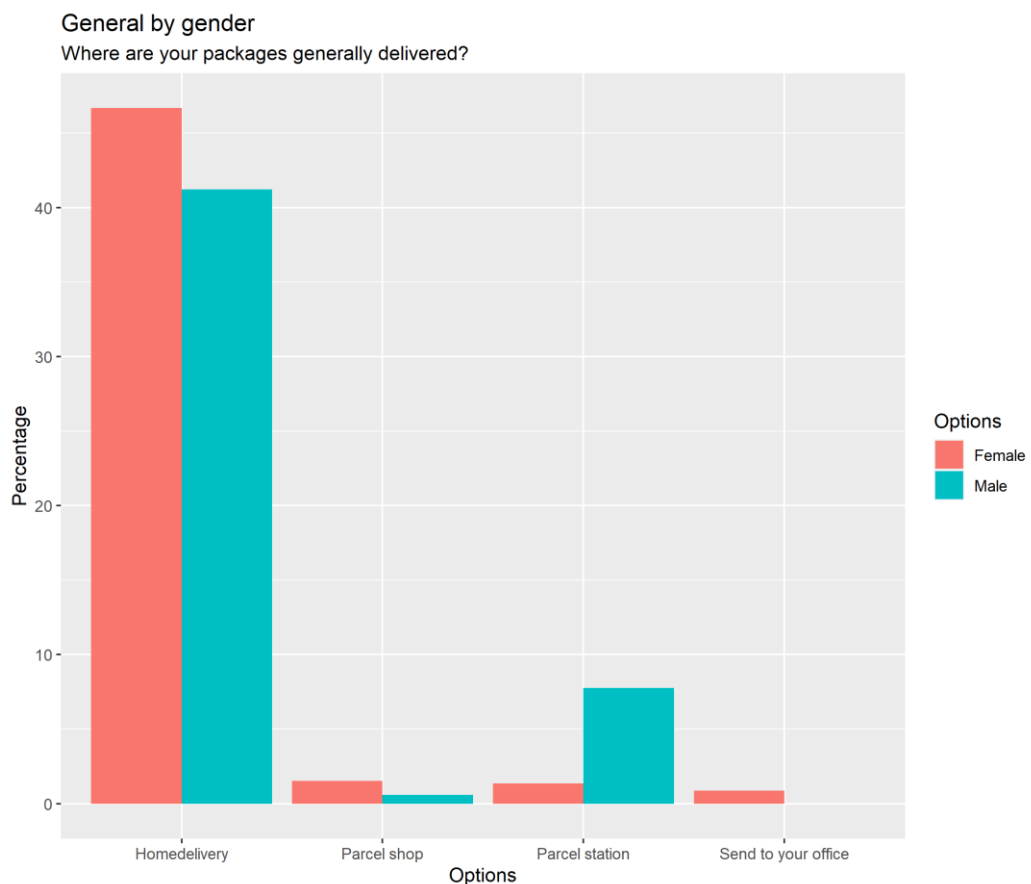
Figure 15 Results question 5 "Where are your packages generally delivered?" by gender

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49
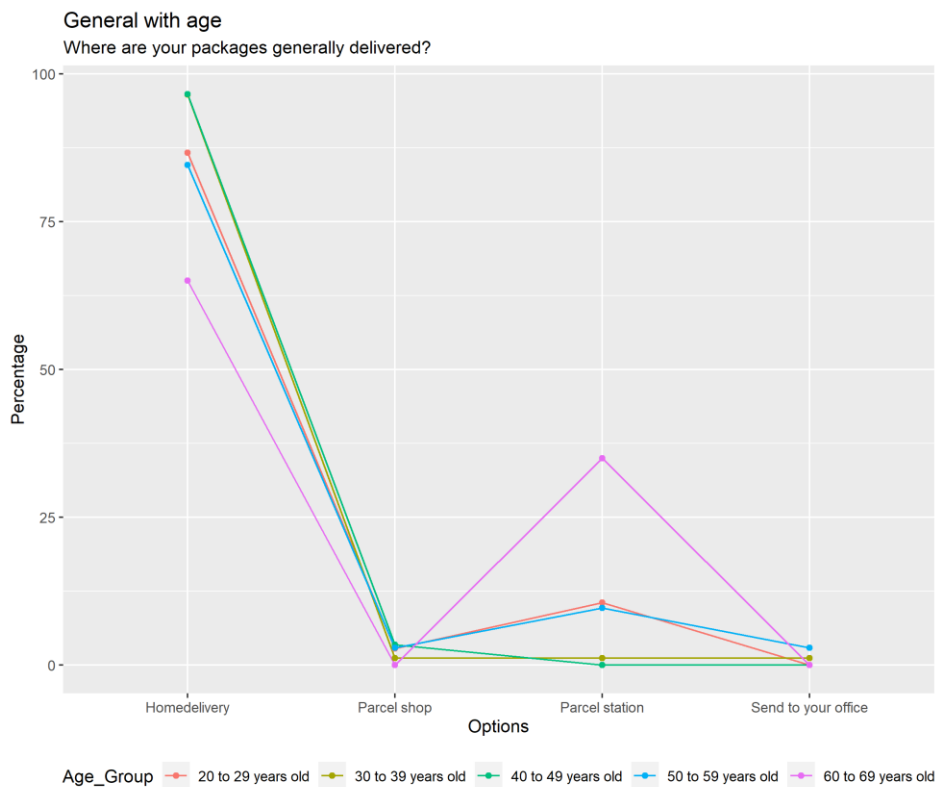
Figure 16 Results question 5 "Where are your packages generally delivered?" by age group

Question 6 "If you get parcels by homedelivery, are you at home when the deliveries come?"

Figure 17 shows the results for question number 6. Most of the people (51%) affirm that they are "Very often" at home when their deliveries come. Followed by the option "Sometimes" with 29% and "Rarely" with 14%. Only 2% of the people says to be "Always" at home when the deliveries come and 2% are "Never" there.

The results are contrasting with the previous question (question 5), where most of the people get home delivered but as shown in the plot they are not always at home. This provokes further problems to the last mile, because of failure of "First Attempt Delivery".

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General by gender

If you get parcels by homedelivery, are you at home when the deliveries come?
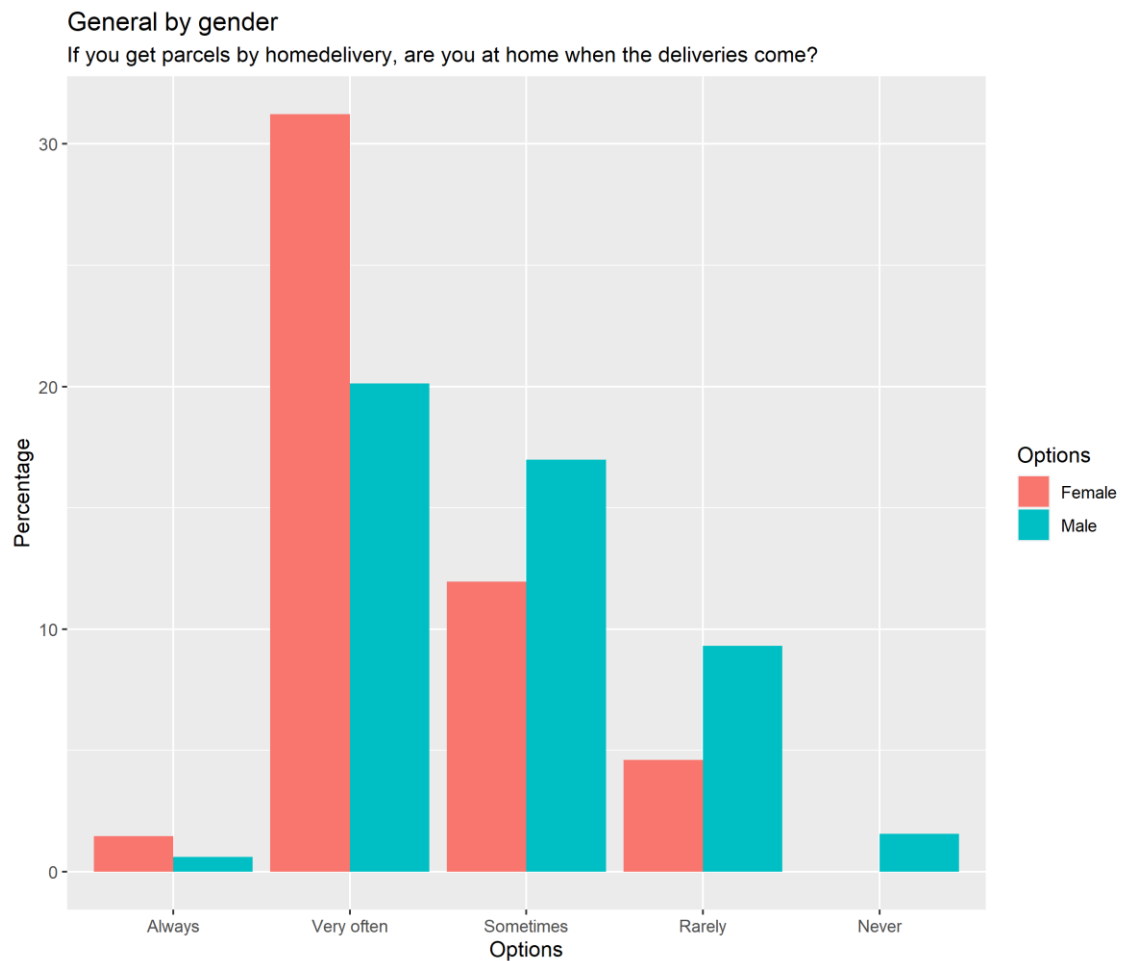
Figure 17 Results question 6 "If you get parcels by homedelivery, are you at home when the deliveries come" by gender

There were changes when analyzing the data by gender, as shown in *Figure 17*. Here, 62% of the women respondents affirm that they are "Very often" at home when their deliveries come, while only 40% of the men do the same affirmation. For men the option "Sometimes" had 34% of the votes, on the other hand women selected this option only 24%. While none of the women answered they are "Never" at home, 3% of men selected this option.

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51
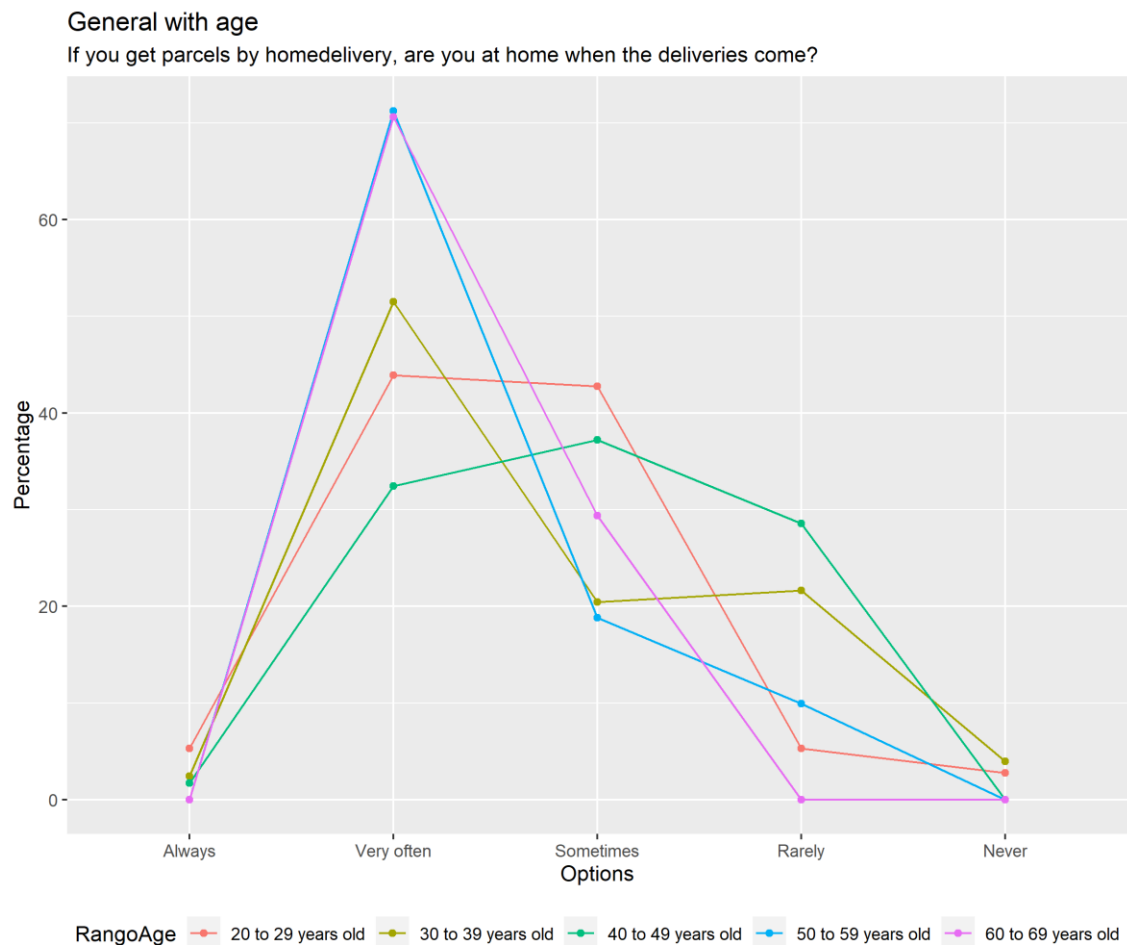
Figure 18 Results question 6 "If you get parcels by homedelivery, are you at home when the deliveries come" by age

There were some differences between age groups. They can be seen in the *Figure 18*. Most of the people between "40 to 49 years old", chose "Sometimes". Followed by "Very often" with 32%. They also selected "Rarely" as their third choice (29%). Moreover, people from "30 to 39 years old" selected "Rarely" as their second option (22%) and they selected "Never" more than the other groups (4%). This rendering the groups between 30 to 49 years old the ones that are the least often at home when their deliveries come.

In conclusion, people are not always at home when their deliveries come. Men are more likely to not be at home when their deliveries come. This is also the case for people in the age groups between 30 to 49 years old.

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Question 7 "What normally happen if you are not at home?" (Multiple-choice)

This question is related to the questions 5 and 6. Here the participants could choose different options for what happens to their packages if they are not at home when their delivery comes. The results for this question are shown in *Figure 19* home?" the options were reflected with key words. The options were as follows:

- "by the door" = The package is left close by the door
- "neighbor" = The package is delivered to a neighbor
- "parcel shop" = The package is transferred to a parcel shop
- "parcel station" = The package is transferred to a parcel station
- "Other" = Other
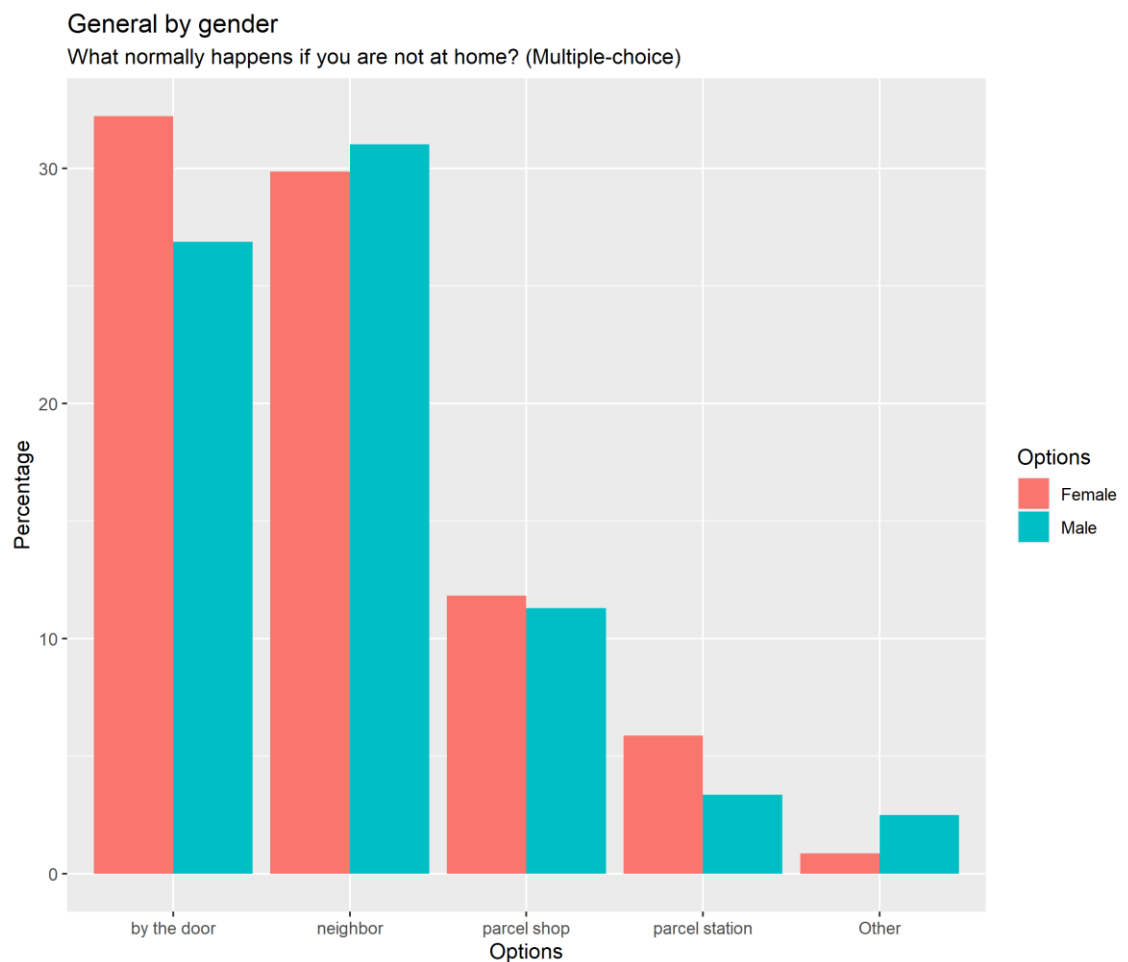
Figure 19 Results question 7 "What normally happens if you are not a home?" by gender

The most popular answer was "The package is delivered to a neighbor" selected by more than 60% of the participants. It was followed by the option "The package is left close by the door" with almost 60%. The option "The package is transferred to a parcel shop" was selected by about 20% of the people, while "The package is transferred to a parcel station" around 10% and less than 5% chose "Other".

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For this question, the differences between gender were that for women the most popular answer was "The package is left close by the door" with 64%, while for men this option was selected 54%. For men the most popular answer was "The package is delivered to a neighbor" with 62%, while this option it was selected by 60% of the women.
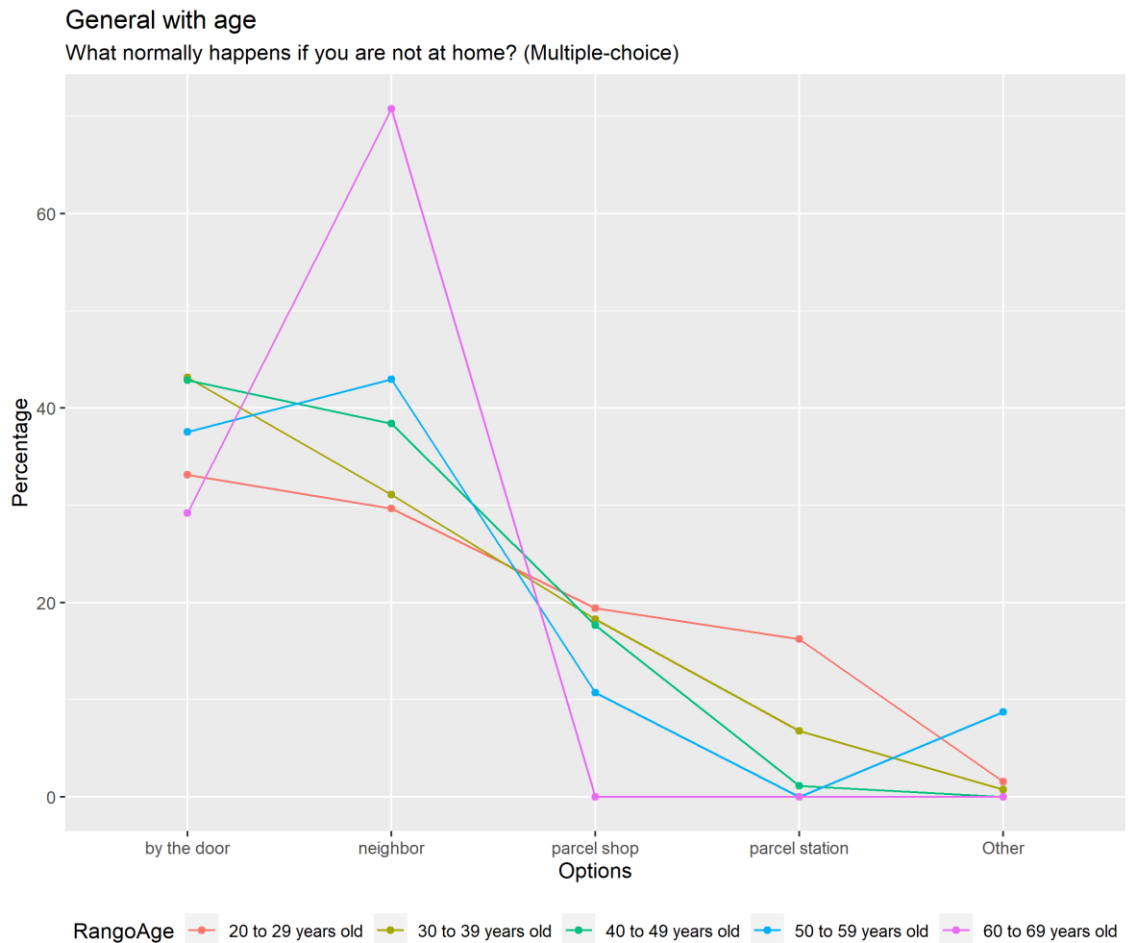
Figure 20 Results question 7 "What normally happens if you are not a home?" by age

The differences between age groups can be seen in *Figure 20*. The main differences were between the younger and the older age groups. For the age groups from "20 to 49 years old" the most popular answer was "The package is left close by the door" and the second "The package is delivered to a neighbor".

While for the age groups from "50 to 69 years old" the most popular answer was "The package is delivered to a neighbor" and "The package is left close by the door" was the second option. Moreover, the age group from "60 to 69 years old" did not select other options at all.

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Overall, the participants showed that most of the packages that fail to be delivered because the person is not at home, are not transported far from the home of the recipient. This would affect the courier by spending more time to deliver a package but there is no extra distance travelled.

Although there is a significant percentage of participants (30%) that responded that the package is transferred either to a parcel shop or a parcel station. This means that the packages need more distance travelled to be delivered. Even when people do not choose these options initially, they end up using this service. For this a better planning or notifications regarding time of delivery could help to choose the right option for the customer, resulting in less wasted time and distance travelled, making first delivery attempts more successful.

Question 8 "What would be a good time of the day for receiving packages at home?"

The results for this question are shown in *Figure 21*. The most popular response was "Evening", selected by more than half of the participants (51%). It was followed by "Morning" with 19% of the votes, and "Afternoon" with 16%. Less popular responses were "Noon", selected by 11% of the participants and "Night" with only 4% of the votes.

As observed from shown in *Figure 21*, there were slight differences between women and men. However, there were differences between age groups. This is shown in the *Figure 22*.

The age group "20 to 29 years old" also has differences in their answer, compared to other groups. The second most selected option was "Morning", followed by "Night". This was the group that considered this option the most. For the age group "40 to 49 years old "Morning" was also the second most popular option, followed by "Afternoon".

On the other hand, the age group "30 to 39 years old" also has its own distribution. The second most selected option was "Noon", followed by "Morning". This was the group that considered "Evening" the most.

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General by gender
What would be a good time of the day for receiving packages at home?
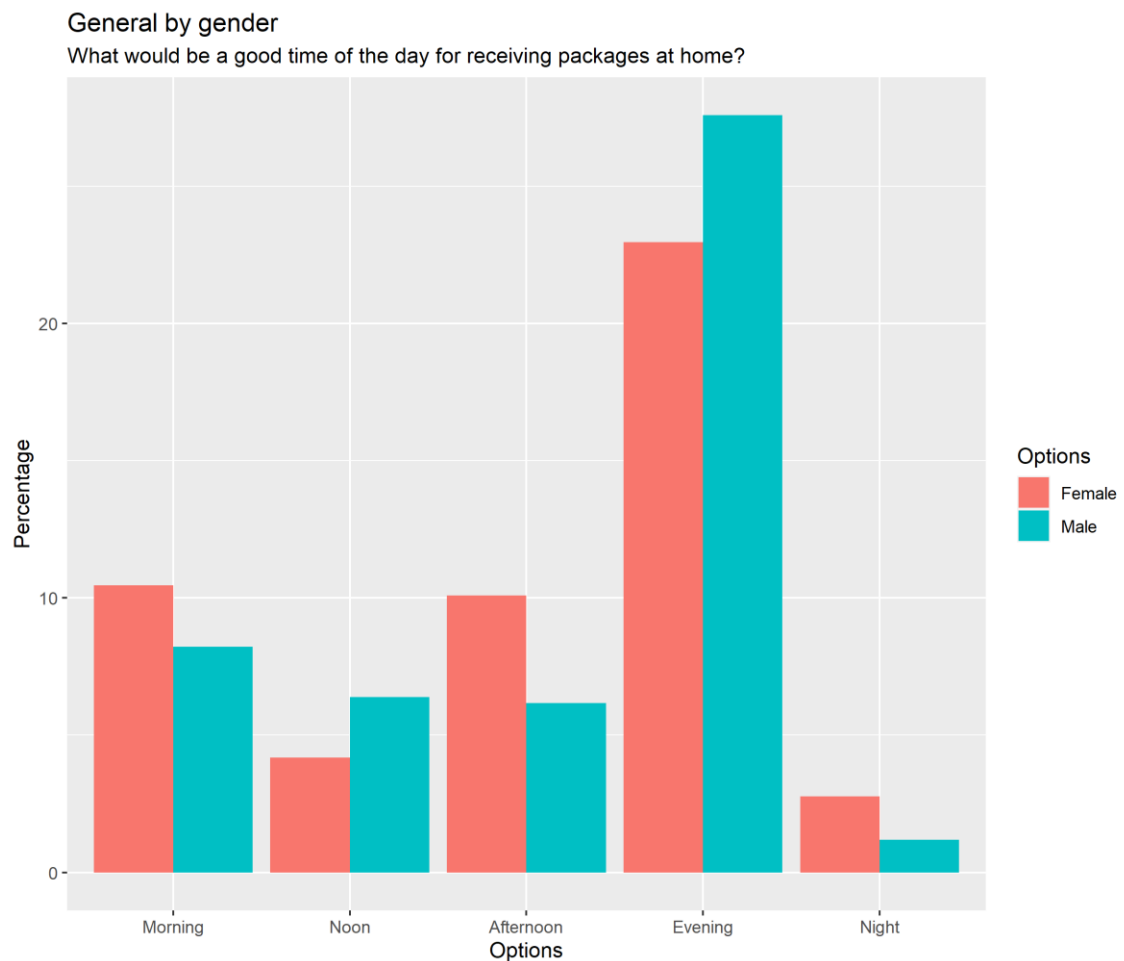
Figure 21 Results question 8 "What would be a good time of the day for receiving packages at home?"

The age group "50 to 59 years old" chose "Afternoon" as second option, followed by "Noon". This means that this group prefers to receive deliveries from midday on.

The group "60 to 69 years old", most selected option was "Afternoon", followed by "Evening" and "Morning". "Noon" and "Night" were the least selected options.

Finally, while "Evening" was the most popular opinion within most age groups, it was not the case for the group from "60 to 69 years old", that prefers an "Afternoon" delivery. It is also remarkable that the 20 to 29 years old" was the one to select "Morning the most. It was the second most selected option for this group.

This information is important for the delivery planning. If the customers were able to indicate the best time of the day for receiving their packages, the first attempt delivery could be successful. As the participants responded, the distribution of the packages could be half from morning to afternoon and half from afternoon till evening.

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General with age
What would be a good time of the day for receiving packages at home?
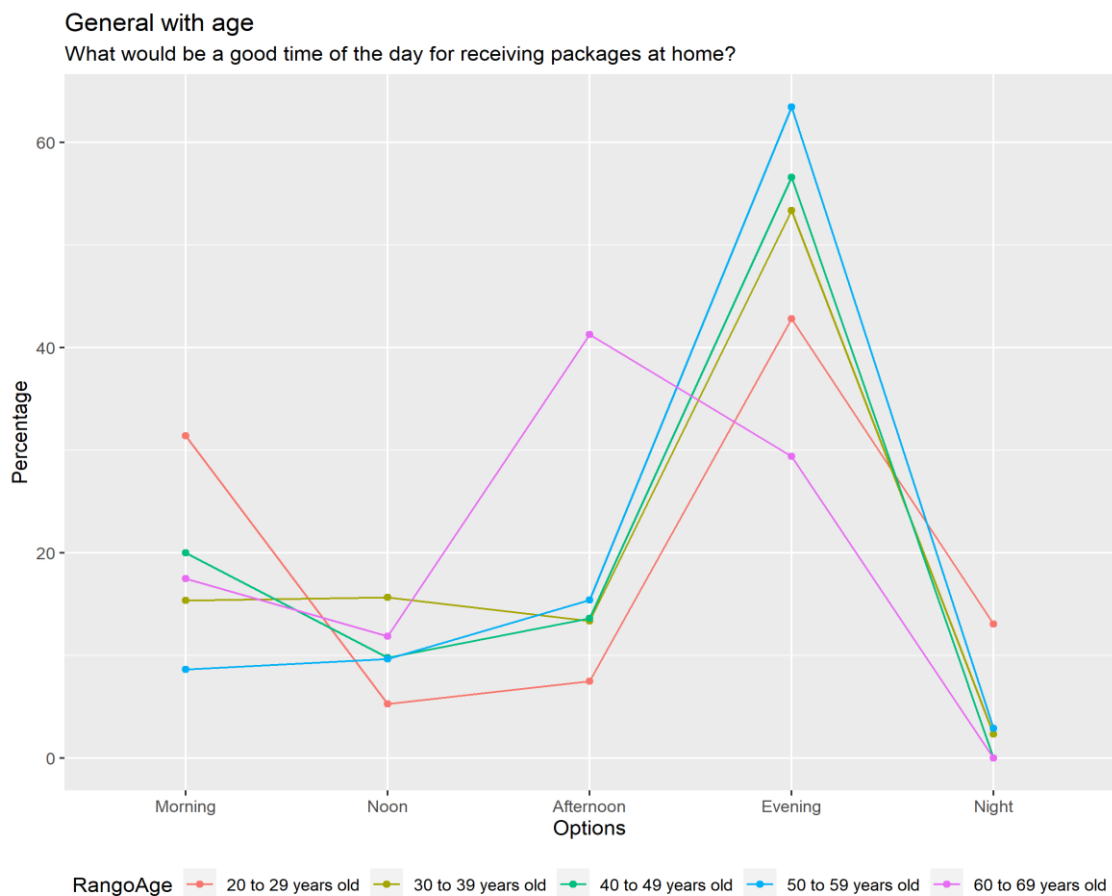
Figure 22 Results question 8 "What would be a good time of the day for receiving packages at home?" by age group

Question 9 "If you get parcels sent to a delivery point: parcel shop, parcel station, pick up at store, how do you arrive there?"

The results for this question are shown in *Figure 23*. Most of the participants chose "By bike" (36%), as a second option they selected "By foot" (32%). Whereas 14% of the participants answered: "By car". Only 9% responded "By public transport" and less than 1% have "Never used one". So, while most of the people (68%) chose zero emissions means of transportation, there was still a considerable amount of people (14%) who would choose to move by car.

When comparing between men and women there were few differences. The distribution in general is the same, but men selected the option "By public transport" more often than women. Women also refrained from answering more than men.

There were differences when comparing the results between the age groups, as *Figure 24* displays, most of the groups had their own pattern.

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General by gender
If you get parcels sent to a delivery point, how do you arrive there?
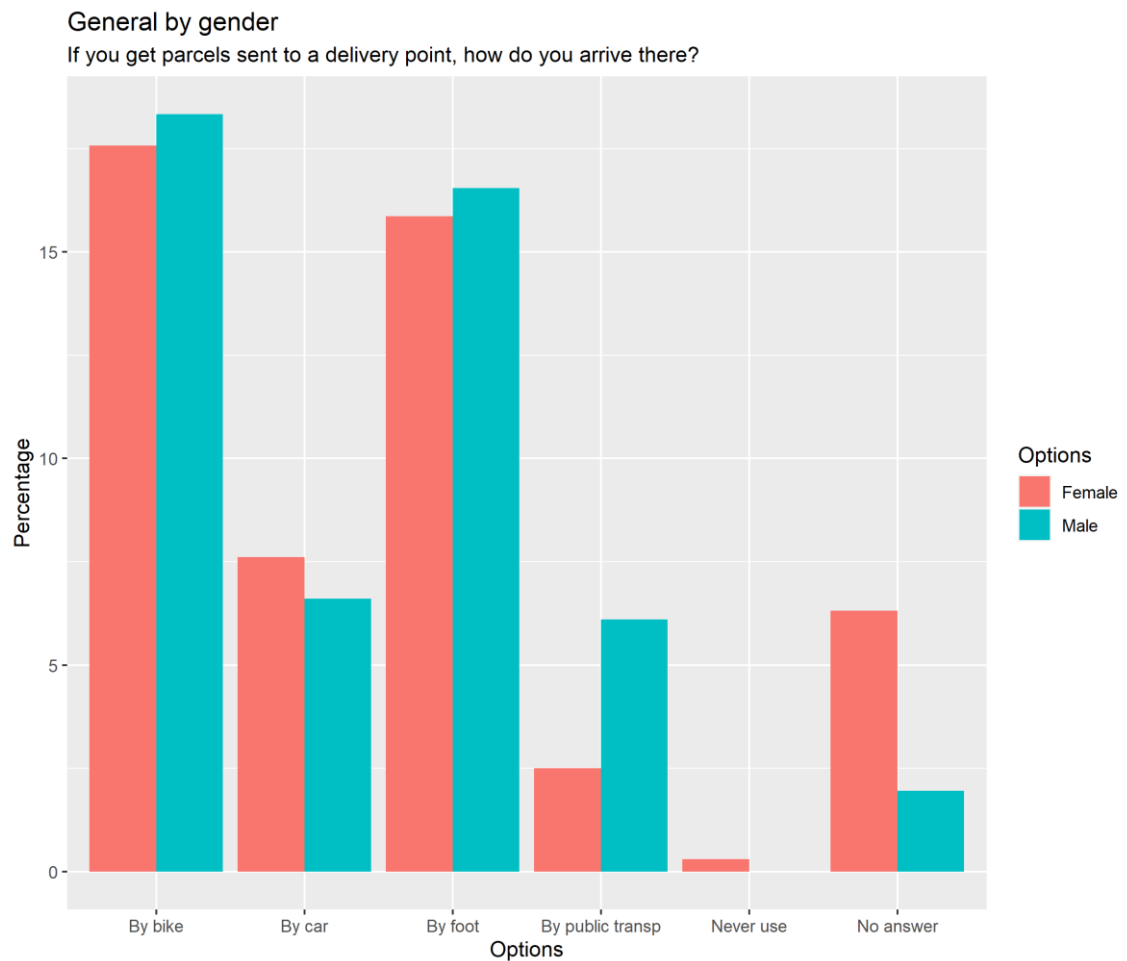
Figure 23 Results question 9 "If you get parcels sent to a delivery point: parcel shop, parcel station, pick up at store, how do you arrive there?"

For age group "20 to 29 years old", "By foot" was the most popular opinion (44%), followed by "By public transport" (27%) and in third place "By bike" (13%), while car was the second least selected option (8%), after "Never use" with 0% of the answers.

For age group "30 to 39 years old", "By foot" was the most popular opinion (38%), very close to "By bike" (37%) and in third place "By car" (12%), while "By public transport" was the second least selected option (11%). This was the only age group to have "Never use" as an answer, although the percentage is minimal (1%).

"By bike" was the most selected option (43%) for the age group "40 to 49 years old". The second most selected option was "By foot" (20%), very close to "By car" (18%) This group did not select "By public transport" as an answer. There was a high rate of no answers in this group (18%) for this question.

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For age group "50 to 59 years old", "By bike" was the most popular opinion (49%), followed by "By foot" (24%) and in third place "By car" (21%), while "By public transport" was the second least selected option (11%). Likewise, to the last age groups, this group did not select "By public transport" as an answer.
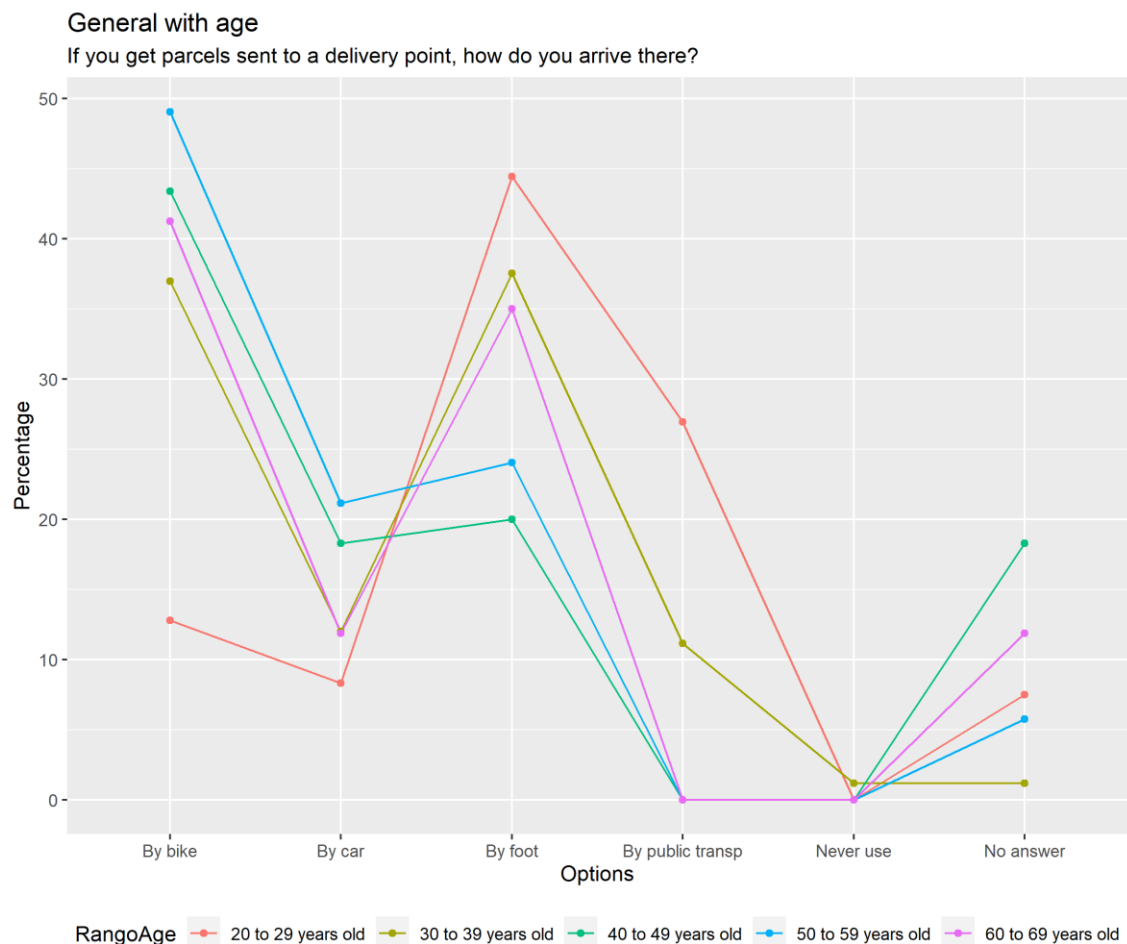
Figure 24 Results question 9 "If you get parcels sent to a delivery point: parcel shop, parcel station, pick up at store, how do you arrive there?" by age group

The group "60 to 69 years old", most selected option was "By bike" (41%), followed by "By foot" (35%) and in third place "By car" (12%), while "By public transport" was the second least selected option (11%). Likewise, to the last two age groups, this group did not select "By public transport" as an answer. There were 12% of participants that refrained to answer.

In summary the younger age groups (20-39 years old) were more willing to transport "By foot", while the other groups preferred to do so "By bike". For the age groups from 40-59 years old car was the third option but very close to their second option (less than 3% difference). As a common characteristic, the age groups from 40-69 years old did not answer "By public transport".

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The mean which people choose to reach the delivery point might be influenced by distinct factors such as the distance to the place, as well as the time to travel, the age of the person, or the mode of transport available. Knowing the age groups that prefer to transport by foot or by bike, can help to make a strategy to promote the delivery points to them, thus provoking less emissions.

Question 10 "When you shop from the same online store, do you schedule your deliveries to arrive the same day?"

The results for this question are shown in *Figure 25*. 25% of the participants chose "Rarely", and the second most selected option with 17% was "I cannot choose". This was very close to the third most popular option "Very often" (16%). The following options were "Sometimes" (14%), "Never" (5%) and "Always" (5%). Most of the people "Rarely" do it but there is also a high percentage of the people that cannot choose (17%).
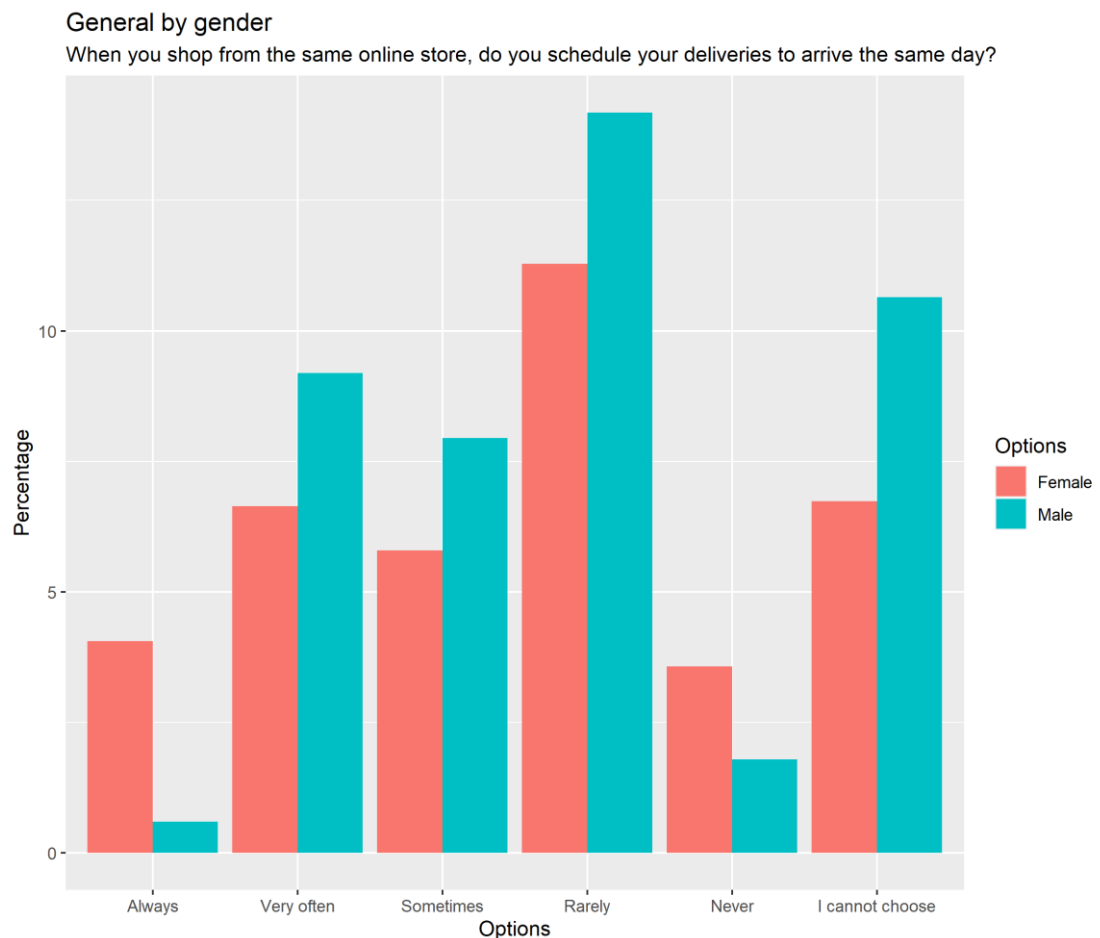
Figure 25 Results question 10 "When you shop from the same online store, do you schedule your deliveries to arrive the same day?"

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There were slight differences between the gender groups, these were that men responded that they cannot choose more than women. Also, least selected option for men was "Always" while for women it was "Never". In general, the two groups have a similar pattern being "Rarely" the most popular answer for both.

There were differences between age groups, as *Figure 26* shows.

For age group "20 to 29 years old", "Rarely" was the most popular option (23%), followed by "Never" (22%) and in third place "Very often" (17%), while "Sometimes" (14%), "I cannot choose" (13%) and "Always" (11%) were the least selected options. Although around 87% of the people in this group can choose to schedule their deliveries, they rarely do it. But there is still 13% of people who said that they cannot choose and could be targeted to schedule their deliveries.

The age group "30 to 39 years old", was the group that answered "I cannot choose" the most, with 29% of the answers. This was followed by "Sometimes" (24%), "Rarely" (22%) and "Very often" (19%). The less popular options were "Never" (4%) and "Always" (1%). This was the only age group to have "Never" as an answer, although the percentage is minimal (1%). It would be helpful that the online stores where this group buys add the option to schedule the deliveries, and in case they already have it then communicate this better to the customers. Then this 29% of people could be targeted to schedule their deliveries.

"Rarely" was the most selected option (40%) for the age group "40 to 49 years old". The second most selected option was "Very often" (24%), very close to "I cannot choose" (20%). The option "Sometimes" had 16% of the answers. This group did not select "Always" nor "Never" as answers. While there is still a high percentage of people in this age group that cannot choose to schedule their deliveries, there is also a high percentage of people that just "Rarely" do it. It might mean that people in this age group are not interested in scheduling. Thus, they might not be a target group to promote this option.

For age group "50 to 59 years old", has a similar behavior compared to the previous group. "Rarely" was the most popular opinion (44%), followed by "Sometimes" (22%) and in third place "I cannot choose" (18%). While "Very often" (12%), "always (4%) and "Never" (0%) were the least selected options. Likewise, to the last age groups, this group might not be interested in scheduling their deliveries even if they can choose to do it.

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General with age
When you shop from the same online store, do you schedule your deliveries to arrive the same day?
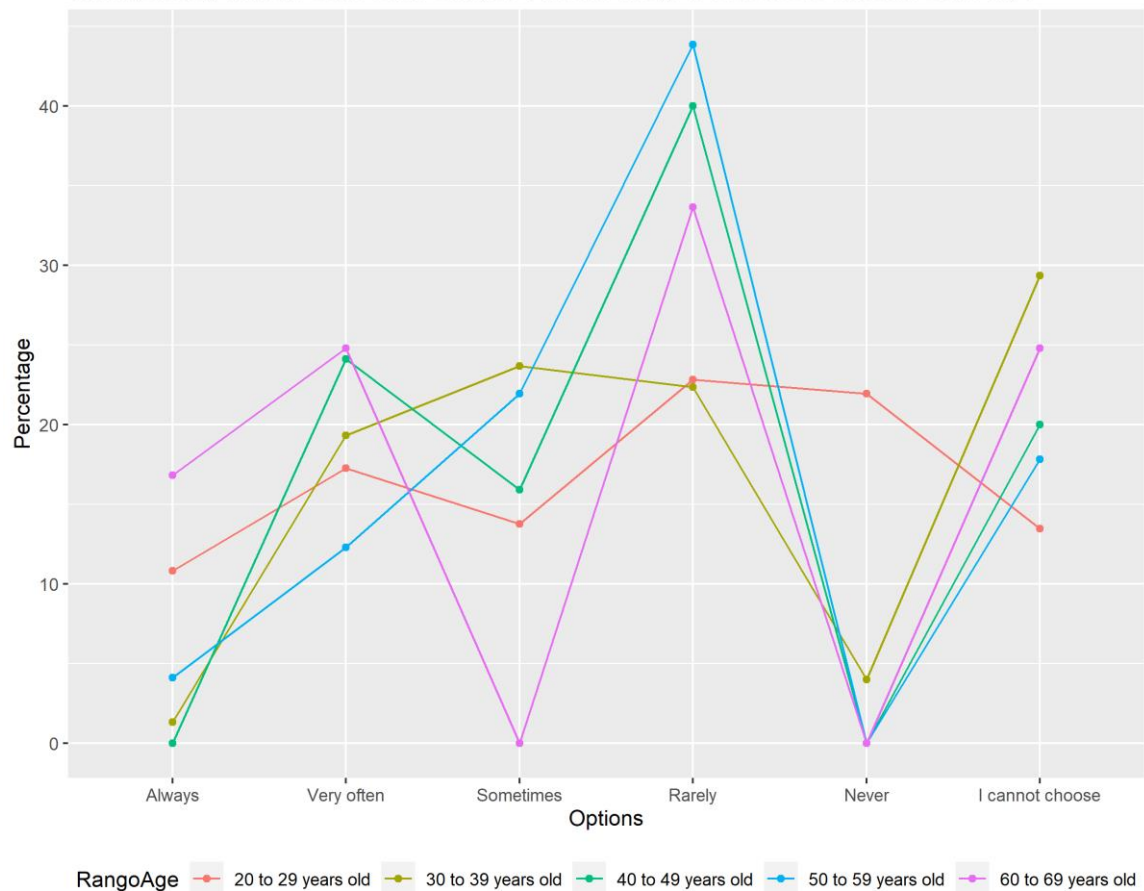
Figure 26 Results question 10 "When you shop from the same online store, do you schedule your deliveries to arrive the same day?" by age group

The group "60 to 69 years old", most selected option was "Rarely" (34%), followed by "I cannot choose" and "Very often" both with 25%. This was the group that answered "always" the most with 17%. This group did not select "Never" nor "Sometimes" as answers. This group showed interest in scheduling their deliveries (group that voted "Always" the most), so it would be helpful to offer to this 25% of the people who cannot choose to schedule, to have the option to have their packages delivered at a specific day.

The age groups that answer the most that they cannot choose were "30 to 39 years old" and "60 to 69 years old". Moreover, the age groups "20 to 29 years old" and "60 to 69 years old" should be more targeted for offering this service since they already show interest on doing it (groups that selected "Always" the most). Binging more people to schedule they deliveries to arrive the same day would reduce the travels to a certain address (less distance travelled, less emissions), as well as, reducing the packaging and, the delivery costs. It would be helpful to add this option to the online stores and try to push the people to select this option, through benefits (e.g., lower delivery price).

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Question 11 "Which services for the delivery are important for you?"

The results for question number 11: "Which services for the delivery are important for you?" were as shown in *Figure 27*. In the plot the options were reflected with key words. The options were as follows:

- "Free deliv" = Free delivery
- "Home-deliv" = Home delivery
- "Free return" = Free returns
- "Environ" = Environmentally friendly delivery
- "Self-chosen" = Self-chosen delivery window
- "Next day" = Next day delivery
- "delivery co" = Choice of the delivery company
- "Same day" = Same day delivery
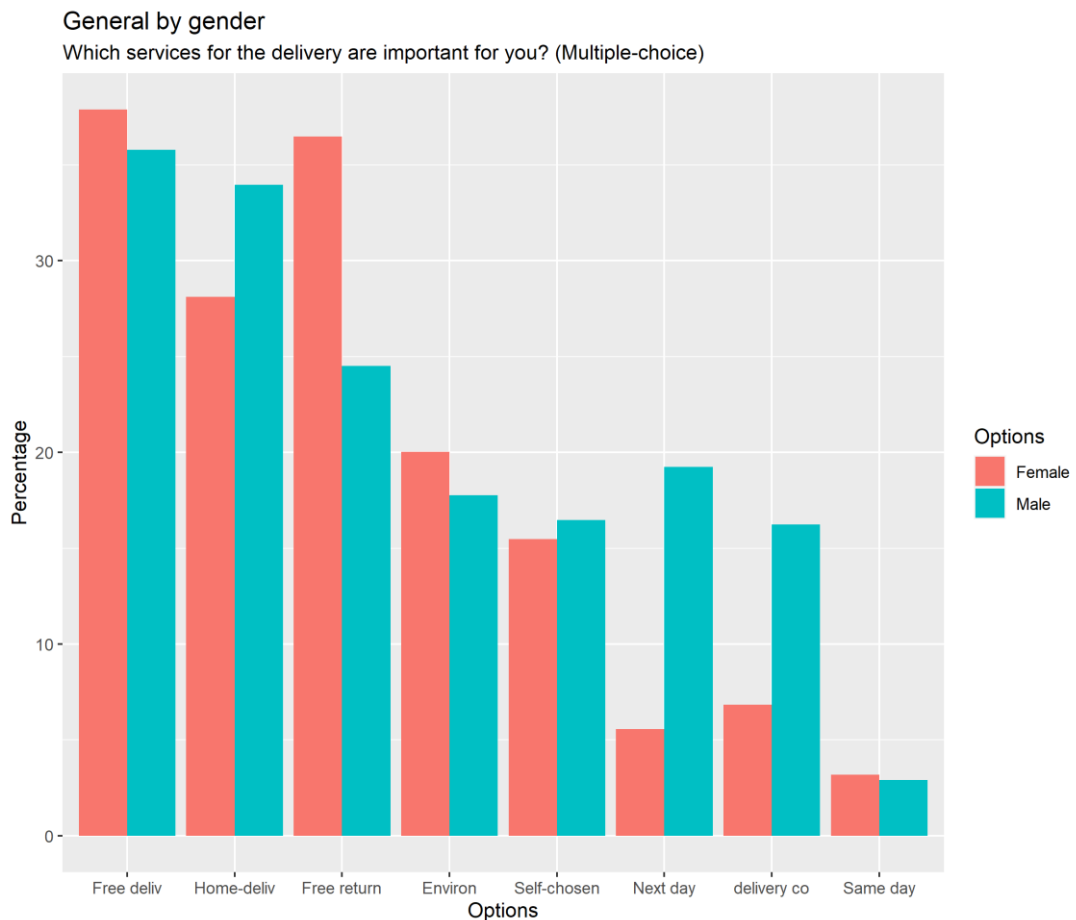
Figure 27 Results for question 11 "Which services for the delivery are important for you?" (Multiple-choice) by gender

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The most important services were "Free delivery", "Home-delivery" and "Free returns", that were selected by more than half of the participants, with 73%, 62% and 61%, respectively. "Environmentally friendly delivery" was the 4th most selected option, with only 38% of votes. This means, that while environmentally friendly deliveries are important to the customers, it is not the main priority service when buying online.

"Self-chosen delivery window" was also moderately important for the respondents, having 32% of the selections. This is related with the question 10, since there are interested people in this service, but not everyone is offered the service. Thus, it is important that the online shops offer the option.

Less important services for the customers were: "Next day delivery" (25%), "Choice of the delivery company" (13%) and "Same day delivery" (6%). This is relevant for the delivery planning since it is more important for the people to have a free delivery or a home delivery rather than a fast or express delivery. Hence, the deliveries could have longer waiting times but offering a more cost-efficient and environmentally friendly service.

There were some differences by gender. Both prefer a "Free delivery", but women chose "Free returns" as second option, while men chose "Home-delivery". Another difference was that men prefer "Next day delivery" before an "Environmentally friendly delivery". This means women might be a better target for choosing environmentally friendly deliveries and for providing the desired delivery window than men.

The different age groups had diverse opinions. These are shown in *Figure 28*.

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General with age

Which services for the delivery are important for you? (Multiple-choice)
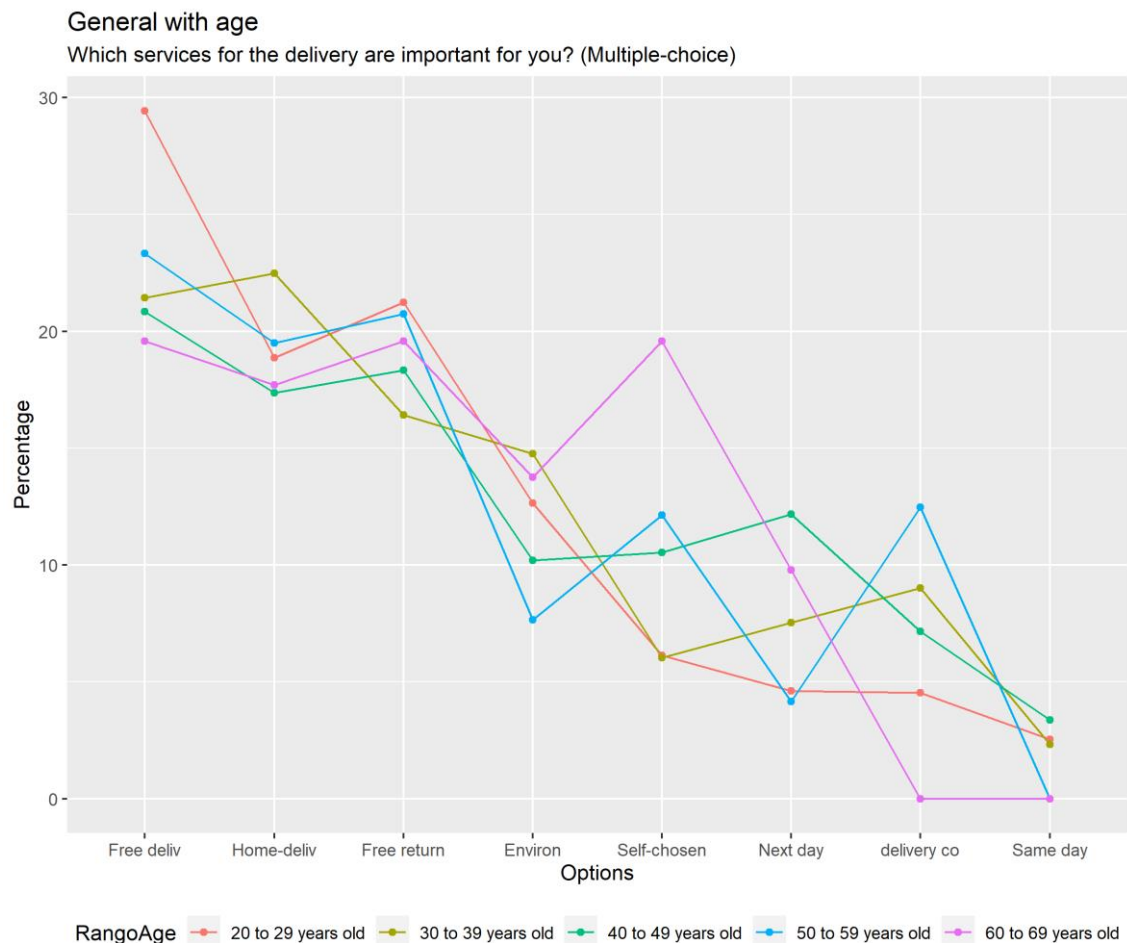
Figure 28 Results for question 11 "Which services for the delivery are important for you?" (Multiple-choice) by age group

The age group "20 to 29 years old", first choice was "Free delivery" with 29% of the answers, followed by "Free returns" (21%), "Home-delivery" (19%), and "Environmentally friendly delivery" (13%). The less popular options were "Self-chosen" delivery window" (6%), "Choice of the delivery company" (5%), "Next day delivery" (5%) and "Same day delivery" (3%). This was the age group that appreciates a free delivery the most.

"Home-delivery" was the most selected option (22%) for the age group "30 to 39 years old". Very close to the second most selected option "Free delivery" (21%). Followed by "Free returns" (16%), "Environmentally friendly delivery" (15%) and "Choice of the delivery company" (9%). The less popular options were "Next day delivery" (8%), "Self-chosen delivery window" (6%), and "Same day delivery" (2%). This is the age group that selected "Environmentally friendly delivery" the most.

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For age group "40 to 49 years old", "Free delivery" was also the most popular opinion (21%), followed by "Free return" (18%) and in third place "Home-delivery" (17%). The fourth most popular option was "Next day delivery", this was the group that selected the option the most (12%). While "Self-chosen delivery window" (11%), "Environmentally friendly delivery (10%), "Choice of the delivery company" (7%) and "Same day delivery" (3%) were the least selected options.

For age group "50 to 59 years old", "Free delivery" was also the most popular opinion (23%), followed by "Free return" (21%) and in third place "Home-delivery" (20%). The fourth most popular option was "Choice of the delivery company" (13%), making it the group that selected the option the most. While "Self-chosen delivery window" (12%), "Environmentally friendly delivery (8%), and "Next day delivery" (4%) were the least selected options. The option "Same day delivery" was not chosen for this age group. It is to notice that this was the age group that selected "Environmentally friendly delivery" the least.

For the group "60 to 69 years old" the most selected options were "Free delivery" (20%), "Free return" (20%), and "Self-chosen delivery window" (20%) followed by "Home-delivery" (18%). Less selected options were "Environmentally friendly delivery (14%), and "Next day delivery" (10%), while "Same day delivery" and "Choice of the delivery company" were not selected at all.

The group "60 to 69 years old" was the group that answered "Self-chosen delivery window" the most which is a preference discovered in this group also for the last question. This reiterates that it is a group interested in this option and should be offered to.

The age group "30 to 39 years old". possibly can be a focus group for marketing environmentally friendly delivery since was the group that selected this service the most. This group was also the only more interested in a "Home-delivery" than "Free returns". Finally, free returns were chosen as a second option for most of the age groups, even though they are rather a service to avoid when talking about the environment. Returns cause additional transport activity, hence additional emissions [56]. The customer should rather be discouraged to return the products, this could be through showing them their carbon footprint or by avoiding offering free returns as much as possible [56].

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Question 12 "How important is to you that the delivery is environmentally friendly?"

The results for question number 12: "How important is to you that the delivery is environmentally friendly?" are portrayed in *Figure 29*.
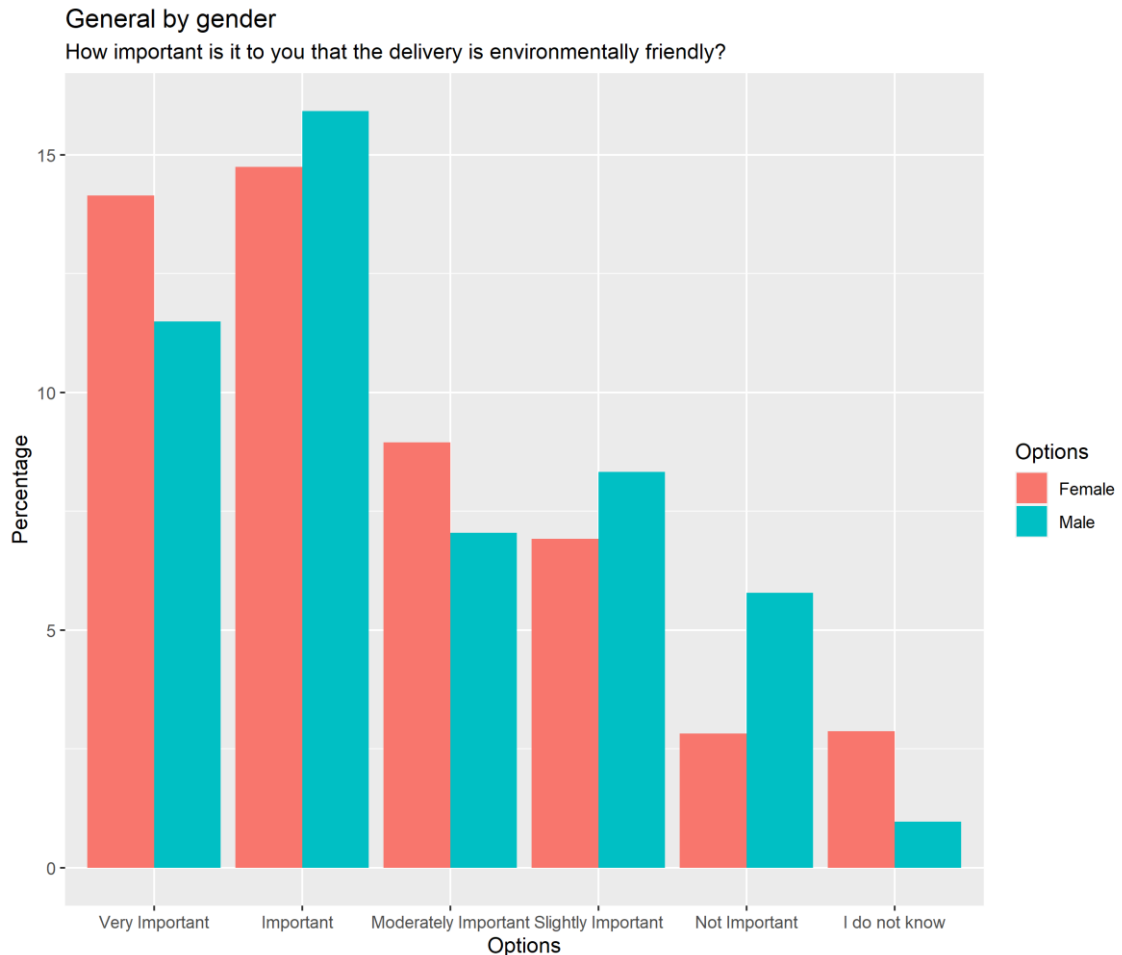
Figure 29 Results question number 12 "How important is to you that the delivery is environmentally friendly?"

Most people (57%) find it "Important" (31%) or "Very Important" (26%) that the delivery is environmentally friendly. Then the 16% consider it "Moderately important" and the rest find it sightly important or nor important at all (24%). Also 4% of the people do not know how important is for them.

For the answers to this question, we could say that the environmentally friendly deliveries are indeed important for the customers. Although when comparing it with the previous question it is to notice that it is not their main priority.

There were not big differences between the distribution for men and women. Although there were differences between age groups, they can be observed in *Figure 30*.

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The age group that considered environmentally friendly delivery "Very Important" the most was, the one from "60 to 69 years old", with 41%. This contrasts with the outcome from the previous question, were this group selected that service as their fourth priority service. The age groups that followed were "40 to 49 years old" and "30 to 39 years old" with 32% and 27% respectively. On the other hand, the age group "50 to 59 years old" selected this option only by 20%. Also, the age group "20 to 29 years old" was the one that selected "Very important" the least (14%).

The age group that considered environmentally friendly delivery "Important" the most was, the one from "60 to 69 years old", with 47%. Making it the group that seems to put more importance to the issue. The age groups that followed were "50 to 59 years old" and "20 to 29 years old" with 34% and 32% respectively. The age group "30 to 39 years old" selected this option only by 26%. Also, the age group "40 to 49 years old" was the one that selected "important" the least (22%). Although in all groups, except the youngest group, the majority (more than 50%) thinks it is very important or important to have an environmentally friendly delivery.

"Moderately important" was the most popular option between the respondents between "20 to 29 years old" with 37%. Followed by the group "30 to 39 years old" and "50 to 59 years old" with 13% and 12% respectively. The group "60 to 69 years old" also selected the option with 12%. the age group "40 to 49 years old" was the one that selected "Moderately Important" the least (3%).

The option "Sightly Important" was the most selected for the age group "40 to 49 years old" with 32%. This was followed by the age group "50 to 59 years old" with 18% and the group "30 to 39 years old" with 14%. On the other hand, the age group "20 to 29 years old" selected this option only by 8%. Finally, the age group "60 to 69 years old" was the only one that did not select this option at all.

The age group "50 to 59 years old" was the group that selected "Not Important" the most (13%). Followed by the age groups "30 to 39 years old" and "40 to 49 years old", with 12% and 10% respectively. On the other hand, the age group "20 to 29 years old" selected this option only by 5%. Finally, the age group "60 to 69 years old" was the only one that did not select this option at all.

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General with age
How important is it to you that the delivery is environmentally friendly?
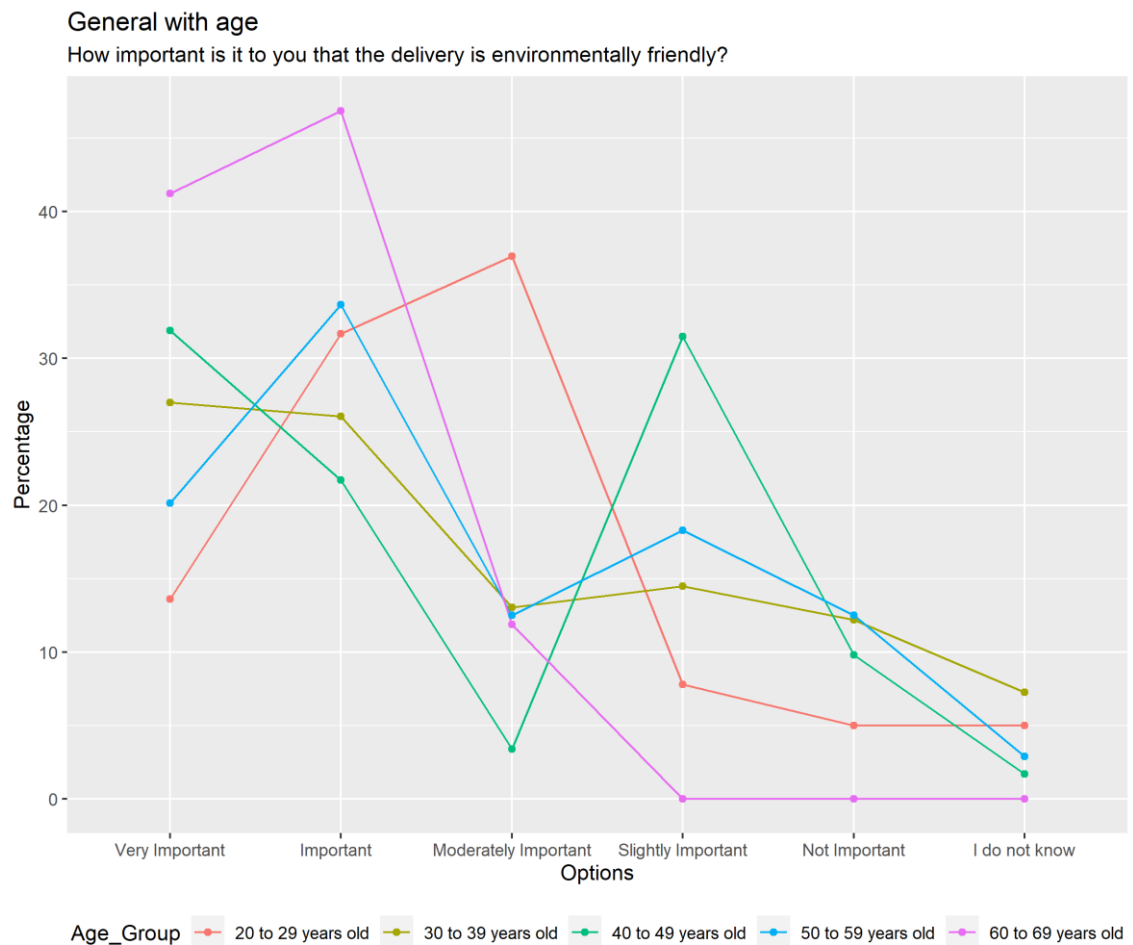
Figure 30 Results question number 12 "How important is to you that the delivery is environmentally friendly?" by age group

All groups selected the option "I do not know" by less than 7%. And the age group "60 to 69 years old" was the only one that did not select this option at all. Besides it was the second group to select "Environmentally friendly delivery" as an important service for them in the previous question, the results from this question for the age group "60 to 69 years old" showed too that environmentally friendly deliveries, are important or very important for them (88% of the answers).

Although the age group "40 to 49 years old" was the second to answer "Very Important" with 32%, the same percentage answered it is only "Sightly Important". So, there is still a considerable proportion of people that disagrees and should be shown the relevance of it.

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In the question 11 the age group "30 to 39" years old was the one most selected the service "Environmentally friendly delivery". Likewise in this question the majority (53%) thinks it is "Very Important" or "Important". On the other hand, 27% of the people answered they consider it "Not Important" or only "Sightly Important", hence there is still a considerable proportion of people that should be shown the importance of the issue.

Question 13 "Who should be responsible for making the delivery environmentally friendly?" (Multiple-choice)

Question 13 was a multiple-choice question. *Figure 31* displays the results for it.
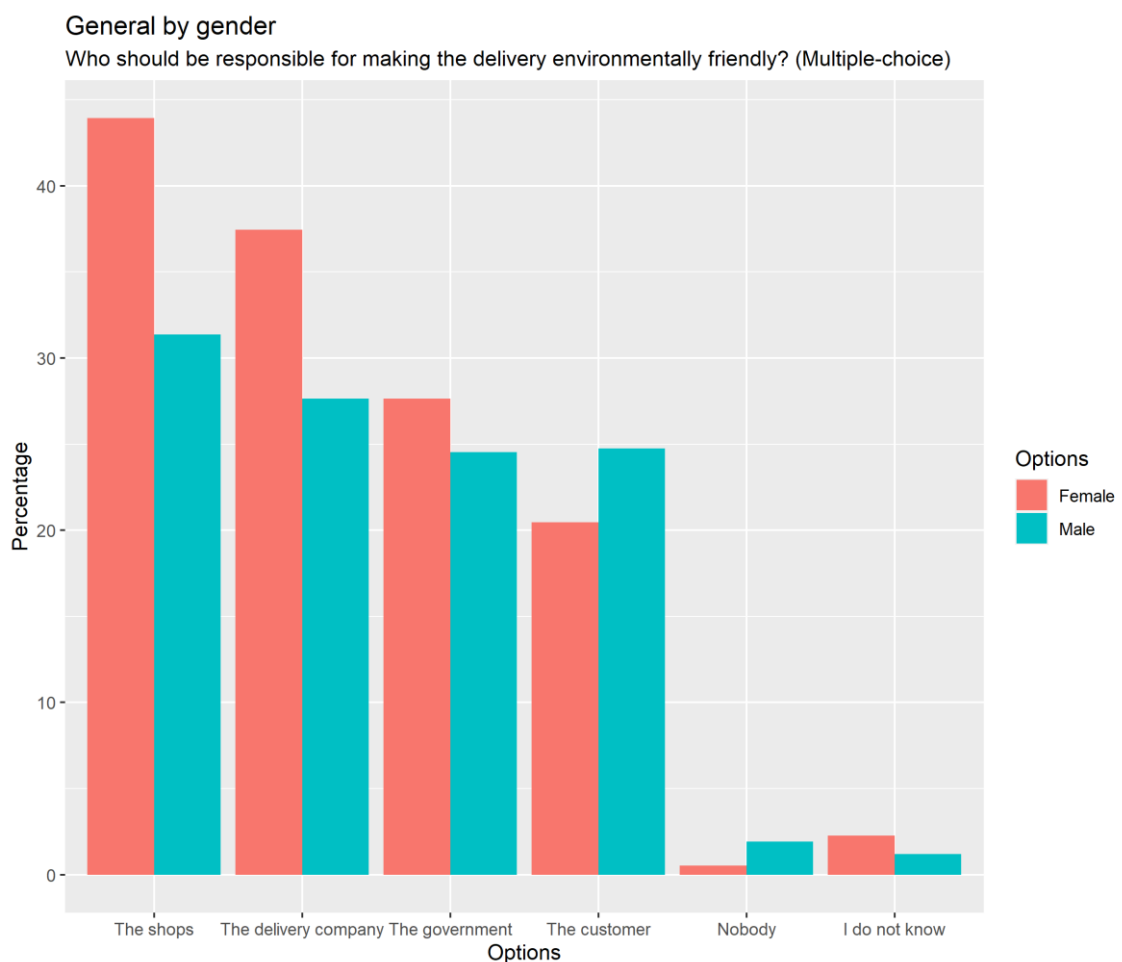
Figure 31 Results question 13 "Who should be responsible for making the delivery environmentally friendly?" (Multiple-choice)

While people consider it important that they become an environmentally friendly delivery the majority does not think that the customer should be responsible for it. Most of the people (75%) answered agree that the shops should be responsible for it and 65% think that the delivery company should be responsible. But only 45% of the participants think that the customer should be responsible for it.

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When comparing by gender the main difference was that the men selected "The cus-tomer" as the third option and "The government" as the fourth. Also, men selected "No-body" more often than women.

The distributions by age can be seen in *Figure 32*.
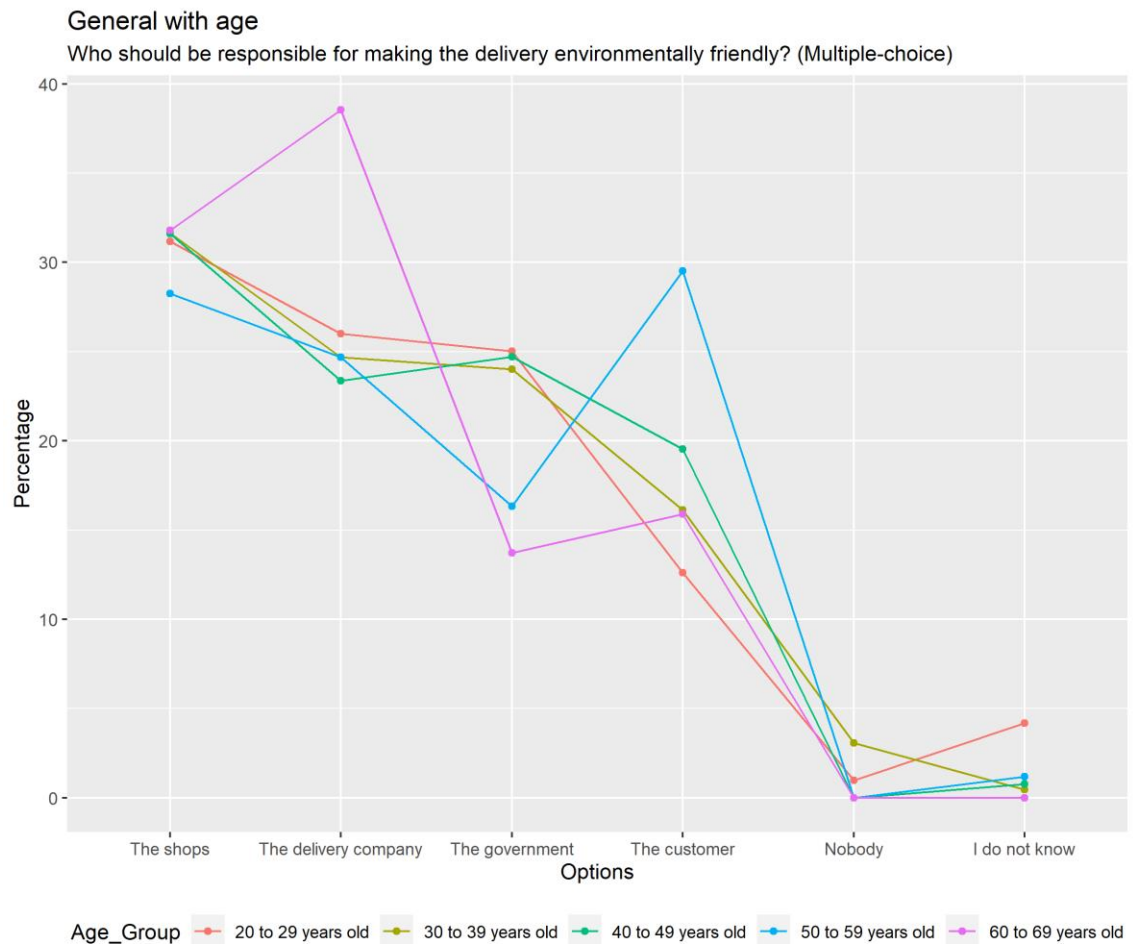
Figure 32 Results question 13 "Who should be responsible for making the delivery environ-men-tally friendly?" (Multiple-choice) by age group

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The age groups between 20 to 49 years old had a very similar pattern to the "General" distribution. The main difference was that the group from "20 to 29 years old" selected "The customer" and "I do not know" more than the others (13% and 4% each). Additionally, the age group "40 to 49 years old" selected "The government" as second option followed by "the delivery company".

In contrast, the age group "50 to 59 years old" was the group that selected "The customer" the most (30%). This matches with the responses from the last question, where this group responded that "Environmentally friendly" deliveries are "Important" for them. It comes together to the answer for question 11, where this the group considered "Environmentally friendly deliveries" as an important service the least. This could mean they consider it is not only a service to be provided but an issue where the customer also has responsibility for.

Moreover, the age group "60 to 69 years old" was the group that selected "The delivery company" the most (39%), followed by "The shops" (32%) and "The customer" (16%). This group was the one that selected "The government" the least (14%). This complements the answer for question 12, because this group considers environmentally friendly deliveries "Very important", although they do not think the customer should be the main responsible part for it.

Although there is a notion that the customer should take part on the responsibility, most of the people do not think that that customer should be responsible for making the deliveries more environmentally friendly. Only the people from the age group "50 to 59 years old" thinks the customer should be the main responsible for it.

Question 14 Imagine you have purchased an item of 40 EUR that will be delivered to you at home with a cost of 4 EUR. How much additional amount of money (in euro) would you be willing to pay for making your delivery more environmentally friendly (CO$_2$ neutral or low emissions, low-noise delivery, delivery with electric vehicles/bikes, less packaging, etc.)?

Question 14 was an open question. The answers were then grouped in spans of 1 euro. *Figure 33* exhibits the results for it.

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Most people's answers (30%) were in the range "[0-1) euro", followed by "[1-2) euro" with 29% and "[2-3) euro" with 27%. That is already 86% of the answers. There were answers for more than 3 euros, but all the spans were selected by less than 4% each. 3% of the respondents answer with arguments pro or against the extra charge for the delivery or the measures mentioned. From the frequency table the mean value for the general population was of **1.8** euro.

There were no big differences between the male and female respondents. The only difference was that men selected "[4-5) as fourth option while women selected "5 or more" in fourth place. There were differences between age groups. These are shown in *Figure 34,* here the last spans were grouped into the option "5 or more" to analyze the plot in a simpler manner.
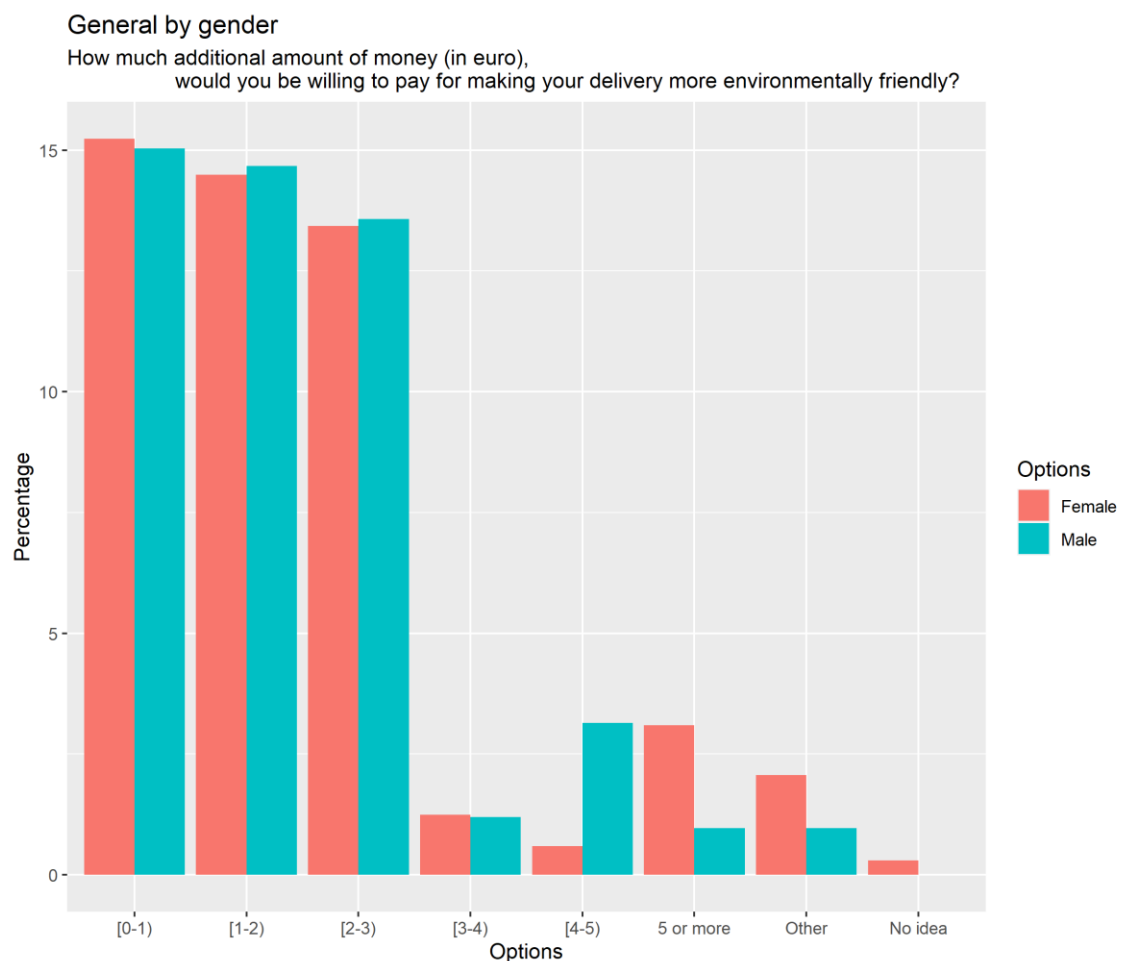
Figure 33 Results question 14 "How much additional amount of money (in euro) would you be willing to pay for making your delivery more environmentally friendly?" by gender

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The age group "20 to 29 years old", first choice was "[1-2) euro" with 48% of the answers, followed by "[0-1) euro" (25%), "[2-3) euro" (11%). The less popular answers were "[3-4) euro" and "[4-5) euro" with 6% each. Only 5% of the respondents answered, "5 or more euro". When calculating the mean from the frequency table the group has a mean value of **1.7** euro.

Most people (34%) in the age group "30 to 39 years old" answered "[0-1) euro". The second most popular answer was "[1-2) euro" (26%), followed by "[2-3) euro" (23%). This was the group that answered "5 or more euros" the most with 7%. On the other hand, 6% of the people answered with a comment rather than a number, with arguments whether they find it good or bad to charge for this. Finally, "[4-5) euro" was only answered by 2% of the people. From the frequency table the group has a mean value of **1.5** euro.
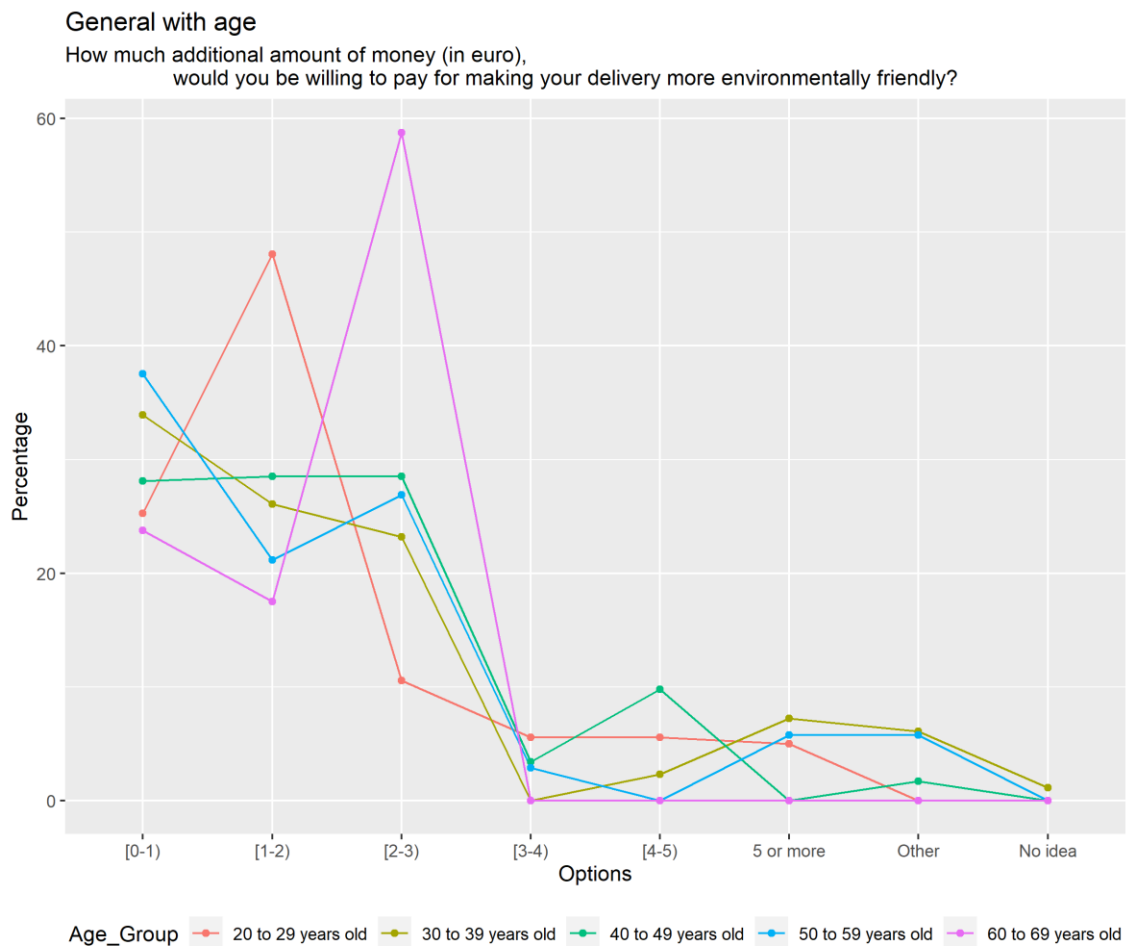
Figure 34 Results question 14 "How much additional amount of money (in euro) would you be willing to pay for making your delivery more environmentally friendly?" by age group

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For age group "40 to 49 years old", "[2-3) euro" and "[3-4) euro" were the most popular opinions with 29% each. This was very close to "[0-1) that 28% of people answered. This was the group that answered "[4-5) euro" the most (10%). Only 3% answered "[3-4) euro" and 2% responded with other statements. From the frequency table the group has a mean value of **1.9** euro. Contrasting with the previous questions, where this group did not mention environmentally friendly deliveries as a main concern, they will be one of the groups willing to pay the most.

The age group "50 to 59 years old" was the one that answered "[0-1) euro" the most. (37%). It was followed by "[2-3) euro" (29%) and "[1-2) euro" (22%). Only 3% answered "[3-4) euro". Also 6% of the people answer other arguments. The mean value for this group was **1.4** euro. While this group thinks the customer has a key role for making the delivery environmentally friendly, they are willing to pay the lowest amount of money for it. This group might prefer doing something themselves to improve the delivery.

For the group "60 to 69 years old" the most selected option was "[2-3) euro", making it the group that answered this option the most (59%). This was followed by "[0-1) euro" with 24% and "[1-2) euro" with 18%. This group did not reply with other answers. This validates the importance this age group gives to environmentally friendly deliveries. Even though they do not consider the customer to be the main responsible for it, they would be willing to pay the highest amount of money from all age groups. From the frequency table the group has a mean value of **1.9** euro.

Finally, the groups that are willing to pay the most were the age groups "60 to 69 years old" and "40 to 49 years old". This matches the answers from question 12, where both groups were the ones to consider an environmentally friendly delivery "Very Important" the most. Although the age group "30 to 39 years old" considered in question 11, "Environmentally friendly delivery" an important service they are not willing to pay the most for it.

Also, the age group "20 to 29 years old" had a different outcome as expected. In question 13, it was the group that answered that the customer should be responsible for making the delivery environmentally friendly the least. Here they are willing to pay more than at least two groups.

This question is analyzed further in the hypothesis verification section, where also the income of the participants is involved.

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Question 15 "Which measures did you take during the corona-pandemic, regarding shopping?"

The next question to analyze is question 15 "Which measures did you take during the corona pandemic, regarding shopping?" This was a multiple-choice question; the people could select different measures and every option counted once. The answers are shown in *Figure 35*.

The options were reflected with key words. The options were as follows:

- "physical stores" = Continue shopping in physical stores as before
- "online stores as before" = Continue shopping in online stores as before
- "home delivered" = Change to online shopping and get home delivered
- "pick up at store" = Change to online shopping and pick up at store
- "Avoid shopping/shop less" = Avoid shopping/shop less
- "local stores" = Shop at local stores close from home (less traveling)
- "Other" = Other

As shown in the *Figure 35*, **34%** of the population answered that they did "changed to online shopping and got home delivered", whereas the most selected option was "Continue shopping in online stores as before" selected by **48%** of the participants. This means that a considerable percentage of people were already making use of online shopping before the pandemic.

The second most selected was "Continue shopping in physical stores as before", selected by **40%** of the population. Hence, that most people selected these options, means that most of the people kept performing their shopping as before (88%).

On the other hand, from the options that meant changing the way of shopping, the most voted option was "Avoid shopping/shop less". The **38%** of the participants selected this option.

Another option selected by **34%** of the participants was "Shopping at local stores close from home (less travelling)", which tells that the people decided to buy at a local store as much as people changed to online shopping.

The results show people mainly kept their doing their shopping through the same mean as before, but there were also changes during the pandemic, such as avoid shopping or shop less and buying at local stores. People also started to change to online shopping and getting delivered at home. In contrast, changing to online shopping and picking up at the store was rather not so popular.

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General by gender
Which measures did you take during the corona-pandemic, regarding shopping? (Multiple-choice)
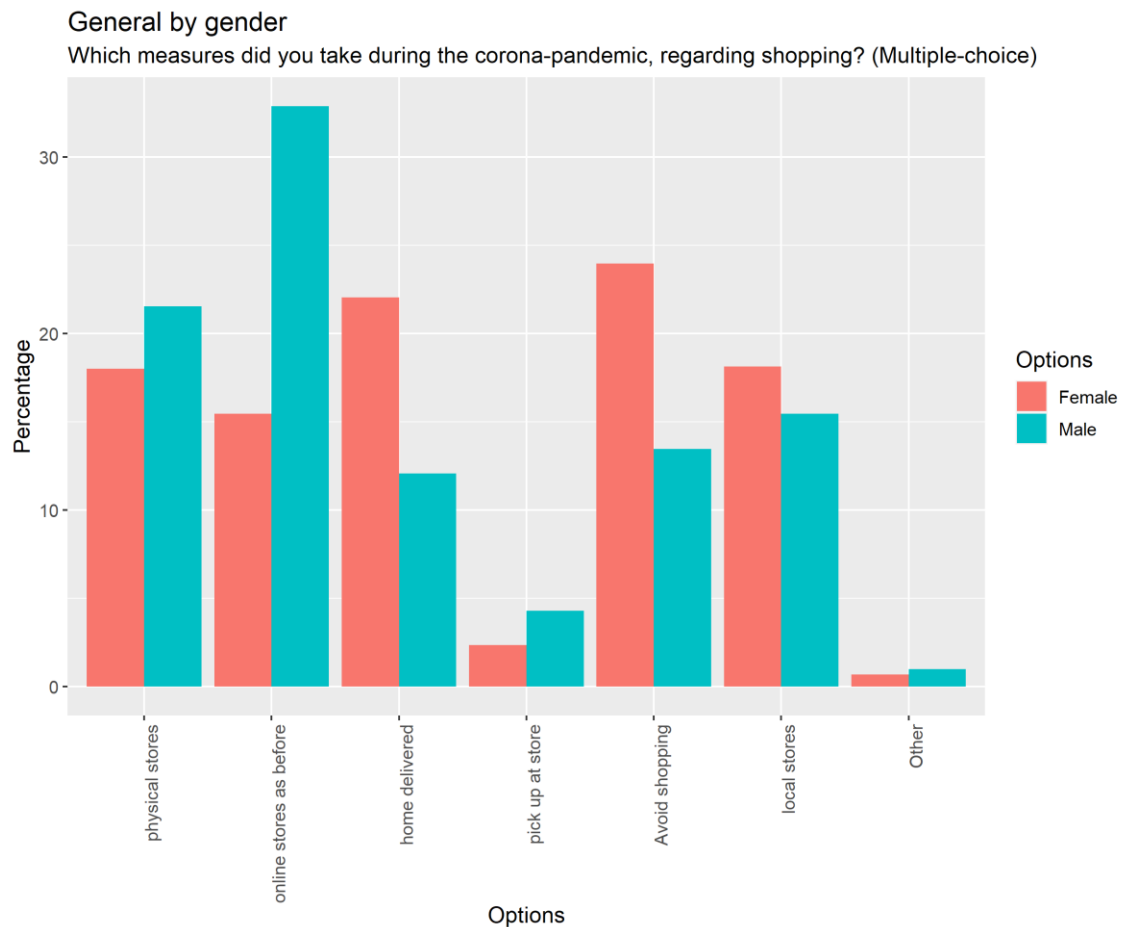
Figure 35 Results question 15 Which measures did you take during the corona-pandemic, regarding shopping?

There were some differences between women and men. The most popular response within women was "Avoid shopping/shop less" (48%), then "Change to online shopping and get home delivered" (44%). This was followed by "Shop at local stores close from home (less traveling)" and "Continue shopping in physical stores as before" (36% each). Less popular options were "Continue shopping in online stores as before" (31%) and "Change to online shopping and pick up at store" (4%).

The responses of men were different. The most popular response was "Continue shopping in online stores as before" (66%), then by "Continue shopping in physical stores as before" (43%), "Shop at local stores close from home (less traveling)" (31%), and "Avoid shopping/shop less" (27%). Less popular options were "Change to online shopping and get home delivered" (24%) and "Change to online shopping and pick up at store" (9%).

Then it is to conclude that women did change the way they shopped during the pandemic (avoiding shopping or changing to online shopping), while men were more inclined to keep shopping in the same place as before (online or physical stores).

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Figure 36 shows the results of question 15 divided by age group**.**

The age groups "20 to 29 years old", "30 to 39 years old" had a very similar distribution of answers. The most popular answer was "Continue online shopping as before", followed by "Avoid shopping/shopping less" and "Change to online shopping and get home delivered". Less popular answers were "Continue shopping in physical stores as before", "Shop at local stores close from home (less traveling)" and "Change to online shopping and pick up at store".

For the age group "40 to 49 years old" the distribution was very similar, but there was a higher preference for "Shop at local stores close from home (less traveling)" over "Avoid shopping/shopping less".

The age group "60 to 69 years old" also had a similar pattern as the previous group but they preferred to "Continue online shopping as before" as much as they preferred to "Continue shopping in physical stores as before".

The age group "50 to 59 years old" had its own pattern. The most popular answer was "Shop at local stores close from home (less traveling)". Then it was followed by "Continue shopping in physical stores as before" and "Avoid shopping/shopping less". Less popular opinions were "Continue online shopping as before", "Change to online shopping and get home delivered" and "Change to online shopping and pick up at store".

For most of the age groups the most popular answer, was "Continue online shopping as before". Meaning that while it was a tendency to buy more online these age groups were already buying online. Only the age group "50 to 59 years old" did not prefer to buy online but rather bought at local stores or the physical stores they frequented before.

It is to conclude that most people kept buying in the location they did before (online or physical stores). Although there was a tendency to change to online shopping it was also a tendency to shop at local stores or to avoid shopping.

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General with age
Which measures did you take during the corona-pandemic, regarding shopping? (Multiple-choice)
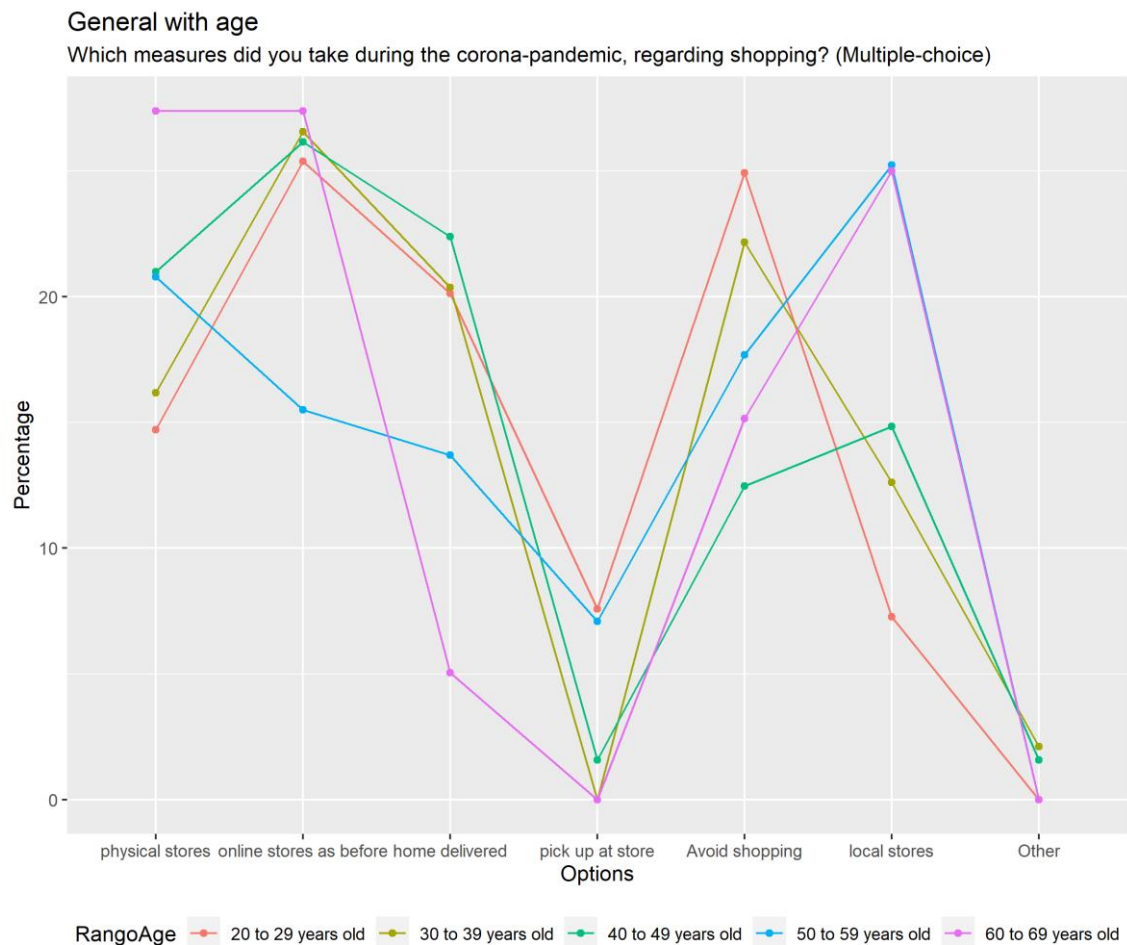
Figure 36 Results question 15 "Which measures did you take during the corona pandemic, regarding shopping?" by age group

Question 16 "Do you agree with the following statement? Currently you shop more online than before the pandemic?"

For the question 16 "Do you agree with the following statement? Currently you shop more online than before the pandemic?", the options were: "Strongly Agree", "Agree", "Undecided", "Disagree" and "Strongly Disagree".

As shown in *Figure 37* 16% of the population strongly agrees and 26% agrees with the statement, so 42% of the respondents are on the agreeing side. While 20% of the participants disagrees and 17% strongly disagrees, this is 37% of the people are in the disagreeing side. The other 21% is undecided.

While most people are in the agreement side, not everyone agrees with the statement and the difference is small (5%), hence the results are inconclusive.

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There were differences between the genders. Most women (23%) "Strongly Agree" with the statement. Most of them were in the agreement side (45%). While for men the 30% answered "Agree". Although the agreement side was higher (39%), the disagreeing side was also very considerable (38%). Thus, the results for men are deficient for making a conclusion.

General by gender
You shop more online than before the pandemic...
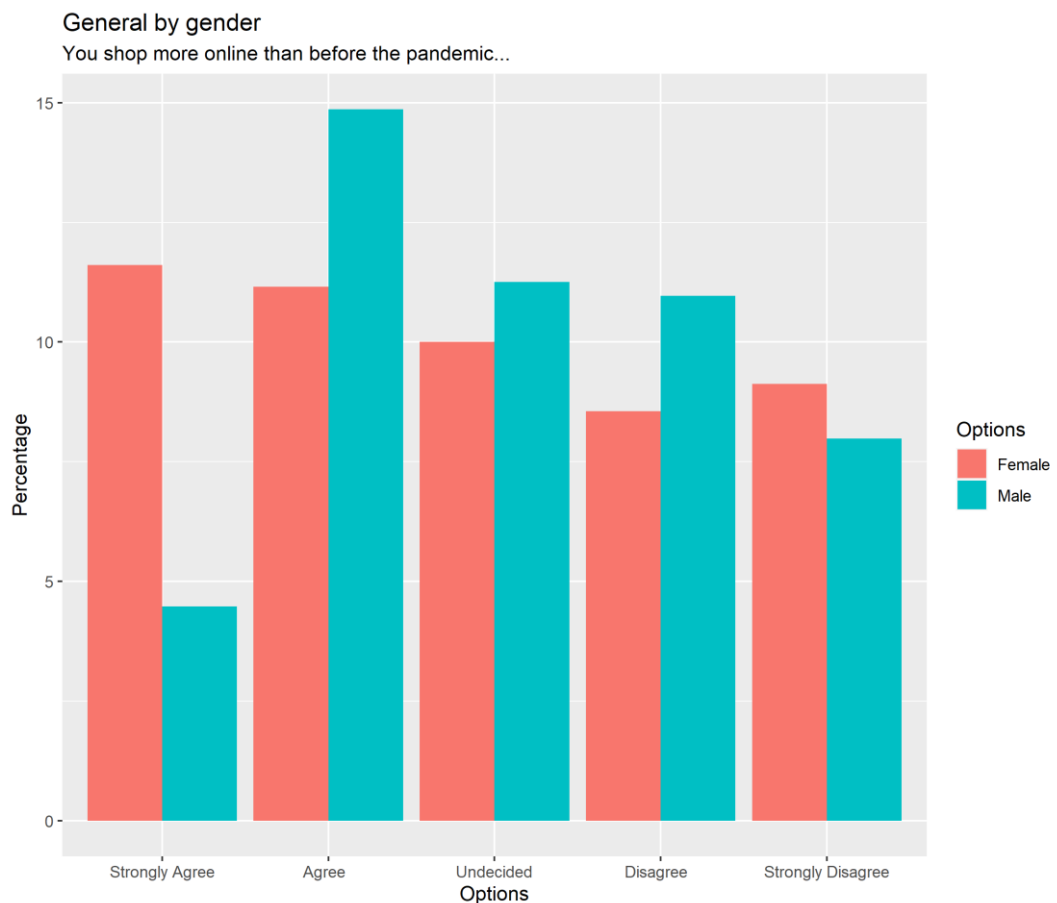
Figure 37 Results question 16 "Do you agree with the following statement? Currently you shop more than before the pandemic"

The *Figure 38* displays the results for question 16 by age group. The behavior for the age group "20 to 29 years old" was similar to the general results, with the following percentages: "Strongly Agree" (20%), "Agree" (26%), "Undecided" (16%), "Disagree" (25%) and "Strongly Disagree" (13%).

Most people (24%) in the age group "30 to 39 years old" disagrees. The second most popular answers were "Strongly Agree" and "Undecided" with 21% each. They were followed by "Strongly Disagrees" (17%). Only 15% of the respondents in this group agrees with the statement.

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General with age

You shop more online than before the pandemic...
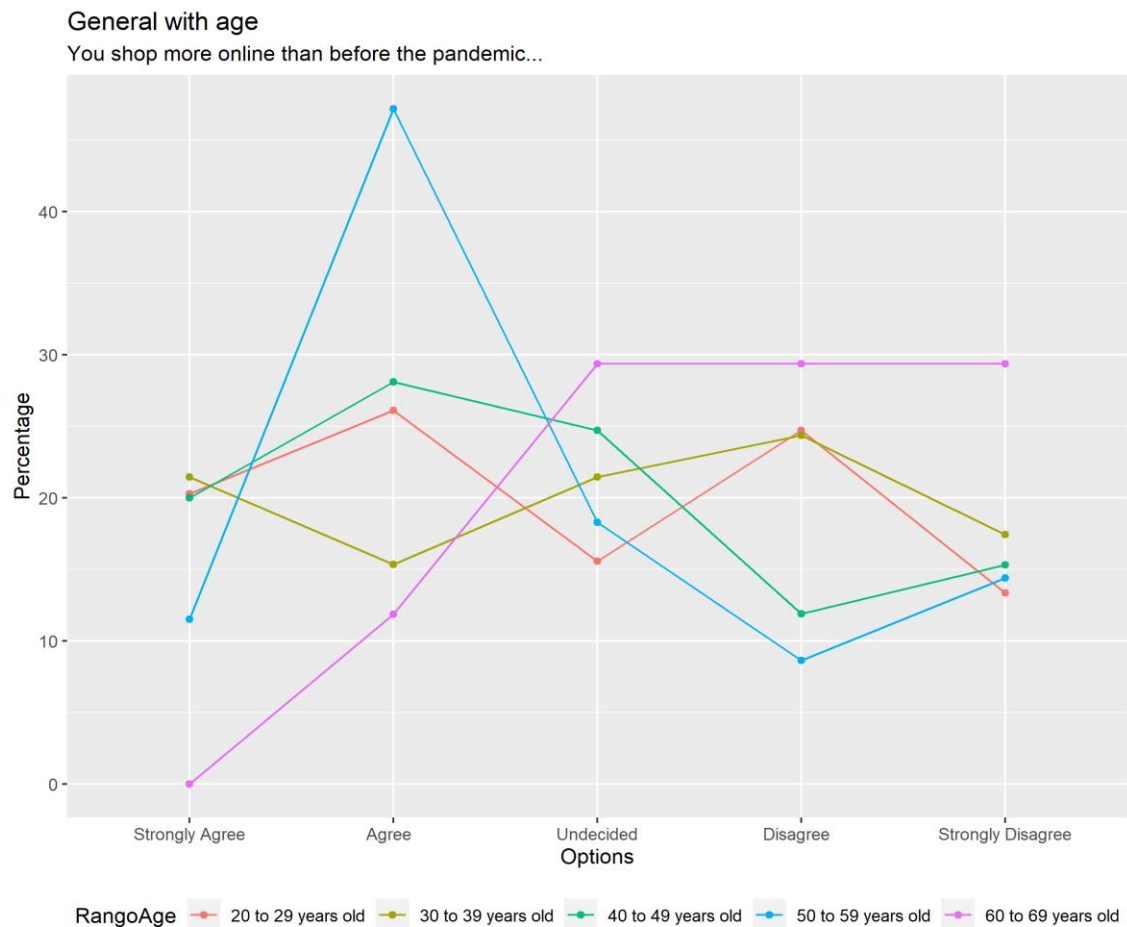
Figure 38 Results question 16 "Do you agree with the following statement? Currently you shop more online than before the pandemic" by age

For age group "40 to 49 years old", the most popular opinion was "Agree" with 28%. This was close to "Undecided" with 24%. This was followed by "Strongly Agree" (20%) and "Strongly Disagree" (15%). Only 12% of the respondents in this group disagrees with the statement. In total 48% of the answers this group are in the agreement side.

The age group "50 to 59 years old" was the one that answered "Agree" the most (47%). It was followed by "Undecided" (18%) and "Strongly Disagree" (14%). Less popular answers were "Strongly Agree" and "Disagree" with 11% and 9% each. Making it the group that most of the answers are in the agreement side (58%). Despite the fact that changing to online shopping during the pandemic was not their most selected option (as in question 15), they do agree that they increased their online shopping compared to before the pandemic.

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For the group "60 to 69 years old" the options "Undecided", "Disagree" and "Strongly Disagree" were the most popular ones with little more than 29% each. Only 12% agrees with the statement. This fits the results for question 15, where this group did not change to online shopping despite the pandemic.

The age groups "20 to 29 years old", "40 to 49 years old" and "50 to 59 years old", were the ones where the people were mostly in the agreement side, being the last one more than 50% of the people. On the other hand, the people between "30 to 39 years old" were mainly in the disagreeing side (41%). Lastly the oldest group mostly disagrees or strongly disagrees with the statement (58%).

The results could be influenced by other characteristics of the respondents, such as the occupation. The answers will be analyzed by occupation in the section *4.5.1.2 Ha - Analysis by occupation: People agree that their online shopping increased permanently due to the pandemic.*

Question 17 Gender

The results for this question were already shown at the beginning of the chapter. The data was necessary for applying the weights to the answers of the participants, in this way all genders were equally represented.

Question 18 Age

The results for this question were already shown at the beginning of the chapter. The data was necessary for applying the weights to the answers of the participants. In this way all age groups were represented as in the population of Munich.

Question 19 Occupation

The next question was regarding the occupation. It asked, "What is your predominant occupation?". The answers are shown in *Table 6*.

There was high representation for "Full-time employees" as well as for "Students", and "Part-time employees". While there was lower representation for "Retirees", "Freelancers", "Unemployed" and people in "Maternity leave". One percent of the people preferred not to answer.

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Table 6 Results question 19 "What is your predominant occupation?"

Occupation	Frequency	Percentage [%]
Full-time employee	87	54
Student	29	18
Part-time employee	21	13
Retired	11	7
Freelancer	9	5
Unemployed	1	1
Preferred not to answer	1	1
Maternity leave	1	1

Question 20 "How many people in your household are under 14 years old?"

The distribution of the answers for this question are shown below in *Table 7*. Most of the participants (64%) do not have children in their household.

Table 7 People under 14 years old in the household

People under 14 years old	Percentage [%]
0	64
1	13
2	20
3	3
4	0

Question 21 "How many people in your household are 14 years old or older, including you?"

The distribution of the answers for this question is shown below in *Table 8*. Most of the households are formed with 2 people over 14 years old (52%).

Table 8 People over 14 years old in the household

People over 14 years old	Percentage [%]
0	2
1	23
2	52
3	13
4	9
5	1

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Then distinct types of household structures were identified.

Figure 39 shows the distribution of household structures. Mainly (24%) the respondents have a household formed by 2 adults. The 19% has a household with only one adult. The third most common household was 2 adults and 2 children, with 17%. Less frequent structures were 3 adults (10%), 4 adults (9%) and 2 adults and 1 child (9%). Other structures had each less than 5% of the answers.
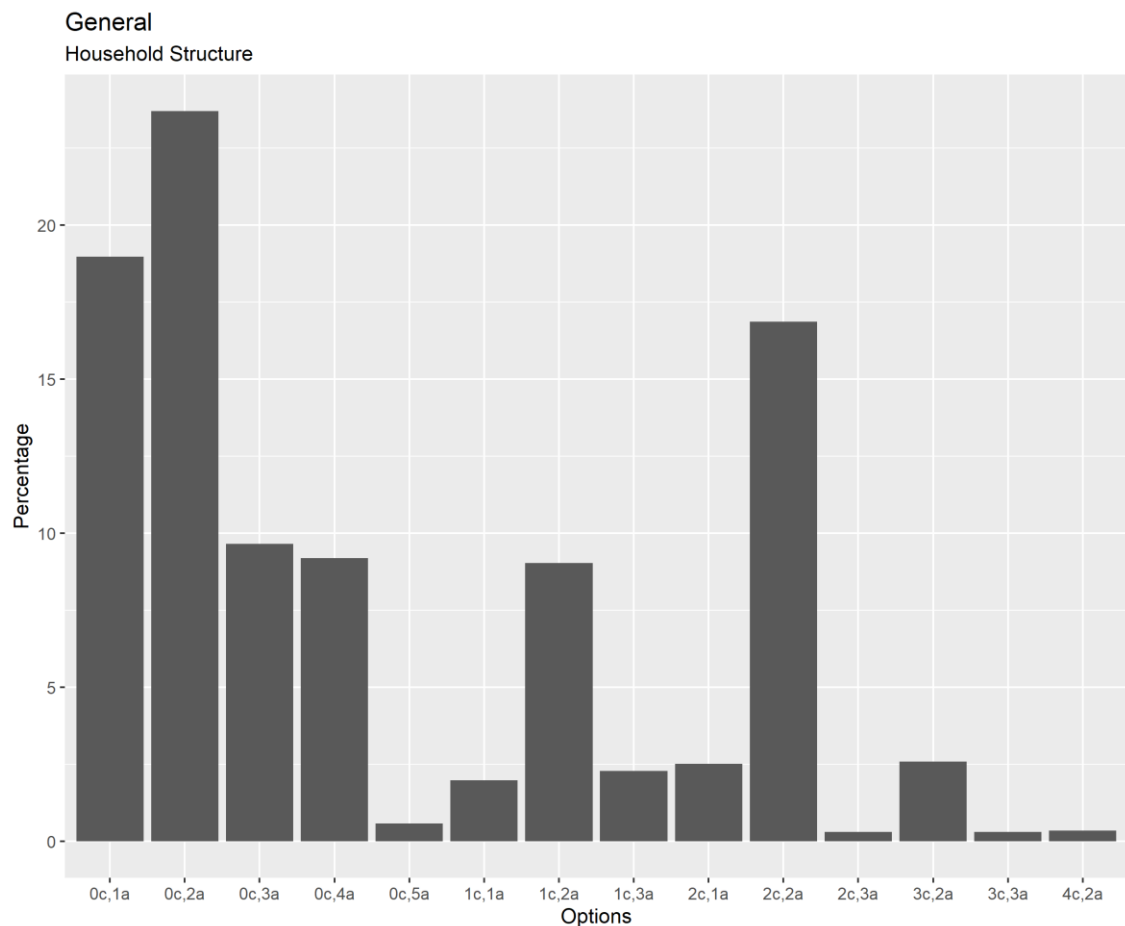
Figure 39 Types of household structures (abbreviations: c = children and a=adult)

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Question 22 "How many people in your household are: full-time employees, part-time employees, or freelancers?"

The results for this question are shown below in *Figure 40*. Most of the people (45%) answer that 2 people in the household work. The second most popular answer was 1 person (39%). Around 8% of the people answered that no one works, this might correspond to some of the students and retired people. Less common answers were 3 (5%) and 4 people (1%). The 2% of the respondents preferred not to answer.
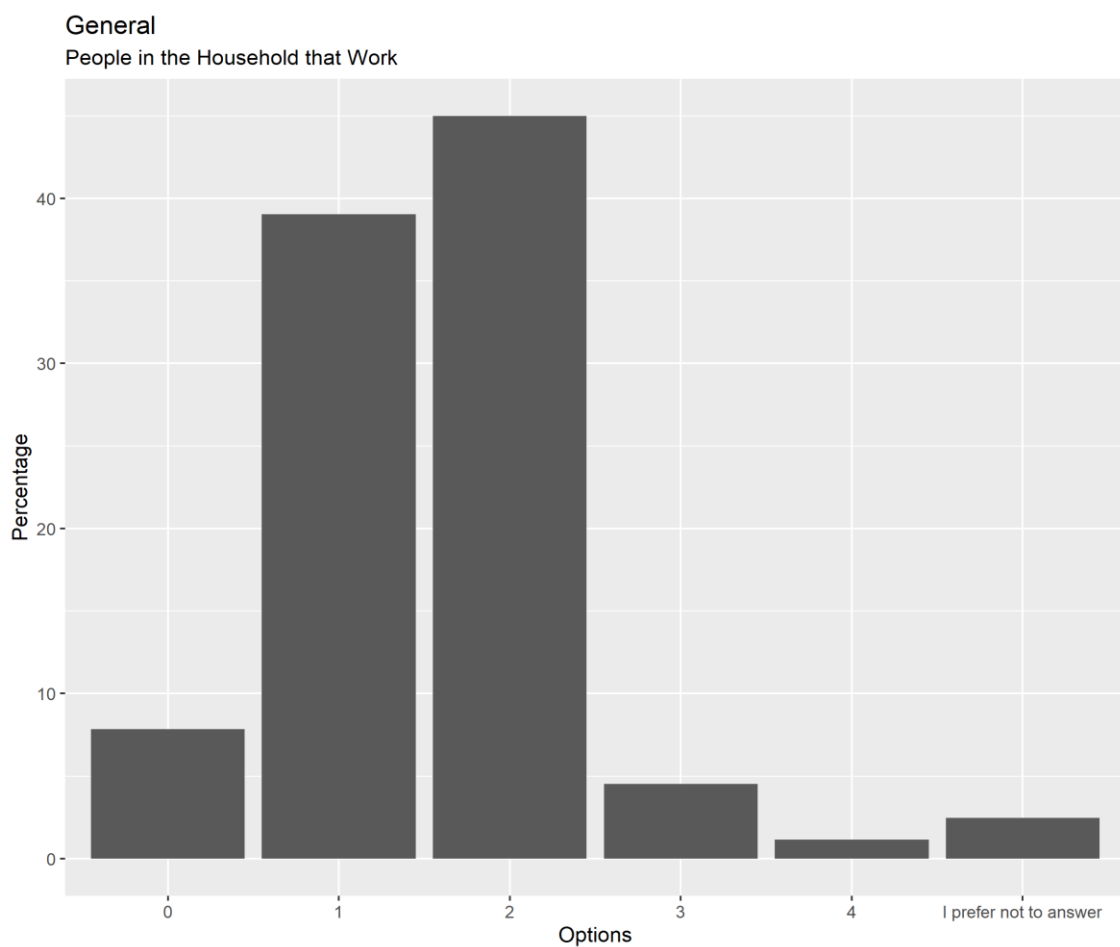
Figure 40 Results question 22 How many people in your household are: full-time employees, part-time employees, or freelancers?

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Question 23 "What is the monthly Net-Income [Euro] of your household?"

The results for question 23 are shown in *Table 9*. As presented, most of the people answer that their net household income is "more than 5000 euro". Then the percentage for lower incomes also decreases. Around 2% of the people answered that they do not know. Also, 18% of the people refrained to answer. Consequently, analyzing the results of other questions by income was complicated.

Table 9 Results question 23 What is the monthly Net-Income [Euro] of your household?

Household Net Income [Euro]	Percentage [%]
less or 1000	4
1001-2000	8
2001-3000	11
3001-4000	14
4001-5000	16
more than 5000	27
I do not know	2
I prefer not to answer	18

Household income equivalent

To calculate the household equivalized income, it was needed to combine the answers for question 17 (income), as well as questions 20 (people under 14 years old) and question 21 (people with 14 years old or more).

The results for the household income equivalent are shown in *Table 10*. Most of the people have an equivalized household income between 2001-3000 euro. Less popular results were "less or 1000 euro" and "4001-5000 euro". There were 2% of invalid answers due to inconsistent responses in the number of people in the household.

Table 10 Monthly Equivalized Net-Income [Euro] of the household

Household Equivalized Income [Euro]	Percentage [%]
less or 1000	6
1001-2000	22
2001-3000	29
3001-4000	21
4001-5000	1
more than 5000	0
I do not know	2
I prefer not to answer	18
Invalid answer	2

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These results helped to further analyze some questions by income, although the groups with higher representation were the ones with an income from 1-4000 Euro.

Question 24 Please add your Postal Code

Different Postal Codes were provided in this question. From the respondents 133 live inside of Munich. Six answers had a non-valid ZIP-Code. Also 21 answers corresponded to the surrounding areas of Munich. A map with the ZIP code areas was created in ArcGIS, containing the frequency each ZIP Code was answered and it is shown in *Figure 41*. Furthermore, the identified city districts, for the ZIP-Codes are shown in *Table 11*.

There was a higher representation for the zone Aubing and Pasing. A further analysis by city zones is rather non representative, due to the low representation of the other areas. Thus, there is a need of further research for making a relationship between city zone and the online shopping behavior.

This might be a consequence of the limited resources for distributing the survey, the time the survey was distributed and, the low participation due to the lack of incentives to the respondents. Thus, the influence of the living environment of the respondents, in their responses, will not be further analyzed. Based on the results, the sample represents the population of urban, relatively dense areas of Munich.

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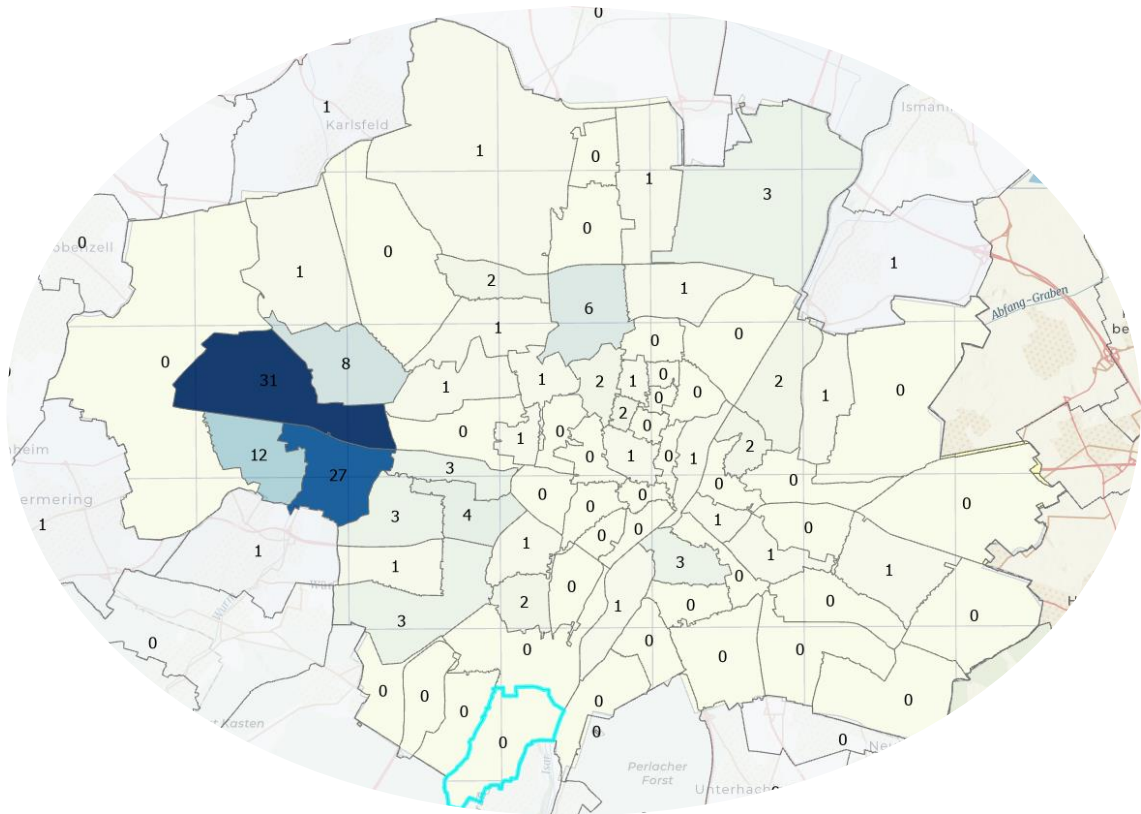
Figure 41 Map with the ZIP Codes of the respondents

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Table 11 Identified city districts for the ZIP-Codes

City district	Frequency
Altstadt	1
Am Hart	1
Au-Haidhausen	3
Aubing	70
Feldmoching	1
Freimann	3
Hadern	3
Laim	3
Milbertshofen	6
Moosach	2
Neuhausen	1
Nymphenburg	1
Obermenzing	8
Pasing	27
Sendling-Westpark	2
Untergiesing	1
Munich surroundings	21
Invalid answer	6
Total	160

Question 25 "Do you wish to participate in the weekly survey?"

After explaining the respondents in what the weekly survey consisted of, they were asked if they wanted to participate on it and to provide their email to do so. Most of the people did not want to participate (69%). Only 26% of the people answered they wanted to participate and 5% replied "Maybe".

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4.3. Analysis of the weekly survey

The weekly survey was sent two times to the interested participants during the month of July and August of 2022. For the week 1, 22 people participated (14%) and for week 2 only 14 people answered (9%). At the end it was possible to collect the information for 36 packages in total.

The low interest in the weekly survey might be due to the need of giving an email to contact the people, also due to the time to spend to participate in such a survey.   A higher interest could be expected if the people were offered a compensation or award for their time.

Following a brief description and analysis of the results is shown.
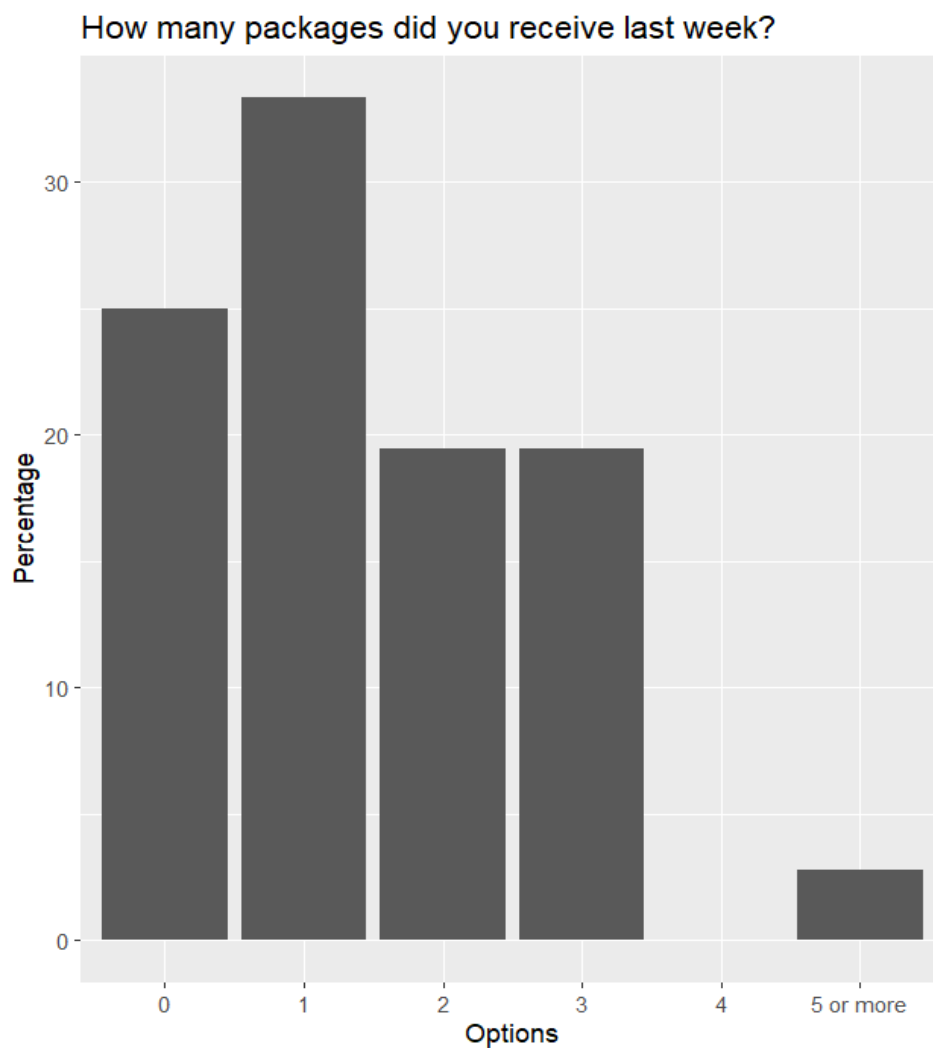
Figure 42 Results weekly survey: Question "How many packages did you receive last week?

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Question "How many packages did you receive last week?"

The results of this question are shown in *Figure 42Figure 42 Results weekly survey: Question "How many packages did you receive last week?*. Here, 33% of the people answered that they received 1 package per week. The second most popular answer was zero packages with 25%. Less popular options were 2 and 3 packages (19% each). The mean value was 1.9 packages per week, which is similar to the data obtained from the general survey (1.8 packages per week).

Question "How many parcels did you received in the same box?"

The results of this question are shown in *Figure 43*. Most of the people (50%) said that they received 2 to 4 parcels in the same box. The second most popular answer was one parcels per box with 41%. Less popular options were 5-7, and 8-10. While many packages contain different product, there is also a high quantity of boxes only containing one parcel. This is a concern in terms of packaging waste.
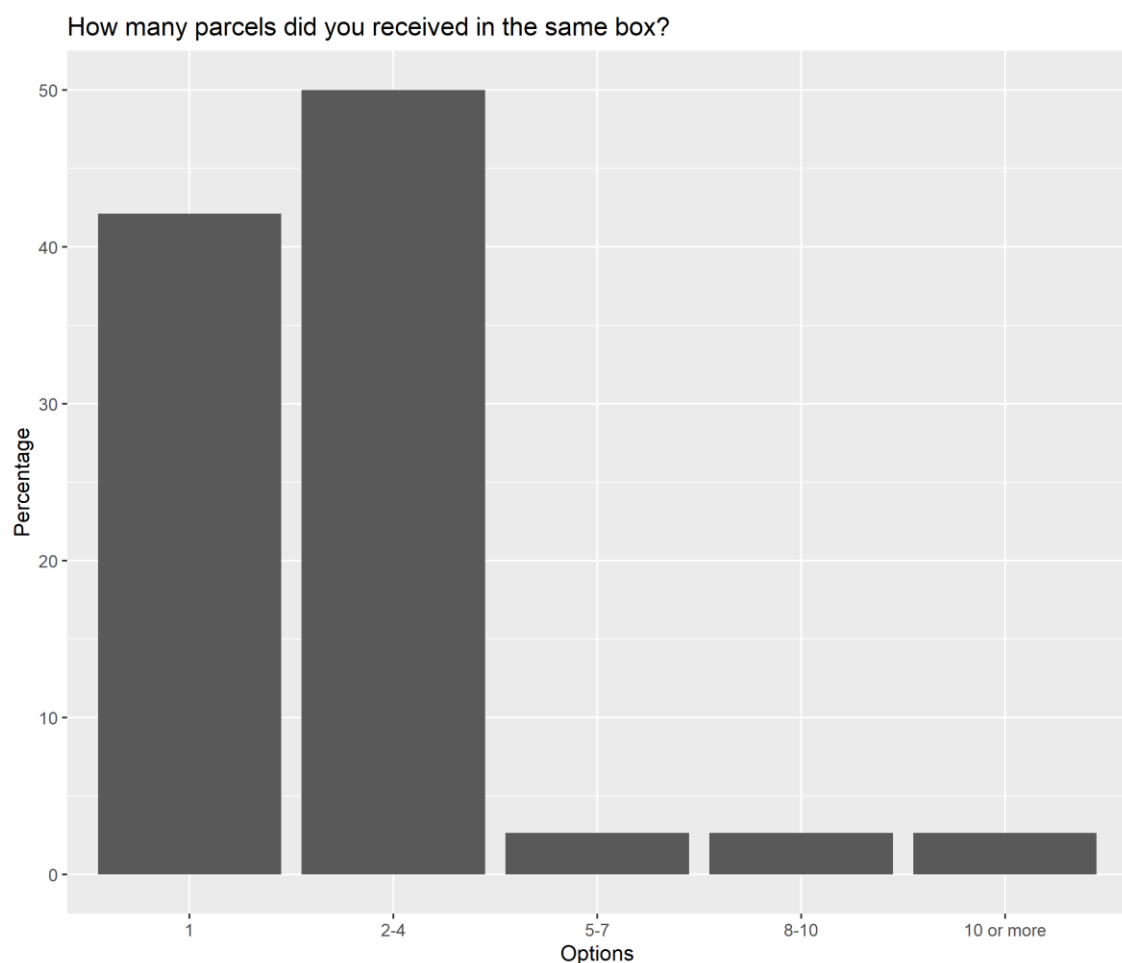
Figure 43 Results weekly survey: Question "How many packages did you receive last week?

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Question "Where did the delivery come from?"

Figure 44 has the results for this question. Most of the deliveries came from online shopping (97%). It implies that the deliveries are a part of the service offered by online suppliers thus it is a consequence of e-commerce. The result is similar to the question 2 of the general survey, where 98% of the respondents provided the same answer.
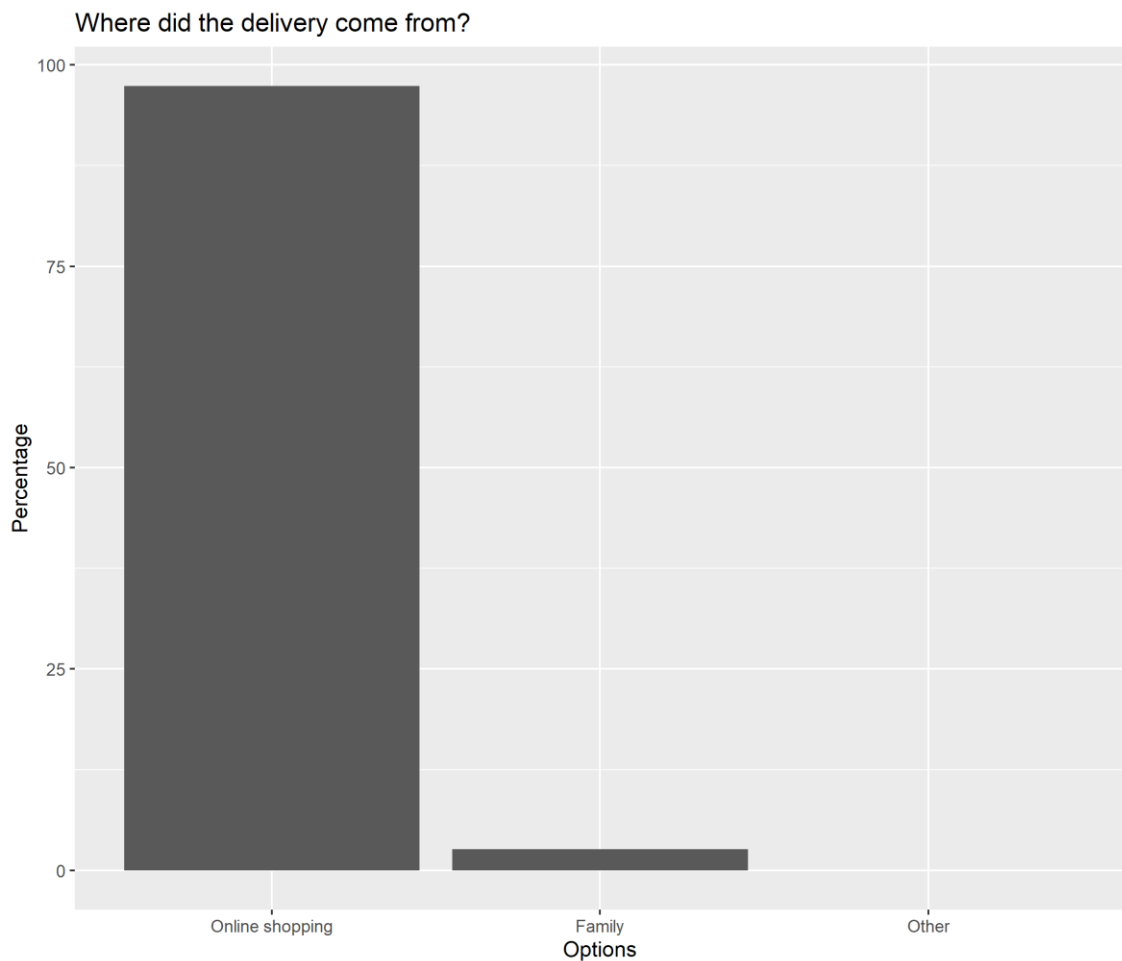
Figure 44 Results weekly survey: Question "Where did the delivery come from?"

Question "What type of good did you received?"

The results are shown in *Figure 45*. Most of the products (27%) corresponded to the category "Clothes, shoes, accessories". The second most popular category was "Furniture, household appliances, gardening", with 19%. Then "Printed books, magazines, newspapers" with 16%. Less popular answers were "Toiletries, cosmetics, beauty, or wellness products" and "Other" with 11%. The least selected options were "Electronics, computers, tablets, phones", "Crafts Products" and "Groceries, cooking boxes" with less than 6% each. Also 5% of the participants did not answer.

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What type of good did you received?
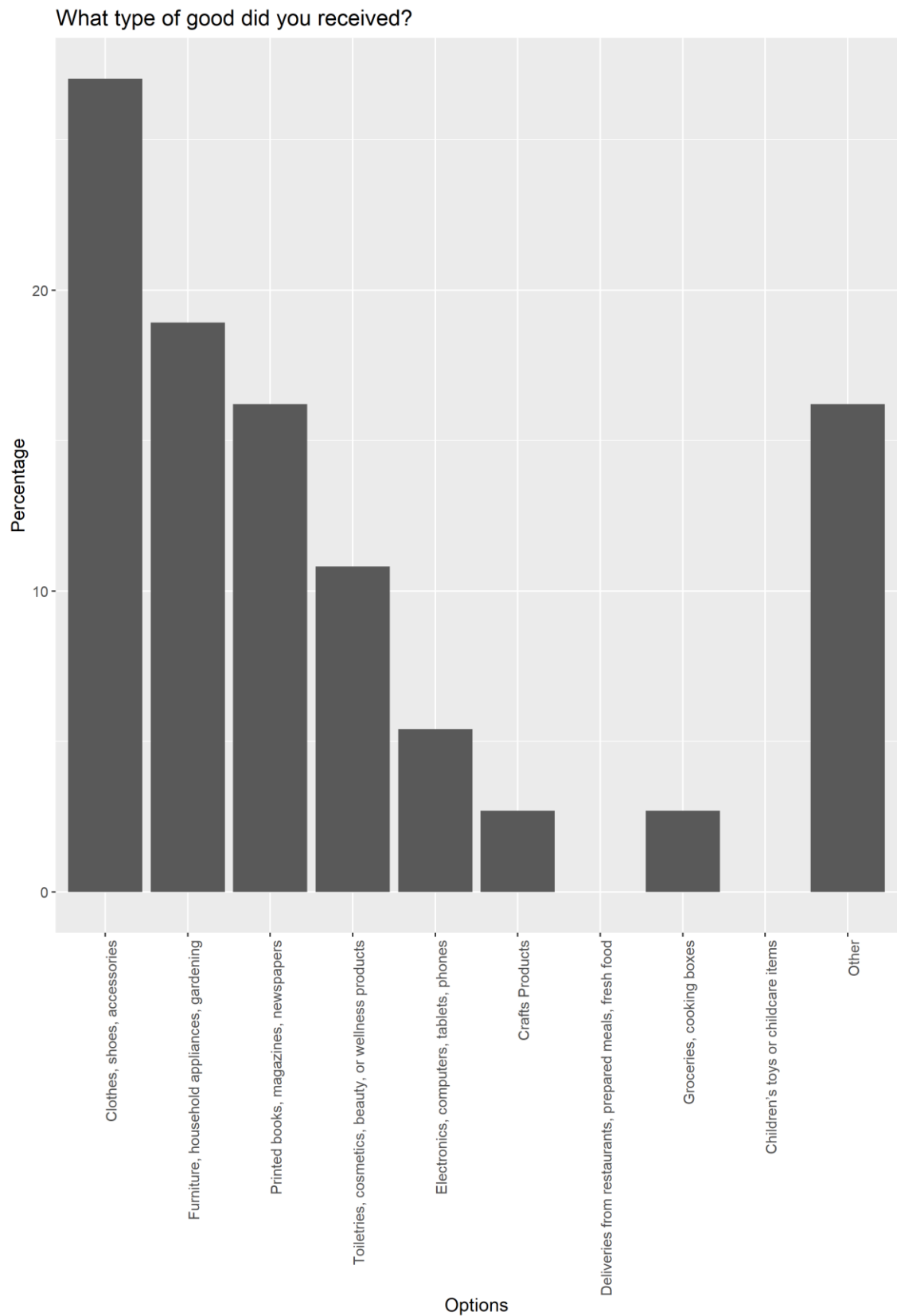
Figure 45 Results weekly survey: Question "Where did the delivery come from?"

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Question "Why did you buy this product in an online store instead of a physical store?" (Multiple-choice)
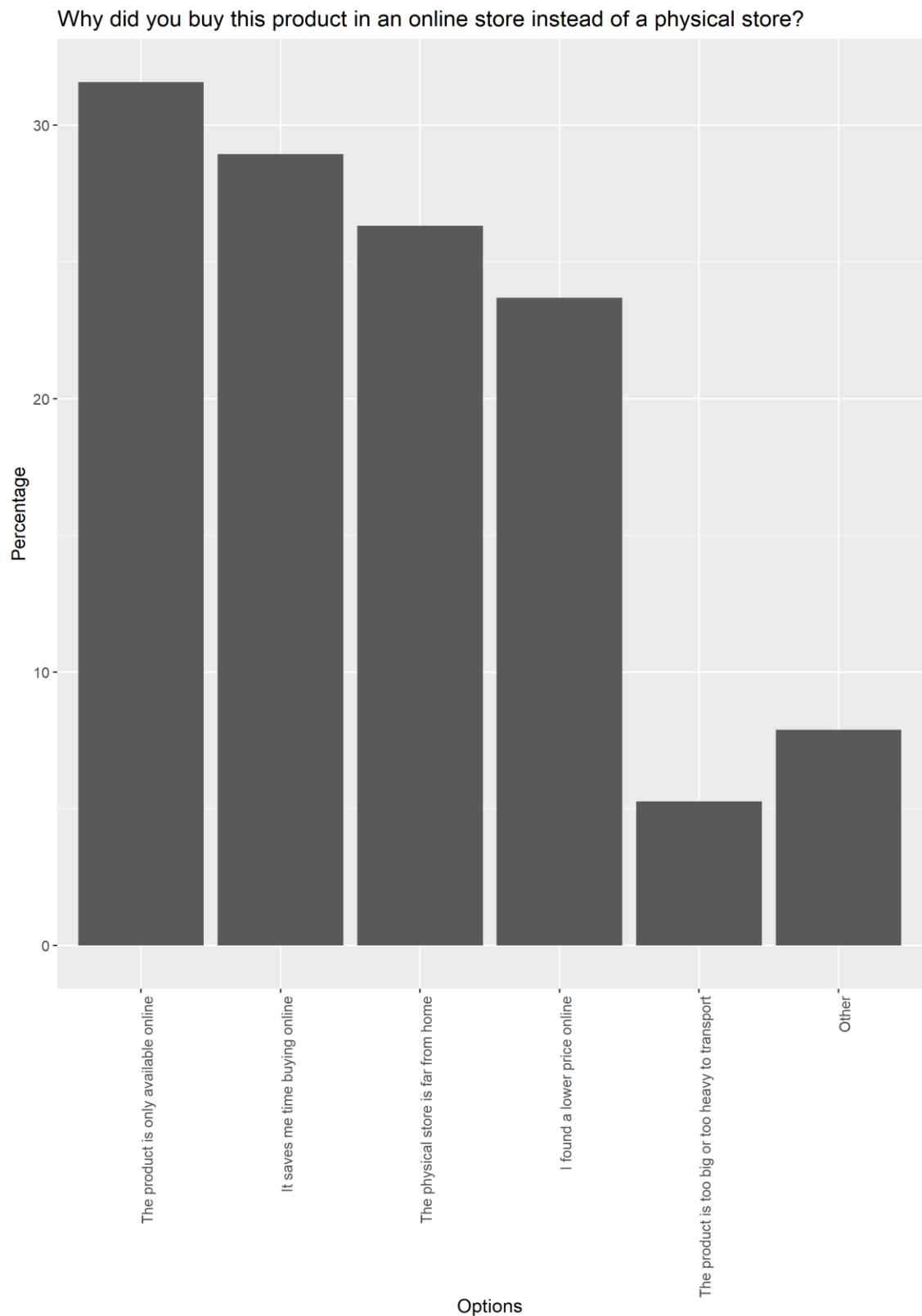
Figure 46 Results weekly survey: Question "Why did you buy this product in an online store instead of a physical store?"

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The results are shown in *Figure 46*. Around 31% of the respondents said that they bought the product online because "The product is only available online". Then 29% of the participants said, "It saves me time buying online". Then 26% of the respondents answered that "The physical store is far from home". Another popular answer was ""I found a lower price online" with 24% of the participation. Less popular answers were "Other" and "The product is too big or too heavy to transport", with less than 8% each.

The answers to this question give us a perspective of the motivations for buying online. While most of the people said that the product was only available online, when this was not the case, they turned to online shopping due to convenience. It can be convenience of time, effort, and price.

Question "How big is the parcel you received?"

The results are shown in *Figure 47*. The answers showed that 49% of the parcels were "Medium (shoe size, shoes, clothes, office supplies, ~38cm x 30 cm x 15 cm)" size. It was followed by "Extra Small (envelope, book, magazines, ~23cm x 15 cm x 3cm)" with 23% and "Small (small electronic articles, toys, ~25cm x 18cm x 10cm)" with 17%. The results differ from the general survey but not by much. While the percentage of packages of medium size is the highest, in the weekly survey it was less than in the general survey, by 9%. The second most popular option here was "Extra Small" while for the general survey was "Small". Also, the percentage of "Extra Large" parcels increased in the weekly survey from 1% to 6%.

Overall, the results kept showing a tendency for medium or smaller packages, being the total of 89% of all the deliveries (from the weekly survey).

Dimensions of the package

People were asked for the exact measurements (Length, width, and height in cm) none of the participants provided this information. Although a rough description of the size was given in the previous question.

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How big is the parcel you received?
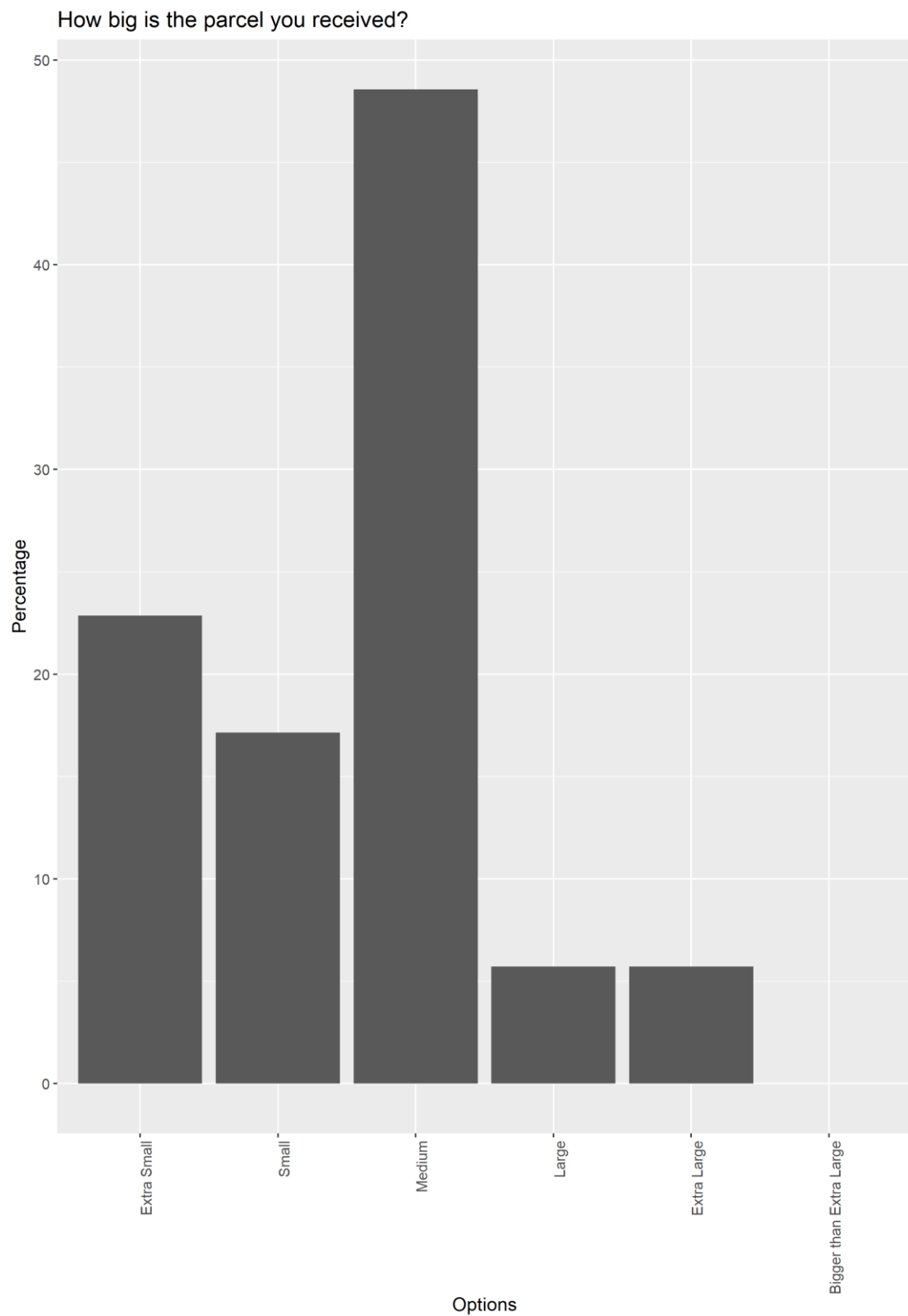
Figure 47 Results weekly survey: Question "How big is the parcel you received?"

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Question "What was the weight of the package?"

The results are shown in *Figure 48Figure 47*. The answers showed that 43% of the packages weighted "Less than 1,1 kg (letter, water bottle)". Then 29% of the packages weighted "Between 1,1 kg and 2kg (i.e., books, laptop, boots)". And 20% of them were "Between 2,1 kg and 5 kg (i.e., a potato bag)".
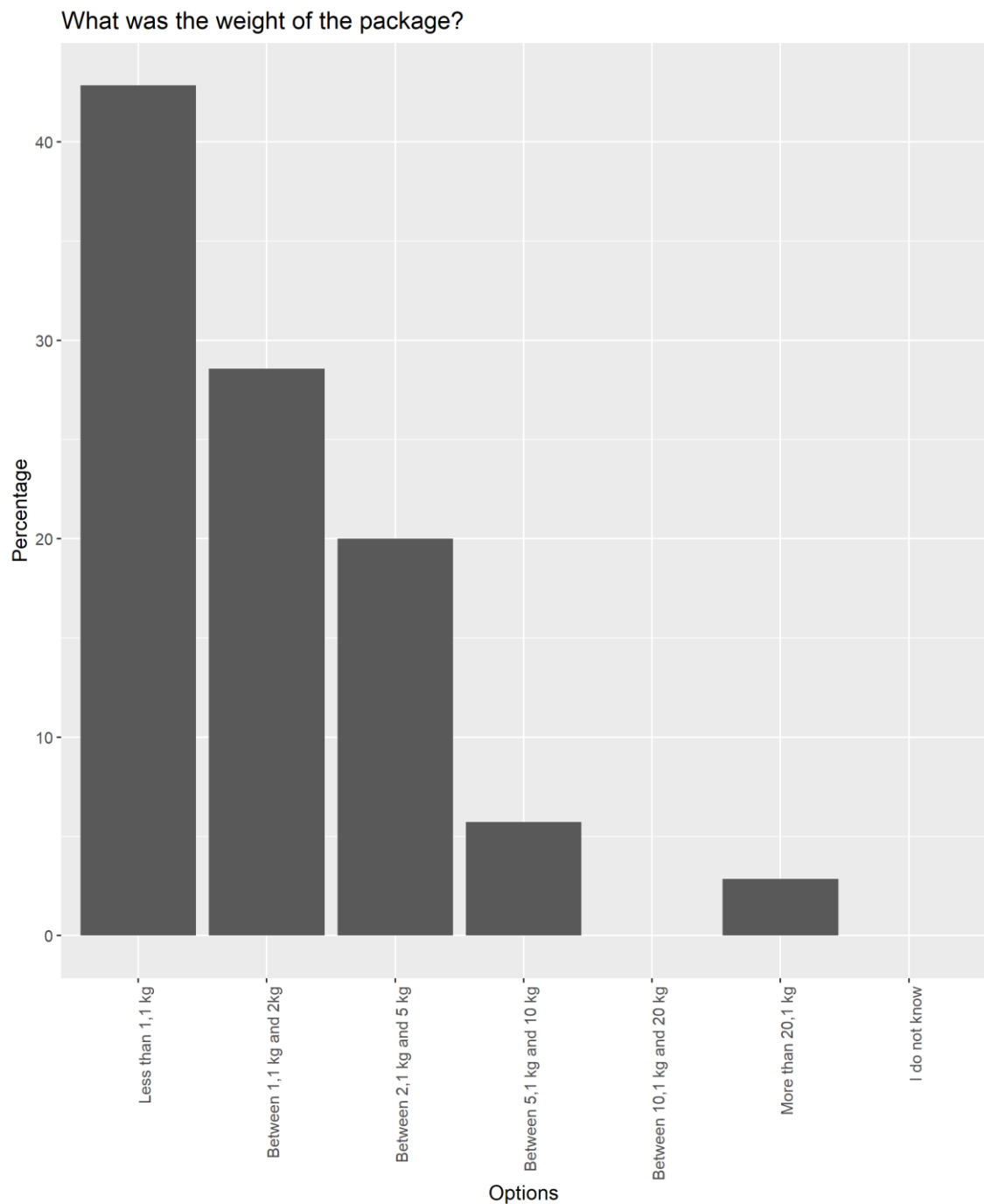
Figure 48 Results weekly survey: Question "What was the weight of the package?"

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Only 6% answered the package was "Between 5,1 kg and 10 kg (i.e., groceries, cooking box)" and 3% answered "More than 20,1 kg (i.e., washing machine)".

This is valuable information when looking at different solutions for the last mile delivery. Most of the packages are less than 2 kg (72%) thus could be carried easily, while around 29% might need to be transported in vehicles of a big size or with a motor support.

Question "How did you get the package delivered?"

For this question 94% of the packages were delivered by a "Homedelivery". Only 3% were delivered to a parcel station and the other 3% were picked up at the shop/super-market. The results are displayed in *Figure 49*. The results are similar to the general survey although, the weekly survey showed that the preference for a home delivery is even higher (94% compared to 88%). And the preference of a parcel station is lower (from 9% to 3%).

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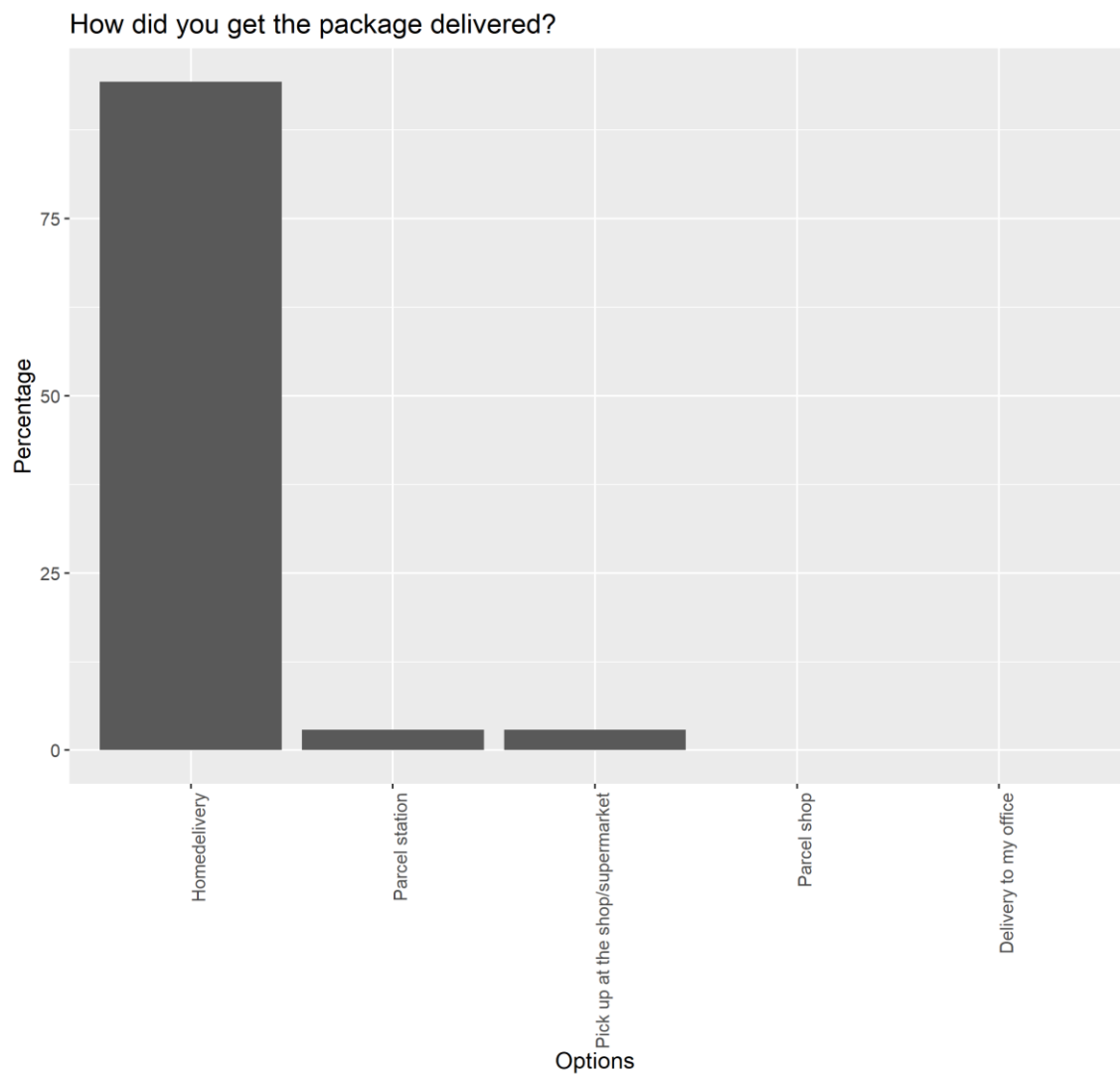
Figure 49 Results weekly survey: Question "How did you get the package delivered?"

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Question "Which delivery provider did you use?"

As portrait in *Figure 50*. The packages were delivered mainly by "DHL" (46%). There were 20% of deliveries that the respondents did not know where they came from. Other companies were "Amazon delivery" and "Hermes" with 11% each. Less common companies were "DPD" (9%) and "Deutsche Post" (3%).

These results show that the market main player is DHL, and the other big market players are mainly Amazon delivery and Hermes. Although it is difficult to have certainty since for 20% of the packages it is unknown where they came from.
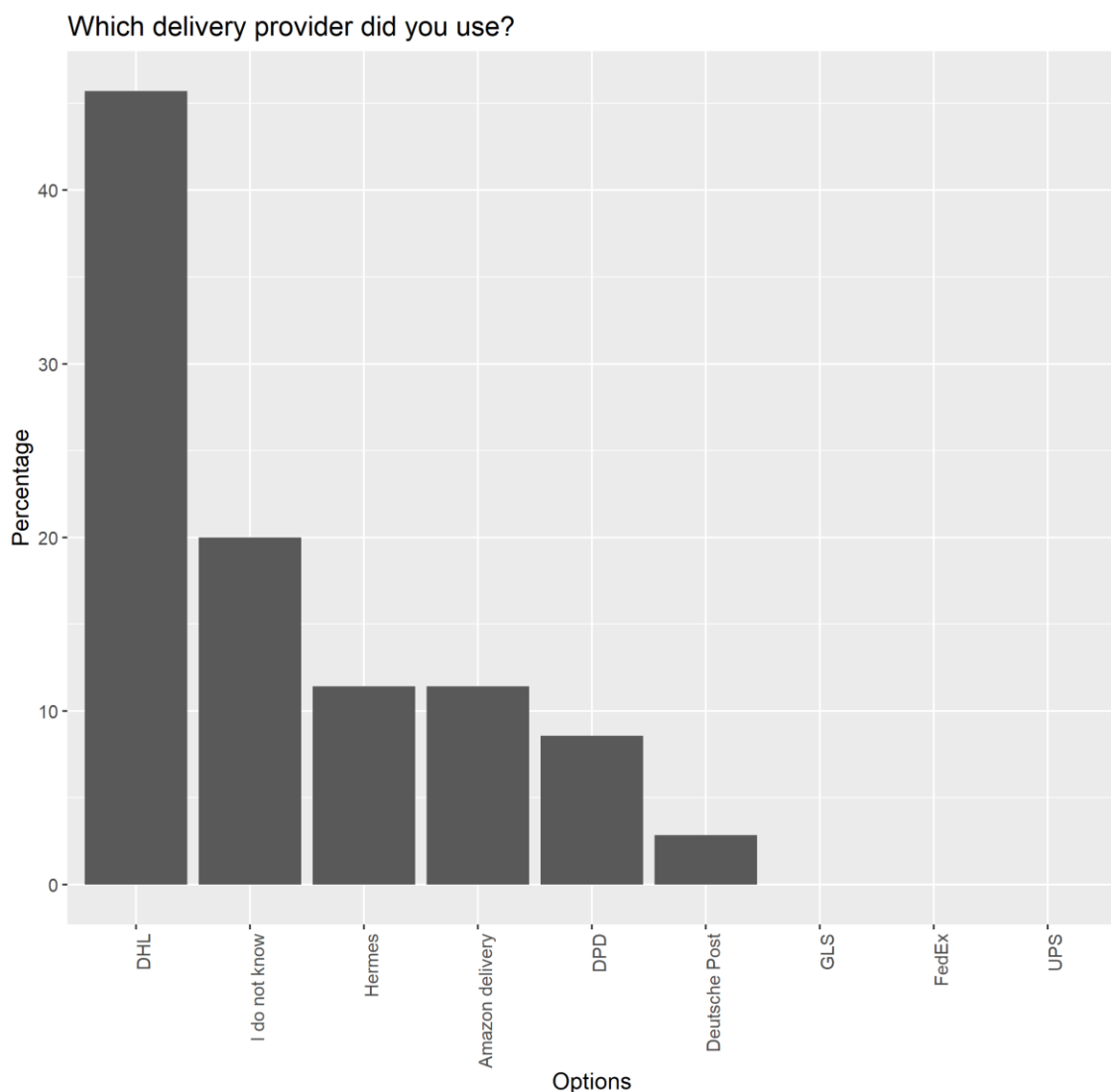
Figure 50 Results weekly survey: Question "Which delivery provider did you use?"

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4.4. Summary of the questions analysis

A summary of all the questions and their main observations is shown in the following table.

	Question	Most popular answer	Differences		Observations
			gender	Age	
1	"How many packages do you generally receive per week?"	"[0-1) – less than one" (34%) Mean value: **1.8** packages per week	yes	yes	In general, the higher the number of packages per week, the lower the observed frequency. The mean of packages received per week was 1.8. Women receive more packages per week than men. The age groups "40-49 years old" and "50-59 years old" were those that have the highest frequency of received packages per week, with a mean of 2.2 and 2.5 packages per week, each.
2	"Where do most of your deliveries come from?"	"Online shopping websites" (98%)	few	no	Most of the deliveries a person receives come from online shopping. It implies that the deliveries are a part of the service offered by online suppliers thus it is subject to customer demands.
3	"In a typical month how many different online stores do you order from? (Marketplace stores count as one)"	"[2-3)" different online stores (58%)	few	no	Most people buy in 2 to 3 different online stores. The people are loyal to few stores that might offer what they need, especially when there exist big services that cover several branches.
4	"What are the most frequent sizes of the parcels you receive?"	"Medium" (58%)	no	yes	Most of the packages people receive are medium or small size (86%). This is important when planning the deliveries and the vehicles needed to distribute the packages. Smaller vehicles can be used when the packages are not big.
5	"Where are your packages generally delivered?"	"Home delivery" (88%)	yes	yes	While delivery at parcel stations is getting more popular people still prefer to get their parcels delivered at home. Parcel stations are more popular within men than women. A linear relationship with age was not found. The groups of "20-29 years old", "50-69 years old" were more willing to select delivery to parcel station than the other groups.

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	Question	Most popular answer	Differences		Observations
			gender	Age	
6	"If you get parcels by homedelivery, are you at home when the deliveries come?"	"Very often" (51%)	yes	yes	People are not always at home when their deliveries come. Men are more likely to not be at home when their deliveries come. This is also the case for people in the age groups between 30 to 49 years old.
7	"What normally happen if you are not at home?" (Multiple-choice)	"The package is delivered to a neighbor" (60%)	yes	yes	The participants showed that most of the packages that fail to be delivered, are not transported far from the home of the recipient. 30% of the participants responded that the package is transferred either to a parcel shop or a parcel station. So even they did not choose these options initially they end up using this service.
8	"What would be a good time of the day for receiving packages at home?"	"Evening" (51%)	no	yes	"Evening" was the most popular opinion within most age groups. The group from "60 to 69 years old" prefers an "Afternoon" delivery. The group "20 to 29 years old" was the one to select "Morning" the most. This is important for the delivery planning. If the customers could indicate the best time of the day for receiving their packages, a first attempt delivery might be successful.
9	"If you get parcels sent to a delivery point: parcel shop, parcel station, pick up at store, how do you arrive there?"	By bike" (36%)	no	yes	The mean people choose to reach the delivery point might be influenced by several factors such as the distance to the place, as well as the time to travel, the age of the person, or the mode of transport available. The age groups from 40-59 years old were more inclined to select "By car" than other groups. The delivery points should be promoted to the groups of people who would rather transport by foot or by bike.
10	"When you shop from the same online store, do you schedule your deliveries to arrive the same day?"	"Rarely" (25%)	few	yes	The groups that answer the most that they cannot choose were "30 to 39 years old" and "60 to 69 years old". The groups "20 to 29 years old" and "60 to 69 years old" selected "Always" the most. Bringing more people to schedule they deliveries to the same day, could reduce travels to a certain address (distance travelled, emissions), packaging and delivery costs.

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	Question	Most popular answer	Differences		Observations
			gender	Age	
11	"Which services for the delivery are important for you?"	"Free delivery" (73%)	yes	yes	Women are more interested on environmentally friendly deliveries and providing the desired delivery window than men. The group "60 to 69 years old" reiterates its interest on "Self-chosen delivery window". The group "30 to 39 years old". Possibly can be a group for marketing environmentally friendly delivery since they selected this service the most. Free returns were chosen as a second option for most of the age groups, even though they are rather a service to avoid when talking about the environment.
12	"How important is to you that the delivery is environmentally friendly?"	"Important" (57%)	few	yes	The age group "60 to 69 years old" showed that environmentally friendly deliveries, are important or especially important for them (88% of the answers). The age group "30 to 39" years old was the one most selected the service "Environmentally friendly delivery". Likewise in this question the majority (53%) thinks it is "Very Important" or "Important". There is still a considerable proportion of people that should be shown the importance of the issue.
13	"Who should be responsible for making the delivery environmentally friendly?" (Multiple-choice)	"The shops" (75%)	yes	yes	Men selected "The customer" as the third option and "The government" as the fourth. Although there is a notion that the customer should take part on the responsibility, most of the people do not think that that customer should be responsible for making the deliveries more environmentally friendly. Only the people from the age group "50 to 59 years old" thinks the customer should be the main responsible for it.

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	Question	Most popular answer	Differences		Observations
			gender	Age	
14	Imagine you have purchased an item of 40 EUR that will be delivered to you at home with a cost of 4 EUR. How much additional amount of money (in euro) would you be willing to pay for making your delivery more environmentally friendly (CO_2 neutral or low emissions, low-noise delivery, delivery with electric vehicles/bikes, less packaging, etc.)?	"[0-1) euro" (30%). Mean value: 1.8 euro	few	yes	There were minimal differences between men and women. In general, the participants were not willing to pay more than 2 euros for making the delivery more environmentally friendly. The groups that are willing to pay the most were the age groups "60 to 69 years old" and "40 to 49 years old".
15	"Which measures did you take during the corona-pandemic, regarding shopping?"	"Continue shopping in online stores as before" (48%)	yes	yes	Women did change the way they shopped during the pandemic (avoiding shopping or changing to online), while men were inclined to keep shopping in the same place as before (online or physical stores). For most of the age groups the most popular answer, was "Continue online shopping as before". While it was a tendency to buy more online these age groups were already doing so. Only the age group "50 to 59 years old" did not prefer to buy online but rather at local or physical stores they frequented before. It is to conclude that most people kept buying in the location they did before (online or physical stores). Although there was a tendency to change to online shopping it was also a tendency to shop at local stores or to avoid shopping.

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	Question	Most popular answer	Differences		Observations
			gender	Age	
16	"Do you agree with the following statement? Currently you shop more online than before the pandemic?"	"Agree" (26%)	yes	yes	While most people are in the agreement side (42%), not everyone agrees with the statement and the difference is small (5%), hence the results are inconclusive. Most women were in the agreement side (45%). While within men the difference between the agreeing and disagreeing was minimal (1%). The age groups "20 to 29", "40 to 49" and "50 to 59" years old, were the ones where the people were mostly in the agreement side. The people between "30 to 39" and "60 to 69" years old were mainly in the disagreeing side. The results could be influenced by other characteristics of the respondents, such as the occupation.
17	Gender				The data was necessary for applying the weights to the answers of the participants, in this way all people were equally represented.
18	Age				The data was necessary for applying the weights to the answers of the participants. In this way all age groups were represented as in the population of Munich.
19	Occupation	"Full-time employee" (54%)			There was high representation for "Full-time employees" as well as for "Students", and "Part-time employees". While there was lower representation for "Retirees", "Freelancers", "Unemployed" and people in "Maternity leave". One percent of the people that preferred not to answer.
20	"How many people in your household are under 14 years old?"	Zero (64%)			Most of the participants (64%) do not have children in their household.
21	How many people in your household are 14 years old or older, including you?	Two (52%)			Most of the households are formed with 2 people over 14 years old. Mainly (24%) the respondents have a household formed by 2 adults.

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	Question	Most popular answer	Differences		Observations
			gender	Age	
22	"How many people in your household are: full-time employees, part-time employees, or freelancers?"	Two (45%)			Most of the people (45%) answer that 2 people in the household work.
23	"What is the monthly Net-Income [Euro] of your household?"	"More than 5000" (27%)			Most the people answer that their net household income is "more than 5000 euro". Then the percentage for lower incomes also decreases. 18% of the people refrained to answer. Thus, analyzing the results of other questions by income was complicated.
23a	Household income equivalent	"2001-3000" (29%)			Most of the people have an equivalized household income between 2001-3000 euro. These results helped to further analyze some questions by income, although the groups with higher representation were the ones with an income from 1-4000 Euro.
24	Please add your Postal Code	"Aubing" (44%)			There was a higher representation for the zone Aubing and Pasing. A further analysis by city zones is rather non representative, due to the low representation of the other areas. Thus, there is a need of further research for making a relationship between city zone and the online shopping behavior.
25	"Do you wish to participate in the weekly survey?"	"No" (69%)			Most of the people did not want to participate (69%). The low interest in the weekly survey might be due to the need of giving an email, also due to the time to answer the survey. A higher interest could be expected if the people were offered a compensation or award for their time.

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4.5. Hypotheses verification

The analysis regarding the hypotheses approached was done with a data analysis in r, creating different plots summarizing the answers of the survey. Accordingly, there are plots that represent the data of the population in general, as well as plots dividing the responses by gender and by age group. The different plots (shown in the previous section) were analyzed to check the validation of the hypothesis.

4.5.1. Ha: People agree that their online shopping increased permanently due to the pandemic

The plot *Figure 37* represents the answers for the question 16 "Do you agree with the following statement? Currently you shop more online than before the pandemic". This question was analyzed by the general results in the previous section.

As described before the 42% of the population strongly agrees or agrees with this statement, while 37% of the population disagrees or strongly disagrees, and the other 21% is undecided.

While most people are in the agreement side, not everyone agrees with the statement and the difference is small (5%), hence the results do not prove the hypothesis. This could have been influenced by other characteristics of the respondents, such as the occupation or age. The analysis by age was also presented in 4.2 Descriptive analysis of the survey responses. In the following sections the answers are analyzed by age and occupation.

4.5.1.1. Ha - Analysis by age: People agree that their online shopping increased permanently due to the pandemic

The *Figure 38* displays the results for question 16 by age group.

The 46% of the respondents in the age group "20 to 29 years old" strongly agrees or agrees with the statement. For people between "30 to 39 years old" this sum was only 36%. 48% of the people in the age group "40 to 49 years old" answer "Strongly agree" or "Agree". The group that was more in the agreement side was the one from "50 to 59 years old (58% of the respondents). While only 12% of the people from "60 to 69 years old" answered "Agree" and zero "Strongly Agree".

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After the analysis by age the conclusion is that some people agree that their online shopping increased permanently due to the pandemic, depending on characteristics, such as age. For example, the age group 50 to 59 years old agrees the most with the statement, while the group 60 to 69 years old mostly disagrees. This might also be affected by other factors such as occupation or other buying preferences. The following section analyses the answers by occupation.

4.5.1.2. Ha - Analysis by occupation: People agree that their online shopping increased permanently due to the pandemic

The plot in *Figure 51* represents the answers for the question 16 "Do you agree with the following statement? Currently you shop more online than before the pandemic" dividing the answers by occupation.

For the occupation "Full-time employee", 45% of the participants strongly agrees or agrees with this statement, while 30% of the population disagrees or strongly disagrees, and the other 21% is undecided. Most people are in the agreement side. Hence, this occupation considered they shop more online than before. This can be a consequence of more people being able to work from home, reducing their mobility and their on-site shopping. Also, receiving parcels is easier when the person is at home.

This was similar to the "Student" population, where 44% of the participants strongly agrees or agrees with this statement, while 37% of the population disagrees or strongly disagrees, and the other 19% is undecided. Most people are in the agreement side. This group was also most of the time at home due to the mobility restrictions of the pandemic. Although, most universities and colleges have also largely withdrawn their corona measures, there are still traffic restrictions for infected people [57]. Which could be a reason of the responses on the agreeing side.

In contrast with the occupation "Freelancer", where 40% of the people strongly disagrees with the statement. This might be because this occupation suffered less modification in their mobility due to the pandemic.

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This was close to the case of the "Retired" people, where 43% of the respondents strongly disagrees or disagrees with the statement. While only 23% agrees with the statement. The results might be influenced by the age of the people in this group (mostly older than 60 years old), for example being less keen to use online platforms to shop. Another reason might be than this occupation did not suffer changes or restrictions during the pandemic, so they did not need to change their shopping behavior in a disruptive manner.
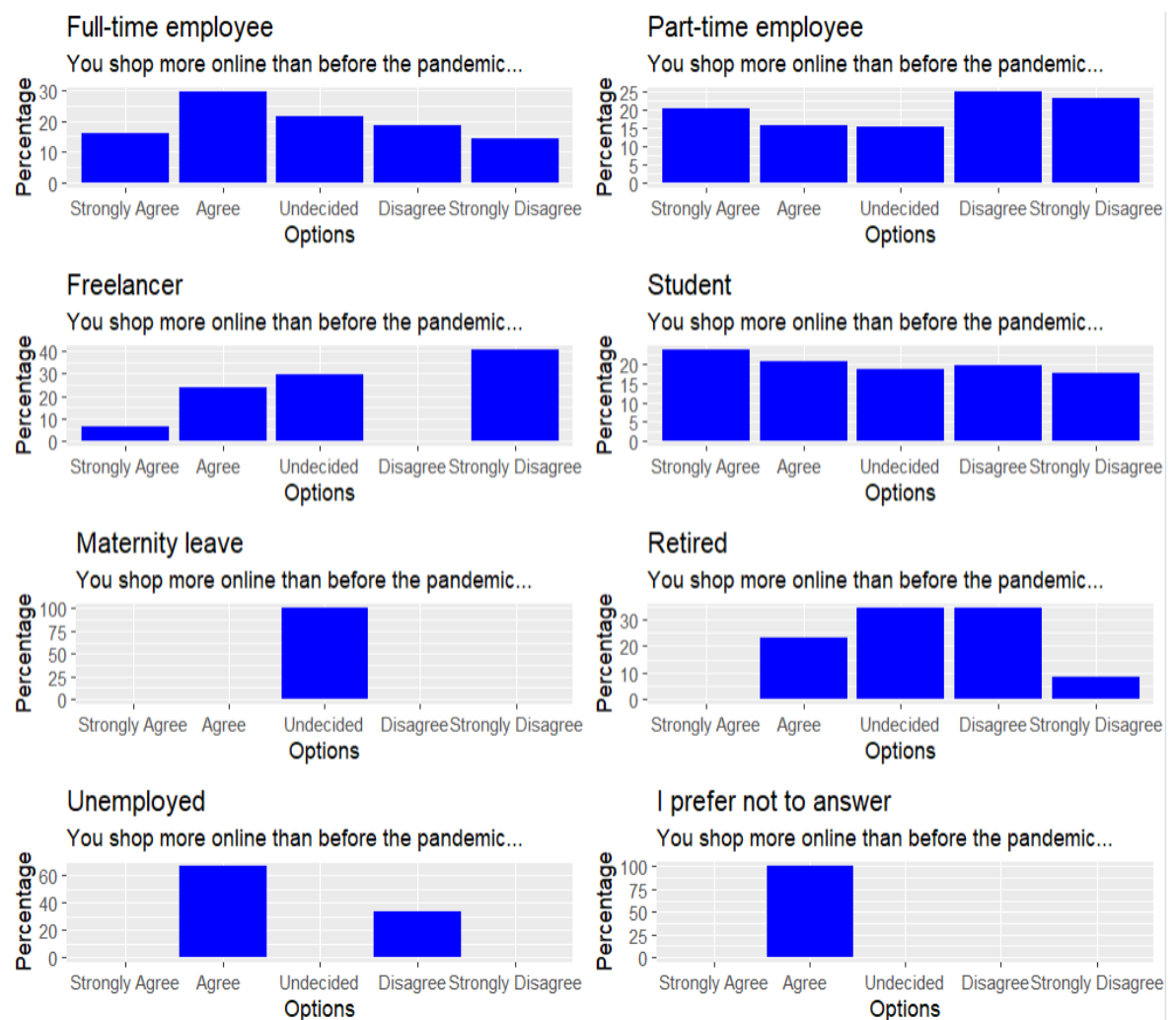
Figure 51 Results question 16 "Do you agree with the following statement? Currently you shop more online than before the pandemic" by occupation

An occupation that has its own pattern is "Part-time employee". Just 36% of the population strongly agrees or agrees, while 48% disagrees or strongly disagrees with the statement. And only 16% were undecided. This means this occupation continues their shopping practices as before the pandemic. This could also be related with loss of income or similar, since the pandemic "left many part-timers clinging onto work", having working reduced hours, or temporarily away from work [58].

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For the options "Maternity leave", "Unemployed" and "I prefer not to answer" the analysis is rather complicated due to the low participation rate of these groups.

After this analysis the conclusion is that some people agree that their online shopping increased permanently due to the pandemic, depending on other characteristics, such as occupation. Full-time employees as well as students agree with the statement. However, groups such as part-time employees, freelancers and retired people disagree.
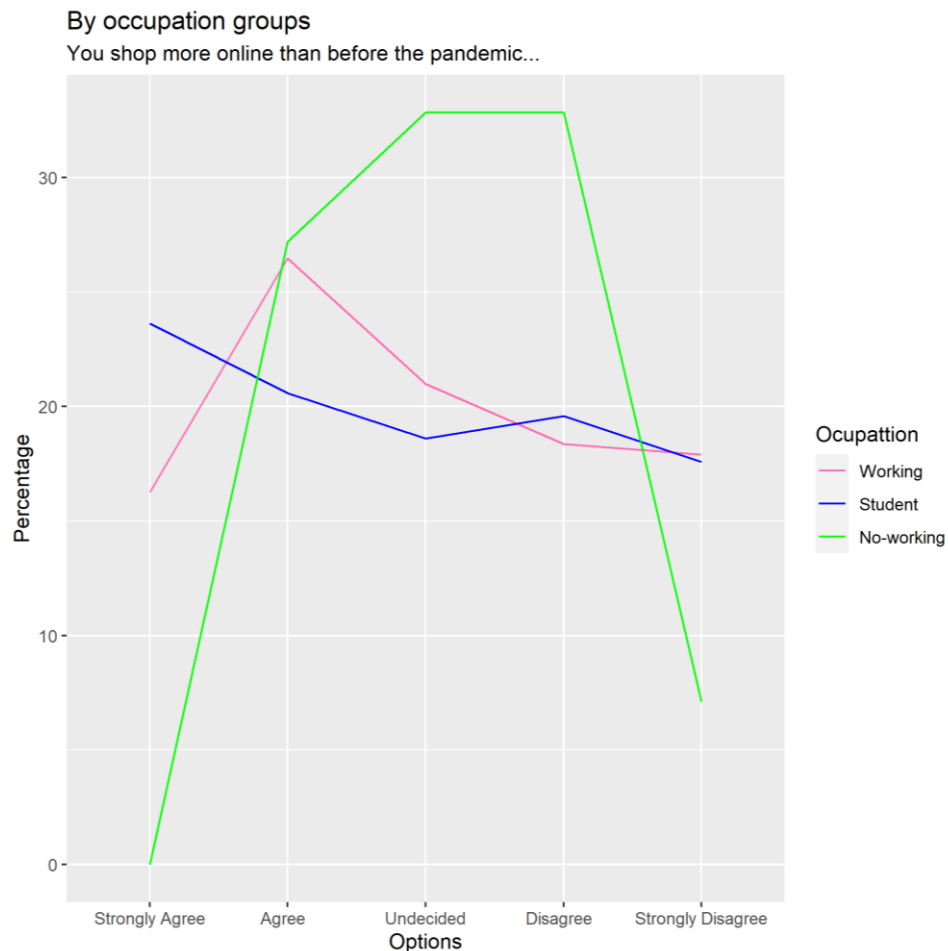
Figure 52 Results question 16 "Do you agree with the following statement? Currently you shop more online than before the pandemic" by occupation groups

For further analysis the results were grouped. All the people that work (full-time employees, part-time employees, and freelancers) were grouped as "Working", another category was "Student", and the last group was "No-working" (including unemployed, retired and in maternity leave). *Figure 52* shows the results. In general, people that work mostly agree or strongly agree with the statement, as well as the students. On the other hand, people that are currently not working are rather undecided or disagree with the statement.

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4.5.2. Hb: People changed to online shopping during the pandemic

The question related to this hypothesis is question 15 "Which measures did you take during the corona pandemic, regarding shopping?" This was a multiple-choice question. This was previously analyzed in the **4.2 Descriptive analysis of the survey responses.**

The analysis showed that people mainly kept their doing their shopping through the same mean as before (88%), whether it was online or in the physical stores. Although due to the pandemic there were some changes, like avoiding or shopping less and start buying at local stores. Changing to online shopping and picking up at the store was not as popular as changing to online shopping and getting delivered at home (selected by 34% of the participants).

4.5.2.1. Hb - Analysis by gender: People changed to online shopping during the pandemic

There were some differences between women and men. The most popular response within women was "Avoid shopping/shop less" (48%), then "Change to online shopping and get home delivered" (44%). Only the women in the age groups from 20 to 39 years old selected "Change to online shopping and get home delivered" as their first answer.

The responses of men were different. The most popular response was "Continue shopping in online stores as before" (66%), then by "Continue shopping in physical stores as before" (43%),

In brief women did change the way they shopped during the pandemic (avoiding shopping or changing to online shopping), while men were more inclined to keep shopping in the same place as before (online or physical stores).

4.5.2.2. Hb - Analysis by age: People changed to online shopping during the pandemic

Figure 53 shows the results of question 15 divided by age group**.** The age groups "20 to 29 years old", "30 to 39 years old" and "40 to 49 years old" were the groups that selected change to online shopping and get home delivered" the most (20%, 20% and 22% each). Although the most popular answer for this groups, was "Continue online shopping as before". Meaning that while it was a tendency to buy more online these age groups were already buying online.

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Lastly, it is not to conclude that most of the people changed to online shopping, since most people answered that they kept buying as they did before (in online or physical stores). The hypothesis only tended to be accurate in a few cases regarding women. Women between 20 and 39 years old indeed changed to online shopping during the pandemic.
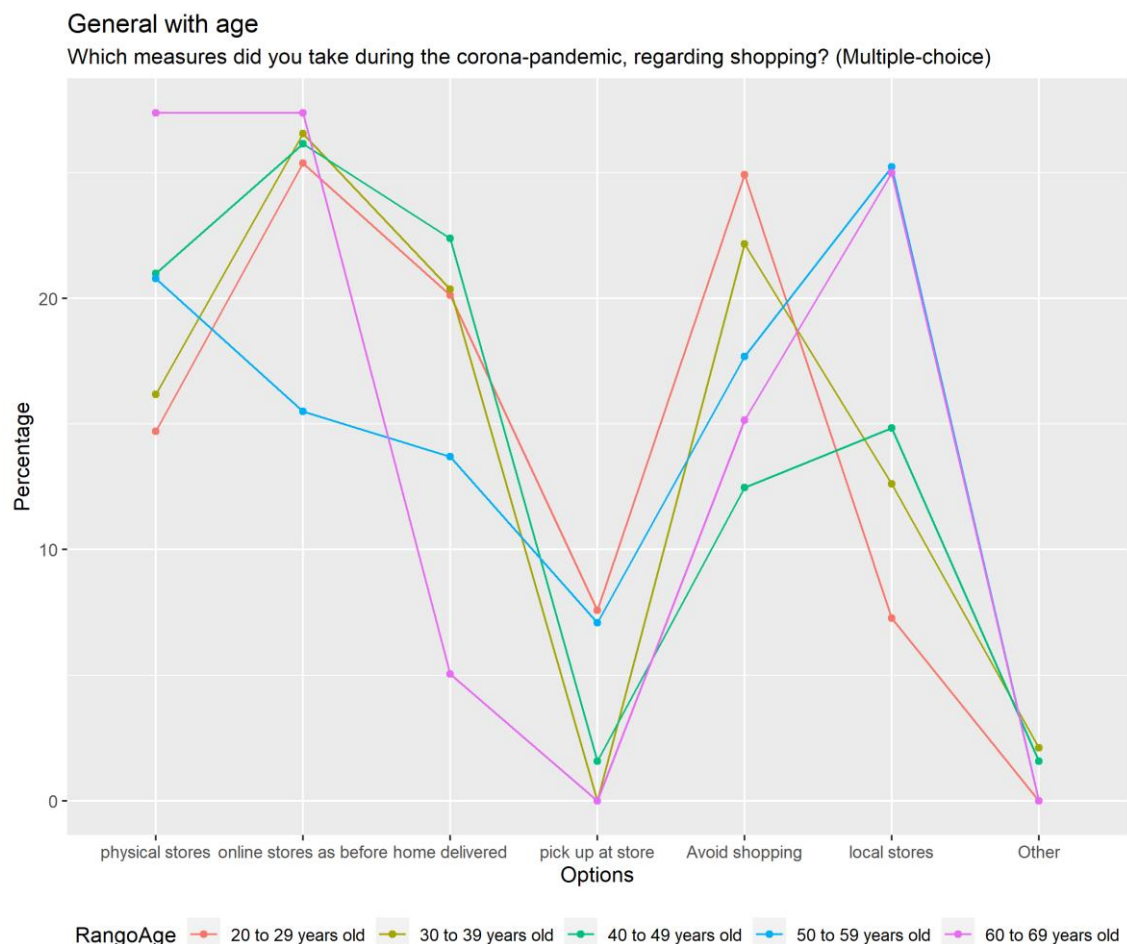
Figure 53 Results question 15 "Which measures did you take during the corona pandemic, regarding shopping?" by age group

4.5.3. Hc: Most of the deliveries people receive are extra small, small, and medium size

The plot in *Figure 11*, represents the answers for the question 4 "What are the most frequent sizes of the parcels you receive?". The most frequent size of parcels people receive is "Medium" (58%) and the second is "Small" (28%). "Extra Small corresponded to 9% of the answers. In this way, we can conclude that most of the deliveries people receive are "Medium", "Small", and "Extra Small" size, representing 95% of the total deliveries. Also from the weekly survey, the results from *Figure 47* showed that 49% of the

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parcels were "Medium", 17% were "Small" and 23% were "Extra Small". Therefore, medium, and smaller sizes were 89% of all packages.

Consequently, the hypothesis is validated. People receive extra small to medium size packages. Thus, big vehicles are not indispensable for making the deliveries.

4.5.4. Hd: People between 20 and 49 years old buy online more frequently (more packages per month) than older people (50-69 years old)

As presented previously in *Figure 5*. For question 1, most of the respondents of the survey (34%) answered "[0-1) – less than one". The second most common answer (31%) was "[1-2) – one to two". Then the percentage of every answer decreased for higher frequencies.

When inspecting these results by age group, as portrait in *Figure 6*. We can observe that the age groups "20-29 years old" and "30-39 years old" have a very similar pattern, corresponding to the distribution of the general population, where most of the respondents selected the options "[0-1)" (48% and 32% each), and then the percentage of receiving more packages decreases.

The mean values from the frequency tables were as shown in *Table 12*.

Table 12 Packages per week by age group

Age group	Packages per week (Mean value)
20-29 years old	1.2
30-39 years old	1.9
40-49 years old	2.2
50-59 years old	2.5
60-69 years old	1.1

Whereas the age group "40-49 years old" has its own pattern, where the most selected option (32%) was "[1-2)" packages per week. The frequency of packages received is higher, than younger age groups.

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For the age group "50-59 years old", the most selected option (33%) was "[1-2]" packages per week. The frequency of packages received is higher, than younger age groups. Also, around 10% of the people in this age group answered "[5-6]" being the age group that selected this option the most.

The age group "60-69 years old", also distribution was also similar to the distribution of the general population, where most of the respondents selected the options "[0-1]" (53%), and then the percentage of receiving more packages decreases.

In conclusion, the hypothesis "Hd: People between 20 and 49 years old buy online more frequently (more packages per month) than older people (50-69 years old)" was not demonstrated, since the age groups had each their own pattern. The results of the survey showed that the age groups "40-49 years old" and "50-59 years old" were those that have the highest frequency of received packages per week, with a mean of 2.2 and 2.5 packages per week, each. This could be attributed to the use of online shopping platforms and a higher income of the mentioned groups.

4.5.5. He: older people (50-69 years old) kept buying in physical stores during the pandemic

Figure 53 shows the results of question 15 divided by age group. The age groups "50 to 59 years old" and "60 to 69 years old" were the two groups that selected change to online shopping and get home delivered" the least (5% and 14% each). Moreover, these age groups chose the option "Shop at local stores close from home (less traveling)" the most (25%). So, while it was a tendency to buy more online this group age also decided to go to a store for buying the products.

The most selected option for the age group "50 to 59 years old" was "shop at local stores close from home (less traveling)" (25%) and the second most popular opinion was "continue shopping in physical stores as before" (21%).

On the other hand, age group "60 to 69 years old" the options "continue shopping in physical stores as before" and "continue shopping in online stores as before" were equally the most selected ones with 27% each. They were followed by the option "shop at local stores close from home (less traveling)" (25%).

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Ultimately the hypothesis is not conclusive because the age groups "50 to 59 years old" and "60 to 69 years old" had different behavior that cannot be classified as the same. It is to conclude that the age group "50 to 59 years old" indeed kept buying in physical stores during the pandemic. In contrast, the age group "60 to 69 years old" kept its previous shopping behavior, which was either in physical or online stores. Although they tended to buy in local stores more than younger groups. The behavior from these groups differs against younger age groups (20 to 39 years old), which preferred either to continue online shopping as before or to avoid shopping, while remaining from buying at physical stores.

4.5.6. Hf: Environmentally friendly deliveries are not a priority for the customers

The next question to analyze is question 12 "How important is it for you that the delivery is environmentally friendly?". The results for these questions are portraited in *Figure 54*, where most of the people (57%) find it "Important" (31%) or "Very Important" (26%) that the delivery is environmentally friendly. Then the 16% consider it "Moderately important" and the rest (24%) find it sightly important or nor important at all. For the answers to this question, we could say that the environmentally friendly deliveries are indeed important to the customers.

Another question related to this hypothesis is question number 11: "Which services for the delivery are important for you? And it was a multiple-choice question, and its results were as shown previously in *Figure 27*. The most important services were "Free delivery", "Home-delivery" and "Free returns", that were selected by more than half of the participants, with 73%, 62% and 61%, each. "Environmentally friendly delivery" was the 4th most selected option, with only 38% of votes.

When analyzing the question by age, the people between 30-39 years old selected "Environmentally friendly delivery" the most (15%). In conclusion, while environmentally friendly deliveries are important to the customers, it is not their priority service when buying online.

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General
How important is it to you that the delivery is environmentally friendly?
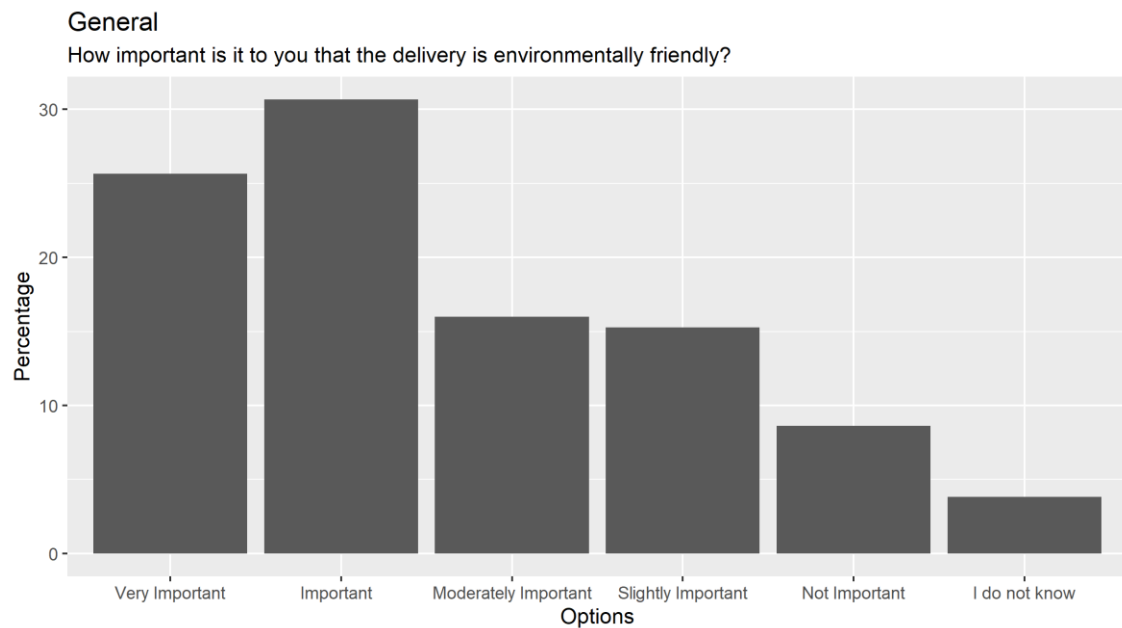
Figure 54 Results question 12 "How important is it for you that the delivery is environmentally friendly?"

When analyzing the results of this question by age group there were differences. The age group from "60 to 69 years old" was the one that considered environmentally friendly delivery "Very Important" and "Important" the most with more than 85% of the answers. Making it the group that seems to put more importance to the issue. Although in all groups, except the youngest group, the majority (more than 50%) thinks it is particularly important or important to have an environmentally friendly delivery.

After the analysis of these questions, it is to confirm the hypothesis Hf, environmentally friendly deliveries are not a priority for the customers. While it is important for them but not as important as other services such as Free delivery, Home-delivery, and Free returns. Although the degree of importance give to the issue also depends on other factors such as the age of the person. Older age groups see the issue as "Very Important".

4.5.7. Hg: People do not think that the customer should be responsible of making the deliveries more environmentally friendly

Question 13 relates to this hypothesis: "Who should be responsible for making the deliveries environmentally friendly". This was a multiple-choice question. *Figure 55* displays the results for this question.

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General
Who should be responsible for making the delivery environmentally friendly? (Multiple-choice)
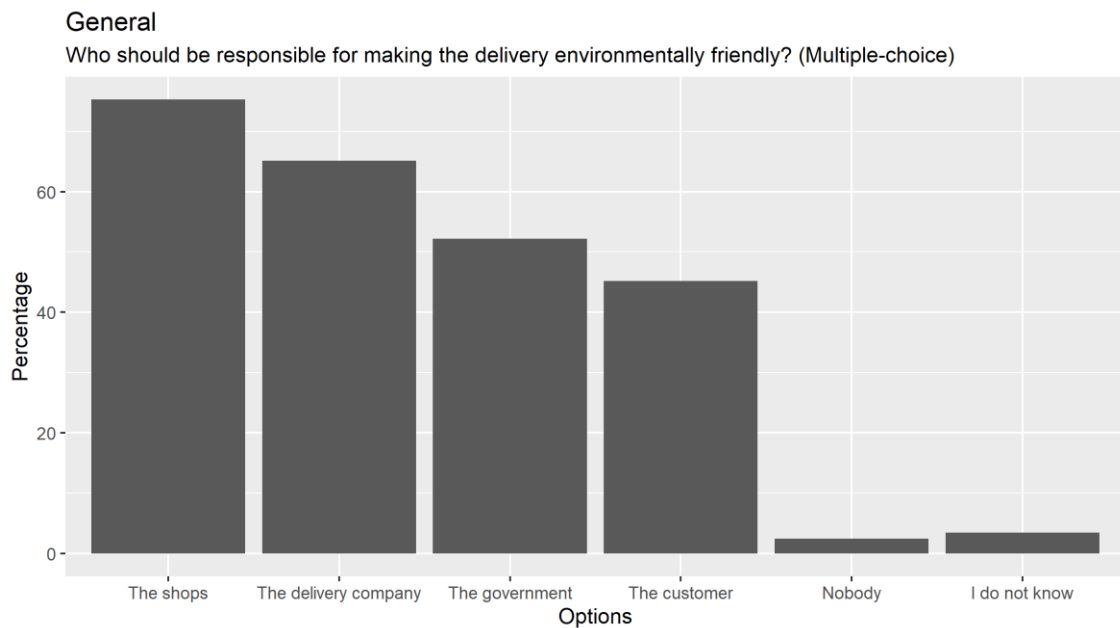
Figure 55 Results question 13: "Who should be responsible for making the deliveries environmentally friendly"

While people consider it important that they become an environmentally friendly delivery the majority does not think that the customer should be responsible for it. Most of the people (75%) answered agree that the shops should be responsible for it and 65% think that the delivery company should be responsible. But only 45% of the participants think that the customer should be responsible for it.

When analyzing the results by age groups there were no big differences within the younger groups (20-49 years old). In contrast, the age group "50 to 59 years old" was the group that selected "The customer" the most (30%). This matches with the responses from question 12, where this group responded that "Environmentally friendly" deliveries are "Important" for them. As in question 11, this group considered "Environmentally friendly deliveries" as an important service the least, it could mean they consider it is not only a service to be provided but an issue where the customer also has responsibility for.

Moreover, the age group "60 to 69 years old selected "The customer" as third option (16%). Although this group considers environmentally friendly deliveries "Very important", they do not think the customer should be the main responsible part for it.

Although there is a notion that the customer should take part on the responsibility, most of the people do not think that that customer should be the main responsible for making the deliveries more environmentally friendly. Confirming the hypothesis Hg.

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4.5.8. Hh: People with higher income would be willing to pay more for making the delivery more environmentally friendly

For making the analysis of this hypothesis it was needed to combine the answers for question 14, and the household equivalized income.

The plot in *Figure 56* , shows the results of question 14 and separates the distribution of the answers by every income range. The range "4001-5000 euro" is not shown in the plot, since there was only one answer, so it is not representative.

For the income group "less or 1000 euro", the most popular answer was "[1-2) euro" with 60% of the answers. The second most popular answers were "[3-4) euro" and "[4-5) euro" with 11% each. The third most voted answers were "[0-1) euro" and "5 or more euro" with 10% each. Making it the group that answered "5 or more euro" the most. When calculating the mean from the frequency table we have a value of **2.5 euro** for this group.

The income group "1001-2000 euro" answered "[0-1) euro the most (57%), followed by "[2-3) euro" (21%). Then "[1-2) euro" was answered by 12% of the people, and in fourth place "[3-4) euro" with 4%. Less popular answers were "[4-5) euro" and "5 or more euro". This group has a mean value of **1.3 euro**.

Then the group with an income from "2001-3000 euro" answered "[1-2) euro" by 39%, very close to "[2-3) euro" with 34%. This was followed by "[0-1) euro" with 16% and "5 or more euro" with 7%. The least answered option was "[3-4) euro" with only 2% of the answers. Also 1% answered "No idea" and the other 1% left a comment instead of a quantity. This group has a mean value of **2 euro**.

Finally, the most popular answer for the income group "3001-4000 euro" was "[2-3) euro" with 32%. Close to the second answer "[0-1) euro" with 29%. This was followed by "[1-2) euro" and "[4-5) euro" with 27% and 12% respectively. This group did not select any other answers. This group had a mean value of **1.9 euro**.

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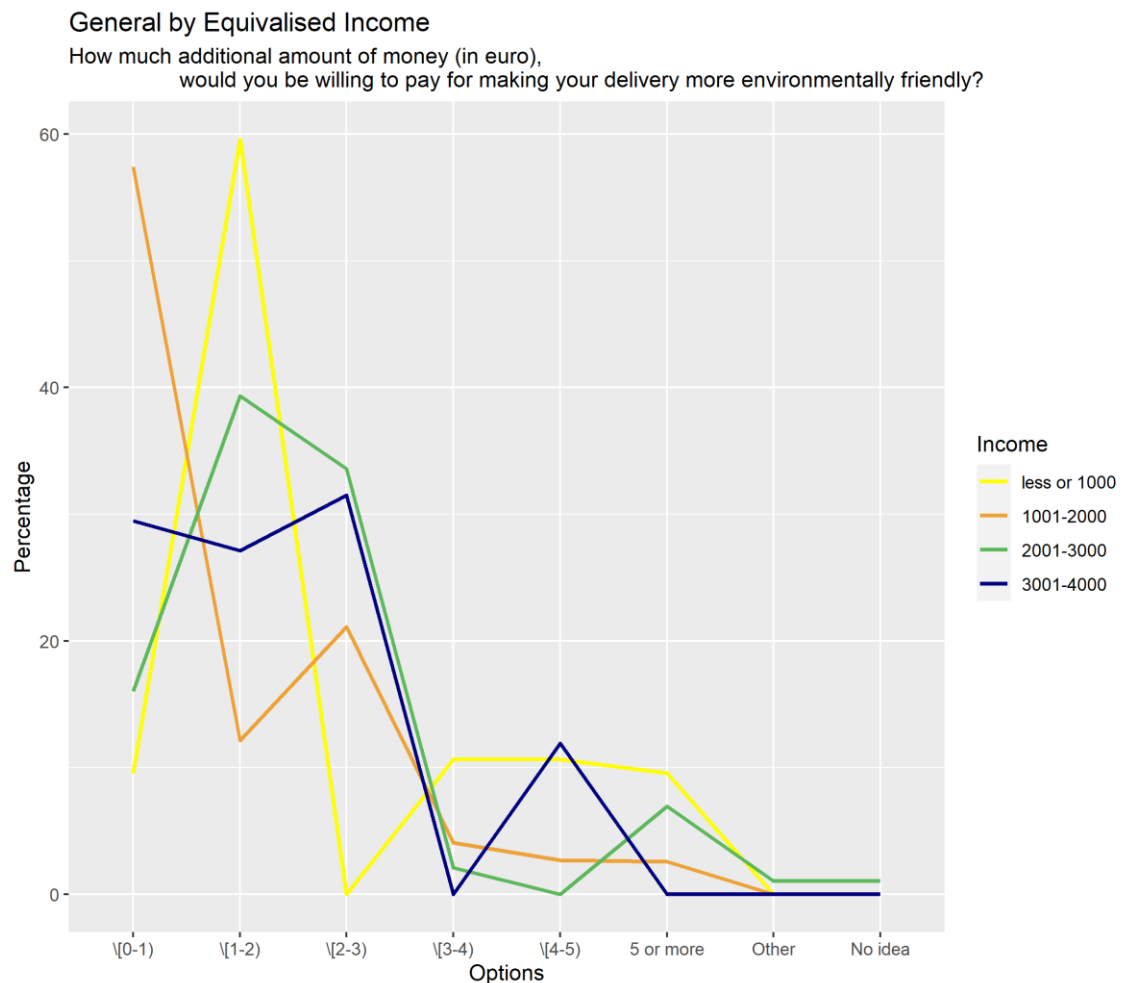
Figure 56 Results question 14 "How much additional amount of money (in euro), would you be willing to pay for making your delivery more environmentally friendly?" by equivalized income

After this analysis the hypothesis was not validated, since people with the lowest income actually had the highest mean value for the amount of money, they will be willing to pay for making the delivery more environmentally friendly. Likewise, the people with the highest income (3001-4000 euro) were not willing to pay the most. Whereas people with an income of 2001-3000 euro would be willing pay more than the people in the income group 1001-2000 euro. Further analysis will be needed to know what other factors make the people be willing to pay more for this service.

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4.6. Summary of the hypothesis verification

Following a table containing the main findings of the hypotheses' verification section is shown.

Table 13 Summary of the hypotheses' verification

Hypothesis	Validated	Next step	Conclusion
Ha: People agree that their online shopping increased permanently	Non conclusive	Analysis by age and occupation	People agree that their online shopping increased permanently due to the pandemic, depending on characteristics, such as age or occupation. The age groups from 30-49 years old agree with the statement the most. Full-time employees as well as students agree with the statement. This might depend on the degree of affection to their mobility patterns due to the pandemic and after it
Hb: People changed to online shopping during the pandemic	Non conclusive	Analysis by age	There was a tendency to change to online shopping and getting home delivered by the age groups between 20-49 years old. But it is not to conclude that most of the people changed to online shopping, since most people answered that they kept buying as they did before (in online or physical stores). Although, in Germany most of the stores that had limitations and closed during the pandemic were retail stores but not supermarkets. Thus, the people might have kept buying in physical stores for grocery shopping.
Hc: Most of the deliveries people receive are extra small, small, and medium size	Validated.	Analysis by age and occupation	86% of the deliveries people receive are "Medium" and "Small" size. The age groups from 20 to 49 years old, had a very similar distribution. For the group 50-59 years old, the "Small" size was more frequent than the "Medium" size. And for the age group from 60-69 years old "Extra Small" was the most selected option after "Medium". Only in men there were big differences by age; the groups from 50--69 years old, the most frequent size was "Small" and the second most frequent "Medium" and the other sizes had zero representation.

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Hypothesis	Validated	Next step	Conclusion
Hd: People between 20 and 49 years old buy online more frequently (more packages per month) than older people (50-69 years old)	No validated		The age groups "40-49 years old" and "50-59 years old" were those that have the highest frequency of received packages per week (mean of 2.2 and 2.5 respectively). This result could be attributed to the use of online shopping platforms and a higher income of the mentioned groups.
He: older people (50-69 years old) kept buying in physical stores during the pandemic	Non conclusive		The age groups "50 to 59 years old" and "60 to 69 years old" had different behavior that cannot be classified as the same. The age group "50 to 59 years old" indeed kept buying in physical stores during the pandemic. The age group "60 to 69 years old" kept its previous shopping behavior (either in physical or online stores). The behavior from these groups differs against younger age groups (20 to 39 years old), which remained from buying at physical stores.
Hf: Environmentally friendly deliveries are not a priority for the customers	Validated	Analysis by age	While it is important for them but not as important as other services such as Free delivery, Home-delivery, and Free returns. Although the degree of importance given to the issue might depend on other factors such as the age of the person. Older age groups see the issue as "Very Important".
Hg: People do not think that the customer should be responsible of making the deliveries more environmentally friendly	Validated	Analysis by age	Although there is a notion that the customer should take part on the responsibility, most of the people do not think that that customer should be the main responsible for making the deliveries more environmentally friendly. Only the age group "50-59 years old" thinks the customer should be responsible for making the delivery more environmentally friendly
Hh: People with higher income would be willing to pay more for making the delivery more environmentally friendly	No validated		People with the lowest income actually had the highest mean value for the amount of money, they will be willing to pay for making the delivery more environmentally friendly. Likewise, the people with the highest income (3001-4000 euro) were not willing to pay the most. Further analysis will be needed to know what other factors make the people be willing to pay more for this service.

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4.7. Analysis of the solutions for the last mile delivery

Currently in Germany exist different approaches and solutions for the increasing stress and demands on the last mile delivery. Furthermore, researchers and consulting agencies have proposed different solutions for making the last mile delivery more sustainable, adapting to the increasing demands of the customers, as well as making the last mile more effective and more environmentally friendly.

An analysis of the different options is needed with the purpose of knowing which might have better outcomes. What do the solutions offer and what is needed by the customers, the delivery companies, the e-commerce industry, and the environment.

4.7.1. Multicriteria Analysis of the solutions for the last mile delivery

The different solutions found in the literature will be evaluated trough a Multi-Criteria Analysis (MCA), following the main 7 steps described in the methodology. The results will be shown in a matrix and then discussed in this section.

The steps are as follows:

The decision context. The aim of the MCA is to find out in which extend the solutions satisfy the need and demands from the customers, the delivery companies, the e-commerce industry, and the environment protection.

1. Identify the options. In the literature review 16 solutions were described. For simplicity of the analysis the solutions will be group in general solutions that share core characteristics. How they are group can be seen in *Figure 57*. Then the options are as follows: collection centers, lockers at strategic locations for the delivery, parcel box at home, customized delivery: option to choose the delivery time and day, as the preferred location, electrification of the fleet, shared last mile (urban depots), crowd shipping, drones, bike couriers, compensation of the CO_2 emissions.

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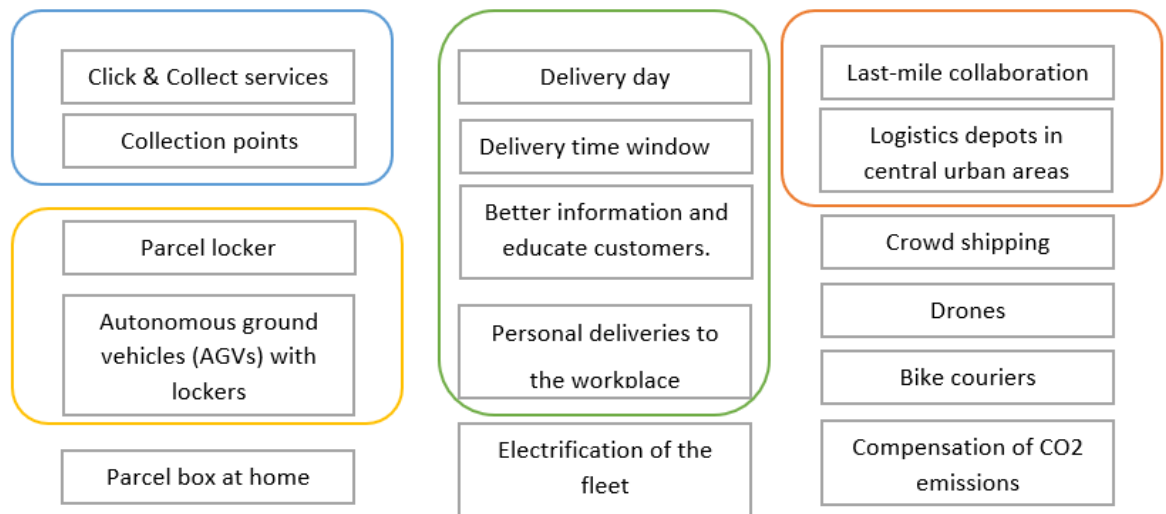
Figure 57 Grouping of the solutions for the last mile delivery

2. Identify the objectives and criteria. The criteria correspond to three main categories:

- Ability to deliver. Includes: frequency, size of parcel, availability of the solution, operation costs, impact on the last mile operation.

- Customer preferences. Includes: selection of delivery location and scheduling of the delivery, price, Additional services.

- Environment aspect. Involves: minimal impact on the environment, stakeholders' involvement.

Below, a brief description of the meaning of each criterion:

- Frequency: An option should be able to fulfill the demand of packages in Munich. It is estimated that in Munich the package volume to customers is of 37 parcels per year per inhabitant [59]. It is similar to the results of the survey. Where the people interviewed receive an average of 1.8 parcels per week, meaning around 93 packages per year per household (within the population of the sample). Thus, the option should be able to respond to a demand of around 185,000 packages per day, considering 6 working days a week.

- Size of parcel: The solution should be suitable to carry packages of varied sizes. According to the results of the survey, it must carry mainly (58%) packages of medium size (shoe size, shoes, clothes, office supplies, ~38cm x 30 cm x 15 cm) or small (28%).

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- Availability of the solution: This criterion refers to whether the solution is already in the delivery business or not. Consequently, its technical feasibility to be implemented in the short and medium term.

- Operation costs: This refers to the economical side of the solution. If it is affordable for the delivery companies to acquire the technology necessary to implement the solution.

- Impact on the last mile operation. It indicates the potential of the solution to take over the last mile delivery. In which degree the whole operation can be taken or changed by the solution.

- Customization of location and delivery time: It means in which degree the customer would be able to customize the delivery site as well as the day and time of the delivery. And if the technology of the solution permits to share with the customer changes on these details. This is important, since the results of the survey showed that this service is particularly important for 32% of the respondents. For example, 51% of the respondents chose "Evening" as a desired delivery time window.

- Price: The degree on which the price of the delivery will be impacted due to the implementation of the solution. Since people in the survey responded that they are willing to pay in average, less than 2 euros per package to introduce measures such as CO_2 neutral or low emissions, low-noise delivery, delivery with electric vehicles/bikes, less packaging, etcetera.

- Additional services: If the solution offers the possibility to have other desired services for the customer, such as free returns, home delivery, fast delivery, and environmentally friendly delivery. This includes the satisfaction of the customer with the delivery.

- Low impact on the environment: In which degree the solution reduces the impact of the last mile on the environment. For example, reducing direct emissions of the delivery transport, by reducing the traffic in city centers, by reducing the indirect impacts of the delivery (packaging), etcetera.

- Stakeholders' involvement: The degree of complexity it has regarding the number of stakeholders involved and the degree they must be engaged to the solution.

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The solution is less optimal, when it is difficult to bring the stakeholders to work together or to accept the solution. For example, the customers think that the shops should be responsible of making the delivery more environmentally friendly, thus this indicates they would prefer to be less involved in the direct implementation of such solutions.

The scale to apply is as follows:

Extremely poor performance	Poor performance	Average performance	Good performance	Excellent performance
• Severe shortcomings of the solution. • Absence of required characteristics. • It is not optimal to implement it.	• Significant shortcomings of the solution. • Lacking sufficient quality and required demands.	• Moderate shortcomings of the solution. • Satisfactory performance but could improve.	• Minor shortcomings of the solution. • A considerable high quality and satisfies required demands.	• No shortcomings of the solution. • A high quality and satisfies required demands and beyond.
+1	+2	+3	+4	+5

Figure 58 Performance scale of the solutions

3. Assessing the weights to each criterion.

The weight for each criterion as well as an explanation of the importance of each is explained in *Table 14*.

Table 14 Criteria of Analysis and their weights

Criterion	Weight	Explanation
Frequency	12	This criterion is very important, since it considers the technical feasibility of the solution. It will indicate if the solution is an option or which percentage of the packages it could deliver.
Size of parcel	12	This criterion is particularly important, since it considers how feasible the solution is in technical terms. If the vehicles used for the delivery are capable to carry diverse sizes of packages or just a certain percentage of them.
Availability of the solution	8	This criterion is essential since a solution that is not existent cannot be quickly implemented. Alternatively, if the solution can be implemented in medium term it is important to consider it and evaluate its potential.

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Criterion	Weight	Explanation
Operation costs	10	It considers the effort on the investments made by the delivery companies and partners to adapt the solution. Higher costs might make them decide against a solution.
Impact on the last mile operation	10	This is particularly important since implies the degree in which a solution can change the last mile supply chain. If adapting the solution will have a big positive impact it is worth adapting.
Customization of location and delivery time	8	This was an important service for the customers. The ability of a solution to provide this information can help the last mile delivery to be more efficient.
Price	12	It is important since the customer is not willing to pay more than 2 euros additionally to the delivery for environmentally friendly measures. Hence if the customer does not pay for it, it will be difficult to implement the solution.
Additional services	6	For the customers it is important the delivery includes additional services, for example tracking of the delivery, availability to return their packages or 24 hours service. This can attract the customer to adapt innovative technologies for receiving their packages. Although the impact of the criterion is not extremely high.
Low impact on the environment	12	This research has as a common goal to propose solutions with low environmental impact. Thus, a solution will be more worthy if the impact to the environment is low.
Stakeholders' involvement	10	How the stakeholders interact can make a solution work or to not be implemented at all. Hence, the importance of this criterion.
Total	100	

The next steps of assessing the expected performance of each option against the criteria. A brief description of the performance of each solution is presented below, then the final performance scores and weights for each of the options are shown in the MCA Matrix in *Table 15*.

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- Collection centers. In the case of the collection centers the frequency of delivery can be accomplished when the city has a network of them. There is no direct limitation for the size of the packages they can receive, although they are limited when the packages are not collected by the customer, and they start running out of storage. This solution has been already adapted in different cities and are starting to become popular in Germany. The initiation costs are not very high, but the operation costs can arise due to the need of staff to operate them. This also limits the opening times, which are constrain by the working times of the staff, which might not always fit the customer needs. [60]

  A study by Davydenko, et. al. showed that "a shift of some 50% from home deliveries to the pick-up points will result in 17% less CO_2 emissions in the last mile network" [56].

- Lockers at strategic locations for delivery. The lockers are a similar solution to the collection centers, but they differ on the place for delivery. Lockers are automatic and do not need staff to give the customer their package, thus a locker can offer a 24 hour, 7 days a week service. One disadvantage of the lockers is the size restriction of the packages. They normally have different sizes from very small to big, but the exact dimensions are standard dimensions and might sometimes not fit all packages. Due to the automatization of the delivery is easier to communicate to the customer that the package is available to collect, also the customer can pick up the package at any time. The operation costs are not high because they do not need someone to contact the customer, but it has high initiation costs. [60]

  From the environmental perspective, they are also beneficial. A previous study, showed that delivery to parcel lockers generates savings up to 10% of the CO_2 emissions per parcel [25].

- Parcel box at home. This solution has not yet been widely implemented, thus there is little information about the impacts it has. The main disadvantage is the need of investment on the box by the customer [33]. It is also restricted to the size of the box that the person has at home, the sizes of the packages it can hold. Another problem is that the network is difficult to grow, then not all the packages can be delivered this way. It provides flexibility to the customer since the package arrives at home even the customer is not there.

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On the other hand, the emissions are the same as for a home delivery but there is potential reduction in emissions for failed deliveries.

- Customized delivery. This is mainly an additional service for the customer. It helps the customer to know when the delivery is coming and give enough time to be present at home when the delivery comes, thus it can increase the First Attempt Delivery Rate (FADR) [36]. The main problem is the need of investing in technology for the delivery tracking and the extent on which it can offer a benefit to all the stakeholders involved. It does not provide additional services for the customers, and it is impact for the environment is not yet known.

- Electrification of the fleet. In the case of the electrification of the fleet, the frequency of delivery can be accomplished as with the normal fleet. The size of the vehicles is similar and might differ only in the distance that can cover, which for deliveries is not a restriction since a van might cover little distance (~60 km) [61]. The solution is already available since electric vehicles already exist and are part of delivery fleets [62]. The initiation costs are high, but nowadays electric trucks are economically viable today, given the currently available purchase subsidies [39]. The CO_2 emissions (due to the electricity consumption) of electric vans are almost half than diesel vehicles [37], so they are a good solution to reduce emissions [38].

On the other hand, electric vehicles do not offer additional services for the customer or make easier to track/program the deliveries.

- Shared last mile (urban depots). Depots at cities can help top reduce the distance for the last mile of the delivery, thus allow the use of diverse means of transportation for example, bikes [63]. They do not change the capacity of the delivery (frequency and size) and can be extended for all the deliveries. The main problem is the operation of the depots by different parties since they must agree to collaborate. Another disadvantage of the concept is the temporary storage of containers in the city [63]. The depots take up valuable space that could be used for other activities or disturb the appearance of the cityscape. As a consequence, the city administration and citizens need to be involved in the decision process [63].

Additional features for the delivery are not integrated in this solution, thus it does not have additional benefits for the customer.

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- Crowd shipping. The main limitation for this solution is the number of packages that can be delivered with this system. A study from Karakikes and Nathanail, showed that up to 8% of all the packages can be delivered in this way, when performed by commuters using public transport [64]. Although there are benefits for the delivery companies when their capacities are surpassed, since they do not need to make an additional investment [64]. The operation costs include the communication network between the shippers and the delivery companies. When combined with other solutions, like parcel lockers and sustainable transportation, there is a significant reduction of CO_2 emissions [64].

  They do not involve direct additional services for the customer, so this might depend on additional features that the companies and shippers are willing to offer (i.e., returns). Another disadvantage is that the business model depends on different participants and their willingness to work together.

- Drones. Research about the potential use of drones for parcel delivery has been done by several companies and authors, however, the potential market and economic viability this type of service in Europe is still unknown [65]. There is a potential of reaching a 30% share of deliveries, but it is dependent on technological developments [65]. Therefore, the frequency of delivery and the size of the parcels can be a restriction for this solution. Also, the delivery companies will need to invest on the drones and their adaptation, this involves higher initial costs than other solutions. Although the long-term benefit is the automatization of the process and the need of less staff to operate/control the drones.

  Additional services for the customers are not integrated to the solution and might need to be selected by the delivery companies in the future time.

  "Drone delivery could also reduce the need for local transport and decrease congestion and air emissions" [65] but it is not yet known in what extent.

- Bike couriers. They have a good potential to deliver packages. Their main restriction is the capacity of the cargo, but they are worth when carrying small and medium size packages. They can have an electric motor integrated that can help to reach higher speed and be able to deliver at a higher frequency. "E-bikes also cut carbon emissions by 90% compared with diesel vans, and 33% compared with electric vans" [66].

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They do not have a customization of the delivery integrated and further investments might be needed to provide this feature for the delivery, for example through GPS tracking integrated in the bikes [66]. Also, additional services for the customer (free returns, etc.) are not foreseeable.

While investment and operation cost are not high, there is a need on involving the city administrations, since long-term investment in cycling provision and safety regulations would be needed [66].

- Compensation of the CO_2 emissions. This is mainly an additional service for which the customer pays. It helps the delivery companies to invest in projects to decrease the emissions of the deliveries directly or indirectly [41]. It can be applied to all the deliveries when the customer agrees to pay for it. The main disadvantage is that many companies work mostly on external projects rather than direct ones [41].

It does not provide additional services for the customers nor customization of the delivery time and place [40].

The main problem is that the customer pays for it, and it depends on the customer if she wants to pay for such a service. Additionally, the stakeholders need to act in order to implement the solution [67], making it difficult to be a generalized solution for all packages.

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Table 15 Multi-Criteria (MCA) Matrix

Categories	Type of delivery					Customer preferences			Environmentally friendly		Total
Criteria	Frequency	Size	Availability of the solution	Operation costs	Impact on the last mile operation	Customization of location and delivery time	Price	Additional services	Low impact on the environment	Stakeholders and their responsibility	
Weight	**12**	**12**	**8**	**10**	**10**	**8**	**12**	**6**	**12**	**10**	**100**
Options						Scores					
Collection centers	3	4	5	2	4	2	5	4	4	3	362
Lockers at strategic locations for delivery	3	3	4	3	4	3	5	5	4	3	**366**
Parcel box at home	5	3	1	2	4	5	3	3	2	3	308
Customized delivery	5	3	3	1	2	5	3	1	2	3	286
Electrification of the fleet	5	5	4	3	5	1	4	1	4	4	**382**
Shared last mile (urban depots)	4	4	3	3	4	1	3	1	4	1	298
Crowd shipping	1	2	3	5	2	5	3	3	2	2	268
Drones	3	1	2	3	3	4	3	2	3	3	270
Bike couriers	4	4	5	5	3	2	3	2	5	4	**380**
Compensation of the CO$_2$ emissions	5	5	4	2	3	1	1	1	5	2	308

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Discussion

The MCA Matrix showed that the best options according to the defined criteria, are electrification of the fleet (382 points), the bike couriers (380 points) and the lockers at strategic locations (366 points). Moreover, these solutions are not exclusive so a combination of the different solutions can also be adapted.

In the case of the electrification of the fleet, it could improve by adding innovative features that allow the customization of the location and time of the delivery. Besides it includes higher operation costs since the delivery companies would need to invest on the vehicles. Although currently electric vehicle prices are going down [39], thus the investment is becoming more convenient.

The worst performances were seen in the following solutions: Crowd shipping (268 points), drones (270 points) and shared last mile (urban depots) (298 points). In the case of crowd shipping, it lacked on satisfying the frequency of the deliveries, since a noticeably big network would be needed to cope with the demand, also the environmental impact is hard to achieve since some of the shippers could include car drivers.

A further analysis can include an extensive study of the solutions that performed better, as well as the ability to combine them.

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5. Conclusions

After the research conducted, it was possible to collect details regarding the online shopping behavior of people in Munich, as well as the main changes of it after the corona pandemic and to analyze different solutions for satisfying the growing demand on the last mile delivery.

According to the survey performed, the most important services for the customers are free delivery, home delivery and free returns. Furthermore, the mean frequency on which people receive packages is about 7 packages per month, and that the most common size of packages people receive is medium (shoes, clothes, office supplies, ~38cm x 30 cm x 15 cm). This has an impact for the delivery's last mile, since big vehicles are not indispensable for making the deliveries, thus making it possible to implement delivery's solutions with smaller vehicles.

Regarding the main changes in online shopping during the pandemic, it was difficult to determine a generalized behavior of the people. The main result was that people kept buying the way they were doing it before. Also, that people aged 20 to 39 years old, refrained from buying at physical stores. Although the general survey did not specify the type of products people bought or shops they used during the pandemic. In Germany most of the stores that had restrictions and closed during the pandemic were retail stores but not supermarkets. Thus, the people might have kept buying in physical stores for grocery shopping. As a result, with the collected data it is not possible to determine on which degree the pandemic affected exclusively retail online shopping during the pandemic.

As for the impact on online shopping after the pandemic, it was possible to confirm, from the results of the survey, that people agree with the statement "you shop online more than before the pandemic". Resulting on a higher stress on the delivery's last mile. For this statement a relation with age was not found. In contrast, when analyzed by occupation a clearer trend becomes visible. While full-time employees as well as students agree with the statement, groups such as part-time employees, freelancers and retired people disagree more often. This might be due to differences in how their mobility patterns have been affected by the restrictions imposed during the pandemic, shopping preferences and, further mobility changes after the pandemic.

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Moreover, regarding the perspectives of the people about environmentally friendly delivery, the results of the survey showed that 58% of the participants considered it important. While the customer has the topic in mind, an environmentally friendly delivery is not the most desirable service for the delivery, compared to services such as homedelivery, free returns and fast deliveries. While there was no relation found between younger age and giving more importance to the issue, it was found that the youngest as well as the oldest age group answered that the topic is important for them the most. Although the common opinion was that the shops should be responsible for making the delivery environmentally friendly, rather than the customer. Knowing this could allow to target the interested groups to be more involved in making their deliveries more environmentally friendly.

It was possible to determine that people are not willing to pay more than 2 euros additionally to the price of the delivery for making their delivery more environmentally friendly. Additionally, a relation between the willingness to pay and the income of the people was not found.

To find out more about environmentally friendly deliveries and how the people behave regarding the topic, it would be needed to perform an additional study on the topic. One possible approach would be to show participants how their online shopping behavior impacts the environment and then asking them what they would do or change in different scenarios. Delivery companies could then use this information to offer the service and help to reduce the environmental impact of the delivery's last mile.

The results of the weekly survey provided information about the type of products and the motivations why people buy online. From the packages analyzed, most of them (27%) were in the category "Clothes, shoes, accessories", this was also the most popular answer in a survey performed in Europe by the European Commission in 2021, although in a lower proportion [7]. Also, the other types of products were selected differently, thus the previous survey does not represent the Munich population. The present study also asked the reasons to buy the product online and about a third of the people said that they did because the product was only available there and, when this was not the case, they turned to online shopping due to convenience of time, effort, or price.

Regarding the analysis of the different solutions for the last mile delivery, the Multi-Criteria Analysis showed that for the criteria established, the most convenient option would be the electrification of the fleet. Other good performing solutions were bike couriers and parcel lockers at strategic locations. These results are important for a further analysis, since they can work as a filter to study only good performing solutions.

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A sensibility analysis would be needed to determine how to improve the solutions by varying their performance in the different criteria. An additional study is needed to find out how the solutions could be implemented together and the impact they would have with different combinations.

Limitations of the study

There were limitations during the study. It was challenging to have a bigger sample size to have more accurate results, due to the limited time and, resources to distribute the survey and to motivate to participation.

As for the weekly survey due to the short time, participants not willing to provide an email or emails going to spam, the sample was very small. This restrained the study for having more representative results to analyze specific details of the packages (type of product, motivation to buy) in a weekly manner.

Additionally, follow up questions would be needed to answer the research questions in a more specific manner.

For further studies, it would be helpful to consider funding to have more resources to distribute the survey and to offer the participants some type of compensation for their time. Likewise, to have more detailed data, it would be necessary to split the study into specific topics, then complement the survey with follow-up questions to collect more details.

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Statement of independent work

I hereby confirm that this thesis was written independently by myself without the use of any sources beyond those cited, and all passages and ideas taken from other sources are cited accordingly.

Yours sincerely,

Diana Sofia Jiménez Ruiz

Munich, at 11.01.2023

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6. Appendix

6.1. Survey: Online Shopping behavior

Welcome. You were invited to participate in this survey. The survey is part of a research for analyzing the changes in online shopping behavior after the coronavirus pandemic in Germany. The collected data will help to bring up solutions for deliveries with low environmental impact that adapt to the customer needs. Your answers are anonymous and will not be shared with anyone else.

Thank you for participating!

In case you have any question please contact me: diana.jimenez@tum.de

1. How many packages do you generally receive per week?
2. Where do most of your deliveries come from?
- Online shopping websites
- Family
- Other: ____
3. In a typical month how many different online stores do you order from? (for marketplace stores consider this just as one, like Amazon, eBay, etc.)
- 1
- 2-3
- 4-5
- 6-7
- 8 or more
4. What are the most frequent sizes of the parcels you receive?
- Extra Small (envelope, book, magazines, 23cm x 15 cm x 3cm)
- Small (small electronic articles, toys, 25cm x 18cm x 10cm)
- Medium (shoe size, shoes, clothes, office supplies, 38cm x 30 cm x 15 cm)
- Large (appliances, bulky items, household appliances, 45cm x 35cm x 20 cm)
- Extra Large (furniture, 60cm x 35cm x 20cm)
- Bigger than Extra Large (washing machine, fridge, 120cm x 60cm x 60cm)
5. Where are your packages generally delivered?
- Homedelivery
- Parcel shop

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- Parcel station
- Send to your office
- Pick up at the shop/supermarket

6. If you get parcels by homedelivery, are you at home when the deliveries come?

- Always
- Very often
- Sometimes
- Rarely
- Never

7. What normally happens if you are not at home? (You can choose more than one)

- The package is left close by the door
- The package is delivered to a neighbor
- The package is transferred to a parcel shop
- The package is transferred to a parcel station
- Other: _____

8. What would be a good time of the day for receiving packages at home?

- Morning
- Noon
- Afternoon
- Evening
- Night

9. If you get parcels sent to a delivery point: parcel shop, parcel station, pick up at store, how do you arrive there?

- By foot
- By bike
- By car
- By public transport
- Other: _____

10. When you shop from the same online store, do you schedule your deliveries to arrive the same day?

- Always
- Very often
- Sometimes
- Rarely
- Never

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- I cannot choose

11. Which services for the delivery are important for you? (You can pick up more than one)

- Free delivery

- Home-delivery

- Same day delivery

- Next day delivery

- Self-chosen delivery window

- Environmentally friendly delivery (CO2 neutral or low emissions, low-noise delivery, delivery with electric vehicles/bikes, less packaging, etc.)

- Free returns

- Choice of the delivery company

12. How important is it to you that the delivery is environmentally friendly (CO2 neutral or low emissions, low-noise delivery, delivery with electric vehicles/bikes, less packaging, etc.)

- Very Important

- Important

- Moderately important

- Slightly important

- Not important

- I do not know

13. Who should be responsible for making the delivery environmentally friendly? (You can choose more than one)

- The shops (by using recyclable packaging, reducing the size of the packages, paying a CO2 footprint fee)

- The delivery company (using low/null emissions vehicles, planning more efficient routes)

- The customer (paying for a CO2 neutral delivery, receiving parcels at parcel shops or stations)

- The government (enhancing low emissions vehicles for delivery companies, increase CO2 taxes)

- Nobody

- I do not know

14. Imagine you have purchased an item of 40 EUR that will be delivered to you at home with a cost of 4 EUR. How much additional amount of money (in euro) would you be willing to pay for making your delivery more environmentally friendly

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(CO2 neutral or low emissions, low-noise delivery, delivery with electric vehicles/bikes, less packaging, etc.)?

15. Which measures did you take during the corona-pandemic, regarding shopping? (You can choose more than one)

- Continue shopping in physical stores as before
- Continue shopping in online stores as before
- Change to online shopping and get home delivered
- Change to online shopping and pick up at store
- Avoid shopping/shop less
- Shop at local stores close from home (less traveling)
- Other: _____

16. Do you agree with the following statement? Currently you shop more online than before the pandemic

- Strongly Agree
- Agree
- Undecided
- Disagree
- Strongly Disagree

17. Age. Select the group that corresponds to your age

- Under 14 years old
- From 14 to 19 years old
- 20 to 29 years old
- 30 to 39 years old
- 40 to 49 years old
- 50 to 59 years old
- 60 to 69 years old
- 70 to 79 years old
- 80 years old or more

18. Gender

- Female
- Male
- Other
- I prefer not to answer

19. What is your predominant occupation

- Full-time employee
- Part-time employee

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- Retired
- Student
- Freelancer
- Unemployed
- I prefer not to answer
- Other

20. How many people in your household are under 14 years old?

21. How many people in your household are 14 years old or older, including you?

22. How many people in your household are: full-time employees, part-time employees or freelancers?

23. What is the monthly Net-Income [Euro] of your household?

- less or 1000
- 1001-2000
- 2001-3000
- 3001-4000
- 4001-5000
- more than 5000
- I do not know
- I prefer not to answer

24. Please add your Postal Code

Weekly Survey

Thank you for answering the first part of the survey. Now more information regarding your deliveries of the past week is needed. Answering will take you around 5 minutes. At the end you will be able to compare your results with the other participants!

25. Do you wish to participate in the weekly survey?

- Yes
- No
- Maybe

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6.2. Weekly survey: Online shopping behavior

Hello, you were invited to the weekly survey. The survey is part of a research for analyzing the changes in online shopping behavior after the coronavirus pandemic in Germany. The collected data will help to bring up solutions for deliveries with low environmental impact that adapt to the customer needs.

You can answer the following questions providing more detailed information regarding your deliveries for the last week. This will take you around 5 minutes. At the end you will be able to compare your results with the other participants!

Thank you for participating!

In case you have any question, please contact me: diana.jimenez@tum.de

1.   Email: _____

Your email will be treated confidentially, and this information will be destroyed after the end of the study

Please provide the information regarding your deliveries from the past week

2.   How many parcels did you receive last week? Mark only one oval.

•   0

•   1

•   2

•   3

•   4

•   5 or more

Describe one of the packages you received during last week

Parcel section

3.   How many products did you receive in the same box? Mark only one oval.

•   1

•   2-4

•   5-7

•   8-10

•   10 or more

4.   Where did the delivery come from? Mark only one oval.

•   Online shopping (go to question 5)

•   Family (go to question 14)

•   Other: _____

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5.   Which type of good is it? Mark only one oval.

•   Clothes, shoes, accessories

•   Deliveries from restaurants, prepared meals, fresh food

•   Groceries, cooking boxes

•   Furniture, household appliances, gardening

•   Toiletries, cosmetics, beauty, or wellness products

•   Printed books, magazines, newspapers

•   Children's toys or childcare items

•   Electronics, computers, tablets, phones

•   Other: _____

6.   Why did you buy this product in an online store instead of a physical store? Check all that apply

•   The product is only available online

•   The product is too big or too heavy to transport

•   It saves me time buying online

•   I found a lower price online

•   The physical store is far from home

•   Other: _____

7.   How big is the parcel you received? Mark only one oval.

•   I know the exact dimensions and will fill them in the next questions (go to question 8)

•   Extra Small (envelope, book, magazines, ~23cm x 15 cm x 3cm) (go to question 11)

•   Small (small electronic articles, toys, ~25cm x 18cm x 10cm) (go to question 11)

•   Medium (shoe size, shoes, clothes, office supplies, ~38cm x 30 cm x 15 cm) (go to question 11)

•   Large (appliances, bulky items, household appliances, ~45cm x 35cm x 20 cm) (go to question 11)

•   Extra Large (furniture, ~60cm x 35cm x 20cm) (go to question 11)

•   Bigger than Extra Large (washing machine, fridge, ~120cm x 60cm x 60cm) (go to question 11)

Size Parcel 1

What are the dimensions of the package?

8.   Length in cm: _____

9.   Width in cm: _____

10.   Height in cm: _____

11.   What was the weight of the package? Mark only one oval.

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- Less than 1,1 kg (letter, water bottle)

- Between 1,1 kg and 2kg (i.e., books, laptop, boots)

- Between 2,1 kg and 5 kg (i.e., a potato bag)

- Between 5,1 kg and 10 kg (i.e., groceries, cooking box)

- Between 10,1 kg and 20 kg (i.e., beer box)

- More than 20,1 kg (i.e., washing machine)

- I do not know

12. How did you get the package delivered? Mark only one oval.

- Homedelivery

- Parcel shop

- Parcel station

- Pick up at the shop/supermarket

- Delivery to my office

- Other: _____

13. Which delivery provider did you use? Mark only one oval.

- DHL

- Deutsche Post

- Hermes

- GLS

- DPD

- FedEx

- UPS

- Amazon delivery

- I do not know

- Other: _____

Additional packages

14. Could you provide information for additional packages?

- Yes

- No

If the answer was "Yes" then the questions from the Parcel section were asked again for each package, up to 5 packages per week.

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