

# **Human-Centered Design Principles in Healthcare Technology Mobile Applications**

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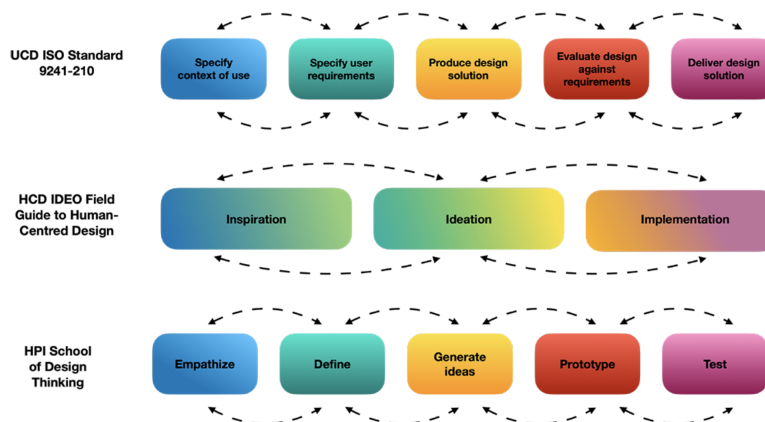
# I. Introduction

In recent years, the healthcare industry has witnessed a significant increase in the use of mobile applications. These digital tools have the potential to revolutionize the delivery of healthcare services and increase patient engagement. However, the success of mHealth (mobile health) applications depends on their design principles and how well the user experience aligns with target users' needs, wants, and limitations. This paper serves to examine the rising importance of human-centered design principles in mHealth applications and provides various examples of how these principles can be applied in practice. Furthermore, this paper critically analyzes the current state of user interface and user experience design in healthcare technology applications and proposes potential areas for future research.

# II. Background

Human-centered design is a problem-solving technique that places target users at the center of the design and development cycle for different products or services. During each phase of the cycle, the goal is to ensure that the solution addresses the users' needs, desires, and pain points.

Currently, there are three main standards or models of human-centered design approaches: the UCD ISO Standard 9241-210 model, the HCD IDEO Field Guide to human-centered design model, and the HPI School of Design and Thinking model (Göttgens et al., 2021). All three approaches incorporate the cycle of understanding customers, designing a solution, and implementing the design.



According to the Journal of Medical Internet Research, for all models of human-centered design approaches, the international standard outlines the following principles (Velsen et al., 2022):

1. The design is based upon explicit understanding of users, tasks, and environments.
2. Users are involved throughout design and development.
3. The design is driven and refined by user-centered evaluation.
4. The process is iterative.
5. The design addresses the whole user experience.
6. The design team includes multidisciplinary skills and perspectives.

In the healthcare technology industry, the approach of human-centered design entails considering the unique requirements of individual patients, healthcare providers, and other stakeholders. By incorporating different user-centric design principles, developers can create healthcare technologies that are more likely to be adopted and valued by their target users. The health technology industry is rapidly evolving with a growing number of mobile healthcare applications ranging from mental health support platforms to medication tracking services. Based on studies from Fortune Business Insights, the global mHealth market size was at \$34.28 billion in 2018 and is projected to grow to \$293.29 billion by 2026 with a CAGR of 29.1% during the forecast period. However, the successful development of these products is dependent upon the mobile application's usability, accessibility, and effectiveness. According to the marketing advisor of LinkedIn, user experience has emerged as a crucial brand differentiator in 2020, surpassing traditional factors such as price and product (Beevers, 2018). This statement holds particularly true within healthcare technology, an industry that caters to a significant proportion of users who may have disabilities or are older and may not be as proficient with technology. Thus, it is crucial for healthcare technology companies to design their applications with human-centered design principles in mind to enhance user experience and ensure that the application aligns with the specific goals of healthcare providers and patients.

### III. Human-Centered Design Principles

There are numerous human-centered design principles that can be applied to new and existing mHealth applications to enhance overall user experience.

1. **Usability:** The application should be easy to use and navigate, with a clear and intuitive interface.
2. **Accessibility:** The application should be usable by individuals with a wide range of abilities and disabilities, including those with visual, auditory, or motor impairments.

3. **Personalization:** The application should be capable of adapting to the individual needs and preferences of a user.
4. **Engagement:** The application should be designed to foster a sense of engagement and empowerment in a user.
5. **Privacy and security:** The application should be designed to protect the privacy and security of a user's personal information.

One principle of human-centered design is usability. The term usability refers to the ease with which a user can learn, operate, and understand a product or system. In the context of healthcare technology, usability includes factors such as the layout, navigation, application functionality, and its ability to meet user needs of healthcare providers and patients. According to a study published in the *Journal of Medical Internet Research*, “usability is a key determinant of the success of mHealth apps and should be considered at every stage of app development” (Kreps et al., 2015). To elaborate, usability testing should be conducted during the development process to gather feedback from potential users as well after the product release of the application to continuously evaluate the app. Another study by the *Journal of Medical Systems* found that “usability evaluation is an important aspect of mobile health app development, as it can provide insights into the user experience and identify areas for improvement” (Khan et al., 2018). The study highlights the importance of involving end-users, who are healthcare providers and patients in this case, in the usability testing process to ensure that the application meets their specific needs and preferences. In summary, developers need to ensure that their mHealth application is user-friendly and meets the specific needs of healthcare providers and patients.

A second key principle of human-centered design in healthcare technology mobile applications is accessibility. Accessibility refers to how usable a product is by individuals with a wide range of abilities and disabilities, such as visual, auditory, or motor disabilities. In the context of healthcare technology, accessibility includes factors such as being able to navigate the application with keyboard commands instead of a mouse, using high-contrast colors and large font sizes that can be easily distinguished, and including alternate text for media like images and videos. According to a study published in the *Journal of Medical Internet Research*, “accessibility is a critical aspect of mHealth app development, as it allows for the inclusion of individuals with disabilities in the use of these technologies” (Kreps et al., 2015). The study explains that accessibility is of utmost importance during the design and development process to ensure that the application is usable by individuals with a wide range of abilities and disabilities. However, a study published in *JMIR mHealth and uHealth* discovered that “only a small number of mHealth apps, though, have been specifically designed for people with disabilities, and an even smaller number of apps have undergone accessibility evaluation with people with disabilities” (Zhou et al., 2020). The study also highlights specific methods of actively involving individuals with disabilities in the usability testing process that developers can practice, such as “collecting feedback from people with disabilities and introducing customizable accessibility

features” (Zhou et al., 2020). It is essential for developers to build accessibility into their design to ensure that their mobile health application is usable by a wide range of individuals.

Another critical aspect of human-centered design in healthcare technology mobile applications is personalization. The term personalization refers to how well the application can adapt to a user’s own individual needs and preferences. In the context of healthcare technology, personalization includes factors such as the ability to customize the application’s layout, the ability to set reminders and notifications, and the ability to save specific data the user is interested in. According to a study published in the *Journal of Medical Internet Research*, “Personalization is a key feature of mHealth apps, as it allows for the tailoring of the app to the specific needs and preferences of the individual user” (Chen et al., 2016). The study highlights how personalization can improve the usability of the application because it will increase user-acceptance with personalized content or features. One benefit of personalization, as described in a study published in *Procedia Computer Science*, mentions that “the personalisation of the user experience may be particularly important to maintain the patient engaged with the application towards a long-term use to take full advantage of the application’s features” (Madeira et al., 2018). If developers consider personalization during the design and development process, it will ensure that their application is specifically tailored to healthcare providers and patients.

Yet another key principle of human centered design in healthcare technology mobile applications is engagement. It refers to how well the application can foster a sense of engagement and empowerment in the user. Empowerment can come from users having the ability to provide feedback, the ability to track progress, and the ability to provide educational content. According to a study published in the *Journal of Medical Internet Research*, “Engagement is a critical aspect of mHealth app development, as it promotes active involvement of the user in their own healthcare” (Lin et al., 2017). The study further explains that patients prefer to be involved in the decision-making process, so it would be beneficial for mobile health apps to be more transparent about physician-patient communication. Additionally, a study published in the *Journal of Medical Systems* discovered that “engagement is an important aspect of mobile health app development, as it promotes active participation of the user in their own healthcare and encourages adherence to treatment” (Wang et al., 2019). By allowing the user to increase their involvement in their own healthcare, that engagement can improve their interest in their own health and following their prescribed treatment plans. Evidently, it is essential to consider engagement during the design and development process in order to ensure that the application promotes active involvement in patients.

The final human-centered design principle that is important to discuss is privacy and security. Privacy and security is defined in this context as how well the application can protect the privacy and security of the user's personal health information. There are many ways a developer can increase the privacy and security of their app, such as data encryption, secure login, asking for credentials before viewing health records, or network security measures. A study published in

the Journal of Medical Systems revealed that “privacy and security are important considerations in the design of mobile health apps, as they protect the sensitive personal and health information of the user” (Zhang et al., 2019). The study highlights the importance of involving healthcare providers in the development process because of their expertise with how to comply with HIPAA regulations, as well as unique privacy challenges in the healthcare setting. It is essential to consider privacy and security during the design and development process of mobile health apps more so than when developing other apps because of the sensitive nature of users’ personal health information. Developers must tread carefully to design a privacy and security system for their application in order to protect user data and ensure compliance with healthcare regulations such as HIPAA.

## IV. Examples of Current Healthcare Mobile Applications

The popularity of numerous existing healthcare mobile applications relies on their usage of aforementioned human-centered design principles. The most notable applications are Teladoc, Medisafe, 7 Cups, Pillboxie, and MyFitnessPal.

1. **Teladoc:** With over 54 million members, Teladoc is a leading healthcare mobile application that facilitates virtual consultations between patients and licensed healthcare providers for non-emergency medical conditions. The application incorporates several different human-centered design principles in its design, with a focus on personalization. Specifically, Teladoc allows patients to select their preferred healthcare provider and schedule virtual consultations at their own time, catering to users’ individual preferences and needs. Additionally, the application’s design fosters engagement by providing an accessible and streamlined means of communication with healthcare providers, as well as the ability to track consultations. Moreover, Teladoc prioritizes usability through its user-friendly interface and accessibility options for individuals with different abilities and disabilities.
2. **Medisafe:** Medisafe is a personalized medication management application with over four million users. The application provides reminders to take medication, tracks medication history, and allows for refill notifications. Usability and personalization are key design principles incorporated in the application to lead to its success. Medisafe is designed with an intuitive and simple interface, making it easy for users to navigate and track their medications, improving the user experience and increasing the likelihood of consistent use. Furthermore, the application includes personalization features, such as allowing the customization of reminders and messages, to cater to the different needs and preferences of individual users. An update in 2018 allowed users to customize not only the content, but also the tone of messages.

3. **7 Cups:** 7 Cups is an online platform that connects over a million users each month with trained “listeners” for counseling and therapy. The key design principles used in 7 Cups’ mobile application to increase user engagement and retainment are accessibility, personalization, and privacy. According to 7 Cups’ Accessibility Statement, the application is monitored and tested regularly by AudioEye, a third-party provider of Web Accessibility testing and monitoring, to ensure an excellent user experience regardless of any assistive technologies users may need. This allows for a wider range of users to access the application and receive support. Additionally, 7 Cups employs personalization by allowing users to choose the specific type of mental support they need, catering to individual needs and preferences. Finally, 7 Cups prioritizes privacy and security concerns by keeping users anonymous. Listeners only know what is disclosed to them by the person they are helping, and contact information is kept strictly confidential.
4. **Pillboxie:** Pillboxie is a mobile application that reminds patients to take their medications with a gamified visual interface to improve overall patient compliance. The application incorporates engagement, usability, and personalization as some of its main design principles. Pillboxie’s graphics enhance patient engagement by allowing users to access and stock a virtual pillbox to visualize the amount of medication they need to take. This design also increases usability as it reduces the amount of complicated text that users need to read in order to understand their medication needs and progress. In addition, Pillboxie allows patients to personalize their virtual pillboxes to their specific medication needs. Users can customize the colors, shapes, and types of medication they wish to place in their virtual medication cabinet.
5. **MyFitnessPal:** MyFitnessPal is a fitness and weight loss application with over a million members every year. The key design principles that aided MyFitnessPal in reaching its success are personalization, engagement, and usability. The application provides customized recommendations for dieting and exercise based on an individual’s goals and fitness level, allowing them to achieve their fitness goals more efficiently compared to a generic plan. Moreover, the application promotes engagement by providing visual representation of the user’s progress, encouraging the user to continue their fitness journey. Finally, MyFitnessPal’s design focuses on usability by reducing unnecessary text and highlighting different food groups with prominent colors. These features allow users to easily track their daily nutritional intake and their workout progress.

## V. Critical Analysis and Future Research

The integration of mobile technology in healthcare has presented numerous new opportunities for providing patients with convenient and accessible healthcare services. However, despite the various examples of successful human-centered healthcare mobile applications, there is still room for further improvement. A study by the Journal of Medical Internet Research suggests that



there are numerous limitations of human-centered design in healthcare technology (Velsen et al., 2022).

First, human-centered design often results in sampling bias. This approach generally relies on a small sample size due to the nature of user research and testing. In a case study that aimed to design a product allowing senior adults to stay independently at home for longer periods of time, user research methods such as inviting intended users to a demonstration home caused recruitment bias in terms of gender, level of mobility, and interest in technology (Haslwanter et al., 2016). This recruitment bias paired with the difficulty of finding target users who are physically capable or willing to participate in a healthcare technology study furthers the issue of finding enough participants for user research. Consequently, certain groups are underrepresented while other groups are overrepresented, leading to sampling bias in human-centered design.

In addition to sampling bias, the participants themselves may also bring their own biases and limitations to the research. Human-centered design prioritizes the needs, wants, and pain points of targeted users, and these areas are all shaped by their past experiences. Users may come into the study with their own assumptions and attitudes. Heavily relying on these results may cause healthcare mobile applications to adapt to the needs of an even smaller population.

Another major limitation of human-centered design is its risk of supporting the status quo (Velsen et al., 2022). Conducting user research to understand target users for new mobile applications generally begins before the design and development process of a new product. While user testing is continued throughout the design process, key functions are established at the beginning to save companies time and resources. However, when developing innovative and disruptive mHealth products, questions posed to target users will naturally be hypothetical. Thus, responses will likely be limited by the users' ability to envision such concepts. As a result, fully relying on human-centered design in mHealth applications can restrict creativity and innovation.

Finally, exclusive reliance on human-centered design for the design and development of applications creates the risk of overlooking ethical and societal considerations. Focusing on the needs and wants of individual users at the micro-level may cause companies to miss out on broader implications of their products. With the power of today's technology in the healthcare industry, mHealth applications have the potential to truly revolutionize the field. Thus, human-centered design may limit companies in the bigger picture.

There are a number of areas for future research that can help address the limitations of human-centered design. One key area in addressing selection bias is by exploring more inclusive user testing methods, such as providing sign language interpreters, utilizing read-aloud technology, conducting research over shorter sessions spread out over multiple days, or accommodating transportation needs (Rios et al., 2016). Another important area is ensuring that

ethical and societal considerations are taken into account throughout the design process. This aspect can be achieved with the implementation of more-than-human design practices, which takes into account the needs of not only target humans, but also the environment, non-human animals, and future generations (Camocini & Vergani, 2022).

## **VI. Conclusion**

As the healthcare technology industry continues to expand, it is crucial for designers and developers to understand how using human-centered design can shape consumer experience, and in turn, their products' impact. Numerous principles in human-centered design have contributed to the growth and continued success of existing mHealth applications. We have presented several mHealth applications which have applied notable use of human-centered design principles in their design. However, it is also critical that healthcare technology companies recognize the limitations and areas for improvement in human-centered design. By improving accessibility in user research and integrating other design philosophies, companies can ensure that mHealth technology truly revolutionizes healthcare providers, patients, the healthcare technology industry, and society as a whole.

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