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USABILITY OF DIGITAL HEALTH SOLUTIONS IN DIABETES TREATMENT

An Empirical Study

Bachelor's Thesis
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Abstract

Digital health is a relatively new field of study of the crossroads of health care and technology. As populations grow older and diseases such as diabetes become more common, new inventions and improvements in digital health are needed. Many current health care solutions already depend on technology, but how well has this bridge between tech and treatment been built?

This thesis looks into the different digital services currently in use by diabetics and practitioners in Finland, as well as the perceived usability of these systems. This is done by conducting five interviews with diabetics, immediate relatives of diabetics as well as professionals of diabetes treatment. As theoretical frameworks of usability, this thesis draws from two distinguished metrics of usability to support the empirical data from interviews. This thesis aims to find connections with existing literature as well as provide additional information on the usability of existing solutions of digital health care.

Key findings of this study show that while most digital health solutions offered to Finnish diabetics today are useful and appreciated, the field of digital health still needs better solutions to maximise the impact these digital interventions can have in implementing better care.

Keywords Digital Health, Usability, Digitalization, Diabetes

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1. Introduction

This thesis looks into the Digital Health solutions that are currently in use in Finnish Diabetes treatment. By interviewing five participants, either diabetics, immediate family members of diabetics or diabetes treatment professionals and comparing their answers to existing literature on digital health as well as usability within these solutions, this thesis will attempt to see if the phenomena that is found within relevant literature can also be found within this empirical study.

As this thesis is mostly focused on digital health and looks at diabetes care more as a case study rather than studying the medical implications of this disease, the main focus on both the background and the theories utilised will be on digital health. The empirical part of this thesis focuses on the Digital Health aspect of diabetes treatment as well, rather than its medical aspects.

1.1. Definition of Digital Health

As more and more of our world is perceived and developed through digital interfaces, nearly every aspect of daily life in the 2020s is influenced by the new possibilities and challenges of digital life. Even healthcare, a relatively slowly evolving field, seems to be waking up to the digital age, and embracing a new intersection between technology and healthcare, known as digital health.

According to the World Health Organization (WHO), digital health consists of digital, mobile, and wireless technologies in support of health care. Digital technologies can improve care, identify and reduce risks, predict, prevent and help manage healthcare needs and deliver timely, efficient and safe care (Hostetter et al., 2015). In its most basic and widely used forms, digital health can mean text messages or emails between patients and healthcare practitioners. Another rapidly increasing trend in digital health monitoring patients' health through wearable tech.

Many of the current issues healthcare as a field is facing, such as allocation of scarce resources, difficulty in reaching remote areas, timely treatment monitoring,

could be eased or solved completely through better understanding and more efficient utilisation of digital solutions. Possibly partly due to its predicted role in alleviating crises within healthcare, digital health is a topic that has rapidly grown into the wide public's awareness during the 21st century. Like with all things technological, the growth in both public interest, scientific research as well as available funding has been immense (Tecco, 2016).

In the 20th century, the most significant digital health care improvements were based on the digitizing of health records and computers becoming more common. While not fully in line with the current definition of digital health, these can be seen as the first steps towards the emergence of digital health. Research was focused on the newness of computers and the internet as well as the possibilities they provided. Computer monitoring in health care has been in use and studied since the 1980's (Laxminarayan, 1984). Issues with ethics, availability and usability of health data are presented (Phillip and Katzper, 1976), which have quite striking resemblances to the challenges new health data innovations are facing today.

In the 2010's, digital health articles started to catch up with the rest of the world in terms of technological possibilities. Research from this point in time ties digital health possibilities together with other topical trends, such as blockchain and the Internet of Things (IoT). Blockchain's main principle of securing the next piece of data by linking it to the previous, poses an interesting possibility to fight against the rise of counterfeit medicine (Mettler, 2016). The Internet of Things, on the other hand, provides links between smart homes and hospitals, providing solutions for safer at-home care (Gia et al., 2015). The ability to make efficient computing powers fit into smaller and smaller gadgets for less and less money provided a launching space for the boom of wearable technologies connected to the internet that allowed self-monitoring (Swan, 2012).

In today's digital health care landscape, the most interesting questions revolve around big data, machine and deep learning as well as cyber security, alongside the blockchain and IoT- innovations. Combining big data and machine learning can help predict diseases in large populations as well as in individuals (Ravi et al, 2017). Cyber security, a very trendy topic in across many fields, is a very topical study area

within digital health as well. While providing health records on a cloud-based system means faster retrieval of critical patient information, it also subjects this very sensitive data for cyberattacks (Farzandipour et al, 2010). This was the case of a Finnish therapy provider Vastaamo, from which dozens of patient records containing names, social security numbers and therapy session memos were stolen and spread across different online platforms, ultimately causing the provider to go out of business, on top of the trauma their patients had to deal with.

1.2. Digital health in Diabetes Care

There are a multitude of reasons that make diabetes treatment such a clear example of the current issues being solved by technological advantages. As a chronic illness that places a heavy burden of self-management on the patients; is treated with a medication such as insulin that can be, when administered wrong, prove to be life-threatening; can cause medical expenses up to 2.3 times higher than non-diabetics (Huang et al, 2009) and causes significant challenges to maintain a balance in treatment (Khunti et al., 2018), it is clear to see that diabetes could be a therapeutic area that would most benefit from well-functioning technical assistance.

Currently there are many digital possibilities available for diabetics that boast significant possibilities for improved and simplified care. These digital solutions most utilised today include blood-sugar monitors and censors connected to smartphones or computers via Bluetooth or NFC-technology, insulin pumps that aim to mimic the functions of a healthy pancreas, and data management apps that collect and combine blood sugar data with other relevant info, such as activity, medication or meals. (Iyengar et al., 2016)

As with any digital system, errors and bugs are a given. Issues with connectivity as well as human errors occur with diabetes treatment devices as well, causing them to break in or before use, not transmit information or read blood sugar results wrong. When it comes to the health, medication and well-being of people with chronic illnesses like diabetes, there should not be much room for trial and error. When the stakes are as high as they are in the medical field, technical and digital solutions

need to be finetuned to their absolute best in order to be accepted into the field and into patients' lives.

1.3. Diabetes Care

As an overarching research question, this thesis will ask how digital health is impacting diabetes care. More specifically, the perceived usefulness to see if digital health practices give more in results than they take in terms of time, energy or money and how this ratio changes within different age groups. Additionally, this thesis will hopefully also find some reasons behind the differences in implementation of digital health solutions based on the patient's given age group. This thesis looks into the use and perceived utility of digital health solutions in diabetes care by asking the following questions:

> What kind of digital solutions are commonly utilised in diabetes treatment currently in Finland?
>
> Which aspects of these solutions can be attributed to the solution's perceived performance?
>
> Can these attributes be linked to existing literature and theoretical frameworks regarding Digital Health and/or Usability of Digital Solutions?

2. Literature Review

In this chapter, relevant theoretical frameworks and literature are reviewed. As this thesis is mostly focused on digital health and looks at diabetes care more as a case study rather than studying the medical implications of this disease, the main focus on both the theories utilised as well as the empirical study will be on digital health.

2.1. Diabetes Care

Diabetes is a collective name for several diseases, all of which are characterized by high blood sugar. Types of diabetes include type 1 diabetes (T1D), type 2 diabetes (T2D), gestational diabetes, LADA and MODY diabetes, and diabetes due to other causes. Within the scope of this thesis, all these are considered as one unified disease. It is estimated that more than 500,000 Finns already suffer from diabetes. The number of people suffering from type 2 diabetes in Finland, as well as globally, has grown rapidly in the early 2000s. This can be due to genetics, or globally changing dietary and exercise habits in recent decades, both of which can predispose to diabetes. Type 1 diabetes is also predicted to become more common if the current trend continues. (Hyöty and Virtanen, 2004.)

The lack of or resistance to insulin means that when untreated, diabetic people cannot properly utilise the glucose that enters their body. Essentially, insulin produced in the pancreas is the key that allows sugar to enter cells from blood. Without insulin, the sugar from ingested food does not enter the cells in the body, but instead stays in the bloodstream. This leads to high blood glucose levels, also known as hyperglycaemia. Hyperglycaemia can cause a multitude of symptoms, ranging from thirst and headaches to cardiovascular problems and ketoacidosis. Ketoacidosis is a state where the body turns to breaking down fat as fuel, when the sugar in the bloodstream is not delivered to the cells to be utilised, due to lack of insulin. Using fat as fuel leads to acids building up in the bloodstream, that can cause severe consequences, even death, when untreated.

In order to avoid hyperglycaemia, diabetics can either medicate with daily dosages of insulin (all T1D patients, sometimes T2D patients as well) or with other

medications that help with lowering blood sugar levels (T2D). Insulin and other medications help lower blood sugar levels by increasing the blood sugar intake into cells, that then turn the sugar into energy that cells need to function.

This blood sugar lowering medication can, however, cause dangerously low blood sugar levels or hypoglycaemia. Hypoglycaemia can make the patient hungry, tired and even cause unconsciousness. If a hypoglycaemic episode is not treated, the loss of energy to the brain cells, that would normally be provided by glucose, can eventually lead to a coma.

Both hypo- and hyperglycaemia are dangerous states for the body and diabetes treatment is a constant balancing effort between these two states. Taking too much or too little insulin, approximating the amount of ingested carbohydrates wrong, or virtually any shift or human error in the patient's daily life can cause severe consequences. (Ilanne-Parikka et al., 2019)

When not in control, diabetes can cause a multitude of other health problems, including heart disease, chronic kidney disease and nerve damage. Timely and effective care is key in managing current issues as well as preventing new complications. However, it is approximated that 60% of adults with T2D globally do not have their blood sugar within desired limits (Khunti et al., 2018).

The issue is made even more evident by studies showcasing the challenges of diabetes care, which is usually done multiple times a day and is heavily reliant on the patients themselves. This daily burden of self-management weakens patients' ability to follow through with intended treatment (Funnell and Anderson, 2004). Patients often do not properly document their self-management, making it difficult for patients and their healthcare providers to identify and correct problems (Debong et al., 2019). In addition, geographical challenges that can affect any given health condition, are prevalent in diabetes care as well, making it more difficult for patients and providers to reach each other.

2.2. Usability of Digital Solutions

There are many different metrics and theoretical frameworks presented to better understand and improve usability in different contexts. For this thesis, two of these are considered; the ISO (the International Organization for Standardization) standard ISO9241-11 model on Ergonomics of human-system interaction, and Jacob Nielsen's (1993) usability attributes.

Both these frameworks are a part of a relatively new paradigm of software development known as human-centered design. While in the past systems have been designed with a technology first, user second- mindset, which has left the user into a more compromising position. Intuitively, this sort of method does not fare well with the deeply human-centered field of health care. Therefore, this paradigm shift into more humane and human-centered design is a very necessary step in ensuring human oriented care. Additionally, human-centered design has been linked to minimising its users' cognitive load (Oviatt, 2006).

Cognitive load means the stress and pressure a user feels when navigating a system, meaning lessening the load leaves the user less mentally burdened. Both models aim to direct digital solutions into a state that does not cause its user any unnecessary cognitive load. The easier and simpler a system is to use, the less of a load the system places on its user and the more pleased the user can be expected to be with the system. (Oviatt, 2006)

Not to be confused with utility, which looks into the system's ability to do what is needed of it, usability looks into issues where the system technically provides what is needed from it, but in reality, issues within the system doesn't allow for achieving goals as wished. In these cases, the outcome is clear: no use or advantage is found in utilising the system and the system is left unused. If, however, this low-performing system is a mandatory part of a process, it dramatically lowers both user productivity and satisfaction.

According to the ISO9241-11 model, usability is defined as a system's capability to enable users to achieve their goals effectively, efficiently and with satisfaction. This applies to all different kinds of users: regular users, learners, infrequent users and

maintenance admins. An ergonomic system allows for the learning, using and maintenance – regardless of frequency – to be completed effectively, efficiently and with satisfaction.

According to Jacob Nielsen, the five measurable aspects of usability include learnability, efficiency, memorability, low number of errors and user satisfaction. This means that a highly usable system is easy and fast to learn, works efficiently, its functionality is easily remembered, there are not many errors, and the user is ultimately satisfied with the performance of the system. All these together can predict the easiness and pleasantness of using a certain product or system.

These metrics are not equally significant in every situation, since not all of these are equally important or applicable to all systems (Nielsen, 1993). Therefore, within the scope of this thesis, only the metrics applicable to the interviews' contents are taken into consideration.

3. Methodology

This empirical thesis draws from semi-structured interviews conducted for this thesis, alongside reviewing existing literature in the field of digital health. As is typical for a semi-structured approach, these interviews are built with predetermined themes in mind, but do not limit the interview to solely focus on them, allowing for freer exchange of thoughts (Given, 2008).

These interviews are conducted in an attempt to find both similarities and possibly dissonances between the experiences of the interviewees and the relevant existing theories. In addition, the aim is to find possible discrepancies in experiences between the patients and the practitioners to be studied further to see the implications of these possible discrepancies.

The findings from these interviews were analysed drawing inspiration from thematic analysis (Braun and Clarke, 2006). There are many different approaches of thematic analysis used in qualitative research, which look for reoccurring patterns of information known as themes and attempts to find connections between different data sets. This method was utilized where applicable in the process of this thesis.

The empirical data consists of five interviews, which were conducted in Finnish and lasted for approximately 30 minutes each. The data was transcribed, and direct quotes translated into English. Three of the participants are either diabetics themselves or a parent to a diabetic and two are practicing professionals in diabetes care. The interviewees are categorised in the tables below:

Patients	**Age of Diabetic**	**Years of treatment**
Patient A	80	Approximately 15
Patient B	22	3
Patient Parent	8	7

Practitioners	Education	Years of practice
Practitioner A	Doctor specialist in internal medicine	17
Practitioner B	Diabetes nurse	Approximately 30

All the questions that were provided for the participants beforehand, as well as the group to which the question was presented, can be found in the below table.

Question	Group
1. Can you describe yourself and your relationship with diabetes? Could you give me a brief run-through of your journey and current situation?	All
2. Can you describe what digital health means?	All
3. What kind of digital health systems, if any, are you familiar with? What DH systems or solutions do you use in your treatment/practice? How often is DH used in your daily life?	All
4. How do you perceive tele-treatment?	All
5. What DH solutions do like using or find useful? Which ones do you not like?	All
6. Do you find DH solutions as a part of your treatment/practice helpful or a nuisance, or something in between? What would you say is the ratio of perceived aid in care to time, energy or money consumption?	All
7. How do you receive help with any arising issues with your DH systems?	Patients
8. How do you decide which patients are eligible for DH methods and which are not? How does this impact the overall care?	Practitioners

4. Findings

> Patient B: *For me, digital health means that having this illness is made as simple as possible.*

Amongst the interviewees, some key factors were very similar. All share the same experience of dealing with diabetes treatment daily, since diabetes treatment happens daily for both patients and practitioners. All the digital systems, services and solutions mentioned were familiar to more than just one interviewee, and the most commonly used systems, such as glucose censors and tracking apps, were mentioned in multiple interviews. From this, it can be deduced that the experiences these interviewees have are related to the same or similar services and modes of operation and are therefore comparable to each other.

Most interviewees had similar understandings of the definition and usage of digital health systems, with some marginal irregularities based on varying characteristics such as age now and age when diagnosed. Most praise and criticism toward digital health as a whole that were brought up in these interviews were also very similar, varying only slightly based on the aforementioned variables.

Drawing from this qualitative data and looking at them through the lens of thematic analysis, the experiences these interviewees had with digital health solutions can be divided up into either dynamic, well-functioning or overly complex, unintuitive experiences.

4.1. Dynamism

When talking about a dynamic digital health system, most of the interviewees mentioned characteristics such as fluid, flexible, easy to understand and shape into exactly what the individual needs, so that each patient can get what they need, nothing more and nothing less. This proved exceptionally true when talking of tele-treatment, which is perceived by all participants as a positive addition to their treatment. Patient A described their overall experiences with digital health and tele-treatment saying:

> Patient A: *In my opinion, this remote reception, when it is possible, is definitely better. You can get [to the reception] faster, you get connected immediately or the next day at the latest.*

A key component of user-friendly dynamism that was praised on many occasions was the possibility to rely on visuality. Visual additions to tele-treatment, meaning video calls over phone calls or text-based communication, was perceived to enhance connection between patients and practitioners. The only downside to tele-treatment that was mentioned, a lack of human connection and authenticity, was seen as significantly reduced when introducing the possibility to add this visual aspect to tele-treatment sessions. Patient B explains:

> Patient B: *For some people, they fare well with only a phone call. For me, that is not enough. I need the human connection, the eye connection, to be seen as a human. Especially since [the call or live-meeting] is concerning me and my disease, which is so personal, I like to feel the genuine connection.*

In addition to tele-treatment, visual aspects of blood-sugar tracking apps or insulin pumps was named a key factor in patients' own understanding of their illness. Visualising the blood sugar into graphs instead of just showing patient numbers on numbers makes the vital data easier to understand. Practitioner A showcased this with a story of a patient:

> Practitioner A: *The visualization of blood sugar data has improved tremendously. It has not only made work easier, but also meant a lot for the patient. Many patients have said the same quite frankly, one even said that they had been sick for 20 years and now for the first time they understand what the blood sugar is telling me.*

These kinds of digital aspects have been shown to increase both patient and practitioner adherence to treatment (Kulzer et al., 2018). Patient B even stated that tracking their glucose from an app makes managing their illness less straining and giving treatment sort of a gameplay-like feel, describing:

Patient B: *Gathering motivation [for self-treatment] is getting easier and easier. I feel as if I was playing a game with my blood sugar when I see it on the screen and aim to keep it between the correct values.*

Digital health solutions were also named to lessen the effects of geographical distances and transportation. In addition to the intuitive effects of tele-treatment of not having to travel long distances, other factors were brought up as well. The ability to choose tele-treatment over in-person treatment was seen reducing stress at work or school, when no extra time needs to be taken off, as well as lessening the everyday strain caused by having to look for parking spaces or planning a journey on public transport in order to make the visit.

Patient Parent: *I could see that remote treatment is a really good addition and alternative [to live-meetings], and I believe that for some it works even better than the live one. There are those situations where you have to take public transport or queue for parking spaces, and you will be away from school and work longer. I would believe that it is a really good alternative and addition - maybe because you could choose for yourself which kind of meeting to select. However, I see the live-meeting as more important because they have their own atmosphere, and it is nevertheless a more genuine encounter.*

Practitioner B: *For example, when we had clients of working age, and the reception hours were so silly, from nine to four, they did not suit everyone of working age at all, or it was difficult to organize meetings since not everyone lived right around the corner. These working age clients accepted these remote treatments well and it suited them well. It saved a lot of everyone's time. Remote care has rationalized reception work by a lot.*

In this way, digital health solutions were not only alleviating the stress introduced by the illness, but also the stress of everyday life. This can be directly linked to both the ISO and Nielsen's usability metrics' first component, efficiency, since tele-treatment is seen as more efficient than traditional in-person treatment.

Being able to reach out to patients or practitioners through a secure connection message board was also seen as lowering the threshold of getting in contact, even

with questions seen by the patient as small or insignificant. This can be linked to the usability metrics of learnability, memorability and satisfaction, since these message services are, according to the interviewees such as Patient A, easy to use for the first time as well as subsequent times.

> Patient A: *[Digital messaging services] have worked great for me since the beginning. I have not encountered any problems using them. They have been made really easy to use.*

Additionally, these message services leave you satisfied with both the experience and the additional information from your patient or practitioner, which would have been more challenging, time-consuming or draining to ask for without the help digital solutions.

> Practitioner B: *To me it seems that being able to send a message lowers the threshold to get in contact. The patient asks questions and gets answers quicker with these services.*

In addition to this, tele-treatment and flexibility in treatment, which is seen as a result from implementing more digital solutions, allows for treatment place to be selected based on personal connections and preferences rather than oversimplified geographics. This means that patients have the ability to choose their treatment location themselves. This could be seen in cases such as choosing a health center located near a workplace rather than home, since most visits happen during work hours, or choosing to stay at the previous health center location after moving in order to keep pre-existing relationships intact and waste no time on getting acquainted with new practitioners.

Flexible digital health systems were also named to increase independence. This was seen true for both children and adults, since digital solutions allow for more self-monitoring and self-controlling. Utilising digital systems was seen to increase the patients trust in themselves, along with the parent and practitioner feeling more confident in the diabetic individual’s capabilities of self-management in the moment as well as in the future. As the participant Patient Parent said of their child’s treatment:

Patient Parent: *It creates such security, faith and trust in the future, that when we can keep a more stable balance of care, better glucose values in everyday life, it brings faith that even when the child is in their twenties, they can manage on their own.*

However, it was noted either in the interviews or existing literature, that some of these flexible additions to digital health solutions can prove counterproductive, when introduced to unsuitable situations. Visuality, for example, is seen as a good add-on rather than an assumption in digital health services. Since it adds complexity to the systems, this can negatively impact certain patients' capability to manage these solutions. Some still prefer phone calls or texts over video chat and do not feel the need to visualise their glucose levels, in which case these visual aspects should not be introduced to their treatment in order to avoid adding to their cognitive load.

Independence can also be seen as a similarly dual-edged sword. It can be brought into question whether or not independence adds to too much pressure on the patient or their family, causing excessive care fatigue for patients dealing with issues alone. Patient B describes their experience when dealing with challenges:

Patient B: O*f course [dealing with challenges] brings an additional trouble to me and others who face them, that you have to go to such lengths to deal with it. It is often the case with me too, that I cannot bear to make the effort. Especially if there is care fatigue involved, all the extra work is really hard.*

4.2. Complexity

When raising the question of unsatisfactorily functioning system the participants had encountered, most answers circulated around a similar experience of complexity superseding functionality. Systems that don't work, work poorly or are too difficult to understand were named as making treatment more complicated instead of simplifying, as well as shifting attention and energy away from actual treatment. As Practitioner B described:

Practitioner B*: [Digital health solutions] really have to work well. If the system does not work, people get agitated and bored, and I get agitated and bored*

myself. If everything goes well, remote care saves time, but then if everything does not go according to plans, it wastes an awful lot of time. If the information is not transferred, there is absolutely nothing to say at the meeting or anything on the basis of which to treat the patient.

A prime example of such complex system was brought up on both patient and practitioner-sides: the digital patient record solution currently in place in Finland called Apotti. Apotti has since its partial launch in 2018 caused a frenzy both inside and outside the medical field. Even within the very small scope of five interviewees, more than half had had negative experiences with Apotti, directly causing issues in their own or patients' treatment. The participants had experience ranging from less impactful general confusion surrounding Apotti causing delays in visits, to highly impactful loss of patient and medical records.

Patient B*: The personnel have not been able to use [Apotti] properly, because it has been new for them as well. The employees cannot do anything about it either. […] They were at a turning point, but the customer does not know that. […] I have received apologies and apologies for receptions that have been delayed or missed altogether because patient information is difficult to find or has been completely lost. It is a pity.*

Practitioner A: *I have only ever met one or two colleagues who think Apotti works well. The rest, on the contrary, are very disappointed or even angry about the way it works.*

Some of the participants had similar issues with Apotti-based website and mobile app Maisa. After securely logging in, Maisa offers the patients the possibility to communicate with practitioners, order supplies, check laboratory results and book visits. Healthcare practitioners can confirm appointments and answer to patient's messages through Apotti, which is the professional counterpart to this system. While according to those participants of this study who brought up Apotti on their own, Apotti was unanimously regarded as non-functional. However, opinions on the functionality of Maisa were more diverse. Patient B described their experiences with booking appointments and making supply orders through Maisa, saying:

> Patient B: *[Maisa] is really simple and easy, I can place medical supply orders there with just a message, I can get in touch with my diabetes nurse, and I just booked the flu vaccine through it. Somehow everything is there in one package.*

However, others were not fully impressed, with Practitioner A claiming:

> Practitioner A: *Even though these chat and video options have become more common during this pandemic, the way we communicate in healthcare still has a lot of room for development. What is clearly still lacking in my experience is how the necessary recordings of patient information are made based on the communication via these remote connections.*

Other overly complex systems were brought up in the interviews as well. Systems for monitoring glucose levels at night were discarded as too complex even for people highly affluent with technological solutions. The complex bureaucracy with ordering new and replacing of inoperative or broken medications and medical devices was seen as a major flaw within the health care system. However, most participants agreed that especially in the past ten to twenty years, these sub-optimal systems have gotten better or replaced with newer, improved solutions.

Sub-optimal systems can cause distrust towards digital health systems in general. This means that the first and most used systems have more pressure to be deliver what is expected of them, or cause distrust and unwillingness to utilise other digital systems, that could be better and yield expected results. Practitioner A explains:

> Practitioner A: *During my own time [as a practitioner], patient information systems have been digitized and it has not always been painless. The uppermost emotional states that come to mind when thinking of digital patient systems are heavy and laborious.*

In the case of diabetes-specific systems, this goal is reached on both patient and practitioner sides represented in this study. Systems concerning larger populations, however, did not fare that well in the scope of this thesis.

5. Discussion

It should be noted that even though in this thesis complexity and dynamism are presented as opposing characteristics, in actuality they are not two ends of a spectrum. In reality, in order for a system to provide this sought-after flexibility to cater to many different user needs, it needs to be complex enough. In the case of digital health systems, as well as many other digital systems, you can't have one without the other. However, the crucial question here revolves around finding the perfect balance of complex enough to support dynamic usage, but not complex enough to cause issues.

Similarly to how diabetes treatment is a constant balancing effort between two unsafe endpoints of hyper- and hypoglycaemia, efficiency, a factor named in both the ISO and Nielsen's usability metrics, can be seen as something that balances between two ends of a complexity spectrum. Excessive complexity results in users getting lost, unable to finish their tasks and unsatisfied, while lacking necessary complexity means the system is unable to offer what is needed of it, negatively impacting the satisfaction yet again.

In his book About Face (2014), Alan Cooper introduces a flawed way of thinking of a complex, flexible and widely satisfying system. He states that according to this flawed logic, in order to satisfy as many different needs as possible, the system must have as broad of a set of functionalities as possible. This logic and practice, however, results in a system that is too complex to utilise and therefore answers none of the required functionalities it was made to serve. Designing health care systems with this logic can therefore result in satisfaction for none of its users.

Apotti has been built to answer the needs of thousands of professionals working in healthcare or social services. Keeping in mind the danger of 'too many cooks' introduced by Cooper, it is not surprising that all of these thousands of requests were not met – and that attempting this happened at the expense of the system functionality.

Cooper's theory of successful design continues with a suggestion that in order to meet the main requirements, systems should be designed to cater specifically to the

main users in question. This theory can be seen validated within the scope of this thesis by looking into how differently the interviewees rated their experience with diabetes-specific digital solutions, versus systems that attempt to serve every user imaginable, such as Apotti. When a system is designed to serve a certain group, such as diabetics, within the scope of this study it is clear to see that the results this design mindset yields in the system's users are positive and successful. On the other side, systems that attempt too much end up being perceived as dysfunctional and low-performing.

In an article published in Helsingin Sanomat on November 5th, 2022, many healthcare practitioners share their frustrations with the Apotti system. In the article, issues very similar to what the participants of this thesis had, are brought up and supported by hundreds of Finnish practitioners, as well as serious claims of placing patient safety at risk. Apotti is criticised by the practitioners in both this article and thesis interviews for being way too complex, unintuitive and not focused on the human beings either using, or being treated with, Apotti. As a system for logging in new data and checking old patient records from previous visits, lab tests or at-home care, Apotti was seen by some as worse than paper-and-pen-recording, which caused them to revert to old methods of logging treatment that are no longer in use.

The 'mental model' (Norman, 1998) describes people's knowledge and understanding of a certain thing. In the book, mental model is explained as follows: 'If people do not have a good mental model of something they can only perform actions by rote. If something goes wrong, they will not know why and will not be able to recover'. This seems to accurately describes how this selection of interviewees felt about Apotti. These flaws can directly be linked to Nielsen's attributes of learnability and memorability: if a system is not easy to remember or learn, of which Apotti seems to be neither, it does not meet the criteria of a well-performing system. The diabetes-specific systems mentioned in the interviews of this study, however, seem to all align with these memorability and learnability metrics quite well, since no interviewees had named issues with learning or using these systems.

As mentioned before, a low-performing system can cause significant harm to user productivity and satisfaction. Both of these can impact the user's motivation to

continue with the system, which according to the interviews conducted for this thesis, can result in drastic lowering of self-treatment as well as treatment control and balance. This means that it is crucially important that not only are the methods provided for the clients functioning properly, but also that they are easy and simple to use. Otherwise, there is a risk that a digital tool meant to improve the state of treatment actually does the opposite by lowering the patient's motivation and capability to look after themselves and their disease.

When discussing digital health solutions and whether or not they should become the new normal, some limitations must be brought up. Digital systems as a whole require access to, as well as understanding of digital services. This is not a reality to all. Digital health systems mentioned in this thesis require access to either computers or smartphones, preferably both, as well as Internet. Requiring the patients to have access to these alienates many groups of people, such as individuals with less money, no digital devices and no access to the internet. Other incapability to use digital systems, such as old age or disabilities can also negatively impact an individual's access to digital health services. This can create an uneven distribution of care between people with and without access to digital health services. This bias could further weaker the position of the aforementioned groups of people.

As another hesitation to digital health services surpassing the traditional in-person services, most of the interviewees in this study agreed that digital health should not be seen as the sole method of treatment within the next step of health care evolution, but rather as a complementary feature. The interviewees felt that human connection is still and will always be vital to health care services, as it makes the visits and treatment feel like genuine encounters, allowing people to meet and treat others as humans, instead of subconsciously reducing them to just numbers or blood glucose values on a screen.

6. Conclusions

Overall, the participants of this study had positive, appreciative and comfortable feelings surrounding digital solutions in diabetes treatment. Many said to be grateful for the current state of treatment and the role of digital solutions in it, stating that abandoning the in-use digital solutions would drastically lower their confidence in maintaining the current level and balance of treatment.

However, no participant was completely without criticism toward the systems they have used, suggesting that regardless of the systems' overall positive effects on treatment, not all aspects and individual systems are as well designed and executed as others.

6.1. Limitations and future research

As the most obvious limitation to the length and depth of the research presented is the restrictive nature of a bachelor's thesis. This is most notable in the narrow scope of questions as well as the small sample size of interviewees.

Given the narrow scope of questions, it is too broad and unspecified to fully prove any specific variables to be responsible for the level of success of digital health solutions as a whole. Similarly, within this small sample size of diabetics and professionals represented in this study, there was not enough variability between gender identity, age now or when diagnosed, level of disability, geographical location within Finland or socio-economic status, all of which can significantly impact the experiences with digital health as part of treatment.

Additionally, the data in this empirical study consist of interviews with a relatively homogenous group of people with the same nationality. This is especially significant given the unique circumstances of Finnish medical treatment field. The Finnish medication reimbursement system renders finance a non-issue, which would not be the case in other contexts. Diabetes treatment is practically fully covered by state, leaving order and delivery costs the only financial burden of treatment allocated to the patients. According to the World Health Organisation, a major barrier to effective

treatment of diabetes is the affordability of medication, a trend that affects many countries regardless of the countries' income levels (2021).

As suggestions for future research, this study suggests looking into two questions that emerged during the conduction of this thesis. Firstly, the perceived usability of illness-specific versus all-around health apps and systems should be further studied to see if the illness-specific ones prove superior in all cases, and to see which characteristics this is based on. Secondly, the uneven distribution of care between people with and without access to digital health services should be further studied to find possible occurrences of inequality with treatment. Further research into both these areas could have positive consequences and prove useful in further implementing digital health care as efficiently and broadly as possible, without compromising the quality and equality of treatment in the process.

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