



Developing human-centred framework and guidelines for disc golf application design

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Abstract

Disc golf is an increasingly popular sport, especially in Finland and the USA. The disc golf industry and Professional Disc Golf Association have proceeded in the digital transformation; therefore, disc golf applications have penetrated the markets. There is a need for evaluating and developing the current quality of disc golf application design and looking for general guidelines for designing comprehensive applications. This thesis aims to study what kind of framework is hidden behind the disc golf application design from a human-centred perspective when also several stakeholders are concerned.

The study is based on theoretical and empirical research. Theoretical research is conducted by literary review of existing disc golf application design guidelines, together with human-centred design, user-centred design, and stakeholder-centred design theory and methodologies in general. Nevertheless, a research gap is found as far as disc golf, golf, and sports application design are concerned. Thus, the review expands to study field practitioners and mobile health context. The literary review also examines disc golf as a sport and in numbers, together with current disc golf applications.

Empirical research adapts human-centred design methods by studying users' expectations, needs, and wishes in the mean of questionnaires, and interviews. Also, the context of use is identified and visited, user requirements are mapped, disc golf personas are created, and the disc golf application's stakeholders are identified. Then, the method adapted from service-dominant logic is used for preparing value proposals for all disc golf application users, and other stakeholders.

By adapting the design guidelines from the literature and empirical findings, the human-centred guidelines for disc golf application design (HGDG) framework is presented as the first main finding of the thesis. The HGDG framework can be used for disc golf application design and ensuring the usage of the human-centred approach. The second main finding, 15 design guidelines and instructions for disc golf application design reinforces the HGDG framework. The third main finding suggests using 15 design guidelines as a metric for evaluating if the designed application achieves an ideal win-win-...-win situation between of application provider, users, and other stakeholders.

Keywords

human-centred design, user-centred design, stakeholder-centred design, service-dominant logic, disc golf, sports, application

Supervisor

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Foreword

Writing and conducting this thesis has been an almost two-year-long master's studies journey at the University of Oulu. I had limited time for studies but with my passion to disc golf and adopting an academic mindset, transferring studies, master's studies, and thesis were finalized in time. Working with a theme that is increasingly popular but still missing academic research has been a privilege.

I would also like to mention my thesis supervisor Leena Arhipainen who provided guidance and support throughout the actual writing process of my thesis. Leena also helped me identify this topic's potential from my previous course assignment. I enjoyed the discussions about the topic. I would like to also thank the thesis's second reviewer Mikko Rajanen who also introduced me to the world of evaluation and higher design ethics during my university studies.

I am also grateful for the participants in this thesis and research process which included several university courses. Thanks to everyone who donated their valuable free time, e.g., for answering the questionnaire, being a target for observation, answering questions in interviews, providing design ideas and feedback, being user testers in various projects, etc.

Also, the University of Oulu deserves gratitude because of providing me with a public office (student workstation) in Tietotalo for over 6 months. Some university workers even came to talk to me about what I am doing there every day. I felt social cohesion. University courses provided me with also the possibility to engage with disc golf in various forms of course assignments. I highly recommend finding a purposeful and interesting topic that can be worked on and refined from various angles during the studies. Doing what you like does not feel like a school assignment.

Special thanks go to my friends in disc golf but also to my like-minded friends who were there for me and discussed for hours about the flow, values, design, and evaluation – even in deeper contexts. Let us encourage each other to the great work! I would also like to thank my wife for her strength and understanding concerning my studies. Living with a student budget can be challenging or almost impossible for older students and their families.

Writing the master's thesis supported my personal growth. For example, I learned to give and receive meaningful, constructive feedback during my studies. I also adapted the iterative working style for almost anything I do in life. Probably the biggest obstacle in my mind before the studies were related to my verbal English skills but during the last weeks of final courses, I had a couple of seminars and presentations after which I realized that I did not even consider my English skills anymore.

During the last two years, I have discovered my academic self. Hopefully, future projects will give a possibility to continue this journey in the form of advanced studies and research. Also, it would be remarkable to witness how some existing or new disc golf application company would find and utilize this work for creating comprehensive, the next generation disc golf application. It is surely needed in the field.

Abbreviations

DX	Design Experience
EX	Evaluator Experience
HCD	Human-Centred Design / Human-Centric Design / Human-Centered Design
HCI	Human-Computer Interaction
HG	Human-centred Guidelines
HGDG	Human-centered Guidelines for Disc Golf application design framework
ISO	International Standardization Organization
mHealth	Mobile Health context
UCD	User-Centred Design
UI	User Interface
UX	User Experience
SCD	Stakeholder-Centred Design
SDL	Service-Dominant Logic
SW	Software

Disc golf vocabulary

Ace	A hole-in-one in disc golf.
Bag	Pack bag or bag with wheels specially designed for holding disc golf discs, towels, drinking bottles, etc.
Basket	The target into which the disc is meant to be thrown with as few attempts as possible.
DG	Disc Golf
Mando	An obstacle that is mandatory to circle by a given order.
myBag	Author's disc golf application project.
OB	Out of bounds, that is an area not located in the course. If the disc lands OB, a penalty throw is given to a player, and the next throw will be thrown from the course boundary where the disc left the course.
OFS	Oulu's Disc Golf Club (Oulun frisbeeseura)
PDGA	Professional Disc Golf Association, the global roof organization of disc golf.
Playbook	A beforehand-made plan of how to play every disc golf fairway of a certain disc golf course.
SFL	Finnish Disc Golf Association (Suomen frisbeegolf liitto)
TD	Tournament director is a person responsible for planning and organizing a certain disc golf competition.
Tee	The area or the mat from where the first throw of each fairway is done.

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1. Introduction

The number of people playing and being interested in disc golf is increasing faster than ever. For example, every fifth adult Finn is interested in disc golf, but among 15-24 years old people disc golf is even more popular – 42 % hobby it. Also, Disc golf is in third place among the most popular sports in the age of 11-15 boys; only football and cycling were more popular in this category. (SFL, 2022.) At the same time, the disc golf industry has transferred into the stage of digital transformation, where players, local clubs, national associations, and the Professional Disc Golf Association (PDGA) communicate via digital devices, and disc golf companies prepare data- and digital-based business strategies. Also, several disc golf applications have penetrated the market. Some of the applications are mandatory to use in competitions but lack even the basic features, while some other applications are preferred in training, and some in casual playing with friends.

Because the disc golf industry and culture are still quite new, there have not been academic studies concerning disc golf (DG) applications and how to design those. Simple guidelines seem not to exist. However, according to Google AdMob (2022), when designing wellness and health applications, users should be offered a smooth user experience where the user is in control and user is guided to perform critical tasks. The application should also motivate and challenge users for becoming better players. (Google AdMob, 2022.) Today's DG application is not designed only for players, but there are several other stakeholders involved. In application design, all the main stakeholders are supposed to participate for having comprehensive results (Koumpouros, 2022; Witteman et al., 2021). In the DG context, e.g., PDGA, national associations, local clubs, and tournament directors (TD) should be noticed and consulted. For ensuring the app's high level of usability and better user experience (UX) in general, a human-centred design (HCD), and user-centred design (UCD) process is among the best tools (Witteman et al., 2015; Caselli & Ferreira, 2018).

The topic of this thesis is at the heart of the human-computer interaction (HCI) field. More specifically, the human-centred design has been a huge part of the evolution of HCI design in general (Rajanen & Rajanen, 2023). According to Rajanen and Rajanen, (2023), human-centred design actualizes the idea of designing not only for users but also with users and by users. In this case, the human-centred design includes user-centred design together with the stakeholder-centred design (SCD). Today's business and application production is not a zero-sum game anymore but discovering new ways to gain mutual value for all stakeholders is preferred. It is also remarkable what kind of digital culture there is evolving around the disc golf genre. Disc golf players have found ways to communicate online and through social media. Also, disc golf-related user-generated content has increased a lot. Even the Finnish YouTube channels of professional disc golf players and broadcasters get tens of thousands of views. However, there is a certain problem in the disc golf field; the field lacks comprehensive disc golf applications designed to match players' needs. This thesis accepts the challenge of not only exploring the existing literature and practitioners but also conducting a human-centred design process for framing human-centred guidelines for disc golf application design.

The thesis's introduction makes a quick overview of the disc golf genre and the author's engagement with it, together with presenting the research questions and revealing the structure of the thesis.

1.1 Background and motivation

Over a couple of decades, disc golf sport has been continuously evolving. The player amounts are increasing in the USA and Europe. Also, new disc manufacturers are popping up to take a part of the cake. There are already references to digital transformation on the market but also an ordinary player has been taught to use digitalized equipment for scorekeeping and even practicing. So, pen and paper have been replaced with disc golf applications. Because of multiple stakeholders, such as PDGA, national associations, local clubs, and players with different status and needs, has led to situations where disc golf players are almost demanded to use several applications to implement different things. Even in official competitions, player groups are required to use more than one application for scorekeeping. In the eyes of usability and user experience, the current situation is nearly intolerable.

The author's own experience with disc golf applications includes the fact that decent applications can help you improve as a player, but some current applications can be frustrating and even painful to use. When participating in the disc golf competition Perämeri Open 2022, our four people player group was required to use two different applications to keep our score. Also, when observing the Prodigy Disc Pro Tour in Pikkarala 2022, the four-player pools used three different applications for keeping their score and entering the required statistics. Therefore, according to the author's own experience together with the acts witnessed in Pro Tour, it might be justified to ask, if there is a need for having a comprehensive disc golf application for scorekeeping and other features.

1.2 Research questions and methods

This chapter describes the research process and research methods for developing a framework for disc golf application design from a human-centred perspective. After Figure 1 provides an overview of the research timeline and dimensions, research questions are presented.

At the beginning of this process, there was only the idea of an advanced disc golf application. Since then, the idea evolved and gained support from the existing literature and the empirical research and findings; highlighted with the grey back color in Figure 1. The timeline in Figure 1 moves from the top to below. Figure 1 presents encountered literature topics along with the university courses which demanded different kinds of assignments, reports, and empirical work. University courses are marked with a dashed line and described in Appendixes A-E. Figure 1 demonstrates how the design solutions have adapted something new in every phase. For example, in the early phase, there is only the author's personal experience and preferences, while the second phase expands the view with the users' expectations, needs, and wishes. In the next phase, the contexts of design and the application provider's business are also considered. Also, existing guidelines and different stakeholders are examined. Then, the theoretical part produces existing design guidelines from the literature, and the empirical part produces new, discovered guidelines from the empirical research. Finally, design solutions refine into the human-centred guidelines for disc golf application design (HGDG) framework, and

identified guidelines are adapted and united to form 15 design guidelines that also support the HGDG framework.

Along with this thesis, the research process has produced other outputs, such as the myBag disc golf application for Windows (Appendix A), a couple of new feature designs (Appendix A, and F), an innovation strategy for DG company (Appendix B), DG company's plan for becoming an analytical competitor (Appendix C), together with full-scale usability and UX testing plan and report for existing DG company (Appendix D), and literature review of disc golf application design guidelines (Appendix E).

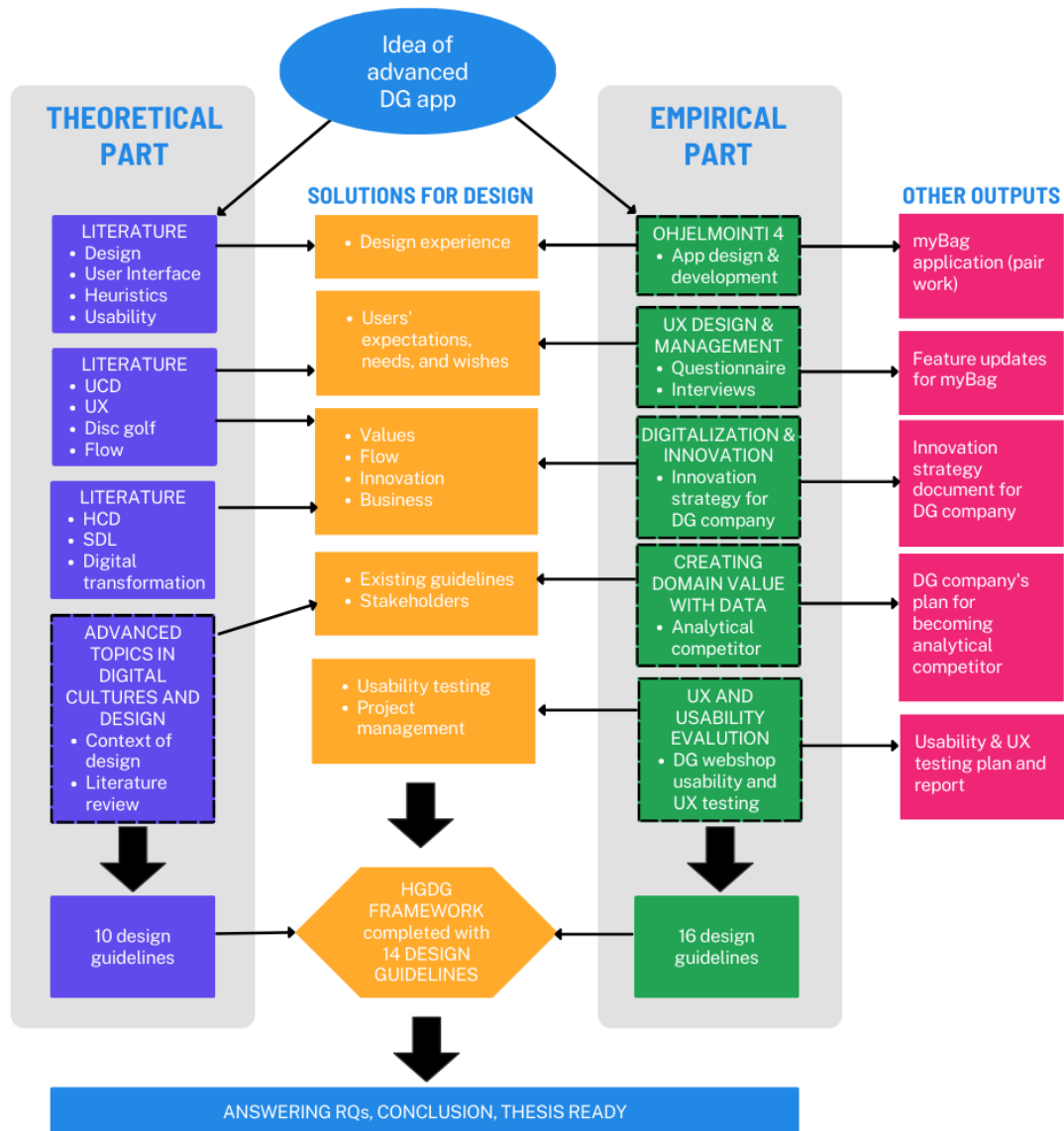


Figure 1. The research process for master's thesis (CC BY 4.0 Marko Moilanen).

The research problem is that there are no clear instructions for designing a comprehensive DG application where users and other stakeholders are considered. Guidelines or heuristics for this kind of design do not exist. The research problem of the thesis can be approached from the following research questions:

RQ1: What kind of framework there is behind the human-centred design process when also all the stakeholders in the disc golf context are considered?

RQ2: What guidelines should be followed when designing disc golf applications from the human-centred perspective?

To answer research questions, the thesis includes a literary review adapting the guidelines by Green et al. (2006), and an empirical, qualitative study adapting the guidelines by Kitchenham et al. (2002) with the research methods such as thematic analysis (adapting Braun & Clarke, 2012), and contextual inquiry (adapting Holtzblatt & Beyer, 2014).

A literature review is used for gaining the core message of the previous literature concerning the theoretical background, suitable methodologies, and empirical studies. For the literature search, there were used the key databases of the HCI field, such as ACM digital library, EBSCO, IEEE Xplore, and ScienceDirect, together with databases such as Google Scholar, and OULA-FINNA University of Oulu library database. Also, ISO standards were searched to find official definitions. There were no difficulties to find conceptual and theoretical lenses or suitable methodologies, but the previous empirical studies were extremely hard to spot. Searches included e.g., the following phrases in various forms:

“human-centred design”, “user-centred design”, and “disc golf”, “golf”, sport*, application*.

By these means, the literature review summarizes the state-of-the-art of human-centred application design in the disc golf context, or the closest suitable context.

1.3 Objectives and scope of the thesis

The objective of this thesis is to produce a framework and guidelines for developing a comprehensive disc golf application with a human-centred approach. On the theoretical level, the thesis objective is achieved by conducting the literature review and summarizing the findings. On the empirical level, the thesis objective is achieved by using HCD methodologies. The gained empirical and literal knowledge is united into the form of the HGDG framework.

The research process concerning DG applications has produced also other results, such as the myBag application (Appendix A), prototypes for new DG application features (Appendix A, and F), DG application innovation strategy (Appendix B), DG company’s plan for becoming an analytical competitor (Appendix C), and a full-scale usability testing project with usability testing plan and report (Appendix D). These results are limited out of the thesis’s scope but partly introduced in the appendixes (Appendix A-D, and F). Also, traditional application design issues, such as usability, accessibility, and UX are limited and considered only as far as the human-centred quality and the design guidelines are concerned.

1.4 The structure of the thesis

The thesis presents the literature review of academic studies in chapters 2 and 3. The review includes theoretical background, methodologies, and empirical findings. Moreover, chapter 4 makes an overview of the disc golf world. Chapters 5 and 6 start the empirical part using data gathering and analysis. Chapter 7 demonstrates the usage of basic HCD methods. Then, chapter 8 summarizes the findings by developing the

HGDG framework and 15 design guidelines. Chapter 9 answers to research questions and considers the thesis' limitations. The thesis' implications adapt HCI research contribution categories by Wobbrock and Kientz (2016). Finally, chapter 10 presents the conclusions of the thesis.

2. Theoretical background

This chapter summarizes the theoretical background for the thesis concerning human-centred design, its variables, and its manifestations.

2.1 The Human-centred design

In everyday language, design is associated with the art in manners of e.g., producing sketches and plans. Design as a verb may refer to e.g., representing, or fixing an artifact, system, or society. In general, design can be considered the driving force for implementing creative thought. In today's field of design, there are three major practicing movements: technology-driven design, sustainable design, and human-centred design. Usually, all three design genres lead to different outcomes – no matter the regulatory, context, or economic resources. Thus, the chosen approach is motivated by technical novelties, planetary impacts, or human meaning. (Giacomin, 2014)

Already in 1985, Gould and Lewis suggested three principles for design. Their suggestion included an early focus on users and their tasks, implementing empirical measurement of usage, and using iterative design. The suggestion included the idea of modifying, testing, modifying again, testing again, and then repeating the cycle until the results are accepted. (Gould & Lewis, 1985)

If the traditional view of design is based on the designer's imagination together with the artifact's material and technological requirements, HCD makes the difference by concentrating on the intended people using the product, system, or service. Users are in the spotlight in the HCD; thus, the design relies on their *needs, desires, and experiences* – and how well the HCD techniques are utilized to communicate, interact, empathize, and stimulate the users. The HCD process creates products, systems, and services which are intuitively in congruence with the users. (Giacomin, 2014) In other words, the HCD field aims to design and develop products, services, and systems which, from the user's perspective, are easy to use, meaningful, and serve pleasure (Savolainen, 2020).

The general guide to human-centred design by Ideo.org (2015) points out that human-centred design is not only about individual people/system users but also about society and communities. Ideo.org (2015) also presents the philosophy of the HCD in the form of seven mindsets. According to the manual, a human-centred designer reflects the virtues of empathy, optimism, iteration, creative confidence, making it, embracing ambiguity, and learning from failure (Ideo.org, 2015).

In his research, Giacomin (2014) suggests a way to understand the different dimensions of human-centred design (Figure 2). The paper presents a set of questions that challenge researchers to expand the scale for the HCD from the physical level of people's interaction with the product, system, or service to the metaphysical level of asking the existing questions. Giacomin (2014) also states that whenever a designed artifact will meet a person's life also on higher levels, there are better opportunities for commercial success and brand development.

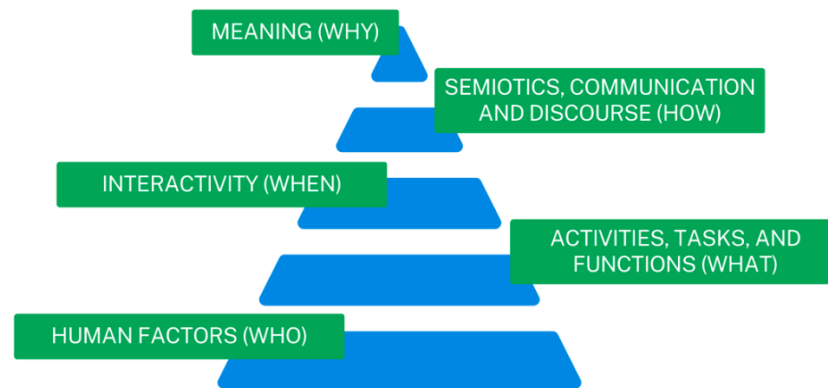


Figure 2. The human-centred design pyramid. (Adapted from Giacomini, 2014)

2.2 Measuring and evaluating the human-centred design

According to ISO (2018), the HCD is an approach to system design and development for refining interactive systems into more usable conditions. The HCD process keeps its focus on the system by applying the knowledge and techniques of human factors, ergonomics, and usability. An appropriate way to measure and evaluate the HCD is called human-centred quality. Human-centred quality is defined as fulfilling the requirements of *accessibility, usability, user experience, and avoidance of harm from use*. (ISO, 2018; ISO, 2019)

2.2.1 Avoidance of harm from use

Human-centred quality attribute *avoidance of harm* is defined as a system's usage should not have negative consequences as far as health, safety, finances, and the environment are concerned (ISO, 2018).

Designers can cause harm when practicing so-called dark design. The dark design is not unintentionally bad, but something where the designer conducts e.g., deceit and misleading design work. For preventing dark design, designers should consider their responsibilities to users, other stakeholders, companies and other organizations, the whole society, and the environment and sustainability. (Rajanen, 2022)

According to Rajanen (2022), there are four ethical dimensions of design as far as human-technology interaction is concerned:

1. Designing ease of use,
2. Honest design,
3. Sustainable design, and
4. Safe design.

The main statement from Rajanen (2022) is that the universal golden rule could be adapted for ensuring an unharmful design. The updated, HCI golden rule suggestion is: “*Design as easy to use, honest, sustainable, and safe human-technology interactions as you would want others to design for you.*” (Rajanen, 2022)

2.2.2 Accessibility

In a society where people's average age is increasing, there is a need for considering senior citizens to be part of mobile applications' regular end-users (Yu & Chattopadhyay, 2020). According to Yu and Chattopadhyay (2020), senior users have three major challenges with mobile user interfaces (UI):

1. Insufficient visual emphasis,
2. Too many options for use, and
3. Stumbling information instance.

Also, there are users with visual, auditory, cognitive, and learning disabilities, and the more diverse the user base is, the greater underlining should be done with accessibility (Alajarmeh, 2021).

ISO definition for accessibility states "*the extent to which products, systems, services, environments and facilities can be used by people from a population with the widest range of user needs, characteristics, and capabilities to achieve identified goals in identified contexts of use*" (ISO, 2018).

When adapting the accessibility mindset in design and development, easy digital access is guaranteed for both – people with disabilities and non-disability people. This is advisable because mobile applications are used by also people with special needs and disabilities. (Masruroh et al., 2022)

Di Gregoria et al. (2022) present in their paper some basic instructions for noticing accessibility in the design phase. The paper guides us to pay attention to e.g., font size and presentation, color contrasts, touch target sizes, enabling content resizing, using labeled buttons, and links, together avoiding images with unnecessary text but still preferring content layouts with united images and text, etc. (Di Gregoria et al., 2022)

2.2.3 Usability

In everyday life, usability announces how easy an interface is to use when completing tasks (Fuhrmann, 2018). Moreover, usability can be considered as a sum of functionality and ease of use (Lauesen, 2005):

- Functionality refers to the system's ability to allow users to perform their tasks.
- Ease of use refers to the system's features so those are implemented in a way of users easily learn those and easily perform the tasks.

Usability heads back to the 1990s when Nielsen presented his theory concerning usability. According to Nielsen (1993), usability is formed of

1. how easy the system is to learn,
2. how efficient the system is to use,
3. how easy the system usage is to remember,
4. system has only a few, and noncrucial, errors, and
5. user is subjectively satisfied.

Lauesen (2005) modifies Nielsen's definition by removing the issue of noncrucial errors, and by adding fit-for-use and understandability issues. Lauesen's definition is presented in Table 1.

Table 1. Usability factors. (Adapted from Lauesen, 2005)

Usability factor	Measurement
Fit for use	Is the system built to support real-life tasks the user has?
Ease of learning	How easily different user groups can learn the system usage?
Task efficiency	How efficient the system is for its main users?
Ease of remembering	How easy system usage is to remember for occasional users?
Subjective satisfaction	How satisfied users are with using the system?
Understandability	How easily users can understand what the system does (e.g., in error situations)?

The current ISO definition for usability is “*the extent to which a system, product or service can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use*” (ISO, 2018). According to ISO (2018), the context of use is formed of users, tasks, and resources, together with the environment which refers to physical, technical, social, cultural, and organizational dimensions. On the other hand, Lupton (n.d.) describes that context of use refers to the actual, everyday conditions wherein an artifact or product is used. This thesis engages with Lupton’s definition of context of use.

2.2.4 User experience

User experience is one of the terms in the HCI field that has not achieved an unambiguous definition, and thus, it is problematic to be comprehensively understood (Gómez-López et al., 2019). Still, UX is also considered an umbrella phrase for realizing and studying the quality of use concerning interactive products (Bargas-Avila & Hornbæk, 2011). However, ISO defines the UX as “*user’s perceptions and responses that result from the use and/or anticipated use of a system, product or service*” (ISO, 2018). According to ISO (2018), UX considers “*user’s preferences, attitudes, emotions, and physical and psychological responses that occur before, during, and after use.*” ISO also adds four notes e.g., for explaining which personal features experience can be formed and which external and internal factors have an impact on it. Also, the fourth note states that the HCD cannot manage anything else but the aspects of UX resulting from the system’s designed aspects. (ISO, 2018)

UX can be approached from three different perspectives; UX can be considered as a phenomenon, as a field of study, or as a practice. As a phenomenon, UX e.g., reflects the user’s unique manifestation, something that is lived through. UX also has an active and passive side, and it is influenced by prior experiences and future expectations. Moreover, UX has social and cultural contexts. (Roto et al., 2011)

All the influencing factors that have a part in a person’s UX, can be placed under three categories (Roto et al., 2011):

- *Context of use*: Changing context may affect UX, even if the system remains the same.
- *User*: Because of the dynamic nature of a person experiencing the system, also UX is dynamic. Thus, e.g., the user’s changing moods, mental resources, and expectations correlate with the UX.

- *System*: UX has a relation with the user's perceptions about the system's current properties, added or changed properties, and especially consequential properties. System-related UX is also affected by the brand and image of the system supplier.

As far as UX factors are concerned, Roto et al. (2011) remind us that UX cannot be characterized by listing the factors, but rather factors can be used for explaining the setup where a person experienced the specific UX.

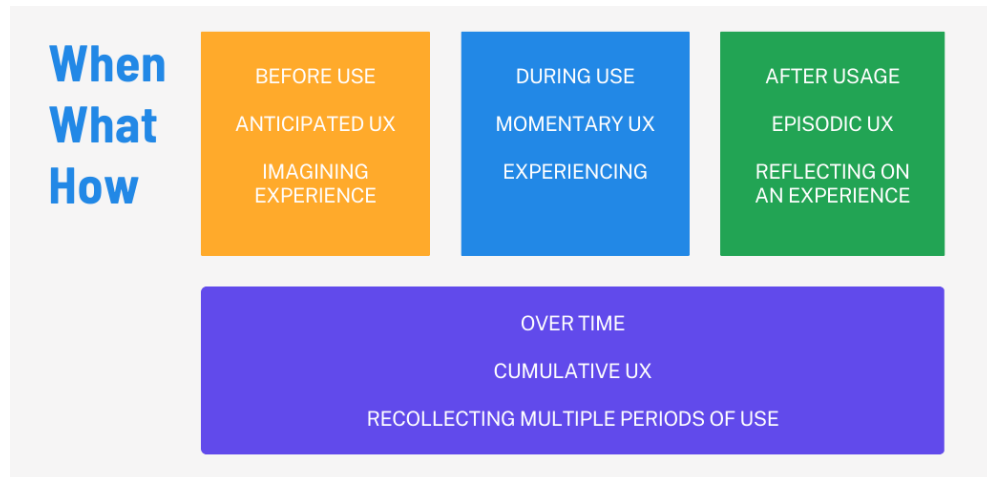


Figure 3. Time intervals of UX. (Adapted from Roto et al., 2011)

Another perspective for UX is formed with time and periods. UX has not only over the time dimension but also during, before, and after usage spans. (Roto et al., 2011) Four different types of UX identified by Roto et al. (2011) are presented in Figure 3 where each UX type is related to a specific timespan and user's internal process.

Based on their review, Bargas-Avila and Hornbæk (2011) suggested nine dimensions for designing and measuring the UX factors. Their suggestion is agreed upon and used by e.g., Kocabalil et al. (2018), in their paper about measuring user experience in conversational interfaces. The suggested UX dimension are:

1. Generic UX,
2. Affect/Emotion,
3. Enjoyment/Fun,
4. Aesthetics/Appeal,
5. Hedonic quality,
6. Engagement/Flow,
7. Motivation,
8. Enchantment, and
9. Frustration.

According to Bargas-Avila and Hornbæk (2011), the most popular options for the UX dimensions are emotions, enjoyment, and aesthetics.

Another perspective for UX comes from organizations whose businesses and strategies are increasingly adopting UX. Companies taking UX seriously should prepare the departmental home for it by forming multidisciplinary models in the key development areas. The long-term objectives could include developing new business directions with UX-oriented value propositions, correcting design choices converging UX, and making

deep organizational changes with the basic operations to better meet UX. (Roto et al., 2011)

2.2.5 Clarifying the relation between usability and the UX

Gómez-López et al. (2019) stated above that the UX definition is quite ambiguous and hard to fully realize. Nevertheless, Masruroh et al. (2022) suggest that the evaluation of usability and accessibility are part of the user experience. Also, Norman and Nielsen (n.d.) guide to separate the UX and usability. According to them, usability measures the quality of the user interface while user experience is a wider concept – it includes all the interaction between the user and the company together with its services and products (Norman & Nielsen, n.d.).

Another way to approach the difference between usability and UX is by making a note that usability is a part of the objective quality whereas UX is associated with the whole quality of use (Kurosu, 2019). The difference between usability and UX is demonstrated in Figure 4, where usability is inside objective quality in design while UX forms the entire lower section. Kurosu (2019) clarifies this division; for example, the usability test is suitable for measuring the usability related to the quality of design, and thus, it is not suitable for measuring the quality in use or the UX. The difference comes from the realization that usability can be evaluated in the usability labs while UX requires natural settings for triggering the natural behavior of users. (Kurosu, 2019)

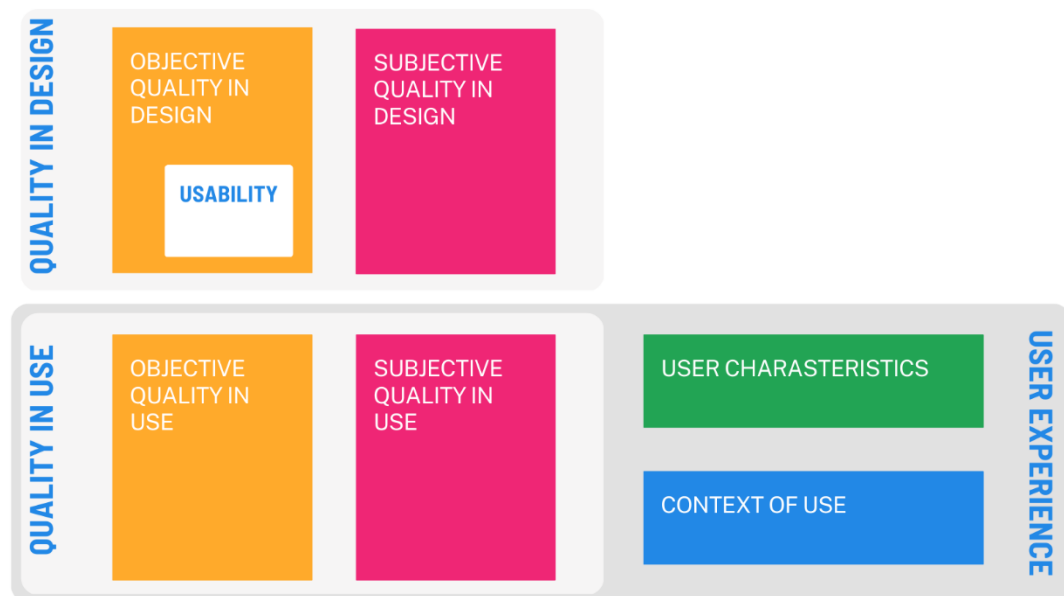


Figure 4. Model of quality characteristics that explains the location of usability and UX. (Adapted from Kurosu, 2019)

Related to the topic of attractiveness and user satisfaction, Guo et al. (2019) make important observations. Their study considers the first contact with the user with the new mobile user interface. According to the paper, the user's first impression forms subconsciously and immediately, and therefore, it has been problematic to measure it. However, with the new neural mechanism method, Guo et al. (2019) make note that aesthetics is the critical influence factor. Moreover, the Guo et al. (2019) study used only aesthetics and usability as dimensions for measuring first impressions. The criticality of the dimensions was considered when users had the freedom to browse new mobile interfaces. The study's results state that usability and aesthetics were considered almost

equally important if the user's first impression was positive. However, the difference stood out when the first impression was negative. When the user was engaged with the user interface with lower aesthetics, it demanded higher usage of the user's psychological resources, and thus, it increased the cognitive load. Usability did not have this same issue, and thus, the study claims aesthetics to be more important when a first impression is formed. (Guo et al., 2019)

2.2.6 Heuristic evaluations

Heuristic or expert evaluation is a review process of a product or system which is often implemented by a usability expert, or someone specialized in human factors. The evaluator should have only a small or no status at all in the project under evaluation. The review is conducted by following accepted usability principles – heuristics. Principles are based on research, and literature concerning human factors, together with the former experience of professional duties. (Rubin & Chisnell, 2008) Moreover, heuristic evaluation can include usability specialists or colleagues inspecting the different screens of the system and giving feedback (Lauesen, 2005). Altogether, heuristic evaluation is an expert-based evaluation method for ensuring good usability (Bader et al., 2017).

Heuristic evaluation is also quite quick and inexpensive to establish, as far as laboratory or field studies are compared (Bader et al., 2017). Rubin and Chisnell (2008) continue by stating that especially in the early stage of a project when usability issues are welling, it can be unnecessary to test artifacts with several participants when heuristics will probably discover the same issues. Lauesen (2005) still warns that heuristic evaluation also discovers a lot of irrelevant problems, and of relevant problems, it discovers only half. Therefore, using heuristic evaluation alone for testing and evaluation approach is not advised (Lauesen, 2005).

From the age of early usability heuristics by Nielsen or Shneiderman, the field has expanded to also concentrate on overall UX (Bader et al., 2017). According to Bader et al. (2017), new heuristics are naturally born when contexts are expanding. Bader et al. (2017) suggest that new heuristics can be created from several approaches; fresh heuristics can be based on:

- a. Previous heuristics,
- b. Empirical findings,
- c. Literature reviews,
- d. Experts' answers from questionnaires, or
- e. The validation process of applications.

Concerning the completeness and adaptability of new heuristics, it is problematic to develop heuristics that are easy to follow and implement, and still not overlook specific topics (Bader et al., 2017).

Bader et al. (2017) present a quality model of heuristic evaluation. The model describes the connections between heuristics, test objects, evaluators, and users. According to the model, evaluators must understand users and the heuristics they are using, heuristics should help users and be in congruence with the system, and evaluators are required to know how to use the system under the testing. After connecting the actors, the model includes literature-based quality criteria for heuristics in three categorical depths:

Ensuring the efficient use of heuristics:

- a. Following heuristics should gain an advantage for the user.
- b. Heuristics are validated through comparison with existing heuristics.
- c. Heuristics are suitable for the context they are created and have no negative influences on comprehensibility.
- d. Heuristics are comprehensive and simple enough to execute, even by non-specialists.

Additional quality criteria:

- e. Heuristics are selective.
- f. There are less than 10-15 heuristics.

For ensuring identical construction, heuristics should also have:

- g. Designation,
- h. Description, and
- i. Provide an example.

2.3 From users to stakeholders

The ISO standard that has been under the magnifying glass, has a topic-related definition for stakeholders. A stakeholder is a “*person or organization that can affect, be affected by, or perceive themselves to be affected by a decision or activity*” and in this case, the decisions and activities are related to using the systems, products, or services as stated in above (ISO, 2018). The same standard also makes notices that stakeholders can include e.g., users, system owners and managers, and any people who are under the unidirectional affection, and that different stakeholders can have their own needs, requirements, or expectations (ISO, 2018).

ISO’s definition of human-centred quality attributes also considers stakeholders by adding a note to the avoidance of harm definition. The note states that the negative impacts are not limited to considering the system’s users only but must include all the system’s stakeholders. (ISO, 2018) Also, a research paper by Rajanen et al. (2017) states that usability is not only a matter of users, but today’s UX professionals see usability also affecting the organization, business, and customers in general.

2.4 Context of design

Svanæs and Gulliksen (2008) present a theoretical concept called the context of design. Their definition states that the context of design is “*The socio-technical system comprising the design and development process in a lifecycle perspective.*” Svanæs and Gulliksen (2008) justify the need for definition by arguing that boundary conditions of today’s projects are playing an increasingly more remarkable role and thus, have an impact on the project’s success. According to Svanæs and Gulliksen (2008), defining and understanding the context of design could offer better results because of the possibility to implement tailored UCD activities.

The definition of the context of design is divided into two parts. The first part of the definition is presented above. The second part states that the context of design may include (but is not mandatory) e.g., the internal structure of the developer and the client

organizations, the legitimate relationship of developer and customer, different levels of maturity, stability in organizational structure, lifecycle point-of-view, software (SW) engineering tools, handover issues between agencies, mismatching requirements, and stakeholders' agendas and relations. (Svanæs & Gulliksen, 2008)

When presenting instructions for tactical UCD, Svanæs and Gulliksen (2008) notice that contexts of design can be an unstable environment where various stakeholders are with conflicting interests. Also, some deep-rooted development practices might be problematic to change (Svanæs & Gulliksen, 2008). Next is described the elements of tactical UCD, as described by Svanæs and Gulliksen (2008):

- a. Understand the project's specific context of design already in the early phase. Analyze different relations for identifying the stakeholders. Authors note that this process is relatively like those of identifying users in UCD.
- b. Identify risk factors concerning the issues having an impact on I) user-centred activities, such as workshops, user participation with observations, and usability tests, or II) the actual implementation of previously mentioned UCD activities.
- c. Tailor the design process to notice the identified risk factors. Also, ensure the knowledge of project-specific context of design, so that better selections between different UCD methods can be made during the design process.
- d. Changing the context of design whenever it is necessary, and possible.

2.5 Flow state and flow experience

Flow state's roots head back already to Taoism and its concept called wu-wei. Several studies have discussed the similarities between the flow and wu-wei. Both concepts are based on the idea of losing the sense of self and feeling effortless when performing something. The purpose behind the flow is described to be the flow state itself – keep the flow flowing without seeking any peaks or utopia. (Kee et al., 2021)

From a psychological perspective, flow is described as a subjective experience where the individual is fully engaged with the current activity until performance becomes effortless. Flow can be defined as “deep and effortless concentration” which has internal and external dimensions. Internal flow includes activities, such as thinking in a deep effortless way, while external flow includes e.g., playing sports with effortless concentration. (Marty-Dugas & Smilek, 2019)

The concept of flow experience defines the mental state where the person is so deeply involved in an activity that everything else seems not to matter. The flow experience is so enjoyable that a person will prefer the current task almost at any cost – only for the sake of doing it. (Kim & Thapa, 2018) Flow is defined by Kim and Thapa (2018) to have the following attributes:

1. Focus of awareness narrows
2. Self-consciousness is lost
3. Clear goals are responded
4. Feedback is unambiguous
5. Control over the environment is sensed

Flow research has studied multiple domains, such as outdoor recreation activities, athletic performance, gaming, and internet browsing (Kim & Thapa, 2018) but the most notable has been the sports (Marty-Dugas & Smilek, 2019). Altogether, flow is associated with life in general but especially with sports performance where it describes the positive experiences and optimal mental state an athlete can gain. Flow's positive

experiences include e.g., satisfaction and pleasure. (Stavrou & Zervas, 2004) According to Kee et al. (2021), the optimal psychological flow state is highly valued by athletes, and it has been researched on a large scale.

In their book about the flow in sports, Jackson and Csikszentmihalyi (1999) present a framework of nine dimensions to describe an athlete's flow state:

1. Balance between challenge and skill
2. Union of actions and awareness
3. Clear goals
4. Unambiguous feedback
5. Focus on the task
6. Sense of being in charge
7. Losing self-consciousness
8. Transforming time
9. Autotelic experience

Kee et al. (2021) comment that these nine dimensions are representations of what an athlete can experience in a flow state when an athlete's performance achieves its peak or is enhanced.

2.6 The human-centred design methods and warnings

A professional human-centred designer is rather transparent than an opinion leader because the core of HCD is to awaken, transmit, and interpret the hidden will of the people involved in the design process. HCD tools utilize e.g., psychophysical, cognitive, emotional, psychological, sociological, and philosophical human data and models. For gathering data about users' needs, wishes, and meanings, verbally based techniques, such as questionnaires, think-aloud analysis, personas, scenarios, brainstorming, and contextual inquiries are suggested. Another set of techniques is non-verbal in nature and includes e.g., game playing, cultural probes, body language, and facial coding analysis, together with physiological measures. Designers can also simulate the possible futures with e.g., storyboard futures, and role-playing techniques. (Giacomin, 2014)

A more practical approach to HCD methods is presented by Ideo.org (n.d.), a nonprofit organization full of HCD experts. The methods they highlight are collected in Table 2 and divided into three categories according to what HCD phase technique is related.

As far as the relation between HCD theory and practice is concerned, several studies have identified a gap between the academic HCD frameworks and real-life settings of design and development projects. Nevertheless, the traditional view states that a close connection with users defines if the project is human-centered or not. However, today's HCD mature companies have already accomplished successful human-centred design projects without directly involving users in the design process. A case study by Savolainen (2021) demonstrates how HCD mature company has multiple sources of user knowledge, and thus, can run different kinds of HCD processes successfully and without directly participating users. (Savolainen, 2021)

Table 2. List of the human-centred design tools from Ideo.org expert organization.

Inspiration	Ideation	Implementation
Align on your impact goals	Explore your theory of change	Optimize and adapt for scale
Photo journal	Create a logic model	Live prototyping
Body language	Build and run prototypes	Define your indicators
The five whys	Journey map	Explore scalability
Frame your design challenge	Ways to grow framework	Roadmap for success
Recruiting tools	Brainstorm rules	Sustainable revenue
Interview	Download your learnings	Pilot
Group interview	Create a concept	Keep iterating
Expert interview	Bundle ideas	Build partnerships
Conversation starters	Create frameworks	Monitor and evaluate
Analogous inspiration	Design principles	Staff your project
Card sort	Mashups	Capabilities quick sheet
Collage	Co-creation session	Funding strategy
Create project plan	Gut check	Create a pitch
Guided tour	Share inspiring stories	Keep getting feedback
Draw it	Determine what to prototype	
Peers observing peers	Rapid prototyping	
Build a team	How might we	
Define your audience	Role play	
Secondary research	Storyboard	
Immersion	Integrate feedback and iterate	
Resource flow	Get feedback	
Extremes and mainstreams	Get visual	
	Business model canvas	
	Find themes	
	Create insight statements	
	Explore your hunch	
	Top five	

2.7 The user-centred design methods

When having the UX as an evaluation meter, among the best solutions for developing products, services, and information systems are the user-centred design (Witteman et al., 2015; Caselli & Ferreira, 2018). The goal of the UCD is to make the product meet the needs of the users for whom the product was originally designed (Caselli & Ferreira, 2018). This is how the product achieves the status of e.g., being usable and understandable (Caselli & Ferreira, 2018) and effective (Witteman et al., 2015). For example, usability is a part of the evaluation criteria when measuring the UCD. It is also used for verifying the usefulness of the application. (Fuhrmann, 2018)

The main principles of the UCD (Caselli & Ferreira, 2018) are:

- Explicit understanding of users, tasks, and environments,
- User involvement in the entire design and development
- User-centered assessment
- Interactive process
- Full consideration of user experience, and
- Adoption of multidisciplinary skills and perspectives.

Among the literature, there have been different attempts to describe the UCD process and its phases. No matter if the descriptions have had three, four, or five steps, all the models share the same core content. The process always begins by understanding the problem and the context where the problem is present. The first phase ends with the list of requirements which are the instructions for the next phase. Then, concepts are formed for solution suggestions for the current problem. The chosen concepts refine into low and high-fidelity prototypes. At the same time, an iterative process of design and evaluation takes place to find the best solution to the problem. The result is the specified and validated prototype which was implemented with the users, to have a commercially feasible and sustainable product. (Caselli & Ferreira, 2018) The framework of user-centred design is also presented in Figure 5, as Witteman et al. (2015) describe it.

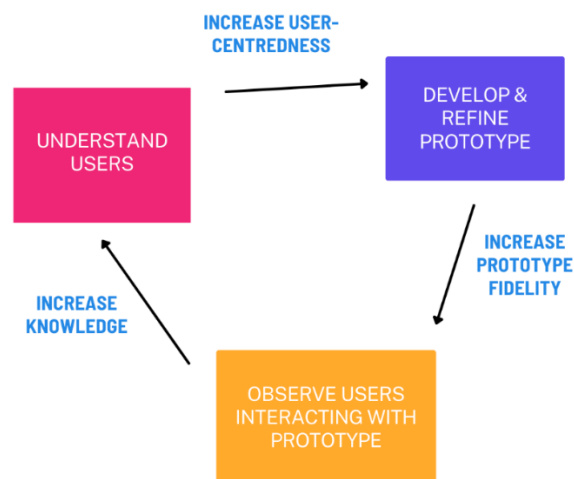


Figure 5. Framework of user-centred design. (Adapted from Witteman et al., 2015)

According to UCD practitioners, support from peers and colleagues is one of the most recognized methods in the lifelong UCD learning process. Also, the most popular methods for implementing the UCD are *prototyping*, *user testing*, *user journeys*, and *workshops*. User experience professionals prefer the same, trusted tools because of the time pressures and in many cases, too complicated methods. Especially, the agile context might be difficult for implementing the UX methods. (Cajander et al., 2022)

Jiboku and Sodeinde (2021) give warnings about implementing the UCD; the design team should consider the possible problems related to:

- Communication between users and the design team,
- Objectives that are conflicting,
- Team's competence,
- Is UCD suitable in this specific case, and
- Requirements engineering that could contradict the process.

2.8 The stakeholder-centred design methods

There is a clear need for designers to adopt a broader view than the traditional UCD. Today's services and platforms are designed for several stakeholders, not just certain users. (Forlizzi, 2018) To see beyond the UCD and the UX, there are three points to consider; the points which make services different than products (Forlizzi, 2018):

1. The dynamic nature of services requires designing for multiple stakeholders, not just users.
2. The value exchange is the core of a service experience. Therefore, value is not gained only by a company but by all the individual stakeholders.
3. The economic models are inseparable from the design, even though UCD and UX often ignore them.

Also, e.g., Alamaki & Dirin (2015) suggest that a new successful mobile service should satisfy the needs of not just end users but also business managers, SW developers, project management, and project financiers.

2.9 The service-dominant logic

The service-dominant logic (SDL) was originally presented as a critique of the status quo concerning the goods-dominant logic of the business (Novani et al., 2021). Table 3 presents the main differences between the goods- and service dominance as Hartwig et al. (2021) describe.

Table 3. Comparing service-dominant logic to goods-dominant logic. (Hartwig et al., 2021)

Service-dominant logic	Goods-dominant logic
Multiple actors co-create value	Value created internally
Integrating resources and exchanging service	Value embedded into goods
Value in the usage process	Value exchange in one-time transactions

For moving from academic propositions into the SDL practice, Ballantyne et al. (2011) suggest adopting the mindset covering the following issues. Business must be based on supporting customers' value-creation processes. Also, supplier firms cannot create value by themselves, but they can make value propositions to customers or any stakeholder. Moreover, supplier firms should focus on the value-in-use by tracking the changing standpoints of their key customers and bringing there the desired value gains. (Ballantyne et al., 2011)

The practitioner view for SDL is presented by the Indeed editorial team (2022) with their online guidelines for implementing SDL. According to the guidelines, products should be seen as service-deliver vehicles. Then, customers' wants and needs are required to be understood. Next, customers' needs are advised to be put at the forefront. Guidelines also encourage to study of the interaction between customer and service and underline the cooperative aspect of business relationships. Guidelines also state that have a relationship and engagement with your customers and offer technological improvements for the customer experience. Even, adopt a co-creation mindset with the customers. During the development process is advised to collect feedback and use it for the improvement of service. Finally, the last guideline considers meeting the evolving needs of customers by innovating continuously. (Indeed editorial team, 2022)

3. Guidelines for application design

The chapter presents the previous results of the empirical studies concerning human-centred guidelines for application design. Because of the research gap in disc golf, golf, and sports application contexts, the mobile health (mHealth) context is adapted.

3.1 Guidelines for mobile health applications

It is crucial to engage with the needs of the intended users when developing effective mHealth tools. To achieve this objective can be used iterative user-centered design process and active participation of target users in the design. (Schnall et al., 2016) Also, the limited involvement of stakeholders during the design and development phases can greatly affect the quality of mHealth applications produced in terms of clinical content, interface design, and usability (Koumpouros, 2022).

Koumpouros (2022) has studied the mHealth applications and what kind of guidelines there are and should be for design and development. He underlines the holistic approach and the usage of human-centred design, together with user-centred design. Especially, user-centred design can make remarkable improvements for application issues, such as ease of use, understandability, and acceptability. (Koumpouros, 2022)

For optimizing the quality and retention rate of mobile health applications, the following issues are relevant to ensure (Koumpouros, 2022):

- a. Active participatory design involving the different stakeholders,
- b. Optimal user experience,
- c. Communication of what the end user is missing out on by not using it, and
- d. Appropriate subjective assessment.

Koumpouros (2022) also suggests the issues be avoided. According to the paper, there are eleven main reasons why users uninstall mHealth applications:

1. The first impression matters because the uninstall rate is higher on the first day of use
2. Low level of aesthetics with the unclear interface
3. Too many features were implemented
4. User expectations were unmet
5. Too many bugs
6. User cannot find the value of use related to one's daily life
7. User is annoyed by too many notifications
8. Defective communication leads to forgetting to use
9. Issues with the content (no updates, not interesting enough, etc.)
10. Application often asks for permissions without explanations
11. Not intuitive interface that requires too much time to learn to use

3.2 User- and human-centered design for personal health tools

The Witteman et al. (2021) paper is qualitative research including the justification and formation of the user-centered design 11-item measure (UCD-11). The paper states that the measure can be adapted for documenting the results if the design and development process was implemented in terms of user-/human-centeredness.

The quick instructions for UCD-11 are that evaluator goes through 11 questions and answers those simply 'yes' or 'no'. The more there will be 'yes' answers, the more human-/user-centered the design was. The first five questions are related to the end users and how they were participating in the design and development process. Then it is asked if the process were iterative and if the changes were explicitly reported. Next, questions 8, 9, and 10 ask if the health professionals participated and consulted in the design and development process. The last question finally asks about the involvement of a panel of other experts. (Witteman et al., 2021)

Items and scoring of the UCD-11 by Witteman et al. (2021) have the following questions:

1. Were potential end users (e.g., patients, caregivers, family and friends, surrogates) involved in any steps to help understand users (e.g., who they are, in what context might they use the tool) and their needs?
2. Were potential end users involved in any steps of designing, developing, and/or refining a prototype?
3. Were potential end users involved in any steps to evaluate prototypes of a final version of the tool?
4. Were potential end users asked their opinions of the tool in any way?
5. Were potential end users observed using the tool in any way?
6. Did the development process have 3 or more iterative cycles?
7. Were changes between iterative cycles explicitly reported in any way?
8. Were health professionals asked their opinion of the tool at any point?
9. Were health professionals consulted at any point before the prototype was developed?
10. Were health professionals consulted between initial and final prototypes?
11. Was an expert panel involved?

3.2.1 Guidelines for Health & Wellness application design

According to Google AdMob (2022), applications have achieved a new level of importance in Health & Wellness sector in general. To explain the changed environment, Think with Google has cocreated a study with MTM where they offer a deeper knowledge of how to create a Health & Wellness application that will win the hearts and minds of the users. The study forms a four-stage model to explain the life circle of an application's usage. The authors suggest that the goal of any application provider should be achieving stage four.

1. Discover – this is the phase when a user discovers the application and downloads it.
2. Onboard – is the process including first use and registration.
3. Engage – this happens if the user chooses to use the application more regularly.
4. Embed – is the ideal state of the user thinking the application is 'vital' to his/her life.

From the developer's point of view, embedded users are the golden eggs because they visit the application more often, they are more loyal to the brand, and revenue is higher from them. (Google AdMob, 2022)

Google AdMob (2022) study presents two core needs of Health & Wellness application users:

1. Application is expected to motivate and challenge users to advance in their way of becoming a better and healthier version of themselves.
2. Application is expected to offer a smooth experience where users are in control and are guided to meet and maintain their goals.

The study also adds that fulfilling the user's needs at a certain point in time is still not enough. For example, there should be a continuous flow of refining the app's UX, design, and features. Also, providing social features is highlighted. The study encourages us to think in a way that app's journey never ends. (Google AdMob, 2022)

3.2.2 The UX intervals in sports applications

As Roto et al. (2011) suggested dividing the user experience into four different intervals, Caselli and Ferreira's (2018) paper suggests dividing the UX of sports applications according to these same four intervals. Table 4 presents the intervals and which issues are noteworthy in each phase.

Table 4. User experience time intervals in sports. (Caselli & Ferreira, 2018)

Type of UX	Time interval	Noteworthy issues
Anticipated UX	Before use	Preparation for the activity: <ul style="list-style-type: none"> • Arriving at the location • Setup equipment • Preparing mind and body • Contact others
Momentary UX	During use	Executing the activity: <ul style="list-style-type: none"> • Exercises • Practising movements and techniques • Contact others • Memories from the experience
Episodic UX	After use	Concluding the activity: <ul style="list-style-type: none"> • Organizing and putting away equipment • Finish contact with others • Leaving the location • Analyzing the performance
Cumulative UX	Throughout time	The activity improving reflections and actions: <ul style="list-style-type: none"> • Purchasing and exchanging equipment • Tracking the overall performance • Activities to improve body techniques • Contact others for experience exchange

3.3 U²E-Frame and ten UX heuristics

In her thesis, Arhippainen (2009) presents a usability and UX framework called U²E-Frame for assisting in planning and implementing UX studies. Framework describes the connection between user and product, but also the interaction between collective experience and subjective experience. From the collective experience, the framework underlines the different contexts, social, cultural, and physical. Correspondingly, from the subjective side is highlighted the temporal context where user experience can be interpreted with dimensions of optimal experience, emotional experience, and subconscious experience. Usability is placed in the center of the frame where it is actualized in the moment when the user uses the product. (Arhippainen, 2009) The contexts of the U²E Frame are presented in Figure 6.

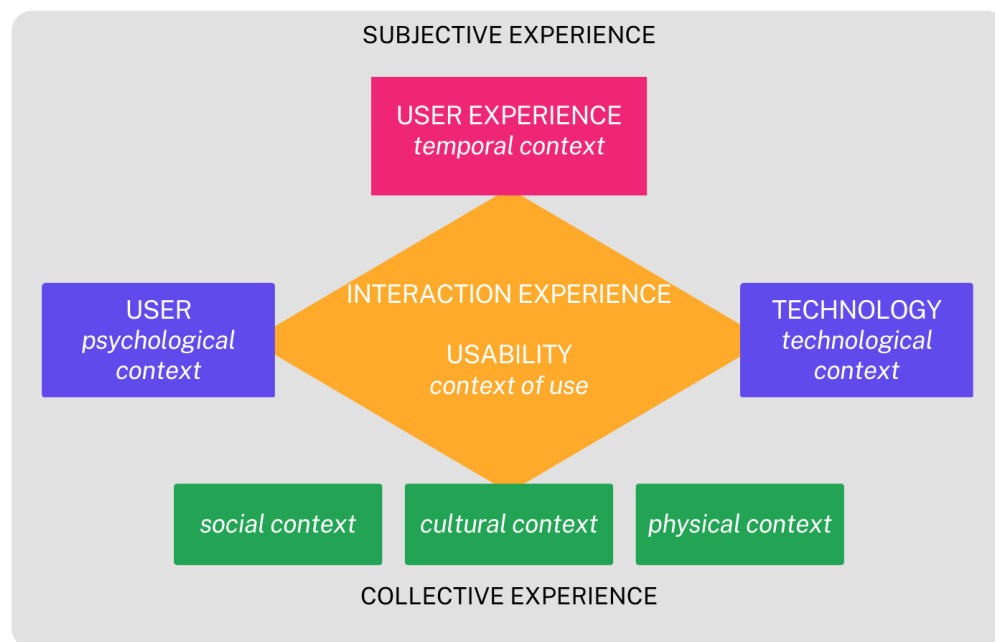


Figure 6. U²E Frame. (Adapted from Arhippainen, 2009)

Based on previous literature and several case studies, Arhippainen (2009) has collected and formed ten UX heuristics for designers. Ten UX heuristics guide designers to consider UX at a general level; thus, designing for better UX for real end-users. Arhippainen (2009) adds that these heuristics are adaptable for any product or service, not only for mobile ones. Ten UX heuristics by Arhippainen (2009) are:

1. Ensure usability
2. Provide utility matching with the user's values
3. Surpass the user's expectations and minimize the gap between negative expectations and real usage
4. Respect the user
5. Design the product or service to fit the intended contexts
6. Provide several ways to interact and leave choices for the user
7. Respect user's privacy and security
8. Support user's activities but do not force them
9. Go for a perfect visual design
10. Give a surprise gift

3.4 Discovered design guidelines from the literature review

The literary review has presented HCD, UCD, and SCD philosophy and methodologies. Table 5 presents the discovered design guidelines from the literature review. Presented guidelines are labeled with ID for later referencing. According to the existing literature, when designing a disc golf application, these guidelines are necessary to follow.

Table 5. Suggested guidelines discovered through literature review (L) for disc golf application design together with the adaption examples.

ID	Guideline	Source	Adaption
L1	User-need: Motivate and challenge the user for becoming a better and healthier version	(Google AdMob, 2022)	The application should motivate and challenge disc golf players for becoming better players.
L2	User-need: Provide smooth UX where the user is in control and advised	(Google AdMob, 2022), (Koumpouros, 2022)	The application should provide smooth UX by letting users be in control and by guiding them on how to fulfill their tasks.
L3	The holistic approach to design	(Giacomin, 2014), (Schnall et al., 2016), (Koumpouros, 2022), (Witteman et al., 2015), (Caselli & Ferreira, 2018), (Witteman et al., 2021)	Designers are suggested to use HCD together with UCD methods for design. This will make the application easier to use, understand, and accept. UCD methods also make the design process iterative and report the changes during the process.
L4	Actively participate the users in the design	(Schnall et al., 2016), (Koumpouros, 2022), (Indeed editorial team, 2022), (Witteman et al., 2021)	Participating especially hobbyists, players, and tournament directors.
L5	Actively participate the stakeholders in the design, identify their values, and make value proposals	(Koumpouros, 2022), (Ballantyne et al., 2011), (Forlizzi, 2018), (Witteman et al., 2021)	Participating players, TDs, clubs, associations, and PDGA, together with DG experts, DG shops, and other stakeholders. Identify stakeholders' values and make value propositions for everyone.
L6	The importance of the first impression	(Guo et al., 2019), (Koumpouros, 2022)	Providing high-level aesthetics in the user's first time of use.
L7	Continuum of the app	(Google AdMob, 2022), (Indeed editorial team, 2022), (Caselli & Ferreira, 2018)	Continuously refining the app's UX, design, and features together with providing social features to meet users' evolving needs.
L8	Identify the context of design	(Svanæs & Gulliksen, 2008)	Ensuring that the design environment prefers HCD methods.
L9	Support player's flow state	(Jackson & Csikszentmihalyi, 1999), (Kee et al., 2021)	The designed application should support the player in the flow state; letting the player focus on a task, giving a sense of being in charge, etc.
L10	Test application with heuristic evaluation and other methods	(Bader et al., 2017), (Lauesen, 2005)	Let someone not involved in the application design project evaluate the application.
L11	Avoid dark design with the HCI golden rule.	(Rajanan, 2022)	Ensuring that the design is not misleading or deceitful, but application is safe, easy to use, and designed honestly and sustainably.

4. Disc golf

The chapter presents disc golf as a field of sport. First is made an overview of DG's status and numbers. Then, the digital transformation process of the disc golf world is described.

4.1 Disc golf overview

Disc golf is a form of sport where is united an interesting game and outdoor activity. Disc golf uses the analogy of traditional golf, and the idea of disc golf is to throw a disc from the starting point to the target basket with as few throws as possible. The stereotypical disc golf course is in the park with plenty of natural obstacles on the course. When playing the round, the player can change discs and throwing angles depending on the certain fairway. There are normally 18 holes in the disc golf course, and the winner is the player who used the lowest number of throws during the entire round. (Toivonen, n.d.) From the 1960s till today, disc golf has increased its popularity, probably because of being so easily accessible; courses are free, a beginner player needs only one disc, and disc golf is gentle to learn even for first-timers (Glattke et al., 2018).

4.2 Disc golf in numbers

The structure of the disc golf world from top to bottom begins with the worldwide Professional Disc Golf Association. All the other national disc golf associations, such as Finnish Disc Golf Association (SFL) are linked with PDGA. Inside the national level operates local disc golf clubs, such as Oulu's Disc Golf Club (OFS). Finally, on the lowest level are the players who are hobbyists, amateurs, or professional players. Figure 7 states the position of Kristian Kuoksa, the most famous disc golf player in North Finland in 2022 (Seeskorpi & Loukkola, 2022).

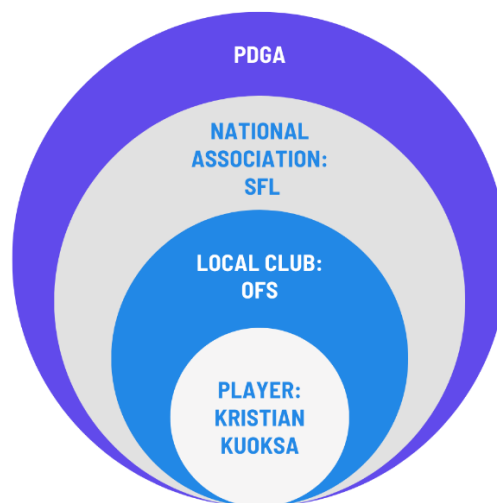


Figure 7. Structure of the Disc golf world from the player level to the roof organization (CC BY 4.0 Marko Moilanen).

According to SFL (2022), when disc golf player amount is compared with the population, Finland is the number one country in the world. And when the player amount is not compared, only USA climbs over Finland. SFL has over 10.000 members this year. Also, 263.000 Finnish people hobby disc golf at least once a year, from which 49.000 plays at least once a week. Also, every fifth adult Finn is interested in disc golf, but among 15-24 years old people disc golf is even more popular – 42 % hobby it. Also, Disc golf is in third place among the most popular sports in the age of 11-15 boys; only football and cycling were more popular in this category. (SFL, 2022)

4.3 Digital transformation of the disc golf

The evolution of the disc golf field has been fast. For example, in May 2010 it was still a default solution to have pen and paper for scorekeeping.¹ The official disc golf rules are still accepting pen and paper or electronic applications for scorekeeping. Nevertheless, the summer 2022 Oulu area competitions all used electronic methods for scorekeeping, and it was advised to use the Disc Golf Metrix application together with the PDGA Live application e.g., in Perämeri Open 2022 (Metrix, 2022). Even though some players would prefer pen-and-paper-scorecards; someone would still have to put all the scores into the Metrix and PDGA applications. It seems that electronic scorekeeping has come to stay in disc golf. According to Verhoef et al. (2021), a textbook example of digitization is using online applications instead of written forms, and thus, disc golf's scorekeeping meets the conditions.

The PDGA organization has proceeded from the digitization phase because in 2022 player statuses, competitions, and live results were opened online, on the PDGA website. This type of activity, such as changing business processes or communication channels into digital form refers to digitalization (Verhoef et al., 2021).

In the field of disc golf applications, there are already some actors going through digital transformation. For example, in Finland, Disc Golf Metrix has developed an application that is used as a platform for organizing disc golf competitions in Finland. Metrix has gained the status of being the official cooperation party of SFL (SFL, 2021). Metrix's platform unites SFL, local clubs, and their tournament directors and players. Metrix has achieved a competitive advantage with its new, innovative business logic, and according to Verhoef et al. (2021), these are the characteristics of digital transformation.

4.4 Disc golf applications

According to disc golf application providers and professional players, disc golf applications are used for tracking scores, checking courses nearby, and improving as a player. (Soppe, 2023; Udisc Disc Golf, 2016) The most popular disc golf applications according to Google Play in Finland, are presented in Table 6 where are included download amounts, the latest updates, and user review results of each application.

¹ Discussion about having weekly competitions of disc golf in Kajaani area in 2010. <https://keskustelu.frisbeegolfliitto.fi/viewtopic.php?t=1406>

Table 6. The most popular DG applications presented by Google Play in Finland (6.4.2023)

Application	Downloads	Latest update	User reviews
UDisc Frisbeegolf	+500.000	5.4.2023	4,8 of 35.500
Upsi Frisbeegolf	+50.000	5.3.2023	4,5 of 1.565
Discores – Frisbeegolf	+50.000	13.6.2016	4,0 of 366
Disc Golf Metrix	+10.000	23.12.2020	Denied
Tjing Disc Golf	+10.000	1.3.2023	4,1 of 35
Frisbeegolf Suomi	+10.000	14.8.2020	4,7 of 150

4.4.1 UDisc application

According to Soppe (2023), UDisc is the leading DG application players use for tracking scores, measuring throws, and finding courses. Soppe (2023) also states that UDisc is always used in bigger events in the USA, such as Disc Golf Pro Tour and World Championships. Moreover, UDisc offers live scores from the big disc golf events and is in close cooperation with the PDGA (Disc Golf Pro Tour, 2023)².

Table 6 reveals that over 500.000 players have downloaded UDisc and rated it with 4,8/5 which is a remarkably good rate. Figure 8 (A, B, and C) below presents screenshots of the UDisc application's main views that ordinary players use for scorekeeping.

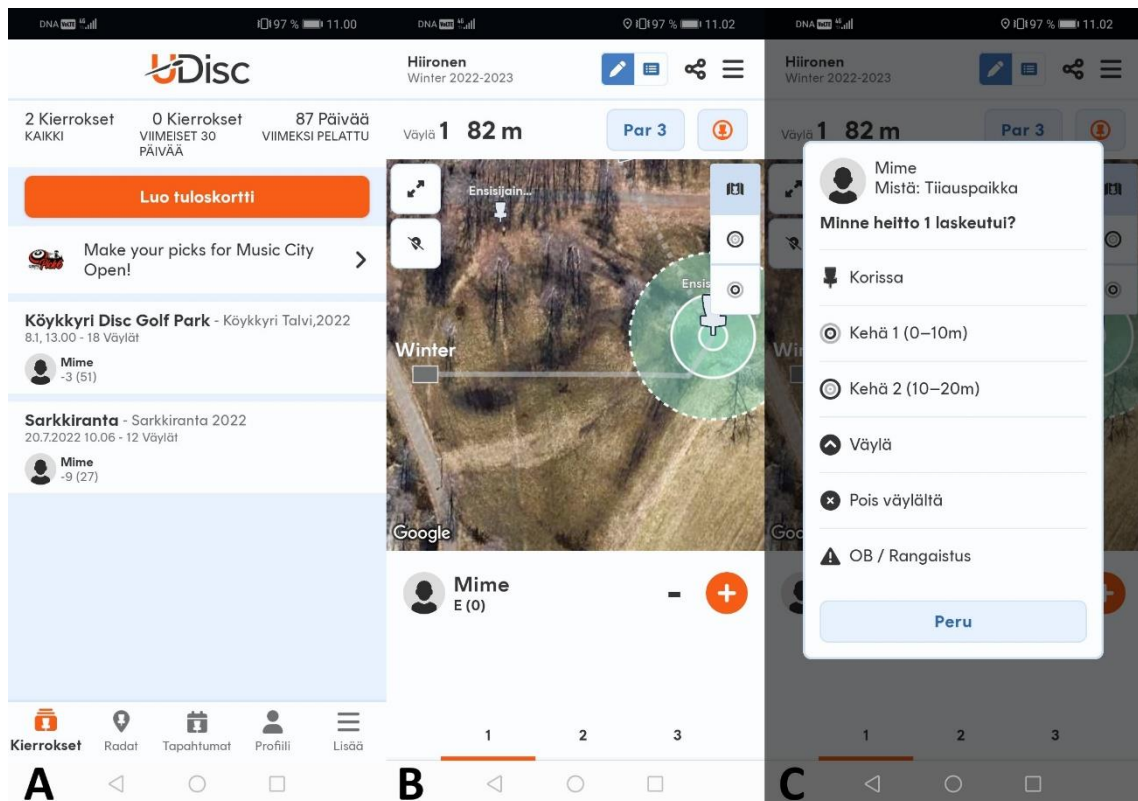


Figure 8. UDisc application's A) main view, B) scorekeeping view, and C) adding statistics and score view.

² On the website, select headline "Scores", or enter: <https://udisclive.com/>

4.4.2 Disc Golf Metrix

Disc Golf Metrix is an Estonian disc golf application, which is popular among European disc golf countries, such as Finland, Estonia, and Norway. Metrix is used for not only scorekeeping by regular players but also for organizing bigger tournaments and local weekly competitions. (Soppe, 2023)

According to Table 6, Metrix has over 10.000 downloads, but its previous update is from the year 2020, and user reviews are denied. Figure 9 (A, B, and C) below presents screenshots of the Metrix application's main views that ordinary players use for scorekeeping in their free time, and in competitions (e.g., in Finland).

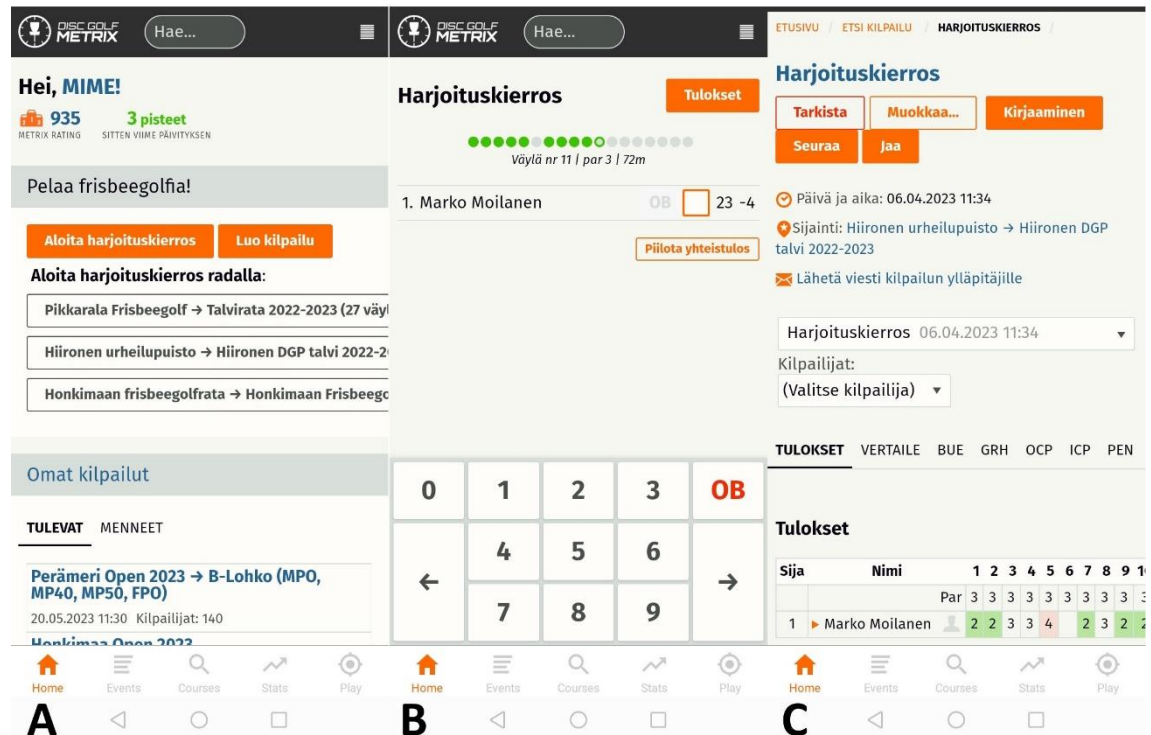


Figure 9. Disc Golf Metrix application's A) main view, B) scorekeeping view, and C) practice round view.

4.4.3 Upsi application

The Upsi application allows players to keep scores, invite friends to play, and find disc golf courses with weather information. Upsi also makes it possible to see friends' scores in Live. (Upsi, n.d.) According to Google Play user reviews, the Upsi application is preferred as an optional DG application that is easy to use and contains only the most relevant features that DG hobbyists are looking for.³

According to Table 6, Upsi has over 50.000 users who have rated it with 4,5/5. Figure 10 (A, B, and C) below presents screenshots of the Upsi app's main views that hobbyists use for scorekeeping. The Upsi's unique mechanism is that when the user points his finger to the person icon (Figure 10, B), the view presented in Figure 10, C opens. Then, the user keeps his finger on the touchscreen and moves the icon to the

³ See e.g., Juuso J and Adeno Ong in Google Play public reviews.

result that the player got in that fairway. Upsi's mechanism does not require any numerical input, but only moving the finger.

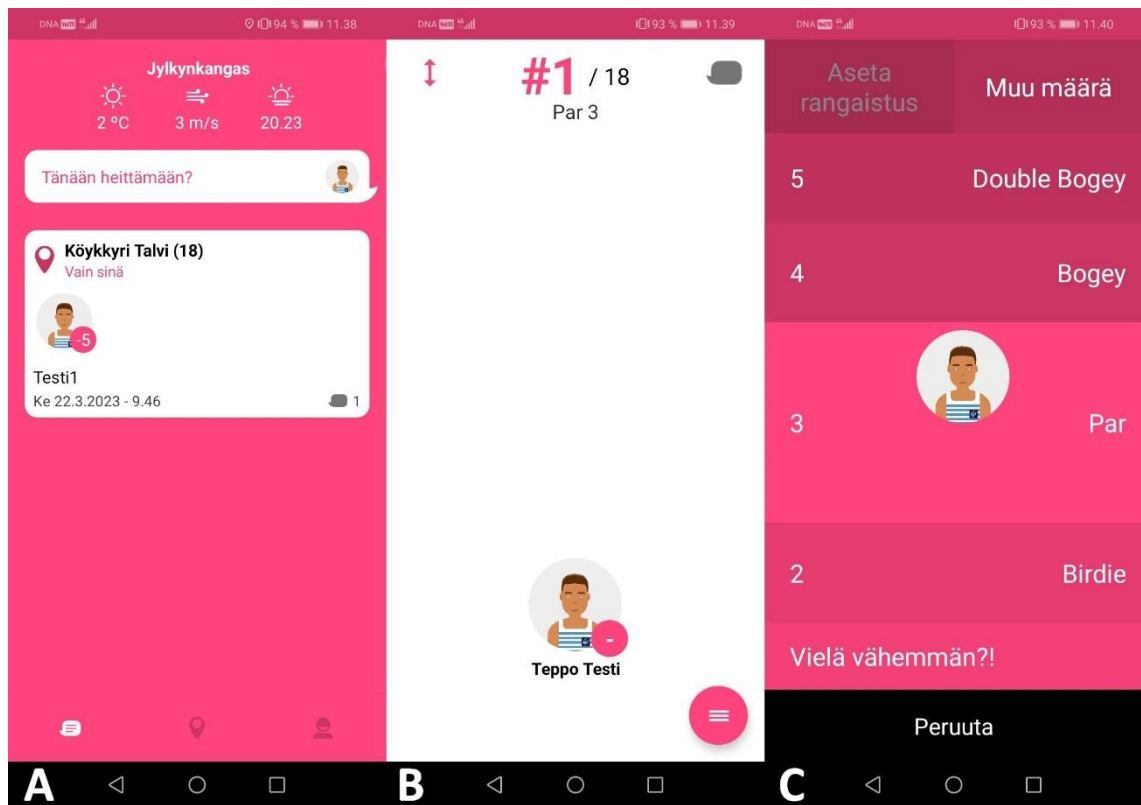


Figure 10. Upsi application's A) main view, B) scorekeeping view, and C) adding score view.

4.4.4 Other applications

There are also other disc golf applications, such as Discoscores – Disc Golf App, and Frisbeegolf Suomi, but those have not been updated in recent years. Also, Tjing Disc Golf has an increasing number of downloads, and according to its website, Tjing is an official application of the Swedish disc golf association (Tjing, n.d.). There are also more specific DG applications, which are used e.g., for making putting exercises. Examples of these are Perfect Putt 360, and JYLY Putting Game (see e.g., Soppe, 2023). Also, the professionally made disc golf mobile game, Disc Golf Valley has already more than 1 million downloads from Google Play (Figure 11).

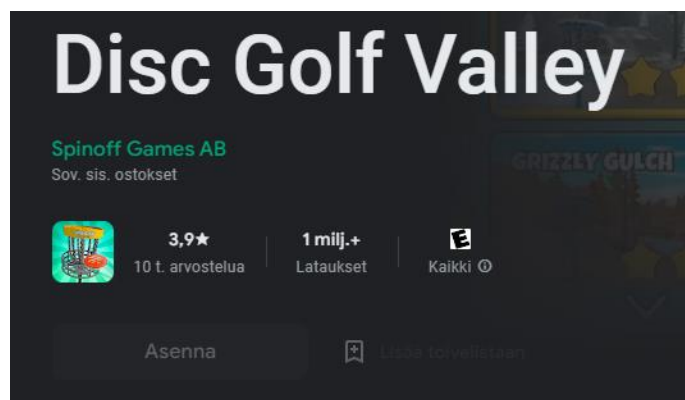


Figure 11. Screenshot (28.4.2023) from Google Play displaying Disc Golf Valley.

5. Study I: Questionnaire

This chapter presents Study 1; empirical, qualitative research in the form of a questionnaire. The chapter explains how this questionnaire was used for data gathering, and how the gathered data is analyzed.

5.1 Questionnaire and participants

For collecting qualitative data with quantitative hue, a web-based questionnaire was implemented at the end of May 2022, in the Facebook group “Oulun Frisbeekanava”. The questionnaire was implemented in Finnish. For questionnaire questions and English translations, see Appendix G. Questionnaire was part of a course assignment in the university course User Experience (UX) Design and Management at the University of Oulu; this thesis refers to those results. Questionnaire participants read informed consent where was explained that their answers will be utilized in the course assignment and possibly for developing a DG application. The questionnaire got 94 answers 26.5. – 30.5.2022, although it was open till 12. June 2022. Altogether, all the 94 questionnaire answers came in five days and after that, no one answered it anymore.

The questionnaire was planned to answer the basic questions concerning disc golf sport as a hobby or profession. Firstly, it was wanted to know who the players are. Then, it was asked that do players use disc golf applications, and if they do, which applications they use and why. Also, players’ expectations, needs, and wishes toward disc golf applications are golden data. The questionnaire also included questions about how players store their discs, and do they trust the flight numbers offered by manufacturers. Also, data for a new feature “Playbook” was collected.

Because disc golf events and general information concerning the game are communicated through social media, it was decided to use social media for data gathering. The Facebook group called “Oulun frisbeekanava” was selected because of its various forms of DG players. In Oulun frisbeekanava, there are present over 5000 DG hobbyists, amateurs, and professional players from the Oulu area. On the channel, there are news and updates about Oulu area disc golf courses, together with all kinds of news, articles, and information about the sport.

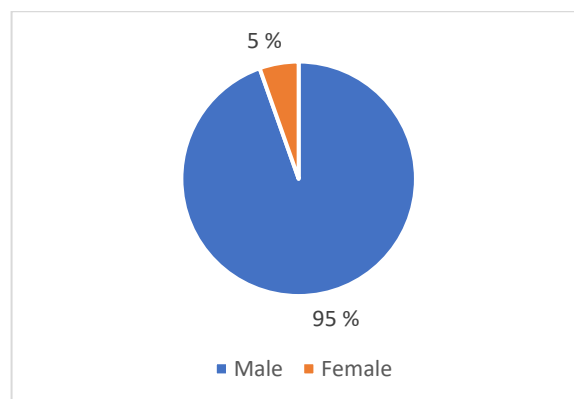


Figure 12. Participant’s gender.

In total, 94 people took part in the questionnaire. All the basic information about the participants is presented in the diagrams above. An average participant is male with an accuracy of 95% (Figure 12), and from 18 to 39 years old with 59 % accuracy (Figure 13).

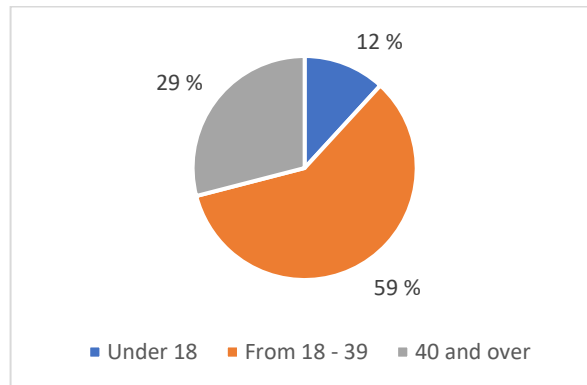


Figure 13. Participant's age.

An average participant plays disc golf once a week or more (Figure 14) and is a hobbyist or amateur player (Figure 15). Figure 15 states the categories into which participants were able to label themselves. There are presented two amateur categories, for those players who compete and those who do not. The competitive amateur player competes in weekly competitions without a PDGA license or competes also in bigger competitions with a PDGA license but does not accept monetary prizes.

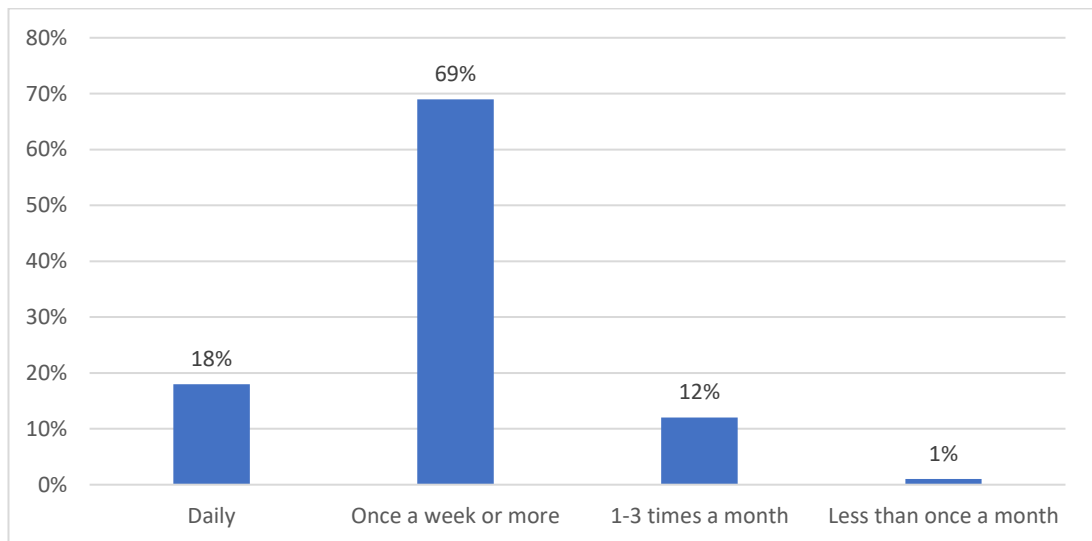


Figure 14. Player's activity in disc golf.

Figure 14 describes the activity level of a participant in disc golf sport. A clear majority of participants play disc golf once a week or more but not daily. Also, almost every fifth player plays daily, while only every tenth player plays only 1-3 times a month. There was only one answerer who plays less than once a month.

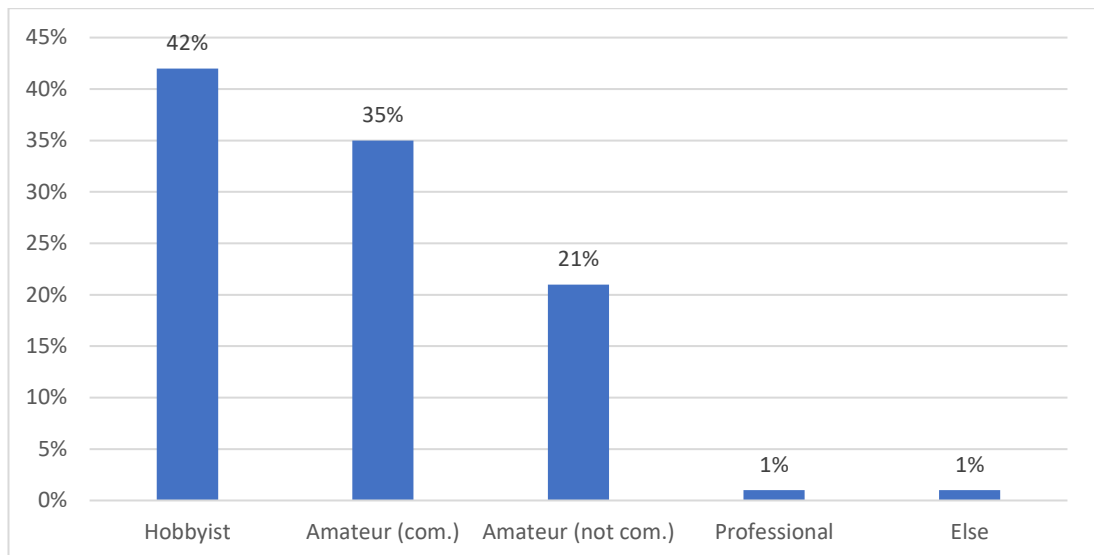


Figure 15. Participant's status in disc golf.

5.2 Findings

This chapter presents the main findings from the questionnaire concerning DG application usage, users' expectations, needs, and wishes, together with information about owning and storing DG discs. Also, information about the Make a Playbook feature is presented.

5.2.1 Application usage and the most popular applications

Most participants (96%) are using at least one disc golf application (Figure 16). In the questionnaire, it was possible to choose multiple applications that the participant uses. According to Figure 16, the three most popular disc golf applications are:

1. UDisc (40 %),
2. Metrix (28 %), and
3. Upsi (26 %).

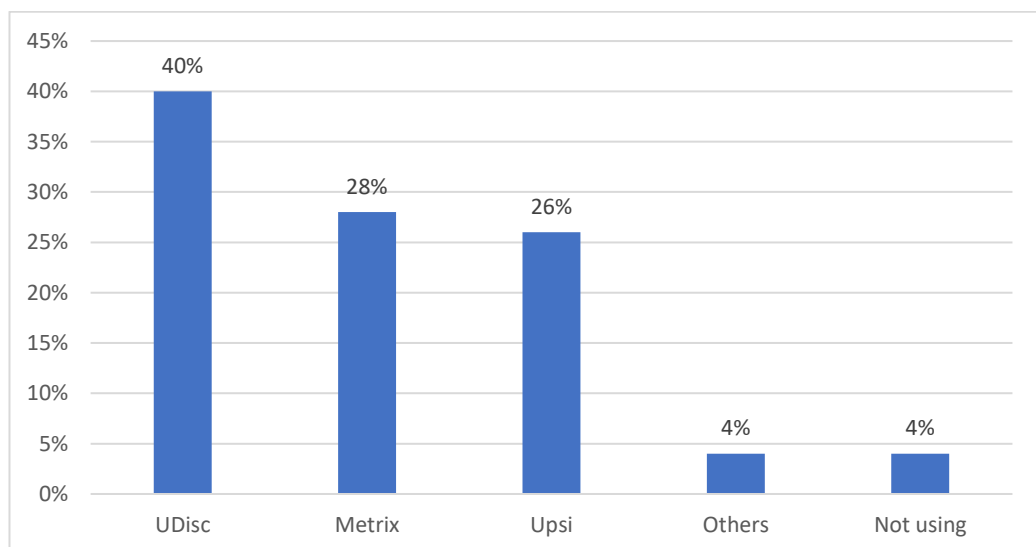


Figure 16. Disc golf application usage of participants.

5.2.2 Users' expectations, needs, and wishes

The collected data was coded by adapting the thematic analysis methodology (Braun & Clarke, 2012). First was decided to have three categories, each for the user's expectations, needs, and wishes. Then, collected data from several questions were analyzed if there were participants' answers which related to these categories. This was repeated multiple times, until all the data was under the top categories, or removed with an unsuitable status, such as joke answers.

The tables below present the expectations (Table 7), feature needs (Table 8), and wishes for future applications (Table 9) after the coding. The tables also have priority status, which comes from how popular the answer was. If the status is high, approx. half or more of the respondents, who answered this question, saw it as crucial. For medium status, about 10-25 % of the respondents saw it important. Also, for the rest, low-level status, there were only a few respondents who mentioned the issue.

Table 7. Users' expectations of disc golf applications are arranged in the priority form.

Expectation	Priority status
Ease-to-use	High
Functional	High
Updates	Medium
Simple	Low
Reliable	Low
Useful	Low

Table 8. Users' needs for disc golf application features are arranged in the priority form.

Need / Feature	Priority status
Scorekeeping	High
Statistics	High
Maps/ Map updates	High
Measure throws	Medium
Social features	Medium
Diagrams/data of each course	Low
Compare own results	Low
Manage competitions	Low
Play with different game modes	Low
Course ratings	Low
Mark disc for throws	Low
After the round, show the rating	Low
Add discs, form bag	Low
Putting exercises	Low
GPS	Low
Weather information	Low
Apple Watch supported	Low

According to Table 7, users expect disc golf applications to be easy-to-use and functional. A remarkable number of players also expect the application to have regular updates. For example, according to Participant ID19, the application should be so easy to use so that handling the mobile phone will not take too much time after each fairway.

Table 8 reveals the basic needs for features that players have. For example, the respondent with ID 4 states that he needs an application that unites three things: scorekeeping (also with friends), course maps, and measuring throws. Table 8 confirms that almost all the players need to have at least scorekeeping, statistics, and disc golf course maps (which updates) in the application they use. Also, many players need a tool for measuring their throws and for social dimension. Social features, especially adding friends, sharing scores, seeing friends' scores, and chatting were mentioned. Also, different game modes, e.g., pair, skin, and match play modes were asked for features. Many of the low-priority needs were somehow related to advanced statistics features.

Table 9. Users' wishes for future disc golf applications.

Wish	Priority status
Everything in the same app	Medium
No advertising	Low
Keep playbook	Low
Auditive UI for scores	Low
Remind me if forget to add scores	Low
Slomo video recording	Low
Application announces distance to the sweet spot	Low
Managing own competition calendar	Low

The analysis identified some players' wishes from the data. The following quotes from the players are translated into English:

- *“In practice, current applications have all the necessary things you need, but you must use more than one app.”* (ID 69)
- *“All the disc golf issues under the same roof; from putting exercises to direct instructions.”* (ID 50)
- *“I use applications for supporting my training. I do not want to use more than one application; thus, there should be some application that has enough features and is easy to use. I wish the application can help improve my game and scores.”* (ID 1)

Table 9 confirms that a notable number of players share the wish about having one comprehensive disc golf application.

5.2.3 Owning and storing discs

Here are presented the findings concerning owning and storing DG discs.

Number of discs

According to the questionnaire results, players have an average of 58 discs. Also, 62 % of disc golf players do not know how many discs they have. Yet players were asked to

estimate how many discs they have. Estimated values and known facts were used to calculate the average of how many discs players own. The minimum number of discs reported was 6, and the maximum was 305 discs.

Secondly, the average number was tested so that two extreme values from each end were removed from the data. After deleting the extremes, the average result was 52 discs. Thus, there was no significant change in the value.

Storing discs

Almost every player keeps all the discs they are using in the bag/back bag/bag with wheels/etc. Also, the discs that are not in use, are stored in the closets, boxes, car, back yard, garage, etc. It seems that discs are divided into two groups: discs that are actively in use, and discs that are not.

Sorting systems

A majority (86 %) of players use some sorting system for their discs, while 14 % of players do not sort discs in any way. Also, 57 % of players use sorting order only in their bag, while other discs are in no specific order.

5.2.4 Disc's flight route

The majority (47 %) of players said that discs are usually flying as manufacturers have promised, but approx. half of them still said that you will have to know the wind, and how worn the disc is, and some individuals (of discs) just fly differently (Figure 17).

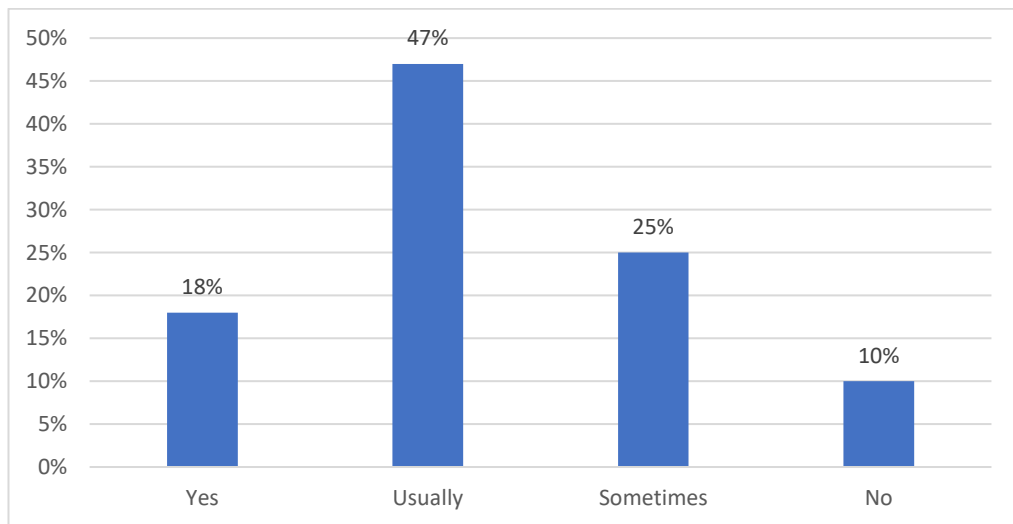


Figure 17. Players' evaluation about do discs fly as flight numbers state.

5.2.5 Making playbooks

The playbook means a rational beforehand made game plan for playing a certain disc golf fairway. Usually, the playbook includes a couple of different scenarios per fairway. Scenarios consider e.g., wind and other weather conditions, together with the safe or attacking playstyles. In every scenario, the chosen disc is decided before entering the course.

Selecting the disc to throw

Players were asked how they choose the disc they are throwing next. The answers were broad and some of them are presented below. The most used answer related to looking map or fairway and then approximating the distance to the target. The second popular issue was thinking about the wind conditions.

- Looking map and distance to target (ID 1; ID 47; ID 77; ID 79)
- Thinking about the wind (ID 6; ID 9; ID 74)
- Using intuition (ID 26; ID 59; ID 84)
- Thinking the shape of the fairway (ID 11; ID 70; ID 72; ID 85)
- By guessing (ID 14; ID 51)
- With intelligence (ID 16; ID 30)
- By visualizing (ID 19)
- Is it the fore, or backhand fairway (ID 3)
- By observing other people's throws (ID 31; ID 94)
- By experience (ID 36; ID 42)
- By analyzing (ID 34; ID 48)
- Asking friends (ID 61)
- Feeling (ID 11; ID 50; ID 52; ID 67)
- Using the trusted disc (ID 40; ID 45)
- By reading the fairway guide (ID 44)

Familiarity with playbooks

The majority (76 %) of answerers were already familiar with the term playbook and 16 % had an idea of it (Figure 18).

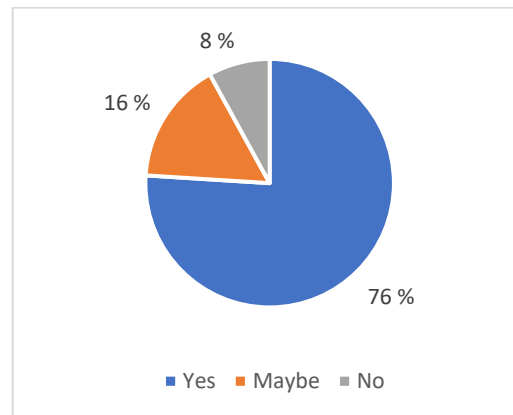


Figure 18. How familiar players are with the term playbook.

Figure 19 reveals that the clear majority (75 %) of players are making/using playbooks usually or always when playing disc golf. Almost half of the players always use playbooks when playing disc golf, while about a third of players rarely or never use a playbook.

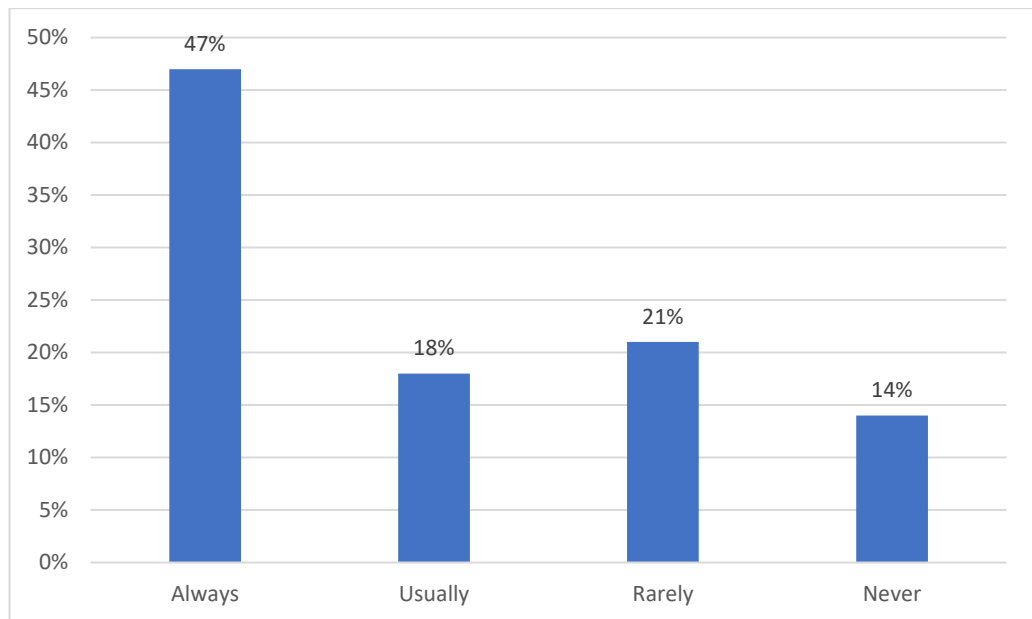


Figure 19. Percentage of players using and making playbooks.

How playbook is prepared

Next, participants were asked to describe how they form a playbook. Here are some example answers:

- Listing the fairways, watching maps and descriptions, and choosing discs for each fairway. (ID 1)
- Planning before playing in competitions. (ID 8)
- Making it in my mind. (ID 6)
- Watching videos and looking at maps. (ID 13)
- By playing practice rounds. (ID 26)
- Making 1-3 plans for each fairway, with 1-3 different discs. (ID 49)
- Choosing the fairways where to attack, and where to play safe. (ID 54)
- Thinking about my throws and then choosing the best ones. (ID 63)
- Thinking about my strengths and weaknesses. (ID 81)
- I was thinking about how to avoid risks. (ID 82)
- Looking at maps and distances. (ID 93)

Willing to use an application for making a playbook?

According to Figure 20, 27 % of participants would use a new application for making playbooks. Also, 40 % of players would at least consider using it. Altogether, 2 of 3 players would at least consider and try a new playbook feature in their disc golf application.

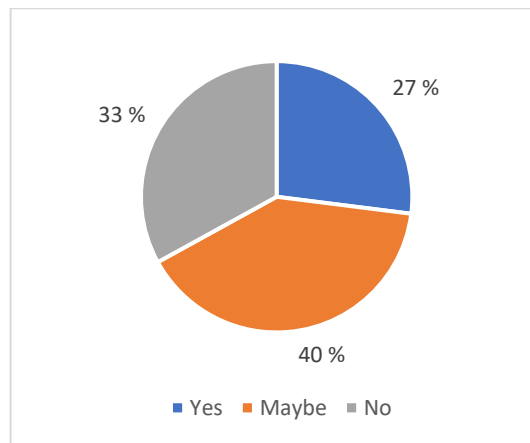


Figure 20. Players' willingness to use applications for making playbooks.

Players' instructions for how the playbook feature should be designed

The questionnaire also asked players how they would design the new playbook feature for the disc golf application. Here are some example answers:

- By drawing and making notes. (ID 18)
- You would need statistics, then a fairway description. After that, you can draw the throws. Also, adding wind direction. Then you can choose the right disc. (ID 54)
- This would require detailed fairway descriptions and space for notes and an easy-to-use system. (ID 63)
- Application could first take scores for scorekeeping and after that show you the playbook for the next fairway. (ID 65)
- System would save your throws and later suggest you new plan based on your previous results. (ID 76)
- Application could give you suggestions based on e.g., the maximum distance of your drives. (ID 81)
- Basic memo, or a menu of the discs you have in the bag or drawing throwlines to the fairway map image. Also, you could see average scores per different throwing lines. (ID 82)
- Application could take values of how your discs fly and show where your discs will land on the map. (ID 88)

Players' familiarity with drawing applications

Participants were asked how familiar they are with any drawing applications. 45 % of players are familiar with drawing applications, and 22 % were unsure. Also, one-third of players stated to be unfamiliar with drawing applications. (Figure 21)

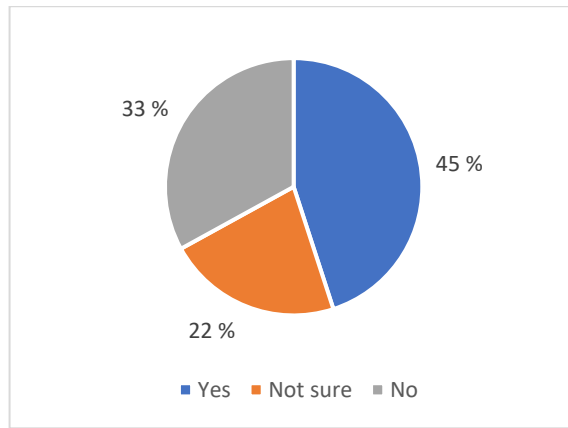


Figure 21. Players' familiarity with drawing applications.

6. Study II: Contextual inquiry (observation in the wild)

This chapter continues empirical, qualitative research by presenting three cases adapting the contextual inquiry method in the Oulu area in 2022. For gaining an understanding of critical design choices such as requirements, personas, features, and content strategy, Salazar (2020) suggests using contextual inquiry as a research method. Study II adapts contextual inquiry methods from Holtzblatt and Beyer (2014).

6.1 Contextual inquiries and participants

Contextual inquiries are implemented in separate sessions – a session for a professional player, and another session for hobbyists and amateur players. For both sessions, different goals were formed:

1. A professional player session:
 - a. Seeing how the professional player uses disc golf applications while playing.
 - b. Gaining an understanding of disc golf sport in general, and of different parties and organizations together with the different disc golf applications used in the competitions and when practicing.
2. Amateur player sessions:
 - a. Seeing how amateur players use disc golf applications while playing.
 - b. Spotting the best and worst experiences while using applications.

Contextual inquiries were implemented while playing disc golf, in disc golf courses. The first session was on the Pikkarala Pro course with a professional disc golf player. The interview was unstructured. The second session took place in the disc golf course, in Kiiminki Honkimaa. The third session was again in Pikkarala, but now in the technical course. Contextual inquiry sessions are introduced in Table 10.

Table 10. Information about the contextual inquiries (CI).

ID	Time and Place	Duration	Present
CI1	19.5.2022, Pikkarala Disc golf course	140 min	P1 & Author
CI2	28.5.2022, Kiiminki, Honkimaa Disc golf course	180 min	A1, A2 & Author
CI3	2.6.2022, Pikkarala Disc golf course	90 min	A2 & Author

Participants were chosen to match identified groups of amateur and professional players. Participants were personally recruited by the author and motivated by the possibility to advance the general progress of DG. For ensuring the anonymity of participants, more detailed information about them is not presented. Although, some basic information about the participants is introduced in Table 11.

Table 11. Basic information about amateur (A) and professional (P) participants.

ID	Demographics	Experience in disc golf
P1	40 years old, male, teacher, professional player	A professional player who knows most applications in the field
A2	32 years old, male, unemployed, amateur player	An amateur player who knows some applications and sometimes participates in competitions.
A3	31 years old, male, student, amateur player	A disc golf hobbyist who knows some applications and hardly participates in competitions.

6.2 Findings

Here are presented the findings from the contextual inquiry sessions. Findings are categorized under each session and include extracts from the interviews and observations.

6.2.1 Session C11

The first session gave a general overview of how professional players think nowadays and how they use applications when playing disc golf. Only a few years ago players had only paper and pen and only one player at a time from each group (usually 4 people) wrote scores down. Now the situation is different.

In small competitions, there is always one person who must keep scores with an application called Metrix. But in the bigger tournaments, there are at least two applications for scorekeeping that players use, and a third application that players or someone else is using. So, in the bigger competitions, three applications must be used for every 4-player group. According to P1, these applications are Metrix, PDGA Score, and UDisc. Metrix is used because it is mandatory and events are organized through it, PDGA score is used because the scores are also required to be visual on the PDGA website, and then, UDisc is used for having more specific statistics. Metrix does not include statistics features, and therefore, another application is used. In smaller competitions, UDisc is not usually used at all. Altogether, tournament directors give instructions to players in player meetings before competitions. Then is also told which applications are required to use for scorekeeping. Then, players decide whose turn is to use each application. For clarification, tournament directors are persons responsible for organizing and managing certain disc golf competitions. TDs are trained by the local clubs, and they need to pass the PDGA-certified rules official exam.

P1 personally uses Metrix when competing and UDisc when practicing. It might be too complex of using multiple applications while competing and thus relevant statistics will be missed in every minor competition where UDisc is not used.

P1 also told that professional players practice a lot in the soccer fields. Players are measuring their throw distances, but they do not write down how their discs behave. They only memorize it. Then, it was discussed the idea of using a disc golf application for forming a playbook. P1 considered it to be a great idea. He visualized the scenario so that he would throw the disc in the field, and then draw the flight line to the same application that also measures the throw distance. (See also Appendix F)

When playing disc golf, P1 had no problems while using the application. Scores were collected after each hole, in the next tee area. P1 told that there are certain procedures to follow, but now he just makes the notes for his purpose. When further asking about that purpose, he said that purpose is to be a better player and to spot weak spots in one's own game. Here statistics plays an important role.

After the round, P1 was asked about the expectations, needs, and wishes concerning the disc golf applications. He said that using the application is mandatory, in competitions of course, but also for your purposes (referring to the statistics features). The application needs to work properly and be easy to use here in the woods, in every weather condition, and even in wintertime. The application should have training features too and would be nice to make playbooks with it.

6.2.2 Session C12

In the second contextual inquiry session was mainly adapted observation. Here are the main results of using disc golf applications:

Both players were familiar with the following applications: Metrix, UDisc, and Frisbeegolf Suomi. Players have used UDisc but ended it when the free trial ended. Frisbeegolf Suomi was then used for scorekeeping, and players were pleased with it. However, after taking part in some weekly competitions, players have changed to use Metrix, because it is mandatory to use it in the competitions, and therefore, players wanted to learn how to use it. Still, players are not fully satisfied with Metrix, because it lacks features such as detailed statistics per fairway, and is quite sensitive to errors, etc.

Before entering the course, players agree to use the disc golf application Metrix for keeping their scores. Players also consider whose turn it is to use the application. Players say that everyone keeps scores in their turns, and players seem to have different styles for keeping scores. A1 is making the notes by himself and hardly asks about the scores of other players, while A2 uses a different strategy, he asks about the score of each player. A2 asks about the score immediately when discs have entered the basket or sometimes when walking to the next tee area, and sometimes when in the next tee area. Also, A1 and A2 have a difference in keeping the score, because A1 wants to see the scores in real-time while A2 selects the feature for not showing the current scores until the round is finished.

When observing the planning of the game both players were a bit confused about that do they have playbooks or not. The following acts happened:

Act 1

A1: *"I have a playbook for this fairway."*

Then, when entering the tee, the player selects another disc that was supposed to.

Act 2:

The question was asked: How do you select the disc for the next throw?

A1: *"I watch where the basket is and choose the disc from my bag. I trust the feeling."*

Result: the disc is not landing near the basket.

Act 3:

Player A2 is speaking aloud about which disc he should choose. This hesitation affects his throw, and he throws way too carefully.

Act 4:

When walking to the next tee question was asked: do you have a playbook for the next fairway?

Both players answer no.

Act 5:

Question on the next fairway: do you have a playbook for this fairway?

A1: *“Yes, I make a playbook right now, in my mind.”*

This clearly shows that players do not necessarily know what the term playbook means. It is a premade plan for how to play the fairway.

6.2.3 Session CI3

The third session was with amateur player ID A2, in Pikkarala Disc golf park. It was agreed that I will be observing our game and application usage during the round.

CI3 offered an example of how applications can ruin players’ flow state. It was A2’s turn to use Metrix for keeping our scores. First, A2 was playing well, but after a few fairways, when adding our scores into Metrix, a mistake was made.



Figure 22. Screenshot from Metrix application with highlighted buttons.

Figure 22 displays the Metrix application's view for adding scores. We were playing on a rainy evening, and A2 accidentally clicked the play icon which is highlighted as red. He should have pressed the arrow icon highlighted as green.

By this mistake, Metrix closed the scorekeeping view and opened a new view. There was no dialogue, such as "Are you sure...". Also, by pressing the back arrow, the system did not take the user back to the scorekeeping view, but the system opened the front-page view. It took us approx. 3 minutes to find back this same view that was closed by accident. After the episode, A2 lost his flow state, and thus, did not play that well anymore. Of course, there is always a mental game going on when playing, but in this case, the Metrix application was part of ruining a good run.

7. Designing with HCD methods

The seventh chapter presents the third part of the thesis' empirical, qualitative research. Research adapts the basic HCD methodologies for identifying the context of use and user requirements. Also, disc golf personas are created, and stakeholders are identified. To stakeholders, value propositions are demonstrated.

7.1 Context of use

When forming the context of use for DG application, it is used Lupton's (n.d.) definition and the additional contexts from the U²E Frame by Arhippainen (2009).

Physical context:

Physical context varies from the user's home and indoors to the forests and parks outdoors. In Finland, also wintertime playing has become more and more popular. The weather is a major issue when using the application outside, e.g., on rainy days or in wintertime.

The main features, such as scorekeeping is used mainly in the course, outdoors. Correspondingly, e.g., statistics can be studied and planned at home, or anywhere where there is a time for using applications. Altogether, the application must be easy enough to use, even though the user would be in a difficult environment. It is also a must to use the application as a mobile version because no one carries a laptop or even iPad on the course.

Social context:

Disc golf can be played and practiced alone, but the average case is to play with 1-3 other people. Usually, one person uses the scorekeeping application and asks other players about their scores after each fairway. After the round, all the scores are visible in each player's application.

In every competition, a player is required to register for the competition through the application. In the app, there should be possible to contact tournament directors. Also, when entering the competition, a player is required to participate player-meeting, through application and usually face-to-face.

Disc golf's social context also includes YouTube and social media. For example, Jomezpro⁴ presents almost all the major USA competitions on YouTube, and the same role is with Disc Golf Finland⁵ and Disc Golf Stream - Suomi⁶ in Finland. There are

⁴ <https://www.youtube.com/@JomezPro>

⁵ <https://www.youtube.com/@DiscGolfFinland>

⁶ <https://www.youtube.com/@discgolfstreamsuomi>

also tens of channels concerning disc golf on Facebook, and even certain disc golf courses have their own Facebook pages.

According to the questionnaire, players are demanding more social features in applications. Players would like to add friends, follow others, share results, and discuss with others.

Cultural context:

The cultural context of DG includes e.g., following certain rules when playing. Normally, players learn the official PDGA rules step by step, and e.g., weekly competitions are a good opportunity to learn more specific rules. DG also has a language that might be hard to follow for outsiders. For example, spike hyzers, cut rolls, and sweet spots say nothing to an outsider but describe throws and certain fairway areas to advanced players.

It is also possible to see the newly-born digital culture when uniting the cultural context with the social context above. There is a ton of user-generated material about DG online, and it is even possible to follow DG events in real-time.

Organizational context:

A disc golf application is required to match the organizational structure of the disc golf world. From top to bottom, the structure is:

- Global association PDGA
- National associations, such as SFL (Finnish disc golf association)
- Local clubs, such as OFS (Oulu's disc golf club)
- Players

A person can hobby disc golf without being a part of any local clubs, but membership is required whenever a player wishes to participate in bigger competitions.

Technical context:

Disc golf applications are used mainly on the field and thus mobile phones are required to use the application. However, e.g., statistics can be studied and used almost anywhere. Therefore, also the technical context may vary. Some players may prefer using a computer, laptop, or iPad for studying statistics; thus, offering also, e.g., Windows or browser-based applications might be required. Also, according to the questionnaire, players would like to use Apple Watch with the application (ID 11).

Psychological context:

As with any sport, also disc golf has a mental and psychological dimension. When the pressures are high e.g., in top-level competitions, players prefer interfaces that are easy to use rather than those that are vulnerable to small touching mistakes. For a bad example, see CI3. The application should not disturb the player's flow state.

Temporal context:

There are also temporal contexts that can be considered as certain moments in a day or a week. For example, players can use the application at home for seeing the statistics and considering playbooks. Then, a couple of hours later, the player uses the same

application for scorekeeping and maps or measuring throws on the football field nearby. All these acts are temporal moments of using the application. Also, when a player adds throwing results to the application and those results refine into the statistics, the player can gain new knowledge concerning one's own game and thus, use this data for improvement, to become a better player. Like this, temporal moments refine over time as Roto et al. (2011) defined.

7.2 User requirements

User requirements are the results of the questionnaire where players were asked about their expectations, needs for features, and wishes for future disc golf applications (see Tables 7, 8, and 9). Table 12 presents players' high and medium-priority expectations, needs, and wishes for disc golf applications.

Table 12. Users' high-priority expectations, needs, and wishes for disc golf applications.

Expectations	Needs for features	Wishes
Ease-to-use	Scorekeeping	Everything in the same app
Functional	Statistics	
Updates	Maps/Map updates	
	Measure throws	
	Social features	

Disc golf application users expect their application to be easy to use, functional in all circumstances, and include a continuous flow of updates. According to Appify (n.d.), a decent amount is 1-2 small updates per month. Users need their application for scorekeeping, statistics, course maps and map updates, measuring throws, and social interaction. The main wish of the users is that all the basic features would be in the same application.

7.3 Disc golf personas

Forming DG personas begins with a stereotype of a disc golf player according to the results (percentages) of Study I. The stereotype is called *Disc Golfer*, and he has the following attributes:

- 18 – 39 y/o (55 %)
- Male (94 %)
- Amateur (57 %)
- Plays disc golf at least once a week (68 %)
- Uses disc golf application (96 %)

Next, DG personas are formed to represent statistically different disc golf players. Different DG personas present a variety of gender and age but also the ability to use mobile devices, personal DG skills, together with the general knowledge of the sport and the person's role in the DG community. Each persona has one's motivations and frustrations concerning DG and one's role in it.



Figure 23. DG persona for the hobbyist (CC BY 4.0 Marko Moilanen).



Figure 24. DG persona for the amateur player (CC BY 4.0 Marko Moilanen).

Even though, according to the questionnaire, 94 % of players are men, in the name of equality, a woman candidate, Sari Kulmala, is presented as a hobbyist (Figure 23). Sari is fluent with mobile applications and loves to be outdoors playing disc golf. Sari is

frustrated about lacking time and skills, together with uncertainty concerning which DG application to use.

After Sari is presented an amateur player Jarmo Koskinen (Figure 24). Jarmo enjoys harmless competition with his friends and is native to disc golf applications. Jarmo would like to be a better player but not having enough time and resources has made his skill-level to stay still. Jarmo also feels frustrated with some DG applications' jamming usability.



Figure 25. DG persona for the tournament director (CC BY 4.0 Marko Moilanen).

The last DG persona is a tournament director called Jukka Hautakorpi (Figure 25). Jukka likes to oversee, organize, and manage DG events and competitions. Jukka has always been there in DG – first playing in his free time, then competing and taking an active part in the DG community. Jukka is frustrated with the application that is used for organizing competitions, and that local councils do not value DG even though the statistics clearly show how many people play DG. Jukka also feels helpless when the DG event is fully booked in under 10 seconds after registration is opened, and thus, plenty of players are left outside the competition.

7.4 Disc golf application stakeholders

The chapter presents the identification process of different DG application stakeholders. First is overviewed the existing DG applications and then, a list of DG application stakeholders is revealed.

7.4.1 Identifying stakeholders from the existing disc golf applications

Here is presented what stakeholders were identified from the three most used DG applications.

UDisc stakeholders

In the UDisc app, stakeholders can be identified from the settings view. The following list contains stakeholders and reasons why they appear in the application.

- PDGA: The application displays the official PDGA rules for users.
- Disc golf shops: The application offers visibility and potential customers.
- Local clubs: The application includes a feature for running UDisc leagues which could be refined for the use of local clubs too.
- Disc golf places: The application offers visibility for disc golf courses and famous cities related to the sport.
- Tournament directors: The application offers the possibility to make player and competition statistics.
- User: For users, the application offers features such as scorekeeping, disc inventory, measure throws, and statistics, together with putting and approaching exercises.

Disc Golf Metrix stakeholders

In the Disc Golf Metrix app, stakeholders can be identified from the home view and main menu. The following list contains stakeholders and reasons why they appear in the application.

- User: For users, the application offers features such as scorekeeping, registration for competitions, and competition statistics. Seemingly, the application offers also paid version with e.g., player statistics.
- Tournament directors: The application offers features for managing competitions.
- Local clubs: The application offers features e.g., organizing competitions, and having a homepage for visibility.
- National associations: The application offers features e.g., organizing competitions.

Upsi Frisbeegolf stakeholders

In the Upsi Frisbeegolf app, stakeholders can be identified from the home view and main menu. The following list contains stakeholders and reasons why they appear in the application.

- User: For users, the application offers features such as scorekeeping, and an archive of played rounds, together with a social feature for finding playmates for a round. There is also a paid version of the application where users can measure throws and play different game modes.

7.4.2 List of identified disc golf application stakeholders

Different stakeholders for the DG application have been identified from the interviews, and from studying the existing applications' content and websites. For stakeholders, there are also identified entities, not only humans. It is still noted that because all the entities also include humans, also those stakeholders are acceptable to be present in this list, even the perspective is still human-centred. For example, PDGA is an entity where

is the board leading it. PDGA's board is formed of elected humans who are remarkable members of the DG community.

Table 13. Disc golf application stakeholders.

ID	Stakeholder	Description	Source of identification
1	User	A person using a disc golf application. E.g., any of DG personas.	Metrix, Udisc, Upsi
2	One-time undirect user	E.g., the player who is not registered as a user but participates in a round where some application user keeps scores with the application.	Experience in use with Metrix
3	Customer	Person or entity who buys disc golf applications. Customer can be also a user or not. E.g., junior players' parents who never play DG by themselves are a customer but not a user.	Observation in weekly competition
4	TDs	The person organizing disc golf competitions. See e.g., persona Jukka.	Metrix, OFS Facebook channel, Study II (CI1)
5	Local clubs	The local club for managing disc golf issues in a certain area or among certain people. E.g., OFS.	Metrix, OFS Facebook channel
6	National associations	National Association for managing disc golf issues in a certain country. E.g., SFL.	Metrix, SFL website
7	PDGA	The global roof organization of disc golf.	Udisc, Study II (CI1)
8	Disc golf places	E.g., public, and private courses, famous disc golf cities, such as Charlotte in North Carolina, Austin in Texas, and Jyväskylä in Finland.	Udisc, Metrix
9	Disc golf shops	Shops selling disc golf equipment.	Udisc
10	Disc golf experts	Person or entity who e.g., presents, teaches, or analyses disc golf content. E.g., coaches, and YouTube channels.	YouTube, Facebook
11	Application provider	The entity, such as a company or organization providing the application. E.g., Disc Golf Metrix, and Udisc. Also, the provider's stakeholders, such as shareholders, and investors are part of application provider stakeholders in this context.	Disc golf applications

Table 13 presents the compaction of the identified stakeholders from the existing DG applications, together with the stakeholders identified in this study. Table 13 also states from which DG application a certain stakeholder was identified. There are also e.g., stakeholder candidates such as DG players' or DG events' sponsors, and policymakers of local councils who make decisions concerning e.g., DG courses. These candidates are excluded from the list because they are not directly related to DG applications.

7.4.3 Value propositions for disc golf application stakeholders

Service dominant logic advises considering which kind of value each DG stakeholder could gain through cooperation with DG application. Then, when understanding the stakeholder's real needs and expectations, a value proposal can be targeted to match this certain stakeholder. There are several ways to consider and map the values but here is

simply asked what could be important for each stakeholder. For example, for users, what could be the important issue why to select this application among others? In the user's case, Table 14 answers: *becoming a better player*, is important to the user. Correspondingly, local clubs are offered *knowledge about the club's members*, and DG experts are offered a way to *have more followers*. Following this same pattern, Table 14 presents examples of proposed values for each DG application stakeholder.

Table 14. The examples of value propositions for disc golf application stakeholders.

ID	Stakeholder	Value proposition	Description
1	User	Becoming better player	Ease-to-use, functional DG application for scorekeeping, statistics, and maps/map updates support application users becoming better players. Also, the application should offer an advanced UX.
2	One-time undirect user	Being part of the group	Players can participate in the round without having an account in the application.
3	Customer	Supporting children in having an outdoor hobby	The mother can buy/register in the DG application for her child because she wants to support outdoor hobbies.
4	TDs	Mastering DG events	TD can enjoy planning, organizing, and implementing DG events with an ease-of-use, functional DG application/SW with all the necessary features. Note. TDs are linked with local clubs and national associations.
5	Local clubs	Knowledge about the club's members	Clubs can follow their members, have statistics about them, and even use applications for member registration and annual billing.
6	National associations	Knowledge about licensed players	Associations can follow their licensed players, have statistics about them, and even use applications for member registration and annual billing.
7	PDGA	DG Education	PDGA can implement DG education through application in the form of rules and manners. Also, visibility can make more players interested in PDGA activities.
8	Disc golf places	Visibility	Disc golf courses can attract more players. Also, famous DG cities/areas can attract more tourists.
9	Disc golf shops	Offering a better customer experience	DG shops can make more sales by offering new ways to buy discs and making long-term customers by offering a better customer experience.
10	Disc golf experts	Having more followers	DG experts and their social media channels can have visibility. Thus, there will be followers.
11	Application provider	Professional pride and profitable business	The provider can be proud of the great application that offers value for several stakeholders. Also, having a profitable business is advised.

7.5 Examples of unethical acts with disc golf applications

This chapter presents a couple of ethical cases that have appeared with disc golf applications. Here is no answer to these questions but rather pointed out what kind of ethical situations are possible with disc golf competitions and when disc golf applications are used.

In late summer 2022, there were rumors and discussions in Oulu area weekly competitions that some players had fixed their competition scores a couple of days after the competition. This could improve players' ranking which is needed to participate in some advanced competitions.

On 22. April 2022 in the Facebook group Oulun frisbeekanava, an experienced tournament director announces that there are many players registered for multiple competitions on the same day. This means that some other players cannot register for the competition until the registered players cancel their double-booking registration. Players use disc golf applications for registration.

On 6. May 2023 in the Facebook group called Metrix Suomi, a user posted with evidence image that his username and his real name were used by someone else in another country. Some disc golf applications lack the identification feature.

In Study I, ID 14 states that is willing to support Finnish disc golf applications if there would be one. ID 14 does not explain the reasoning behind this statement, but it can relate to that some applications operate from low-tax countries while the owners and users are still in another country. Thus, this statement can be an ethical one, but it is also possible that it is not.

In the late May of 2023, the Facebook group Metrix Finland includes posts where is shown how some users are entering false competition scores to the Metrix system. This has caused corruption of the competition and course-based ratings and user data. In this case, a user had marked an Ace (hole-in-one) for his score in every fairway of the course. Also, this same score had been marked multiple times.

7.6 Discovered design guidelines from the empirical research

Empirical research made a practical introduction to the disc golf world together with the players and stakeholders. Empirical research included the questionnaire, contextual inquiries, and adapting HCD methods for presenting the context of use and the user requirements, creating disc golf personas, and identifying and mapping stakeholders. Also, a couple of considerations for underlining the unethical acts with disc golf applications were pointed out. Table 15 presents the main empirical findings and the design guidelines discovered during the studies. Findings are labeled with ID for later referencing. According to the empirical findings, when designing a disc golf application, these guidelines are necessary to follow.

Table 15. Suggested design guidelines discovered through empirical (E) research.

ID	Guideline	Source
E1	User-expectations: ease-to-use, functional, updates	Study I (Table 7)
E2	User needs: scorekeeping, statistics, maps/map updates, measure throws, social features	Study I (Table 8)
E3	User-wish: Everything in the same app	Study I (Table 9)
E4	Players use different types of storing and sorting DG discs.	Study I (Owning and storing discs)
E5	New feature: Playbook, which is “manually” used by most players	Study I (Figures 18, 19, and 20), Study II (CI1)
E6	New feature: Drawing the actual flight route of the disc when measuring/saving the throw.	Study II (CI1), Appendix F, also Figure 21.
E7	Design should cover different stakeholders, or multiple applications are required to use.	Study II (CI1)
E8	Design so that users can be better players and spot weak spots with statistics	Study II (CI1)
E9	The application needs to work in the woods, in every weather condition	Study II (CI1)
E10	Features for advanced DG training	Study II (CI1)
E11	Notice the different preferences users have (e.g., in scorekeeping).	Study II (CI2)
E12	Ensure a high level of usability to support the player’s flow state.	Study II (CI3)
E13	Adapt DG personas.	Chapter 7.3. (Figures 23, 24, and 25)
E14	Consider all 11 identified DG application stakeholders in design.	Chapter 7.4.2. (Table 13)
E15	Propose carefully considered value for users and stakeholders.	Chapter 7.4.3. (Table 14)
E16	Avoid leaning on another application or its features but design a comprehensive one.	Study I (Table 9), Study II (CI1)
E17	Consider the ethical issues of the application usage.	Chapter 7.5.

8. The framework of human-centred guidelines for disc golf application design

This chapter presents the formation process for the framework of human-centred guidelines for disc golf application design. The HGDG framework was developed during two years of university studies, and personal research. The process is visualized in Figure 1, where design suggestions are gathered from the theoretical and empirical paths. Figure 1 also shows other outcomes the process has produced. This chapter follows the timeline, from up to down, like Figure 1, and presents the design framework models developed during the journey.

8.1 Natural flow between the user and system

The first design suggestions arose from the author's personal experiences with DG applications. Personal experiences included my own experiences but also other people's experiences from the DG practice rounds and competitions. The first design model is presented in Figure 26, and it mimics the basic interaction between the system and the user. These kinds of images are used for describing the HCI in academic textbooks.

At this phase, theoretical issues such as usability and heuristics became familiar. This was also the time when the author's first DG application was designed and developed as a pair work on the university course. The application was tested with heuristic evaluations together with small-scale user testing.

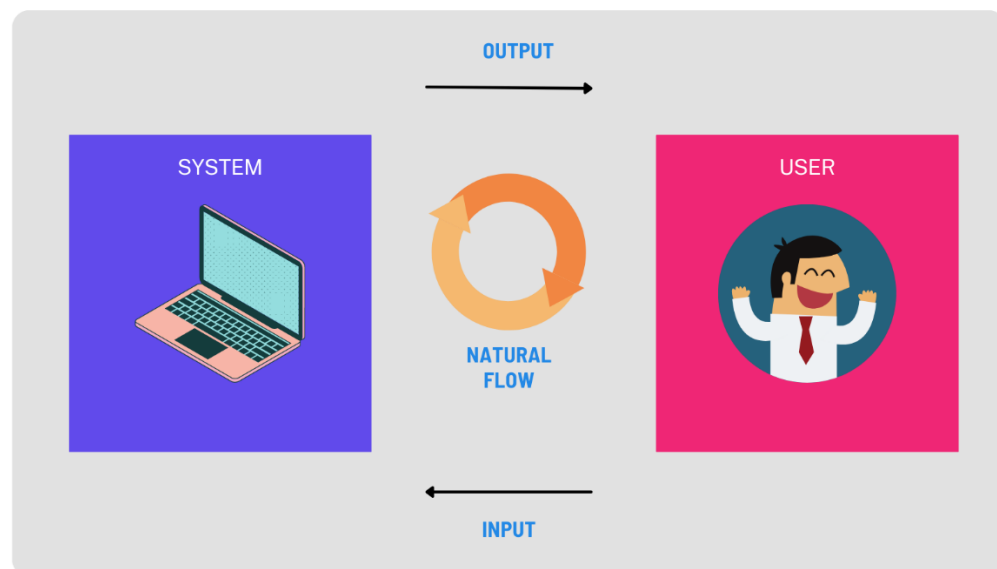


Figure 26. Model demonstrating the natural flow between the user and system (CC BY 4.0 Marko Moilanen).

The main design lesson from the first phase was to realize how fragile the natural flow is. When a user uses the application, it should not be disturbing the natural flow but support it. The natural flow between the user and the system is visualized in Figure 26. A textbook example of a ruined flow state is presented in Study II (CI3).

8.2 Setting users into the core

The second phase came with the realization that the author (and designer) is not the only one using the system. In this phase, the author was involved in a few UCD processes and implemented the first one by himself. The author's own UCD process considered the same DG application that was designed and coded in the previous phase. The second iteration of the application was named "myBag", and it involved users already in the early phase of design. There were user studies, interviews, contextual inquiries, and a questionnaire. A lot of data about DG sports and players were gathered. Also, some new features such as making a playbook were designed and tested. Users also gave design ideas, and actively participated in testing the new features in paper prototype form.

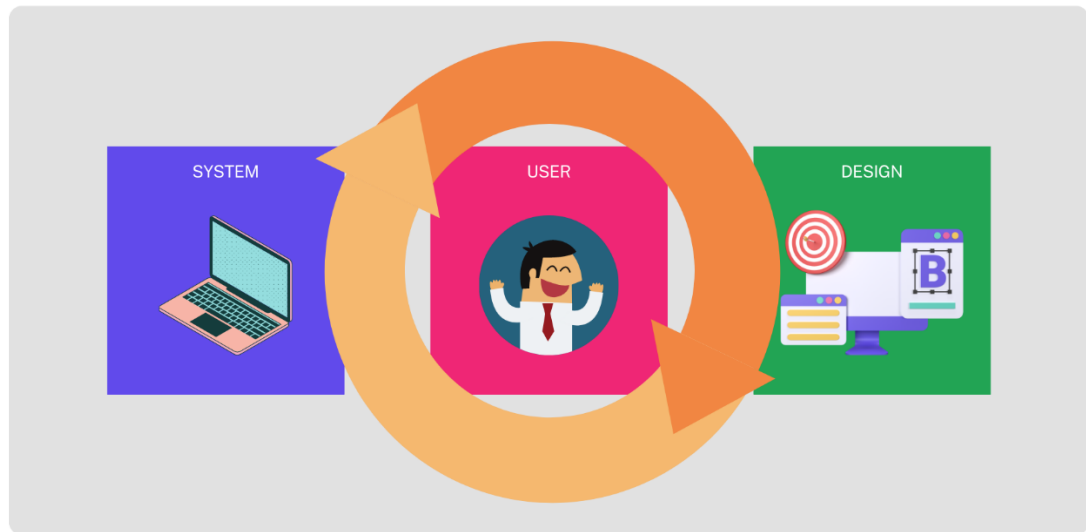


Figure 27. Model demonstrating setting users into the core of the design process (CC BY 4.0 Marko Moilanen).

By setting users into the core of the design process, usability issues of myBag were quickly on the tolerable level; thus, there was a possibility to concentrate on studying and designing UX issues too. The author practiced setting UX goals, designing a system with users for achieving those goals, and planning testing setups for ensuring those goals were met. Setting users to the core of system design is visualized in Figure 27.

8.3 Value-centered thinking

The third phase brought design suggestions, especially concerning value-based thinking. The author was introduced to SDL which the author studied and used in a course assignment. Even though the course assignment was about robot butlers, it gave the idea of using SDL also with the DG application.

From the literature, the context of design and stakeholders were met. Stakeholders were confronted also with university studies, when the author designed e.g., an innovation strategy for DG company and DG company's plan for becoming an analytical competitor. From the field practitioners such as Ideo.org, the author adopted HCD methodologies. As an outcome of phase three, the first sketch for a human-centred framework for DG application design was produced (Figure 28).

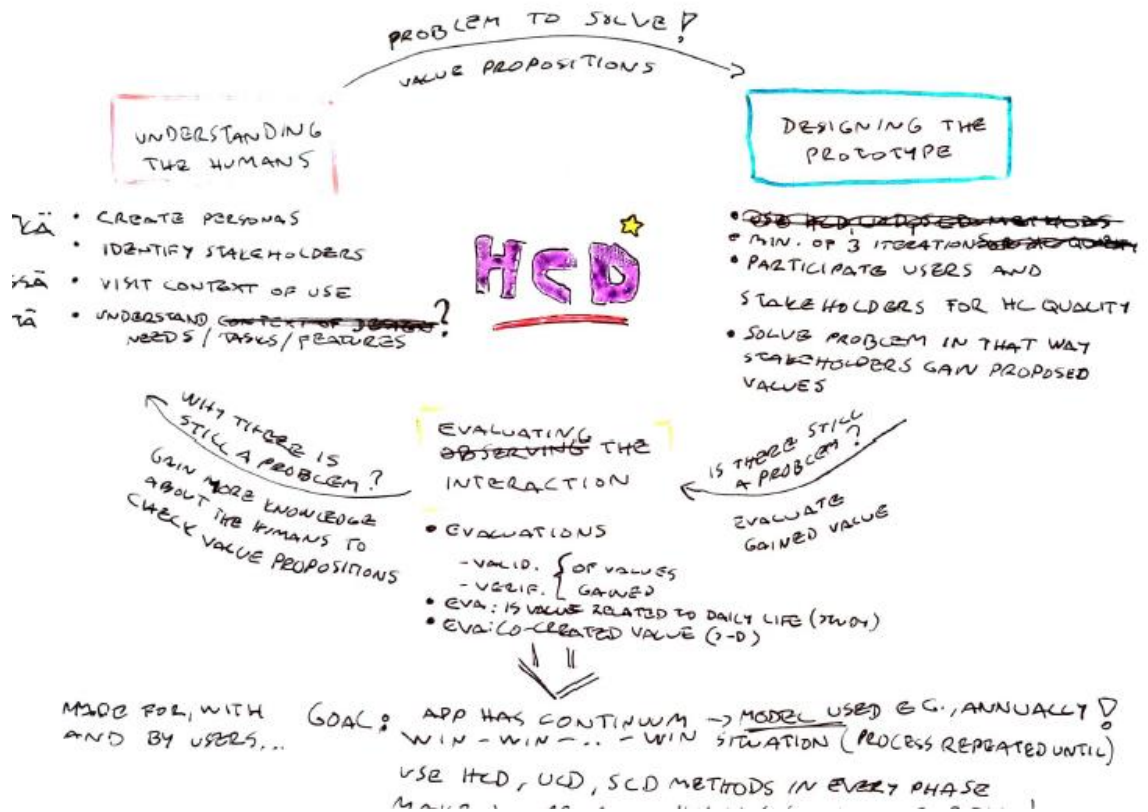


Figure 28. First sketch for HGDG framework (CC BY 4.0 Marko Moilanen).

8.4 Integrating the HGDG particles

The fourth phase of developing and collecting the design suggestions included experiences in full-scale usability testing projects. In one of these projects, the author also gained experience as a project manager in a real-life disc golf company case (Appendix D). In the literal path, existing guidelines for design were examined from the mobile health context.

After learning about evaluation and testing, the lack of context of evaluation came up. There is no definition for the context of evaluation like there is the context of design and context of use. At this point, also the view of ethics spread from the dark design to e.g., include user behavior and stakeholders. These discoveries were added to the HGDG framework while collecting all the previous discoveries under the same frame. The result is presented in Figure 29.

HGDG framework has four core assumptions:

1. HCD (including UCD, and SCD) methods are adapted in every phase during the entire process.
2. Application cannot create a natural flow of things but only follow and support it; to be in congruence with it.
3. Value proposals cannot be forced but only offered. Also, value propositions are based and targeted on humans or entities. For highlighting the HCD perspective it is advised that whenever a stakeholder is an entity, such as an organization, enterprise, or association, the responsible humans are

- identified, and value propositions are based and targeted on them. Value propositions still cannot form a contradiction with the entity's values.
4. As the context of use describes the actual conditions under which the application is used, also the context of design and context of evaluation describes the actual conditions under which the application is designed and evaluated.

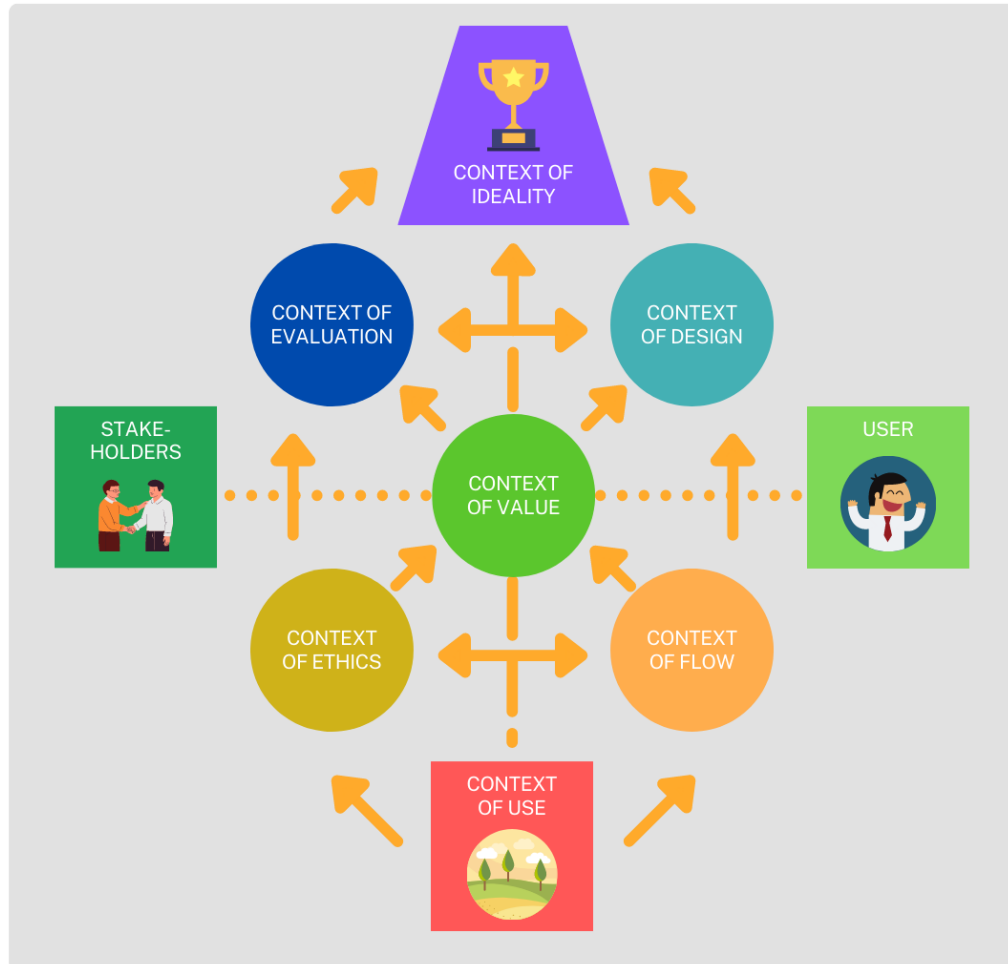


Figure 29. The HGDG Framework: the framework of human-centred guidelines for disc golf application design (CC BY 4.0 Marko Moilanen).

The HGDG framework is advised to be read from the below to the top, following the dashed line (without dots). There are two types of humans involving the frame, users, and other stakeholders. Because of their crucial role concerning the application, users are separated from the stakeholders to be their section. The dashed dot line still unites users to be part of stakeholders. The dashed dot line is also movable so that users and stakeholders are already in the context of use and move upwards to the context of value and the context of ideality. Altogether, users and other stakeholders are present in every context of the HGDG framework.

In the below part, the context of use describes the actual real-life conditions under which a DG application is used. Context of use includes dimensions of physical context, social context, cultural context, organizational context, technical context, psychological context, and temporal context.

The arrows guide different paths that process flow can follow, and the process is iterative in nature. The idea is that everything influences everything else. For example,

natural flow exists in users who have their way of doing things and are looking for a flow state while playing DG. Also, different stakeholders have their business and process flow, and designers make the best design in the creative flow state. Also, evaluators can make system/application evaluations in the flow state. Another example is that design has an impact on natural flow; it can compromise it or let it flow. Also, applications can be designed to propose value to users and stakeholders, and design can be in cooperation with evaluation or fighting against it.

Above the context of use, the framework presents the context of natural flow and the context of ethics. As described above, the application should support the user and other stakeholders being in the flow state without disturbs. Concerning ethics, the application should not harm users or any stakeholders. The application should also not allow users to conduct unethical acts, such as manipulating the data. Also, the ethical maturity of the designer and evaluator is advised to be checked in their contexts.

The next level of the framework presents the context of value. Concerning the value proposals, the application should offer carefully considered value propositions to each stakeholder involved. Values present the reasons why different parties should be in cooperation with others. If the offered value is acceptable, the reason for cooperation exists.

The upper part of the frame presents two remarkable contexts in DG application design; contexts of how the actual design and evaluation are implemented. As arrows demonstrate, design should also notice evaluation and vice versa. Both should also consider users and stakeholders, together with value proposals and natural flow, and the actual context of use.

The framework condenses to the context of ideality with win-win-...-win situations where all involved parties gain the proposed value without too much compromising their natural flow. Refining value proposals, design, and evaluation are advised to proceed until the win-win-...-win situation is met. In the win-win-...-win situation, the HGDG framework is temporarily finished – this is the ultimate goal. Still, after the win-win-...-win situation, the HGDG framework is advised to be checked annually because of the continuously changing nature of the business, markets, user demands, and stakeholders.

The relationship between the existing UCD process models, such as the one by Witteman et al. (2015) displayed in Figure 5, is that the lower half of the HGDG framework is associated with the understanding of the user part and upper half with design and evaluation/observation. Therefore, the HGDG framework is in congruence with the existing UCD process model but is more descriptive because of identified new contexts.

8.5 Design guidelines behind the HGDG framework

Behind the HGDG framework can be identified 15 human-centred guidelines which can be used for disc golf application design. These guidelines are partly based on the existing literature and the other hand, on the empirical findings of this thesis. References for adapting the found guidelines from the literature review (L) and empirical research (E) are addressed in the guideline descriptions below. For literature review and empirical research guideline descriptions, see Table 5 and Table 15. After

the guidelines, Figure 30 displays the connection between each guideline with the HGDG framework sections.

These 15 human-centred design guidelines are also a reminder that not every business should be based on a zero-sum game but looking for mutual interests. Consequently, the ideal win-win-...-win situation can be considered and aimed already when designing a new application.

1. Identify and visit the context of use

When visiting the actual context of use, there is no need to guess but observe. Attention should be paid to the different hues of context, such as physical, technical, social, cultural, organizational, psychological, temporal, etc. (Adapting e.g., E1, E9)

2. Create personas

According to the HCD guidelines, users are placed at the center of the design process. Thus, users are required to be known so well that made personas match reality as accurately as possible. Personas are advised to be described in the persona cards. (Adapting e.g., L4, E13, E15)

3. Identify stakeholders

For knowing everyone involved in the process, all the stakeholders should be identified and mapped. It is advised to prepare similar cards from the stakeholders than from personas. (Adapting e.g., L5, L8, E7, E14-15)

4. Ensure that the application fulfills users' and stakeholders' expectations, needs, and wishes

At the core of HCD and UCD are the users' expectations, needs, and wishes. Therefore, the application design is mandatory to be based on those. Also, when the stakeholders are added to the frame, their expectations, needs, and wishes are compulsory to be considered. (Adapting e.g., E1-3, E5-6, E8, E10, E12, E16, L1-2)

5. Be in congruence with the natural flow

Without the app, there are some natural flows of how stakeholders operate, and DG players learn to play and develop themselves to be better players. Flow states are also present when designers design the application in the creative flow state and when evaluators evaluate the application. Nevertheless, most importantly, the designed application is required to be in congruence with the DG players' flow state when they practice and compete. For example, if the DG application has issues such as described in CI3, the player loses his focus on the task and must consider the app's features and views rather than the clear goal of e.g., having a birdie on the hole. (Adapting e.g., L1-2, L9, E12)

6. Check the ethical background

When checking the ethical background, it is advised to go through every party involved in the application design project, one by one. First, for ensuring a sustainable design, check that the context of use is not harmed. Then, check that the application does not cause any harm from the use to users. Also, ensure that users cannot use the application in an unethical way. Check also if the stakeholders and

the application provider match with the ethical quality requirements. Also, consider the designers and evaluators for implementing honest work. (Adapting e.g., L3, L11, E17)

7. Prepare and offer value propositions to each stakeholder

Prepare with careful examination the value proposals to users and each stakeholder. Value proposals can be added to the persona and stakeholder cards. Then, offer the discovered value to users and stakeholders. (Adapting e.g., E14-15)

8. Identify the context of design and ensure it supports HCD

Identify the context of design, together with the designers and their characteristics. Ensure that the context of design is based on HCD methodologies, such as making personas, scenarios, and use cases, together with participating users and stakeholders in the actual design. (Adapting e.g., L4-5, L8, E4-6, E10-11)

9. Have more than three iterative design cycles

When designing under the HCD protocol, every design cycle/iteration includes all process phases, such as further studying the context of use, designing new prototypes, and evaluating those with real end-users. This phase also includes checking if the natural flow is not compromised, and value propositions are interesting enough. (Adapting e.g., L3)

10. Design the application to have a mesmerizing first impression and reliable continuum

The application should notice the special dimensions, such as first time of use, and continuum of usage over time. Aesthetics should be emphasized when the first impression is concerned. Regarding the continuum, it is suggested to have updates every month at a minimum. In the case of an existing app, see the previous update date. (Adapting e.g., L6-7)

11. Identify the context of evaluation and ensure it supports HCD

Identify the context of evaluation, together with the evaluators and their characteristics. Have at least two heuristic evaluations already in the early phase. Ensure that the context of evaluation is based on HCD methodologies, such as user testing, expert user testing, and usability testing. Cooperate with the designers so that the application is also evaluated by the expert designer (who is not the actual designer). (Adapting e.g., L3-5, L10)

12. Evaluate if the users and stakeholders gain the proposed value

Keep the proposed value as a meter and evaluate if the proposed value is gained by the user and stakeholder. Do not mix the values between different parties because everyone is interested in only the value that was originally proposed to them. It is also advised to validate the value by asking if it was the right value that was proposed. For verification can be asked if the value is gained appropriately. If the proposed value cannot pass validation or verification, refine, or replace the proposed value. (Adapting e.g., L3)

13. Ensure that the application provider has suitable business

Reviewing the application provider's business is sort of a reality check. For validation, confirm that the application provider makes or is supposed to make a profitable business. For example, see the provider's business plan and strategies. For verification, see if the business is based on HCD methodologies and valuing usability and UX, etc. (Adapting e.g., L3)

14. Evaluate the HCD quality

From an objective perspective, evaluate when usability achieves a tolerable level. From a subjective perspective, evaluate when there are enough options for users for having advanced UX. Also, consider the variety of users (and stakeholders) by designing a high level of accessibility. Ensure also that application is not affecting any harm to users or stakeholders. (For usability adapting e.g., E1, E9, E12, and for UX adapting e.g., L1-2, E4, E11)

15. Design for the co-created value greater than the value each stakeholder can create by themselves

When the application is designed in such a way that users and each stakeholder achieve greater value by being in cooperation than they can create by themselves, there is no reason to leave the party. The situation looks like the Nash equilibrium where there are no moves left to have a better result with the chosen strategy. This situation is win-win-...-win in nature, everyone involved wins by gaining the proposed value. (Adapting e.g., L3, L5, E7, E14-15)

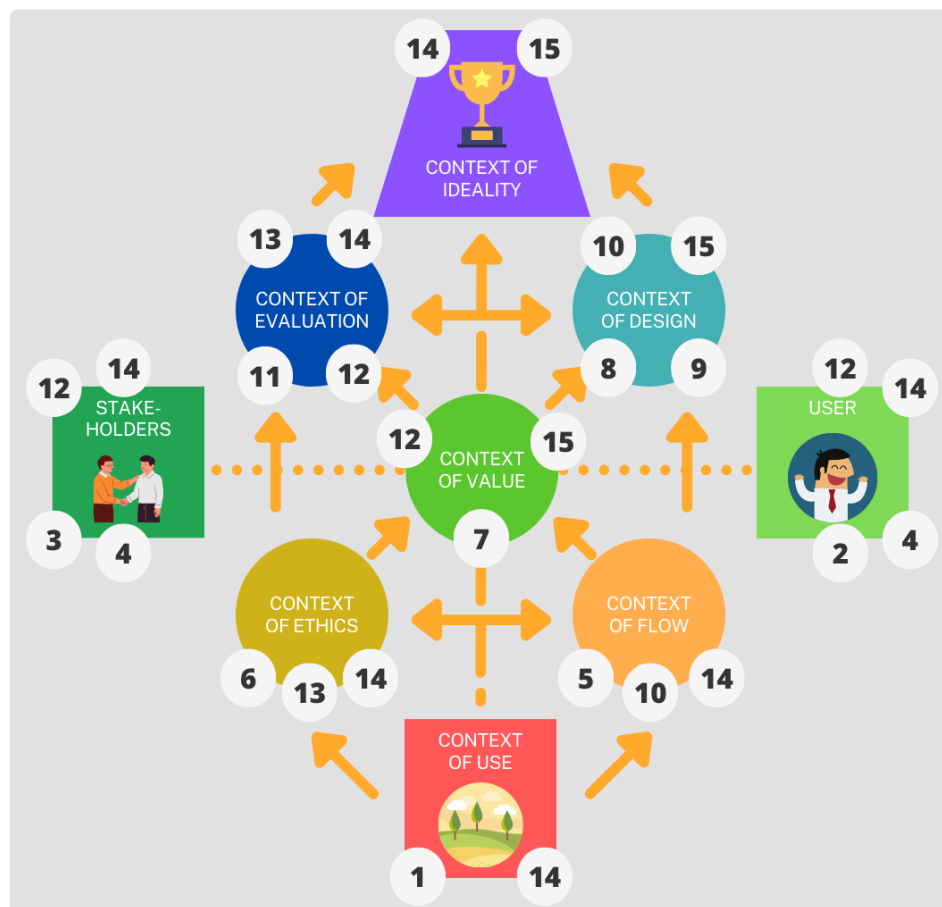


Figure 30. The 15 design guidelines related to the HGDG framework sections (CC BY 4.0 Marko Moilanen).

8.6 The design guidelines as an evaluation tool

The 15 design guidelines presented above can also be used as a measurement and evaluation tool if the application project is human-centred and in congruence with the HGDG framework. When using guidelines as an evaluation tool, the guidelines are transformed into the question form. The evaluation tool is presented in Appendix H.

When conducting the evaluation, the focus is kept on having positive answers to the evaluation questions. There are three options for each question: I) Yes, II) Partially, and III) No. The 'No' answer simply means that this issue is ignored in the project. A 'Yes' answer means that this issue is comprehensively considered in the project. A 'Partially' answer means that the issue is taken into account but not comprehensively. For example, when asking about creating personas, if those were not created, the answer is 'no'. If one or a couple of personas were created, the answer is 'partially', and when all the intended users are mapped and personas are created on that basis, the answer is 'yes'.

If some of the questions have a negative answer, the HGDG framework encourages asking why there is this gap/problem. To understand the root of the existing gap/problem, it is mandatory to gain more knowledge about the humans involved, check the natural flow, and refine the value propositions. This means another round with the framework. In some cases, the recommended changes can be quite huge; even changes in organizational structure, business models, or a need to recruit new employees or hire a field expert.

The ideal condition is that the project receives nothing but yes answers from the evaluation. The ideal condition ensures that the project under evaluation understands and acts according to the HGDG framework.

9. Findings and discussion

This chapter discusses the literature review and empirical research findings for answering the research questions. The chapter also considers the limitations of this study and presents the main implications, after which future research is advised.

9.1 Answers to the research questions

RQ1: What kind of framework there is behind the human-centred design process when also all the stakeholders in the disc golf context are considered?

Answers to the first research question came from literature and empirical findings. Behind the human-centred design process when also all the stakeholders are considered is the HGDG framework (see Figure 29). The HGDG framework describes and explains the journey from the context of use to the context of ideality where an ideal win-win-...-win condition is met. Then users and each stakeholder gain appropriate value when participating in the holistic application design process.

In the HGDG framework, the context of use describes the actual environment where the application is used by real end-users. There are several dimensions involved, such as psychological, social, cultural, organizational, physical, temporal, and technical. Some dimensions are more related to users and some to stakeholders.

The HGDG framework notices all the stakeholders involved in the application design process. Users are also stakeholders, but because of their special status, they are separated into their sections. Users and stakeholders are advised to study with the HCD methods, and e.g., forming personas and stakeholder cards are mandatory.

Without the DG application, there is the context of flow describing how stakeholders operate in their businesses and other processes, and how users play and evolve in DG - naturally. The HGDG framework suggests that application design should not interrupt the natural flow but rather model and reflect it. In practice, this means that users and stakeholders have their expectations, needs, and wishes, and application design should be in congruence with the majority of those. For example, when the DG application supports players' will to be familiar with the statistics of their game, it is in congruence with the natural flow that the players will keep using the application.

For ensuring the ethical durability of the application design project, the HGDG framework guides checking the ethical status of each party involved in the project. Whenever possible, the application is advised to design in such a way that no unethical acts are possible to conduct. Also, checking the background of each stakeholder together with the design and evaluation team is advised.

Especially literature and assignments concerning SDL opened the context of value, and value proposals in the HGDG framework. Concerning users, different personas should be prepared, and value propositions should be targeted to them. Also, concerning stakeholders, each stakeholder should be considered separately, and value propositions should be targeted in this same way. For value proposition examples, see Table 14.

The context of design was identified from the literature but also self-reflected by the author during the personal DG application design process. In the HGDC framework, the context of design means the actual environment and conditions under which the design work happens. Users and stakeholders, together with the evaluators should be visiting and actively participating in the design process as HCD methodologies guide.

The context of evaluation was identified from the empirical cases where a team, including the author, implemented full-scale usability testing projects. In the HGDC framework, the context of evaluation includes all various forms of testing, such as getting feedback from users and stakeholders, heuristic evaluations, user tests, and usability testing. The context of evaluation means the actual environment and conditions under which the evaluation work happens. Users and stakeholders, together with the designers should be visiting and actively participating in the evaluation process as HCD methodologies guide.

The reason for separating design and evaluation contexts is based on that designers should not evaluate their work. There are also possible contradictions when designers are not necessarily believing the results and suggestions given by the evaluators and rational data.

The HGDC framework is used in an iterative way, where users and stakeholders are participated in considering the contexts of use, flow, value, design, and evaluation until an ideal win-win-...-win situation is formed. This is the endpoint of the framework. Here users and stakeholders are not too much compromising the natural flow, and everyone gains the proposed values. However, because of the changing nature of e.g., user needs, business, and markets HGDC framework is advised to be checked annually.

RQ2: What guidelines should be followed when designing disc golf applications from the human-centred perspective?

From the literature review, 11 design guidelines were discovered (Table 5). Also, from the empirical research, such as the questionnaire and contextual inquiries, 17 guidelines were discovered (Table 15). These 28 guidelines were partly overlapping or even identical. However, next, all these guidelines were considered and matched with the HGDC framework, and as a result, 15 human-centred design guidelines (including and adapting these 28 guidelines) were identified. These guidelines are presented in Chapter 8.5 but here opened with more detailed suggestions.

When identifying and visiting the context of use, attention should be given to that application is easy to use, functional, and updated regularly. Also ensuring that the application can be used in the woods and every weather condition, even in the wintertime in Finland.

When creating the DG application, getting familiar with the DG personas (Figures 23, 24, and 25) and all 11 identified stakeholders (Table 13) is mandatory. Being familiar with everyone involved also helps to prepare and offer suitable value propositions for each stakeholder (see examples from Table 14) and user persona.

For being in congruence with the natural flow, a designed DG application is suggested to ensure that the application fulfills users' and stakeholders' expectations, needs, and wishes. As far as users are concerned, the DG application should have features for scorekeeping, statistics, maps, map updates, measuring throws, and social features, such as adding friends, sharing scores, etc. Users also wish to use only one DG application,

so the application should be comprehensive. Users also want to have new, advanced features, such as keeping a playbook, and drawing the disc's flight route when measuring the throw. Also, advanced training features are asked for. Users also expect usability to be at a high level, and UX to be smooth, so the application supports their flow state and offers enough motivation and challenge when becoming better and healthier versions of themselves. However, not any advanced feature or design solution is advised to compromise the ethical design and protocols. For example, avoiding dark design principles and designing for sustainable applications are highly recommended.

As far as the contexts of design and evaluation are concerned, those need to prefer HCD methods. Without participating users matching DG personas and different stakeholders, the successful design might not happen. Concerning design, notice e.g., that players have different sorting and storing preferences for their discs. Players also have different habits for scorekeeping. For ensuring a successful design, more than three iterations are suggested.

DG application is suggested to pay attention to the special dimensions; to implement the mesmerizing first impression and the reliable continuum. The application should convince users to continue using the application also after it is used for the first time. This is suggested to do in aesthetically and with tolerable usability. The application is also expected to have a continuous flow of updates, at least once a month. This gives a reliable image of the application provider and sends the message to the users that they are heard.

Another guideline suggests a reality check concerning the application provider's business and whether it is suitable and supporting HCD methodologies, such as valuing usability, UX, and higher ethical standards. Notably, the application provider's own business, strategy, organizational culture, or people in charge can form the barriers to successful DG application design.

When evaluating DG application design, and especially in users' cases, evaluation is suggested to be based on HCD quality criteria. From an objective perspective, usability must be at a tolerable level. From the user's subjective perspective, enough options should be offered for having advanced UX. Also, designing high-level accessibility and following ethical practices already from the early phase, will better the odds of great design results.

When evaluating the DG application from a holistic perspective, it is suggested to consider if users and stakeholders gain the proposed value or not. If everyone involved gains the promised value, there is no reason why any party involved would end the existing cooperation. Also, the best-case scenario is when the co-created value is higher than the value each stakeholder can create by themselves. This ideal win-win-...-win condition is the ultimate evaluation criteria for a successful DG application.

9.2 Limitations of the study

Three major limitations in this thesis could be addressed in future research. First, this thesis is conducted by a single author. The author has spent a lot of time on the field discussing and observing, but on the other hand, because of the author's close relationship with disc golf, it is reasonable to consider if the objective perspective has been compromised. Also with the sole author, triangulation might be an issue. Nevertheless, there have been selected two different data gathering techniques, the

quantitative questionnaire, and qualitative interviews with observation. Also, to validate the presented HGDG framework, objective evaluation from the other researchers is needed.

The second limitation of this thesis concerns the transferability of empirical findings. The questionnaire was implemented in a Facebook group where most participants are living in the Oulu area. Also, contextual inquiries were conducted in the Oulu area. For ensuring transferability, future research could implement similar questionnaires and contextual inquiries on the scale of the whole of Finland and other top DG countries in Europe, and states in the USA.

The third limitation is the lack of previous research. Even though the research gap has produced a possibility for new research, it is still also a limiting factor because there were no existing empirical research or guiding design frameworks. It is highly suggested that future research tries to fulfill this research gap.

9.3 Implications for research

The thesis includes a literature survey contribution that gathers articles concerning HCD, UCD, and SCD. Even though the survey did not find specifically DG-related research, mobile health-related research together with this thesis is suggested to adapt until the research gap in DG, golf, and sports application design theory and methods are covered. In the survey, 11 design guidelines for DG application design were identified. The literature survey also presents the current state of DG in numbers.

As a theoretical contribution, the thesis presents a descriptive HGDG framework, which can be utilized in the HCD process especially when there are several stakeholders involved in the design and development process. Another theoretical contribution is identifying the concept called the context of evaluation.

The idea of adapting SDL in SW development, and especially with HCD, UCD, and SCD processes with application design is a methodological contribution the thesis makes. Adapting SDL also provides a new metric for evaluating design results from the perspective of the gained value for everyone involved. After the HGDG framework, the thesis presented 15 guidelines for DG application design. These guidelines are also a methodological contribution, and those can be used as a metric for evaluating if the design process reaches an ideal win-win-...-win condition or not.

The thesis includes empirical findings, such as basic information about DG application users and used DG applications, users' expectations, needs, and wishes, and their habits for owning, storing, and throwing discs. The thesis also discovered new features for DG applications: making a playbook and drawing a throw line when measuring the throw. Empirical findings also include 17 design guidelines for DG application design.

9.4 Implications for practitioners

For practitioners, this thesis includes a literature review of HCD, UCD, and SCD theory and methodologies. The thesis also demonstrates the usage of HCD, UCD, and SCD tools, such as identifying the context of use, and user requirements, creating personas, and identifying stakeholders. From the application design perspective, the study

demonstrates how to develop a DG application in such a way that users will more likely accept it.

Practitioners are also advised to get familiar with the SDL and the HGDG frameworks in their design process. By these means, practitioners are suggested to aim for a comprehensive design process.

The thesis also includes straightforward instructions on how to design new or develop existing DG applications. These instructions include e.g., users' expectations, needs, and wishes, together with feature demands, and new features. A total of 11 design guidelines are presented from the literature and 17 guidelines from the empirical research. These guidelines are integrated into 15 design guidelines that help follow the HDGD framework. Practitioners are also advised to use the HGDG Evaluation Tool (Appendix H).

9.5 Organizational, and societal level implications

For DG organizations, such as local clubs and national associations, the thesis presents general knowledge of DG and the current state of DG applications. The thesis woos for players, local clubs, national associations, and the PDGA organization for accelerating the public discussions for demanding and implementing better disc golf applications where all the stakeholders are considered and valued.

The thesis also presents referenceable knowledge that can be used when presenting DG ideas and issues to the local councils and communities. This type of knowledge is needed e.g., when new DG course projects are funded, designed, and implemented.

9.6 Future research

This thesis included a couple of interesting topics and results that could be further studied. First, new studies are needed to cover the identified research gap concerning DG, golf, and sport application design and design guidelines. Mobile health context research is far ahead of these contexts. Especially, empirical research from both qualitative and quantitative perspectives is needed.

Another suggestion for future research is to confirm or deny the empirical results of this study. This means similar studies for confirming the existing results, and studies with different data sources, such as forums from Southern Finland, from other European countries, and the USA. Wider data sources would increase the credibility of the results.

The context of design and identified context of evaluation are suggested to study further. As there are user characteristics, there could be identified designer and evaluator characteristics. Furthermore, the UX could be expanded from the users to consider if there are designer experience (DX) and evaluator experience (EX). Human-centred design or quality should not be limited to users only but to every human involved in the design and development process. Concerning the EX there could be identified objective and subjective qualities of evaluation, as there are concerning the design (see Figure 4).

Concerning the newly discovered DG application feature 'making playbook' it is suggested to study this feature further. There was a contradiction between the feature's priority status 'low', yet 27 % of players said that they would use this feature in the DG

application. The contradiction might exist because this was the first time when players considered this new feature for the DG application, and they were not aware of it when answering questions concerning expectations, needs, and wishes for the DG application.

Another relevant suggestion for future research is to evaluate and validate the HGDG framework. The presented framework needs objective evaluation done by other researchers. For evaluation could be adapted e.g., the quality model for heuristic evaluation by Bader et al. (2017). Also, the relation between the HGDG framework and other frameworks and evaluation tools could be studied. Tentatively it seems that using the HGDG framework, and its 15 design guidelines would also make a perfect score (11) in the UCD-11 test provided by Witteman et al. (2021), as far as health professionals are replaced by DG professionals. Also, for gaining empirical results about the HGDG framework, case studies are suggested to implement. Long-term future research could explore if the HGDG framework could be generalized into human-centred guidelines (HG) framework that could be adapted to design processes in general, not just DG or application contexts.

10. Conclusion

The thesis conducted a study for identifying and defining human-centred guidelines for disc golf application design. The research problem considered DG application design; what kind of framework there is behind disc golf application design when a human-centred perspective is taken, and all the stakeholders are noticed. Also, the concrete design guidelines were searched.

To answer research questions, theoretical and empirical research was implemented. Theoretical research was conducted by literary review of existing DG application design guidelines and HCD, UCD, and SCD methodologies in general. A research gap was identified as far as DG, golf, and sports application design were concerned. Therefore, the review was expanded to include also mobile health context together with field practitioners. Adaptable guidelines were identified in this way. The literature review also examined DG as a sport and in numbers, together with the current DG applications.

Empirical research adopted HCD methods by studying users' expectations, needs, and wishes in the means of the questionnaire, contextual inquiries, and interviews. Also, the context of use was visited and identified, user requirements were studied, DG personas were created, and stakeholders were mapped. Value propositions adapted from SDL were prepared for users and stakeholders.

Adapting the design guidelines from the literature and empirical findings, the HG DG framework was presented as the first main finding of this thesis. HG DG framework can be used for DG application design and ensuring the usage of the HCD approach. The second main finding of this thesis, 15 guidelines, and instructions for DG application design reinforce the HG DG framework. Guidelines can also be used as a metric for evaluating if the designed application achieves an ideal win-win-...-win condition between of application provider, users, and other stakeholders.

The HG DG framework, and design guidelines relating to it, are important because of the existing research gap and increasingly popular sport genre, DG. DG community, together with the global organization is looking for research to gain new DG courses and funding from the local communities and councils. This thesis also contributes to field practitioners by demonstrating the usage of HCD methods in application design.

For better validation of the HG DG framework and suggested guidelines, further testing is recommended in the form of case studies and real DG application design and development projects. Also, objective evaluations done by other researchers are suggested.

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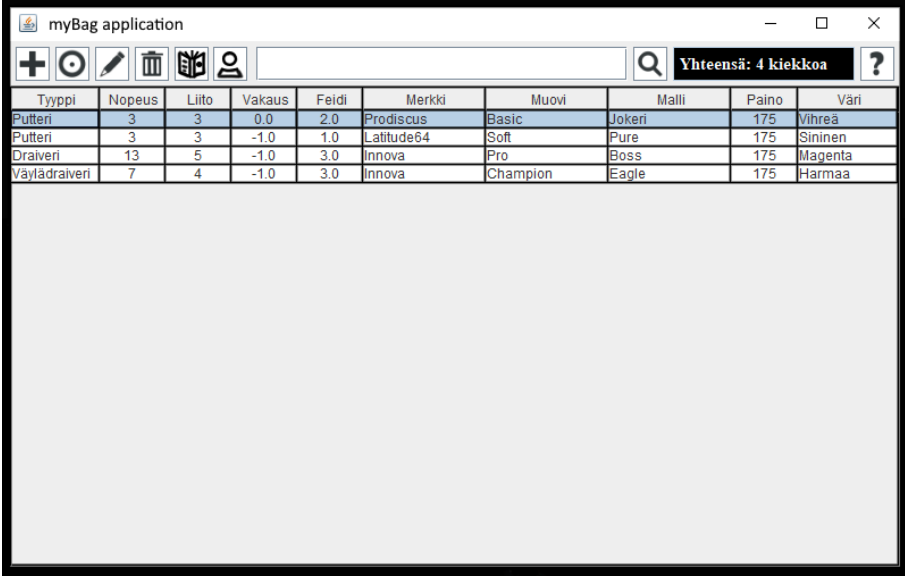
Appendix A. myBag

The myBag, a standalone disc golf application for Windows is an output from a couple of university courses at the University of Oulu. In the course Programming 4 (Ohjelmointi 4) in 2022, the author co-designed and -created software called Frisbeegolfkiekkokatalogi (DG catalogue). DG catalogue is a simple software for managing your personal disc golf discs. After the course, the author developed software by himself and named it as myBag. The myBag was then counter-developed in the User Experience (UX) Design and Management course in the summer of 2022 for having advanced features:

- Draw fairways,
- Draw and save throws,
- Make a playbook,
- Manage profile, and
- Gamification elements: collect prizes, manage tasks, etc.

The design and development process followed the user-centred design (UCD) process; with participating users from the first phase of design till the final evaluations of the application and paper prototypes. The advanced features were left to the form of the paper prototypes, without the actual coding. Nevertheless, myBag application with the basic features works for Windows as a standalone software.

Relating to this thesis, designing, and developing myBag have brought experience for design, participating users, heuristic evaluations, user testing, agile working methods, UCD and human-centred design, etc. The following figures display some of the design sketches together with the actual myBag application.



The screenshot shows the main view of the myBag application. At the top, there is a toolbar with icons for adding (+), deleting (trash), and editing (pencil). A search bar contains the text "Yhteensä: 4 kiekkoa" and a help icon (?). Below the toolbar is a table with the following data:

Tyyppi	Nopeus	Liito	Vakaus	Feidi	Merkki	Muovi	Malli	Paino	Väri
Putteri	3	3	0.0	2.0	Prodiscus	Basic	Jokeri	175	Vihreä
Putteri	3	3	-1.0	1.0	Latitude64	Soft	Pure	175	Sininen
Draiveri	13	5	-1.0	3.0	Innova	Pro	Boss	175	Magenta
Väylädraiveri	7	4	-1.0	3.0	Innova	Champion	Eagle	175	Harmaa

Figure A1. The myBag application's main view with the designed icons for the playbook and profile (CC BY 4.0 Marko Moilanen).

Figure A1 presents the main view of the myBag application. Here user can manage his disc golf discs. Two developed design suggestion icons are visible: a book icon for making a playbook, and a person icon for having a profile.



Figure A2. A design sketch for Profile view in myBag application (CC BY 4.0 Marko Moilanen).

Figure A2 displays the Profile view where the user can add his name, rating status, and the professional disc golf association number. Here are also visible the gained user experience and collection of Aces (hole-in-one in disc golf). In the myBag application, Aces are trophies that open video lessons and other additional materials.

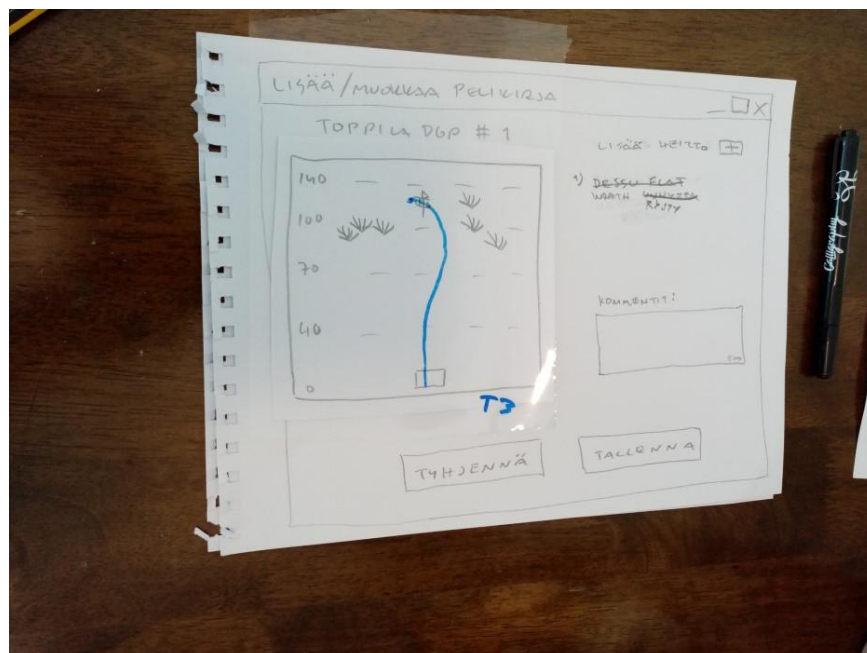


Figure A3. Capture from the paper prototyping session with the intended user adding his playbook for Toppila Disc Golf Park's first fairway (CC BY 4.0 Marko Moilanen).

The paper prototyping session was arranged with the real intended users who tested and gave feedback on making a playbook feature. Capture from the prototyping session is presented in Figure A3 where a user is adding his playbook for a fairway.

Appendix B. Innovation strategy document

On the course Digitalization and Innovation 2022 at the University of Oulu, the author prepared the course assignment Stepping into the Shoes of the Chief Innovation Strategist of Disc Golf Metrix. According to the assignment, the task was to create an innovation strategy for the chosen company; the author selected Disc Golf Metrix.

The course assignment included an introduction to Disc Golf Metrix company, together with an analysis of its current situation in the market. Although Metrix has developed a zero-to-one innovation, an information system for tournament directors for managing disc golf events, the company still seems to have problems with innovative solutions. Metrix application lacks even crucial updates.

In the next phase of the assignment, the innovation goals were formed. The author suggested that Metrix could adopt the digital innovation process (discover, develop, deliver, and exploit) to be their new status quo. Another practical objective was suggested; Metrix could develop its business model for regular end-users for having a better user experience. This might make Metrix's business more profitable while currently, almost 100 % of users use the free version of the system.

The actual innovation strategy part of the assignment was based on the journey from the current situation with no innovation or even updates to the target state with the flow of incremental innovations and readiness for zero-to-one innovations. The methods for gaining competitive advantage were considered, and e.g., customer excitement, user-centred design, and user participation were on the table. Also, aiming for competitive leadership in Europe with lean development and partnering were suggested. For fixing the poor software for regular disc golf players, partnering with the Upsi application was considered as an option.

The main idea for implementing the innovation strategy was the suggestion of adapting the digital innovation process, adapting the studies by Kahn (2018) together with Kohli and Melville (2019). After a detailed description of the digital innovation process, the author conducted a critical evaluation concerning it. The digital innovation strategy could be unsuccessful because of internal resistance to change, lack of money, misinterpreting the users, ignoring relevant KPIs, and dismissing the ecosystem.

This assignment relates to the thesis because of choosing the case company to be Disc Golf Metrix. The assignment forced the author to approach the company from several perspectives. The assignment also expanded the design view for considering business and organizational structure and culture and how those can influence design work.

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Appendix C. Plan for Becoming an analytical competitor

In the course *Creating Domain Value with Data 2023* at the University of Oulu, the author prepared a course assignment *Becoming an analytical competitor – the Powergrip story*. According to the assignment, the task was to create a plan for an existing company for becoming an analytical competitor. The author selected Powergrip company, the European leader in selling disc golf equipment online.

The assignment included studying Powergrip and making an introduction to it. Hiring a new CIO was considered a solution for taking Powergrip to the next level. The plan was divided into two sections: short-term changes and a long-term journey to an analytical competitor. The short-term plan included topics, such as adapting the fact-based decision-making and management style and developing the Powergrip webshop with analytics tools, such as personalized revenue management. Also, a new approach for selling online disc golf courses was introduced. The idea was to utilize some existing disc golf application data concerning the user's pain points in disc golf and offer courses on that basis. For example, users with poor putting statistics would be offered the putting course.

The long-term plan for becoming an analytical competitor included identifying the current situation and defining the phases from this point to the analytical competitor phase. The long-term plan adapted the road map with five stages for becoming an analytical competitor that was presented in the lectures. Also, for evaluating the progress, the DELTA model was adapted, which was also presented in the lectures. The plan included e.g., developing a new algorithm that helps disc golf players choose the right disc golf disc for them. This problem exists in the real world. Next, implementing the cultural and organizational changes was suggested. Finally, for becoming an analytical competitor, Powergrip is advised to adopt new technologies for big data and machine learning, develop a better information system for managing cross-organization data and conflicting information sources, and refine the company strategy for integrating analytics with it.

This assignment relates to the thesis because of the chosen disc golf web shop company Powergrip. The assignment guided the author to study disc golf companies and especially spot some weak points for improvement. This task also gave an idea for asking Powergrip to be a case company for another university course where companies were searched for usability testing cooperation.

Appendix D. Usability and user experience testing

In the course User Experience (UX) and Usability Evaluation 2023 at the University of Oulu, the author worked in a team conducting the usability testing plan, testing, and report. As considered in an earlier course, the author contacted Powergrip company and offered the possibility to have full-scale usability testing. Powergrip agreed to participate in the course as a case company. The author worked as a project manager in this case.

The usability testing process included tasks for describing the system, forming usability testing goals, and selecting the test methods. Also, the test persons were identified and selected. Our team defined test scenarios and test tasks with a post-questionnaire. Two heuristic evaluations were conducted before the testing process. The author conducted a heuristic evaluation with Shneiderman's Eight Golden Rules (adapting Shneiderman et al., 2016). The planning phase ended with pilot testing sessions with the real end-users.

The execution of usability testing included eight sessions with documentation, such as interviews, questionnaires, observation, and open feedback. Next, all the gathered data was analyzed and interpreted. Then, usability findings and recommendations were presented in the usability testing report, in the seminar, and to the client (Powergrip). Altogether, our team discovered several usability and user experience issues and prepared some design suggestions for completing the documented results. Afterward, already some of our suggestions are implemented on the Powergrip webshop (Powergrip, n.d.).

This assignment relates to the thesis because of the chosen disc golf web shop company Powergrip but also because of the gained practical experience from the testing and evaluation process; being an expert evaluator. Also, the final moments when preparing usability recommendations gave the author the possibility to work as a designer, preparing a couple of design sketches.

References:

Powergrip. (n.d.). *The Powergrip webshop*. <https://powergrip.fi/>

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Appendix E. Literature review

In the course Advanced Topics in Digital Cultures and Design 2023 at the University of Oulu, the author conducted a literature review concerning disc golf application design from the human-centred perspective. This literature review was also the first iteration of the literature review of this thesis.

Before conducting the literature review, the course traveled through advanced topics in digital cultures and design. For example, topics such as human-centred design (HCD), user-centred design (UCD), digital cultures, user-generated content, and context of design were faced.

According to the course agenda, students wrote an article review every week for five weeks. Writing academic article reviews gave the author a necessary routine for generating academic text; a highly needed skill when writing the thesis.

The course gave the author a possibility to study and research the topic which also refined to be a remarkable part of this thesis. Therefore, the course essay assignment was straight associated with the thesis's literature review; it was the first literature step forward. Another link for the thesis was the course topics, such as HCD and UCD, together with the digital cultures and user-generated content. The author deeply considered how those issues are related to the disc golf culture. From the course topics, also e.g., the context of design was adopted to be a remarkable part of the thesis's human-centred guidelines for disc golf application design (HGDDG) framework.

Appendix F. Design proposal prepared with a professional disc golf player

If a disc golf (DG) player would use some DG application for making playbooks, one would need to somehow save the actual flight routes of the discs. Those flight routes are required inputs when the playbook is prepared. In Study II session CI1, an expert user suggested using the measuring throw tool and then modifying the throw line. We prepared Figure F1 below for demonstrating the suggestion. Figure F1 utilizes the UDisc application as the foundation and adds a simple line with division spots. Line with division spots is a familiar concept from the image-handling software.

On the left is the regular UDisc view for measuring throws. The next screen on the right demonstrates added line. The next section demonstrates a normal flat or unhyzer line and the most right one demonstrates the regular hyzer line. Two screens on the left are made so that the user has drawn the new line shape by moving black dots with his finger.

The expert user and author were satisfied with the design sketch and are quite trustful that this idea will take place in DG applications shortly.

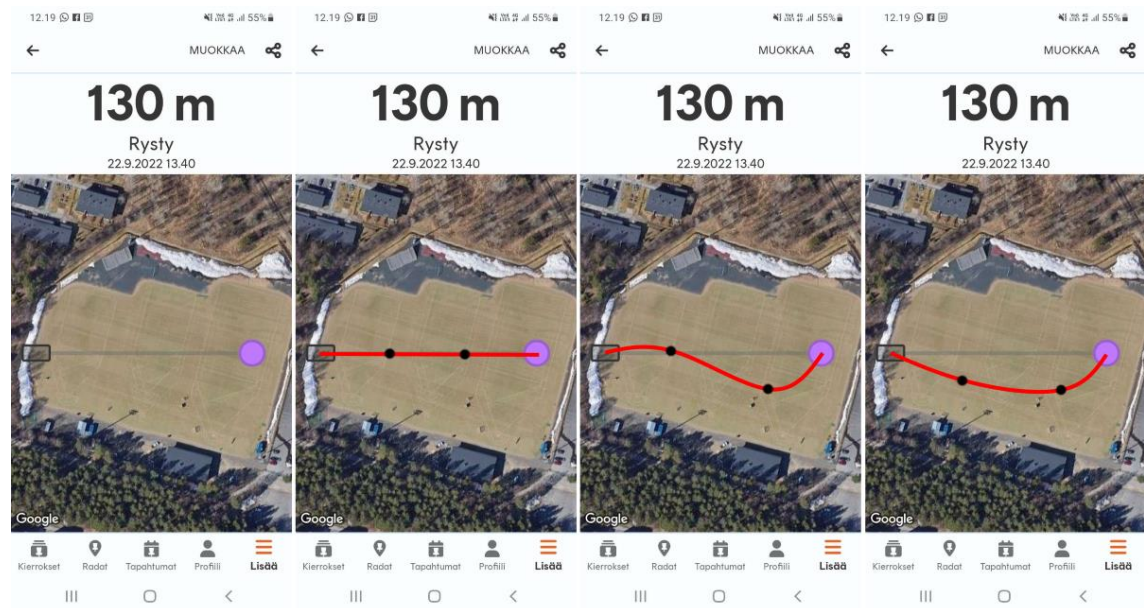


Figure F1. Design Proposal: Introducing a new feature in the disc golf application for saving disc throws along with their flight routes (CC BY 4.0 Marko Moilanen).

Appendix G. Questionnaire

Here are presented the questions that were asked in the Study I questionnaire. The questions are firstly presented in Finnish as those were in the questionnaire. Then, English translations are provided.

Kyselyn kysymykset suomeksi

Peruskysymykset:

- Minkä ikäinen olet?
- Mitä sukupuolta edustat?
- Mikä on suhteesi frisbeegolfiin?
- Kuinka usein käyt pelaamassa?

Kysymykset liittyen frisbeegolf sovelluksiin:

- Käytätkö mitään frisbeegolf sovellusta? Jos käytät, niin mitä ja miksi?
- Mitä odotuksia sinulla on frisbeegolf sovelluksia kohtaan?
- Mitä toimintoja uuden frisbeegolf sovelluksen tulisi mielestäsi sisältää?
- Oletko kaivannut jotain tiettyä toimintoa nykyisissä sovelluksissa?
- Osaatko eritellä omia tarpeitasi ja toiveitasi uuteen frisbeegolf sovellukseen liittyen?

Kysymykset kiekkojen säilyttämiseen liittyen:

- Tiedätkö, kuinka monta frisbeegolf kiekkoa sinulla on? Ja jos tiedät, niin kerro, ja jos et tiedä, niin arvaa. Kirjoita: "Tiedän: 12" tai "Arvaan: 27"
- Missä ja miten säilytät kiekkojasi?
- Onko kiekkoillasi jokin tietty järjestys?

Kysymykset pelaamiseen ja pelaamisen suunnitteluun (pelikirjaan) liittyen:

- Kun heität kiekkoa radalla, lentääkö se kiekkovalmistajan kuvaamalla tavalla?
- Suunnitteletko koskaan etukäteen, miten aiot pelata, eli esimerkiksi millä kiekolla aiot avata minkäkin väylän?
- Kun olet uuden väylän tiillä ja on sinun heittovuorosi, miten valitset sen kiekon, jolla suoritat avausheiton?
- Valitsetko avausheittoihisi useimmiten oikean kiekon? (esimerkiksi kiekko lentää 10-rinkiin, tai sinne mihin halusit sen lentävän)
- Olisko tulos voinut olla parempi jollain toisella kiekolla?
- Tiedätkö mitä tarkoittaa termi "pelikirja"?
- Oletko koskaan laatinut itsellesi pelikirjaa? Ja jos olet, niin miten teit sen?
- Käyttäisitkö sovellusta pelikirjan suunnittelua varten?
- Osaatko yhtään arvata, miten sovelluksen avulla voisi suunnitella pelikirjaa?
- Millaisia piirtotyökaluja olet tottunut käyttämään eri sovelluksissa? Mitä piirtosovelluksia osaat käyttää?

Translated questionnaire questions in English

Basic questions:

- How old are you?
- What is your gender?
- What is your status in disc golf? (Hobbyist, amateur, or pro)
- How often do you play?

Questions about the usage of disc golf applications:

- Are you using any disc golf applications? And if you are, which one and why do you use it?
- What kind of expectations do you have toward new disc golf-related software?
- What kind of functions new disc golf-related applications should include?
- Have you missed some functions in the programs you have used?
- Can you describe your needs and wishes in more detail?

Questions about maintaining discs:

- Do you know how many discs you have? And if you do, tell the amount, and if you are not sure, please estimate/guess. Write: "I know: 12" or "I guess: 27".
- Where do you keep your discs?
- How are they arranged?

Questions about playing and planning the game:

- Do your discs fly following the flight routes that are described by disc manufacturers?
- Do you ever plan how you are going to play the course?
- How do you choose which disc to throw when you start the fairway?
- Do you usually choose the right disc? (Throw it into a 10 m circle)
- If you would have chosen a different disc, would you have better result?
- Do you know what the playbook is?
- Have you ever made a playbook by yourself? If have, how did you do that?
- Would you use software for planning the playbook for the course?
- Do you have any ideas for how this could happen?
- What kind of drawing tools have you used in applications? Which drawing software have you used?

Appendix H. HGDG Evaluation Tool

Design guidelines of the HGDG framework (CC BY 4.0 Marko Moilanen).

DESIGN GUIDELINES OF THE HGDG FRAMEWORK

Evaluation Title :
Date and time :
Evaluator :

Please rate how much you agree with the following questions.

	Yes	Partially	No	Note
1. Was the context of use identified and visited?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	_____
2. Were personas created?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	_____
3. Were stakeholders identified?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	_____
4. Does the application fulfill stakeholders' and users' expectations, needs, and wishes?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	_____
5. Is the process in congruence with the natural flow?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	_____
6. Was the ethical background checked?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	_____
7. Were value propositions to each stakeholder prepared and offered?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	_____
8. Was the context of design identified and supporting HCD?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	_____
9. Was the design process iterative with more than 3 cycles?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	_____
10. Has the application been designed to have a mesmerizing first impression and reliable continuum?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	_____
11. Was the context of evaluation identified and supporting HCD?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	_____
12. Do users and stakeholders gain the proposed value?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	_____
13. Does the application provider have a suitable business?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	_____
14. Is the HCD quality evaluated?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	_____
15. Is the co-created value greater than the value of each stakeholder can create by themselves?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	_____