Applying user-centered design method to improve Taskukirjasto application

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Degree programme	
BBA of Business Information Technology	
Thesis title: Applying user-centred design method to improve Taskukirjasto application	**Number of pages and appendix pages** 50 + 1

The rise of mobile devices and application-based solutions make services more accessible and approachable to the mass. To withstand the harsh competition against billions of easily available applications, a product needs to be able to adhere to its users' real needs and be adaptive to their habits. Besides, users expect the design of the product to be approachable and coherent. Meeting these needs is ensured by applying user-centred design (UCD) methods during the design and development of the product. This thesis adopts the UCD approach to build a case study examining the user experience and usability of Taskukirjasto – a mobile application serving Helmet library customers. The application allows users to reserve, borrow and manage borrowed items among other activities.

The theoretical section introduces theories on (1) user experience, (2) UCD principles and methods, (3) usability and (4) conducting usability evaluation. The theories on user experience and usability explain the impact and features of a satisfactory design. The concept of UCD method then assists readers to understand an exemplary design process focusing on understanding users of a product. Last but not least, usability evaluation techniques discuss usability testing and heuristic evaluation as the chosen approaches to assess Taskukirjasto application.

The empirical section pursues usability testing and heuristic evaluation to conduct studies on Taskukirjasto, based on the fundamentals of usability methods. The usability test discovers usability issues reported by test users as they interact with the application. The heuristic evaluation assists a more thorough assessment of the application as it tackles use cases that are too contextual to be covered in the usability test.

The findings gathered from the study are interpreted and translated into design change recommendations. These resolve the most severe usability issues found through the usability evaluation. The proposed modifications aim to provide a more effective and efficient experience for users of Taskukirjasto. The changes are accompanied with reasons behind design decisions and its visualisation in the form of before-and-after comparisons.

Keywords

User experience, User-centred design, Usability, Usability testing, Heuristics evaluation.

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1 Introduction

Together with the development of technology, the emergence of portable gadgets including smartphones, tablets, smartwatches, and other mobile devices, has empowered the rise of application-based products and services. Mobile applications provide services - ranging from lifestyle, entertainment, social networking, to work and education, accessible via a few touches on a mobile screen. In 2020, 218 billion mobile application downloads were reported by Statista Research Development (2021a). To survive in such a competitive market, a product needs to be able to comply with its users' real needs and be adaptive to their habits, as well as an approachable and aesthetically pleasing interface.

A product is considered successful and meaningful to its users when it seeks to satisfy not only business-centric but also customer-centric requirements. In other words, besides offering unique values and reducing cost of development and maintenance, the product also needs to meet the target users' key needs and expectations as well as provide well thought-out experience and interface design. To accomplish such desirable outcomes for customer-centric goals, user-centred design (UCD) is an appropriate approach. UCD principles and methods enable designers to gain a thorough knowledge of who will be using the product they are designing. The foundation of UCD practice lies in gathering information about users and integrating those findings into the design.

Acknowledging the significance of UCD in digital product development, this thesis employs the practice to examine and improve the usability performance of a mobile application serving in the library service industry, known as Taskukirjasto. Through usability evaluation and analysis of the results, the study discovers usability issues and suggests design recommendations to overcome found issues. Besides findings gathered from the usability evaluation, the design proposal also takes into consideration design principles for mobile application. For instance, designing for small screen sizes requires responsiveness of the design, thumb-friendly touch targets, and concise content. Design modifications are supported with elaborated reasons and demonstrated with high-fidelity wireframes.

1.1 Research question

As mentioned, the objectives of the research are to identify usability problems of Taskukirjasto and recommend design modifications utilising information gathered through usability evaluation methods: usability testing and heuristic evaluation. The thesis adopts the

UCD approach to closely evaluate Taskukirajsto as a fully developed product and seek answers to following research questions:

- What usability problems do users encounter when interacting with Taskukirjasto?

- How can UCD help eliminate those problems and deliver better user experience to the users of Taskukirjasto?

1.2 Scope

This research anticipates the usability evaluation to uncover various kinds of usability issues. However, considering resources available to the project, solutions are provided only to the most severe problems with usability. The thesis will neither attempt to redesign the entire application, nor tackle less problematic issues. Results of the study will be presented as design recommendations in the form of before-and-after comparison of specific screens.

2 User experience and usability evaluation

This section provides and reviews theories that were implemented to support the study. UCD approach and usability evaluation techniques were applied as a guideline to conduct this study. In this chapter, instructions for conducting usability evaluation methods were reviewed. Besides, theories relevant to this thesis are related to design principles for mobile application, which supported a heuristic evaluation of the application.

2.1 User experience and user-centred design

User experience refers to feelings received by people when coming into contact with a product (Garrett 2010, chapter 1; Kraft 2012). Such experience is achieved and delivered not only by the inner workings of a product but also by how it performs when people interact with it (Garrett 2010, chapter 1).

The principle of user experience concentrates on purposefully and appropriately delivering experiences (Interaction Design Foundation s.a. a) that effectively fulfil the specific needs of users (NN Group s.a.). An exemplary user experience also yearns for product simplicity and delicacy. High-quality user experience, on the other hand, goes beyond providing users with their literal needs through product features and seeks coherence in the execution of collective disciplines, ranging from engineering to practices of design in various aspects. (NN Group s.a.)

User experience design is an umbrella term covering a multitude of different areas, including user interface design and usability. Terminology wise, user interface design and usability are oftentimes confusedly used to convey the concept of user experience design. However, they are a few of the most foundational elements of user experience design, among other subsets. (Interaction Design Foundation s.a. a.)

Based on the basis of Three Circle of Information Architecture, Morville (2004) developed User Experience Honeycomb (Figure 1) to explain and illustrate the facets of quality user experience. The Three Circle of Information Architecture, which demonstrates the component of effective and sustainable information architecture, performs as a solid foundation to explain user experience (Morville 2004).

Figure 1. The user experience honeycomb (Morville 2004)

According to Morville (2004) and Interaction Design Foundation (s.a. b), the seven features contributing to a beneficial and meaningful user experience consist of usefulness, ease of use, visual appeal, discoverability, accessibility, credibility, and value of a product or service. A product is considered useful when it delivers, for instance, enjoyment, aesthetic appeal, or other non-practical values to users. In other words, a useful product does not necessarily enable users to achieve or accomplish a goal that found meaningful by others. Besides, ease of use of the product or service is mandatory and needs to be emphasised. A product is seen as easy to use when it empowers users to complete an objective effectively and efficiently. (Morville 2004; Interaction Design Foundation s.a. b.)

Regarding the visual appeal of a product or service, it is commonly achieved by the use of the pleasant image, brand identity, and other design features, help solidify users' emotion and appreciation towards the product. A desirable product tends to nudge its users to discuss it and shape desires in other users. (Morville 2004; Interaction Design Foundation s.a. b.)

Regarding information provided in the product or service, it should be locatable and navigable. Besides content within a product, the findability of the product itself among other digital products also plays an important role in determining its user experience success. Furthermore, information needs to be accessible to users with disadvantages. It is suggested that a product made accessible appears to be easier to use for everyone, not just those with impairments. (Morville 2004; Interaction Design Foundation s.a. b.)

Additionally, the product or service should be able to attain trust from users. A product is perceived as trustworthy when it can function timely and deliver what it is supposed to and is durable for a satisfactory amount of time. Lastly, the product or service needs to be capable of yielding value for both the users as well as the business developing it. (Morville 2004; Interaction Design Foundation s.a. b.)

In addition to purposeful user experience, the relevancy of a digital product or service is also looked forward to. As a user experience designer, according to Interaction Design Foundation, there are three questions they need to seek answers to, to create an appropriate product for their targeted users. The three questions include the Why, What and How of product use.

As illustrated in Figure 2, user experience designers, by asking Why, typically start with seeking an understanding of motivations behind the user's adoption of a product. The motivations can be relevant to performing a needed task, and/or values and views associated with possessing and using the product. By understanding user's motivations and desired values, designers proceed to determine the What - product features that enable users to fulfil the mentioned motivations, and/or solve the required tasks. As the requirements for functionality are measured, and features are decided, designers then advance to the design of functionality and emphasise the accessibility and aesthetics of the product so that meaning user experiences can be established and ensured. (Interaction Design Foundation s.a. b.)

WHY		WHAT		HOW
Motivations Values and views	→	Functionality Features	→	Accessibility Aesthetics
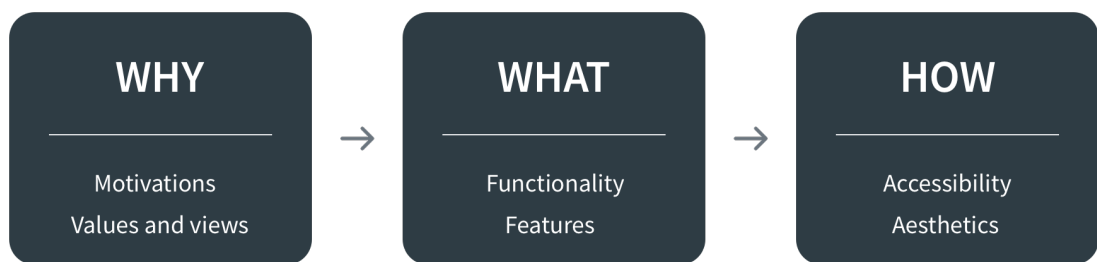
Figure 2. The Why, What and How of UX design (Interaction Design Foundation s.a. b)

An engaging and efficient user experience is the outcome of UCD practices. Garrett (2010) defines the concept of UCD as a design process where users are taken into consideration every step of product development. The UCD process is iterative including 4 stages as illustrated below in Figure 3. (Usability.gov s.a. a; Interaction Design Foundation s.a. c).
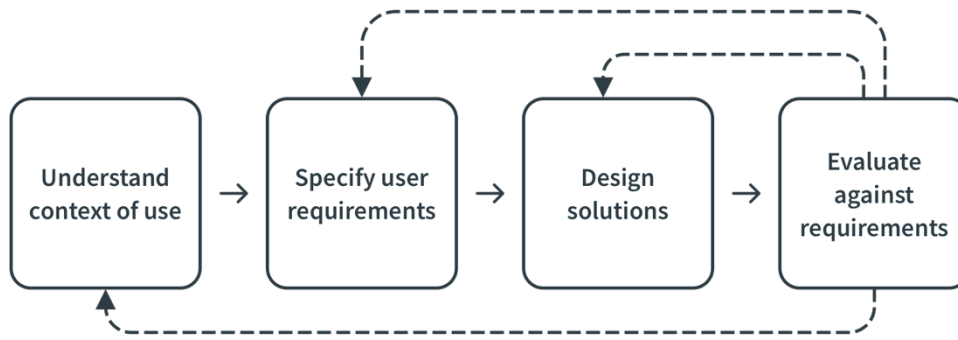
Figure 3. User-centred design process (Interaction Design Foundation s.a. c)

The design process commences with a definition of the product target user, and contexts and motivations that drive the target group to employ the product and find it useful in the real world. With the understanding of the context of use specified, the design process continues by a specification of user requirements and interpretation of user goals together with business requirements that need to be fulfilled so that the product can be successful. As user requirements are established, design solutions are developed starting from a vague concept to a finished design. Once solutions are designed, the next step is to evaluate whether it satisfies identified context of use and user requirements. Evaluation is typically undertaken with usability testing to gather feedback from real users. Based on the evaluation results, iterations of the above phrases will be pursued until the established requirements are sufficiently met. (Usability.gov s.a. a; Interaction Design Foundation s.a. c).

2.2   Usability and usability testing

Usability is a quality aspect of a product referring to the ease of use of its interface (Nielson s.a. a). It measures the effectiveness, efficiency, and satisfaction of the performance of a specific user in a specific context when using a product to accomplish a stated goal (Interaction Design Foundation s.a. d). Usability is a component of user experience design (Interaction Design Foundation s.a. d) and multi-dimensional property of the user interface of a digital product, defined by five major usability attributes, namely learnability, efficiency, memorability, errors, and satisfaction. A product is learnable when its users can effortlessly perform simple tasks using the system the first time they encounter its design. Meanwhile, a product is efficient when its users could accomplish tasks once they have learnt and are familiar with the design of the system. Once users are familiar with the product yet have not been actively interacting with the interface for some period, its mem-

orability is reflected in how painless it is for users to resume their proficiency when return-ing to the design. Another attribute is the measurement of how many errors are caused by users, how drastic are they, and how can users easily recover from those errors. Last but not least, the overall satisfaction of the design is determined based on the pleasant and subjectively satisfied it is for users to interact with the system through the interface. (Niel-son 2012a; Nielson 1993.)

Usability is vital to user experience and, consequently, user retention (Nielson 2012a). Ac-cording to Shneiderman (2012), fixing a design fault after product release, and winning back lost customer, is more expensive, both monetary- and effort-wise, comparing to solv-ing the issue before the release. Such a design fault can be determined and revised be-forehand with usability evaluation and inspection. Usability inspection can be conducted using usability testing and heuristic evaluation.

Usability testing

Usability testing refers to experiments performed to obtain certain knowledge of a design. The needs for usability testing arise from the evidence that designers tend to view their creation from a designer-centric perspective, which makes it difficult for them to look at the design from their user's point of view. On other hand, designers are usually fluent in the design of the product, whilst the actual users are more inexperienced in using this new product in their hands. Therefore, listening to and acting on feedback from real users about the product is essential to the advancement of its usability performance. (Shneider-man 2012.)

Usability testing is conducted when the designer wants (1) to identify usability problems in product or service design, (2) to discover design improvement opportunities, and (3) to ob-tain knowledge about the target user's behaviours and preferences (Moran 2019). Per-forming usability test allows designers to find possible overlooked design flaws (Interac-tion Design Foundation s.a.), observe target audience's interaction with the design in the real world, which provide insight and guideline for design iteration for a better outcome (Moran 2019). In other words, watching how test users executing tasks provide designers with an imperative understanding of how well the design and/or product performs (Interac-tion Design Foundation s.a. e).

According to the Interaction Design Foundation (s.a. e) and Usability.gov (s.a. b), one of the primary objectives of executing a usability test is to verify whether test users can per-form and complete specified tasks successfully without additional assistance. Another

goal of a usability test is to evaluate the efficiency and mental state of test users when they work on completing given tasks. Additionally, designers can determine the satisfaction level of test users with the testing product, while detecting problems and their severity, and necessary adjustments improve the performance and contentment of users. Lastly, performing a usability test helps regulate whether product performance meets usability objectives. (Interaction Design Foundation s.a. e; Usability.gov s.a. b.)

Usability testing, depending on the study's goal and intention, and the point at which it is performed, is subdivided into two types. Testing done during product development is known as formative testing, whose goal is to diagnose problems and adjust accordingly. This type of testing is conducted in a smaller scope and is normally repeated during the development stage of the product. Once issues are solved, another formative testing will be performed to verify whether the fixes work. Testing done at the end of the product development is known as summative testing, whose goal is to validate whether product requirements are satisfied. This exercise requires a larger scope with a substantial number of participants or test users so that statistical validity can be ensured. (Barnum 2010, 14).

Heuristic evaluation

Heuristic evaluation as a method assists in the identification of usability issues that cause damage to user experience, and in the enhancement of product usability in its user interface design (Interaction Design Foundation s.a. f). A heuristic is a set of principles for human-computer interaction design, including (Nielson 1994a; Interaction Design Foundation s.a. f):

− Visibility of system status: Design should provide users with its status through appropriate and timely feedback. System status provides users with the outcome of their prior actions and decision for the next steps. Users' trust in the product is constantly built through open and continuous communication.

− Match between system and the real world: Design should use the language users are familiar with and show information in ways they understand - naturally and in a logical order, achieved from following real-world convention. User interface reflecting real-world conventions is likely perceived as easier to learn and remember.

− User control and freedom: Design should offer users control, and clear and discoverable exit from undesired actions without going through a hassle process to undo errors. When users have easy options to leave a process or undo an interaction, they achieve a sense of confidence and freedom.

– Consistency and standards: Design should remain consistent to prevent users from confusing between, for example, different words, actions or icons. This principle goes hand in hand with Jacob's law of internet user experience, which states that users' expectation of how a product should work is established based on their previous experience with other digital products. In other words, it is recommended that design should not only maintain consistency within itself but also a family of products.

– Error prevention: Design should either prevent situations to foster possible errors or provide users with a warning before committing risky actions. Errors can be caused unconsciously by inattention, or consciously by a discrepancy between the design and the user's mental model.

– Recognition rather than recall: Design should minimise the cognitive effort required from users by providing them with visible and retrievable information, guidance and instruction to recognise the interface's elements and actions.

– Flexibility and efficiency of use: Design should be flexible enough so that tech-savvy and experienced users can accomplish goals more efficiently. Such flexibility is achievable when the design allows users to tailor frequent actions to their preferences and customise how they want the system to work.

– Aesthetic and minimal list design: Design should avoid clutter and only provide information relevant to current tasks. Unnecessary or irrelevant piece of information made visible to users competes with relevant ones and rejects their relative visibility. Content and visual elements of the interface should support users to attain their primary goals.

– Help users recognise, diagnose, and recover from errors: Design should provide straightforward language when it comes to problem indication and solutions to resolve such a problem. The use of visual treatment is encouraged to help users recognise and notice errors.

– Help and documentation: Although a system should be easy to use without additional explanation, it is still necessary to provide documentation that could help users to understand how to accomplish their tasks or overcome problems. Provided help and documentation should be searchable with a list of concise steps that need to be executed.

In addition to the above heuristics, design can also be assessed against designers' own list of heuristics established on their own market insights, business requirements, and other design principles. Designers are encouraged to develop their own heuristics since Nielson and Molich's heuristics, even though still relevant and applicable, are less accommodated for modern designs. Therefore, the original heuristics can be perceived as an inspiration and baseline for designers to establish their own design-specific heuristics. (Wong 2020.) Besides, there are many other user experience relevant design standards available for mixing and matching to tailor the goal of the evaluation.

2.3 Planning and conducting usability testing

Planning for usability testing provides knowledge on tasks that need to be done and people that should be involved.

Establishing test goals

The planning steps start with establishing test goals. The goals of the study should focus on user experiences that are significant to researchers and designers. (Barnum 2010, 107.) At this stage, addressing research questions, purpose and areas of interest are high priority (Loranger 2016). The timing of the usability testing also has an impact on the goals of the study. Testing conducted earlier on in the development process suggests different sets of goals compared to those conducted to, for instance, follow up with a prior study. (Barnum 2010, 107-108.)

Testing goals can be determined based on criteria introduced by Whitney Quesenbery's 5Es, which stands for Efficient, Effective, Engaging, Error tolerant, and Easy to learn. These criteria not only perform as a guideline for testing scenarios and task list creation but also enables designers to make the decision on expected result yielded from the study. For instance, if designers look forward to understanding the efficiency of the interface, they can measure how quickly can users complete given testing tasks within a fixed timeframe and without additional assistance. Similarly, seeking answers to how useful the application or software is in assisting users to accurately accomplish their tasks or meet their goals helps designer gain insights into the effectiveness of the design. Another aspect that designers can study is how intriguing, interesting and pleasant the interface is to use, or how well the application prevents errors and aids users in recovering from made mistakes. Lastly, researchers can also focus on how well the application support users during their first-time use and continued learning, which reveals whether the product is easy to learn, (Barnum 2010, 108; Quesenbery 2004.)

Demonstrated in Figure 4 is Quesenbery's 5Es model explanation. Depending on the needs of designers conducting the test, the balance of the model might change. (Barnum 2010, 108; Quesenbery 2004).
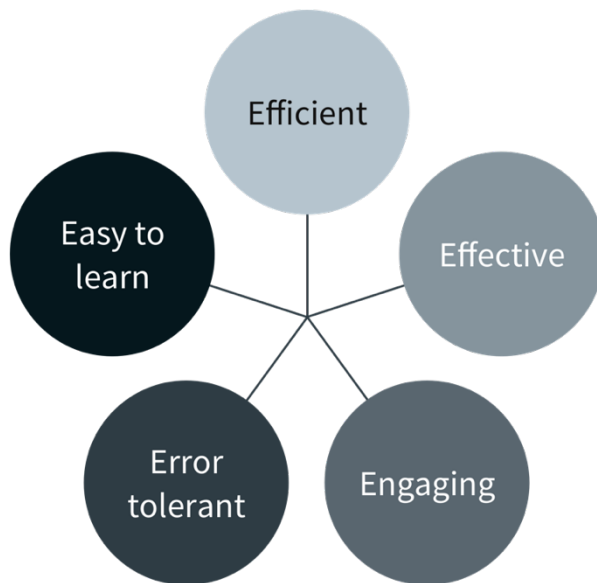
Figure 4. Whitney Quesenbery's 5Es model (Quesenbery 2004)

In addition to the listed criteria, accessibility is a relevant basis when establishing usability testing goals. Accessibility as a testing goal measures how well the application supports people with limitations or disabilities to use and interact with it. By setting such a goal, it helps designers to attain an understanding of their design performance - accessible wise, and opportunities to make the application farther-reaching to other parts of their user population. Besides, it is acknowledged that applications made accessible to users with disadvantages also provide an improved user experience for users without disadvantages. Accessible design is proven beneficial to elders, people with low literacy level or without native language fluency, people with access to unstable network connection, and people inexperienced with modern technologies. (Barnum 2010, 109-110.)

Determining test type

Establishing test goals help determine the type of test. Commonly, four major methods can be utilised to structure a usability test. As described earlier, formative testing refers to conducting a usability test during the development process to diagnose design issues. This type of testing is known as the "typical" test of the product where user feedback on their experience with the application will be collected while they perform certain given

tasks. On the contrary, summative testing is conducted at the end of the development process to establish metrics for the application, together with requirements for future feature implementations. This type of testing is referred to as benchmarking. (Barnum 2010, 112.)

Another type of testing is the comparison of designs, in which users will be presented with more than one designs and asked to choose one that fits their personal preference. The last test type is competitive evaluation, in which users will be asked to complete certain tasks using the developing design along with competitor products. This type of test enables researchers and/or designers to learn about user preferences and evaluate their design against competitors. (Barnum 2010, 112.)

Defining user profile

Once the critical factors, such as motivation and prior experience, has been determined, other characteristics can be examined to generate a healthy and diverse test population. Additional traits of participants cover age range, gender, educational level, language, ethnicity, disabilities, and economic factors. The mixture of these characteristics varies depending on the goal of the test. (Barnum 2010, 118-119.)

Prior to participant selection, it is essential to prescribe the characteristics of potential participants. Provided that there are more than one user group involved in the study, composing a list of characteristics for each group would help differentiate testing groups. Traits of a user group range from their familiarity with the type of the application and the application itself, to technical skills related to the use of the application. Characterising test participants by labelling them with "novice" and "expert" in technical skills is discouraged due to the subjectiveness of participants when asked to interpret and rate themselves. Instead, focusing on participant experience with the given tasks or tools would generate a more accurate estimation of their expertise. (Barnum 2010, 117-118.)

Another factor that influences the recruitment of test participant is aligning their motivation with the goals of the study. Without this alignment, it is more likely that participants perceive testing tasks as exercises that do not provide actual value to them. (Barnum 2010, 118.)

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Task-based scenarios

A strong and valid task is concrete and does not contain indications that could stimulate how users behave when using the application (Loranger 2016). Tasks should be realistic and true to the nature of how people use the application. They should also be actionable and encourage users to interact with the interface. Assuming that the aim of the test is to learn how people explore and discover information, testing scenarios can be exploratory covering open-ended tasks without attempting to seek a correct answer. On the other hand, more specific, focused and closed tasks require users to accomplish certain goals. (McCloskey 2014.)

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Test metrics

Although measuring usability might not be accurate and representative in small-scale testing, it still provides an overall insight into the performance of the application. During or after the test session, designers could collect several common usability metrics, namely successful task completion, critical errors, non-critical errors, and time on task. On top of these metrics, designers can also collect more qualitative information from test users by asking open-ended questions, such as their likes, dislikes, and recommendations that could further improve their experience. (Usability.gov s.a. c.)

Firstly, a scenario considered as completed when users find asked specific information or accomplish the task goal without further instruction from the test facilitator. Secondly, critical errors are those that prevent users to complete the targets of the task. It is possible that the test participants are not aware of the incompletion. On the other hand, non-critical errors are those that recoverable and do not impact the completion of the task. However, they might influence the efficiency of task completion. Last but not least, time on task records the amount of time spent on completing the task. (Usability.gov s.a. c.)

Think-aloud method

During the course of testing, participants are encouraged to continuously verbalise their thoughts when using the application as they navigate and explore the interface (Nielson 2012b). One common technique that belongs to think-aloud methodology is Concurrent Think Aloud (CTA). When working with CTA, the test moderator or facilitator only prompts users with phrases such as "mm-hmm" and "keep talking." (Bergstrom 2013.) Using the think-aloud method enables designers to quickly grasp users' instant responses and reactions, as well as their misinterpretations of the design (Nielson 2012b). However, this method faces a shortcoming in gathering detailed statistics (Nielson 2012b) and interfering with certain test metrics, for instance, accuracy and time on task (Bergstrom 2013).

2.4 Planning and conducting a heuristic evaluation

Planning a heuristic evaluation commonly commences with defining the scope of the study with realistic targets and objectives. With the study goals established, the process extends to deciding on the set of heuristics to use. (Goldberg 2019.) Although there is no official recommendation for choosing heuristics, on average, the majority of heuristic evaluations contain five to ten items. Less than five heuristics cause a lack of severity when diagnosing potential flaws, while more than ten items overwhelm evaluators. (Wong 2020.)

When it comes to choosing evaluators for the study, it is generally encouraged to involve at least three evaluators with usability knowledge and familiarity with the application and/or expertise in the industry type the application is serving (Wong 2020; Schlecht 2019). However, under circumstances where hiring multiple usability experts is unaffordable, it is possible to evaluate an application with limited resource. Heuristic markup is an alteration of heuristic evaluation in which the evaluator/designer's gut reactions and responses are recorded and emphasised instead of recognised standards. (Buley 2013, 136.)

To yield unbiased and quality results from the study, the evaluator should adopt and put themselves in their persona's shoes with accordingly motivations and desired goals to achieve. During the course of conducting heuristic markup, the evaluator follows a set of task-based markup established on core use cases or scenarios that the application supports. While navigating through the application to complete predetermined tasks, the evaluator is advised to take screenshots, record their thoughts and reactions, and store them for later interpretation. (Buley 2013, 137-139.)

As the tasks are completed and heuristic violations are documented, the evaluation process is followed by rating the severity of the listed violations. To define how severe a usability problem is, there are three factors to take into account: (1) the frequency of the issue occurrence, (2) the impact of the issue when it occurs, and (3) the persistence of the issue after the first encounter. (Nielson 1994b.)

With the factors in mind, the violations can be rated on the scale from 0 to 4, representing (Nielson 1994b):

- 0 = I do not agree that this is a usability problem at all

- 1 = Cosmetic problem: can be fixed when there is additional time

- 2 = Minor usability problem: low priority fixes

- 3 = Major usability problem: important and high priority fixes

- 4 = Usability catastrophe: imperative fixes before releasing

2.5 Design principles for mobile application

Designing mobile applications differs from designing for other environments, including desktop, tablet, and smartwatch devices. When designing for mobile devices, it is suggested that designers take into consideration various factors made up of device screen size, behaviour and contexts users are in when using their mobile phones. With that in mind, the following is a set of simple and powerful principles providing guidelines for mobile experience design.

Mobile mindset

Designers are recommended to shift their mindset from either desktop or tablet mindset to a mobile mindset in which they should first be focused. Given the pocket-size real estate, less is more. Unnecessary features can be edited out viciously to ensure the task completion of users. Secondly, among approximately 2.95 million mobile applications available on the market (Statista Research Department 2021b), standing out is challenging. It is beneficial for designers to understand what differentiates their works from others, then amplify them. Thirdly, the design of mobile applications is expected to be charming. Nowadays, mobile devices are seen as everyone's constant companion. On average, adults spend around 3.8 hours on a mobile device daily. With that in mind, it is understandable when users establish attachment with applications delivering a friendly, delightful and reli-

able experience. Lastly, being considerate of real users generates an engaging experience. (Stark 2014.) This last point is always fundamental when it comes to product design in general.

Mobile context

To be able to put oneself in the shoes of their users, understanding contexts of mobile device usage are necessary. Namely, there are three major contexts where users would normally pick up a mobile device: bored, busy and lost. In a boring context, users look forward to engaging in long usage sessions with applications delivering an immersive and delightful experience. Yet, it is expected that interruptions are likely to occur during the session, therefore, effortlessly resuming the incomplete action or journey is required. Examples of such experience can be found in social media applications, web browsers, and games. (Stark 2014.)

In a busy context, users look forward to accomplishing tasks swiftly and reliably, usually with one hand, on the go, and in a chaotic environment. It is also very common that users will have tunnel vision, so sizable and vivid visual cues are beneficial. Examples of such experience can be found in email, calendar, and banking applications. (Stark 2014.)

In a lost context, users can be situated either in an unfamiliar environment or in a familiar environment yet curious about something new and/or unknown. In this context, it is wise to expect unstable internet connectivity and long usage sessions of the device, which lead to large battery consumption. Therefore, consideration of offline support and battery life consideration is appropriate. Examples of such experience can be found in digital maps and travelling applications. (Stark 2014.)

Global guidelines

Applications tailored to different contexts require different techniques and design methods. However, the fundamental nature of designing for small screen sizes necessitate various global guidelines, including, first of all, the responsiveness of the design. User interactions need to be acknowledged instantly. The responsiveness of an application is dissimilar from how fast it processes operations. Certain actions might take time to operate, and users should always be informed of the process and progress. Another aspect that designers need to pay attention to is the finish of the design. Concerning the established companionship between users and their mobile devices, users are likely to notice and appreciate the perfected little details presented to them. The "fit and finish" of an application

seems to boost user experience alongside its functionality and overall outlook. (Stark 2014; Wrobrewski 2014; eSparkBiz 2020.)

Additionally, designing touchscreen interfaces for thumb usage is the default. It appears that either with a one- or two-handed grip, it is more likely that users interact with mobile devices using their thumbs instead of fingers. According to Hoober's study (2013), 49% of people rely on their thumb to operate on their mobile. Closely related to designing for thumbs, it is crucial to take into consideration the average size of thumbs, which in turn affects the average size of targets on the touchscreen. It is recommended by Apple's Human Interface Guidelines (s.a.) that the 44-pixel UI element is thumb-friendly, while Google (s.a.) suggests 48 pixels and Microsoft 34 pixels. Designers should also be circumspect of placement and spacing between UI elements to avoid unexpected errors. (Stark 2014; Wrobrewski 2014; eSparkBiz 2020.)

On top of that, the intuitiveness of touch interfaces has embraced how users directly interact with content. To have content presented up-front and centre on the interface, minimising UI elements, such as buttons, checkboxes, sliders and so on is suggested. Besides, considering the shorter and shorter concentration span of users these days, content should be kept minimal and effective. To help users accomplish their tasks, only relevant content and essential elements should be displayed on the interface promptly. Besides, to maintain users' focus on the content, controls should be placed beneath them, or at the bottom of the screen. With this setup, users have a better understanding of the effects of their interaction with the controls. This contradicts the design of website or desktop software, however, the size of a mouse pointer on a desktop screen is relatively much smaller than the size of a thumb on the mobile screen. On another note, keeping controls within thumb reach for both left- and right-handed users to enhance accessibility should also be taken into consideration. (Stark 2014; Wrobrewski 2014; eSparkBiz 2020.)

3   Study design

This section firstly provides a brief introduction to the subject of this study with a description of the Helmet library and Taskukirjasto mobile application. It is then followed by discussing usability testing and heuristic evaluation plans for studying Taskukirjasto.

3.1   Taskukirjasto application case study

The helmet is a network of public library connecting city libraries in Helsinki metropolitan area, including Espoo, Helsinki, Vantaa and Kauniainen. Customers of the Helmet library have full access to 64 libraries, 3.2 million volumes besides public events oreganised by the libraries. In addition to visiting the libraries in person, Helmet also offers services online for managing reservations and loans. Information related to local libraries, for instance, opening hours, contact details and library events, are also available online. In 2019, Helmet served an averagely of 30 million visits per year, of which more than half were visits via the website, Helmet.fi. (Helmet 2019.)
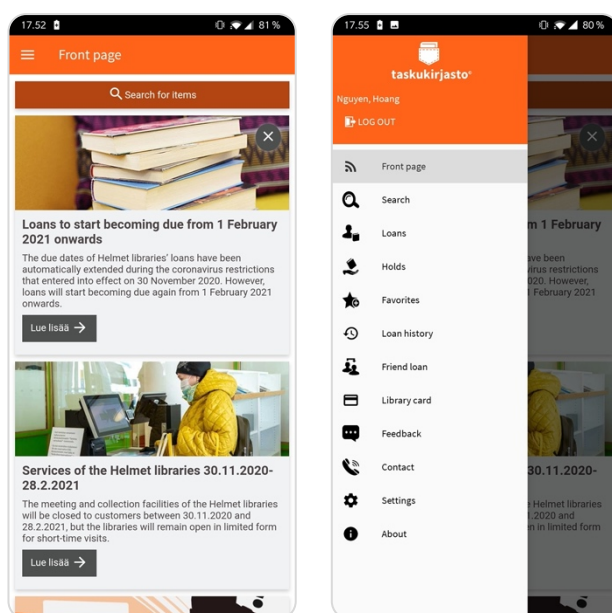
Figure 5. Frontpage and navigation drawer of Taskukirjasto application

Taskukirjasto (Pocket Library) mobile application was launched in June 2016 as a part of the library online experience (Saastamoinen 2019). The application allows Helmet customers to make and manage reservations and renew loans, receive recommendations and create favourite items list, check libraries' detail information, and borrow library items from friends. Similar to the main website, Taskukirjasto is available in Finnish, Swedish,

English and Russian languages. To fully experience the application, users are required to have a library card, or in other words, to be a customer of Helmet library. (Helmet 2021.)

To further understand the user of the application and the problems they experience, reviews on the Apple and Play stores were examined. Taskukirjasto is currently rated as 3.7 out of 5 points on Play Store, and 4.4 out of 5 on Apple Store. Figure 6 demonstrates user feedback collected from mentioned app stores. Considering that the reviews were written in Finnish, texts shown in screenshots were translated into English using Google Translate.
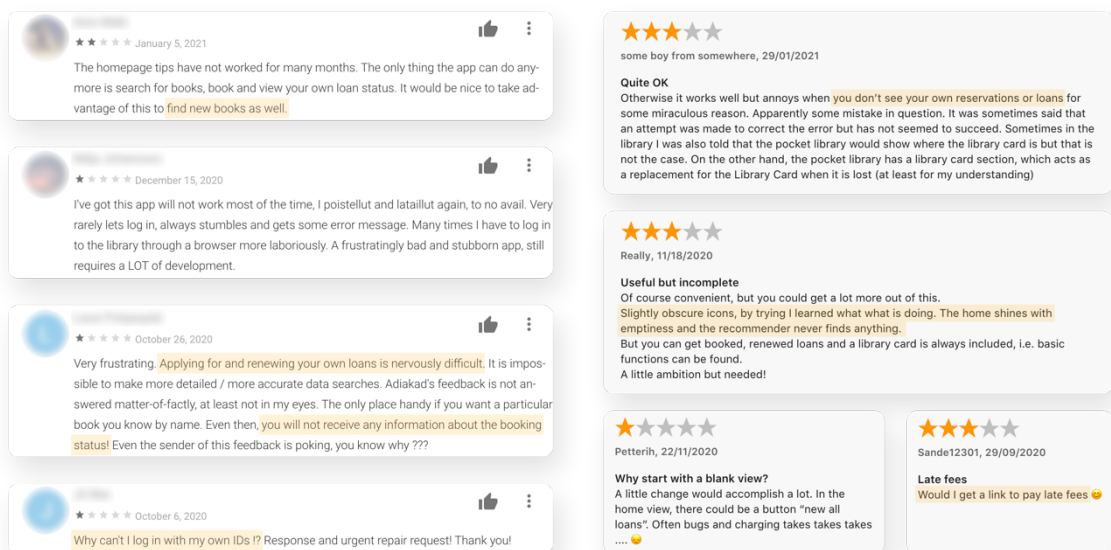
Figure 6. User reviews of Taskukirjasto on Apple and Play stores

To establish the goals of the study, Quesenbery's 5Es model (Barnum 2010, 108; Quesenbery 2004) was implemented. Based on the feedback from users on both app stores, it appears that the majority of Taskukirjasto users employ the application to search for and make reservations for books, check statuses of their reservations and loans, and replace their physical library cards with digital ones. They need (1) a convenient way to look for and borrow books (effective/engaging), (2) a good overview of their reservations and loans, so they know when to pick up and return items before the expiration date (efficient/error-tolerant), and (3) to be able to access their digital library card quickly (efficient)

3.2 Usability test plan

Taskukirjasto mobile application as of 20 February 2021 will be tested with selected test participants. In order to maintain test users' attention and interest, and test sessions brief

and focus, the scope of the usability testing covers only a few major activities offered by the application. Demonstrated in Figure 7 are the actions asked from users and the flow of the test.

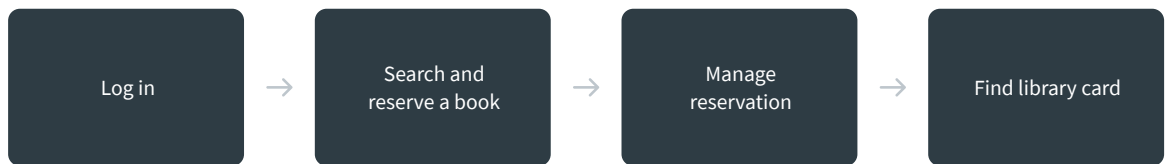| Log in | → | Search and reserve a book | → | Manage reservation | → | Find library card |

Figure 7. Test activities flow

Test users will be asked to first log in to the application, then proceed to search for a book and make a reservation for it. Once the reservation has been made, users will be requested to update their reservation. The last activity requires users to allocate the digital version of their library card on the application.

Purpose

The usability test focuses on the effectiveness of Taskukirjasto as a mobile application. The test results will answer the questions of whether users successfully (1) find and make a reservation for a book, (2) view and manage their reserved items, (3) find their library card, and (4) their experiences after using the application.

User profile

Based on Barnum's (2010, 116-119) guidelines for defining characteristics of test participants, targeted users will be chosen based on one or more of the following traits: (1) motivated to use library borrowing services, (2) familiar or unfamiliar with the concept of the application, (3) familiar or unfamiliar with the application, and (4) native or non-native language speaker.

Equipment

Test sessions will be executed in a semi-controlled environment recorded with a voice recorder. The record serves as a tool facilitating more accurate and efficient analysis works. Besides the audio recorder, test equipment also includes a mobile phone, pen and paper to take note during the session.

Scenarios

To help test users understand and immerse themselves into the context, the following background story will be read to the users:

> *"A friend of yours recommended you an interesting book. On your way home, you would like to see if you can borrow the book from the Helmet library. After browsing their site, you realise that they have a mobile application, so you download it. Your aim is to use the application to quickly find and make a reservation for the book."*

Once users have downloaded the application, they will be asked to perform the below tasks and describe their thoughts, impressions, opinion while interacting with the application. The tasks should be as follows:

1. Log in to the application.

2. Find a book called "Why nations fail" and reserve it.

3. Cancel your reservation for the book "Why nations fail".

4. Find your library card.

Metrics

During the test, the author will keep track of the following metrics: successful task completion (Yes / No after each task), critical errors, and non-critical errors.

After the sessions, participants will fill the following questionnaire: subjective measures of overall satisfaction, ease of use, ease of finding information, and getting enough system feedback from actions. The test will be concluded by collecting users' likes, dislikes and further recommendations under the form of open questions if they have any.

3.3 Heuristic evaluation

Taskukirjasto mobile application as of 1 March 2021 will be tested with selected test participants. Besides subjects similar to the usability test, the scope of the heuristic evaluation also covers the other functionalities highlighted by the Helmet library, including the flows of (1) viewing and managing borrowing / borrowed items, (2) bookmarking items, and (3) viewing local library information. Combining this list with the scope of the usability test plan, the author is able to obtain an overview of violations the application is currently facing.

Heuristics

Heuristics applied for the usability evaluation of this study follows Nielson's (1994a) works including:

- Visibility of system status

- Compatibility between system and the real world

- Freedom and control to the user

- Consistency and standards

- Error prevention

- Flexibility and efficiency of use

- Recognition rather than recall

- Aesthetic and minimalist design

- Help users recognise, diagnose, and recover from errors

- Help and documentation

Scenarios

To conduct the heuristic evaluation, the scenarios to be performed by the author should be as follows:

1   Find a book called "Why nations fail" and reserve it.

2   Cancel your reservation for the book "Why nations fail".

3   Extend the borrowing time of a book called "Ego is the enemy".

4   Browse and bookmark a fictional book written in English.

5   Find out when the library that's most convenient to you is open tomorrow.

4   Usability evaluation conduct and results

This section is dedicated to present results yielded from the usability test and the heuristic evaluation.

4.1   Conducting a usability test

To ensure that the testing scenarios and tasks align with test users' mental models when using library online services, a pilot test was conducted. According to the pilot test, the order of the testing scenarios was adjusted. The test case started with asking users to find a book called "Why nations fail", followed with making a reservation for the book, then cancel the reservation afterwards. The last scenario remained as planned.

The test was conducted with seven participants in total, including one mentioned pilot test participants and six others. All the results of the test were recorded. As the scenarios used in the pilot test were slightly different from the rest, to maintain the consistency of the report, these pilot test results were documented following the structure and content of the test scenarios used in other tests.

The majority of the test participants share the same background of nationality as non-native Finnish speaker, while only one of them speaks Finnish natively. Out of seven participants, six of them were iOS users. Other descriptions of participants' traits and characteristics are described in Table 1 below. In order to preserve the identities of the test participants, they will from now on being referred to as P0 representing pilot test participant, P1 as test participant number one, so on and so forth.

Each test lasted approximately 20 to 30 minutes.

Table 1. Test user profiles

	Reasons for using library borrowing services	Frequency	Familiarity with the concept of library service app	Familiarity with the testing app
P0	Books and audiobooks Board games	Once every 2 months	No	No
P1	Books	Once a month	No	No
P2	Books, magazines	Once a month	Yes	No
P3	Books	Twice a year	No	No
P4	Books, DVD, tools	Twice a year	No	No
P5	Books	Three times a year	Yes	No
P6	Books Board games	Twice a year	No	No

4.2 Usability testing results

The seven usability tests provided insights into various user experience and usability issues that emerged from interactions between users and the interface. Besides the satisfactory performance of the application portraited in certain parts of the interface, there are design and functional flaws that hurt the overall experience of the users. Immediate impressions of the users are illustrated below (Table 2).

Ratings of each category were translated to numerical values so that they can be presented in a more systematic and precise format. Respectively, any category rated as Excellent equals the value of five (5), and Very poor equals the value of one (1).

Table 2. Questionnaire result

	Overall satisfaction	Ease of use	Ease of finding information	Getting enough feedback
P0	3	2	4	5
P1	3	4	2	3
P2	3	3	3	4
P3	2	3	2	2
P4	3	2	3	1
P5	4	4	5	4
P6	3	4	2	4
	3.0 / 5.0	**3.1 / 5.0**	**3.0 / 5.0**	**3.3 / 5.0**

Interpretation of data provided by the questionnaire suggests that users perceived the application as of average quality. Averagely, users found the application somewhat satisfactory to use as they were able to accomplish given tasks, with the assistance of the author. Besides, they also perceived the application as partially easy to use and information was slightly easy to find. From the observation, even though the interface provided expected information related to the desired item, in this case, study, a book named "Why nations fail", some important information was overlooked or placed at unanticipated places. The last category of receiving feedback from the system for taken actions was marginally higher. However, there were still complaints that users were reluctant to take action since they did not want to accidentally make mistakes.

During the test, users faced problems that were both recoverable and non-recoverable. When confronting those critical issues, frustration emerged and was carefully observed. According to Table 3, the majority of test users failed to search for and make a reservation for the requested item. Other than that, the accomplishment of tasks related to managing item reservation required additional help from the author.

Table 3. Task completion rate

	P0	P1	P2	P3	P4	P5	P6
1. Find the book "Why nations fail"	**Pass**	**Fail**	**Fail**	**Fail**	**Fail**	**Fail**	**Pass**
Search for the book	Pass	Fail	Fail	Fail	Fail	Fail	Pass
View information of the book	Pass	Pass	Pass	Pass	Pass	Pass	Pass
2. Reserve the book "Why nations fail"	**Pass**	**Fail**	**Fail**	**Fail**	**Fail**	**Fail**	**Pass**
Log in to the application	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Make a reservation for the book	(!)	Fail	Fail	Fail	Fail	Fail	Fail
3. Cancel the reservation of the book	**(!)**	**(!)**	**(!)**	**(!)**	**(!)**	**(!)**	**Pass**
Open list of reservation	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Find the reservation of the book	(!)	(!)	(!)	(!)	(!)	(!)	Pass
Cancel reservation of the book	(!)	(!)	(!)	(!)	(!)	(!)	Pass
4. Find your digital library card	**Pass**	**Pass**	**Pass**	**Pass**	**Pass**	**Pass**	**Pass**

Demonstrated in Table 4 are the key findings from the usability testing sessions. Issues found were categorised into testing scenarios, described in detail, and analysed according to their types ranging from Critical, Non-critical to Suggestion. Issues were then assigned issue points respective ranging from three (3) point to one (1) point. The frequency of the occurrence of found issues was counted and calculated. Severity of the issues was determined by combining the value of the issue points and frequency.

$$Issue\ point * Issue\ frequency = Issue\ severity$$

Issues with severity values equal to or larger than two (2) were considered as major and critical to the usability of the application requiring to be prioritised to correct. Those between the value of one (1) and two (2) were acknowledged as non-critical and lower in the priority list. Last but not least, issues with severity values lower than one (1) can be fixed when there is time available.

Table 4. Summary of issues found from usability test

Issue ID	Task No.	Issue description	Issue type	Issue pts	P0	P1	P2	P3	P4	P5	P6	Count	Frequency	Severity
			Issues		Participants									
1	1	Information is shown in both English and Finnish when using app in English	Critical	3	1	1	1	1	1	1	1	7	100%	3.00
2	1	Search bar is too small, not very obvious	Non-critical	2		1	1	1	1	1		5	71%	1.43
3	1	Can't find a place to change language setting	Non-critical	2			1					1	14%	0.29
4	1	It would be easier to see suggestive search when typing search query	Suggestion	1	1	1		1		1	1	5	71%	0.71
5	1	When there is a typo in search query, return totally irrelevant search result	Critical	3		1	1	1	1	1		5	71%	2.14
6	1	It would be easier to see multiple entities of same item listed together	Suggestion	1	1							1	14%	0.14
7	1	App crashed twice during checking different items when using app in English	Critical	3	1		1	1			1	4	57%	1.71
8	1	Can't find information on item availability and reservation queue in the summary	Critical	3	1		1	1			1	4	57%	1.71
9	1	Confused about 0 available item and Show available item button	Non-critical	2		1	1	1	1	1	1	6	86%	1.71
10	1	Confused about meaning of On Holdshelf	Non-critical	2	1		1		1		1	4	57%	1.14
11	2	When not logged in, there's no indicator to remind user to log in before making reservation	Critical	3	1	1	1	1	1	1		6	86%	2.57
12	2	On iOS device, camera button appears hidden	Non-critical	2	1	1			1	1	1	5	71%	1.43
13	2	On iOS device, placement of Log In button is non-standard, didn't expect to see it in top right corner	Non-critical	2	1	1	1	1	1		1	6	86%	1.71
14	2	Confused by the icons of the buttons	Critical	3		1	1	1		1	1	5	71%	2.14
15	2	Can't find Reservation button, figured out it was hidden under Export icon in top right corner	Critical	3	1	1			1	1	1	5	71%	2.14
16	2	User was not familiar with and confused about meaning of Export icon	Non-critical	2	1							1	14%	0.29
17	2	Confused about meaning of Place Hold, found it odd translation	Non-critical	2	1			1	1		1	4	57%	1.14
18	2	It would be nice to have the default destination library saved on web app remembered on mobile as well	Suggestion	1	1							1	14%	0.14
19	2	It would be easier to quickly search for destination library instead of scrolling	Suggestion	1	1	1	1	1	1	1	1	7	100%	1.00
20	2	It would be nice to have a confirmation dialog after tapping Send button	Suggestion	1		1			1			2	29%	0.29
21	2	Confused by "I don't need this material..." language	Non-critical	2				1				1	14%	0.29
22	3	Can't find Cancel Reservation button	Critical	3	1	1		1	1	1		5	71%	2.14
23	3	Under Export icon, there was still option to reserve the item even though it is already reserved	Critical	3	1	1		1	1	1		5	71%	2.14
24	3	It would be easier to have all the information on reservations and loans in one place	Suggestion	1	1		1			1	1	4	57%	0.57
25	3	User was surprised to learn about reservation queue only after making reservation	Critical	3	1							1	14%	0.43
26	3	User expected newest item to be on top when sorted by date	Non-critical	2		1				1		2	29%	0.57
27	3	It would be easier to search for a specific item than scrolling when there are too many items there	Suggestion	1	1	1	1			1		4	57%	0.57
28	4	User expected to open their profile when tapping on their name	Non-critical	2	1						1	2	29%	0.57
29	4	It would be nice to have a Profile page	Suggestion	1	1	1	1	1			1	5	71%	0.71
30	4	It would be nice to have a page dedicated for loan and reservation information	Suggestion	1	1	1	1	1			1	5	71%	0.71

According to Table 4, issues required immediate attention related to the language used on the interface. Currently, the interface presents information in both English and Finnish languages even though the language of the application has been set to English. This issue was strongly specified by all of the test users. To Finnish speaking user, they decided to switch the application language to Finnish. The other six users had to progress with a mixture of English and Finnish information on the interface for the rest of the test. Many of them expressed their disappointment immediately as they experienced this issue.

During the first task, users confronted an issue when searching for the requested item after hearing it spoken by the author. Five users entered the name of the book with a typographical error – "why nation fail" instead of "why nations fail". This led to a list of search result which was unrelated to the search query. At this stage, test users assumed the collection of the library did not carry this item, which was not the case. The author needed to provide the exact spelling of the name of the item so that users can find the requested item.

The second most serious issue encountered by six out of seven users was the lack of any signal on how users might proceed to reserve the book once they had found it. This issue occurred since users were not logged in to the system, hence the needed action button was unavailable. In this situation, many test users articulated that it might due to the unavailability of the desired item. Assistance was required from the author to guide users to log in so they can complete the given task.

Upon logging in to the system, users advanced to complete the task, yet they faced another issue at this point. Many of the users puzzled to find the button that allowed them to make the reservation for the book. The button appeared to be hidden to the users due to its representative icon or placement on the interface. On the page where a list of relevant search results was offered, the "Place hold" button appeared insignificant among other buttons that shared the same visual weight. On the page where detailed information of a specific book was presented, the "Place hold" button can only be found under the "Export" button placed in the top right corner of the screen. Concerning the primary use of an application performing library services, this was an unusual location to place the button.

Similarly, users experienced the same issue when looking for a button to cancel their made reservation.

4.3   Conducting a heuristic evaluation

During the heuristic evaluation session, the author navigated and performed predetermined test scenarios using Taskukirjasto. In addition to the listed scenarios, an explorative task was added later on so that the author could obtain a more thorough assessment of the application. To accomplish this task, parts of the application there were not inspected in the usability test and the heuristic evaluation was scrutinised. Screenshots of heuristic violations were taken while performing the scenarios and closely analysed the in next section.

Given that the web version of Taskukirjasto has been employed by Helmet customers long before the launch of the mobile version, users have accustomed themselves to the experience established by the web application. Particular expectations towards the mobile application could be driven by previous interactions between users and the web application. Therefore, for certain test scenarios, the mobile application was examined against its web version.

The heuristic evaluation was conducted using an Android device. This information is clarified due to the differences in placement or design of certain elements of the interface.

4.4   Heuristic evaluation results

Considering that there were issues that violated more than one heuristic, the evaluation results will be documented following the order of test scenarios instead of heuristics.

In the first scenario "Find a book called "Why nations fail" and reserve it", as described in the result of the usability test, the first heuristic violation was inconsistency in the language used in the application was reconfirmed in the heuristic evaluation. Demonstrated in Figure 8 is how information was presented to users on the interface. Parts of the texts on the interface were in English while other parts were in Finnish. To assure that the application language was English, this information was confirmed under the Settings page of the application. However, the issue remained the same. This issue violated the rule of "Consistency and standards" regarding the coherence of the language of the application.
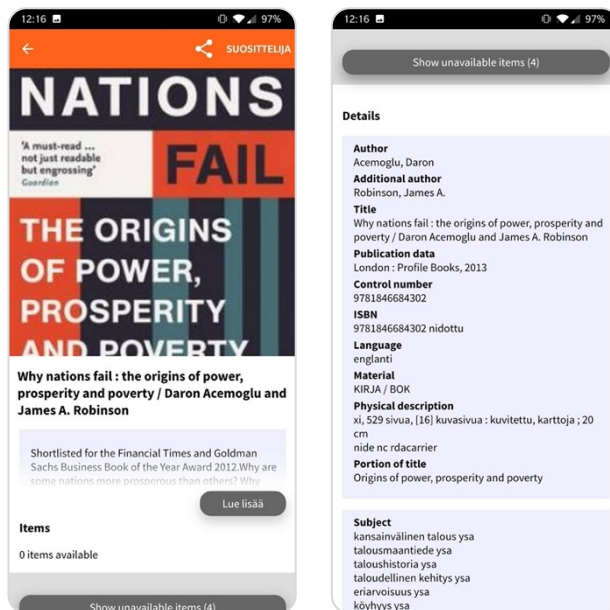
Figure 8. A mixture of the language used on the interface

Another issue elaborated earlier was the lack of suggestive search while performing a search on the mobile application. Demonstrated in Figure 9 are the examples of how the search feature functioned using the same search query on the web versus the mobile versions of the application. Suggestive search has been well-formulated on the web application, which was more commonly used by Helmet customers in comparison to the mobile application. Besides, suggestive search has been observed to be widely implemented in digital products from various product family, hence, this mechanism was expected from Taskukirjasto as well. This issue violated the rule of "Consistency and standards" regarding the uniformity of the performance of the Search function across platforms.

Figure 9. Search functionality on the web versus mobile application

Besides the inconsistency, the absence of the suggestive search also increases the chance of errors caused by users. According to a study conducted by Grammarly (2019), the likelihood of producing typographical errors was 42 percent, meaning 42 errors per 100 words. Taking into consideration this number, the probability of users making mistakes when searching for an item is reasonably high. On the other hand, it is very likely that users only hear the name of the desired item and proceed to look for it without consulting other sources. In this case, the probability that users mishear the title, especially when the title is not in their native language, and make similar typographical errors as demonstrated in the usability test is fairly high. This issue violated the rule of "Error prevention" regarding the inability to preclude error-prone situations from developing. The consequence of typographical errors when executing a search will be discussed immediately in the next paragraph.

Given that suggestive search is not implemented in the application, when searching for an item with a typographical error, the application returned entities that were entirely unrelated to the search query. Demonstrated in Figure 10 is an example of such a result. With the absence of a letter "s" in the search query, the search outcome was different. When examining closely, the search result did not contain any phrase or word that was relevant to the search query. Without any indication of the occurrence of typographical errors in the search query, it is reasonable that users could not comprehend why they cannot find the needed item. This issue violated the rule of "Help users recognise, diagnose, and recover from errors."

Figure 10. Returned results of a search query with a typographical error

Without logging in when searching for items, at the time that the needed item was found, the author proceeded to make a reservation for the book. As elaborated in the usability test result, the absence of an indicator to suggest users logging in to proceed with their actions was spotted during the heuristic evaluation. Demonstrated in Figure 11 were the examples of information and actions available to users when they were not logged in to the service. It is apparent that the standard of having a "Request it" button even though users are not logged in has been strongly established and reinforced on the web version of the application; therefore, it was expected to be applicable on the mobile version as well. Upon interacting with the "Request it" button, users would be directed to the login form and progress from there. This issue violated the rule of "Consistency and standards" regarding the availability of information under similar condition across platforms.
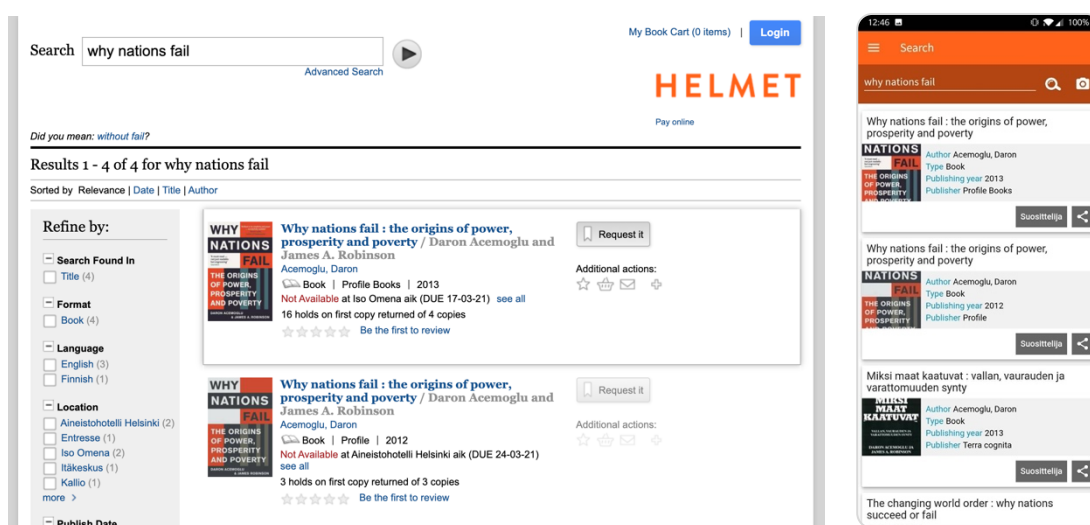

Figure 11. The interface of web versus mobile application when users are not logged in

After logging in, the search result listed relevant entities with quick action buttons. Yet, without additional explanation, some of these icon buttons could confuse users. Demonstrated in Figure 12 is the example of one of those icons. The button meant for reserving items uses the icon of a hand holding a book. It was acknowledged that "Hold" and "Place hold" are terms regularly used in libraries, therefore, the adoption of the illustration conveying the message of "Place hold" was understood. However, it is questionable whether it could deliver the same meaning to the majority of users who do not use these terms frequently in their daily life. Additionally, this icon has rarely been recognised anywhere else, hence, it is likely that it does not align with the real-world convention of users.

Figure 12. Uncommon icon buttons without textual explanations

Besides, the usage of the "Place hold" term on the interface was alarming as well. Even though this is a common vocabulary used extensively in libraries, the majority of library users might not be familiar with it. This issue violated the rule of "Match between system and the real world" regarding the inability to speak the language familiar to the users.

Additionally, since users have familiarized themselves with the term "Request it" on the web application, introducing "Place hold" on the mobile application would increase users' load of cognitive effort required to understand the terminology. This issue violated the rule of "Consistency and standards" regarding the conformity of language used across platforms.

When examining closely at the presentation of information and actions required for completing a task, in this case, reserving a book from the library, it was discerned that the interface was cluttered with irrelevant or less important elements. Given that making reservations for items is one of the main functions of the application as claimed by its developers (Helmet 2021), the entry point to this action was poorly accessible. Demonstrated in Figure 13 is the examples of the "Place hold" button either being de-emphasised when placed among less important buttons, or being enclosed in an unanticipated place, behind another button. This issue violated the rule of "Aesthetic and minimalist design" regarding the inability to prioritise content supporting task completing the goals of users.
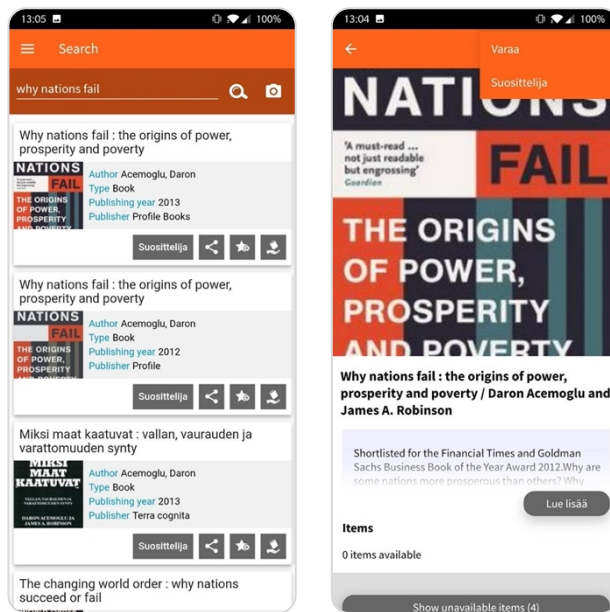
Figure 13. Cluttered interface leads to poor availability of the "Place hold" button

No heuristic violation was discovered while completing the second scenario "Cancel your reservation for the book "Why nations fail".

When executing the third scenario "Extend the borrowing time of a book called "Ego is the enemy", the research confronted another issue related to the inconsistency between the language used on the web application and the mobile application of Taskukirjasto. Demonstrated in Figure 14 is the examples of vocabulary used on the two platforms conveying the same meanings. On the web application, "Checkouts" were used to indicate items that were currently borrowed by users, while "Loans" were used on the mobile application. The disagreement between the platforms can be seen as a minor learning curve that put pressure on the cognitive effort of users during their migration from the web to the mobile application. This issue again violated the rule of "Consistency and standards" regarding the conformity of language used across platforms.
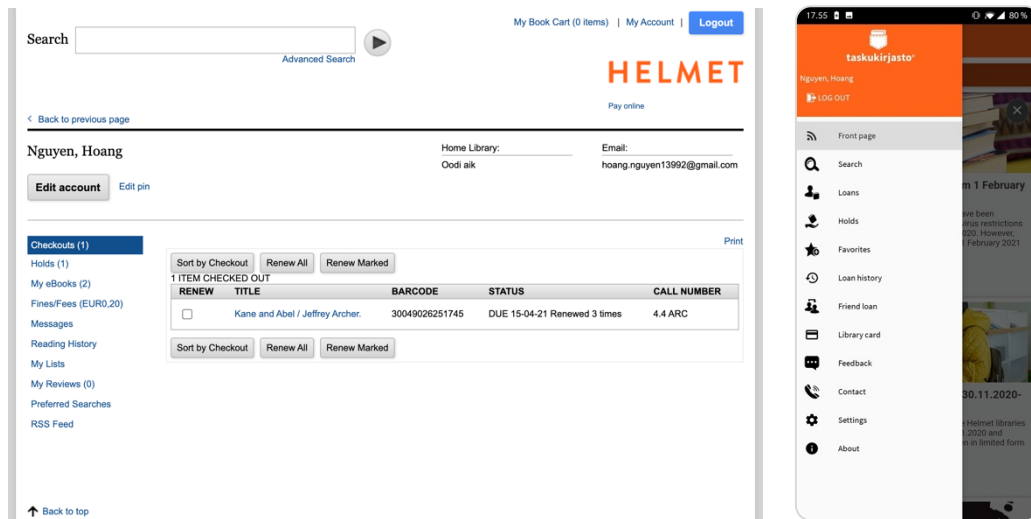
Figure 14. Vocabulary used on the web versus on the mobile application

In the attempt to accomplish scenario four "Browse and bookmark a fictional book written in English", the author realised that Taskukirjasto does not emphasise this use case. The application mainly enables its users to search for and make reservations for items instead of browsing. Therefore, features supporting item browsing use case were not available on the mobile application.

During the last scenario "Find out when the library that's most convenient to you is open tomorrow", a different example of conventional usage of the interface element was identified. Demonstrated in Figure 15 is the visual of the "Contact" button versus the action that occurred when interacting with the button. It was unexpected that the button with a label as "Contact" and a complementary icon as a phone call would take users to view the opening hours of local libraries. A button with similar components frequently communicates the action of getting contact information including phone number and/or email address of either local libraries or customer services. This issue violated the rule of "Match between system and the real world" regarding the misalignment between the perceived and the exact meaning of a button.
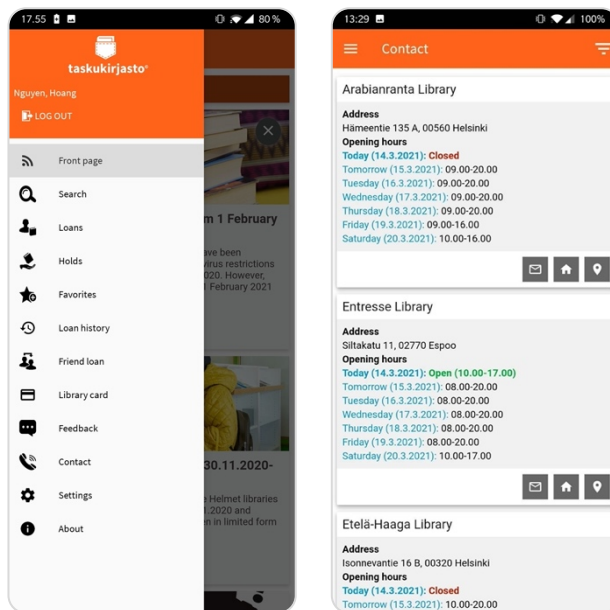
Figure 15. Poor alignment between the meaning of "Contact" button and its actual action

While performing the explorative task, the research encountered a functionality named Friend loan. Demonstrated in Figure 16 is the interface of the Friend loan screen. There was no introduction or explanation of what users could use the feature for. This feature was fairly new to the author since it had not been introduced previously on the web version. To obtain knowledge of the Friend loan feature, the author needed to exit the application and find the information on the website of Helmet. The feature was briefly mentioned in the page introducing Taskukirjasto, yet its explanation and instruction can only be found under the Frequently asked questions section of the website. Without any further assessment of the information architecture of the website itself, it appeared that information related to the Friend loan feature was concealed from users and required lots of effort to access. This issue violated the rule of "Help and documentation" regarding the inability to provide users with help documentation in a timely fashion.
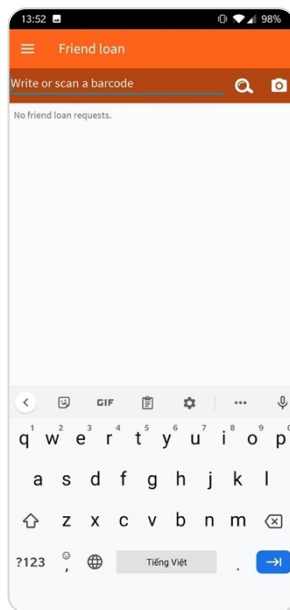
Figure 16. "Friend loan" page without content explaining the feature

Throughout the heuristic evaluation result interpretation, it appeared that the majority of found issues occurred during the completion of the first scenario. From the second scenario onwards, only minor or recurring problems emerged. Key findings from the evaluation are summarised in Table 5 below. Issues are listed and categorised into usability heuristic together with its severity ratings. Severity of issues was rated based on the combination of factors of (1) its occurrence frequency, (2) its impact when it occurs, and (3) whether users can overcome similar issues once they learn about it.

The most recurrent usability issues originated from the inconsistency not only within the application but also between the platforms. Among the issues within this category, having a mixture of English and Finnish language used on the same interface was perceived as a usability catastrophe. Given that users equipped with some knowledge of the language, can guess the meaning of a foreign word, adapt to it and move on with their task, the frustration persists every time they interact with the application. Under the circumstance that they are not familiar with the language at all, it is reasonable that they will abandon the task as well as the application.

Another catastrophe identified related to the performance of the Search function. As discussed, people have a high tendency to make typographical errors, especially when typing with mobile keyboards. With a typographical error in the search query, the system ei-

ther claims that there is no match result or return irrelevant results. Providing that the system does not support suggestive search and fails to indicate the root of the issues, recovering from the error requires more effort than it should.

Table 5. Severity of heuristic issues

	Issue description	Heuristics	Severity
1	Inability to speak the language familiar to the majority of the users (Place hold)	Match between system and the real world	2
2	Misalignment between the perceived and the exact meaning of a button (Contact)	Match between system and the real world	2
3	A mixture of English and Finnish language used on the interface	Consistency and standards	4
4	Misalignment of Search functionality on the web versus mobile application	Consistency and standards	3
5	Misalignment in the availability of information under similar condition across platforms	Consistency and standards	3
6	Misalignment in the language used across platforms (Request it vs. Place hold; Checkouts vs. Loans)	Consistency and standards	2
7	The absence of suggestive search increases the chance of users making typographical errors	Error prevention	4
8	De-emphasis of a major action button (Place hold) on the interface	Aesthetic and minimalist design	3
9	Absence of indicator of a typographical error in a search query	Help users recognise, diagnose, and recover from errors	4
10	Lack of help documentation to introduce users to a new feature (Friend loan)	Help and documentation	2

5   Design improvement recommendations

Although various usability issues were discovered during the usability test and the heuristic evaluation, this thesis focuses on providing design improvement recommendations for the most severe problems in consideration of its scope. The proposed design includes changes in the presentation of information and action buttons on the Frontpage, the Search and Search result page, the side navigation and the Item management page.

The modification made on the Frontpage is minor, where the "Search" button was moved to the top app bar. Demonstrated in Figure 17 is the design of the Frontpage before and after the usability evaluation. Providing that the Frontpage of the application appears to be dedicated to keeping their users updated with, for instance, the availability of library services during the pandemic, the current appearance and placement of the "Search" button make it unnoticeable. When scrolling downwards, the "Search" button disappears from users' sight and only reappears when scrolling upwards to the top of the page.

The proposed design places the "Search" button as an icon button on the top app bar, on the same level with the side navigation "Menu" icon and the title of the page. This approach resolves the availability of the "Search" button, even for smaller screen sizes. As scrolling away, the top app bar can either remain sticky at the top of the screen or become hidden and reappear immediately when users start scrolling upward.
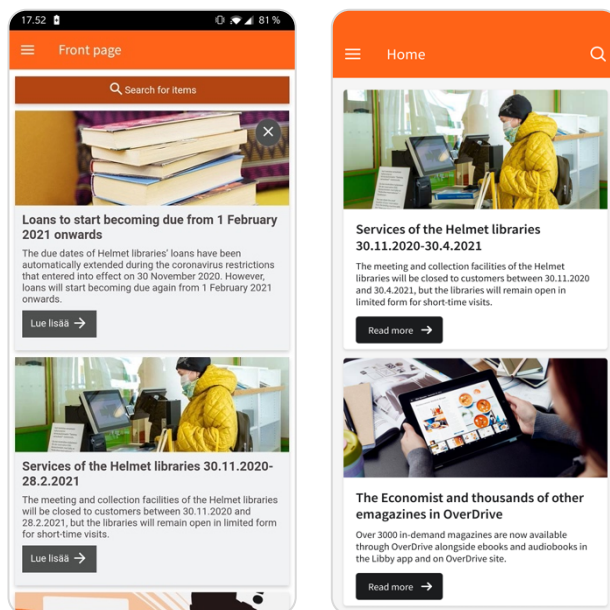

Figure 17. Frontpage before testing (left) and after testing (right)

Additionally, the language of the application is made aligned in the new design. As shown in Figure 17, the latest news is displayed on card elements, where the title and its content are in English, while the action button is in Finnish. The proposed design replaces "Lue lisää" with "Read more" as the action button text.

Upon clicking the "Search" button, users are directed to the Search page. Demonstrated in Figure 18 is the design of the Search page before and after the evaluation. Currently, the Search page instantly shows "No search results" upon entering the page. This can be considered a waste of space on the screen. The new design proposes to utilise this space for displaying the recent search queries. Providing recent searches help reduce the effort required from users when they need to conduct a search for the same items (Babich 2016). Users then can control to clear the search history one by one or as a bulk action.
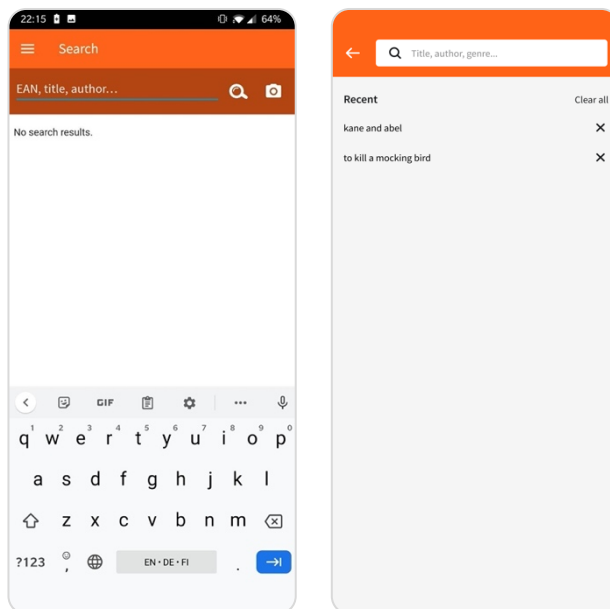

Figure 18. Search page before testing (left) and after testing (right)

Related to delivering a better search experience to users, the new design suggests the implementation of suggestive search, or autocomplete search function. Suggestive search refers to a system action of showing recommended search queries as users fill in the search field. These recommendations alter as users type. Suggestive search helps shorten the mental and physical efforts demanded from users since they can type less when searching. It also reduces the chances of users encountering typography errors while typing. (Moran 2018.) Demonstrated in Figure 19 is the design of the Search page before and after the evaluation.
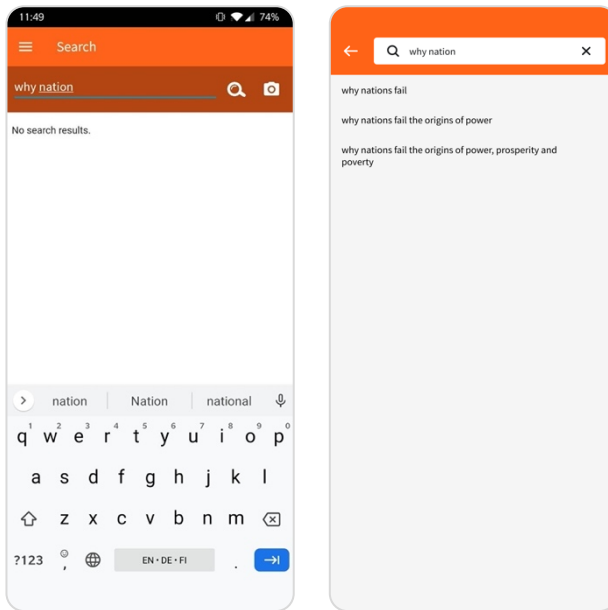
Figure 19. Searching view before testing (left) and after testing (right)

Currently, Taskukirjasto allows users to use the application and explore the library collection without logging in. This is good practice; however, the current design lacks a signal to remind users to log in before they can continue with their task, which is to reserve an item. Demonstrated in Figure 20 is the design of the Search result page before and after the evaluation. The new design introduces the "Request it" button with an icon similarly used in the web version of the application. Besides, it removes less important information and actions from the interface to keep users focus on the necessary ones.
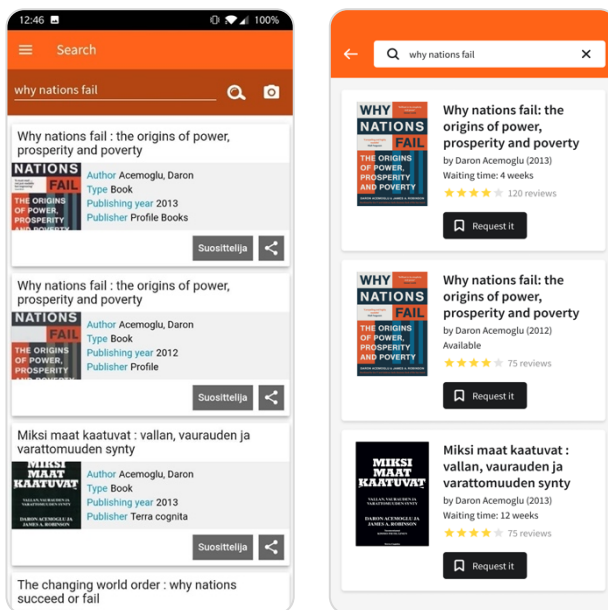

Figure 20. List of search results before testing (left) and after testing (right)

The "Request it" button on the new design will be available and accessible to users even when they are not logged in to the application. When users are not logged in, they will be directed to the log in screen and proceed forward. When users are logged in, they can make a reservation for the desired item.

To help users make decisions already on this page, the proposed design suggests a new type of information, which is the availability status of the item. Users can be informed about the waiting time before an unavailable item becomes available to them, given that they reserve it now. For instance, as shown in Figure 20, the first item on the list has the waiting of four (4) weeks. Other than that, the status is shown as "Available" to users. This information enables users to decide whether they want to make a reservation for the searching item.

As users move on to view more information on an item, they will be taken to the Detail page of the search result. Demonstrated in Figure 21 is the design of the Detail page before and after the evaluation. The current Detail page provides users with very detailed information on the item. Nonetheless, the presentation of the page confuses users when they cannot access the desired information and actions. The new design restructures the information of this page by utilising the upper part of the screen to display the most relevant details, including the item title and author, rating, waiting time (if any), and the language of the item. This section is immediately followed by two primary actions: request the item or save it for later. The rest of the page is filled with other details of the item.
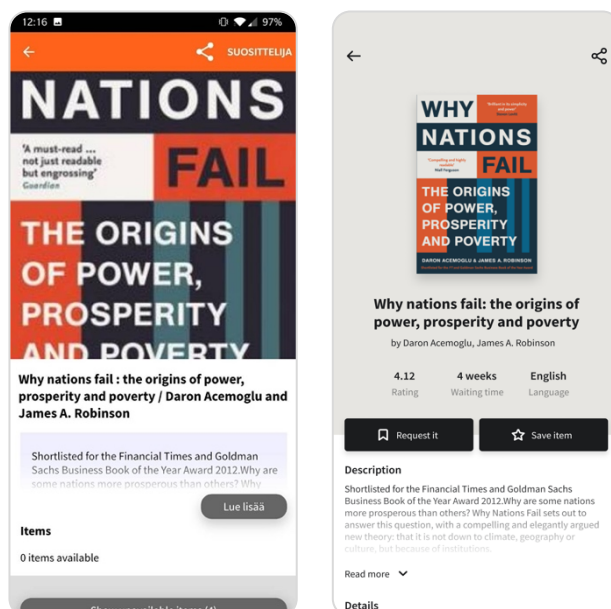

Figure 21. Item detail view before testing (left) and after testing (right)

The proposed design allows users to obtain enough information for the decisions by having a glance at the page. This approach, compared to the current one, assists users to accomplish their task without investing too much effort. For smaller screen sizes, the proportion of the page might need to be adjusted to achieve a similar impact.

Regarding the side navigation section of the application, modifications were made to reduce the number of items available on the screen. Demonstrated in Figure 22 is the design of the side navigation before and after the evaluation. Currently, there are 13 items displayed on the interface at the same. It is apparent that information related to item management, including checked-out, reserved, saved, or read items, belong to one category and can be listed under this category. On the other hand, presenting users with this number of options can put users into analysis paralysis, which prevents or delays their decision-making ability (Chen 2020). In the new design, these items can be accessed under the "My bookshelves" item. Elaboration on this destination will be discussed shortly. The redesign of the menu declutters and decreases the number of items available at once from 13 to six (6), which help reduces the cognitive load for users when they need to allocate information on the side navigation.

Furthermore, the label and icon of the "Contact" button were also updated to align with the button available on the web application. Instead of using "Contact" and the phone icon, the new design use "Libraries" and the clock icon to help explain the action.
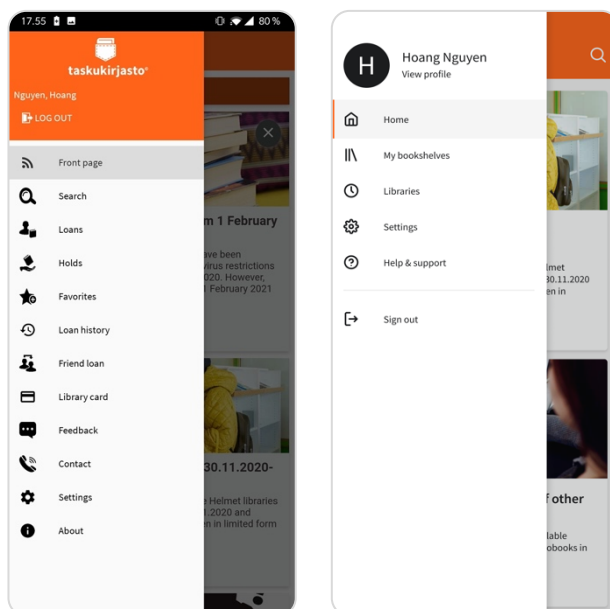

Figure 22. Side navigation before testing (left) and after testing (right)

As mentioned earlier, the side navigation organises pages related to item management under the "My bookshelves" item, which introduce this new page to the application. Demonstrated in Figure 23 is the design of pages related to item management before and after the evaluation. At the moment, to go from, for instance, checked-out item page to re-served page, users need to open the side navigation then navigate to the desired destination. The proposed design recommends the My bookshelves page, where the information is organised in one place and is accessible through the tab navigation underneath the top app bar. On this page, users can switch between categories, view items under each category, sort items by their name or due date, and manage these items accordingly. Similar to the Search result page, only relevant information and actions are displayed on the screen.
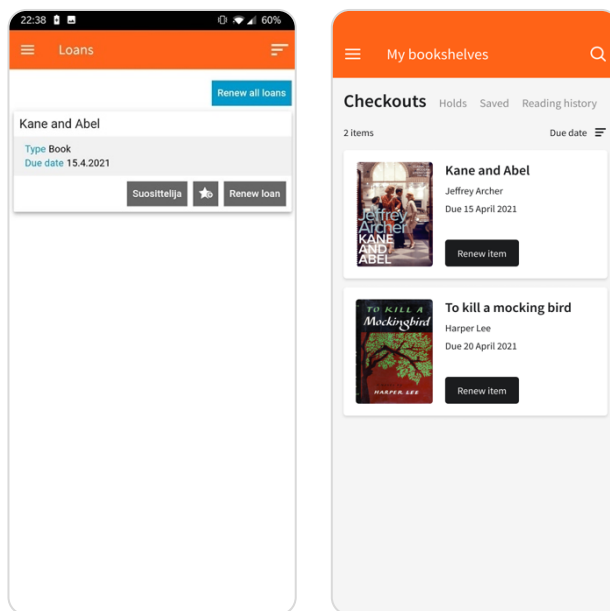

Figure 23. Item managing page before testing (left) and after testing (right)

6 Discussion and conclusion

The purpose of this thesis was to identify the usability problems of Taskukirjasto and propose design recommendations to solve problems found. These recommendations utilised information gathered through usability testing and heuristic evaluation. The usability test covered major goals users can achieve when employing the application for library services. Additionally, a heuristic evaluation was conducted to examine more contextual use cases that were not covered by the usability test. User feedback and findings from the assessment contributed to the proposed version of the application.

The thesis practised a UCD principle where it placed a developed product under examination with the intention to improve its user experience. The process started with obtaining the understanding of the product use cases and user requirements. Based on this knowledge, the usability test was conducted. To keep users interested and attentive throughout the session, the test was kept succinct. During the test, users' interactions and impressions of the application were observed and documented. The heuristic evaluation then facilitated the finding of usability issues that were not covered by the usability test.

Utilising the results of these studies, the most severe problems were identified and tackled through the design improvement suggestions. However, concerning that the redesign work did not address less severe issues, there are unresolved problems remaining and new complications may emerge. To eliminate such consequences and continuously improve the performance of the design, implementation of an iterative design process is strongly recommended. In other words, further usability tests and heuristic evaluation by multiple experts are encouraged to ensure the continual improvement of the product. The results of the study confirm that by focusing on matters that are beneficial and valuable to users, a useful product can be developed and delivered.

This study, however, encountered a shortage of the diversity of its testing population. The test users, which shared a similarity of demographic background and previous experience with mobile applications, represented only one user profile of the application. For instance, without the engagement of users from more than one age group, the study was unable to gather further information related to the accessibility of the application. Additionally, with the majority of the test users being English speakers, the study was able to discover design issues related to the English language of the application only. Therefore, the clarity of Finnish, Swedish and Russian languages used on the interface was not closely examined.

To conclude, further research is required to cover a larger user base and establish a stronger comprehension of user requirements. Simultaneously, performing frequent usability evaluation to maintain a user feedback loop in the product life cycle is essential. Even though users' feedback has been attended to during the process, it is crucial to understand that their needs and habits are shaped by trends and the industry, and continually evolves. Being able to adapt to the changes is vital to the product.

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Appendices

Appendix 1. Usability test consent form

Usability testing for Taskukirjasto - mobile application of Helmet library, is a project for Graduation Thesis. Your feedback will help us understand your experience with the application.

During this study you might be asked to:

- Work with the application to do a set of tasks

- Talk out loud while doing a task

- Answer interview questions

- Take a post-test survey

A researcher will observe and take notes as you work with the application.

By signing this form, you give your permission to Hoang Nguyen to use your statements, our recordings, and our notes to evaluate and improve the application. With your permission, we will record your voice and your interactions with the application. We will not share your name or any personal information.

If you need a break, just tell us. You may withdraw from this study at any time. If you have any questions, you may ask now or after the session.

If you agree with these terms, please indicate your agreement by signing here:

☐ I agree to participate in the session

☐ I agree to have the session audio recorded, which includes my voice

Signature: _____

Please print your name: _____

Date: _____

Thank you!