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The user experience on mobile devices in digital commerce

Author: **Eirini Katrantzi**

Supervisors:

Author: _____Eirini Katrantzi_____ _____" __07.05__" 2021

Supervisor: _____Mati Mõttus_____" ___07.05 " 2021

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Abstract

Mobile devices play a significant role in our daily routine and additionally in our online shopping behaviour. M-commerce became a fast growing field in recent years. However there are user experience issues which don't allow the users to complete a purchase through mobile devices. The goal of this thesis is to make a list of issues that the users face through the interface of an online shop on mobile devices and create a structured basic guideline with design improvements. The issues which are revealed from this study are not exhaustive, but they will lead to investigations that may result in new issues being identified.

It will be investigated why cart abandonment is a major issue on mobile devices and which are the reasons that occured on it. The methodology that is used identifies issues which is a review of the literature of mobile e-commerce. The resources found in both academic and trade publications. Literature findings are combined and analyzed with the survey which was conducted for the purposes of this study. E-commerce gained a practical importance in the mid-1990s, on the other hand, m-commerce started to be present in a limited way in the late 1990s. As a result, an extensive body of literature was produced and is present for e-commerce rather than m-commerce. Some research articles in academic journals related to m-commerce appeared recently, and many trade magazines with articles related to user experience as well.

A survey was designed to collect data from 70 respondents about the reasons why users prefer online shopping and which are the user experience issues that they face on mobile shopping. The study found out that participants spend a lot of their time searching and saving products on mobile devices but they don't prefer to complete an order on them. They mentioned usability issues during checkout flow, security and trust concerns about the safety of payment transactions through mobile and lack of content visibility and readability.

Moreover, the findings suggested design improvements from a user-centered perspective which can improve and minimize part of issues that display on m-commerce. A structured basic guideline is presented. This can be used from ux designers, developers and product managers who want to improve an existing online shop or create a new one.

Acknowledgements

At this point, I want to thank all the people who have accompanied me during the last year and provided me support, the time that I was working on this thesis. It was a nice knowledge journey that taught me a lot of things. Special thanks go to my supervisor Mati Mõttus, for supporting me with my research and giving me the freedom to find my own way and research interests.

Furthermore, my deepest thanks go to my family who supported me and encouraged me all this time. This support gave me a lot of energy and confidence to continue my research. Working on this thesis was an exciting, but sometimes also exhausting time and I am grateful that I have a great family and great friends who often cheered me up.

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FAQ Frequently Asked Questions
MCM Mobile Commerce
ID Identification
UX User experience
UI User Interface

1 INTRODUCTION

Nowadays mobile phones are gaining more and more prominence over computers and people prefer to make their daily tasks using their mobile because it's easier and faster. This approach of users can also affect the e-commerce field since many people order products online through mobile devices. While electronic commerce (e-commerce) continues to impact the global business environment, technologies and applications are beginning to focus more on mobile computing and the wireless Web since mobile devices are the prominent device in user's daily activities. Mobile e-commerce (also called mobile commerce or m-commerce) which combines interactive business activities and processes related to a commercial transaction conducted through communications networks that interface with wireless devices.

Based on the shopping trends statistics in 2016 which were published (A. Meola, 2016) for the second quarter of 2015, there were 59% of adults in the USA who were spending their time on mobile phones but only 15% of them spent their money on mobile and the rest of 85% on desktop. However, they had problems in user interface design which was approved as a poor mobile shopping experience among the users, which was because of few factors (P. Tarasewich, R.C.Nickerson & M. Warkentin, pp. 41-64, 2002) such as small screen size, speed, security and the most significant is that many of the sites are not mobile optimized (friendly customer experience) in terms of user interface design.

Mobile commerce is getting fast popularity since it allows the freedom of movement and ease of access virtually from anywhere. This fast development of usage of mobile devices, it will demand the user experience will be improved, analysed and implemented so the m-commerce field will be enhanced. It was studied that mobile phones produce the need to more than half of customers to make a purchase decision after one-hour of product research on their mobile phone (SessionCam, 2015).

Moreover the mobile services for m-commerce there are so many, including business apps, ecommerce apps, retail apps and many others. Digital market is a very dynamic shopping and mobile apps in this market are a powerful tool for consumers. So mobile commerce is the next generation of e-commerce. The future of mobile commerce heavily depends on how easy and how friendly will be the service for users to use. An effective user friendly interface design plays a central role in the success of mobile commerce. According to Seth, Osei m-commerce is extensively receiving more attention as it provides the trendy means of business and commerce. For this reason it can be said that m-commerce is becoming a dominant force for carrying out business largely due to its service, design, and content characteristics, which make it more feasible than e-commerce. (A. Hussain, A. Mahmood & R. Naser, 2017)

Keywords*: user experience, mobile, e-commerce, online shopping, customers, digital market, mobile app, usability, m-commerce, user interface design.*

1.1 Research Problem and Significance

1.1.1 Abandonment of a purchase on mobile

Shopping cart abandonment happens most frequently on the checkout section after the user has already started the purchase process (Factory.hr, 2018). This happens of course in all platforms like web, tablet and mobile but somehow more frequently on mobile. This is presented in the statistical analysis by Barilliance (Barilliance, 2019) in which the 80.79% average cart abandonment rate on mobile devices is significantly higher than those on desktop devices, which stands at 73.93% (see Figure 1). Consumers tend to find the online shopping experience on desktops more seamless. On mobile devices, on the other hand, difficulties such as trouble reading text and locating where to click on are proving to be a hindrance to checkout (Oberlo, 2019). The reasons could be many and this research will try to find out some of them and present them. Statistically more than half of mobile site visits will be abandoned if a mobile site takes more than three seconds to load. Additionally, people who have a negative experience on mobile are less likely to purchase from that brand in the future. The main focus will be the cart abandonment on mobile in comparison with desktop because many people are using mobile as an extension of their hand and open it and navigate on it more than 2,617 times every day, according to a study by research firm Dscout (Julia Naftulin, 2016). So it's interesting to investigate if the reasons for cart abandonment on mobile are the same as the reasons in desktop and how the user experience of mobile can play a significant role in the abandonment.

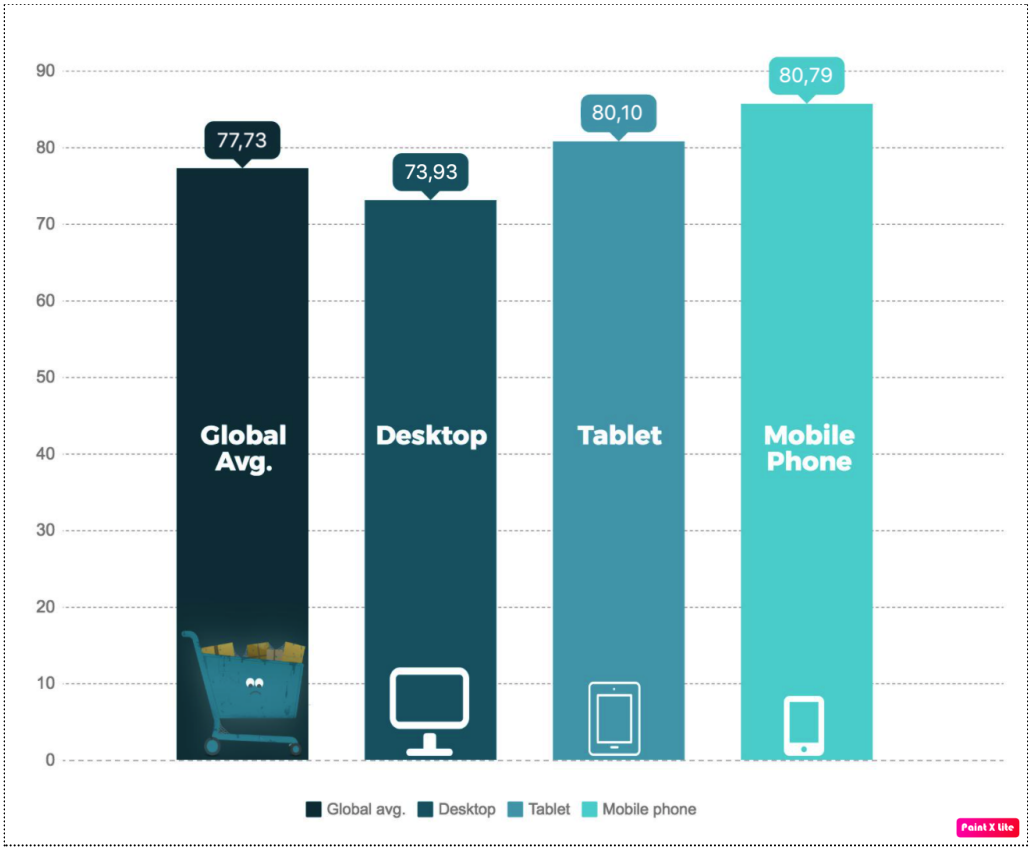


Figure 1: Average cart abandonment rate 2019 by Device (Barilliance, 2019)

However in both devices mobile and desktop the customers face the most of the problems in the checkout process where they decide to quit or continue to complete their purchases. Insecure is the main element in checkout which can make the customer change his behaviour and quit. Unfortunately nowadays the internet is overflowed with different scams and it should be ensured that the customers are protected from them. So the customers should feel trust and security in the eshop that they visit within the checkout funnel and their personal data will not be misused (Kaja Laura Toczyska, 2019). This can be achieved by trust icons or better user experience flow which will include security and reliance.

Another reason could be the content which is responsive on mobile phones so it will be pretty visible for the users but the users should scroll a lot to find and read all the information for the products that they want to buy. Research has shown that hundreds of visitors digest information harder on mobile phones. For example, a merchant may show the 15 most recent reviews for a product, but reading them all is difficult on a mobile device. On mobiles there is a limited time approximately 30 seconds to show the products to the consumers and convince them to buy this product (Nabeena Mali, 2020). So in many mobile devices the order of the information that is displayed to the consumers is wrong and the consumers are confused and overloaded with so much content and at the end they don't have the patience to reach and click the button "Add to cart" and complete a purchase.

Unfortunately mobile devices hold a weaker user interface than desktop in aspects of usability in terms of screen size and text input (Jakob Nielsen, 2017). Also on mobile devices, only one single window is visible at once. That makes it difficult for the users to compare different products and come to a conclusion that makes them buy a product through mobile navigation.

1.2 Research Goal and Motivation

The goal of this research is to find out, present and categorize why cart abandonment happens extensively on mobile devices and if the reason is that user experience is inefficient in m-commerce. The research will be focused to investigate the main reasons that users consider online shopping on mobile devices complicated based on usability on mobile and in which flows of online shopping users abandon the shopping. Also a number of possible issues in mobile e-commerce will be presented which will be investigated from users or will may be speculated. Moreover this research has an aim to provide suggestions for improvements that should be done so the user experience will be more helpful and the cart abandonment will be reduced during the online shopping on mobile devices. One more thing that will be investigated is if there are the same or different reasons for cart abandonment on mobile and desktop devices. Although e-commerce has the same goal to persuade and urge the users to buy things through online shops, the user experience of the user to reach the goal to complete an order is different on mobile devices. The reason is that the elements on mobile devices display in different ways from desktop devices. So this research will try to answer the question if it's only a matter of user experience that makes cart abandonment inefficient or there are other reasons?

The methodology that I will use is to identify similar researches in literature of mobile e-commerce which is present in both academic and trade publications. E-commerce itself became of practical importance in the mid-1990s, although it has produced an extensive body of literature. M-commerce started to show itself in a limited way in the late 1990s. Some articles in academic journals related to

m-commerce appeared recently, but there are only a few papers about cart abandonment on mobile devices. On the other hand there are many expert people like Product Manager, UX Designer who have worked in the field of e-commerce and publish various articles on tech blogs about the issue with cart abandonment on mobile devices.

1.3 Research Questions

1. What are the reasons for cart abandonment on mobile devices ?
    a. Do users prefer buying more on desktop devices and not on mobile devices ?
    b. Why can user interface disturb users and prevent them from buying products on mobile devices or are there other reasons?
    c. Are there security reasons which can prevent users from doing online shopping through their mobile devices ?
2. How should the design concepts be changed to reduce the cart abandonment?

1.4 Research Procedure

The research methodology builds to serve above the research goals. The study starts by giving an overview of the current findings in the ecommerce field. It will be analyzed which are the constraints and strengths on mobile devices in e-commerce. It will be answered how mobile apps have popularity in online shopping and why. I will mention all the reasons for cart abandonment and what else disturbs the users when they do online shopping on mobile devices. Also I will emphasize the value of data from the questionnaire that I have created. I will combine and adapt the existing UX mapping methods with quantitative and qualitative data.

I will analyze all information and I will try to suggest UX improvements which should be done so the user experience will be improved in a better way for the users on mobile devices. As a result the users will be more convenient to buy products and the cart abandonment will be reduced and the responsiveness will be more understandable and easy to be used.

This research will include the following main parts (see Figure 2):

1. An initial literature review to further understand the topic from an academic and professional perspective.
2. A survey that aims to gather data and measure people's feedback about online shopping and specifically on their preferences in mobile online shopping. How the users interact with their mobile phone when they want to buy something. The aim is to get as much information as possible and have enough quantitative data.
3. A statistical analysis of the survey data in order to identify significant patterns in participants' responses to the survey.
4. Based on the findings from the survey and literature review, a set of recommendations and improvements that should be made so the users will not give up an order on mobile device and in general how the user experience needs to be improved on mobile devices from search to add to cart so at the end the user can buy whatever he wants without any disturb.

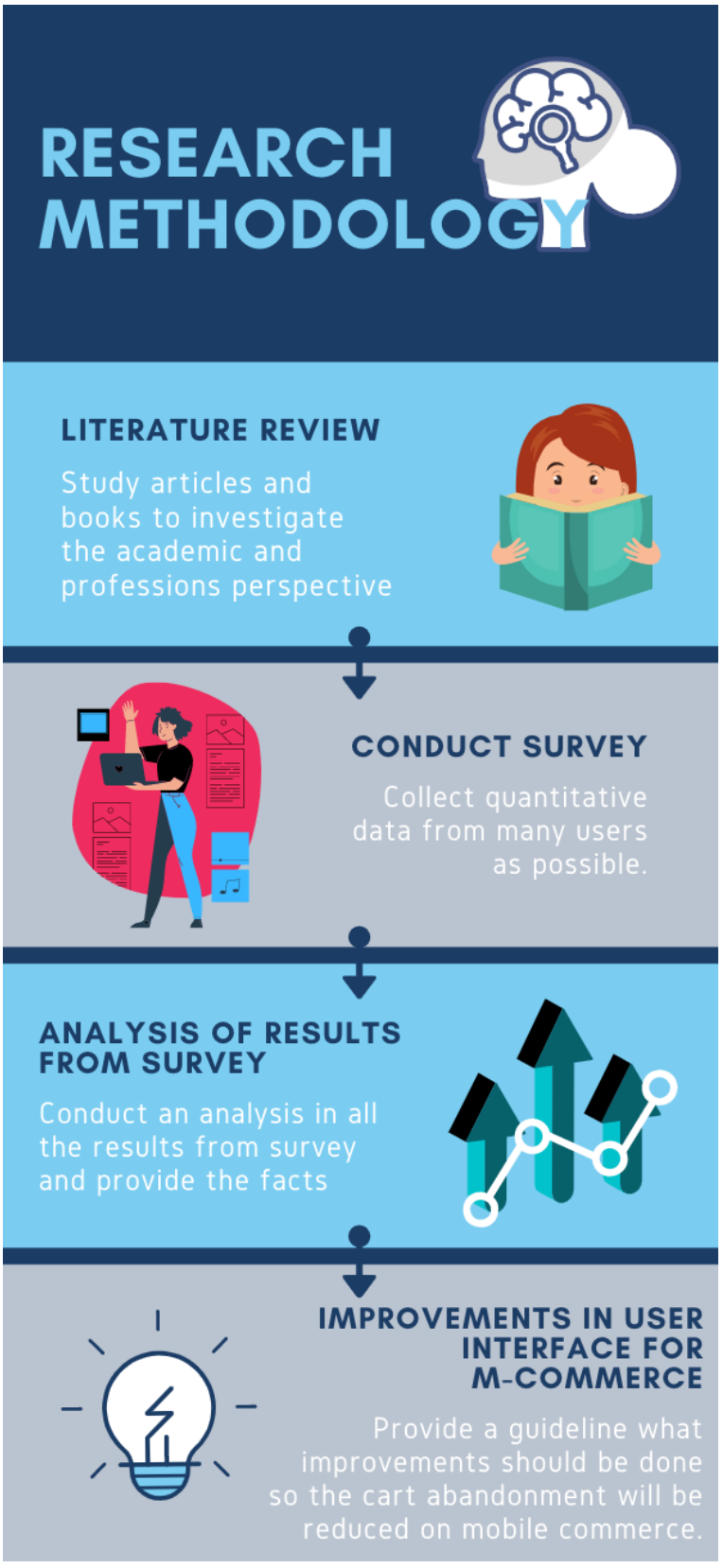


Figure 2: The research methodology of this study *(by Eirini Katrantzi)*

2 THEORETICAL BACKGROUND

This section includes and analyses the current literature about the difference between m-commerce and e-commerce. It explores the usability of m-commerce and which improvements have been done in this direction. Also there is a big analysis around user experience in mobile devices and all the benefits that m-commerce has. The research has been made through different articles and papers from different sources so the outcome will be more completed with as many as possible information.

2.1 M-COMMERCE AND E-COMMERCE

In general e-commerce stands for electronic commerce, when the shopping is done over the internet. We are referring usually to e-commerce activities which are conducted with the help of desktop computers and laptops. M-commerce is generally known as the extension of e-commerce. It can be defined as a transaction that takes place using wireless internet-enabled technology, for example mobile devices and personal digital assistants, and gives the freedom of movement to the end user. In this case people can do their business transactions anywhere they go as long as they can access the internet on their mobile phones and can perform purchases clicking some tabs in the mobile screen (Forbes Contributors, 2018).

A more comprehensive definition of m-commerce is given by Turban et al (2004) they defined m-commerce as a monetary transaction for goods and services conducted by a mobile device, an operating system specific to mobile devices and a mobile dedicated infrastructure (W. Aziz, Y. Hashmi, 2009).

Mobile Commerce (MCM) is the next generation of commerce and e-businesses from a variety of fields try to integrate it into their models. M-commerce is defined as any type of transaction of an economic value by using mobile telecommunications network and at least one mobile device. Transactions include buying or selling of goods or services, transferring ownership or rights, transferring money. In other words, it is similar to e-commerce transactions performed by a customer using a hand-held device and a wireless internet connection. The mobile and electronic commerce business environments and activities have a lot in common. Since they involve the same functionality, the use of the internet, they differ from each other when it comes to the mode of communication as well as the types of internet access devices (A. Vasileiadis, 2014).

Based on device portability, mobile commerce is more reachable to the customers than e-commerce through desktop devices. The retailers can approach the customers everywhere with advertisements and sell them products so they have better opportunities to increase their conversations rates. A conversation rate can have many different purposes depending on the business goals. Here are a few common types of conversions: making a purchase, submitting a form (contact us form, registration, etc), signing up for a subscription (either paid or free—like a newsletter), downloading something (software trial, eBook, mobile app, etc), using something (new/advanced feature on your software or app, simply using your software/app for a certain amount of time). All these examples can succeed if the user experience is well-integrated.

Another advantage is the location tracking that can be achieved through mobile apps. The retailers can track and identify user locations with the help of GPS technology and Wi-fi. In this case mobile apps can provide location-specific content and personalized recommendations and these recommendations can contain personalized discounts based on the customer's preferences.

On the other hand, security is the weakest part in m-commerce and e-commerce. In most cases credit cards constitute the most common form of payment in online shopping. But in parallel the customers are still afraid of sending the details of the credit card numbers over the internet. The development of security in mobile commerce is a little more expensive but more extensive because m-commerce can offer biometric authentication via face ID or fingerprints, something that doesn't exist in e-commerce. In addition two security measures two-factor authentication and multi-level authentication are present in both mobile and desktop versions.

Nowadays, modern consumers are willing to pay for goods and services by using their mobile devices. Overall mobile application and m-commerce continue to expand. Over 1 billion people use smartphones to go online every day, and mobile shopping is trending as never before. ⅓ of e-commerce total is mobile-driven (Victor Mangur, 2020).

A survey which was conducted in the USA shows that online shopping is easier than hopping in the car and driving to the store and it is even easier if the user can do it when he is sitting in his favorite chair, while watching TV. The 80% of users regularly use their smartphones to shop online and on the other hand 70% of users now use mobile phones in stores during the holidays (see Figure 3). If a company doesn't present its products and services with an easy view from a mobile phone, it can lose the opportunity the users will be willing to buy products from its online shop (Anonymous, Marketpath).

Figure 3: Growing rate for online shopping on mobile devices

2.2 M-COMMERCE USABILITY

The development of user interfaces for mobile devices is challenging as it addresses specific usage of mobile devices because users want rapid responses to their actions while minimizing the amount of information entered. Based on the nature of mobile devices, they face many constraints such as limited size of display and motoric limitations on information input. Good usability is a primary requirement for interface design and is critical to attracting and retaining users, especially in business applications such as mobile e-commerce systems (P. Paskevicius, R. Damasevicius, undated).

Although usability of the mobile applications has improved significantly in the past few years enabling the users to carry out more jobs in the mobile context. Progress that has been made in the field of mobile technologies has caused developing an extensive variety of applications that could be utilized by the users which are very dynamic and movable (Kire Jakimoski, 2014).

Of course there are some challenging usability issues that m-commerce should overcome. M-commerce has been launched the last few years and still it's something new in the field of UX. In contrast to e-commerce the usability design contains some challenges in m-commerce that are not present in e-commerce like the small screen size, limited screen resolution, limited processing capabilities, inadequate battery power of mobile devices when someone is on the road and different operating systems.

There are some fundamental challenges that someone can face when designing the user experience from website to mobile e-commerce such as the following factors that are displayed in the table below (see Figure 4).

E-commerce	M-commerce
Bigger screen with more available space for content, features.	Smaller screen and alignment of features in different positions so all of them will be visible to the user.
Less scrolling to find the appropriate information.	More scrolling to find the appropriate information.
Designers can attract the attention of the user with different ways and without the stress to order specifically the content.	In mobile devices the designer should achieve to attract the user in very limited time so the content should have a specific order.
The security and privacy is a factor that somehow it's more easily to be fixed.	The issue of information privacy is a growing concern from a customer perspective as in m-commerce the world is a global village.
Navigability is a dominant characteristic in the web where the user can navigate and search and filter the data easily without	Navigability is the key in mobile devices: how easily the user can find the information in a short time and not getting lost in the

feeling confused because the big screen helps the users to have a control of their steps that they follow through their navigation.	huge amount of data in a small screen.

Figure 4: Differences between e-commerce and m-commerce *(by Eirini Katrantzi)*

One vital factor in mobile commerce is user trust. Ozok and Wei (2004) has identified that user trust in secure data transmission using mobile devices is considerably high, as compared to e-commerce (Manjot Kaur, 2014).

2.2.1 M-Commerce Usability Issues

There are usability issues that have been investigated in m-commerce that will be presented in this paragraph. There are a lot of references that have explored different issues that are correlated to m-commerce. Different issues and challenges related to m-commerce are discovered to help practitioners in recognizing these issues and challenges. It's a fact that m-commerce usability presents one of the demanding issues in accepting m-commerce. Compared to e-commerce, studies demonstrate big demands in the usability modeling of mobile commerce that don't exist in e-commerce. Some references of these demands are related to the limited processing capabilities, small screen size, inadequate battery power, limited screen resolution and large input mechanisms of the mobile devices. Furthermore, another usability challenge is that while a user uses the mobile phone in one hand to hold the mobile, the other hand is used for data entry. The most significant user-related challenges are the restricted data entrance and data recovery facilities (Kire Jakimoski, 2014).

Mobile devices and other wireless terminals with small screens could generate problems to the users. Having in mind this detail, usability of user interface is needed in order the user experience will be improved. One of the methods for upgrading the bounded display area is translucency (A. Gunasekaran & R. E. McGaughey, 2009).

Issues like understandability, learnability, operability, friendliness, and playfulness are vital factors indicating the quality of the mobile service, highly contributing to further promotion and overall acceptance. The application should allow easy understanding of its functioning and behaviour even by novice m-commerce users. Aesthetics of user-interface, consistency and ease-of-use are attributes of easy-to-learn systems with a rapid learning curve. Taking into consideration human emotions, an application may provide friendly messages to the user adapted to his/her personal profile. Playfulness is a significant feature that should be examined to see whether it is required by the application and if so, to what extent. It is important to note that playfulness is a critical success factor for certain mobile applications (Andreas S. Andreou* & all, 2005).

2.2.2 Essential factors of m-commerce acceptance

There are some essential factors of m-commerce acceptance that were introduced from Choi (2008) in Korea. They figured out that these factors have a significant impact on customer satisfaction while

using m-commerce. The factors such as ease of navigation, ease of use, content quality, perceived usefulness, and mobile portal reliability strongly affect deciding whether the customer should revisit that mobile portal or not. If these factors are considered in mobile portal development it will increase m-commerce usability. In the following table (see Figure 5) there are detailed contents of these essential factors of m-commerce acceptance.

Factors	Description	Researchers
Convenience	Perceived ease of use Ease of Navigation	Cheong and Park (2005), Wu and Wang (2005), Kim et al, (2005)
Transaction Process	Transaction Time Transaction Process	Ghinea and Angelides (2004), Kim et al, (2005)
Mobile portal and Reliability	Systems Perceived risk Perceived system quality Compatibility Product Perceived content quality Degree of content up-to-date Variety of content	Cheong and Park (2005), Wu and Wang (2005), Kim et l, (2005)
Information	Categorization of information Naming of information	Kim et al, (2005)
Price	Cost Perceived level of price	Ghinea and Angelides (2004), Cheong and Park (2005), Wu and Wang (2005)
Security/Privacy Usefulness	Perceived usefulness Usefulness of content	Cheong and Park (2005), Wu and Wang (2005), Kim et al, (2005)
Experience	Internet experience	Cheong and Park (2005)
User behavior	Attitude to m-internet Intention to use	Cheong and Park (2005), Wu and Wang (2005)
Representation	Size of image/text Readability of information Convenience of navigation	Kim et al, (2005)

Figure 5: Essential factors of m-commerce acceptance in the previous studies

2.2.3 User experience in m-commerce

User experience is related to the perception that a user has after having interacted with a website either positively or negatively.

"*The noun 'user experience' refers to an encounter with a system that has a beginning and an end. It refers to an overall designation of how people have experienced (verb) a period of encountering a system. This view emphasizes the outcome and memories of an experience rather than its dynamic nature. It does not specifically emphasize its individual nature because 'a user experience' can refer to either an individual or a group of people encountering a system together. "* (V. Roto, E. Law, A.Vermeeren, J. Hoonhout, 2011)

The user experience plays an important role in e-commerce because it can bring more sales and more traffic. More traffic can be achieved through the interaction that the user has with the website. But depending on what we want to achieve in the website the user experience should be focused on this goal. There are some actions that can be taken so the user experience will be improved in m-commerce. One of them is the analysis of the customer's behaviour with bound percentage and time spent in Google Analytics, heat maps which is a tool that measures and displays which areas users click most on the website and behavior recordings so each visit will be captured and check the customer's behaviour every moment until he will leave the website which can give the reason why the

customer didn't complete an order, maybe a pop-up appears over the button that the customer needs to click so he will be redirected to checkout but because of the pop-up the user isn't able to see and click the button (Victor Mangur, 2020).

Also something that is very important in m-commerce is the usability so the user should navigate through the website easily and without thinking too much, all the elements should be visible and understandable from him. The structure of categories and subcategories of products should be clear and help the user to find quickly what he wants to buy. Also on mobile devices infinite scroll has become more useful than moving around with clicks. As Steve Krug said "*our objective is making our clients buy without having to think or exert any type of effort"*.

Another big topic in the m-commerce field is the checkout process. Checkout should be easy and understandable with simple steps so the user will be able to pay and complete his purchase successfully. The checkout process should be the number one priority because a complicated checkout with many steps leads straight to a loss of sales.

2.3 Benefits of m-commerce

Many advantages came up from mobile commerce. Mobile commerce is the next generation of e-commerce, that's why it was mentioned the most important m-commerce benefits. There is the fact that 66% of all the population globally have mobile devices as of January'17. And 90% of time people use phones they spend on apps, only 10% on the Internet (Victor Mangur, 2020).

Figure 6: What features do mobile shoppers value most?
(https://thinkmobiles.com/blog/mcommerce-benefits/ retrieved 18.04.2021)

One of the biggest advantages is that the user can make **faster purchases**. For the reason that the mobile version of a website is generally 1.5 times faster and the search result of products faster because there is no need to pull data from a server and customers can browse and purchase products faster. M-commerce revenue has been rising at 30-40% rate annually since 2014. The biggest retail

app Amazon increased the number of customers from 43 million in 2015 to 67 million in 2016. The reason for such achievements is intuitive mobile browsing, which drives sales up. As a result of it, the user experience has a positive impact and the purchases are easy and fast.

Since people are well familiar with how mobile phones and tablets work, they already know how to navigate to desired products in a few clicks. So the smooth user experience can increase the conversation rates and the revenue if the navigation is fast, convenient, exclusive and interactive. From a customer standpoint, the biggest benefit is simplicity and speed.

Another good benefit is the direct communication to the users with notifications and personalized messages. Consumers receive such alerts when they open a mobile app, and may get them even without activating an app. 50% of users like notifications, and 80% of users say offers and rewards make them more loyal to a brand (Victor Mangur, 2020). Except for personalized notifications that users can receive, also he can get personalized content based on his preferences, location, items viewed and social media profiles. With a mobile app we can set such preferences based on collected customer data. A mobile app then tracks users' behavior and offers recommended items in real-time. The more specific and personal content, the better. A good example here is the amazon app. In the first 2 years since launch, Amazon mobile app has served 1,000,000 customers (Victor Mangur, 2020).

A significant benefit that could bring more advantages if the user uses a mobile app is that the annual support and maintenance cost can be reduced and the productivity can be improved. For instance, average mobile app maintenance cost is 20% of initial development price. So, for an app that has cost you $50,000 you would have to spend just $10,000 annually for support (Victor Mangur, 2020). If a mobile app has social media integration, users will do their part in spreading the word instead of marketing campaign costs which can be cut off. One of the top benefits of m-commerce solutions is navigating users to nearest stores in their vicinity via GPS. This shortens the time for customers to find a store and make a purchase and increases store visiting and as result online shopping can be increased.

The social sharing functionality through mobile phones is something that users can use more conveniently. Ecommerce apps integrate social media like Facebook, Twitter, Instagram, Pinterest to offer such options. Moreover, Facebook and Twitter have already added "Buy buttons" within posts and pages.

2.4 Responsiveness on mobile devices

A responsive website is one that changes based on the screen size of the device. It has dynamic content that changes, optimized images, correct spacing based on device, and is reliant on mobile operating systems for functionality. A three-column layout transforms to one layout that can fit in the device's screen perfectly. If someone is on a website on a desktop and wants to see if it's responsive, simply shrink the window and observe whether or not the display changes to match the window size. Responsive websites react with the user in mind, and enhance usability no matter what the device is (Matt Labus, 2018).

We use our phones today more than ever and it's necessary a website will provide responsiveness to the users. The reason is that based on a survey more than 58% of American adults own a smartphone and almost 60% of all website traffic is from mobile devices. In fact, there are currently more mobile

devices on earth than the existing people (see Figure 7). And one more significant fact is that every month mobile usage continues to grow, so every month more and more prospects and users will view a website from a mobile device. If their experience viewing and interacting with a website is poor, they'll likely have a lower option of a specific brand, and they'll also be more likely to visit a competitor's site (Anonymous, Marketpath, undated). Moreover there is a difference between responsive design vs. mobile-friendly.

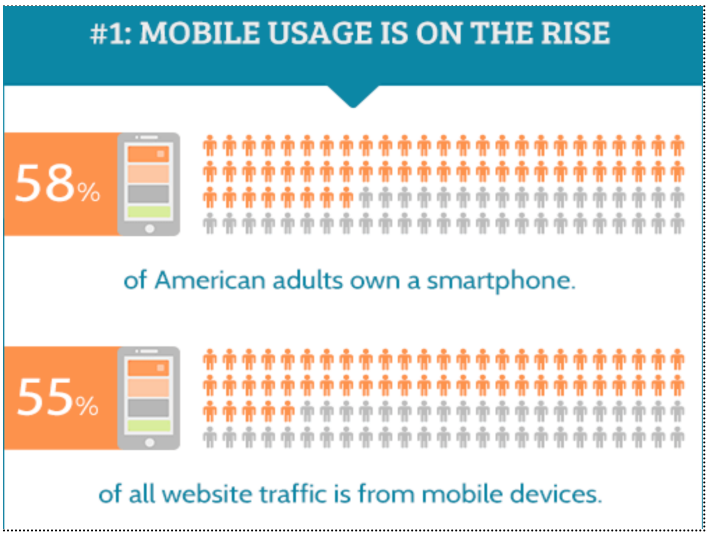


Figure 7: Mobile usage is on the rise (Anonymous, Marketpath, undated)

Responsive development is Google's recommended approach for mobile web design. Based on Google principles, responsive websites will perform better in search rankings because they provide a better user experience than sites that are not mobile friendly. Additionally, Google likes that responsive sites use single URLs in comparison to different URLs for separate mobile versions of websites (A. Kalinowski, T. Usewicz, K. Cichon, K. Tocyska, undated).

One more benefit of responsive development is that the companies don’t need to manage and update two sites one main site and second one the mobile version of the site which is inefficient at the end. Unfortunately there were many organizations which had two websites the main site and a second mobile version of the site but this is a very wrong practice. With a responsive site, the site will adapt to each device, providing the relevant layout and content that best meets the users' needs. It also means that a business will only have one site to manage, meaning that the content should be updated one time, regardless of how different people consume the content. That also means lower web content management costs and higher R.O.I.

Last but not least there are plenty of business reasons to implement a responsive website, but all of them connect back to the goal of providing a better user experience for the users (see Figure 8). A responsive site means no more pinching and zooming, and no more side scrolling, to see an entire site that doesn't fit on a mobile screen. And a better user experience reduces bounce rates, boosts website conversions and improves brand perception.

Figure 8: Benefits of responsive design *(by Eirini Katrantzi)*

On the other hand a mobile friendly site functions the exact same way regardless of the device. In other words, mobile-friendly designs do not change based on the device being used. Nothing changes in the functionality other than the scale of the site. Many great features of the website, like navigation drop-downs, are limited, as they can be difficult to use on mobile.

One of the most important things is the fact that Google ranks mobile sites above desktop sites for SEO ranking. This means when someone searches from a mobile device, websites that are optimized for mobile viewing will rank higher than websites that aren't.

Mobile web usage will continue to grow as more and more people use mobile phones. Nowadays, 4 out of 5 consumers use mobile phones to shop. The mobile market is huge, and creating a user-friendly web experience that works across devices will provide exponential value to the users (Team Staff, 2016).

2.5 Mobile usage in online shopping

2.5.1 Sources of mobile usage

There are quite a few statistics that show that mobile usage has increased in recent years. The latest mobile statistics hint at a high reliance on online shopping on mobile devices and, in particular, through mobile apps. More than half (51%) of users use their mobile phones to purchase products online and two out of every three (66%) say they use shopping apps on their mobile devices – be it a mobile phone or a tablet (Ying Lin, 2020).

For example in the UK 37% of online sales are made on mobile devices and that's 8.9% of all retail sales which is expected to rise to 27% by 2018 (SessionCam, 2015). Something interesting that came

up from different researches and my own research conducting an online survey mobile phones produce immediacy in purchasing decisions. After one-hour of product research on mobile phones, more than half of users want to make a purchase. That's an opportunity for businesses to provide exclusive deals to mobile shoppers (SessionCam, 2015). The latest mobile usage statistics show that nearly seven out of ten users in the USA say they would look for customer reviews on their mobile phones while in-store before approaching an employee. The 58% of users are also looking for other products similar to the ones they're thinking about purchasing, and 55% are looking up product specifications (Ying Lin, 2020). Of course there are the users that are searching products through mobile phones but they ended up completing the purchase of this product on a web browser and this is something that we need to present the reasons for this behaviour from users.

Figure 9: Mobile usage facts *(by Eirini Katrantzi)*

eMarketer experts expect the global mCommerce sales to reach $3.5 trillion by 2021, and account for 72.9% of the eCommerce market (Miklos Philips, 2019). This number of sales gives us a very significant reason why the companies need to invest more time in user experience on mobile phones for the reason that more and more users decide to complete a purchase on mobile devices. Most of them over the average of users pay more attention to the superficial aspects of a site, such as visual elements, than the content that exists for a product.For example, nearly half of all consumers (or 46.1%) in the study assessed the credibility of sites based in part on the appeal of the overall visual design of a site, including layout, typography, font size and color schemes (Aaron Orendorff, 2017).

An interesting research comes from Adobe Analytics' data from "Cyber Monday" in 2017 is based on an analysis of one trillion visits to over 4,500 ecommerce sites. Desktop computers now only account for slightly more than half of visits to ecommerce sites, but the sites got dramatically less revenue from visitors on mobile devices than they got from visitors coming from desktops. Thus desktop still generates 2/3 of the revenue, which is what matters to business. The lower sales on mobile phones are

caused by a worse user experience than the one offered up to shoppers visiting from desktop computers (Jakob Nielsen, 2017).

The data is as follows:

2017 data	Visit	Revenue	Ratio revenue/visit
Desktop computers	53%	67%	1.27
Mobile phones	40%	24%	0.60
Tablets	8%	9%	1.18

Table 1: Data in commerce 2017

2016 data	Traffic	Revenue	Ratio revenue/visit
Desktop computers	47%	65%	1.38
Mobile phones	44%	22%	0.57
Tablets	9%	10%	1.11

Table 2: Data in commerce 2016

In 2016, the ratio between revenue and visits was 143% better for desktop visitors than for mobile visitors. Comparing 2017 with 2016, we see that the mobile user experience has improved a little during the year, changing the superiority of desktop vs mobile phones from 143% to 111%. This is a nice improvement, though not as much as seen in previous years (Jakob Nielsen, 2017).

There is a report about Black Friday in IBM's Watson on 2015 that shows a slight increase in the performance of mobile ecommerce sites compared with the miserable statistics from 2014: (Jakob Nielsen, 2017)

- **Mobile phones**: 44.7% of traffic and 20.6% of sales = ratio of sales-to-visits of 0.46
- **Tablets**: 12.5% of traffic and 15.5% of sales = ratio of sales-to-visits of 1.24
- **Desktop**: 42.7% of traffic and 63.8% of sales = ratio of sales-to-visits of 1.49

There is also a report regarding Christmas period from IBM that shows the following allocation of traffic and sales to online shopping sites during Christmas 2014: (Jakob Nielsen, 2017)

Mobile phones: 40.6% of traffic and 15.9% of sales = ratio of sales-to-visits of 0.39

- **Tablets**: 15.9% of traffic and 18.4% of sales = ratio of sales-to-visits of 1.16
- **Desktop**: 42.9% of traffic and 65.2% of sales = ratio of sales-to-visits of 1.52

It seems that desktop sites sell almost 4 times as much as mobile sites, but more likely the reason for these terrible mobile conversion rates is that many of these ecommerce companies don't even have a special mobile design or proper user experience but try to show the same design to users regardless of platform. Scaling a user interface across different platforms doesn't just involve stretching or shrinking the same info to fit different screen sizes as with a native implementation of responsive design much more is required to optimize a design for different screen sizes and input mechanisms.

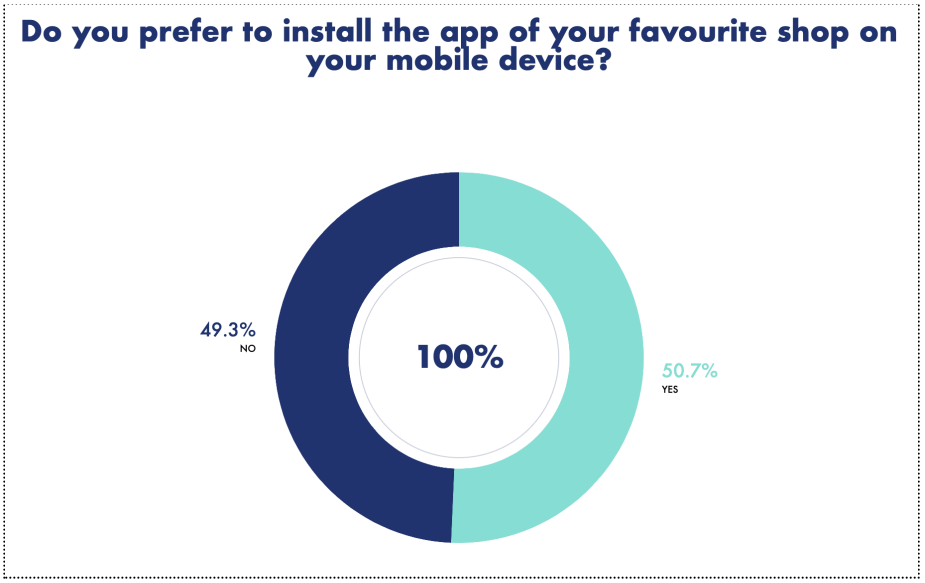


Figure 10: Do you prefer to install the app of your favourite shop on your mobile device? (study's survey 2020)

Considering also the survey that I conducted most of the people (50.7%) are willing to install a mobile app with their favorite online shop on their mobile device but however they don't feel so confident to proceed and complete a purchase with their mobile device (see Figure 10). Moreover the half of the people who don't prefer to install the mobile app with online shop the reasons are that they don't want to have one more app that they are not going to use so frequently and overload their mobile device with an app that will take place a big space in their storage of their mobile device and they don't think

that is practical. Also they don't want to receive notifications and also they will be more prone to buy things more often from the app. In general all the reasons are connected that the app with an online shop will not be useful for them. So companies should consider having a responsive version of e-shop and not only a mobile app for those who don't prefer to install an app on their phone. For example e-shops like Amazon.com and eBay.com don't have responsive design versions.

Additionally in Google's survey (Google research, 2016) is presented that more than half of mobile phone users turn to their phone to shop. In more details 58% of users use the mobile phone for shopping-related activities and of those 66% perform shopping functions at least weekly. This means that many of the users prefer to complete some of their shopping activities directly on their mobile phone instead of using the web application in their laptop/pc.

Another interesting finding from Google's survey is when the users want to use a mobile application, the completion of a purchase is one of the reasons that they choose the mobile app. The percentage of users is 37% for successful order and 32% of users mention that they use a mobile app if a specific activity or task is easier to be implemented in the user interface of the mobile application.

2.6 Improvements of User experience on mobile devices

In this section I will provide all the suggestions for improvements that should be implemented so the user interface of mobile devices for m-commerce will be more efficient and convenient for use for users. There are some UI usability challenges that should be overcomed and a user interface structure which is the baseline that a m-commerce system should follow.

The good interface design requires both elements from a user perspective and also mobile devices constraint. The development process it's not only the developer can fit all the information in limited screen size of mobile (J. Buranatrived & P. Vickers, 2002). Another researcher (P. Tarasewich, 2003) believes that the m-commerce design has their own guidelines based on three categories of context such as m-commerce environment, participants (user) and activities that are involved with m-commerce tasks and goals. A designer must understand the interaction between those categories in order to achieve good m-commerce design. Good interface design guidelines can be used by companies to increase usability and trust among users (Y.-S. Y. Yung-Ming Li, 2010). The important factor that brings the success of m-commerce is to ensure the user interface design can fulfill the customer's experience (V. Venkatesh, V. Ramesh & A. P. Massey, 2003). All the features of user interface design such as page (navigation menu, bars, button and icon) and content design including detail information, catalogue and shopping cart are the key factors of m-commerce transaction and contribute if the user will complete an order or not.

2.6.1 interface usability improvements in m-commerce

If the implementation of user interface on mobile devices could be usable, there are some UI usability challenges that have to be overcomed (see Figure 11). (D. Cyra, M. Headb & A. Ivanovc, 2006) These challenges are the following: **Predictability** which is the minimal number of UI elements and the user should be able to read fast the UI elements for example the content with images and text. **Controllability** which is the consistent and always available navigation consistent colour schemes for

key actions. **Unobtrusiveness** is to avoid entering duplicate information which do not limit user input format for example special controls for sophisticated input. **Privacy** is another challenge and it will not be allowed to collect unnecessary private information in advance like phone number and birth date (D. Cyra, M. Headb & A. Ivanovc, 2006). Last on is the **breadth of experience** so it will use well known symbols for representing user actions. The UI is also built on a set of criteria for evaluating interfaces based on user needs formulated in efficiency, simplicity, symbiosis and motor limits (N. Ayob, A Hussin & H. Dahlan, 2009).

Some other design improvements should be implemented in the **checkout process** where many users face problems with the long and complicated processes which are useless on mobile devices where the screen is smaller. As a result the user gives up the process in a few minutes because he feels confused and anxious. **Security and trustworthiness** can be one of the most important things that should be considered as well. Moreover **speech recognition and accessibility** constitute the improvements that can help not only the people with disabilities but also the people who want to use voice recognition for example when they are in their car or bicycle and they want to complete a purchase like a food order or a ticket order for aeroplane or metro/tram. Last but not least is the **search and categorization** in an online shop because if the user doesn't have the possibility to search and find easily and quickly the product that he is looking for, he will find another online shop or he will continue his search in his laptop. Some of these challenges will be analyzed in the next sections with more details and suggestions.

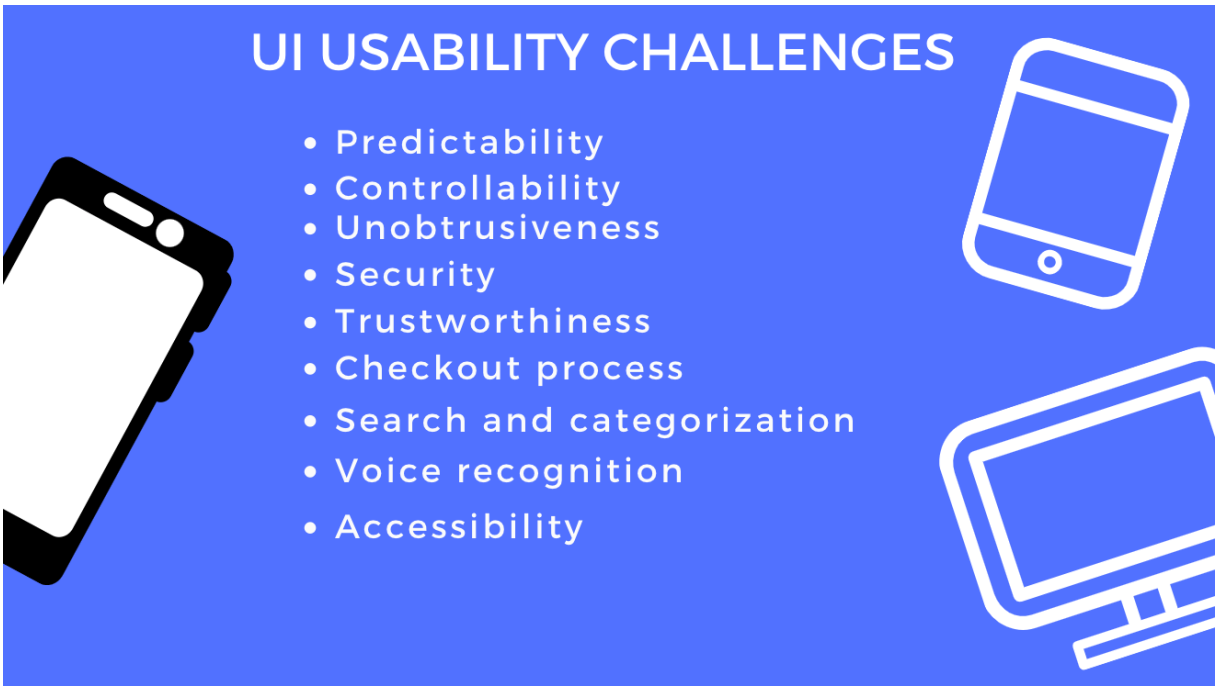


Figure 11: UI Usability challenges *(by Eirini Katrantzi)*

2.6.2 Improvements for security and trustworthiness

There are some improvements that should be implemented so the users will feel that are navigating in a secure environment. The ideal user interface is simple to operate and safeguarded against attempts to steal users' private information. Delivering such a design is typically framed as a tradeoff between usability and security because if the interface is easy to use, it's less secure but if it's secure, it tends to be more difficult to use. This tradeoff is a myth. It's still possible the designed user interface will be simple and secure without compromising the quality of either. UX designers play a critical role by ensuring that both technical demands and user needs are met. They decipher technical requirements and make them understandable for users. They also exercise situational awareness by deciding when to focus on simplicity or when to involve sophisticated security measures as result balance is key (Mayank Sharma,undated).

Based on a case study conducted by Conversion Fanatics (Justin Christianson, 2017) found a massive increase in conversion rate after adding trust seals on the checkout page. According to the study, the trust seals resulted in a 28.2% increase in conversions among new customers and a 19.2% increase in successful orders. The trust seals also resulted in a 71.1% increase in revenue per visitor. Using trust badges by security services like Norton or McAfee helps users perceive a website positively. These trust badges can be placed on the top header of the checkout process or somewhere on the bottom (see Figure 50, 58). Also if we communicate that their transactions are secure, this adds a lot of value to the positive perception shoppers have towards a store, an example of this could be if we can add the label "Secure checkout" in the button which is placed in the shopping cart page, in this way the user will click it with more trust (see Figure 51).

When we come in the registration process of a new user, some users probably are confused with the secure instructions or they don't feel that they are in a safe environment when there isn't any authentication during the registration.

There are a number of strategies that could improve the password UX. As always, it's important to have a picture of core users when planning a password experience and a secure balance should exist with clear instructions, simple actions when the user sets his password and keep a normal user experience in security authentication and security description below of the registration form. It has to be easy for a user to create a password. Forcing users to adhere to a long list of password requirements causes friction in the registration process. It's better to allow users to create whatever passwords they want, but if they choose something very simple, a notification should display that the length is vulnerable. (Chirag Bakshi, 2014)

It's good if we allow users to see passwords by placing Show/Hide icons within password input fields. An eye that opens and closes when clicked is common, but depending on the product and users, it might be more effective to include a simple Show/Hide text toggle.

"Usability suffers when users type in passwords and the only feedback they get is a row of bullets. Typically, masking passwords doesn't even increase security, but it does cost you business due to login failures." – Jakob Nielsen. (Jakob Nielsen, 2009)

Another good UX of a secure solution could be the password strength meters which gives real-time feedback and tell users how well passwords will withstand data attacks. Strength meters should be paired with thoughtful copy that communicates different levels of password effectiveness.

Also single sign-on (SSO) is a strategy whereby users gain access to multiple products and services with only one username and password. Sites and apps that use SSO rely on third parties (companies like Google, Facebook, and Apple) to verify user identities. All users have to do is grant access to their SSO accounts. Especially when the user uses his mobile phones and the screen is smaller this strategy can save a lot of his time and he can have access easily to the products and why not to buy sooner. SSO prevents users from piling up passwords, increases onboarding speed, and allows businesses to benefit from the security infrastructure of larger companies.

Many phones, laptops, and tablets are equipped with biometric technology that is easily integrated into the sign-on process. The users don't need to enter passwords but simply touch or glance at their devices. Security increases because faces and fingerprints are difficult to forge. One drawback is that there are still devices without biometric capabilities, so designers should make other login options available.

Last but not least the email login/registration could be another solution. Almost everyone who uses digital products has an email address, and most people already use email for security measures like forgotten passwords and usernames. Why not go the email will be the only one requirement for sign in and registration process? Email login works by sending time-limited links to users' inboxes. Slack and Medium have an email login feature called "Magic Link" that makes sign-on much more seamless.

Also another thing in the registration field that can give an additional trust to the users is the confirmation of privacy and terms and conditions rules that are placed below the registration form. (see Figure 53) A terms and conditions agreement (also known as a terms of service or terms of use) is essentially a legal contract that outlines the rules that visitors must abide by when using a website or app. Its purpose is to protect both owners and visitors and ensure the website or app offers the intended experience. Without a terms of service page, a website is legally naked in terms of protecting its ownership rights over its content (designs, articles, and so on). This element gives the user the feeling that the website is protected and is covered with some regulations. When the user is able easily to understand the terms and conditions, he feels reassured that he can explore the website without fear of being taken advantage of or scammed. It's a breath of fresh air to be able to read through and understand a website's terms at the first go. It shows that the company cares about its user.

Some other methods that can provide trustworthiness and security to the users are the following elements. Contact information, the links of the social media and a frequently asked questions (FAQ) page gives the user the impression that the website is serious and his data import and transactions are secure.

The product reviews help users to understand more about the product, also this will help alleviate any concerns they may have and provide great eCommerce UX. A step further could be by offering product reviews along with additional information about the reviewers, or by summarizing the reviews. This step can help make it easier for users to get the full benefit of others' opinions.

Input of trust seals can increase the trust of the users (Crazy eggs, 2014). A trust seal verifies the legitimacy and security of a website. Some trust companies even add an extra layer of protection by offering some insurance if the transaction turns out to be fraudulent. Using recognized trust seals assures potential users of a secure transaction process, which leads to increased sales and provides better eCommerce UX.

Moreover the attention to detail makes the website look legitimate and professional by avoiding typos, missing images, broken links, 404 errors (page not found), or other eCommerce UX-killing mistakes.

During the checkout process if the user has the possibility to pay with an easy and secure payment method like Google-pay or Paypal gives him the confidence to complete the payment transaction because many users don't feel confident to fulfil the payment form with their credit card information on a mobile device.

2.6.3 Improvements in search and categorization

One of the key challenges for the user experience in an online shop is the easy navigation so the users can find products quickly. The correct hierarchy in category search also is very important and the first step for finding products (Kaja Laura Toczyska, 2019). Users typically search the website at the beginning of their shopping journey, and there can be instances when displaying a search form later in the journey may harm the UX. For example, during the checkout process, search is no longer useful and will only distract because it could make users lose focus and forego their commitment to the purchase.

Users often use their mobile devices to discover or purchase a product so prominent and well-designed search takes on critical importance for any mobile commerce app or site. Search bar should be visible and sticky on the homepage and in the search results page always, especially on mobile phones. So the user can use it as many times as possible. The cart icon on the top header should have a badge with an indicator how many items each time the user adds to the shopping cart, this confirmation helps the user to check the quantity of products quickly without opening the shopping cart page (Page Laubheimer, 2018).

There are some helpful and widely used techniques for testing categories just are tree testing and card sorting. Categories should also be easily accessible from the main navigation, but not having too many categories because they will decrease readability, so it's better if there are a couple of main categories and then list the rest as sub-categories. Names of the categories should reflect how users think, not how business or technology thinks (Kaja Laura Toczyska, 2019). eBay believes its site search is one of the most important features for mobile users and emphasizes it by placing it in the center and above the fold on the interface (Tommy Walker, 2019).

It's important to users (52.2%) to navigate easily on their mobile device (see Figure 34) and search for categories and products that they want to buy and they will not get lost in hidden and strange icons that contain the filters and the search by categories. Search bars are also an important tool for the users in online shops on mobile devices. Users should be able to quickly find what they are looking for. Showing just a search icon is not enough — display a whole text input or at least a partial input. If the search bar can be a steady sticky header on the homepage or search results page, it can help a lot of users (see Figure 16).

A look-ahead search by using data acquired from common search patterns, and displaying related products on search results pages can be very useful for the users. Also the advanced filtering options that allow customers to find their desired products quickly and effortlessly. By dynamically suggesting matching results when the user is typing, you substantially lower the time needed to complete the search activity and the number of mistakes (see Figure 14,15) (typos) (Kaja Laura Toczyska, 2019).

One more important thing in search is the auto-suggestion and auto-detection features. The main purpose behind auto-suggestion is to make it easier and faster for users to fill out forms. Auto-suggestion predicts common search queries and helps shoppers find products more easily. Mobile usability can be further improved by using credit card type auto-detection in the checkout process for example. Auto-detection streamlines the purchase process by providing immediate feedback for supported card types. Automation of as many data entry processes as possible—preferably with visuals improves the user experience and will positively affect conversion rates (see Figure 12,14).

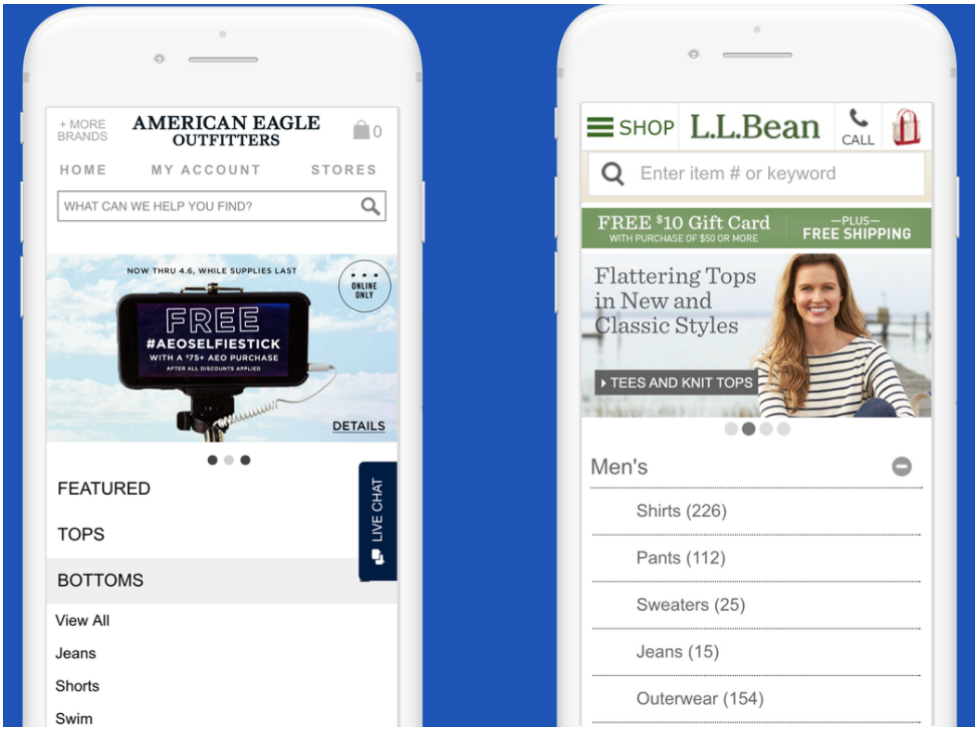


Figure 12: Search in American Eagle Outfitters' and L.L.Bean's mobile applications.

In the search results page except for the price and add to wishlist icon, it's good additional pieces of information will not display as it will make the list of products harder to be scanned from the user and make the page feel overwhelming (Kaja Laura Toczyska, 2019).

Something that could help the users is if there is a quick option in the search results page with the call to action button, add the product to the shopping cart so the users will not have to do an additional step and go to the product details page and add the product from there in the cart. But this could be possible only for specific products like books or food products for which the user doesn't want to check more details.

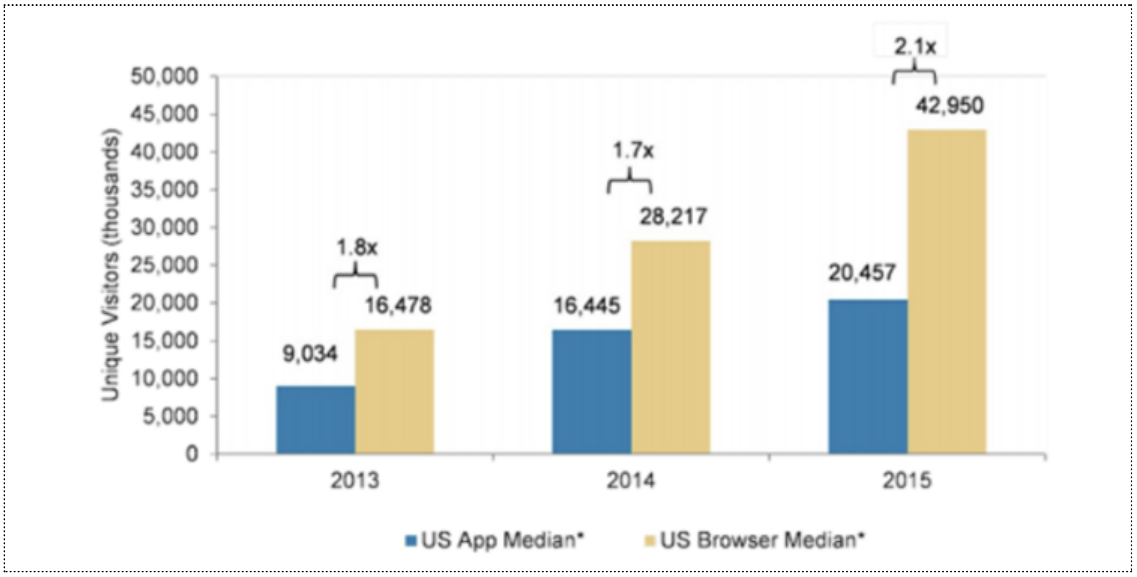


Figure 13: Mobile browser audiences compared to mobile app audiences

The above graphic (see Figure 13) presents that U.S. mobile is still largely a browser based world as mobile browser audiences are ~2X larger than app audiences across the top 50 U.S. mobile web properties. Mobile browser audiences have grown 1.2x faster than mobile app audiences off of a 1.8x larger base (Nabeena Mali, undated).

This difference to the most commonly cited industry report on app and browser behavior published by Flurry, which asserts that: Nearly 90% of time spent on mobile (across iOS and Android devices) occurs in apps.

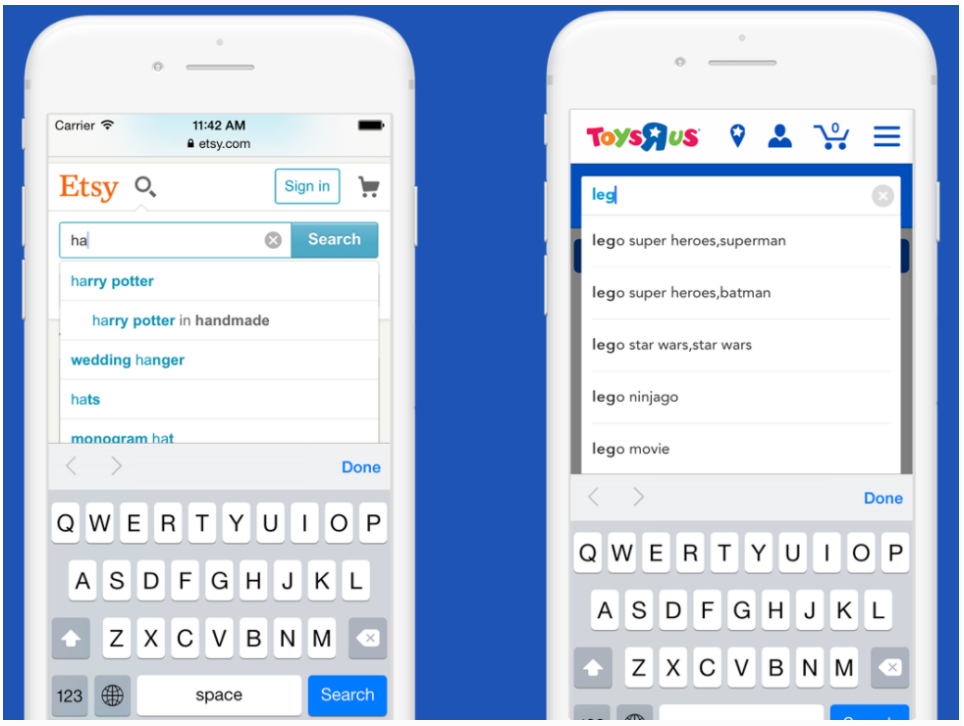


Figure 14: Search with auto-suggestion in Etsy's and Toys"R"Us' applications.

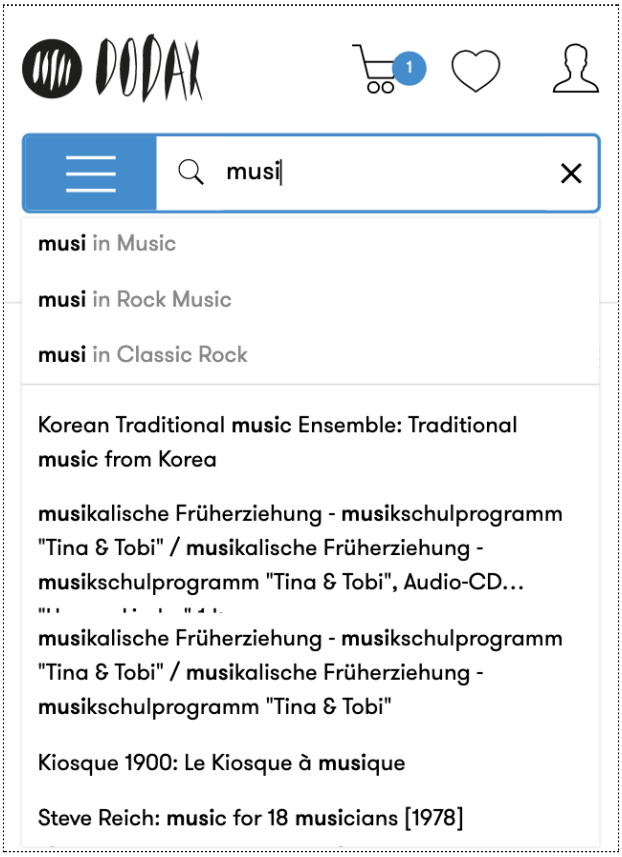


Figure 15: Search word, showing the categories in which it belongs (dodax.com)

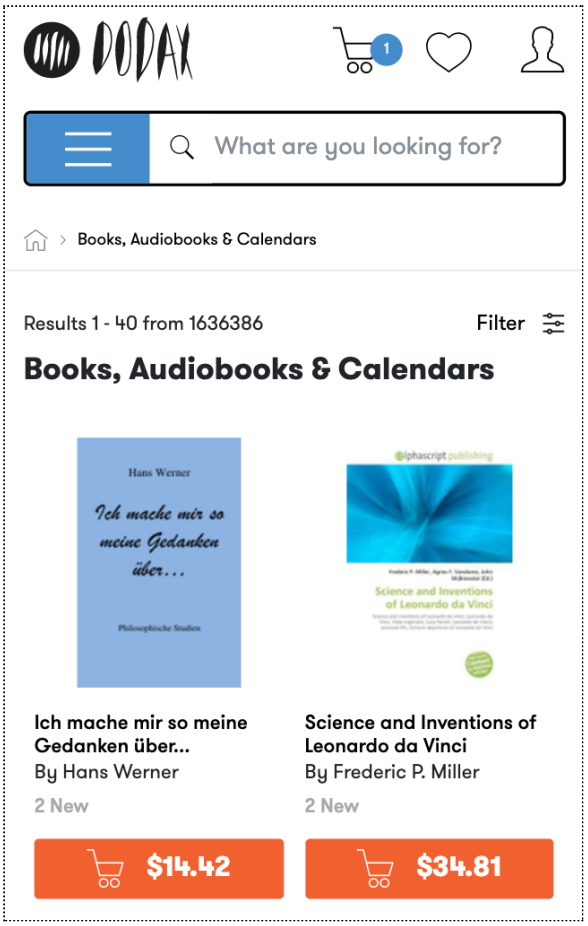


Figure 16: Search bar in search results page (dodax.com)

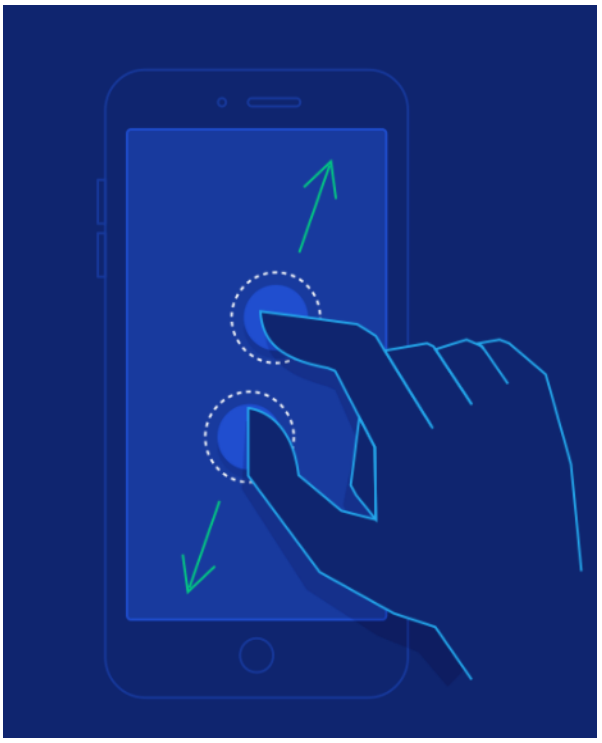
2.6.4 Improvements in product details page

Product details page has an important impact on the user. From this page the user will add the product to the shopping cart and start the process of purchase. So the user experience of this page should be easy and quick without crowded information that could distract the user, because the screen is smaller on mobile devices and the user can get lost very easily when the product information is crowded. The product images should have high quality and the zoom functionality provides a detailed overview of the product.

Since people are familiar with gestures like double tapping and pinching in order to zoom in to images on mobile. So image zooming by pinching and double tap gestures are helpful and useful for mobile devices so the users will have a better overview of the product details (see Figure 17). Low-resolution images are the equivalent of no-zoom images. The option to zoom in on a low-quality image is pretty much useless, as it doesn't allow the user to see details. During a mobile eCommerce usability study, the Baymard Institute (Baymard institute, undated) found that, quite naturally, shoppers want to be able to inspect the product thoroughly and are concerned about the small details. Users who were interested in purchasing a product but couldn't explore it by zooming in didn't feel

comfortable buying it and often didn't want to continue to search other products in the website through mobile devices. Interesting thing is that 40% of mobile applications don't support zooming gestures.

In the product details page an effective way to cater the users is the product description will be broken down into pieces that one part will contain a no-nonsense introduction and second part a lengthier walk-through of additional details. In this way the user can read the most valuable information in the first section and if he wants to continue and read more about the product details, he can continue in the second section of the description.



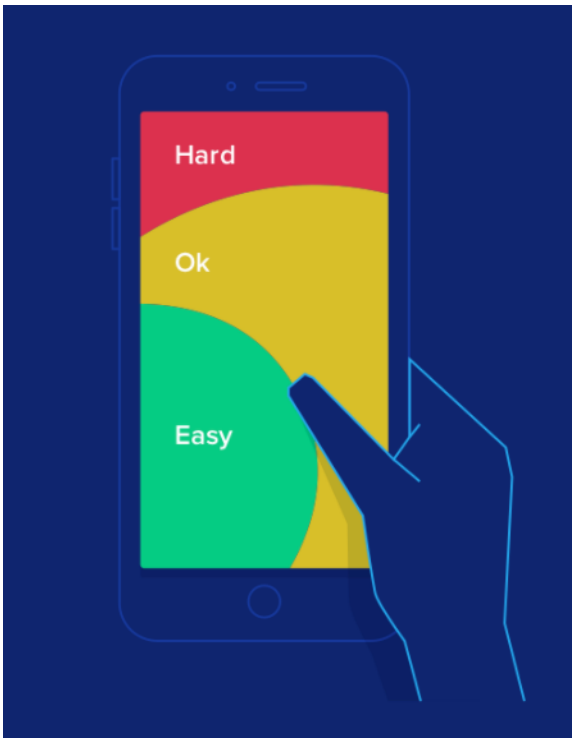


Figure 17: Image zooming (Miklos Philips, undated) **Figure 18:** Thumb-oriented interaction

Another important UX element in the product details page is the Steppers element which is much more touch-friendly than dropdowns and can reduce user's effort where we can use steppers for quantity input (see Figure 19). Steppers are used to increase or decrease value by a constant amount and are a solution that's faster to work with and more appealing to the eye (Miklos Philips, undated).

For mobile users a "save shopping cart" button could allow users to continue their shopping without the need to search for the desired product on their return and save time for opening more tabs on mobile phones which are hidden below each other. According to eMarketer, 56% of shoppers use the shopping cart to hold or save items for later. We also know consumers shop and browse from multiple devices.[3] So it will be really useful to keep products saved in the shopping cart when the session of the user is expired and he logged out so the next time when the user will decide to come back to the website, his product preferences will be still active and he can proceed immediately to checkout.

One thing that can boost the speed of the purchase is the Buy Now (one-click checkout) button on the product details page. The user can be forwarded faster in the checkout process and complete his order.

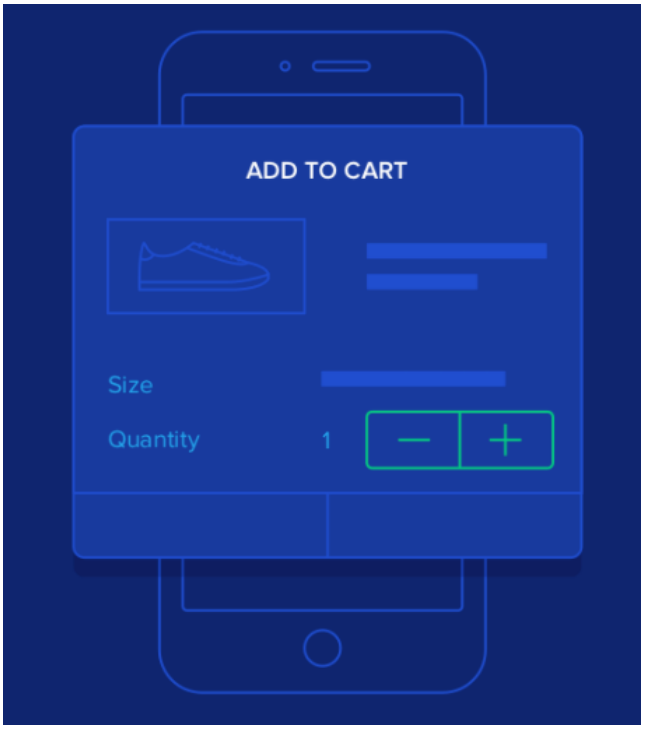


Figure 19: Steppers reduce user's effort (Miklos Philips, undated)

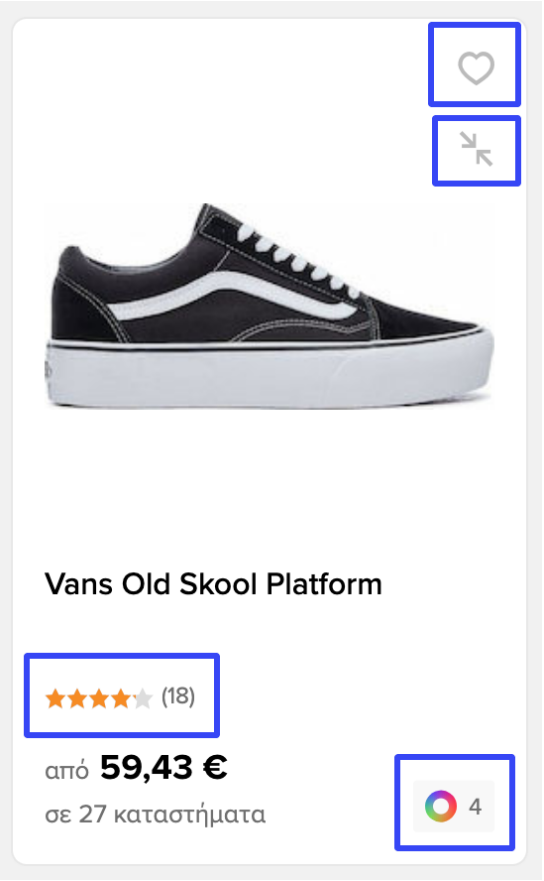


Figure 20: Microinteractions in product details page (wishlist, zoom in/out, product reviews, product options)

Moreover the microinteractions can improve the mobile shopping experience. As microinteractions we describe the details in a product's UI so the user will accomplish a simple task. For example if a user likes or rates a product, pick a color or size and swipe down to refresh the data. Microinteractions are useful so the interactions will be felt more smooth and natural and also they convey a better sense of trust, reduce user's anxiety and prevent errors (Miklos Philips, undated) (see Figure 20).

Another UI improvement in the Product details page could be the easy and thumb-oriented interaction (see Figure 18), of course this improvement can be implemented in other pages as well. It can be achieved by adapting the UI and understanding the common way that the user holds the mobile device and navigates through it. As a result, people will use the mobile device with their finger naturally which will increase comfort and reduce user's anxiety.

2.7 Final Consideration

According to literature review and recent studies some essential information was extracted. This information highlighted and gave answers to the research questions of this study. It was found out that nowadays the majority of the people use their mobile phones and in parallel they prefer buying from them instead of laptop/pc. Based on a survey which was conducted in the USA shows that 80% of users regularly use their smartphones to shop online and on the other hand 70% of users now use mobile phones while in stores during the holidays (Anonymous, Marketpath, undated).

Nevertheless there are some challenging usability issues that m-commerce should overcome and lead as the top of shop devices. The usability design of mobile phones contains some challenges like the small screen size, limited screen resolution, limited processing capabilities, content quality inadequate battery power of mobile devices when someone is on the road and different operating systems, security concerns when someone is buying on mobile phone, trustworthiness and accessibility.

The recent studies highlight and present many usability improvements that should be done so the user will feel more confident using his mobile device for online shopping. The design improvements which were found in literature review, give emphasis in checkout process, accessibility, security and trustworthiness, search and categorization and content readability.

The following sections will investigate if the findings in literature review have common facts with the survey that will be conducted for this study. The findings will try to reveal the problem and give the answers that even if mobile shopping is increased, there are still significant usability issues that prevent the users to navigate easily through an online shop in their mobile devices and complete a purchase successfully without the issue of cart abandonment.

3 THE STUDY

3.1 RESEARCH PROBLEM AND STRATEGY

Research was planned in four parts. The first part consisted of reviewing earlier research within the field of m-commerce and e-commerce, the user experience in online shops in mobile and web versions and the reasons for cart abandonment as well. Information was gathered from published works within the professional and academic community and also from trusted tech articles in online tech magazines. The second part, a survey was created to gather data on user's behaviour in online shopping and their user experience barriers that users can face during their navigation in online shops, especially on mobile devices. In the third part, the research data, gathered from the reviewed literature and survey, made the foundation for data analysis and defined some of the reasons that the users can abandon a purchase in an online shop. In the fourth part, suggestions and design solutions were presented and proposed based on reviewed articles, conducted survey, tech articles and personal work experience in the field of e-commerce to improve the user experience of m-commerce applications

The research goal of the study will add to the field of research by providing more in-depth data as it relates to user behavior given his shopping activity in an online shop on a mobile device. Moreover, the research can provide insights that explore trustworthiness and security concerns in the context of shopping in mobile.

To achieve this goal, the following research question was proposed:

- What are the reasons for cart abandonment on mobile devices ?

The reasons for cart abandonment based on the study which is conducted by Baymard Institute is in most of the cases the long, confusing and complicated checkout process, including the fulfilling of forms like delivery address form and missing guest user option directly in the checkout process. (Kaleigh Moore, 2018)

To help meet the research goals, two related hypotheses were proposed from the research question:

- H1: User interface on mobile devices can't help the user to complete an online purchase.
- H2: The security concerns create insecurity to the user and don't allow him to trust any online payment transaction on a mobile device.

The users themselves are characterized by those that use mobile devices on a daily basis and very frequently and those who are using desktop devices for more important cases like a payment or transfer of important data. User behaviors were defined by the actions that users take when for example the checkout process is long with multiple steps or when the user needs to make a registration on an online shop before he buys a product. Security and privacy concerns are one of the reasons that can prevent users from trusting an online shop on a mobile device. A literature review was conducted to understand better the user behaviour during the last years and how much the cart abandonment can

differ among desktop and mobile devices. The literature review helped me to define and specify the questions and direction that I wanted to use in my study and to create a survey because I couldn't find many academic articles for this problem probably for the reason that cart abandonment on mobile devices is a new trend for deep investigation.

As an outcome for the data collected, inputs from the survey were used to create data analysis and suggest design solutions. The value of this information can be used to better understand the user bases and depict possible pain points that the users expressed concern over.

3.2 Data collection

This study aimed to identify which are the reasons that cart abandonment happens more frequently on mobile devices in comparison with web applications. It will be investigated how the user interface or security concerns and issues can play a significant role in cart abandonment on mobile devices. Both theoretical and empirical investigation is necessary and important for the study. The theoretical investigation will cover one big part of qualitative analysis of the data and the empirical investigation will provide useful information from the real people for both quantitative and qualitative analysis. The theoretical part includes scientific journals, research papers and approved statistics. The empirical investigation consists of a survey that is conducted with many people.

The survey was designed based on the research method that covered a large range of people in total of 70 people. The questions of the questionnaire were designed to measure different and many aspects, how users see online shopping in general, which are the reasons that they prefer to do online shopping on mobile devices, how they interact with the mobile application and which are the interaction barriers that they face during online shopping on mobile devices.

3.2.1 Recruitment

The people who participated in the survey belong to a range of ages (16-55 years old) 55,7% of them were women and 42,9% were men but the majority of the people are young people who are working in different work environments but most of them in the business and IT field. The different work environments were selected so it will be investigated the users' behaviour in online shopping based on the user's occupation. The goal was different ranges of age will take part in this survey and cover how is the user behaviour in online shopping based on the age because for example the people over 40 years old prefer doing shopping in physical stores for the reason that they don't feel secure and comfortable to complete a purchase on mobile devices. So it will be investigated how the age of the user can be a significant factor or not in online shopping. Most of the users were recruited by posting a link to the survey combined with a message which was posted on threads, hashtags and groups on social media networks like Facebook and Linkedin. Also I shared the survey in my work environment and in my close social network of family and friends. The respondents were informed about the purpose of the study (see Figure 21) at the beginning of the survey and I received a lot of feedback from people who were willing to invest time from their free time to fill in the questionnaire. The final total number of participants were 70 people, a noticeable sample that could bring valuable information

in the future research findings. The survey was anonymous, it wasn't requested from the respondents to give their names and more personal data.

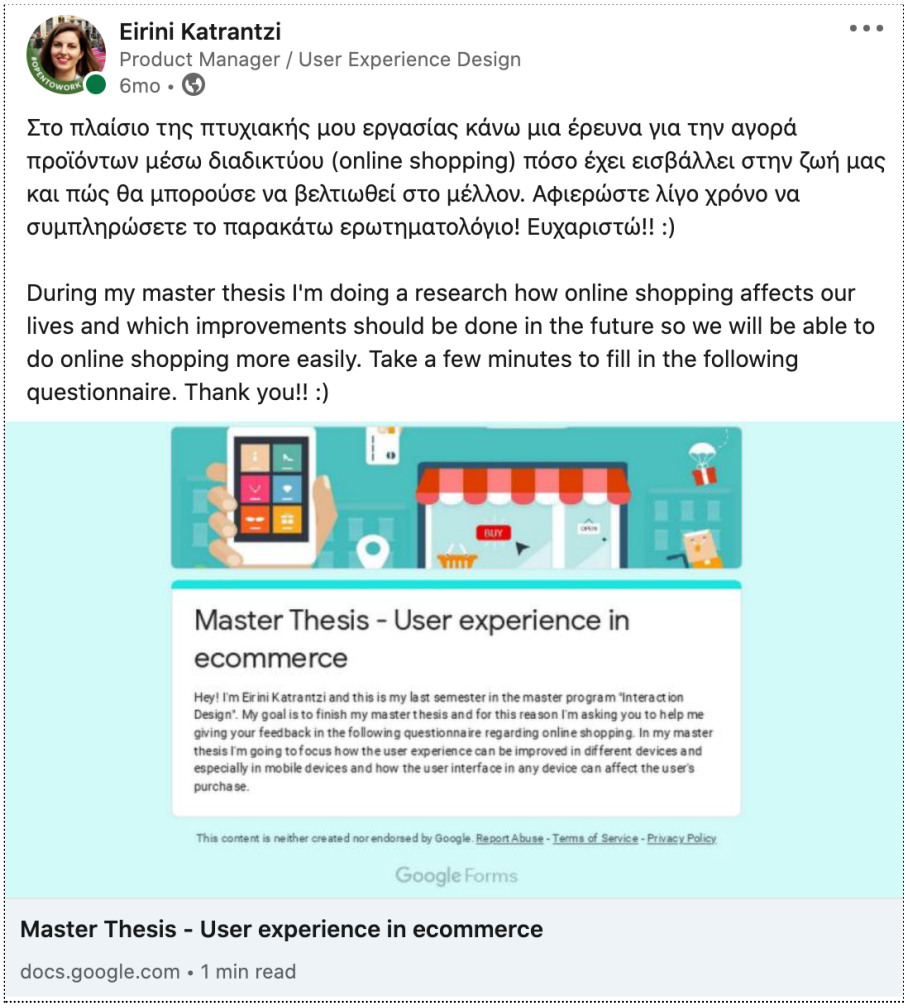


Figure 21: Purpose of the study for the recruitment of respondents

3.2.2 Questionnaire

The questions which are included in the questionnaire are presented below in detail. The goal of the questionnaire was to gather useful information about mobile usage in online shopping. Secondly, I want to investigate the issues or the problems in user experience design that users face during their online shopping on mobile devices and make them to incomplete an order on mobile.

The questionnaire of survey was splitted in four sections which include different categories of questions (see Table 3). The first section of the survey aimed to collect demographic data and this was achieved by asking respondents to state their gender, age and occupation. These questions were useful to get more personal detail information about who the respondents were. Because based on the demographic data I could recognise which ages are more willing to buy on mobile devices and why. The second section covered general questions about online shopping, for example if the users prefer online shopping, how often they are doing online shopping, the reasons that they prefer to buy online and which device they are using to complete online shopping. This section is important because useful

information can be gathered. For example the users like online shopping because he checks other users' reviews before completing a purchase or he likes to receive the ordered products at home because he is busy and he lives far away from the big shopping centers. These reasons can give the explanation why online shopping is important for the user and why he is willing to buy from his mobile device. The last question will extract information for one of the research questions about the device and which is more popular either mobile or desktop device. This question can give us the overview of a user's preference based on the device that he is willing to buy. The question is **(Question 10 : Table 4)** What device are you using in your online shopping?

Categories in questionnaire	**Description**
Demographic information	Questions about general information of respondents (gender, age, occupation).
General question about online shopping	General questions about online shopping and user preferences in online shopping.
User online purchase journey	Questions about the user's interaction when they start their online purchase journey.
User interface suggestions on mobile shopping	Suggestions about the improvements in user interface on mobile devices.

Table 3: Categories in survey's questionnaire

If the users prefer doing online shopping much more with their mobile devices or laptop devices and why. The third section includes questions about the purchase journey of the user and there are two important questions. One of these questions **(Question 19: Table 4)** is to examine the reasons that the users quit an order on mobile devices and the second **(Question 20: Table 4)** if the users install an app of an online shop on their mobile device or not. These two questions will try to give answers to research questions and identify the reasons why there is cart abandonment on mobile devices. The last and the fourth section requests from the users to suggest changes in user experience design on mobile devices so the users will be more willing to buy online from mobile. The goal of this question **(Question 22: Table 4)** was to identify what can help users on usability level so they can proceed with more confidence in completion of an online order on a mobile device. **(Appendix B)**

List of questions in the questionnaire

N.	Questions
	Demographic information
1	How old are you?
2	Gender

3	What is your current job?
	General question about online shopping
4	Do you like online shopping?
5	If you answered "No" in the previous questions, why don't you like online shopping?
6	How often are you doing online shopping ?
7	Which is the reason that you prefer to buy products online?
8	Do you think that online shopping makes our life easier?
9	What are you doing more often online shopping or shopping in physical stores?
10	What device are you using in your online shopping?
11	What do you prefer to buy online?
12	Which is the product that you can find it only in an online shop?
13	When you want to buy a product online what do you prefer to do?
14	Where have you seen advertisements of products before you buy them online?
	User online purchase journey
15	When you start the process to buy something online do you save the items in the shopping cart before you decide to buy them?
16	When you start the process to buy something online do you save the items in the wishlist before you decide to buy them?
17	If you answered "No" in the previous questions, does it mean that you buy immediately what you found?
18	Which payment option do you use when you buy online?
19	Which are the reasons that could make you quit completing an order in a mobile device?
20	Do you prefer to install the app of your favourite shop on your mobile device?
21	If you answered "No" why don't you prefer to install it?
	User interface suggestions on mobile shopping
22	What do you suggest to be changed so you will be able to use your mobile phone more frequently to buy online?
23	Which online shop are you using?

Table 4: Questions in questionnaire 2020

The participants of the survey had to respond to two different types of questions. The questionnaire consists of multiple choice questions and free text questions. In multiple choice questions are combined with predefined answers but also at the end of the choices, a free text was provided so the participants will add additional personal information which was missing from the predefined answers. The questionnaire includes free form answers when the participant answered "No" in a previous question he had to explain in more details the reasons for his negative answer. The participants could give more than one response in some questions and also add additional information if he wanted. The structure of the questionnaire was simple and easy to be completed. A responder needed approximately 3 to 4 minutes to complete it.

The survey was created using Google Forms and it was active for collecting data over a 2 months period. The target of this long period was to be collected as much as useful information that could bring valuable data for analysis. The reason that I used Google Forms was that I could have the data saved as long as I want and Google Forms provides for each result of a question a graphic with the outcome.

3.3 Qualitative data analysis

This study used the thematic analysis. It was considered the appropriate method and the reasons will be explained in more details below.

"*Thematic Analysis is considered the most appropriate for any study that seeks to discover using interpretations. It provides a systematic element to data analysis. It allows the researcher to associate an analysis of the frequency of a theme with one of the whole content.*" (Alhojailan, Mohammed Ibrahim, 2012)

This consideration from (Alhojailan, Mohammed Ibrahim, 2012) helped me in this study to analyze in depth the elements from the data analysis and group them by frequency and create the themes that represent them.

Thematic analysis was used in this study because it's a good approach for the research when we need to find out something about people's opinions, knowledge, experiences or values. from a set of qualitative data. In case of this study survey responses will be used and analyzed. The goal of thematic analysis was the possibility to link the various opinions of the respondents and compare these with the data that has been gathered in literature review during this study. The qualitative analysis focused on the respondents' answers from the following questions: **1.** What is the reason that you prefer to buy products online? **2.** What are the reasons that could make you quit completing an order in a mobile device?

Also Namey et al. (2008) said, *"Thematic Moves beyond counting explicit words or phrases and focuses on identifying and describing both implicit and explicit ideas. Codes developed for ideas or themes are then applied or linked to raw data as summary markers for later analysis, which may include comparing the relative frequencies of themes or topics within a data set, looking for code*

cooccurrence, or graphically displaying code relationships." (p.138) (Alhojailan, Mohammed Ibrahim, 2012)

What was described from Alhojailan will be applied in this study. The goal isn't to count the explicit words or phrases but the investigation of implicit or explicit thoughts from the users so the extraction of the essential meaning will be analyzed and grouped in categories. Based on Miles & Huberman (1994) model for the thematic analysis process. It consists of three link stages: data reduction, data display and data conclusion-drawing as illustrated by the following figure below (see Figure 22). (Alhojailan, Mohammed Ibrahim, 2012)

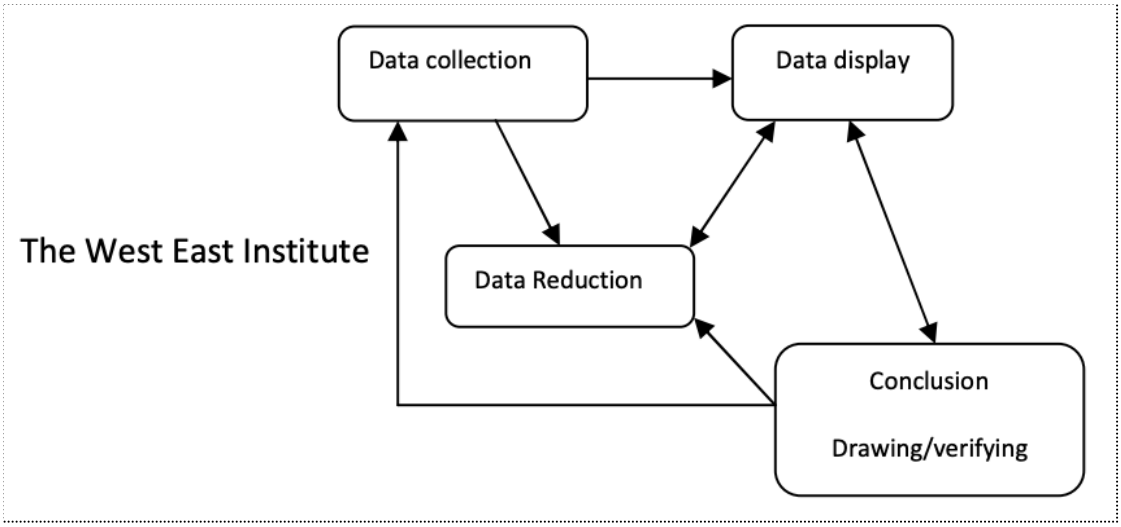


Figure 22: Component of data analysis: interactive model in (Miles & Huberman, 1994, p.12)

"The final stages of the data analysis process are linked by arranging and organising the research's concepts and thoughts. This is achieved by building coherent findings and drawing structures of the results from the data that is displayed. During this stage, the meaning of contradictory and identical data needs clarification." (Miles & Huberman, 1994). "

The above citation will play a significant role in this study. The first step based on (Miles & Huberman 1994) will be the data collection of the respondents' answers. As a second step using data display techniques the data will be organized and compared together and then as the last step the data reduction will be applied so the duplicated data will not exist and categories of the data reduction will be created.

3.3.1 PROCEDURE

The procedure includes the approach of coding and categorization of the extracted information. Since thematic analysis provides the opportunity to code and categorise data into themes, this approach will be helpful to analyze and elicit the respondents' answers. The data from opened answers of users will be collected and will be categorized in categories (themes). Except for the categorization of the users' answers that will be applied, the categories (themes) will be combined and compared with the whole

literature review providing the overall answers in the research questions. For example one category (theme) that was created is the Security concerns in online shopping through mobile devices, this information will be analyzed with the findings from literature review that are connected with security and trust concerns.

The analysis will be splitted in three levels of categorization. First stage will be the data collection which will be based on the additional information that respondents gave out of the predefined choices in questions of the survey of this study. The additional information will be categorized per question and in the next step there will be the data reduction. In the second stage of data reduction only the codes (phrases or words) will be extracted from the respondent's answers. In this stage will be considered the issues or the facts that the respondent faced and not his/her thoughts or ideas. For example if the user gave the answer "I think I couldn't buy a fridge from my mobile device because I can't return it back" this is a thought of the user and it can not be considered as fact and it will not be saved as code. But in the case that the user replied for example "I have quit a purchase through a mobile device because GooglePay option was missing and I didn't want to give the data of my credit card because I didn't feel secure" this answer is a fact and an issue that the user faced. In the last and third stage the similar codes will be categorized into categories (themes) which will represent respondents' answers. The themes will highlight particular issues in user experience for example usability issues, readability, ux issues.

The method that will be used, is visualized in the following (see Figure 23) to give an overview of all the steps will be taken so the analysis will be fully completed and present the right outcome. In the second thematic analysis about cart abandonment on mobile devices, the initial categories (themes) from the codes were gathered and categorized in bigger categories (themes) because some categories (themes) had similar topics (see Figure 26).

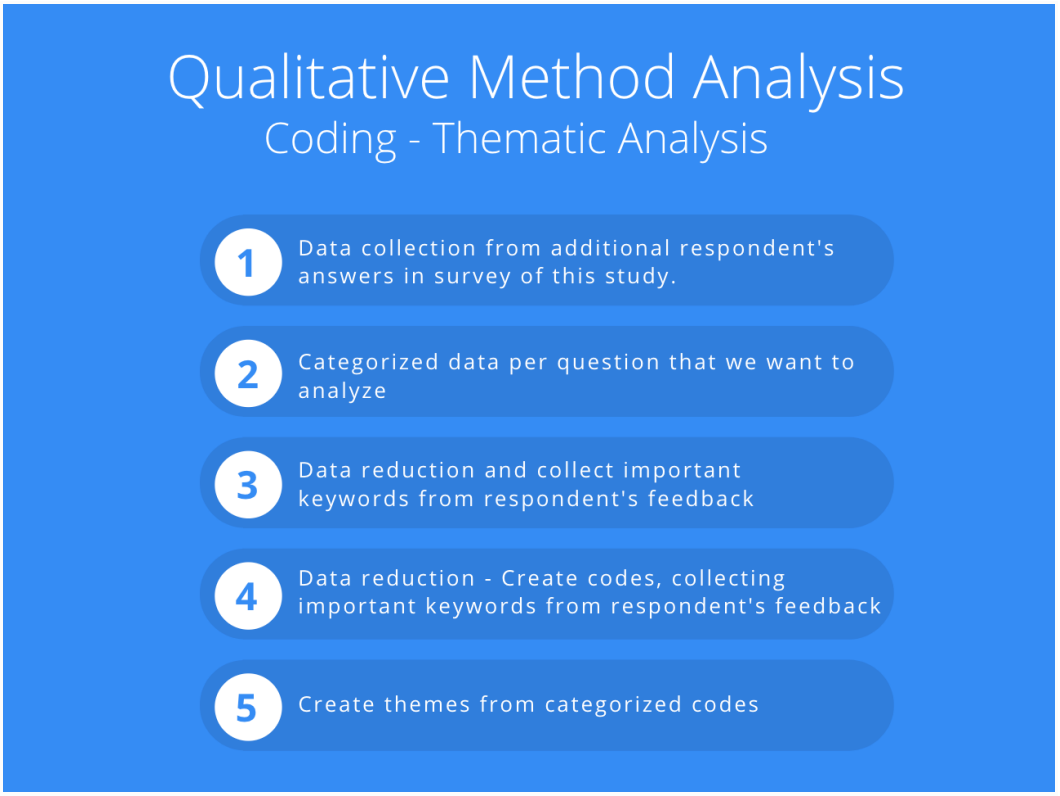


Figure 23: Qualitative Method analysis *(by Eirini Katrantzi)*

3.3.2 Buying Reasons of online shopping

The additional information from the survey came up from the respondents' feedback. This information is connected with the reasons why the users prefer online shopping and how the user experience design can have an impact on which device the user will choose to continue his online purchase. The users answered that online shopping is easy and quick for buying products and in parallel they save time and money because they can find better discounts and deals, available only online. Additionally the most useful for them is that they can make price comparisons for the same product at the same time in many online stores where the product is available. Of course the product comparison isn't so easy and convenient for the users on mobile devices that's why many of the users prefer to return on their laptop/pc and continue the search and comparison of the products because they can navigate easily through the browser tabs on laptop/pc devices.

Just two people answered that they have quick access to user reviews that help them to make better buying decisions. Another factor for one respondent is that his location is far away from the shopping malls, so online shopping helps them to save time (see Figure 24). Online shopping has an advantage with the product reviews because it's the factor that makes the relationship between user and online shop strong and builds loyalty and trust to the potential users. For example if the user can't find a product review in an online shop, he will not proceed to purchase even if the product content is well-structured and the user experience is easy. The reason is that the user can't see online the quality of the product material but if someone else bought it already and write an objective review, the user will be more willing to proceed and buy the product. The users can see other users' reviews for specific products in online shops that help them to have a better overview of the product, for example about the product quality, price, product's issues and so on. The users give a huge meaning in product reviews and they can change their mind and decide at the end they will not buy the product which they wanted a lot when they started to search for it online. This option doesn't exist in physical stores, so it's an important advantage of online shopping independently from the device that user is using.

Also some additional information came from a smaller percentage of people who mentioned that home delivery is a reason that they buy products online. Some people pointed out that they can find many products in a short time and they have many options to choose from like brands or products that are sold in different continents and it's impossible to find them in the country where they live. Another thing that users found very convenient for them is that they can buy any product anytime during the day so this option saves their time and makes the whole online purchase much quicker.

According to an article (Annmarie Hanlon, 2016) there are six reasons why people are motivated to buy online. In 2004 Dave Chaffey suggested the 6Cs of customer motivation in a world where the online offer was developing. These six motivation reasons are the **content** which includes more detailed product, service information and value-adding content, **customisation** which is the personalisation of content, **community** which contains user reviews on web/mobile applications, **convenient** is the 24/7 availability, huge range of **choices in products** and better **product costs**.

All the above mentioned reasons from Dave Chaffey are quite similar with all the reasons that the users mentioned in the survey of this study. So during the last few years the customer motivation hasn't changed drastically.

In the following (see Figure 24) below all the important information (codes) are collected and six categorized themes were created which identify the global **Theme** about the buying reasons of online shopping. In Table 5 below it's represented which data are open responses from users and which are the predefined responses.

Codes	Open users' responses	Predefined users' responses
Easy and quick shopping		✓ (47 respondents)
Shopping anytime during the day	✓ (3 respondents)	
Save time	✓ (42 respondents)	✓ (42 respondents)
Better discounts and deals		✓ (34 respondents)
Save money	✓ (42 respondents)	✓ (42 respondents)
Home delivery	✓ (2 respondents)	
Comparison of products in many online shops		✓ (40 respondents)
More products available	✓ (2 respondents)	
Find products with technical stuff like SD cards	✓ (1 respondent)	
Find brands and shops that are far away from my area	✓ (5 respondents)	
Live far away from malls and city center	✓ (2 respondents)	
Quick access to user reviews	✓ (2 respondents)	

Table 5: Open and predefined users' responses for online shopping (survey 2020)

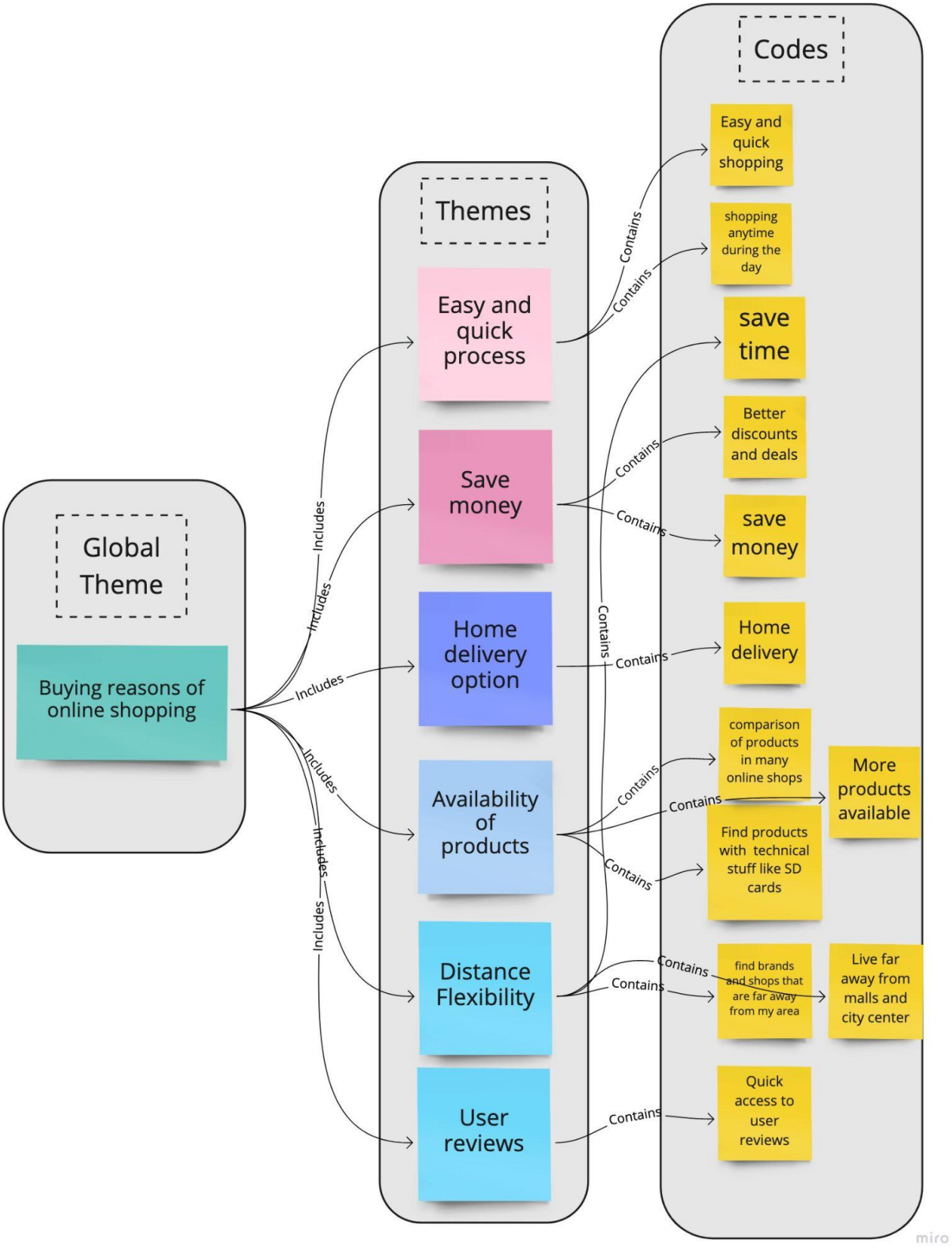


Figure 24: Thematic analysis for online shopping (survey 2020)

3.3.3 Reasons of cart abandonment on mobile device

In this section the two research questions (1.2, 1.3) will be investigated in depth, providing the answers in the main research question "What are the reasons for cart abandonment on mobile devices ?". The investigation will use the thematic analysis and the answers will be extracted from the survey of this study with the method of coding as it's described above (Section 3.3.1) . Moreover the answers of the respondents in the survey of this study will be analyzed with the findings from literature review so the outcome will be more complete.

Based on the research that I did with users in the survey of this study and the research on the field of online shopping that I found out from different organizations and companies, I have gathered some facts and reasons why abandonment on mobile phones happens more frequently than desktop devices. It's interesting to see why the users prefer to buy with more confidence through desktop and not on mobile phones.

There are different positions through a website that the user is frustrated and he can quit his online shopping navigation. The first position seems to be the **checkout process**. Due to difficulties in payment in the checkout process, 47% of shoppers abandon purchases on their mobile phones. In addition, 63% of users who abandon their shopping carts are less likely to try buying from that same retailer.[16] (SessionCam, 2015) Additionally from the survey of this study is revealed that when the checkout process has many steps the users feel overwhelmed and in most cases they don't want to follow all the steps and complete the order, especially in mobile phones where these steps are shrink in small screen of mobile phone, make the user feels stressed when and how he can complete successfully all the steps. The user prefers to see a simple and clean layout without many elements and information on checkout steps so he can finish them faster and without anxiety (see Figure 25).

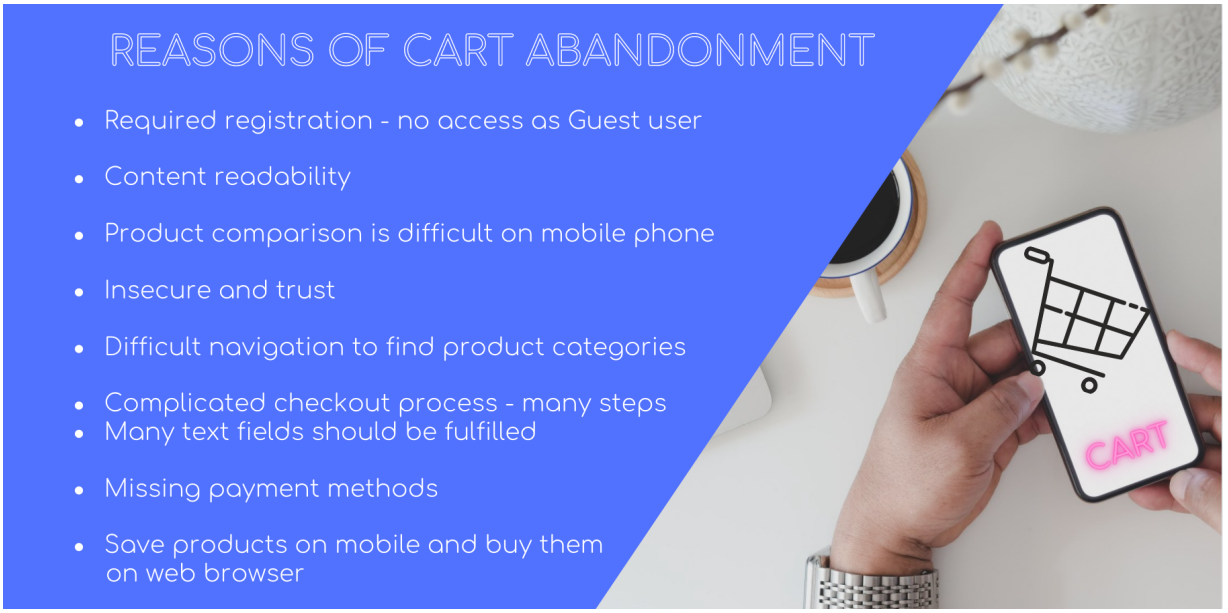


Figure 25: Categories for reasons of cart abandonment *(survey 2020) (by Eirini Katrantzi)*

I used the thematic analysis to extract the qualitative data for cart abandonment (see Figure 26). From the survey that I conducted in 70 people, most of them gave the feedback that they can quit an order on a mobile device because they can't see the product details page very well with all the product's information, including content and images. On the other hand, many people are frustrated to make a registration before they will complete a purchase and this is a complicated process for them on a mobile device because they need to give a lot of their personal information.

People don't feel secure enough to proceed and complete a purchase on a mobile device. The reason that the users gave was that the online payment methods aren't secure and their personal bank accounts can be easily hacked on mobile or secure payment methods on their eyes like Paypal and GooglePay are missing. Also around 46 people mentioned that there are too many fields that should be fulfilled during the checkout process or many steps until the order will be completed as a result this situation is annoying for them to fill in too many fields and they end up to quit the order on a mobile device.

Also most of them replied that in the payment step in the checkout process the payment method that they are using frequently it's missing and they decide to not proceed until the completion of the purchase. Some users prefer to save the products on their mobile device and buy them later on a web browser that's why they don't complete their order through their mobile device. The reason for this decision is that they are using mobile devices for searching products and not for buying products because on mobile devices they can't make a product comparison easily. That's why they prefer to save the products and buy them later on desktop devices.

In the following Figure 26 it's presented the thematic analysis of users' feedback about the reasons for quitting the purchase in mobile devices, some of the answers have been given as free open answers. The following detailed Table 6 shows how many users' responses are free opened and predefined.

Codes	Open users' responses	Predefined users' responses
Search products on mobile	✓ (20 respondents)	
Save products on mobile buy on laptop/pc	✓ (13 respondents)	✓ (15 respondents)
Comparison of products are difficult on mobile device	✓ (10 respondents)	
Check only discounts on mobile	✓ (13 respondents)	
Not paypal payment	✓ (10 respondents)	
Not GooglePay payment	✓ (2 respondents)	
Many steps to complete the checkout process	✓ (10 respondents)	✓ (24 respondents)
Many fields to be fulfilled	✓ (24 respondents)	
Don't feel secure to buy from mobile	✓ (28 respondents)	✓ (28 respondents)
No Guest user option	✓ (27 respondents)	
Don't see well the product details/content	✓ (38 respondents)	✓ (38 respondents)
Give a lot of personal information	✓ (24 respondents)	

Table 6: Open and predefined users' responses for cart abandonment (survey 2020)

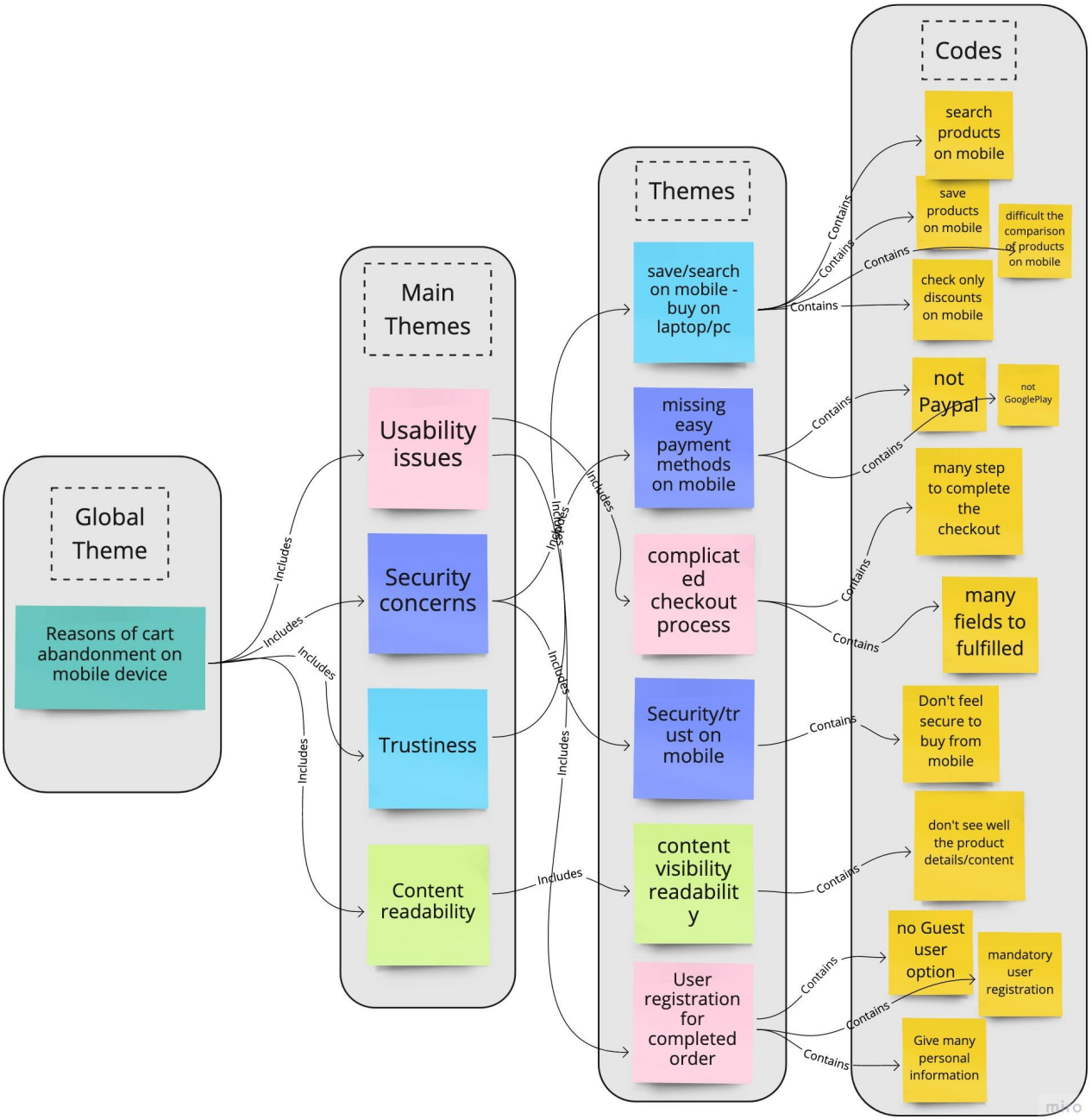


Figure 26: Thematic analysis of cart abandonment on mobile devices (survey 2020)

As we can see from thematic analysis the users face many and different issues on mobile devices when they want to buy something online as a result they abandon the purchase. It seems that the users don't feel a lot of trust to buy products from mobile devices, instead of this they prefer to navigate, search, save their favorite products or find the best discounts and later proceed to order products on their laptop/pc devices. The main reason is that they can't make an easy comparison among the different products in the small screen of the mobile device. So they want to check better the products on a bigger screen and make the comparison until they will end up in the final decision.

Moreover the users feel insecure when they have to pay through mobile devices because either the payment methods demand more steps or the existing payment methods aren't secure. The users

mentioned when the payment methods like GooglePay and Paypal are missing, they don't proceed to purchase because they consider these methods secure through mobile devices. Something else that is related with user experience is the complicated checkout process where the steps are many and not well-designed so they will offer clear and understandable navigation for the users. The users need to fulfill many fields with information in the checkout process and it isn't so convenient for them in a small device. Also the users prefer to use their mobile device for quick and small purchases with easy login and logout but many mobile apps require user registration as mandatory choice and they don't offer Guest user option. This can be another important reason for cart abandonment during the checkout process.

Last but not least the users face issues with how the content with product information is displayed in mobile apps. For many users the readability of the content can be a significant factor to abandon a purchase on a mobile device because they can't recognise all the information which is given in the small screen of mobile. So the structure of content with all the elements in the right position can increase the ability of the users to navigate and find all the appropriate information for products.

Something else from the user experience point is that during the checkout process, the one thing that you would like is to ensure that your customer's attention is focused on making the purchase. This means getting rid of everything on the page that may distract them from doing just that, including website navigation components**.** They may seem like a good thing to have during your checkout process, but navigation components could confuse a customer, leading to them abandoning their purchase. Unlike in the real world where retailers place "impulse buys" in online shopping companies should allow the users to see other items before they checkout, there is nothing that is stopping them from abandoning their purchase completely to go hunting for them.

In the checkout process the layout of the pages plays an important role. The design of checkout pages should not conflict with the eye flow. It should be ensured that these pages don't include any additional information that could disturb the user flow to complete the purchase, only the most necessary information which is needed for the completion of an order. Especially on mobile phones the buttons for the next steps should be visible and understandable from the users without unnecessary information like detailed amounts or advertisements and promotions. Otherwise the users can quit the checkout process or be confused when they can't find the call to action button to move to the next step because the button was covered from advertisements.

Many checkout pages don't have a progress bar or a timer to show the user how much longer it will be before the checkout process will complete and some of the users can get lost especially if there are many steps to complete. This is an important reason for cart abandonment and it should be improved.

There are some websites that ask the users for a wealth of information that is not relevant to the purchase that is being made. This tends to work against these websites, as there are very few users who don't have the time, or are willing to spend more time than necessary on their online shopping. The easiest way to ensure that the best conversion rate is possible when the user's shopping experience is quick and easy.

One of the advantages of mobile phones can become a disadvantage which is the portability of mobile phones. Since mobile phones are portable and easily can fit in a pocket or purse and we carry them everywhere. Because we use phones in a variety of contexts and situations, we are more likely to be interrupted when using such devices: an external event in the outside environment may demand our

attention and require us to stop whatever we were doing on the small screen. As a result, attention on mobile is often fragmented and sessions on mobile devices are short. In fact, the average mobile session duration is 72 seconds. In comparison, our own studies show that on desktop, the average session is 150 seconds: more than twice as large (Raluca Budiu, 2015).

3.3.4 Reasons of cart abandonment on m-commerce and e-commerce

While there are similarities between e-commerce and m-commerce, the latter should be recognised as a unique business opportunity with its own unique characteristics and functions, and not just an extension of an organisation's internet-based e-commerce channel. As such, these characteristics should first be fully understood and then drive the development activities of a mobile application. In most cases m-commerce customers may be more demanding and less patient than e-commerce users (Pitoura, E. & Samaras, G., 1998). Mobile users require value-added services that can be feasible or infeasible according to existing technologies and m-commerce constraints, such as performance, reliability, security, ease of use, bandwidth and so on.

A small introduction about the meaning of cart abandonment is that shopping cart abandonment is when a high-intent shopper visits an eCommerce website, adds at least one or more products to the shopping cart, and proceeds to exit the website without completing the purchase. Products that are added to the shopping cart but are not purchased are considered to be "abandoned" by the shopper. Shopping cart abandonment has absolutely nothing to do with the visibility of the website or the offers run in the advertisements. So this cart abandonment problem cannot be solved by giving away more freebies. This requires a careful analysis of why exactly users are bouncing away from the website despite clearly liking the products. 88% of Web buyers say that they have abandoned an online shopping cart without completing a transaction. (Sucharita Kodali, P. Hult, P. Freeman Evans, B. McGowan, 2010)

More or less the reasons for cart abandonment are the same in m-commerce and e-commerce the most of the users face issues in the checkout process in which there are many steps to complete until they reach the final step and make the purchase successfully or there are more fields that they need to fulfill. So long and complicated checkout processes with multiple pop-up windows or a cumbersome interface and the fear of products looking different from the picture/description is one common issue between m-commerce and e-commerce. Another important common reason for cart abandonment in both parts is that a user account is needed and it's mandatory so the user can proceed to the checkout process which bothers both users on desktop and mobile versions as well.

Moreover there are some reasons which differ between m-commerce and e-commerce. One of these is that on a desktop the screen is bigger and can attract the user's attention and also the user can navigate easily through the screen whereas in mobile phones the screen is smaller and the user struggles to see all the information. In addition in many apps notifications are being sent which in turn distract the user from completing the purchase. On mobile phones mainly the users prefer to navigate through an online shop and search for the product that they are interested in but they don't make a purchase the same day and usually they prefer to save their preferences about the products and complete the order the next day from their pc/laptop where they can see in bigger screen all the product details and description (see Figure 27).

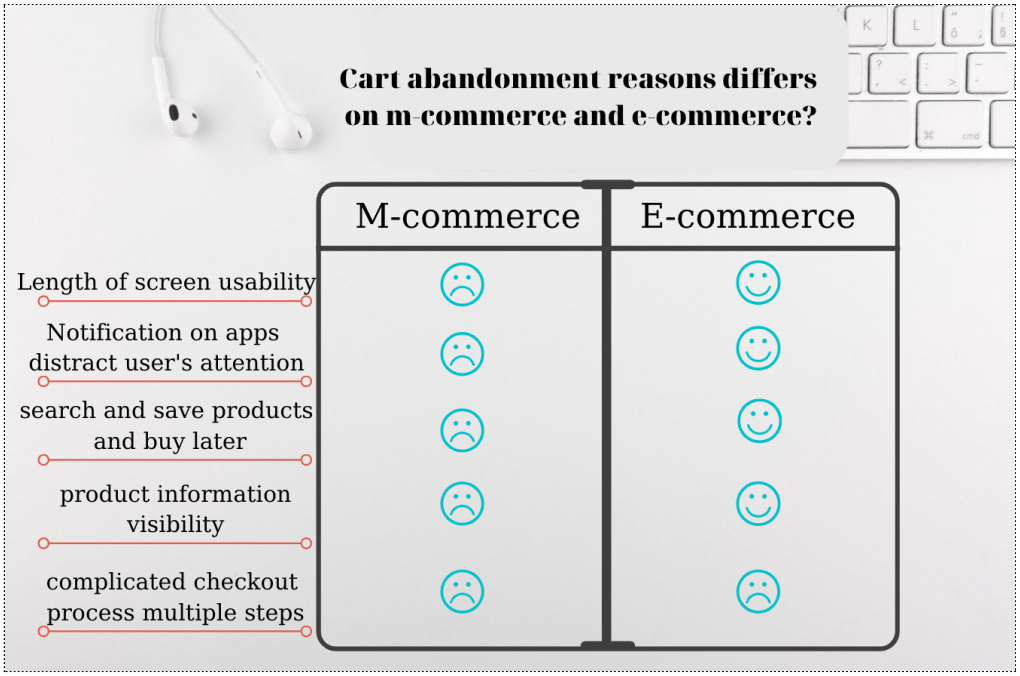


Figure 27: Cart abandonment reasons differ on m-commerce and e-commerce? *(by Eirini Katrantzi)*

3.3.5 Security concerns on m-commerce

One of the most important reasons in m-commerce is that most of the users don't complete their purchase is that they don't feel that there is safety during the payment process through their mobile device. So the main concerns of m-commerce is the security aspect in the checkout process. To make customers feel comfortable when using mobile phones, quality of the security level provided has to be ensured. Besides the security, another concern is about privacy: whether the site or app will protect their personal data.

Users don't want to risk having their card details compromised and that's only natural. According to the Baymard report, concerns about payment security was one of the biggest reasons why people abandon their carts. The report found that around 19% of shoppers abandoned their carts because they didn't trust the site with their financial information. (Shane Barker, 2018)

In the survey of this study almost 39.1% (see Figure 41) of the users answered that quit a purchase on a mobile device because they don't think that there is safety to make a payment transaction so they decide to complete their order on their pc or laptop. Also another survey by Statista (Statista, 2019) shows that more than 60% of users still feel concerned about having their financial information hacked when using a mobile phone. Nevertheless, customer satisfaction is still fairly high, with mobile retail giants like Amazon and Apple both receiving a satisfaction rating of more than 80%.

Insecurity in the checkout process as mentioned before, worries most of the users if they are using mobile or desktop interface. Dropping off the checkout process especially in the mobile phones is the most frequent behaviour. It's important for the companies which develop e-shops to ensure that user's information is secure and the users will be aware that they will not fall prey to scams (Khalid Saleh, 2014).[18] The easiest way is to ensure that you place trust and security seals strategically within the checkout funnel to show your customers that their information will not be misused in any way. There

are a multitude of different seals you can choose from, so you are going to have to test out the ones that work best for you.

Another problem with this is that there are some users that would like to make a purchase but are not willing to create accounts. In fact, it has been found that at least 23% of people will abandon a purchase if they are forced to make a purchase. Forcing people to create an account before they can make a purchase is a kind of forcing someone to obtain a point card at a retail store before they can make a purchase. Large retail stores do not do this as they know that not all users would like to get one of these cards, and the same practice should be carried out by websites.

The visa company was among the first in the field of m-commerce to implement payment verification. Visa allows cardholders to authorize the payment in real time and makes sure that payment information sent over the network system cannot be accessed, thus enabling users to secure their visa a/c by not allowing illegal use.

Also information security is a key issue in mobile commerce. In a transaction, each party involved needs to be able to authenticate its counterparts, to make sure that received messages are not tampered with, to keep the communication content confidential, and to believe that the received messages come from the correct senders. Data can be lost due to the mobile terminal malfunctions. Worse scenario is, these terminals can be stolen and ongoing transactions can be altered.

The users are worried when they don't see trust icons during the checkout process or when the online shop isn't part of the verified company of trusted shops, this is an icon that is placed always somewhere in the footer of shop and identifies that the online shop is reviewed not only from the users but also from an organization which have undeniably criteria.

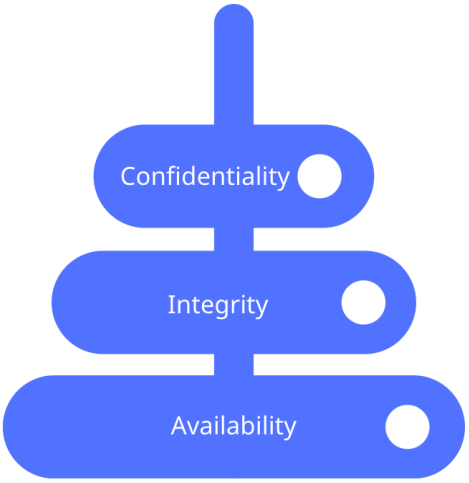


Figure 28: M-commerce security concern - Pyramid Concern (Deepak Kumar, Nivesh Goyal, 2016)

Moreover there is the security Pyramid Concern (Deepak Kumar, Nivesh Goyal, 2016) (see Figure 28) which has three security requirements about m-commerce: **1) Confidentiality:** Data is one of the important assets for any organization. If we want to make it secure and confidential, we need to keep information safe from unauthorized access, for example, any personal information, bank account, government documents, credit card numbers and so on. For privacy reasons, we need to keep data safe and secure. **2) Integrity:** Data Integrity is used to save information from being modified by

unauthorized users. Data has value only if it is correct. If data is altered, it might lead to heavy losses. For example, if our account information is tampered with while transferring money to another account, the money might be lost into unknown accounts. **3) Availability:** A user authorized can access data only when data is available. Data holds value only if the right user can access at the correct time. Hence, to access data, the user needs to have permission to avail the data.

Based on the survey results that I conducted and all the early studies that I mentioned above, users have concerns about the security on mobile phones more than in a laptop/pc. Applying user-centered design solutions could change the perception of the user when visits the mobile app for the first time and make him feel that it's safe to buy products from his mobile phone without the fear that his personal data or credit card information will be stolen. For example the checkout environment will be different from the rest environment of e-shop and includes trust signs and reliable payment transactions. Also the user should be aware of the terms and conditions and confirm them before he proceeds to the completion of a purchase. All these things can ensure the trust of the user to shop. Nevertheless the path to trustworthiness on mobile phones is still long but with good usability techniques and solutions the user will change his attitude towards practice in online shopping and his familiarity with transactions on mobile phones.

3.4 Quantitative data analysis

3.4.1 Demographic data

In total, 70 people participated in the survey. The majority of 70 people who took part in this survey answered all the questions, only some of them like 5 people didn't give a feedback in the optional questions. The majority of people more than 50% who participated in the survey was in the age from 30-35 in total of 70 people (see Figure 29). The different ranges of age were valuable for this study because based on Verto Analytics data (Connie Hwong, 2018) the majority of users who do online shopping are under the age of 75, 95% of online shoppers are between the ages of 18-74. Millennials (between the ages of 18-34) are 30% of the online shopping population. Members of GenX (ages 35-54) account for 34% of the online shopping population, trailed by Boomers (ages 55-74), who are 31% of the online shopping population (see Figure 30). All these people were reached on different social platforms like Linkedin, Facebook and Slack (feedback from my work environment). Also the participants who responded, had many and different nationalities (Polish, Greek, Austrian, German, Romanian) so the results came from different countries and ways of life. Interesting part is that women were more than men in this survey and most of the people around 50% are working in the IT field and the rest of them are teachers, economists, students and housewives.

Firstly the people who want to buy a product online, they are searching it on google search to find online shops with the preferred product (71%) or find online trusted shops (62.3%) and some of them ask their friends who can recommend specific online shops (4.3%) (see Figure 31).

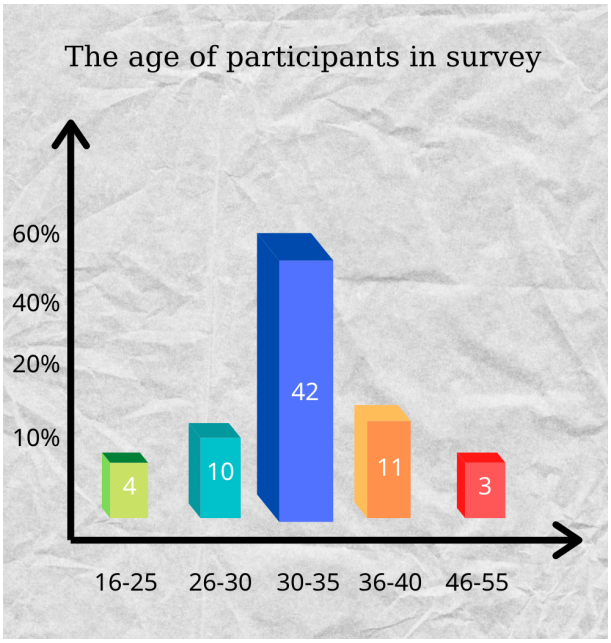


Figure 29: The age of participants in study's survey 2020

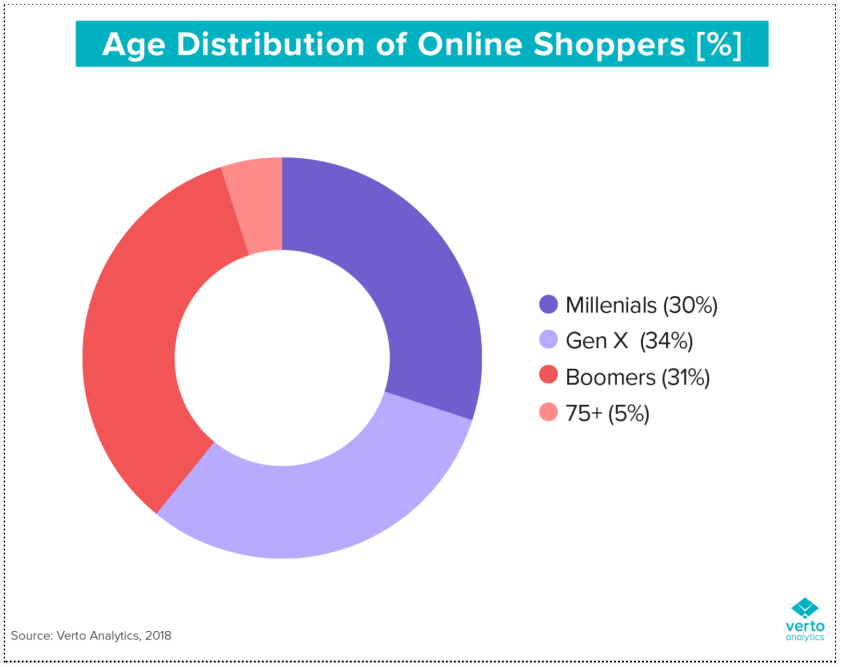


Figure 30: Age Distribution of Online Shoppers

Millennials (18-34 years old), GenX (35-54 years old), Boomers (55-74 years old)

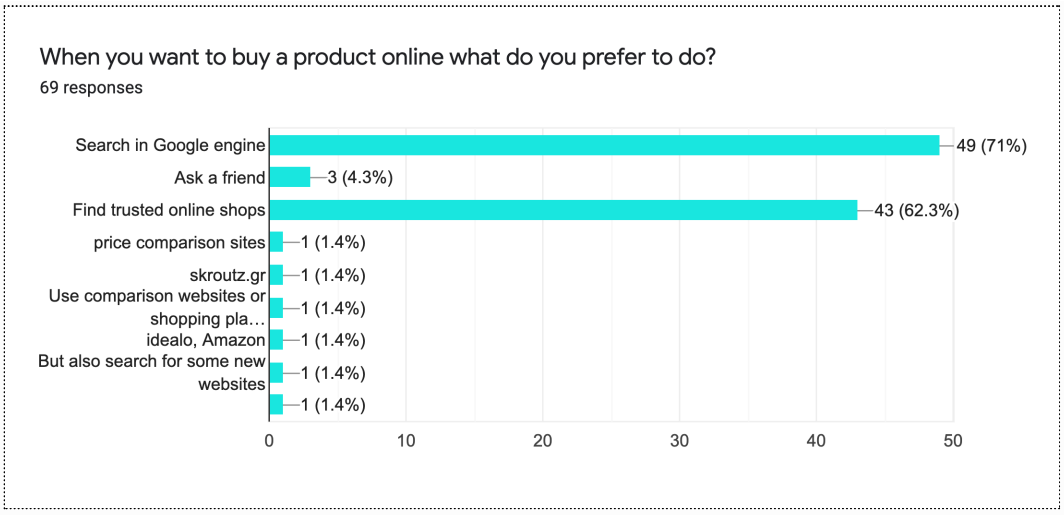


Figure 31: When you want to buy a product online what do you prefer to do?

The majority of people in all ages from 16-55 years old are influenced to buy products by advertisements in social media like Facebook (55.1%), instagram (46.4%) and youtube (26.1%). Only one respondent replied that he is influenced by advertisements in Tik tok and Pinterest. On other hand there are also people who can see discounts or deals through email newsletters and take the decision to buy online (33.3%) (see Figure 32). The percentage of email newsletters corresponds more to ages 35-55. Moreover two of the participants gave the feedback that they don't trust advertisements and they prefer to ask friends or they aren't influenced by advertisements.

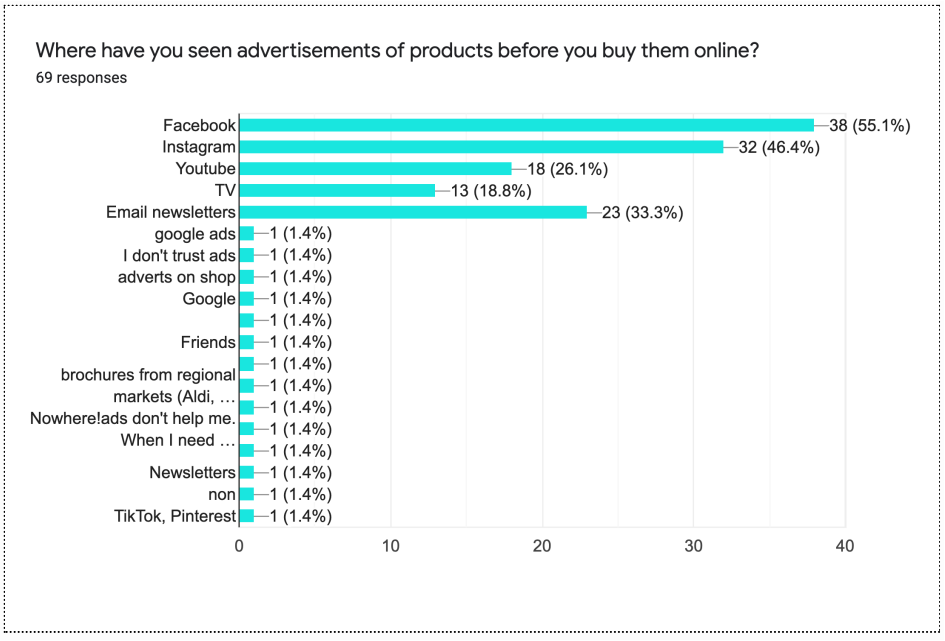


Figure 32: Where have you seen advertisements of products before you buy them online?

The specific question "Where have you seen advertisements of products before you buy them online?" was added in the questionnaire by purpose. The reason was that based on statistics of Statista (2019) the majority of users are using mobile phones (Ying Lin, 2020) instead of laptop/pc where they

see advertisements through social media networks or mobile app notifications and make them to buy products directly from mobile devices.

"At the start of 2015, less than one-third (31.16 percent) of the global web traffic came from mobile devices. Fast forward to less than five years later to the final quarter of the decade and that number has skyrocketed to 52.6 percent, marking a 68.8 percent jump (Statista, 2019).
In fact, for three years now, mobile traffic has consistently accounted for around 50 percent of the total website traffic worldwide.
And with the emergence of 5G technology, which will bring about much quicker internet speeds and connections, we can expect mobile traffic to continue growing. In line with that, experts are also expecting mobile data traffic worldwide to increase five-fold by the end of 2024." (Ying Lin, 2020)

In this way the users are directed to online shops more frequently through their mobile devices instead of their laptop/pc since mobile devices are the extension of their hand on a daily basis. As a result users start the online purchase firstly on their mobile phone and then they continue to laptop/pc device.

3.4.2 Online shopping and devices

From the survey it's seemed that however that users are using mostly the mobile devices on a daily basis, in online shopping the users behave differently. The laptop/pc devices prevailed from mobile devices. Mobile phones are the devices that the users are using (54.7%) in online shopping instead of laptops/pc devices where the percentage is higher (74,3%) (see Figure 33).
Based on the results of the question "What device are you using in your online shopping?", mobile and tablet devices can be counted as a total percentage since tablets and mobile have responsive design so the user experience is quite similar on both devices. So in total 66.1% of users prefer doing online shopping on responsive design.

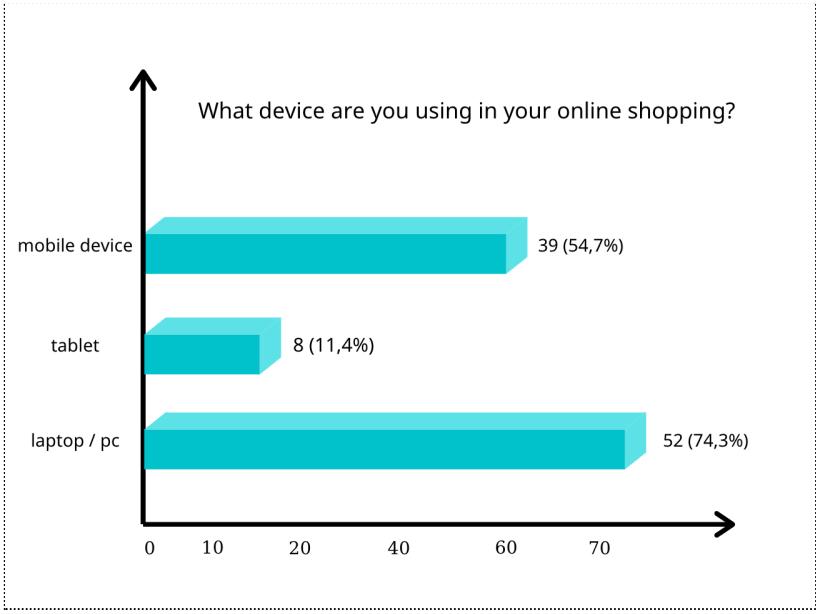


Figure 33: What device are you using in your online shopping? (survey 2020)

The laptop/pc devices receive a big acceptance (74.3%) for online shopping from users. The result of this question makes us understand that mobile devices play a significant role in the daily routine of users but it doesn't hold a strong preference of the users in online shopping. The people with range of ages from 16-35 years old answered that they are using mobile devices for online shopping and the people over 35 years old prefer to buy online sometimes with their laptop or mobile phone.

One more question that was set in the questionnaire which tries to identify how willing are the users to install an app of their favorite online shop on their mobile device. This question brought the following results: 50.7% of the respondents responded positively that are willing to install on mobile devices the app of an online shop and 49.3% answered negatively (see Figure 34). The reason for not installing a mobile app with an online shop was that the users prefer to make their online purchases with their laptop/pc devices (32%) because they have a bigger screen to compare and search the products. Other users answered that they don't prefer to have many mobile apps on their mobile devices because of lack of space and they don't want to receive notifications about discounts or offers for products.

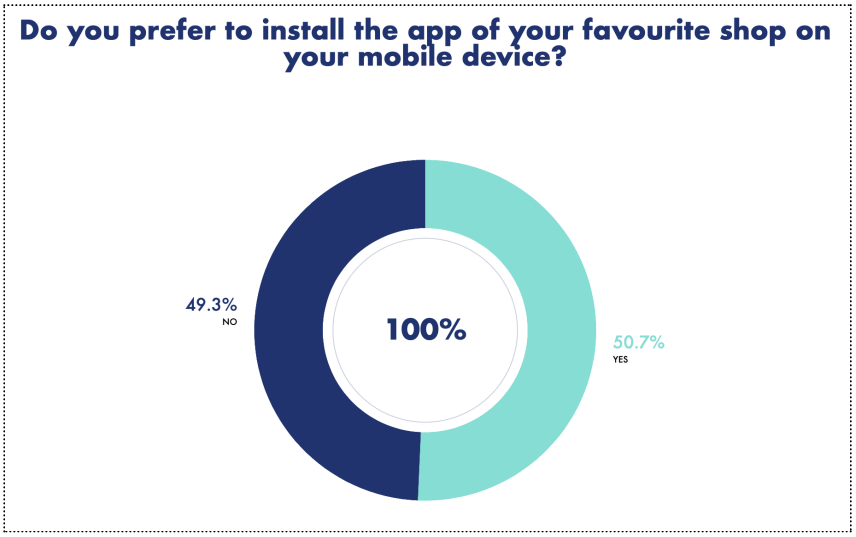


Figure 34: Do you prefer to install the app on a mobile device? (survey 2020)

Based on the survey in Merchant Savvy (Merchant Savvy, 2020) company mobile devices generate the most traffic and retail revenue worldwide. Unfortunately, mobile fails to satisfy two key metrics: Mobile sites have higher cart abandonment rates and lower average purchase values than desktop sites (see Figure 35).

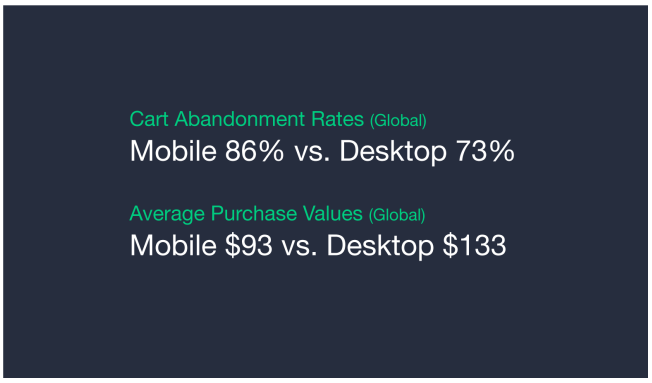


Figure 35: Source Merchant Savvy, 2020

Another survey of the same company (Merchant Savvy, 2020) identified that mobile is starting and ending more consumer journeys. It's important to understand the vast majority of consumer journeys these days involve multiple channels. A 2019 study from Periscope (Periscope by McKinsey, 2019) shows, more than 60% of consumers in the US, UK and Germany say they shop equally offline and online. Online shopping itself is also an omnichannel experience. Mobile is a crucial channel for consumers and retailers alike but it's only one part of a much larger omnichannel shopping experience. Mobile share of total online traffic continues to grow. The Figure 36 shows how the mobile share of traffic continues to pull away from desktop from Dec 2010 to Feb 2021 (tablet line is below from but make up the remaining 2.7%) (Statcounter, Globalstats, 2021). However, it is important to appreciate how much variance there is within this global average.

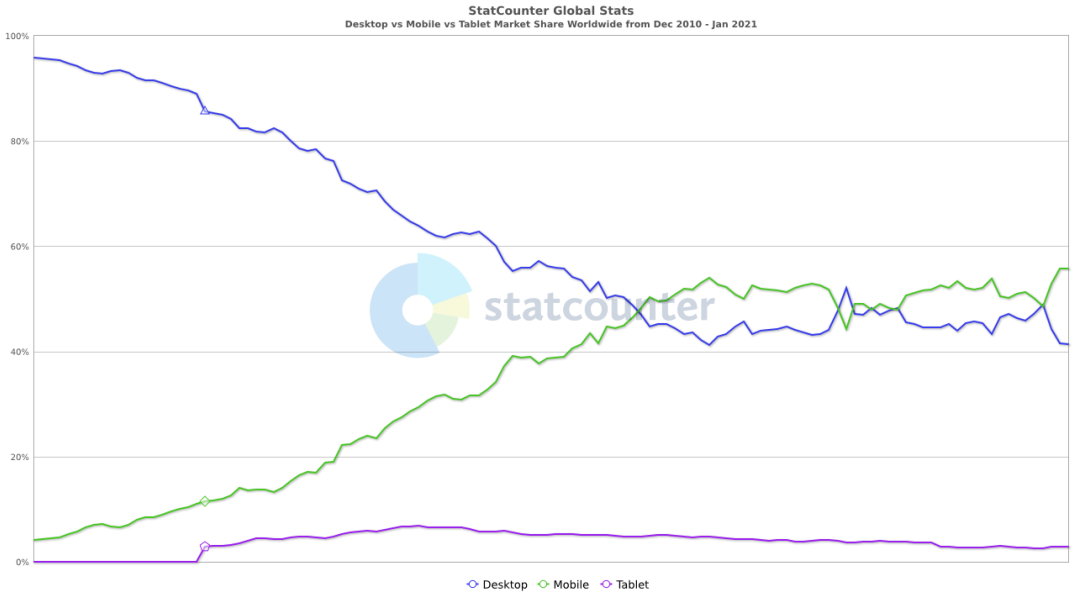


Figure 36: Mobile share of total online traffic continues to grow (mobile 55.68% - desktop 41.45% -tablet 2.87%) (Statcounter, Globalstats, 2021)

Usability and fears about fraud are the main concerns according to Kount's June 2018 survey of 600 merchants, usability and detecting fraud are the main challenges of the growing mobile ecommerce market. They publish an extensive analysis of their survey findings in their The State of Mobile Payment and Fraud report. (Merchant Savvy, 2020)

Another usability issue is about the screen size. The smaller the screen size, the larger the cart abandonment rate. Despite more users using mobiles to make purchases they are more likely to fail to complete purchases compared to desktops and desktops as you can see from the average cart abandonment rates by device on the right (Merchant Savvy, 2020).

This disadvantage of mobile devices could bring troubles to the users is the small size (see Figure 37). Even if we're using the mobile phone because it's smaller and more convenient and portable, it has some disadvantages compared to desktop size. The screen of the mobile phone contains a lot less content and constitutes a serious limitation for mobile devices. The content displayed above the fold on a 30 inch monitor requires 5 screenfuls on a small 4-inch screen. Thus, mobile users must spend a higher interaction cost in order to access the same amount of information and rely on their short-term memory to refer to information that is not visible on the screen. Based on this information the mobile

content is twice as difficult to be viewed from the user. So the user could get rid of completing a purchase on a mobile phone because he can't clearly read all the product details or he needs more time to check the whole content on a small screen which makes him frustrated.

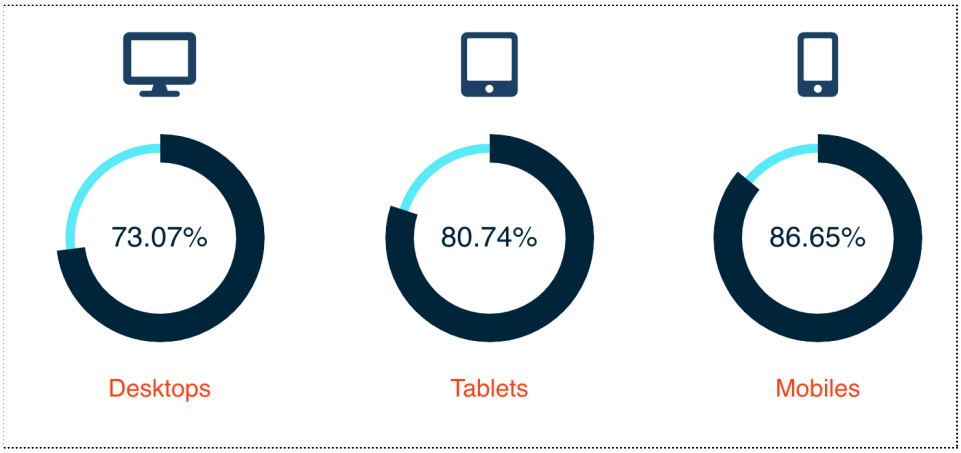


Figure 37: The smaller the screen size, the larger the cart abandonment rate (Merchant Savvy, 2020)

Another interesting thing is that millennials (18-24 years old) are particularly unwilling to put up with slow loading mobile sites. The Unbounce report (Merchant Savvy, 2020) gave more evidence to the growing feeling that millennials crave instant gratification, which is important for those companies with mobile commerce sites. In this study just 26% of 18 to 24year-olds say they'll wait 4-6 seconds on their mobile. That is nearly half the amount who will wait this long on their desktops.

3.4.3 Buying Reasons of online shopping

In the context of research with the survey some additional information came up from the respondent's feedback. This information is connected mostly with the reasons why the users prefer online shopping in general independently from the device that they use. The goal of this question was to identify why the users prefer online shopping independently from the device that they are using. The users gave the answer that online shopping is easy and quick for buying products (67.1%), save time and money (58.6%) because they can find better discounts and deals (48.6%) which are available only online and not in physical stores and the most useful for them is that they can make price comparisons for the same product the same time in many online stores where it is available (52.9%) (see Figure 38).

The findings from survey of this study comes to confirm the study from KPMG International 2017 (Global Online Consumer) that the users prefer buying online because of better deals/discounts 46%, save time 40%, ability to shop anytime 58%, bigger variety of products 28%, free shipping offers 29% and products aren't available in the country in which they live. (Dave Chaffey, 2017)

Figure 38: The reasons why the customers prefer to buy online in percentages survey 2020) *(by Eirini Katrantzi)*

3.4.4 Reasons of cart abandonment on m-commerce and e-commerce

However it was found out from additional findings in this survey that the users face some usability issues and security concerns when they buy products from their mobile devices as results of quitting the purchasing process. All these usability and security concerns give many answers to the research questions if the user interface or security concerns can prevent the user from completing a purchase on a mobile device. These issues and concerns don't appear so frequently when the users make an online purchase from their laptop/pc. As it's presented in the Figure 39 the users responded that they have more security concerns when purchasing from mobile devices (39.1%) than in tablet (31.4%) and laptop/pc devices (29.5%). Even though the users use their mobile devices frequently in their daily activities, they don't feel trust and safety when they want to complete a payment transaction through mobile devices and this is a fact that will be investigated more in the following sections. The users mentioned that some secure payment options are missing on mobile devices (42%) which prevent them from proceeding to the checkout process. The percentage is high also in tablet devices (38%) and significantly lower in laptop/pc devices (20%).

Moreover it seems that the users face usability issues and challenges during the checkout process in mobile (39,1%) and tablet (33.5%) devices. In laptop/pc devices this percentage (27.4%) is significantly lower which means that the users don't face many difficulties in desktop where the screen is bigger and the navigation is easier and smooth. Except for the usability issues in the checkout process most of the users mentioned that the complicated checkout process is a discouraging factor to complete an online purchase. The percentage of 36.7% of users provide information about complicated

checkout processes in laptop/pc devices and the percentages in mobile (34.8%) and tablet devices (28.5%) respectively are smaller (see Figure 39). In the area of checkout process there is one more issue that most of the users mentioned which is referred to mandatory user registration so the users can complete an order and there isn't an easy registration like guest user. The users face this issue in mobile (39.1%) and tablet (33.7%) devices and not so much in laptop/pc (27.2%) devices. If the "Guest" Checkout is missing as option from mobile phones, the user needs to make an additional effort to create an account as result he postpones the process of the purchase and at the end he decided to quit for ordering his products because in smaller screens user is doing more steps to create an account and continue the checkout process and it's very frustrating for him and make him to quit the completion of the order. When there is a demand from the user to make a user registration before completing an order, it means that the user needs to go out of the checkout process, make the registration and return back to checkout. This whole process is an interruption for the user and it can be more complicated in mobile devices where the screen is smaller and the user needs to move from one tab browser to another in a small screen. This is the reason that most of the users mention this usability issue with user registration during the checkout process. Another significant finding from the survey is that most of the users are using mobile devices (56.4%) to search and save the products which they found in an online shop and not proceeding to online purchase directly to mobile devices. On the other hand on laptop/pc (30%) devices this percentage is lower which means that the users don't use the web version of an online shop in their laptop/pc devices for search and save of products only but also the users proceed to the final online purchase.

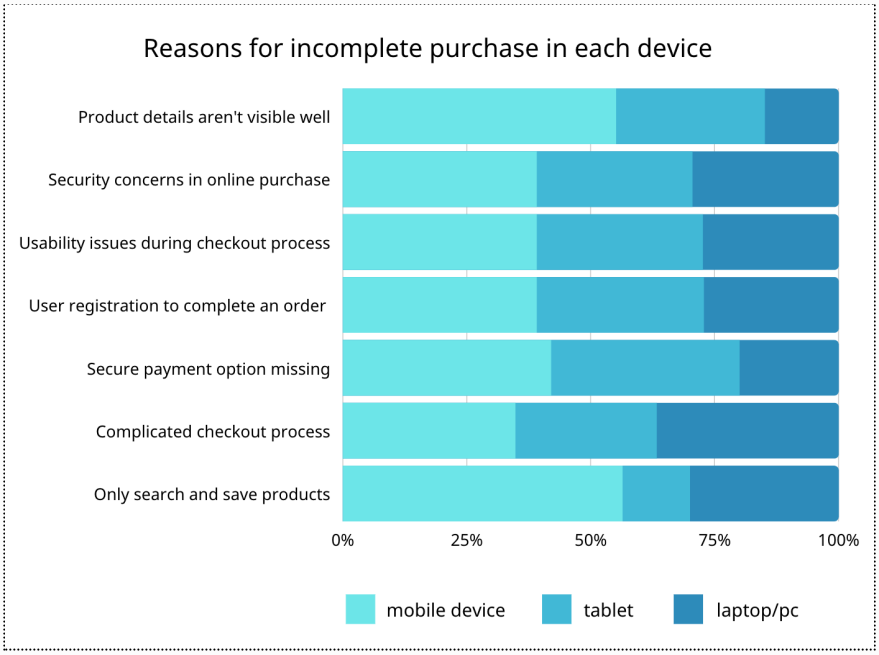


Figure 39: Reasons for incomplete purchase in each device (survey 2020)

Moreover a high percentage of 56.4% is observed on mobile devices where users have issues with the product details and description. This means that the users have to scroll a lot on mobile and tablet devices so they will read more information about the product which doesn't occur in laptop/pc (14.9%) devices where the screen is larger and the product information is visible better from the user.

All this information from quantitative analysis gives us a good starting point to identify some of the reasons that the users face during their online shopping on mobile devices. The most important reasons are connected with usability issues and security concerns.

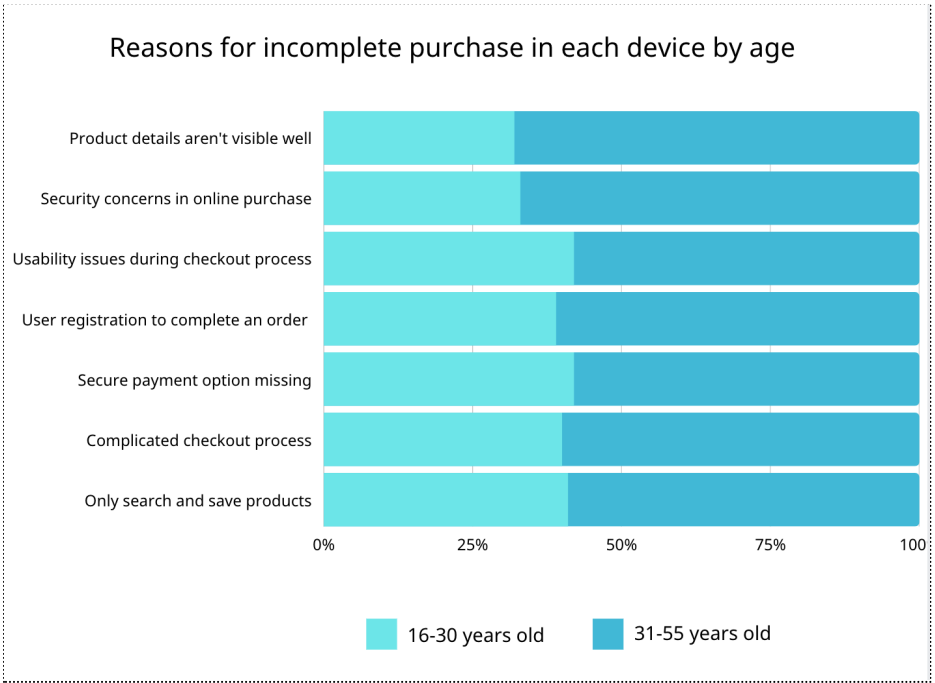


Figure 40: Reasons for incomplete purchase by age (survey 2020)

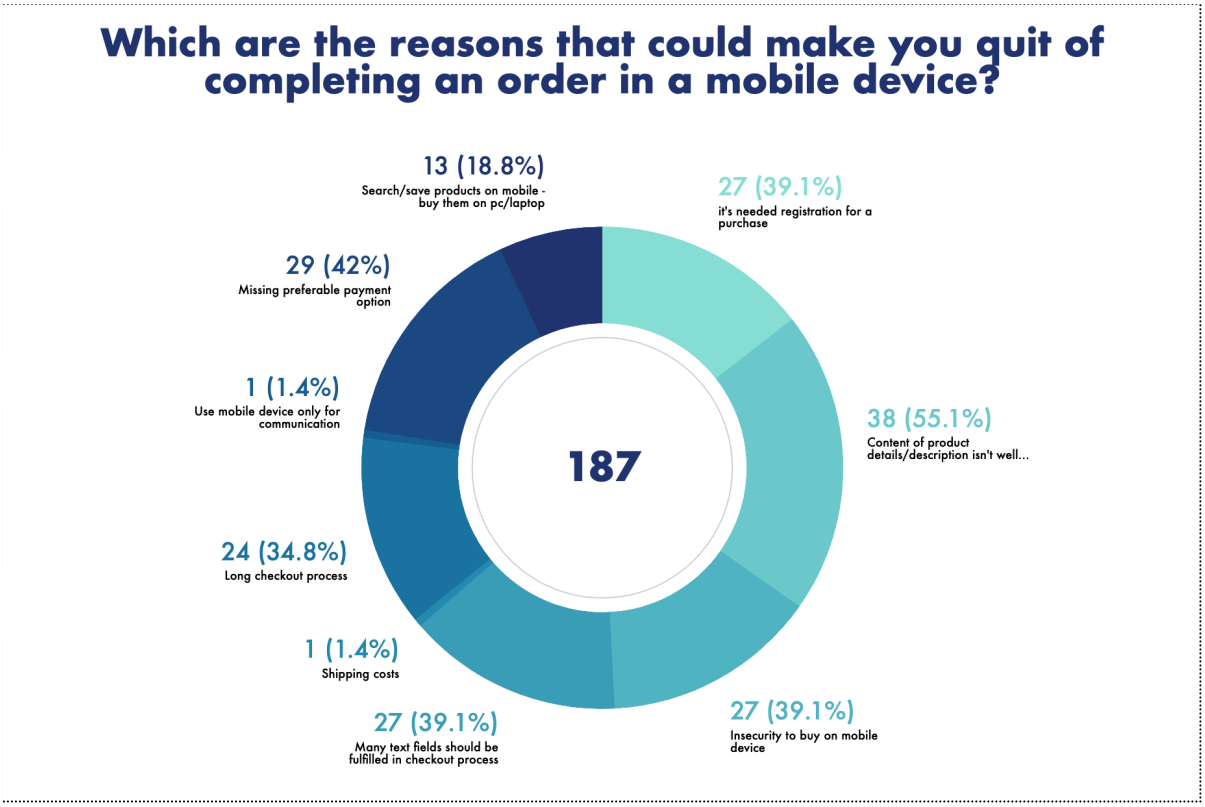


Figure 41: Which are the reasons that could make you quit completing an order in a mobile device? (survey 2020)

The data of the survey for cart abandonment was analysed also by age and some interesting findings were displayed (see Figure 40). Both age groups (16-30) and (31-55) have usability issues in checkout flow and the users don't complete a purchase, either of the complicated checkout flow or the missing secure payment methods. The users of age group (31-55) have security concerns and don't feel safe to make an online transaction in eshop on a mobile device. It seems that the youngest ages feel more comfortable and don't think so much about the safety in online transactions on mobiles.

The people in the age group (31-55) have usability issues when they need to make more steps during the checkout process for example making a user registration or filling in many fields before completing the online purchase. In the small screen of mobile devices, all these additional steps create stress and anxiety to this age group (31-55).

One interesting fact is that during the coronavirus period there was an increase of cart abandonment and Daniel Kornitzer showed based on a research which were the reasons. Below there is the table with the reasons in the USA, UK and some countries in Europe (Daniel Kornitzer, 2020).

Many of the users mentioned that they faced issues with the checkout process, either there was complexity of payment steps or they had the feeling that checkout flow wasn't secure. Some others noticed that they had to enter so much information at the checkout and a user account was mandatory to make their purchases. Moreover an overall of 20% they couldn't pay with their preferred payment methods or the payment approval took too long, as a result they decided to abandon the cart.

	US	UK	Canada	Bulgaria	Italy	Germany	Austria	Overall
They were only ever browsing	25%	30%	24%	44%	30%	28%	33%	30%
They cannot pay with their preferred method	15%	16%	25%	26%	19%	23%	18%	20%
Shipping time	14%	15%	20%	16%	14%	17%	33%	19%
Mandatory customer account for making purchases	15%	11%	10%	21%	22%	19%	24%	17%
Too much information to enter at the checkout	15%	18%	19%	16%	16%	20%	13%	16%
Complexity of payment steps	18%	15%	13%	13%	15%	17%	23%	16%
Checkout doesn't feel secure	13%	18%	15%	16%	15%	14%	22%	16%
Payment approval takes too long	24%	18%	14%	13%	11%	16%	15%	16%
Additional fees charged at the checkout	19%	16%	17%	16%	16%	15%	10%	16%
Checkout screen freezes or crashes	17%	13%	12%	16%	14%	17%	12%	15%
Unhappy with delivery options	11%	17%	12%	10%	15%	19%	18%	14%
They cannot pay with their local currency	22%	9%	11%	10%	13%	15%	10%	13%
Other	1%	1%	-	1%	-	-	-	0%
None of these	6%	3%	7%	2%	4%	5%	4%	5%
Don't know	1%	2%	2%	4%	3%	2%	2%	2%

Table 7: Have you seen an increase in cart abandonments during COVID-19? (Daniel Kornitzer, 2020)

4 Discussion

This section elaborates on findings of this study, provides a list of design considerations for the checkout process in which the users face the most issues as a result the cart abandonment happens more frequently. Also it's presented a suggested guideline for ux designers, product managers, developers who want to implement the user experience design in an online shop.

4.1 Design Considerations in m-commerce

From the findings of the survey the users gave their feedback on what they consider should be changed on mobile devices so they will be more confident to buy online. It was found out from thematic analysis (see Figure 26) that security concerns and usability issues in the checkout process are prominent issues in user experience.

The users mentioned **security concerns** for cart abandonment on mobile devices (39.1% of respondents) (see Figure 41). Prominent reasons include missing payment methods (42% of respondents) for easy and secure checkout like Paypal and GooglePay and insecurity for online transactions through mobile (see Figure 26, 41). In total 50,7% of the users (see Figure 42) gave the response that they would like to have easier and secure payment methods during online shopping on mobile devices. This will help the users feel more comfortable and secure for buying through mobile devices. As a result the different payment options can be beneficial especially for mobile devices where mobile sites can see a 44% increase in conversation with Paypal (Jeff Dearing, 2018). Nowadays one-page checkouts and digital wallets are very popular and can significantly increase conversion and minimize cart abandonment, Amazon Pay, Apple Pay, PayPal One Touch have improved mobile conversion by up to 10% at launch (see Figure 48).

Except for security concerns the users have a lack **of trust** in online purchases through mobile devices. The survey revealed that users don't feel trust when they buy from an online shop if they don't see that the environment is secured or certified with trust symbols. They prefer to search and save products on mobile devices and buy them later on laptop/pc (18.8% of respondents) (see Figure 41). So a solution could be if on the top header of the checkout area only the logo of the company and secure icons are displayed (see Figure 52). As a result the users will feel that they navigate in a secure and trusted online shop. The elements like search bar, product categories or FAQ link should be hidden so the users will not make a search for additional products and go out of the checkout process (Amy Schade, 2014). Within the checkout process, an online shop needs to keep the focus on purchasing, eliminating distractions that might keep the user away from completing his purchase. The checkout process can make or break the conversion rate and affect the user experience. Even the largest and most-trusted brands can benefit from labeling with the words "secure checkout." Through A/B testing, it's shown that there was a 2.73% lift in conversion when locks and security badging were added to the cart and checkout (Jeff Dearing, 2018). The trust seals could include guarantees, payment options,

security certifications, or the logos of trust-inducing organizations because can play a major role in reducing cart abandonment during checkout (Aaron Orendorff, 2017).

Another field that users noticed issues on mobile devices is the **checkout process**. Many respondents in the survey (39.1%) mentioned that quit of an online purchase because there are too many text fields that they need to fill in the checkout process and on mobile devices it's inconvenient (see Figure 41). So the majority of users (66.7%) requested as improvement the checkout process will have less steps and it will be easy and quick with less fields that they need to fulfill (42%) (see Figure 42). The limitation of the number of input fields can reduce typing effort. Fewer input fields will generate a less loaded form and will improve the user experience of checkout flow. Also the descriptive and well-labeled forms are important on mobile devices especially in the checkout process so the user can complete the transactions as quickly as possible (see Figure 44, 45). If we place form labels above the form we can improve readability, ease of use, and clarity. Explaining why certain information is needed will reduce user anxiety when filling out forms on their mobile especially when he wants to add his delivery address or payment details.

The 39.1% of respondents mentioned usability issues during checkout flow on mobile devices. The number of steps in the checkout process are one of those issues (see Figure 26, 39). They explained that checkout flow (see Figure 46) was complicated with many steps which look very crowded on small screens of mobile devices. As a result 66.7% of respondents suggested the checkout will be easy and with less steps (see Figure 42). There are essential steps so the checkout flow will be easy and smooth, labels can be applied in each step of the checkout by numbering and displaying the currently active step (see Figure 54). Also the visual representation like a progress bar which can display in advance the current status of the user, it can be very valuable for the user and reduce his anxiety that he is very close to the end of the checkout process (see Figure 45).

Another topic that respondents (39,1% mobile devices) mentioned, was the access in e-shop with a **guest account** without being mandatory the registration with a user account before they will complete a purchase (see Figure 41, 28). They responded that they can abandon the cart if they need to make a user registration during the checkout flow. According to a study by Baymard Institute, 37% of consumers would abandon the checkout if they realise the site requires account creation. There is further evidence by Commerce Cloud customer data, which shows that 85% of checkouts are made by guests. Mobile users tend to be in a hurry and are even more averse to creating an account than web shoppers (Jeff Dearing, 2018) (see Figure 49). In case that the user has an account in the online shop but he didn't sign in when he started his online shopping but he proceeds to checkout from the shopping cart page, the option should be provided to register and sign in during the checkout process, but it can be a choice. The user should have the option to sign in or make a registration after checkout if the guest option is enabled so the anxiety will be reduced.

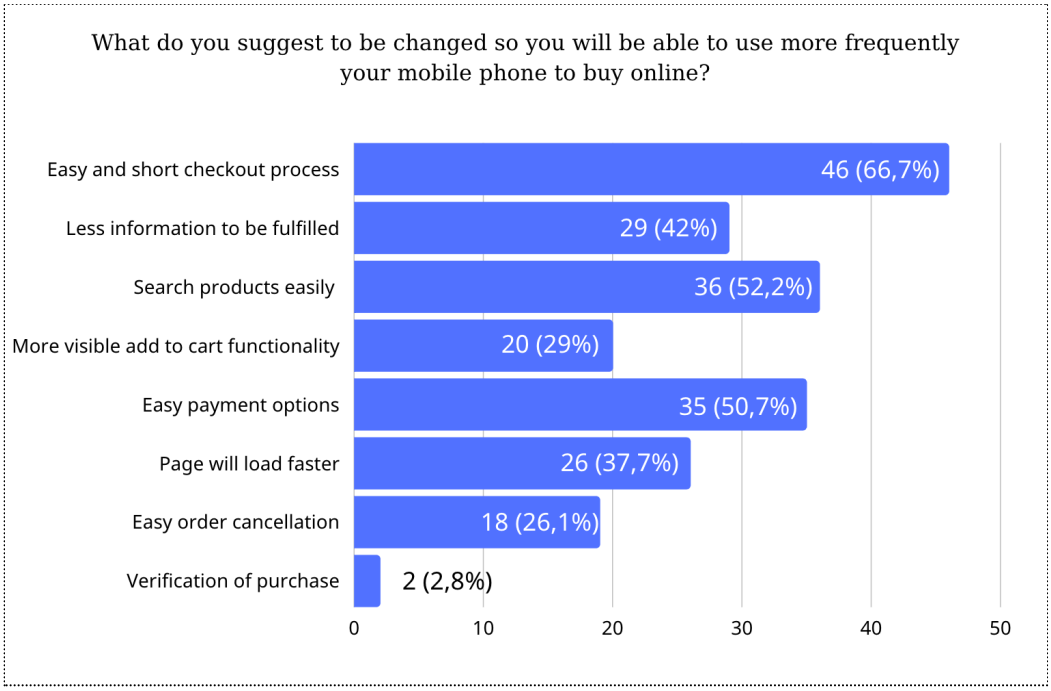


Figure 42: Changes on mobile phone which increase the user's orders (70 respondents)

Easy **access to products** is one of the things that respondents mentioned on the survey either for cart abandonment or user-centered design improvements. The percentage 18.8% of respondents mentioned that they quit online purchases on mobile because they move to complete them on their laptop when before they have searched or saved the products on mobile (see Figure 41). More or less the mobile device is used from the users for searching products. That's why 52.2% of respondents requested that the search for products will be convenient and easy for them on mobile devices (see Figure 42). A solution could be the search bar could be visible and sticky on the top in the main page (homepage) and in the search results page of products, when the user scrolls down the sticky search bar will be still visible (see Figure 54).

Something else that users suggested on mobile devices is the user experience for order cancellation will be possible and easy to find it (see Figure 42). In total 26.1% of people (see Figure 41) mentioned that they can abandon the cart if they aren't able to cancel in an easy way their order. It seems that the process of order cancellation is complicated on mobile devices and the users can't find the button to cancel their order. So a design improvement in the user interface of the online shop, it could help the users to find the way to cancel their order easily and it will be a reason to buy on mobile devices.

4.2 A Suggested guideline for m-commerce

There are some user-centered design improvements that an online shop can implement so the cart abandonment will be reduced and more users will proceed to complete an order successfully on a mobile device. The research of this study highlighted some user experience improvements which synthesize a basic guideline with recommendations that could be applied by people in future who are going to work in the development of an online shop for mobile devices. The categories of this guideline came up and were created from thematic analysis of survey and early findings.
The following guideline represents the four major categories of m-commerce that should be considered when developing an online shop for mobile devices, so the cart abandonment will be reduced (see Figure 43).

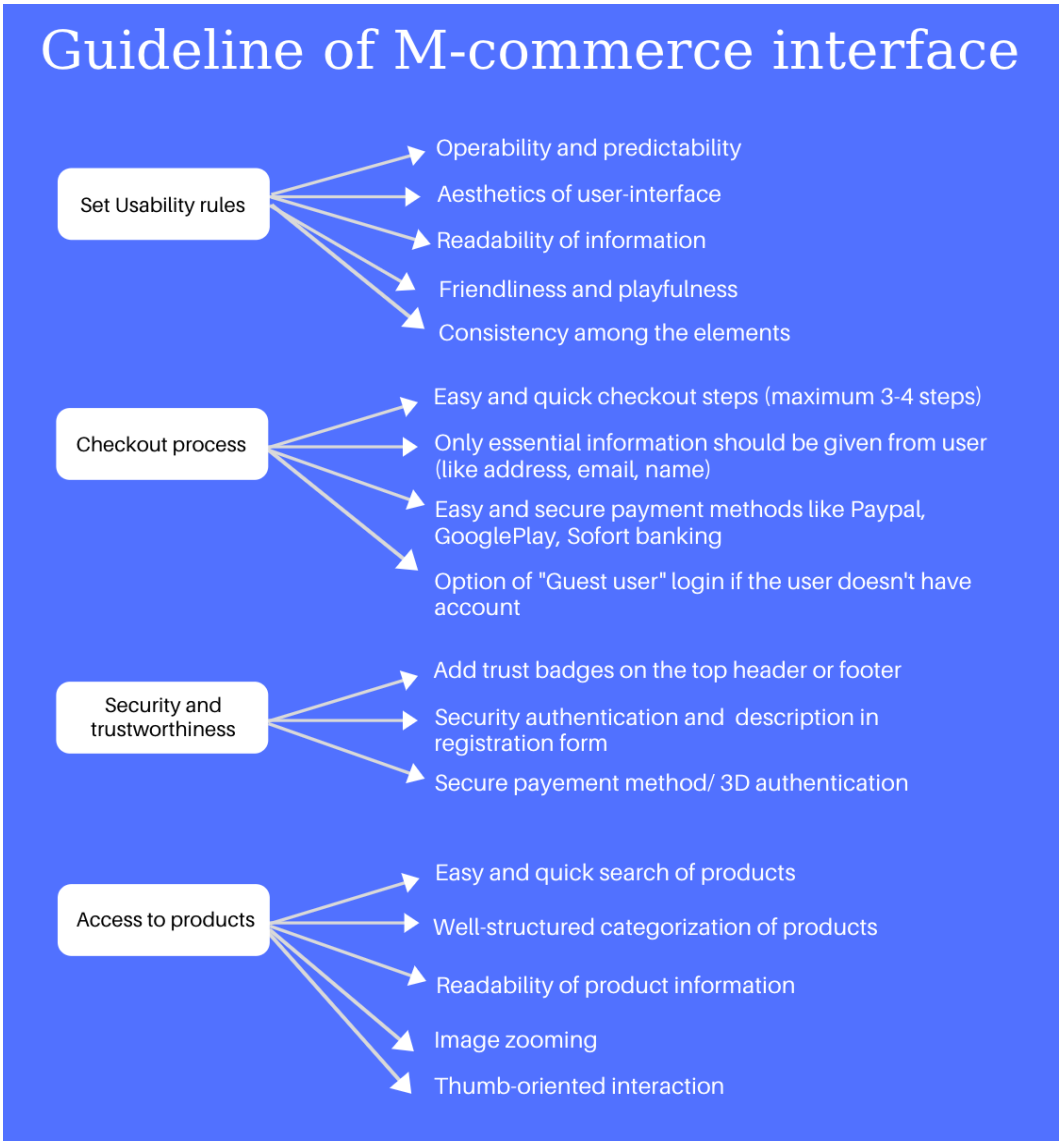


Figure 43: Guideline for designing m-commerce interface

Initially they need to take into consideration the **usability rules** which need to be applied. The first rules are the **operability and predictability** which is the minimal number of user interface elements. It means that the user should be able to read fast the user interface elements for example the content

with images and text without needing to make any effort. The user should recognise easily for example which is the button “Add to cart” in the product details page and not searching to find how he can add the product to the shopping cart. The users mentioned this when they asked what should be improved so they will be more willing to buy from mobile devices (see Figure 42). Another usability rule can be the set of **aesthetics of the user interface** so it will attract the attention of the user. For example if the “Checkout” button which the user clicks it to proceed to checkout flow is small and the color isn’t intense to attract the attention of the user, he will ignore it and make an effort to find it out. This additional effort from the user’s side can affect the willingness of the user to complete a purchase. The **consistency** of elements such as colors, typography, buttons, spaces play a significant role as well. On mobile shopping the consistency of the elements is important so the user will navigate easily through the mobile app. For example if the search bar isn’t always set in the same place, the user will not be able to search what he wants and at the end he will be frustrated and quit his try to complete a purchase on his mobile device. Also **friendliness and playfulness** are important rules that should be applied, so the users will be able to navigate in an environment in which the navigation doesn’t create anxiety to them.

Another important consideration is the **checkout process** for which many users replied that face the more difficulties and inconveniences. The checkout flow should be easy and quick, containing as few steps as possible. This was revealed from thematic analysis (see Figure 26, 41). The users mentioned that **complicated checkout flow** with many steps frustrated them in the small screen of the mobile device. In parallel they pointed out that they prefer to give only essential information during the checkout process so the user will be able to complete fast and easily the purchase. **Easy and secure payment methods** on mobile devices is the main priority for the users so they will be able to feel safe (see Figure 42) and confident to proceed to buy through mobile devices. Payment methods like Paypal, GooglePay and ApplePay can increase the willingness of the user to buy because these methods offer fast payment transactions. Since users use mobile devices on the go, they prefer to have the option to pay only with one click. Moreover the users don’t prefer to make online payment transactions on mobile devices for expensive products because the navigation is happening only with one figure. It means that they can easily make a mistake by accident if an advertisement or a notification displays and distract their attention. So they want to feel sure that any of their payment transactions can take place on laptop/pc where they have a better control. As a result the user experience should be implemented as smoothly as possible on mobile devices so the users can complete a payment transaction even for expensive products successfully. Easy login access like the option of **“Guest user” access** is something that users demand (see Figure 26). This option can help the users to complete a purchase on mobile devices quickly. Since they will not need to add additional information, creating an account when they want to buy only a product for example a bus/train ticket or a concert ticket. It should be given the flexibility to the user to proceed to checkout only with his email address and make a registration when he will decide it. This login flexibility could reduce the checkout time and give to the user more freedom.

One more important thing is the **Security and trustworthiness** of application. In each online shop could be applied security protections like secure payment methods, including 3D authentication. Because the users have secure and trust concerns when buying products from mobile devices. They want to have additional security borders because they feel that risks are more on mobile devices than

on laptop/pc (Figure 26). Trust badges or icons could help to cover the lack of trust. The trust badges will represent the verification of the online shop as a result the willingness of the users to trust the online shop on mobile could be increased. Additionally if the checkout environment is a different user interface and is designed to look like a secure protected environment from the rest of the online shop, it will give a good impression to the user that all the payment transactions through this environment are secured and protected.

Last but not least is the **accessibility of the products** in online shops. The users mentioned that if they were able to search easily and quickly the products on mobile, they will be willing to buy products more frequently on mobile devices. As a result the categories of the products should be well-structured. This will help the users to navigate through all categories and find the products that they want in an easy and straightforward way. This is very important for mobile devices because the screen is small and the search of products is challenging for the users if the navigation is complicated. Moreover the readability of the product information is important on mobile devices since the screen is small on mobile, so images and content should have high quality of readability. The full content of product information should display with the option of “See more” link, so the user will not need to scroll because of the length of the text. The user can click the link “See more” and see all the product information below or in a separate tab which he can close. This solution can be useful so valuable information like the button “Add to cart” will not be hidden. Moreover the user should be able to see the details of the product with the option of image zooming and notice the quality of the product as much as he can. Since the user can’t touch the product like he can do it in physical stores, he should be able to see the product images in high resolution.

5 Conclusion and future work

5.1 Conclusion

The goal of this study was to find the reasons why cart abandonment happens more frequently on mobile devices and provide suggestions for design improvements so the user will shop easily and without any usability interruptions on mobile devices.

This study aimed to answer the following research questions:

1. What are the reasons for cart abandonment on mobile devices ?
    1. Do users prefer buying more on desktop devices and not on mobile devices ?
    2. Why can user interface disturb users and prevent them from buying products on mobile devices or are there other reasons?
    3. Are there security reasons which can prevent users from doing online shopping through their mobile devices ?
2. How should the design concepts be changed to reduce the cart abandonment?

To answer the first main research question, a review of current literature was conducted to investigate what are the reasons for cart abandonment on mobile devices and how user experience design could have an impact on this. Besides the literature review, a survey was conducted with in total of 70 people to get more recent information about the cart abandonment on mobile devices. The data was collected and analysed with the help of thematic analysis. Based on the information gathered the users prefer to buy online more on laptop/pc devices instead of mobile devices.

However on mobile devices the users are searching for and saving products more frequently. The survey and the early studies showed that the cart abandonment happens more on mobile devices because the users face many usability issues especially in the checkout process which includes many steps and in the small screen of a mobile device the usage is complicated and not well-structured. The users reported security concerns and less trust to make payment transactions on mobile devices especially when the secure payment methods like Paypal and GooglePay are missing from the checkout flow. Moreover the lack of trusted signs on online shops make the users feel inconvenienced to trust the shop and start an online purchase. Also the content visibility and readability is harder and the users can't easily find the information that they are looking for.

To answer the second question the literature findings were synthesized in combination with conducted empirical study (the survey). The respondents of the survey mentioned different design suggestions that could help them to be able to complete a purchase through a mobile device. The findings were used to create a guideline for m-commerce interface design that could be useful for ux designers, products managers and developers.

As an outcome, this study suggests a basic guideline with possible design improvements that should be applied so the cart abandonment will be reduced and the usability of online shops will provide a better experience to the users. It includes four different parts, 1) usability rules like operability,

friendliness and consistency among the elements in the user interface, 2) checkout flow improvements, 3) security methods and trust elements and lastly 4) the accessibility to products. This guideline could be useful for the development of any online shop for designers, product managers, developers and business people.

5.2 Limitations

This study had limitations, consisting mainly of sampling method, sample size and contact with the users. All these three limitations will be presented below in more details.

Firstly, the sample size of the recruitment was limited with age groups. Since all the participants were recruited from social media, the age group of 55+ was missing because these ages aren't so active in social media, as a result I didn't receive enough responses from the older population to have data about the difficulties that these ages face. Also if the sample size was larger than 70 survey respondents might have provided more and different views and insights.

Secondly this study could have the interview recruitment (face to face interview) as a sampling method. This wasn't easy to achieve because of the social distancing of covid-19 pandemic period. Therefore I missed more useful and detailed information about cart abandonment on mobile devices.

Thirdly, another limitation of the study was the in-person feedback from the users. The user testing is missing in real time. The users could be tested when they are using online shops through mobile devices and the issues that they are facing in real time. This user interaction could allow me to point out more usability issues and see the user interaction and get feedback in more specific things.

Finally, this study could incorporate more values-elicitation methods – such as value sketches and value-oriented mock-ups, prototypes, or envisioning cards – might have identified additional the user experience.

5.3 Propose future studies

Further studies could be more extended and include the following additional investigation. First of all a follow-up survey with a larger sample size and with extended age groups would be helpful to further investigate findings regarding a broader subset of society. Also the survey could be combined with interviews and user testing, so a comparison will be feasible among different online shops on mobile devices. This further study could highlight the different techniques in user experience design that are used in online shops with tools in user testing and ux analytics.

Secondly, a further study could investigate which products and why users like to buy through mobile devices more frequently. Also which are the categories of products that the users want to have a quick and straightforward purchase on mobile devices. For example, probably the users prefer to buy only books or jewelries through mobile devices and not kitchen equipment, clothes or travel tickets because

the checkout process is more complicated and they want to have a bigger screen to go through all the steps more carefully. This investigation could release some new ways in usability methods so the users will feel confident to complete a purchase with products which are more expensive through mobile devices.

Finally, another study could conduct research about the payment methods that could prevent cart abandonment on mobile devices and make the users feel more secure and have more trust in buying expensive things through mobile. This study could find a solution to present easy and quick payment methods so the user will not need to provide many personal details about his bank account. This study could ensure that online shopping through mobile devices is a secure process as it is on desktop devices.

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APPENDIX A

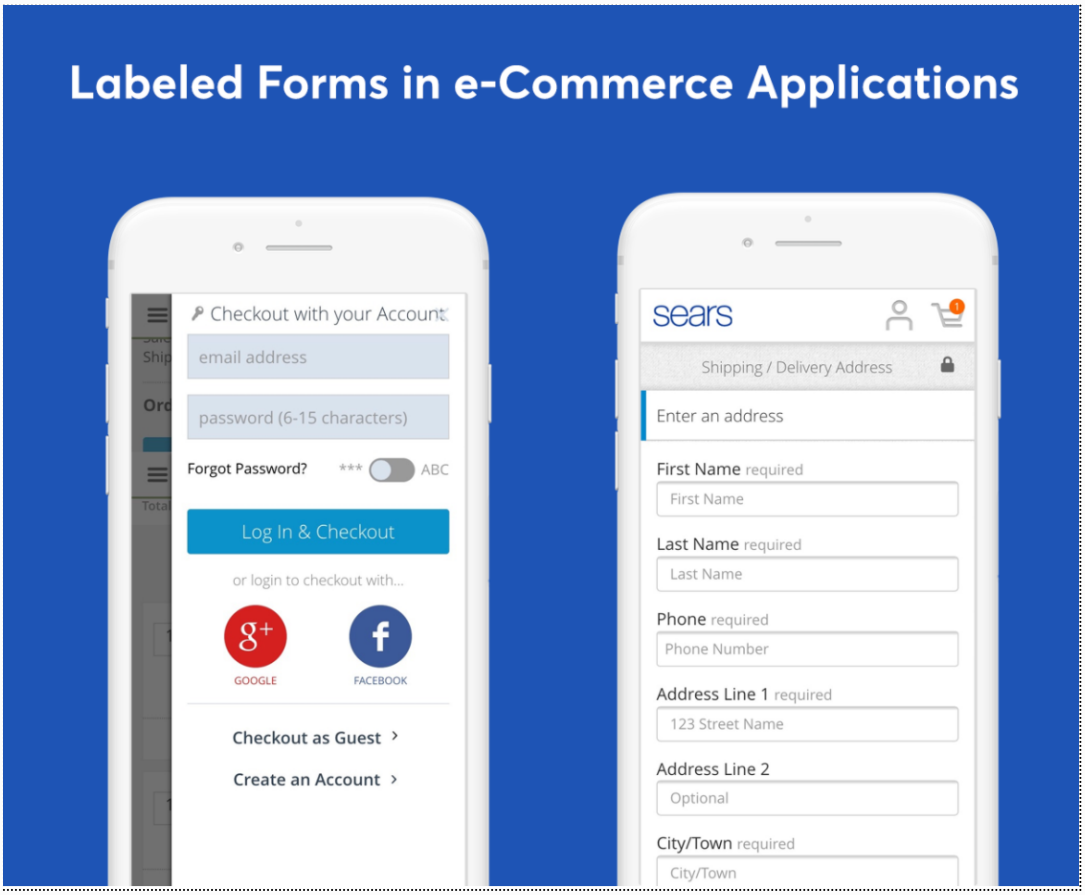


Figure 44: Labeled and well-descriptive forms

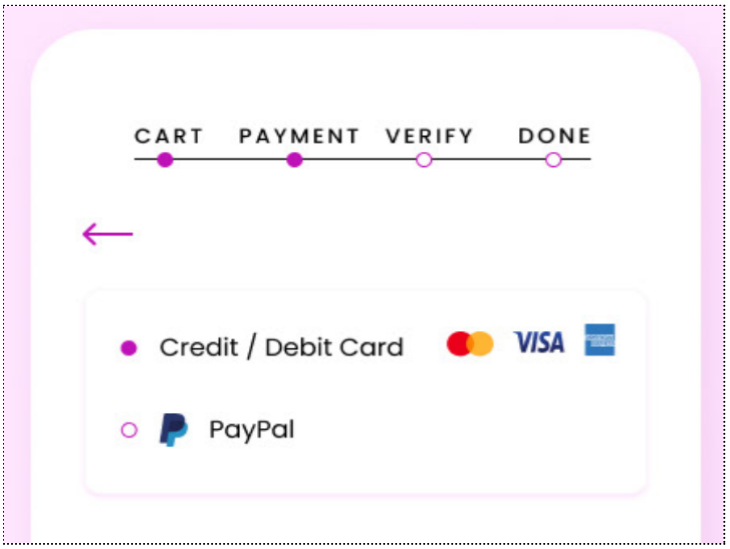


Figure 45: Easy steps in checkout flow - Design mockup from Thaksha Krishnagumar https://www.behance.net/thakshakrish

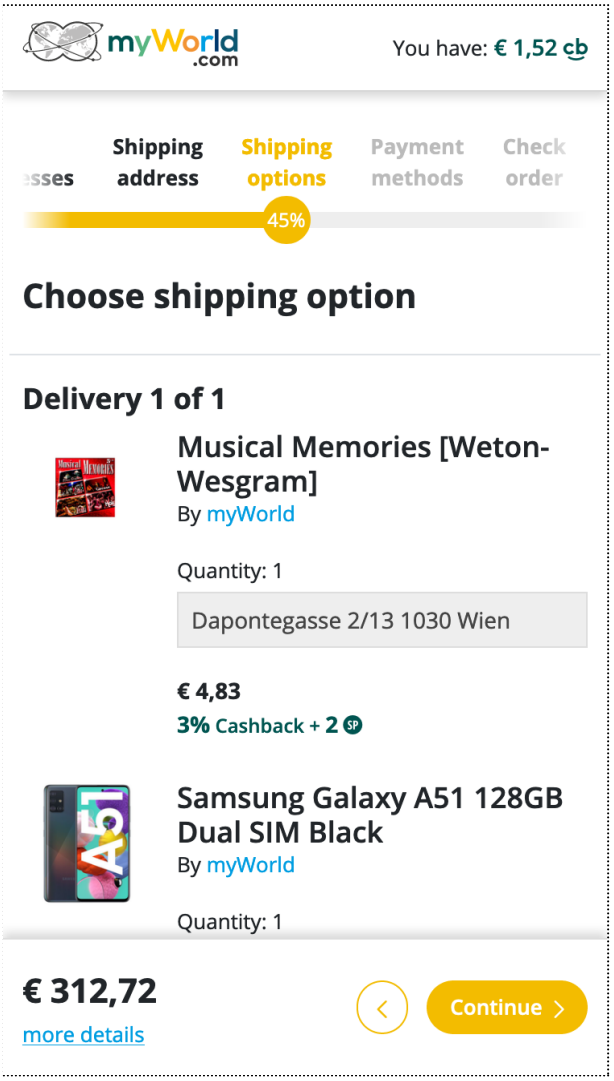


Figure 46: Long checkout process with percentage (Wrong approach) - sticky footer (Good approach in mobile version) myworld.com

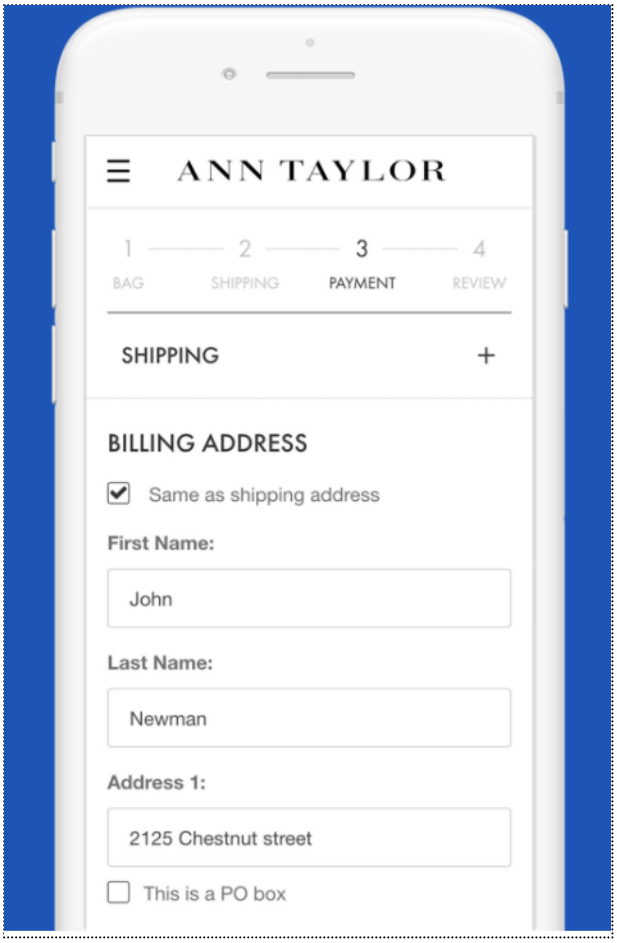


Figure 47: Checkout process with numbering steps (Correct approach) - missing sticky footer https://www.anntaylor.com/

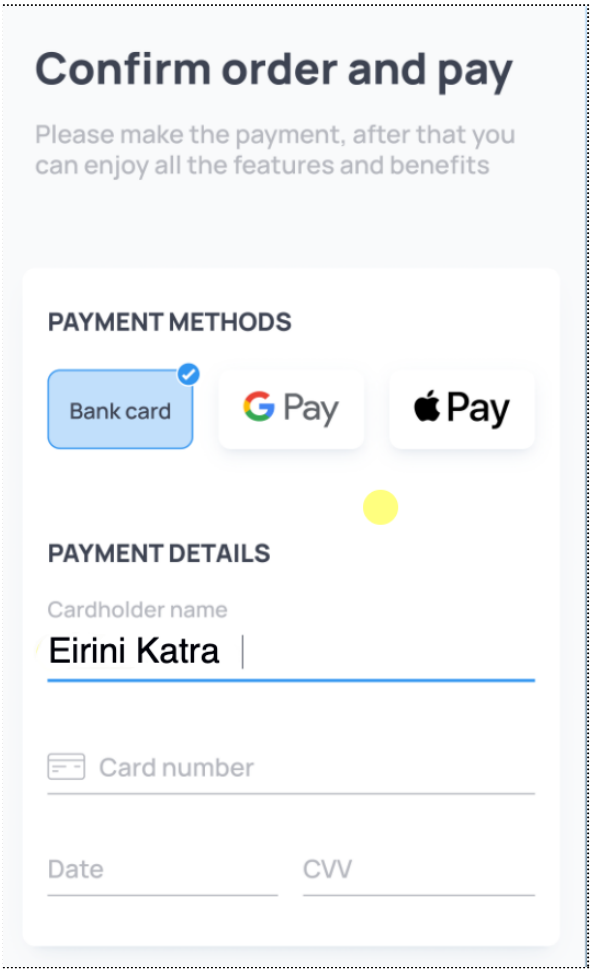


Figure 48: Design mockup from DiSOFT https://dribbble.com/disoftus

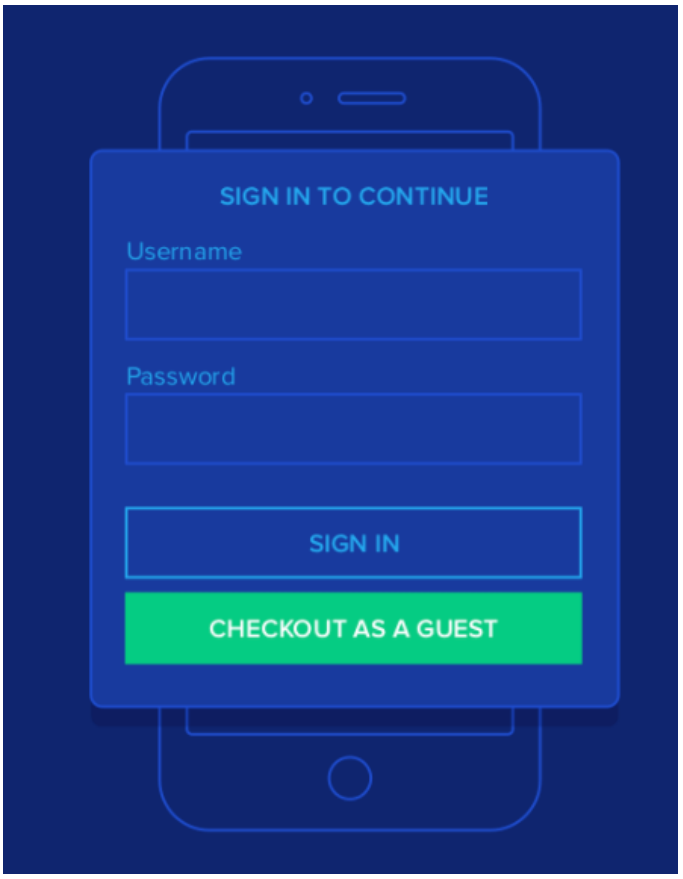


Figure 49: Many users can't find "Guest" option in checkout

Figure 50: Trust badges

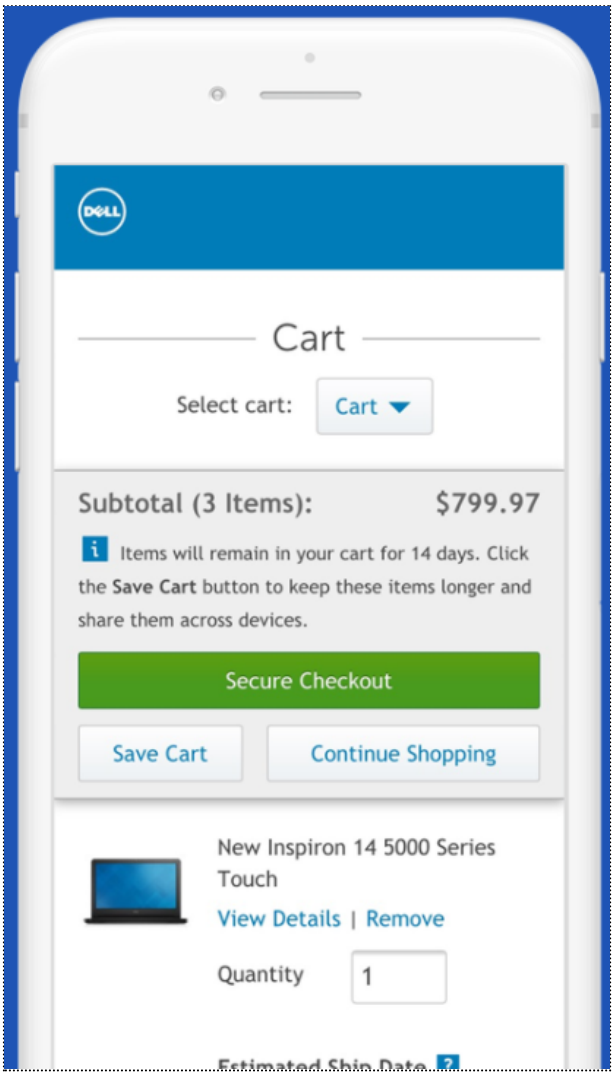


Figure 51: "Secure Checkout" button

https://www.dell.com/de-at

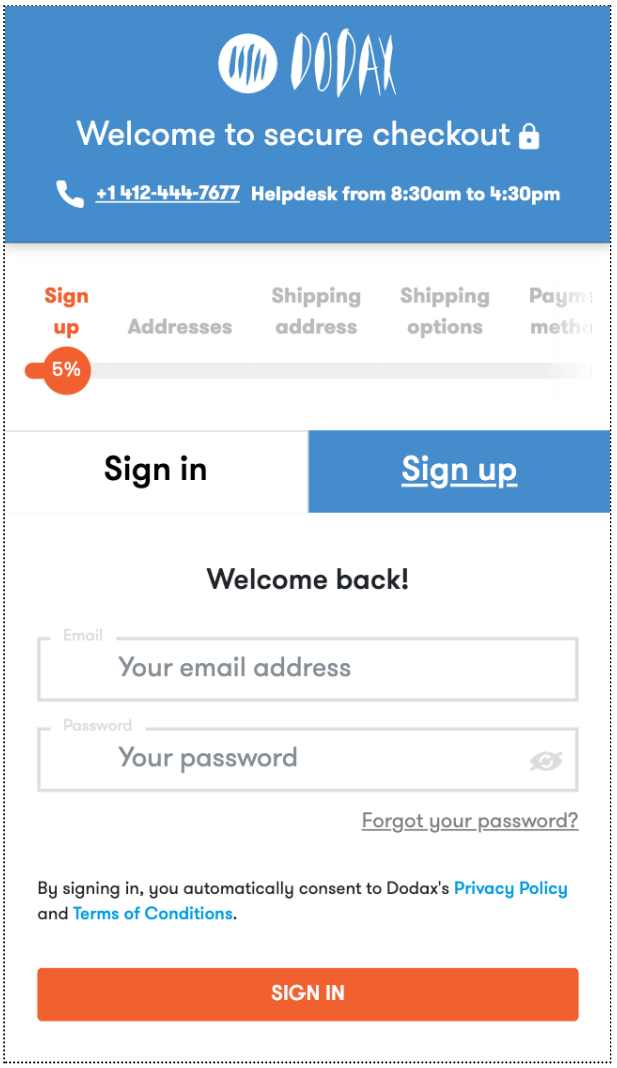


Figure 52: Trusted icon on the top header

Source: www.dodax.com

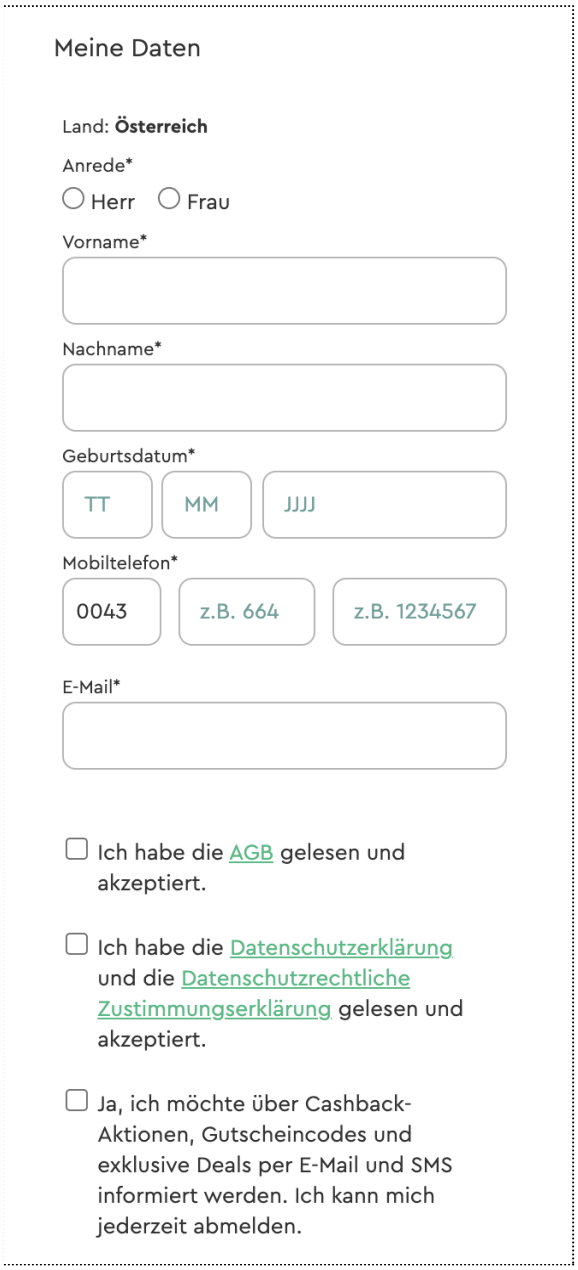


Figure 53: Registration form in myworld.com site

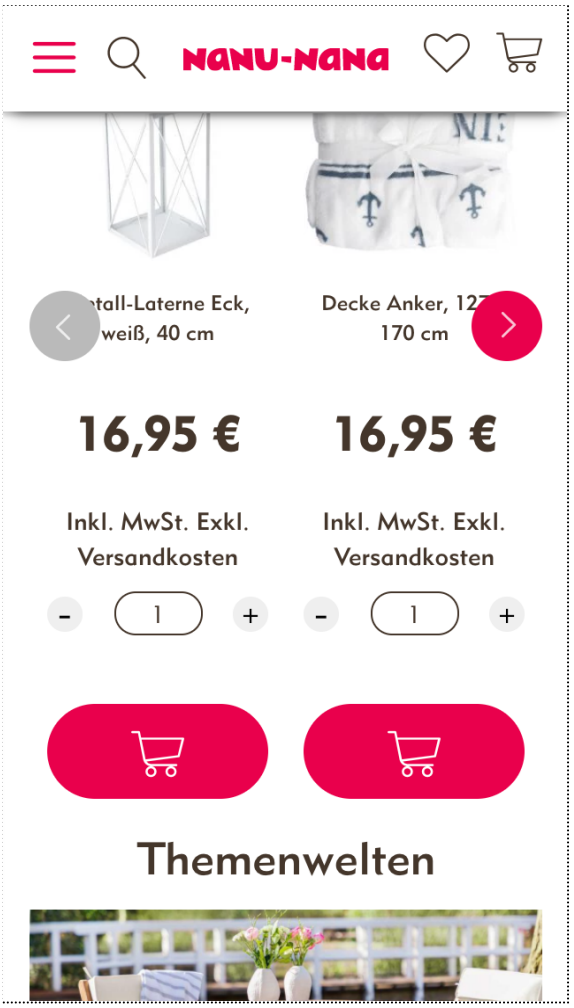
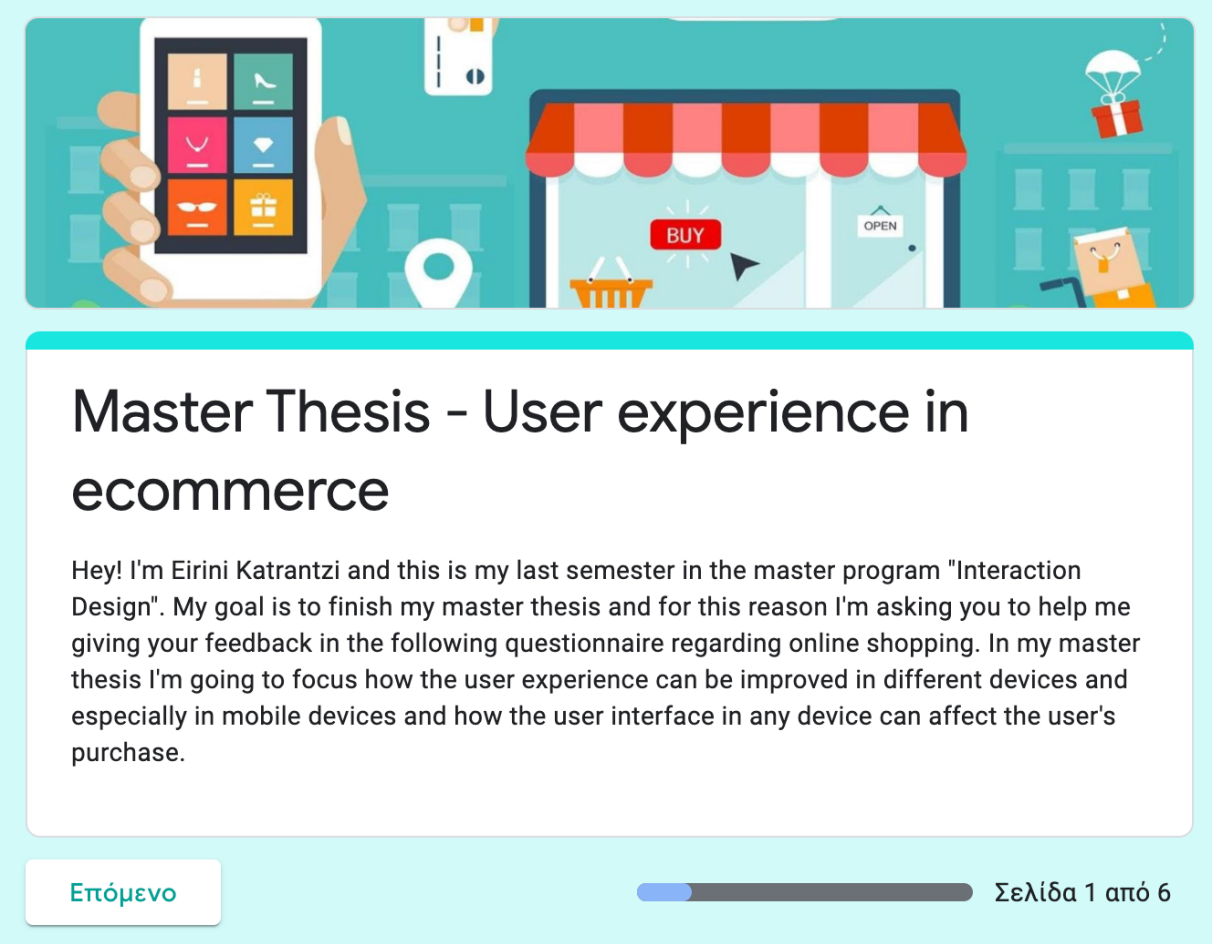
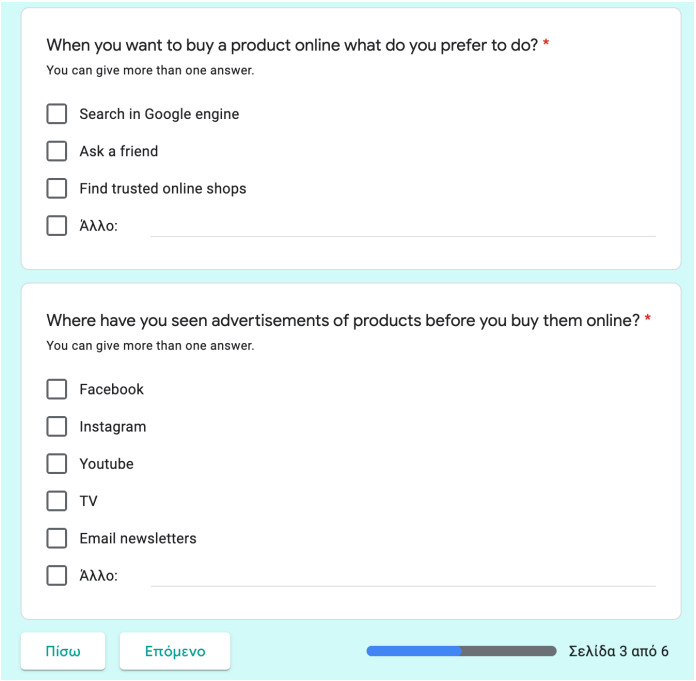
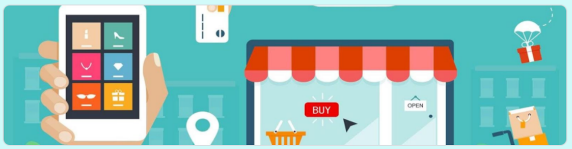


Figure 54: Sticky search bar in.nanu-nana.at

Appendix B


BUY
OPEN
Master Thesis - User experience in ecommerce
Hey! I'm Eirini Katrantzi and this is my last semester in the master program "Interaction Design". My goal is to finish my master thesis and for this reason I'm asking you to help me giving your feedback in the following questionnaire regarding online shopping. In my master thesis I'm going to focus how the user experience can be improved in different devices and especially in mobile devices and how the user interface in any device can affect the user's purchase.
Επόμενο
Σελίδα 1 από 6


When you want to buy a product online what do you prefer to do? *
You can give more than one answer.
Search in Google engine
Ask a friend
Find trusted online shops
Άλλο:
Where have you seen advertisements of products before you buy them online? *
You can give more than one answer.
Facebook
Instagram
Youtube
TV
Email newsletters
Άλλο:
Πίσω
Επόμενο
Σελίδα 3 από 6



Master Thesis - User experience in ecommerce

* Απαιτείται

Personal Data

Please answer a few things about you.

How old are you? *

- 16-25
- 26-30
- 31-35
- 36-45
- 46-55
- over 55 years old

Gender *

- Female
- Male
- Prefer not to say
- Άλλο:

What is your current job? *

Η απάντησή σας

Πίσω Επόμενο Σελίδα 2 από 6

When you want to buy a product online what do you prefer to do? *

You can give more than one answer.

- [ ] Search in Google engine
- [ ] Ask a friend
- [ ] Find trusted online shops
- [ ] Άλλο: _____

Where have you seen advertisements of products before you buy them online? *

You can give more than one answer.

- [ ] Facebook
- [ ] Instagram
- [ ] Youtube
- [ ] TV
- [ ] Email newsletters
- [ ] Άλλο: _____

Πίσω Επόμενο Σελίδα 3 από 6

How often are you doing online shopping ? *

- ( ) Once per year
- (•) Once per month
- ( ) Once per week
- ( ) More than 2 times per month
- ( ) Άλλο: _____

Which is the reason that you prefer to buy products online? *

You can give more than one answer.

- [x] Easy and quick
- [x] Save time and money
- [x] Better discounts and deals
- [ ] Make more comparisons in products in short time in many different shops
- [ ] Άλλο: _____

Which are the reasons that could make you quit of completing an order in a mobile device? *

You can give more than one answer.

- [ ] It's needed a registration to the online shop to complete the order.
- [ ] I can't see very well the product details in my mobile device.
- [ ] I don't feel that it's secure to buy online in my mobile device
- [ ] Many fields should be fullfilled to complete the order and I can't do it easily in my mobile device.
- [ ] There are many steps to complete the order.
- [ ] Missing payment option that I prefer to use when I'm using my mobile device.
- [ ] I prefer to save the products in my mobile device and continue the purchase of them in my laptop
- [ ] Άλλο: _____

Do you prefer to install the app of your favourite shop in your mobile device? *

- ( ) Yes
- ( ) No

Do you prefer to install the app of your favourite shop in your mobile device? *

- ( ) Yes
- ( ) No

If you answered "No" why you don't prefer to install it?

Η απάντησή σας

Πίσω Επόμενο Σελίδα 4 από 6

Ενότητα 5 από 6

General questions

Περιγραφή (προαιρετικό)

What do you suggest to be changed so you will be able to use more frequently your mobile phone to buy online? *

You can give more than one answer.

- [ ] Easy and short checkout process.
- [ ] Less information that I need to fullfill before I complete a purchase online.
- [ ] Search easily products in online shop using my mobile phone.
- [ ] More visible the add to cart functionality
- [ ] Easy payment options
- [ ] Pages will load faster
- [ ] Easy order cancellation
- [ ] Άλλο...

Ενότητα 6 από 6

Thank you for your feedback! :)

Περιγραφή (προαιρετικό)

Your feedback is valuable!