

DEVELOPMENT OF A MOBILE ONLINE BANKING UX/UI PROTOTYPE

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Abstract

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Abstract <p>In today's world, where the mobile market comes to the fore, every industry needs to rethink its digital strategies so as not to be in the losers. This need does not bypass the financial industry. Most banks have already developed online banking services, but in order to be able to compete in the mobile world, they need to create functional mobile banking solutions. However, today it is not enough to create a working mobile application - it must meet all the advanced criteria of usability and provide the best user experience.</p> <p>User-oriented approaches are used to develop suitable applications, which include extensive research and ongoing testing involving the users themselves in the workflow.</p> <p>This thesis aims to create an interactive prototype of mobile banking using the principles of a user-oriented approach with the participation of European mobile banking users in the development process. The thesis explores the concepts of mobile applications, online, and mobile banking. Also, attention is paid to the review of user experience, user interface, usability, prototyping, as well as a review of modern approaches to the development of user experience.</p> <p>For the creation of a prototype, a design tool with an interactive prototyping function was used. The development did not include any technical implementation and followed the user-centered design principles to facilitate the process of user research, collecting and interpreting data, and developing a prototype. In the development process, the inductive analysis of data from qualitative research was used.</p> <p>The whole thesis was constructive research that led to the successful development of an interactive prototype of mobile banking, taking into account the main user preferences. Usability testing helped in evaluating the success of the prototype developed. The prototype evaluation showed that the developed mobile banking, in most cases, is easy to use and provides a satisfactory user experience.</p>		
Keywords Mobile Application, Mobile Banking, User Experience, User Interface, Usability, Prototype		

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LIST OF ABBREVIATIONS

UX	User Experience
UCD	User-Centered Design
UI	User Interface

1 INTRODUCTION

Thesis Background

It is hard to imagine life without the use of modern technology today. Not so long ago, the very existence of smartphones seemed almost impossible, but now, many of us cannot imagine what it is like to spend at least one day without our mobile device. The rapid development of modern technologies, and, as a consequence, the growing popularity of the mobile application market led to the fact that, according to the data of the analytical company App Annie (2019), in 2019 the growth of the mobile application market amounted to 20% compared to the previous year, reaching \$23 billion. Using mobile applications, we now have access to fast communications, mail, taxis, food, clothes, and much more. The possibilities offered by mobile phones are endless.

The mobile channel is becoming increasingly important in the landscape of remote interaction between banks and their customers. The penetration of mobile banking is accompanied by increased competition in this environment. Consumers are no longer ready to be content with a simple application but are looking for a complete - functional, convenient tool to manage their finances through a mobile device. According to data from analyst firm Forrester (Castellon 2019), more than one-third of European online adults are active mobile banking users, and they prefer mobile apps to mobile websites for banking. This preference sets the banking sector apart from many others, where mobile websites are used more frequently than apps.

The same report states that (Castellon 2019):

User experience continues to be the main focus for banking applications. Alongside the addition of new capabilities to their banking apps, financial institutions should also ensure that the most popular tasks – checking an account balance, finding a particular transaction, and transferring money to another account – can be concluded in the fastest and most intuitive manner.

The best way to focus on user experience, understand it, and improve issues of any digital service or product is to follow the user-centered design approach during the whole process of software development.

This thesis is an attempt to understand mobile banking users' scenarios based on users' tasks and make a mobile banking application that can help complete these tasks more manageable. This work describes the implementation of the user-centered design of a

mobile banking application prototype, which focuses on the features described by the users.

Research Question

This thesis aims to find an appropriate concept for mobile banking applications in Europe by applying a user-centered design approach to software development. So, the main question of this research is: “How does the modern mobile banking application with a focus on the efficient and quick execution of users tasks look and what features does it have?”

The application must meet the user-centered design approach as well as usability principles. In the planned research, there will be no particular commissioning company. Instead, it is intended to conduct independent research by studying the user behavior and preferences in terms of UX and functionality of mobile banking in a qualitative method. After the inductive analysis of this research, findings will be applied in the development of an interactive prototype. The prototype will be then tested using both qualitative and quantitative approaches to usability testing.

As a result of this thesis and a practical interpretation of an answer to the research question, a mobile banking interactive prototype that efficiently and effectively satisfies users' needs will be created.

To come with the abovementioned result this study is intended to find the appropriate answers to the following sub-questions:

- Are users satisfied with current mobile banking solutions of European banks?
- What are the issues which need to be considered to improve mobile banking user experience?
- How does prototyping help in software development aimed at user experience?

2 MOBILE DIMENSION

The modern world is impossible to imagine without computers, smartphones, and the Internet. Every day we are faced with the fact that we have to look for the right information on the network, make virtual purchases, communicate through social networks, and do a significant part of our everyday duties online. People use a large number of applications, both computer and mobile, to perform these tasks.

2.1 Application

2.1.1 Definition of Application

An application program is a program designed for direct interaction with the user and outlined to perform specific individual tasks or a class of tasks in a specific field of activity of the user. Since every program has a particular application for the end-user, the term "application" or "app" is commonly used (Techopedia Inc. 2019). In most operating systems, application programs are not able to access computer resources directly but interact with hardware, kits, and other programs through the operating systems and other programs' instruments, for instance, compilers, drivers, assemblers, and API. The term is used to distinguish application programs from programs that directly control computers and are part of system software. (Ziff Davis 2019)

2.1.2 Mobile Application

With the advent and rapid development of mobile technologies, applications have entered a new stage in their history and began to attract a lot of attention and activity from both developers and users in their new form - a mobile application - which is a specially developed application for a specific mobile platform. Nowadays, there are two dominant mobile operating systems for which the majority of developers produce their applications: Apple-developed iOS and Google-developed Android (Mukherjea 2016, xiv).

The mobile application market is growing at a tremendous pace every day, and its stock of growth today seems almost unlimited. The number of applications predicted to be downloaded by 2020 reaches 286 billion (Clement 2019). Moreover, in 2019, more than three billion people use smartphones, which makes up about 35% of the total population (Holst 2019). At the same time according to GSMA Intelligence report (GSM Association 2019, 6) more than five billion people right now have mobile devices, which means that 67% of the world's population have cellular-ready devices such as cell phone, tablet or IoT devices.

Such a dynamic growth of mobile users, as well as the constant development of technologies, indicate that the global mobile applications market is in a phase of active expansion. It is one of the most promising markets, which opens up vast opportunities for IT companies.

Mobile applications have opened up the possibility for us to perform familiar and previously known tasks in a completely new way. It is customary to distinguish three types of technical implementations of mobile application:

- Native app – is a mobile application developed for a specific mobile platform and directly installed on the user's device (taking up a certain amount of device's memory). Typically, an application is developed in a high-level language and compiled into native OS code, giving maximum performance and the ability to use various software and hardware features of the device. One can install native apps through a specific application store of the OS, such as the App Store on iOS and Google Play on Android.
- Web application – is a mobile web site specialized and adapted for viewing and functioning in a mobile device's web browser as a native app. The site may include interactive components implemented by the usage of JavaScript, HTML5, browser APIs.
- Hybrid app -is a mobile application that includes a browser component. In this case, a native part of the mobile application is most often used for navigation and integration with the OS for gaining all the possible device features, and the web component is used to display content. Ordinary users often cannot distinguish such an option from a native mobile application. (Mukherjea 2016, xiv)

Native Application vs Hybrid Application

Let us consider the two most popular types of applications. Choosing the right mobile application model is a very important stage in its development, which is influenced by several factors, such as the technical assessment of the developers, the required level of security, the need for access to information on the device, the impact of internet speed on the application; whether the application is single or multi-platform. (Budiu 2016)

Native Application

Native applications allow companies to make the application according to major users' individual needs so that later they are comfortable using it parallel to the website or another channel to which he is already used to. This integrity is a significant advantage of native applications.

In comparison with another type of technical development of mobile applications, Daniel Rowles (2017, 117-118) identifies the following features of native applications, which can be divided into advantages and disadvantages of them. Some advantages, for instance, are:

- Easy access to device features like geographic location. The geolocation designation allows companies, for example, to adjust their loyalty or promotion programs. Users can receive notifications when they are near physical stores, or have the opportunity to receive a regional discount. That can also be considered as part of another advantage – monetization
- Native apps are easy to use for monetization. In addition to the fact that this type of application can be provided to users in a paid form, which is allowed by all application stores, they can include the subscriptions upon purchase of which the user can be provided with additional application functions
- The data of actions (or inaction) of the user can be easily collected and analyzed, thereby facilitating the assessment of the effectiveness of the entire application or its functions
- Native applications, as a rule, work, and "feel" better. Web applications are sometimes created to simulate native ones, but they are limited by the speed of the Internet and design capabilities
- In terms of security, the native application also has the advantage that it can use the device itself as one-time password hardware in cases such as two-factor authentication (Bostrøm Jørgensen 2014).

Possible disadvantages:

- Native applications are often more expensive to develop, especially for companies that need applications on cross-platform OS;
- Each application store must approve native applications, and the process of attracting the attention of users to it can be difficult (if this is not an application for internal use in the company).

Hybrid Application

Creating a hybrid mobile application has proven to be a promising alternative to the native approach to application development in many projects. This idea allows us to develop a unified mobile application using web standards and delivering it across several mobile platforms with virtually no changes (Malavolta et al. 2015). As mentioned earlier, a hybrid application is a bit of a mobile site written in HTML, CSS, and JavaScript. It differs from

ordinary sites in that it works only in a particular browser shell and has access to various layers of the operating system using the native component.

De Andrade and Albuquerque (2015) identify the following advantages of hybrid applications:

- The standard code allows writing the functional part once, as well as the interface part of the application, which will be executed on the server-side for use on various mobile platforms;
- The ability to use device hardware using native shell via JavaScript;
- The ability to use offline some parts of the application that do not require a permanent Internet connection.

As well as the following disadvantages:

- Some native functions may still be inaccessible through the native shell;
- Hybrid applications access the system functions of the device using various plugins, which, in turn, are nothing more than a JavaScript wrapper for the native code of the platform form. It significantly reduces application performance;
- The style of the application may change, but the logic of it remains the same, regardless of the platform. What may not correspond to the principles of the user interface of a particular platform;
- Hybrid applications will not be able to reproduce all the features of the user interface and the overall style of the platform.

The main interest, not only in this work but also in the modern market of mobile applications, is represented by native applications. This type of application is most widespread and provides companies with a unique opportunity to engage customers in close and long-term relationships, due to interaction with a wide range of hardware and a greater focus of such applications on the user. This means that when interacting with a user, the mobile application interface works, as a rule, more quickly and efficiently. Therefore, in this work, the term “mobile application” is understood as meaning the native mobile application.

2.2 Online Banking

Sharil Sharma (2014) identifies online banking as follows:

Online banking is an electronic payment system that enables customers of a financial institution to conduct financial transactions on a website operated by the institution, such as a retail bank, virtual bank, credit union or building society. Online

banking is also referred as Internet banking, e-banking, virtual banking and by other terms.

The history of online banking in Europe begins in Scotland in November 1982. The Bank of Scotland, together with Nottingham Buildings Society and British Telecom, developed a remote banking system called Homelink. The main advantage of the new development was that at any time, the client could manage accounts. From this time, we can start a report on the development of online banking. (Sharma 2014)

Online banking works in two directions: Internet banking for servicing individuals and Internet banking for servicing legal entities. The specifics of each area are entirely different, so in this work, let us consider one area - online banking for servicing individuals.

2.2.1 Concept of Online Banking

The nature of online banking is that a bank remotely can provide the client with the whole range of banking services that the client could receive by coming to the bank's office. Today, many operations are conducted online, which means real-time operations.

Customers now have the opportunity to control their accounts anytime, anywhere, while banks can reduce their costs, decreasing the number of branches and branch employees. (Satheesh Raju 2015, 112-114)

In order for the client to be able to use this software, (s)he needs to agree on remote service at the bank and get or create the necessary identifiers and passwords for entering the system, which are typically not the same as for any other services of the bank.

Connecting and maintaining remote access is usually free of charge (Sharma 2014).

Currently, in the financial market, online banking is characterized by three level types: information, communication, and operational (Gansle 2019):

- **Information level** provides the opportunity for the customer to obtain some information about a credit institution, mainly of an official and marketing nature. The Bank places marketing information about its services and products on the site. It posts a story about itself, ratings, annual reports, and other public information that may be useful to bank customers. This type of online banking does not bear any financial risks, as Information transfer from a client to a credit institution is not supported;
- **Communication level** allows customers to interact with a credit institution in terms of information exchange, sending, usually by e-mail, any information, and receiving certain information in response. For example, a client can send requests of various

kinds, messages about changes in his details, applications for loans, in response to which statements can be received on client accounts for a certain period, the history of transactions, confirmations. For example, many banks provide an opportunity for a client to apply for a loan through Internet banking. If the bank requires any additional documents, the bank contacts the client, and in a separate order, the client provides all the necessary documents to the bank. Either the bank can automatically approve this application based on a permanent salary project with a client for a certain period, or a permanent payer with a good credit history. This type has a connection with the internal system of the bank since the client sends their data to it. Therefore, this server should already have a reasonable degree of protection. To this end, means should be developed to control, monitor and notify the bank's management of any suspicious transaction or any attempt to unauthorized access to classified information;

- **Operational level** allows implementing a full-fledged distance banking service, providing customers with the opportunity to carry out all operational services provided by the bank online. In particular, a client can pay bills, carry out conversion operations, transfer funds, deposit funds. Therefore, the highest method of protection against unauthorized actions by attackers should be developed here. The bank must continuously monitor and upgrade this system. This is one of the most costly financial activities of the bank, but at the same time, this type brings many customers. Furthermore, clients are the primary income of the bank. (Gansle 2019)

Each of the listed levels of implementation of electronic banking technology has its hardware and software tools, the ability to access information resources of a credit institution, and internal banking systems. In this work, attention will be paid to the operational level of online banking, since participating in the most significant number of interactions with the user and in attracting new customers, it requires the most attention in planning, design, and development.

2.2.2 Advantages of Online Banking

To strengthen the understanding of the importance of online banking and the need for its development, it is necessary to analyze in more detail the advantages that its existence brings.

If a few years ago in online banking there was a small number of operations that the bank could provide to its customers, now the services and products provided are almost equal

to those services and products that are provided in bank branches. That brings several benefits for both customers and banks:

Customers

Considering the essence of Internet banking, note the advantages for which it is convenient for the client to use this service:

- Tracking operations on accounts is an opportunity without an ATM to find out how much money available in the account. Customers can also look at the data on all the deposits tied to the card, and also find out what operations s(he) performed during the specified period: purchases, payroll, transfers, cash withdrawals and everything else (Srivastava 2008, as cited in Singhal and Padhmanabhan 2008).
- Besides comfort, this saves time as there is no need in the majority of cases to go to the bank or spending time in lines anymore. No need in adaptation to the bank branch's work schedule brings a possibility to perform all operations even at night. (Beer 2006, as cited in Singhal and Padhmanabhan 2008)
- Many operations for which the branch bank takes a commission can be performed through the online bank free of charge or for a lower fee. (Williamson, 2006, 2)
- Bonus programs. Working with an online service is not only free of charge, but it can often give additional bonuses and cashback for paying for goods and services via the Internet; (Chen 2019)
- Higher deposit rates. The deposit can be made at the bank, but many offer to do it via the Internet, and in this case, the interest will be higher. (Chen 2019)

Banks

Hosein describes the following (Compaq, 2001, as cited in Hosein 2010) business drivers for online banking:

- Economic benefit due to reduction in customer service costs as customers perform all the duties themselves; despite the fact that the bank incurs significant costs for the development and maintenance of services, they pay off over time due to the growth in the number of customers on remote services as well as reductions in staff, branches, and office stuff;
- Expanding customer base regardless of geographic location as online banking provides flexibility and convenience for them. Improving competitiveness through the development and the implementation of new banking products with their rapid distribution attracts new customers;

- Reduced customer service time, increased bank throughput, speed, and quality of customer service due to acquiring and analyzing the data can improve customer loyalty and engagement.

To summarize after the above advantages. Online banking has a vital role in life, not only of the banking business but also of the client. Every year, banks increase the possibilities of online banking, and the limit has not yet been reached. Banks are conducting large-scale modernization of online banking, and in the future, we will see many new opportunities in this area. One of the main tasks at the bank today is to transfer as many customers as possible to remote servicing.

2.3 Mobile Banking

The main task mentioned previously can be achieved through the active implementation of mobile banking.

Basics of Mobile Banking

The first mobile banking systems appeared in the world in 1999, when European banks starting with Norwegian Focus Bank (now Danske Bank), offered their customers to use this service using SMS messages (Arntzen 1999). Moreover, even earlier, there was such a type of banking as managing payments from a bank account using instructions from the bank's call-center, SMS banking, and the first Java programs. However, only with the advent of later developments that make this process relatively comfortable, mobile banking began to gain fans. (Barnes, Corbitt 2003, 3)

Mobile banking is a way to manage a bank account using a mobile device. As a rule, to do this, a customer needs to download an application to a mobile device.

Mobile banking is the most convenient program and has extensive potential for customer opportunities. Its software is carried out using the Wireless Application Protocol (WAP) technology, and the second essential element is a smartphone or a cell phone. Mobile banking provides round-the-clock and almost full-featured access to online banking services. (Barnes, Corbitt 2003, 3)

Mobile Banking Today

Mobile banking is growing and becoming an increasingly popular way of banking services for many customers. A study published by Raddon Research Insights (Raddon 2019) noted that growth in mobile banking usage increased from 7% in 2010 to 41% in 2017.

Mobile banking users are among the most attractive customers for financial institutions. Such clients conduct more monthly debit card transactions and online banking transactions than customers who do not use this service channel. In addition, approximately 7 out of 10 (71%) users of mobile banking consider it “very important” for them to have a bank branch or an ATM next to their work or home. Among those who do not use mobile banking, the presence of a bank branch is essential only for 58%, and the presence of an ATM for 46%. (Raddon 2019)

Mobile banking affects the use of bank branches, ATMs, and online banking. According to the study, mobile banking users are 33% less likely to visit outlets, although the presence of branches near their home or work is quite crucial for them. Almost a quarter (23%) of all mobile banking customers indicate that they use ATMs more often. (Raddon 2019)

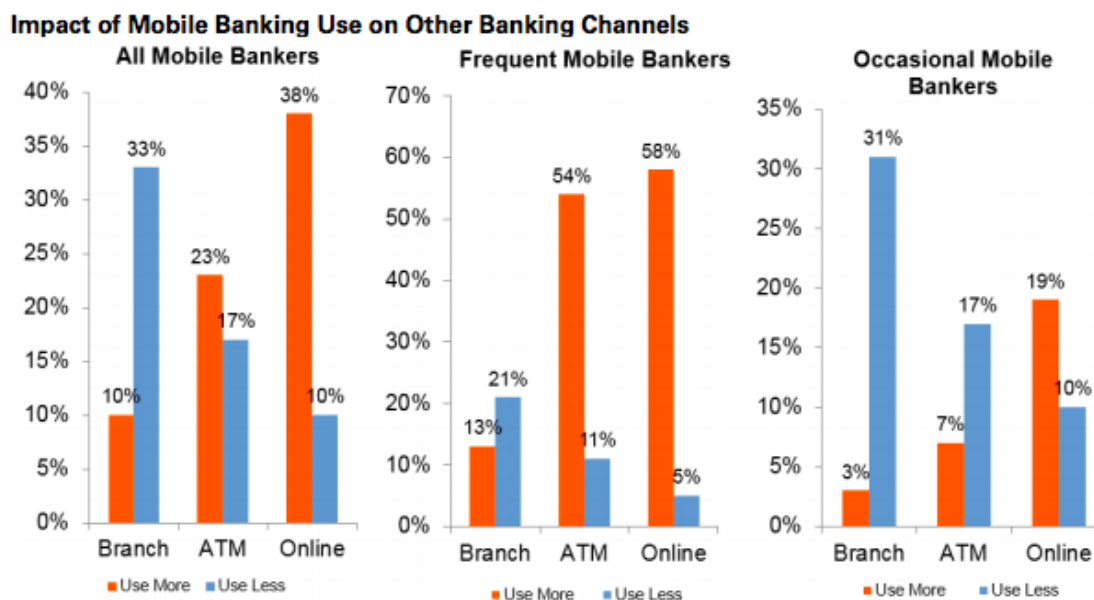


Figure 1 Impact of Mobile Banking Use on Banking Channels (Raddon 2019)

As seen from the study, mobile banking today is attracting users to use those tools like online banking that affect the cost savings of financial institutions, which confirms the advantages discussed earlier.

Future of Mobile Banking

The digital development of the world, which is not going to stop, dictates the need for banks to form a new digital strategy that goes beyond the existing online banking. Most of their daily financial activities people do through digital services such as cafe loyalty applications, money transfer applications, crowdfunding, and brokerage platforms. Moreover, direct banks are getting more popular. Thus, traditional banks need to catch

digital traffic so as not to lose profits. Moreover, the mobile channel is one of the most popular digital channels. Let us consider the future directions of mobile banking development through customer experience.

Banks should use all mobile capabilities to attract traffic to their digital channels, introducing new, helping functionality into them, which in turn will bring new consumer experience. This will allow banks to maintain their position in the changing banking sector. The following principles can be distinguished that will help achieve this goal:

- Modern mobile banking applications of traditional banks offer the user a wide range of services, including checking balances, transfers, and searching for the nearest ATMs, but they are not enough to stand out. Using mobile capabilities makes it possible to stand out, introducing new functionality and services using a camera, voice command or biometric authentication with which the user would be able to solve problems. (Agwu, Carter 2016)
- Personalizing banking services can also help. It is a good idea to start by personalizing the presentation of these services. Thoughtful collection, processing, analysis of personal information of users enables the bank to compare the client and the services that suit them. The massive amount of customer information that banks have, such as all previous transactions that talk about the lifestyle, needs, and interests of the client, can help banks get benefits from pushing offers to consumers. Banks can apply this knowledge by sending notifications to customers containing information about a service suitable for them, which will allow banks to increase customer satisfaction. Thus, banks can play the role of a personalized financial adviser, which will generate additional value to the bank in the eyes of customers. (Al-Jabri, Sohail 2018)
- Traditional banks should seek partnerships with fintech companies, as well as with companies that also provide advanced digital solutions in various fields in which the client can invest their funds - from retail to travel and insurance. In this way, it is possible to satisfy the growing need for digital banking solutions (Barnett 2018)

3 USER EXPERIENCE DEVELOPMENT IN CONTEXT OF MOBILE APPLICATION

The main objective of a mobile application is to solve user problems. A human-oriented approach takes place here; that is, the application interface directly goes to the main plan (Nielsen and Budiu 2012, 4). This naturally implies the fact that one of the critical components of the mobile application is the interface, which in turn affects the future of the product.

3.1 Aspects of User Experience

When studying sources about the design of any digital service, frequent mention of three components is noted: User Experience Design, User Interface Design and Usability. These form a holistic image of the future service. These three concepts overlap, complementing and influencing each other, as well as confusing those who are trying to figure them out. Because of their similarity and dependencies, different interpretations of these concepts and their relationships are born (Smith 2018). Let us investigate each of them carefully:

User Experience

The official definition of UX is as follows:

User's perceptions and responses resulting from the use and/or anticipated use of a product, system or service (ISO 9241-210: 2010, subsection 2.15).

User experience (UX) or user experience design (UXD) is responsible for designing user interaction with the service or product. It is thought over throughout the project and serves to ensure that the application is logical, convenient to use, and solves specific problems of the end-user. UX design is responsible for the impressions and feelings that the user will receive from using the application and how exactly they will use this application. (Moreno 2014; Mockplus.com 2017)

The designer, working on the UX mobile application, develops scenarios for users to follow the path to achieving their goals when interacting with a digital product. In this case, the designer also acts as a psychologist, presenting and analyzing user expectations and their requirements for the product. (S)he selects the appropriate tools and comes up with an application structure that meets all the necessary parameters. (Moreno 2014, Lamprecht 2016)

It is believed that a “positive user experience” is the result of an adequate combination of the six fundamental qualities of an “ideal” UX, defined and tested by Morville (2004), which influence the value of the product for the end-user. These qualities are:

- **Useful** - service or product should be useful for the end-user, bring innovations which help the user to complete their task
- **Usable** - service or product must be easy to use. It is a vital part of UX, which should not be ignored
- **Desirable** - image, identity, brand, and other design elements should be used to evoke emotion and appreciation
- **Findable** - it is necessary to provide the user with such navigation with the help of which he can easily find what he needs from any part of the system
- **Accessible** - any group of users should be able to use the service or product, regardless of their physical or any other abilities
- **Credible** - it is necessary to create such systems and interfaces that affect the trust of the user, turning him to the side of the system. There are particular elements and techniques for this

Babich (2017) names some key principles of Mobile UX design:

1. **Intuitive navigation** - The logic of movements should be consistent, appropriate to the platform, and explain where the user is currently located.
2. **One function on one screen** - This principle provides a more understandable interaction with the interface when each screen is strictly responsible for one thing. However, modern applications are increasingly neglecting this principle due to the introduction of more convenient navigation.
3. **Tips and feedback** - It is essential for users to feel that everything is under control, that the application has feedback on their actions, which users can understand.
4. **Interaction with the application with one hand** - It is vital to consider the possibility of user interaction with the interface with one hand, even with one finger. Every day, people have many situations when such a well-thought-out scenario can improve user experience.
5. **Considering the dimensions of the mobile device** - The screens of modern smartphones are characterized by a relatively good indicator of the diagonal, but they remain small compared to monitors and tablets. This limitation should always be considered when designing a mobile interface. All design elements should be

noticeable even in the sun and at arm's length, and also have a sufficient distance between each other.

6. **Minimization of actions** - The input of large forms for filling on the screen of a mobile phone is a rather tricky task. It is important to minimize the actions that are difficult for the user by providing them with ready-made solutions or focus only on the essential elements that lead to the ultimate goal.
7. **One experience for all devices** - If the product has several versions: for the site, tablet and smartphone, then on all devices the integrity of the product and the seamless transition between different platforms should be maintained.

Some sources state that **user experience design** is a term and process that **goes beyond and includes** the terms and processes of user interface design and usability. (The Interaction Design Foundation 2019) Further, we will consider UI design and usability as fundamental aspects of UX design.

User Interface

The user interface design includes the design of the visual component of the application. The UI is responsible for graphic elements such as buttons and checkboxes, fonts, color schemes, and other visual additions. The designer makes graphic and textual information pleasant and attractive, thereby creating an emotional connection between the user and the interface. (Moreno 2014) UI combines concepts of interaction design, visual design, and information architecture (Usability.gov 2019).

If we draw analogies with the material world, then, taking an example of a person, we can say that the way the internal organs work in conjunction with each other and which functions is what lies behind the user experience, while time as the appearance of a person, his skin, the location of the eyes, nose, and mouth relative to each other, the color of the eyes themselves, as well as his feelings and reactions to interactions with him - this is what the user interface is responsible for. (Lamprecht 2016)

In mobile design, as well as in any other direction of design, there are rules, recommendations, and principles. Today, such guidelines for creating mobile interfaces are Google Material Design for the Android operating system and Apple Human Interface Guidelines which are developed for the iOS platform, respectively.

Guidelines include the principles of both UI and UX design, combining recommendations for the visualization and navigation of the application. Without such generally accepted principles, the user would have to spend time every time to understand the features of the

interface, to understand where there is a button that can be pressed, and where there is just text in a frame. In this case, it would take much more time to solve the problem and the count would go no longer in seconds and milliseconds, but in minutes. This is entirely contrary to the principles of UX design. Therefore, guidelines exist mainly to accelerate the process of solving user problems in the application. (Wasserman 2010)

Best Practices for Designing an Interface

The following practices are proposed for designing a good user interface (Usability.gov 2019):

- **Simple interface.** There is a need to use only the necessary interface elements and pay attention to the language used throughout the application - there should not be any complicated words that are understandable only to a particular group of people.
- **Consistency and common UI elements.** Throughout the service or product, it is necessary to use the repeating principles and elements of interaction that the user can learn, thus learning how to use all parts of the service or product. It is also necessary not to forget about the UI guidelines of operating systems that the user is already used to.
- **Be purposeful in page layout.** It is necessary to work out the relationships between the elements in the interface and arrange them based on importance, thus attracting the attention of the user to what is important for improving the product's readability.
- **Strategically use color and texture.** The user's attention can be directed not only by the arrangement of elements but also by color and shape, contrast and shadows. These are very important tools in interface design.
- **Use typography to create hierarchy and clarity.** Various fonts, shapes, and sizes also help to structure the interface, so attention should be paid to their designing. The right typography can help increase scanability, legibility, and readability.
- **Make sure that the system communicates what's happening.** It is necessary always to keep users informed of their location, actions, changes in state, or errors.

Usability

Interface design principles significantly affect the usability of this interface itself and even intersect with usability rules. However, this does not mean that these concepts are the

same. Visual and informational design elements are just tools that can enhance usability by responding to usability rules.

The design process today comes down to designing new user interaction scenarios. We can design an interesting form, an appealing interface that will be convenient to use, but with an unworked logic, a chain of interactions, and, most importantly, a humanly understandable form of interaction with whoever works with this interface, the system will not be in demand. (Mockplus.com 2017; The Interaction Design Foundation, 2019)

Usability and practicality, its functionality today determine the success or failure of any application, website and other digital services. By usability, we mean the degree of convenience of the interface for the user. As applied to web interfaces, usability means (Mockplus.com 2017; The Interaction Design Foundation, 2019):

- convenience and ease of navigation
- reasonable arrangement of controls
- a logical and simple arrangement of graphic elements
- general ease of design perception

Thus, the usability of the interface is determined by the combination of the above factors. In other words, usability is a clear and smooth interaction with a user interface (Quesenbery 2001).

Nielsen (1995), who is considered to be an expert on usability, created ten rules that were generally recognized and are currently most often used to create the interface with a good usability level:

1. **Visibility of system status** - The user must understand where he is, what is happening, and at what stage he stopped.
2. **Communication between the system and the user** - The developed interface should be designed for a specific audience, should take into account its level of preparedness. This principle affects such interface elements as structure, design, visual perception of information, user assistance.
3. **User management** - This principle speaks of the freedom of choice of the user, who, at any time, should be able to control the situation. This approach gives the user the impression that he can control everything, and the complexity of the interface, in this case, becomes its simplification. For example, the "clear" button works well when filling out a form. Alternatively, if the form has several steps, it is good form to allow the user to return to the previous step or skip one of the steps to return to it later.

4. **Consistency and standards** - Today, there is certain standard generally accepted notations and options for the location of elements, such as the basket icon and contacts located in the upper right corner, and the clickable logotype in the upper left corner. Also, excessive originality of form elements can confuse the user and complicate the development. This principle also indicates the need to comply with the chosen style. This applies to both graphic content - fonts, icons, colors, and the dynamic component - animations of interactive effects. The same applies to the layout.
5. **Prevention of errors** - Wherever possible, it is necessary to remove unnecessary actions and simplify the choice.
6. **Easier to know than to remember** - This principle suggests the need to simplify the life of the user as much as possible, that is, to remember the information entered earlier by him, to give him tips, and so on.
7. **Flexibility and efficiency of use** - according to this principle, the main emphasis must be made based on a simple, untrained user. Since more advanced users will be able to find the controls they need everywhere, they can be made much smaller and placed in less noticeable parts of the screen.
8. **Aesthetic and minimalistic design** - the interface should not contain redundant information, and at the same time, should not request it. Forms should be maximally simplified only to those fields that are minimally necessary for the request.
9. **User assistance in understanding and correcting errors** - this principle means that the user needs to be informed about errors in a timely and understandable language.
10. **Help and documentation** - according to this principle, the documentation should be clear and easily accessible, as well as meet the needs of the user. Also, it should not be redundant, and it should contain concrete and understandable steps.

This set of recommendations is considered primary. Performing them allows us to increase the usability of any interface, and also helps to increase conversion.

Summery

All these terms are combined and accumulated in common user experience. A well-developed user interface (UI) can improve the usability of a service or product when it allows the user to perform a specific task efficiently, effectively and satisfactorily, while at the same time accompanying the user with a beautiful and pleasant graphic design. In

turn, these indicators improve user interaction (UX) with the service or product as a whole. Identifying all points of interaction can help improve each of them, but also help to improve the experience as a whole.

3.2 Approaches to Interactive Systems' UX Development

In addition to the guidelines, which are designed directly for creating applications with characteristics familiar to users of certain platforms, there are also user experience design methodologies that, using cognitive psychology, increase the success of a task performed by a user of the system.

Participatory Design

Participatory design or cooperative design appeared in Scandinavia in the 1960s and 70s. It represents an approach to the assessment, design, and development of technological and organizational systems with an emphasis on the active involvement of current or potential users, as well as all interested parties, in the decision-making process (Trigg and Clement 2000).

This approach allows to:

- improve the knowledge based on which the system is built;
- allow users to imagine what will be the final product, i.e. do not build false expectations;
- reduce user resistance to change;
- remove the barrier between users and the creators of the product;
- increase the motivation of team members by giving them the right to accept decisions that may affect their work and the resulting benefit.

The foundation of participatory design is the conflict of business requirements, user needs, and developer needs. The mismatch of needs and tasks leads to new design solutions that satisfy all parties (Gregory 2003, 67).

Participatory design is based on the following principles:

- determination of not only technical but also social aspects of development;
- analysis of the current situation and joint statement of tasks;
- readiness for changes, training employees in new practices;
- Evaluation, support, continuous improvement;
- iterative design.

The attraction of users takes place at the stage of collecting requirements and designing a product. For this, special workshops are organized, in which 8-9 people usually participate.

It is important to note that even though users are an important source of information and new ideas, they are not entitled to make the final decision and cannot replace experts (Anić 2015).

User-Centred Design

User-centered design (UCD) or user-oriented design is a methodology in which much attention is paid to the needs and desires of the user at each stage of the project.

The principles of a user-oriented approach:

- focus on end-users
- structured and systematic collection of information on users
- empirical user research methods
- prototyping and testing by end-users
- iterative design. (Babich 2019)

The result of using UCD is a product that offers the end-user a more efficient, satisfying and friendly interaction experience (Usabilityfirst.com 2019).

Interaction experience is a key concept of user-oriented design. The shift in emphasis from the collection and consideration of the wishes and requirements of the user to the study and consideration of his experience is the main difference between UCD and PD. The international standard ISO 9241-210 (International Organization for Standardization 2010) defines the experience of interaction as follows:

a person's sensation and reaction due to the use or intended use of a product, system or service.

Human-Centred Design

The human-centered design emerged from user-centered design. Their main difference lies in the fact that the basis of the human-oriented approach is focusing on the needs of not just the user, but the person, i.e., consideration of ergonomics is added to the account of user experience.

ISO 9241-210 (International Organization for Standardization, 2010) considers Human-centred design in a narrow field - in the design of interactive computer systems. This standard describes the basic principles of HCD:

- the design should be based on a precise definition of the intended users, tasks, and environment
- users should be involved in design and development (in contrast to participatory design, the involvement of users in design and development is not direct, but indirect, i.e., involvement occurs through research)
- in order to improve the project, a person-oriented assessment must be carried out
- project improvement should be iterative
- the project should take into account user experience
- specialists with skills and knowledge in various fields.

Since it is the user and their convenience (usability) in this work that is accepted as the main criteria for evaluating the quality of the interface, let us take user-centered design as the main approach. Such an approach increases the availability, efficiency, effectiveness, and sustainability of systems in conjunction with user satisfaction and productivity.

3.3 Prototyping

As seen from the study of methodologies, one of the integral stages of system development is prototyping. In order for mobile development to be the most effective in such methodologies as user-centered design, it is proposed to use prototyping with iterations during the entire process. Since mobile development is adjacent to the risks of high cash costs and time, it is crucial to use those techniques and tools that can reduce these risks. Prototyping is one such tool. Prototyping at all stages of development helps to challenge assumptions, reveal user needs and feelings, and define an explicit direction for product growth. Issues corrected at the very beginning of work on the project can save a lot of time and resources in the future. (Dossey, 2019)

3.3.1 Forms of Prototype

In mobile development, it is customary to develop three forms of interface visualization for testing. The first form is a sketch, and the second is an interactive model. (Dossey, 2019)

Let us take a closer look at each of them:

Prototypes vary in degree of accuracy and proximity to the real product. In addition, different types of prototypes serve different purposes and can solve different problems. At the readiness stage, they can be divided into three stages: conceptual, interactive and animated.

Conceptual Prototype / Sketch

A conceptual prototype is a schematic, low-fidelity representation of future screens and is created in the early stages of product development.

A conceptual prototype must always be done when creating the interface of a new application. This method will help in the early stages to solve most usability issues.

Conceptual prototyping is perfect for the fastest testing of ideas because it allows one to sketch out the main elements of the screens in minutes. Also, to create such a prototype, one does not need to have the skills to work with special tools. It is enough to use improvised means - a notepad, a board or even stickers.

Conceptual prototyping is indispensable when one needs to transfer custom scenarios to the screens of a future application. Thus, the application for the first time becomes the prototype of the final result.

The advantage of conceptual prototyping is the ability to teamwork. It often happens that the visualization of a particular function requires the support of individual specialists - product experts, architects, developers. A conceptual prototype can ultimately be the result of the thinking of a group of people, which is a very effective way to solve usability problems and find a balance between business goals and user goals. (Macomber and Yang 2019)

Interactive Prototype

An interactive prototype is usually assembled from screens that have passed the stage of conceptual prototyping. The prototype is becoming realistic enough to be tested on end-users. It is a good reason to do an interactive prototype when:

- There is a need to simulate any user scenario (for example, registration in the application).
- It is necessary to test part of the scenario on users, and there is no finished application yet. In this case, an interactive prototype is a great way to solve the problem in a short time.
- To show the team what is the stage of work. Explain to the developers the logic of the interface.
- When one needs to briefly and clearly show the management what they are working on. This method may pleasantly surprise managers, which will be a plus for one and the team.

- If one needs to impress a potential investor or promote some application idea in the company. The rule “It is better to see once than hear a hundred times” works here. Not a single story, and no presentation will replace the prototype of the finished application. (Babich, 2017)

Animated Prototype

An animated prototype is the highest level of a prototype. Sometimes it is possible almost completely to simulate the operation of this application with it. At this stage, the designer thinks over a critical aspect in UX - the interaction of the application with the user, the visualization of which is created through animation (Babich 2016).

The animation is a way of communication of an application with a user. It allows the user to stay up to date with all the events taking place in the application, and at times increases the usability of the interface. When the movements of elements in the application simulate natural physical processes, they are read by the brain at a subconscious level, and the user without hesitation understands what is happening. Thus, the movement makes the design more user-oriented. (Babich 2016)

It is a good reason to do an interactive prototype when:

- One wants to think over the animation of controls in the application, except for that they have by default
- It is needed to explain to developers not only the relationship of screens but also the logic of the operation of individual elements and the reaction of these elements to user actions. It is very important because in the end, it is for them to realize ideas.
- High-Level testing is needed, the goals of which are related to the degree of responsiveness of the application
- increasing the effect of presenting an idea is needed. (Smith 2018)

Summery

Prototyping multifaceted combines in itself both hand-drawn sketches at the very first stage of design generation and interactive layouts that are most similar to a real application in subsequent iterations. Each type of prototype can serve different situations and purposes. It is necessary to choose the most suitable types of prototypes for solving urgent problems for each stage of work on the application.

4 MOBILE ONLINE BANKING PROTOTYPE DEVELOPMENT PROCESS

The researched UX design approach will be tested using the development of the mobile banking application of Bank X as an example. Bank X provides a full range of banking services, including the provision of debit, credit, savings accounts, money transfers within the bank, and to the accounts of other banks. A range of additional services is also provided, such as payment automation, trading accounts.

The interface is a native mobile banking application for iOS devices, providing the client with information about the status of his accounts, as well as the ability to use any other banking services.

Based on the User-Centred Design principles, the UX/UI development process includes the following steps:

- User Research
- Creation of Personas
- Development of User Scenarios
- Prototyping
- Usability Testing

4.1 User Research

First of all, we turn to the already conducted study of users of online banking: according to the European Commission (Ec.europa.eu 2018), online banking is especially popular among people aged 25 to 34 years, with 68% using this tool. The use of online banking tends to increase following the level of education of the user. While only 24% of people with low education use online banking, 77% of people with higher education use this service.

Next, we will try to confirm or refute the demographic characteristics of users identified during the study mentioned above, as well as delve into the experience of mobile banking users. For this, a qualitative method of research is used with the creation of an online questionnaire, a link to which was distributed among friends, former colleagues of the author, and their acquaintances before the start of the development. The survey consists of several questions regarding the functionality of mobile banking and focuses on learning of the users' behavior, level of their involvement and desired functions that they lack in their mobile banking. This survey will help answer the first and second questions of this work as well as to understand the directions for the development of an interactive prototype.

User Survey Results

To conduct a successful survey, it is necessary to start by collecting general data about mobile banking users. So it is possible to form a clear idea of their demographic characteristics. Figure 2 shows the average age of mobile banking users. As can be seen from the figure, the data collected in the survey confirm the trend of popularity of this service among young people under 35 years old (81% of respondents).

How old are you?

21 responses

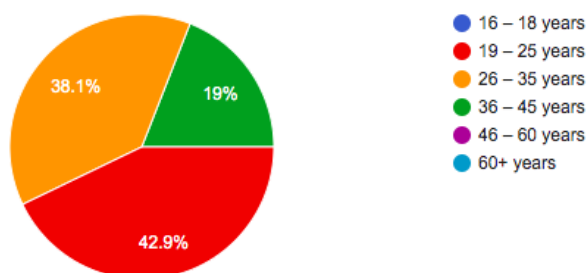


Figure 2. Pie-chart representing the age of the users.

All respondents are living in the European Union. This shows the relevance of the data for Europe. (Figure 3.)

Do you live in European Union?

21 responses

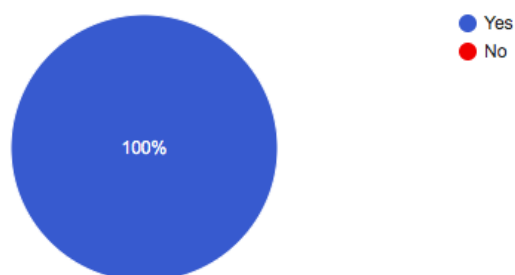


Figure 3. Pie-chart representing the location of the users.

For the full reliability of the study, question number 3 (Figure 4.) identified those who do not use mobile banking. There were three of them. It is worth noting that not a single person who participated in the survey was one who would use the mobile version of web-based online banking that reports the irrelevance of this type of service for mobile devices.

How do you primarily access your bank information on your smartphone?

21 responses

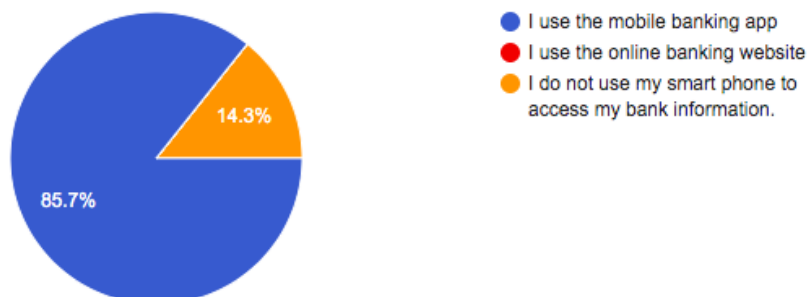


Figure 4. Pie-chart representing

As can be seen in Figure 5, the vast majority (81%) of mobile banking users open and use the application at least twice a week. Moreover, six (28,6%) said they use their mobile banking every day. These data can talk about how mobile banking is necessary for some people these days.

How frequently do you use mobile banking app?

21 responses

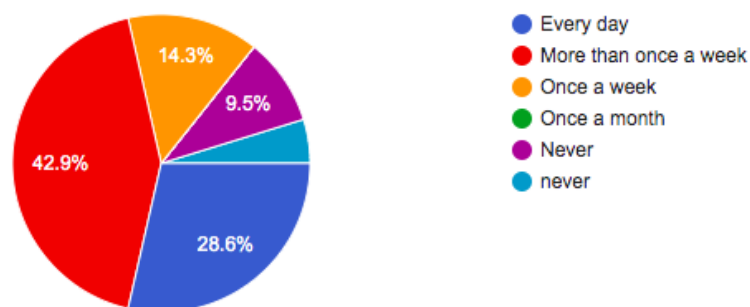


Figure 5. Pie-chart representing the frequency of mobile banking usage

The next question was to describe the frequency of use of certain functions of mobile banking. Due to the abundance of data and the inconvenience of their visualization, only parts of the graph that are important will be presented in this paper. Figures 6-9 show that the most commonly used features are: balance status (18 respondents), biometric authentication (14 respondents), bills payment (13 respondents) and transaction history (11 respondents).

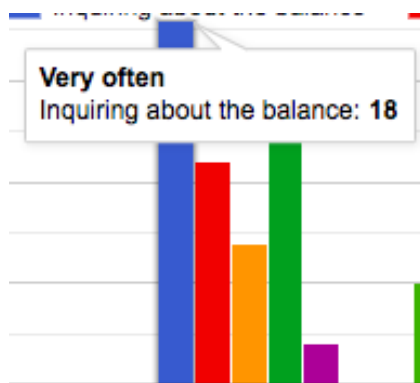


Figure 6. Balance status popularity

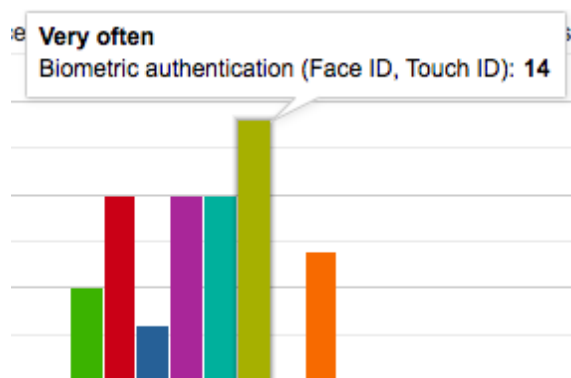


Figure 7. Biometric authentication popularity

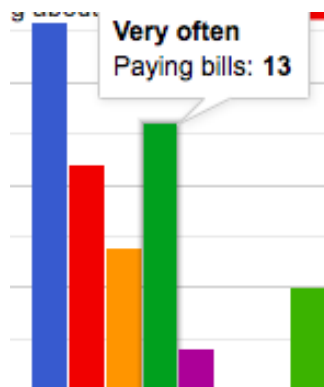


Figure 8. Bills payment popularity

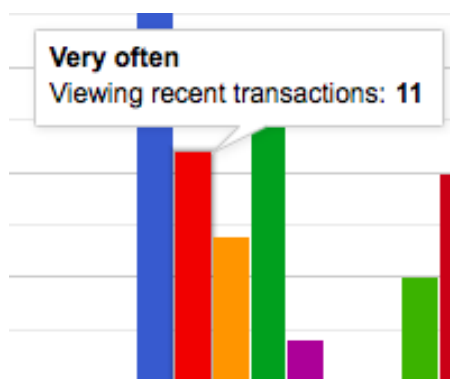


Figure 9. Transaction history popularity

These functions follow by in-app chat function (Figure 10.), which is often used by eight respondents.



Figure 10. In-app customer service chat popularity

According to the survey, the most rarely used functions of mobile banking are (Figures 11-13): ATMs and branches locator, lost card management, card PIN change. If in the case of the functions for changing the card's PIN and managing the lost card the situation of their unpopularity can be explained by the rarity of the events causing the need for these functions, then in the case of the location of the ATM there is no easy explanation. The problem may be hidden both in the non-obvious location of the function in applications and in the lack of demand for this function among users.

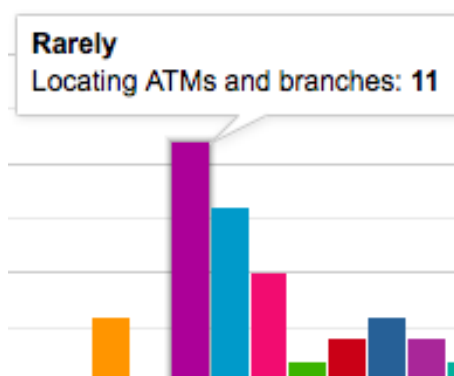


Figure 11. ATMs and branches locator popularity

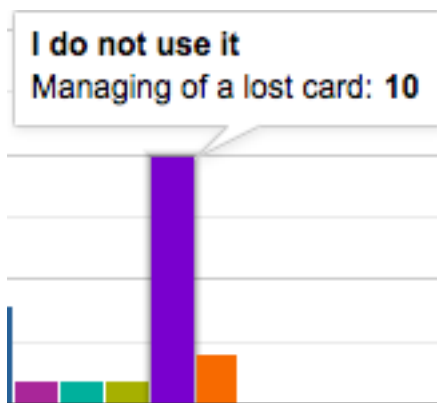


Figure 12. A lost card management popularity

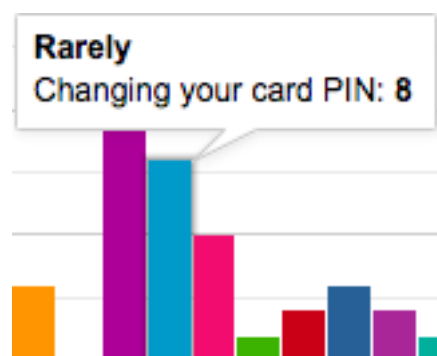


Figure 13. A card PIN change popularity

The following two questions suggested that respondents talk about what they lack in mobile banking (Figures 14-15). Most of the respondents lack the functions that their bank already provides them. The other part of the respondents to a greater extent lacks the functions of scanning bills using the device’s camera, as well as biometric authentication:

Do you miss the features that are not available in your mobile banking app?

18 responses

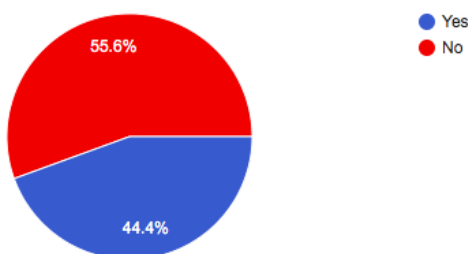


Figure 14. Pie-chart representing users lacking functions in mobile banking

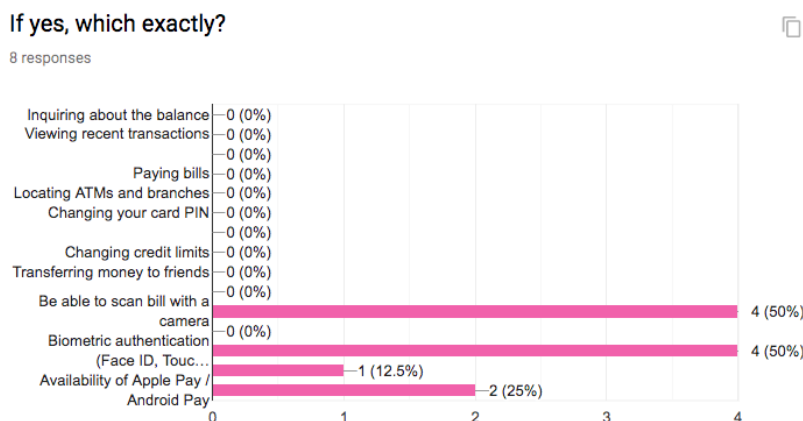


Figure 15. Top of lacking functions

The last question helps to find out how attractive functional mobile banking is to users. Most of the respondents said that they are likely to open an account in a bank, in which the mobile banking application seems more functional. (Figure 16.)

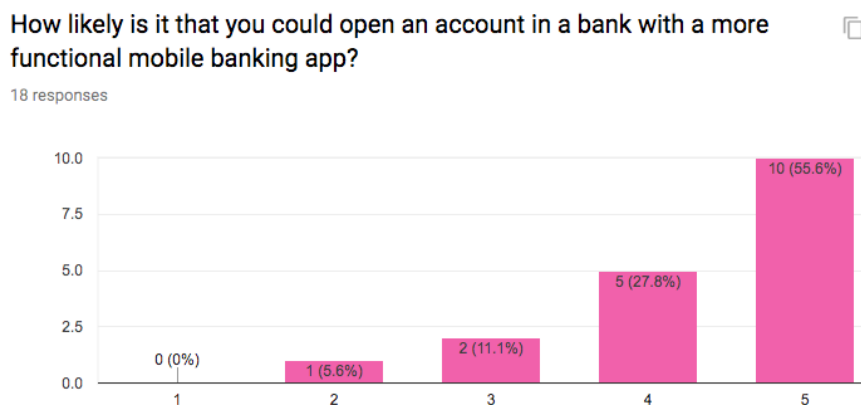


Figure 16. Level of likeliness of opening an account in a bank with a more functional mobile banking app

Thus, the survey helped to identify the target audience of mobile banking applications less superficially and gave directions for the implementation of the most important user scenarios for testing on an interactive prototype. In addition, the survey allows us to answer some of the questions posed at the beginning of the thesis. The next step is to create personas and user scenarios based on our target audience, who are mainly educated people from 25 to 34 years old.

4.2 Personas

Methods for improving the quality of interface design have changed over time and new ones have appeared. Back in 1995, Cooper published the book "About Face: The

Essentials of Interaction Design”. It was Cooper first to use the “personas” method to understand the needs of the end user better. The method is based on the need to create a composite image of the user to solve basic interface tasks. This is done so that the developer is imbued with the users’ problems and better understands their needs. (Cooper, Reimann and Cronin, 2013, 77-79)

Developers distinguish about three characters from the target audience and give them fictitious names, goals, motivations. Further, based on the character and needs of the character, the developers think in detail and describe how these users can use the product and in what conditions. Thus, developers can understand what features of the application will be used more often, which means they can think over these functions better. (Cooper, Reimann and Cronin, 2013, 83-84)


Characters are not allocated from the entire audience, but only from the segmented target audience of the product - the user group that will be most interested in using the product. Description of the target audience includes demographic, social and behavioral characteristics of the potential user. (Cooper, Reimann and Cronin, 2013, 80-82)

At the stage of selecting the target audience and characters, attention is paid primarily to the user and his expectations of the product. In other words, the main thing at this stage is to understand the consumer’s train of thought and lay down the necessary interactions and functions of the application.

Description of Personas

Based on the target audience, three characters were distinguished that convey the needs and requirements of each group to the maximum.

Persona 1



Name: Mark

Demographic characteristics: 23 years old, Front-end Developer from Berlin, income EUR 2000/month, single (has a girl), rents an apartment.

Biography: Mark likes new technologies, gadgets, stylish dressing and his car. He buys a lot online – more likely the goods that are advertised by bloggers Mark follows on social networks.

Free time: meets friends (goes to bars, cinema, concerts). Spends a lot of time in shopping centers in search of something interesting at a discount. In the evenings he spends time mostly on the Internet on the computer (30%) and telephone (70%): visits FB, YouTube, Netflix, his favorite online stores.

Motivation: To buy more goods and make life more **colourful**.

Technology: Uses his iPhone 11 for a bigger part of his interactions with Internet.

Picture 1. Persona 1

Persona 2



Name: Francisca

Demographic characteristics: 28 years old, Sales manager from Frankfurt am Main, EUR 3000/month income, single, has an inherited apartment.

Biography: Francisca has a dream to go to the US and a whole month to travel from the west to the east coast. Therefore, she treats with care to money and tries to not make unnecessary expenditure.


Free time: Improves the knowledge of English by visiting language courses, reading books. Sometimes she meets with friends. Enjoy a meditation. Spends a few hours a day on the Internet. Using a computer (20%), a tablet (30%) and a phone (50%): FB, Netflix, Duolingo.

Motivation: Making a travel dream comes true!

Technology: Uses iPhone X and Apple Pay as her bank has Cashback for purchases with this service.

Picture 2. Persona 2

Persona 3



Name: Adrian

Demographic characteristics: 40 years old, Head Engineer from Frankfurt am Main, EUR 3200 income, Married (+ one child), has an apartment.

Biography: Adrian is a family person, he has a wife, a son and old mother. He does his best to earn enough money to give his family everything it needs and wants. Adrian is a very helpful person and almost never says "no" to anyone. Every second is important for him.

Free time: Takes some extra work. Sometimes he meets with friends. Enjoy time with his family, helps his mother. Uses his smartphone as a useful tool which can save time.

Motivation: Use as little time for daily tasks as possible to save time for other stuff.

Technology: Uses iPhone XS which Adrian considers a perfect tool.

Picture 3. Persona 3

4.3 User Scenarios

A user scenario is a fictional story about the sequence of events of a person in “everyday life” on the way to achieving the goal. In the scenario, it is essential to fix where the user is now, their environment, technology with the help of which they interact with the product, why and how they got to the product (context). (Cooper, Reimann and Cronin, 2013, 111-113)

A good scenario is:

- consistent and builds a holistic story (if the user has done [this], they expect [that], but nothing else)
- allowing to get the most out of the persona and survive their (but not designer's) interaction experience
- not containing descriptions of interface solutions and is limited by the expectations and sensations of the user
- allowing to build a user flow and formalize specific requirements for the interface.

Based on data from the user survey, the following scenarios are created to support development:

Scenario 1

“Mark’s girlfriend is having a birthday soon, but he still does not know what gift to give her. In the evening, Mark browses through Instagram stories and sees a blogger’s advertising story about a beautiful hand watch. Mark recalls that his girlfriend has long wanted a watch, so he decides to follow the link. On the manufacturer’s website, Mark sees that the watch is quite expensive. Mark is not sure that he has enough money on the card, so he opens BankX’s mobile banking application to find out the balance. Unfortunately, Mark has no money for watches as he has already used these savings to pay mainly for his car repair. Mark’s attention is attracted by the Stories format familiar to him from Instagram. A preview of the first Story informs about a new product of the bank - a credit card. Mark looks through the Story and learns that this card has very favorable conditions and the possibility of a quick registration directly through the application, so he decides to order it.”

Scenario 2

“Francisca came home after a hard day's work. Tomorrow she should receive a salary, so today she wants to sum up her financial results of the past week, having analyzed all the expenses. She hopes that it will be easy for her to do this through the application of her bank since she has neither the desire to search for third-party analysis tools nor the strength. Francisca opened the application and immediately saw a list of her spending over the past month. It turned out that the application has a wide range of built-in tools for transaction analysis, as well as useful infographics. Francisca realized that she could quickly figure out where she was spending her money.”

Scenario 3

“Adrian received a message from his mother asking him to pay her bill, which she sent as a photo. She cannot do this, because she feels bad, and the bill must be paid as soon as possible. Adrian is in a hurry for a meeting and hopes that he can pay his mother’s bill through the application of his bank. He quickly finds the tab in the application for payment and money transfer. On the go, Adrian is not very convenient to manually overwrite the data for translation, so he is happy to see the function of automatic input through a document scan. He quickly confirmed the transfer and had time for an interview, and also helped his mother.”

Three scenarios divided the interface into three tabs. The application skeleton appeared - its three main sections.

4.4 Prototyping

After the potential users of the application have been analyzed and on their basis, the persons and scenarios for them have been created, it is time to begin to develop a prototype. Based on a comparison of the types of prototypes from the previous chapter, to achieve the objectives of this thesis, it was decided to create an interactive prototype. To create it, there are several design tools on the market: Sketch, Figma, Adobe Xd, InVision. Let us compare them to understand which one is the most suitable for development.

4.4.1 Choosing a Prototyping Tool

A comparative table where the designer tools themselves are located in the upper part, and on the left are the categories by which the comparison takes place is used to compare design tools. Green is the winner in the category that provides the best solution on the market, red is the worst representative, while yellow is the solution that catches up with the winner.

Table 1. Comparison of Design Tools

	Sketch	Figma	Adobe Xd	InVision
Platform	Mac only	Web based = Mac, Windows, Linux	Mac, Windows	Mac, Windows
Price	Free 30 days trial. 99\$ after	Free for individuals with 3 projects to share; \$12/mo for teams with unlimited projects	Free with one project to share	Free with one project
Ease of onboarding	UI is quite messy and complicated for the begginner.	UI is simple and intuitive, tools are easy to find		UX of InVision Studio is quite complicated for the begginner.
Plugins & API Integration	Sketch has the most popular library of plugins, in which it is possible to find almost everything wanted as a plugin.	Figma is catching up fast offering plugins for the most popular tools but their library is nothing compared to Sketch, although many Sketch plugins have already ported to Figma	Adobe XD is catching up fast offering plugins for the most popular tools but their library is nothing compared to Sketch, although many Sketch plugins have already ported to XD	Invision Studio support plugins but in beta. Number of plugins is extremely limited
File Support	Only supports .sketch files. There is also a known issue of Sketch not opening old .sketch files.	Can open .sketch and .fig files	Can open both .sketch and .xd files, also Illustrator and Photoshop files.	Can only open .studio and .sketch files
Prototyping	Sketch is catching up with prototyping but everything has to be done manually. It is great for simple animations	Figma pretty much offers the same prototyping options as Sketch, but is more fluid and also has Auto animation	Adobe XD 's Prototyping tool acts as a separated tool, it is really powerful, offers screen recording, Voice triggers and speech and the opportunity to Record interactions with audio. Also, it is possible to easily export artboards into Adobe After Effects CC. Has Auto Animate feature	Invision's Prototyping tool is really advanced, offering the opportunity to create fluid interactions and high-fidelity prototypes and adding advanced motion by using timeline editing
Developer Hand-off	Lets export assets and copy CSS attributes, but for that, the developer would need to have Sketch installed.	Lets export CSS, Swift and XML code, also you can download assets and share design specs.	Lets share design specs and assets but not CSS	Provides Invision App which offers Inspect mode, from there it is possible to download assets and copy CSS code, also share design specs

Summary

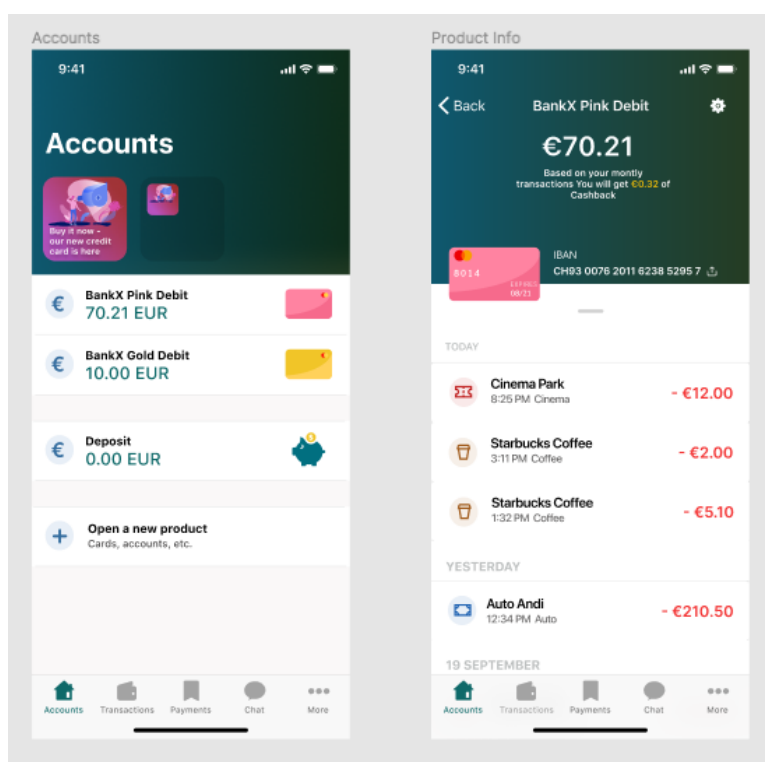
Sketch and InVision Studio does not make sense to consider as a design tool for this thesis. Sketch loses in many categories, and InVision Studio, although it is considered the best tool for prototyping, is too complicated for understanding and provides excessive

prototyping tools that are more suitable for developing a high-fidelity animated prototype. Of the two remaining design tools, Adobe Xd was chosen for the development of mobile banking prototype, since it has more advanced prototyping functions, which is an important criterion for work, however, for several days it worked incorrectly on the author's hardware, so it was decided to use the Figma solution.

4.4.2 Interface Structure

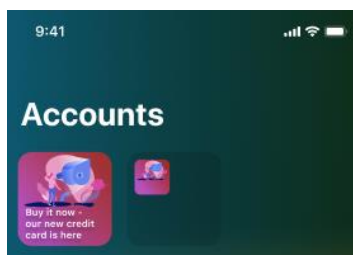
Scenario 1: "Accounts" screen

This is the start screen. When a user gets here, the application shows how much money is left on all the products the user has. Starting after the heading at the top of the screen, all accounts are displayed as a list. To quickly identify each of them, there is an icon in each account tab that repeats the real look of the card. Clicking on any of the products reveals more detailed information about it. Further on the screen is an endless list with the history of operations conducted with the selected product. It helps the user to track all their expenses:



Picture 4. Accounts & Product Info Screens

Going back to the starting Accounts screen, user can see the header of the page with Stories icons that remind users of similar icons from their social networks, which they are already used to and are actively using:

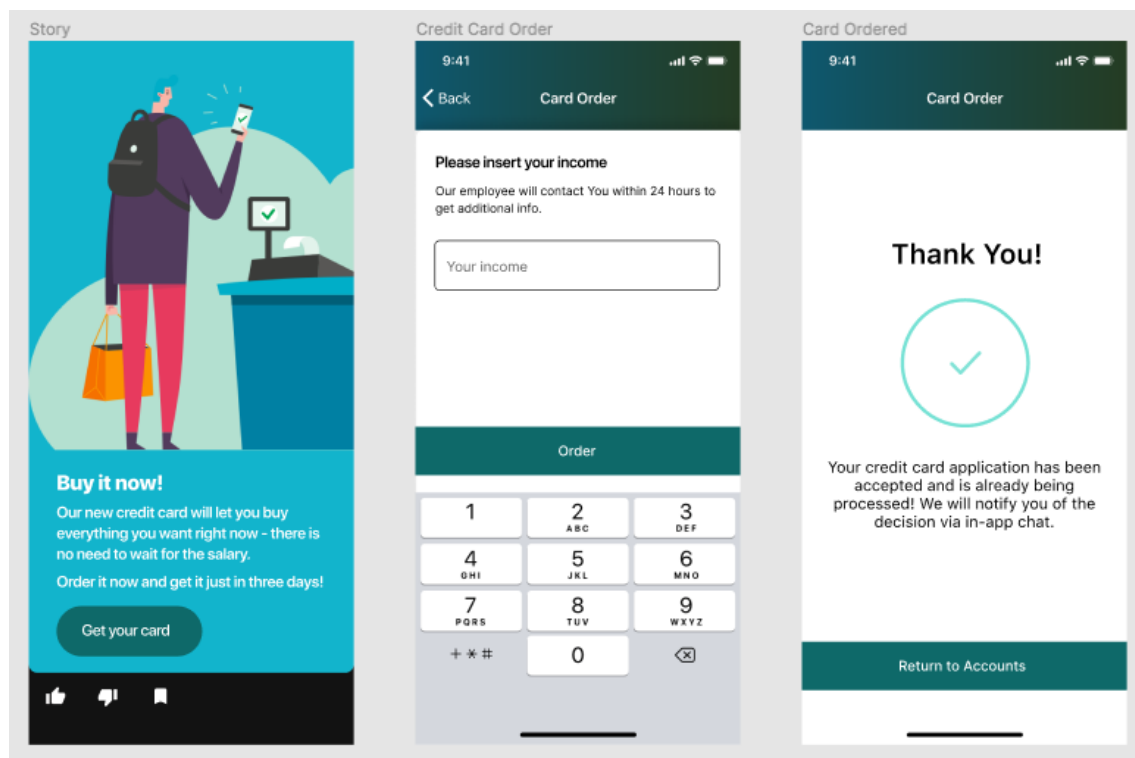


Picture 5. Account Screen Heading with Stories

Clicking on one of them opens, in the form of stories, either announcement about bank products or personalized financial advice with call-to-action buttons to the suitable bank product. Each story can be bookmarked and evaluated so that the following stories are more suitable for the interests of the user.

Clicking on the call-to-action button makes the application take the user to a separate page to fill out a credit card ordering application. To order a card, the user enters their income. That helps bank employees to quickly understand if the user meets the requirements for credit or not. In the positive case, a bank employee will contact the user through in-app chat and ask for additional info.

Having filled in the income field and pressing the "Order" button, the user sees the corresponding confirmation screen and can return to the accounts screen:

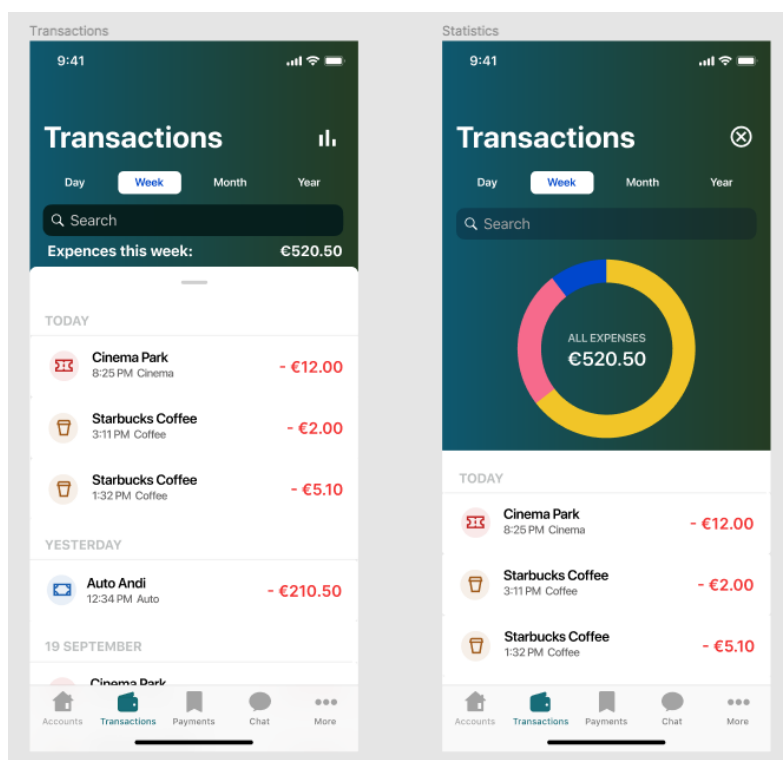


Picture 6. Story Screen, Credit Card Order Form Screen and "Thank You" Screen

Scenario 2: “Transactions” screen

Here the client studies their budget and transaction history. The goal is to make them analyze their financial habits without additional tools. The application helps to research the expenses: study their structure by category and filter in history by date, brand and payment instruments. The task is to give the client as many different filtering methods as possible but to keep the interaction simple and clear. The first thing that is done is combining the history of all products in one roll. This allows the user to evaluate the situation as a whole.

In general, customers fully keep track of expenses (except for the distribution of cash), and the application helps to look at them with the help of a statistic view with the infographic part – pie-chart. To open the statistic view user clicks on a chart icon. The first thing the user sees as a pie-chart is expenses over the past week:

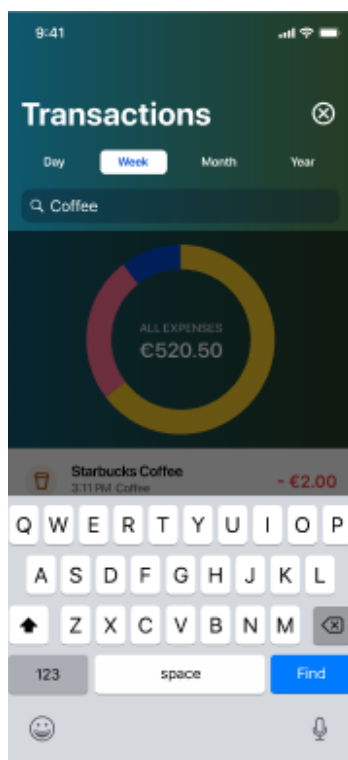


Picture 7. Transactions Screen and Statistics View

Each operation parameter is a separate tag, so the user has a broad control under their expenses. They can search for and apply tags that will, in turn, change the infographic. The tags are:

- the date, week, month or year when the operation is completed
- brand (where the operation is made)
- purchase category.

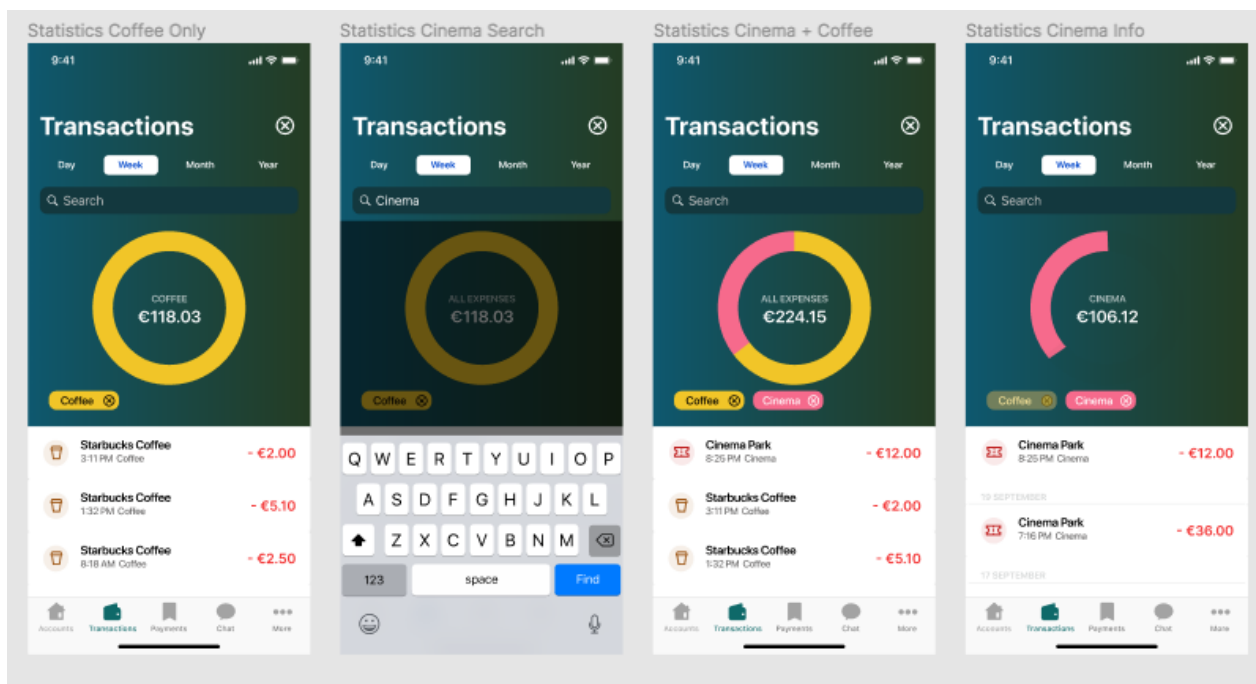
Multilevel tags help fine-tune the selection of operations and look at the structure of expenses from different angles. Each tag can be added to the statistic view by searching it in a search bar:



Picture 8. Tag Search

The idea is that by changing and combining tags, both short-term and long-term conclusions about financial life are made. For example, the user realizes that for the next couple of weeks it is better not to drink coffee at Starbucks every day. Alternatively, the user realizes that they spend too much on cinema.

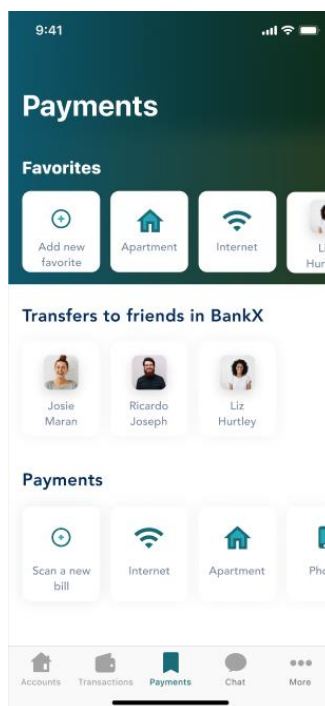
The tags are fixed with the pie-chart, where the spending structure is presented visually. The pie-chart displays the expenses fixed with the applied filter. When the user applies filters, the application visually displays the result of each step.



Picture 9. Statistics View with Different Tags Implemented

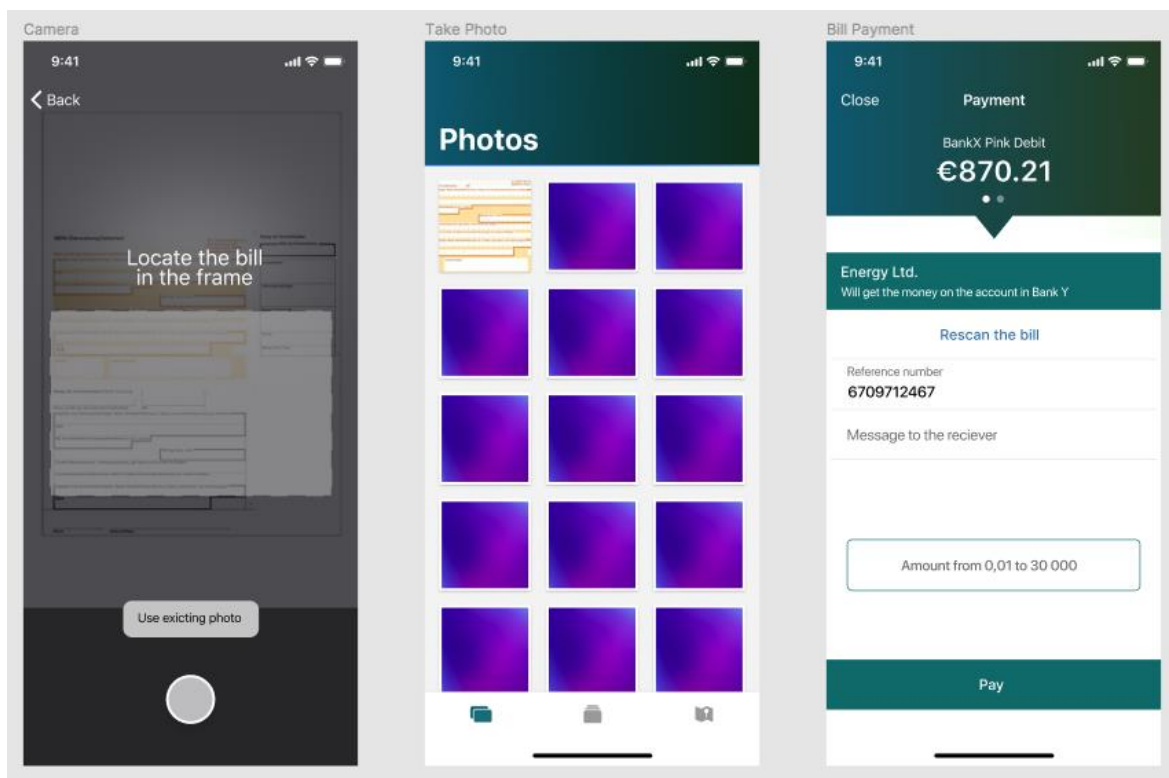
Scenario 3: “Payments” screen

Favorite payments of the user are displayed first. They are pinned to the heading. The user can add any previous payment or transfer to favorites. The convenience is that they are always at the very top and are available with one click. The order of the templates in the list can be edited:



Picture 10. Payments Screen

The first tab in the payments category is a button clicking on which causes the opening of the camera. The application uses the smartphone's hardware to scan the bills. A bill, correctly located in the frame, is automatically scanned and all the information needed for the payment is inserted into the payment fields without any additional actions on the part of the user. If the photo of the bill is in the camera roll, then the user can easily use it. To do this, it is needed to click on the special button in the camera interface and select the desired photo.

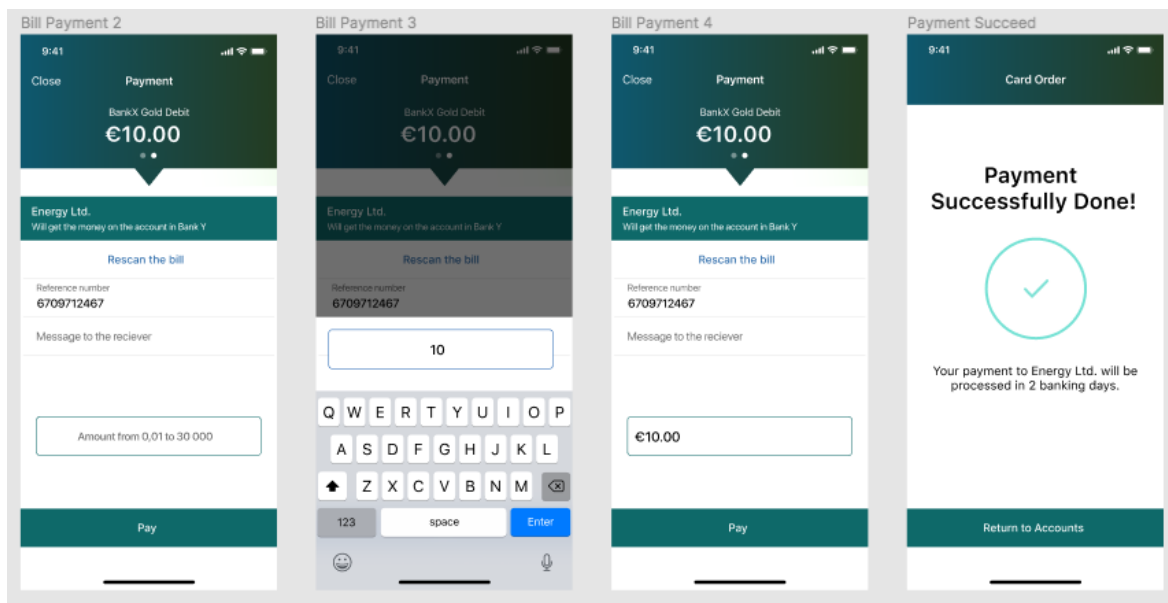


Picture 11. Bill Scanning Process Screens. Camera Interface, Photos Interface and Bill Payment Screen

If the automatic entry of data from the account is incorrect, the user can scan it again or change the information manually.

When making a payment, the user can also select the account from which the payment will be made. The billing indicator is on top. To select another account, the user should

swipe. To make a payment, they need to dial the desired amount and click the “Pay” button:



Picture 12. Bill Payment Process

4.5 Usability Testing

In order for an application to be popular, it is not enough for it to fulfill its functionality - it must also be convenient. Intuitive applications save users nerves and time to learn how to use them. Thus, usability testing makes the product more competitive and is an integral part of testing. (Usability.gov 2019)

Usability testing is a study that can determine if a mass product, prototype, or concept is suitable for its intended use. This process is based on ergonomic testing. This is a method for determining how the product will behave in use, based on the participation of users as testers and the summation of their conclusions. (Usability.gov 2019)

Usability Testing Goal

The main goal is to see how people use the product and find a problem area to improve some functions. It includes four main areas: efficiency, accuracy, recall, and emotional response (Usability.gov 2019):

- **Efficiency** - determines how much time and how many steps it takes testers to complete the tasks?
- **Accuracy** - determines how many mistakes people made when completing tasks? It is very important to determine whether they are fatal or recoverable with the correct information.

- **Recall** - determines how many people remember how to use the product immediately after or after a period of non-use?
- **An emotional response** - indicates how a person feels about completed tasks, whether (s)he is confident, irritated, whether the user will recommend this system to a friend or not.

Testing Process

Testing was conducted on three users who have already participated in user research. Since personas and scenarios for the prototype development were developed based on their answers, they are considered the most suitable users for testing. They were explained the scenarios and the testing process.

Assessment criteria were identified, such as the time of completion of the scenarios, accuracy of completion of the scenarios and ability to redo the scenario without difficulties. For the assessment, a ten-point scale was used for each testing area.

In the efficiency area, ten points are assigned to the one who completed the scenario without errors in the fastest time. For other users, a difference of 5 seconds from the ideal time takes one point out.

In the accuracy area, ten points are awarded if the scenario was executed without unnecessary touches on elements that do not have an action in the scenario. For each such touch, one point is removed. Touching an element that has different functionality than the one expected in the scenario, two points are taken out.

In the recall area, any incorrect interaction with the interface takes 2 points out.

Tables have been created to collect the data.

Table 2. Evaluation of Scenario 1

Scenario 1- Accounts	Efficiency	Accuracy	Recall	Sum
User 1	12 sec. / 10	10	10	30
User 2	10 sec. / 10	10	10	30
User 3	15 sec. / 9	10	10	29

Table 3. Evaluation of Scenario 2

Scenario 2 – Transactions & Statistics	Efficiency	Accuracy	Recall	Sum
User 1	30 sec. / 9	9	10	28
User 2	25 sec. / 10	10	10	30
User 3	48 sec. / 6	8	8	22

Table 4. Evaluation of Scenario 3

Scenario 3 - Payments	Efficiency	Accuracy	Recall	Sum
User 1	28 sec. / 9	9	10	28
User 2	24 sec. / 10	10	10	30
User 3	21 sec. / 10	10	10	30

Analysis of the test results also passes by a quantitative method. A scenario is considered to be successfully completed if the total score for each area is in the range from 30 to 25. Scenarios with points in the range of 25 to 20 should be called attention. A score of less than 20 indicates big problems in design.

Thus, the respondents completed the testing scenarios mostly successfully according to the given criteria. Almost every step of each scenario was completed without mistakes. The most unobvious scenario was with viewing transaction statistics. It should be revised in the next iterations.

After testing all the scenarios, users were asked for comments about their overall impression of their experience with the application. Comments were recorded and subsequently analyzed by highlighting in each comment the mentions of the basic concepts related to user experience and emotional assessment related to each of the concepts. The following statements can be distinguished after analysis:

1. In general, all users liked the prototype and they noted that it was more convenient to use than the mobile banking applications of their banks. Everyone was

pleasantly surprised and interested in the Stories concept in mobile banking. They would love to consider opening a bank account with such an application.

2. The visual design appealed to everyone, but a comment was made about the selected color palette. To one it seemed a little repulsive and it seemed to them that it is better to use "more joyful" colors.
3. The statistics view of the transaction screen is not informative enough and is not likely to be used by the users.
4. Managing tags in the statistics view is not intuitive. The most incomprehensible stage of working with tags is adding them. Without Figma's hints, it would be challenging to understand how to add tags and is it even possible.

Key observations were made on the statistics screen, which should be taken into account in a subsequent study. Otherwise, usability testing showed good results, which may indicate the success and effectiveness of the developed prototype.

5 CONCLUSIONS

Designing interfaces taking into account the characteristics of users is the key to a high-quality and reliable product, its continued popularity among customers, and, consequently, profit. Designing user interfaces becomes an important task in the development phase of user-oriented systems.

Research shows some dissatisfaction with European mobile banking solutions available now. This proves the relevance of research and the importance of the development of a suitable mobile banking prototype.

The user-centered design approach fulfilled the criteria of usability. Users were excited with an easiness and features of the mobile banking prototype usage and gave pleasant feedbacks on the prototype design. The results of the usability testing showed that the user experience of developed mobile banking is overall positive.

5.1 Answers to the Research Questions

The aim of this thesis was finding an appropriate concept for mobile banking applications in Europe by applying a User-Centred Design approach to software development. Below, answers for the research questions are provided. The main research question is answered with the development of the interactive prototype. And the answer to the sub-questions are as follows:

Are users satisfied with current mobile banking solutions of European banks?

Even though banks provide decent functionality in their mobile banking applications, users are still ready to use the services of another bank if its mobile banking service is more functional than theirs. This means that the needs of users are not entirely covered and users are not fully satisfied, which means that designers and developers still have much to strive for.

What are the issues which need to be considered to improve mobile banking user experience?

The biggest drawback of mobile banking was the weak connection with the hardware part of the devices. Users especially lack functions that are tied to hardware development, such as biometric sensors for authentication and a camera to simplify interactions with data.

How does prototyping help in software development aimed at user experience?

Prototyping in software development has proven to be an indispensable part of the whole process. It is thanks to the development of the prototype and its testing on users the shortcomings in the design of mobile banking based on the user-centered principles were revealed. Without a prototype, these important data could slip away and ultimately at least affect the project scope and price or destroy the service potential.

5.2 Reliability and Validity

The thesis used secondary and primary data sources. Secondary sources were books, articles, journals, blogs, and online publications from industry experts. Primary data was collected through user research (survey) and usability testing with an analysis of their results. The survey included data on user interactions with European mobile banking solutions. The objectives of the study were fulfilled, and the research sub-questions were answered based on the development process, and the analysis of primary data. Thus, the study can be considered reliable.

The general conclusions of the study have sufficient reliability at present. However, it should be improved by conducting additional surveys and testing subsequent iterations of the mobile banking prototype, which are the necessary parts of the project that meets the principles of the user-centered approach.

5.3 Thesis Limitation

The thesis doesn't include any technical development of the mobile banking application and only concentrates on the initial design processes with a focus on user-centered design principles. The final product is a medium-fidelity interactive prototype, which can be used only for testing purposes. Technical requirements and development were not considered.

5.4 Future Work

In the future, the developed interactive prototype can serve as a guide or basis for creating of mobile banking applications in Europe. Usability testing revealed issues that still have work to do. In addition, not all results obtained from user research were taken into account in the prototype development process. Thus, the prototype still needs to be finalized and released in new iterations, as required by the user-centered design approach.

A more elaborate study of mobile banking users with a more significant number of participants is also required. A detailed benchmarking of competitors on the market is also

worth conducting, especially since it is also included in the user-centered design approach.

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APPENDICES

Appendix 1. User Survey Questions

Survey on Mobile Banking Applications

Thank you for showing your interest in the survey, conducted by a student of Lahti University of Applied Sciences for thesis research purposes!

The aim of this survey is to determine users' preferences with the interfaces of mobile banking applications. This online questionnaire will not take more than 5 minutes of your time.

***Required**

How old are you?

- 16 – 18 years
- 19 – 25 years
- 26 – 35 years
- 36 – 45 years
- 46 – 60 years
- 60+ years

Do you live in European Union? *

- Yes
- No

How do you primarily access your bank information on your smartphone?

- I use the mobile banking app
- I use the online banking website
- I do not use my smart phone to access my bank information.

How frequently do you use mobile banking app? *

- Every day
- More than once a week
- Once a week
- Once a month
- Other: _____

How often do you use the following features of mobile banking app?

	Inquiring about the balance	Viewing recent transactions	Transactions insights (with diagrams, etc.)	Paying bills	Locating ATMs and branches	Changing your card PIN	Contacting customers service for help in app	Changing credit limits
Very often	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Often	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Sometimes	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Rarely	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I do not use it	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Feature not available	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Do you miss the features that are not available in your mobile banking app?

- Yes
- No

If yes, which exactly?

- Inquiring about the balance
- Viewing recent transactions
- Transactions insights (with diagrams, etc)
- Paying bills
- Locating ATMs and branches
- Changing your card PIN
- Contacting customers service for help in app
- Changing credit limits
- Transferring money to friends

- Transferring money to friends
- Opening new products (saving account, credit card, etc.)
- Be able to scan bill with a camera
- Transfer money to others
- Biometric authentication (Face ID, Touch ID)
- Managing of a lost card
- Availability of Apple Pay / Android Pay
- Other: _____

What is valuable for you in a mobile banking app?

How likely is it that you could open an account in a bank with a more functional mobile banking app?

	1	2	3	4	5	
Not likely	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very likely