**Thesis Portfolio**

User Experience Design to Enhance the Effectiveness of Mobile Technology for the Treatment of Mental Health

(Technical Report)

The Ethics of Mobile Health Technology and Potential Barriers in Developing Process

(STS Research Paper)

An Undergraduate Thesis

Presented to the Faculty of the School of Engineering and Applied Science

University of Virginia • Charlottesville, Virginia

In Fulfillment of the Requirements for the Degree

Bachelor of Science, School of Engineering and Applied Science

Fan Feng

Spring, 2018

Department of Systems and Information Engineering

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# Sociotechnical Synthesis

Healthcare technology, which includes devices, medicines, vaccines, procedures and systems, are developed to solve a health problem and improve the quality of patients’ lives. With the boosting hardware performance of mobile devices (phones, tablets, etc.), healthcare technology on mobile devices has been more widely used. Many researches, for example my capstone project, are being conducted in order to deepen the great potential of mobile healthcare. However, while this technology is being developed, not many discussions about the ethical aspects of this technology can be found. In this year, we have discussed a lot about how the lack of ethical consideration of technologies have caused unpleasant consequences. Therefore, the goal of the STS thesis is to discuss what might be some ethical issues that have been ignored in the development of mobile healthcare, and how developers may improve the technology to avoid these ethical concerns.

The technical portion of the project focuses on improving the effectiveness of treatments in a mental health intervention study, the Mindtrails project. Means of this improvement include giving user interface design recommendations, finding out what sessions are flawed by data analysis, adding personalization and gamification to the intervention sessions etc. Users’ data from the Mindtrails site is used to evaluate the effectiveness of design improvements and to make design choices. Sub-objectives of the study include reduce user attrition rate, improve user engagement and develop interfaces that apply to multiple platforms.

The STS portion of the project, as stated previously, focuses on discussing the ethical processes relating to mobile healthcare technology. The discussion starts by referencing previous researches on what potentials mobile healthcare technology have over traditional healthcare in the clinical settings. Two case studies are then presented to illustrate the current usage of mobile healthcare technology. Case 1 is about auxiliary healthcare devices, e.g. Fitbit, and case 2 is about a more automated version of mobile healthcare technology: using machine learning to enable your cellphone camera to detect skin cancer. Afterwards, two interviews with healthcare professionals are presented to discuss mobile healthcare technologies in the future. In other words, what could be the ethical issues if mobile healthcare technology can replace the roles of physicians in certain scenarios? Based on the above ethical analysis, the discussion section of the STS thesis will focus on what ethical considerations must be taken into account in the development of mobile healthcare technology.

I would like to thank Professor Sean Ferguson for his guidance and for his feedbacks in my process of developing the STS thesis. In addition, I would like to acknowledge Professor Laura Barnes and Professor Matthew Gerber, who guided me and my team through the technical project.

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On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

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**The Ethics of Mobile Health Technology and Potential Barriers in Developing Process**

A Research Paper submitted to the Department of Engineering and Society

Presented to the Faculty of the School of Engineering and Applied Science

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# The Ethics of Mobile Health Technology and Potential Barriers in Developing Process

Mobile health technology has grown continuously in the recent years. However, the adoption of this technology is a not a single and instant action but a composite and possibly long process, because multiple stakeholders will hold different views about mobile healthcare technology. More specifically, both human and non-human actors give this technology a different technology identity in the actor-network (Ulucanlar, Faulkner, Peirce, & Elwyn, 2013). Therefore, this research paper aims to define the network relationships by analyzing a series of identities that form between actors and actants. For example, this technology may be used as an auxiliary tool by mental clinicians, but as a virtual consultant by patients who don't have access to other forms of treatment. This difference can determine how the two user groups adopt to this technology. Several case studies are analyzed in order to illustrate this difference in different stages of mobile health technology. More specifically, from technologies that are used as pure auxiliary tool to much more intelligent technologies. Based on the analysis of these identities, another part of the paper aims to explore the moral issues that may be brought by this technology based on the ethical processes and factors that influence the stakeholders to adopt mobile healthcare technology. Hopefully the discussion of relevant factors can shed light on what to keep in mind while designing, adopting and improving similar technologies.

**Incentives of introducing mobile mental healthcare technology**

According to Kessler et al (2005), the growth in demand for mental healthcare exceeds available resources, and mobile healthcare technology has the potential to offer greater flexibility and to be more patient-centered (Hollis et al., 2015). Because of the nature of its settings, instead of having to go to a clinical room and wait for treatments, patients can receive just-in-time interventions by looking at a device screen. More importantly, this technology has the potential to be a more affordable choice than traditional clinical settings for patients since the software and systems are relatively cheap and the lack of access to mental health care currently suggests a large gap between supply and demand.

**Potential changes brought by this technology**

According to Kuo (2011), if this technology can be widely developed, following changes in mental healthcare industry will include: the paradigm shift from wired access to the internet to ubiquitous access on the move, the paradigm shift from clinic-centered delivery system to community-centered delivery system, the paradigm shift from physician-centered decision-making to physician-patient collaborated decision-making, and the paradigm shift from generic healthcare to personalized healthcare. These paradigm changes are more with respect to the technical aspects of the medical process. However, the sociotechnical part of the paradigm changes is of the same importance. These predictions are avenues to approach not only the identity formation of user and technological system, but also the ethical processes of how the network of actor and actant are arranged.

While these paradigm shifts are happening, there have been many controversies on whether the changes are all beneficial to the society. In the following, to illustrate the potential changes on the sociotechnical perspective, three scenarios, corresponding to three stages of mobile healthcare technology development, will be analyzed, especially focusing on the paradigm changes from physician-centered decision-making to physician-patient collaborated decision-making.

**Case Study: Fitbit as an example of wearables in current medical processes**

Fitbit is a wireless-enabled activity tracking device that measure data such as the number of steps walked, heart rate, quality of sleep, steps climbed, and other personal metrics involved in fitness. According to the Health Metrics Research Inc, the company that developed Fitbit, Fitbit can not only help users track their daily activities, their measurements can also give doctors just-in-time updates about patients’ behaviors.

According to Augur (2016), most doctors do not encourage their patients to use wearables in assisting healthcare treatments. The major reason is that wearables industry has focused on consumer’s daily lives, how to integrate social connections, and gamification. Making that data medical or useful on a larger scale was not quite on the agenda. Most general wearables on the market are not, therefore, accurate enough for medical assertions to be made. Fitbit hasn’t even been clinically validated to conform to U.S. Food and Drug Administration medical grade devices. They are judged by the slightly friendlier “wellness” rubric. Many users do, of course, realize their wearable metrics are not for medical purposes. Yet many still assume data (no matter the size or form) is useful.

From healthcare professionals’ perspective, Fitbit does not serve as much medical purposes as they advertised. According to Andrew Trister, an oncologist at the nonprofit medical research organization Sage Bionetworks, “They come in with these very large Excel spreadsheets, with all this information—I have no idea what to do with that.” Different from medical practices, people exercise for different reasons, and in different ways. The lack of standardization in this information, as well as a general uncertainty of what specifically to do with it, makes it all incredibly precarious. Wearables are fabulous for self-helpers. However, a doctor cannot, and should not, rely on information they aren’t prepared to deal with.

Although it is a good intention to incorporate information measured by wearables into electronic medical records, the implementation will take time. Turning the “self-help” wearables into a tool is not easy—especially the standardization of data.

**Case Study: MelaFind to detect skin cancer**

SkinVision is the first skin cancer risk app with a clinically proven online assessment. Its core technology: MelaFind works by the user taking a picture of his/her skin, and it can give an assessment and probability of whether a melanoma and other skin cancer symptoms exist. This can be done in a few minutes on the user’s phone. The device uses 10 different wavelengths of light to see up to 2.5 millimeters deep into the skin and capture images of its different layers. The convenience as well as good performance are the two major features of this technology.

Doctors hold different opinions in the usage of MelaFind in the medical process. According to an article (Singer, 2013), some members of an expert medical panel asked to review MelaFind a few years ago for the Food and Drug Administration warned that this technology had the potential to give doctors and patients a false sense of security. While this technology can analyze small pigmented spots identified by dermatologists as having signs of melanoma, it is not designed to evaluate other problems: large melanomas, colorless melanomas or two other types of skin cancer — basal and squamous cell carcinoma. Dr. Amy E. Newburger, a dermatologist in Scarsdale, N.Y., said she was concerned that a doctor could inadvertently use MelaFind on a non-melanoma skin cancer, receive a score indicating that the spot was not irregular, and erroneously decide not to biopsy it.

The simplicity of operations in MelaFind also incurs criticism. The app that applies this technology gives nothing more than a rating of melanoma without an interpretations or descriptions of symptoms. Company executives said Mela Sciences deliberately calibrated the machine to catch as many melanomas as possible, understanding that such a high setting could lead doctors to biopsy normal tissue. “It will err on the side of caution,” said Claudia Beqaj, director of commercialization at Mela Sciences. “We wanted to set the system to have such a high sensitivity that we didn’t miss any melanomas.”

Despite the criticism, there are a good number of doctors willing to utilize the convenience provided by MelaFind technology. Dr. Doris Day, one of the first dermatologists to buy the machine said, “It helps me see what I cannot see with my eye.” Like Dr. Doris, almost all doctors who embraced this technology used it as an auxiliary tool for his/her own diagnosis.

In late 2011, the F.D.A. approved MelaFind for sale in the United States. But, given the concerns that general physicians not trained as skin experts might miss a skin cancer, the agency restricted the use of the device to dermatologists — and then only after the doctors had successfully completed a MelaFind training program. Such restrictions reflect the authority’s confidence on this mobile technology as well as concerns that the technology may not be suitable for patients’ own usage.

**Analysis on the technology identities in the case studies**

The two case studies above exemplified two stages of mobile healthcare technology on the current market. Wearable devices as Fitbit are advertised to be helpful in medical processes by functioning as measurement tools. MelaFind, on the other side, implements machine learning algorithms to complement doctors’ diagnoses by giving a rating of melanoma that either challenge or strengthen doctors’ judgements. The fundamental difference of these two cases is the different level of artificial intelligence implemented in the technology. Although used as a complement tool currently, technologies like MelaFind have the potential to replace doctors in giving diagnosis in certain circumstances.

An analysis of ethical processes and factors that influence the stakeholders to adopt the technology will be conducted in the thesis as part of the defining of technological identities in the network. In order to do so, Ulucanlar, Faulkner, Peirce, & Elwyn (2013) gives a method of analyzing the situation for stakeholders. It introduced the concept of technology identity: A narrative or discursive presence of the technology that delineates a particular set of attributed characteristics and performative expectancies as representative of the technology’s distinctiveness and value. Technology identities are with respect to human and non-human actors in the network of technology usage (Robert, Greenhalgh, Macfarlane, & Peacock, 2010).

In the first case, Fitbit works more as a reminder for keep exercising activities to patients and general population instead of a tracker for physicians. Most doctors find it hard to deal with the data coming from the wearables that records users’ daily behaviors. For doctors that actually use wearables, they use it to track blood pressure, weight, pulse rate, and other factors after cardiac surgery or heart failure. Its failure to serve a bigger role in the medical process is due to the lack of standardization on information collected by wearables. As people can predict, wearables with standardized measurements can serve as physician’s assistants in keeping track of more complicated medical records on an hourly basis. Ethical concerns are trivial in this case.

However, for MelaFind, the problem becomes more complicated. From the above description, it is obvious that the immaturity of this technology is one of the concerns that this technology is not open for usage without a doctor’s guidance, for this technology can only give ratings of detection on a subset of skin cancers, and the simple rating can possibly send wrong messages to patients. Patients who have types of skin cancer undetected by this technology, for example, basal and squamous cell carcinoma, may think they don’t need autopsy when they actually do. Due to the types of skin cancer, it seems infeasible to expect a comprehensive coverage of skin-related illness by this technology. Therefore, the F.D.A restrict MelaFind to be used only by dermatologists as reference instead of an independent diagnosis maker. Its introduction of artificial intelligent to medical fields is significant. According to Dr. Hensin, Tsao, the director of the melanoma and pigmented lesion center at Massachusetts General Hospital in Boston, unlike an X-ray or mammography device that requires a medical professional to read the images and identify abnormalities, MelaFind both captures images and analyzes the likelihood of melanoma. That extra intelligence, its accuracy notwithstanding, is bound to change doctors’ interactions with patients.

“Until now, you trusted the doctor to make the decision,” Dr.  Tsao also said. “Now you’ve got a three-way interaction. It’s a brand-new paradigm.” The use of artificial intelligence in making medical decisions can greatly change the future of our medical process. Mobile healthcare technology which implements advanced AI can even make decisions like healthcare professionals for patients in the future. The following section will discuss the ethical issues that may appear if this comes true.

**A future scenario: Can mobile healthcare technology make decisions like doctors?**

The above two case studies illustrated both the current stage of mobile healthcare technology and a trend in this technology predictable in the near future: to be more automatic and intelligent. What if this trend evolves mobile healthcare technology into a form that can make medical decisions independently without supervising from an actual doctor? In order to investigate the potential ethical barriers in this future scenario, two interviews are conducted with two healthcare professionals from Nanjing General Hospital of People's Liberation Army in China. In response to the request of the interviewees, their names and titles are omitted here.

The interviews are in the form of Q & A sessions, where questions were asked to investigate what opinions people working in the healthcare field have about a future scenario, in which mobile healthcare technology can function as doctors. Part of the interview with an analysis is given in the following.

**Analysis on technology identities brought by the paradigm changes**

For patients, although the introduction of medical healthcare technology gives accessibility of medical measurements and treatments, this accessibility can possibly dominate the patients' understanding of his/her condition and make false judgments. According one of the interviewees, “Patients can hardly comprehend the diagnosis without an actual doctor explaining to them. If technology starts doing this job, I expect a higher possibility of patients either overestimate or underestimate their condition.” When a patient gets used to the mobile healthcare technology, without fully aware of the scope of this technology, i.e. being unsure about when it is necessary to ask for healthcare professional's advice and treatments, he/she may falsely stick with the treatments limited by the mobile healthcare functions because of the accessibility and familiarity offered by this technology. For example, the use of mobile healthcare technology may give users a tendency to reject radical treatments like surgeries, because such treatments are outside the scope of their mobile devices' functions. When they get used to sitting at home, making a diagnosis using a mobile phone, and ordering medicines online until getting cured, they would unlikely want to go back to traditional clinical settings and accept doctors' suggestions of radical treatments even when such treatments are necessary. The generation of this tendency, although increasing the efficiency of patient care, may reduce the quality of overall healthcare due to patients’ different attitudes to radical treatments.

What is more, the interviewee suggested that one significant benefit of traditional clinical settings over mobile healthcare is that doctors and clinicians work together and correct false judgments of patients' conditions if necessary. Therefore, severe mistakes in medical diagnosis or choice of respective treatments can usually be avoided. However, after the adaptation of mobile healthcare, patients, usually unfamiliar with medical knowledge, can only depend on the correct judgments of this technology, because there will hardly be a process of peers' review and feedback. If the technology fails and gives inappropriate medical advice, the patients will have trivial chance to prevent themselves from the outcomes of mistake. In these situations, mobile healthcare's identity serves as a boundary for patients to make more appropriate decisions to their health conditions and access treatments that this technology is unable to give, which can hardly be beneficial for patients.

For medical professionals, the advent of mobile healthcare technology can also bring unpleasant changes. Currently, such technology serves as their auxiliary tools to make simple, repetitive diagnosis for them. “For example,” an interviewee says, “this technology can free us from reading patients' physical examination results and check if there exist any abnormalities. Or it can automatically give patients advice on what not to eat after certain treatments so that we only need to worry about the medical decisions that are more subjective and analytical.” However, after the development of this technology's power, especially when this technology can make diagnosis autonomously, which is highly likely, it can serve the traditional role of a healthcare professionals rather than a doctor's assistant. When asked how he will feel in that scenario, one of the interviewee said: “To me, I will feel a sense of insecurity if that technology really comes out. If a machine can complete 95% tasks that we do, what is the purpose of taking 10 years of training just to stand there and read the machine’s decisions to our patients?” This insecurity reflects healthcare professionals may feel their authority being challenged by mobile healthcare technologies. With this idea in mind, they may have an unnecessary tendency to differentiate their treatments from those offered by mobile healthcare. When being asked whether they would intentionally make differentiated decisions with mobile healthcare technology, both interviewees replied that was a possibility, even if they knew that it may not be the most optimized solution to this medical situation. If they do make different judgments with the mobile healthcare technology, they have to take more time to explain why there are such differences and why they are correct. Ideally, this challenge of clinicians' authority can motivate them to do better in their responsibilities, but another more probable consequence is that the medical efficiency in traditional clinical settings falls because their authority is challenged.

For government and health insurance companies, the introduction of mobile healthcare technology can create legal issues on medical accidents. When incorrect decisions are made by doctors, it is relatively easier to attribute the responsibility to the decision-making person or hospital agency. However, the current law does not account for a specified judgment on who takes responsibility of medical decisions offered by an algorithm, or a machine.

**Discussion: Implications of above analysis and what to keep in mind in design**

Now that the ethical concerns from multiple perspectives on the development are identified, what needs to be considered in developing mobile healthcare technology in order to reduce the effects of ethical issues? To answer this question, a few suggestions with respect to each perspective are presented in the following.

In the Fitbit case, the lack of standardization is the major reason why patient-centered healthcare devices fail to play a larger role in medical scenarios. Therefore, the restriction and supervision from medical departments should be implemented more firmly to the development of mobile healthcare devices. This suggestion can also be applied to account for the concern about patients’ attitudes toward healthcare treatments – a more clear and concise scope definition of mobile healthcare technology must be presented to clients, especially patients as the principal of usage. The possible outcome from this act can also be exemplified from the MelaFind case study: when the scope of the technology is not defined with clarity to every user, it may not be the best idea to open up the usage for general patients. Instead, usage under the guidance of a healthcare professional. Not only what technology is capable of doing, what humans are supposed to do in the medical process also needs to be reconsidered and redefined so that doctors no longer feel being challenged by the technology. Last but not least, the government should complete the related medical law to identify the stakeholders in the new medical scenarios before the wide usage of “next-generation” mobile healthcare technology. In other words, before enough regulations and standardizations are set on the next stage of mobile healthcare, it might be more beneficial to the society to only allow patients use it with the guidance of doctors, just as in the case of MelaFind.

What is more, in order to take advantage of peer review and feedback as in traditional clinical settings, one way corresponding to mobile healthcare is to form a community of users developing practical expertise in the devices and in their health. For example, the developer of the technology can enable users to register into a platform where users share review, behaviors and experience with each other to complete the peer checking task. Actually, this kind of community has already been encouraged by some companies. For example, Fitbit (“Fitbit Community,” n.d.) has built an online community forum for users to share their experience in using the devices. As mobile technologies are being developed, this kind of behavior would be helpful in finding rooms for improvement and identifying serious issues.

In conclusion, the development of mobile healthcare technology is both promising and challenging. Despite the outstanding benefits it may bring to patients in the future, ethical considerations must not be ignored in the process of this development. The appropriate usage of this technology requires the shared efforts from multiple aspects of our society.

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**Prospectus**

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Signed: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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Sean Ferguson, Department of Engineering and Society

Approved: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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Laura Barnes, Department of Systems and Information Engineering

Matthew Gerber, Department of Systems and Information Engineering

1. **Overall Introduction**

For the technical project, the Capstone team works with a psychological study team, the Mindtrails group (https://mindtrails.virginia.edu) to deliver mobile mental health treatments to participants on multiple platforms (desktops, laptops, mobile phones) by giving specific training and interventions. Currently the two running studies are Managing Anxiety and Future thinking, aiming, respectively, at reducing anxiety levels and encouraging healthier thinking about people's future. Additionally, the Mindtrails group are designing a new study, as yet unnamed, and would like to work with the Capstone team of six Systems Engineering students to improve the effectiveness of intervention by giving recommendations about the user interface, overall structure of training questions, different notifications with respect to difference user groups, etc. The technical project includes also the analysis of past studies data, and the modeling between participants’ responses and whether they drop out in the middle of the study. By testing the significance of these models, the goal is to predict the probability of dropout of a user throughout the study and give notifications accordingly to reduce dropouts.

On the other hand, the STS project aims to explore the roles played by mobile mental healthcare technologies as they interact with different actors in the formation of a series of identities. For example, the mobile healthcare technology may be used as an effective auxiliary means by clinicians, but as a virtual consultant by patients. Moreover, another part of the project aims to discuss the moral issues that may be brought by this technology based on the ethical processes and factors that influence the stakeholders in adopting mobile healthcare technology.

1. **Technical Topic**

*Significance of Mindtrails Study*

Approximately half the U.S. population experiences serious mental health problems during their lifetime, including 29% with an anxiety disorder, yet more than two thirds will not receive treatment (Kessler et al., 2005). With this level of mental illness burden, it is clear that treating people one-on-one in clinical setting can hardly meet the existing needs (Kazdin & Blase, 2011). This has led National Institutes of Mental Health to call for “Research on the effectiveness of scalable interventions and service delivery approaches that could be broadly implemented using typically available resources.” (“RFA-MH-17-610: Clinical Trials to Test the Effectiveness of Treatment, Preventive, and Services Interventions (Collaborative R01),” grant submitted).

This call comes at a time when advancements in mobile and ubiquitous computing are rapidly changing mental healthcare allowing individuals to receive continuous treatment and assessment outside of the clinical setting. In this new, emerging model, patients are connected throughout the day to devices such as smart phones and wearables. These devices can be used to deliver an intervention at the most beneficial moment, when individuals are most receptive to the training, or are facing a critical decision (Depp et al., 2010).

*Theoretical Basis of Mindtrails Study*

The type of intervention used in Mindtrails is called Cognitive Bias Modification (Hallion & Ruscio, 2011), and it is designed to change how people think in response to situations that make they feel anxious or upset. Cognitive biases are tendencies to pay attention to, remember, and interpret things differently when processing information tied to emotional responses. For example, sometimes it’s difficult to tell whether something that happens is good or bad. People's tendency to interpret these ambiguous events as positive or negative can happen very rapidly and even without them being aware of their interpretation, so it can be difficult to catch these thinking habits, even though a tendency to routinely interpret things in negative ways can make people feel more anxious or sad. That is where cognitive bias modification might help.

Cognitive Bias Modification works by giving people lots of practice processing information in various ways to help develop healthier thinking habits, for example, asking the user to memorize and recall information given previously to them. These tasks may seem repetitive, and it is not always obvious what the program is doing. However, there is growing evidence that Cognitive Bias Modification can be an effective method for reducing negative feelings, like anxiety and sadness (Hallion & Ruscio, 2011).

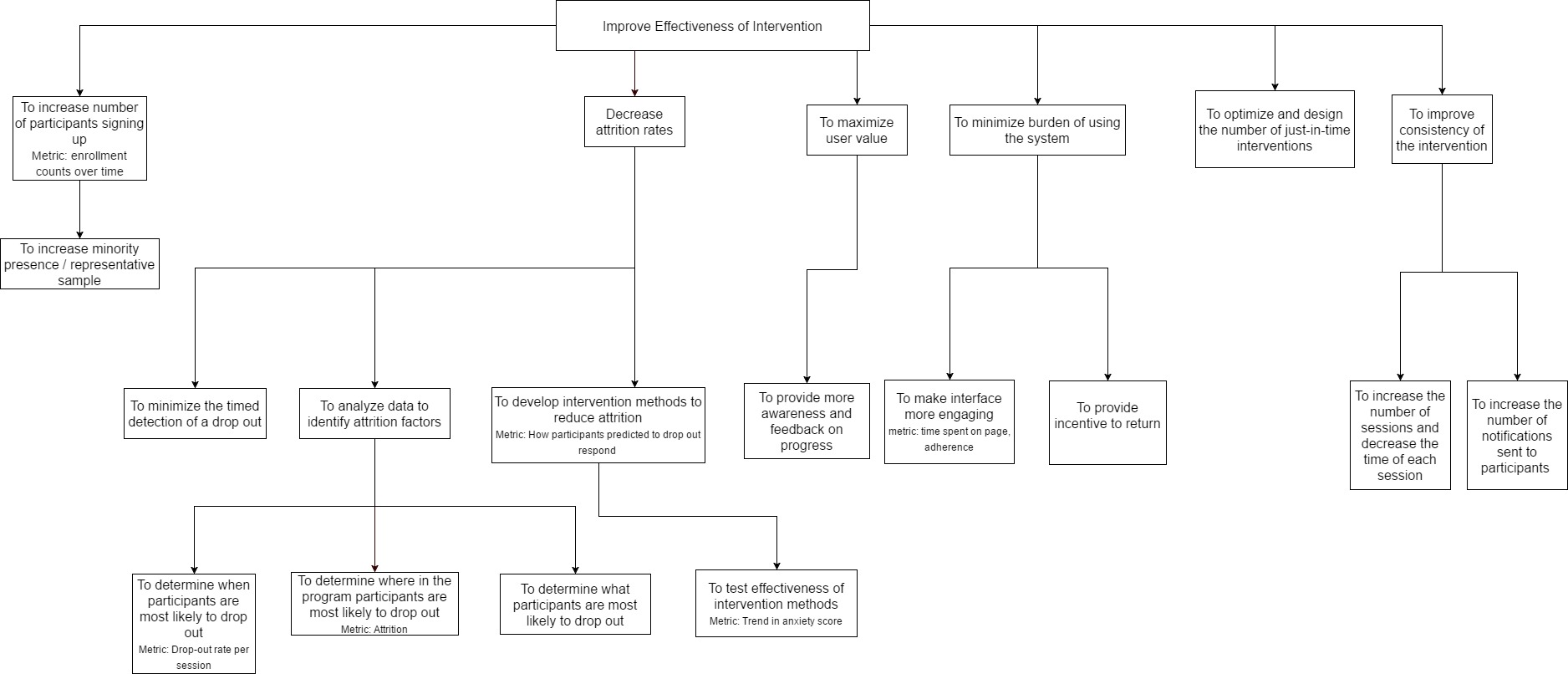
Although there are many examples of Cognitive Bias Modification programs (Beard, 2011) helping to reduce anxiety, and even helping other problem areas like depression, substance use (e.g., alcohol abuse), eating disorders, and anger problems (among others), not all studies using these approaches get the same results, and some studies find decreases in one anxiety measure but not another. Also, more research needs in the new clinical trials to be done comparing different numbers of training sessions to try to find the optimum number, and testing how to make the results for Cognitive Bias Modification done online as strong as results for the program done in the clinic or lab. Though there are still questions need to be answered, one goal of this study is to work on answering these questions in order to refine and improve this promising treatment method.

*How Mindtrails Project works*

Before a participant can join the study, a pre-assessment will be given to them and evaluate if their mental conditions fit the purpose of the study, and once they are proved to be eligible, they can start the training sessions. Each study consists of 4 sessions that are spread out over 2 weeks. Participants will complete 2 training sessions each week, and each session requires about 20 minutes to complete. During each session, they will be asked to read brief stories and complete word fragments, by filling in one or more missing letters in a word. In this process, they will be randomly assigned to different training conditions, because one important question to answer for researchers is what kind of training works best. There are also some short assessments as part of the research study so that users can self-evaluate how well the program works. At the end of the study, users will be given feedback about how their mental conditions changed over the course of the program.

*Capstone Team’s role in the Mindtrails Group*

The Capstone team’s major goal in the study is to improve the effectiveness of intervention. Complete sub-goals are presented in the following as an objective tree. Among all the second-level sub goals, the decrease of attrition rates is what the team most care about because it is highly necessary to keep the participants active in the system until all training sessions are finished. If a participant drops up halfway, not only the researchers lose the observation results of complete training sessions, but the participants themselves also fail to receive sufficiently effective interventions for their specific conditions.

 Currently, most of the teams’ efforts are focused on the interface and structure of the new Mindtrails study. The group proposed recommendations on possible improvements of the interface to make it more unified, understandable and relatively interesting to use, and the group believe improving the user interface is one of the most effective ways of reducing dropout rate, because once a participant join the study, the most probable reason of their dropping out is that they feel unsatisfied with how the trainings are presented, and it is the Capstone group’s goal to avoid this situation as much as possible.

Another task for the group in the following is the data analysis of the study’s result and trying to model the relationship between users’ responses to certain questions and if they dropout at certain sessions. For example, the group can make the hypothesis that user groups of certain demographics characteristics, married mid-aged men for example, will have higher possibility of dropout and test the hypothesis with available data as evidence. If the hypothesis is proved to be significantly correct, system designers can consider using discriminating notifications to that user group in order to reduce dropouts. It may also be true that users who spent relatively longer time than others on certain phases of study will drop halfway more possibly, and if true, the Mindtrails group may consider changing the structure of that particular part of study for it to be more understandable and user-friendly.

1. **STS Topic**

*How Technical and STS project are coupled*

The technical project supports one of many practices of mobile mental healthcare technology. However, the adoption of this technology by stakeholders is a not a single and instant action but a composite and possibly long process, because multiple stakeholders will hold different views about mobile healthcare technology. More specifically, both human and non-human actors give this technology a different technology identity in the actor-network (Ulucanlar, Faulkner, Peirce, & Elwyn, 2013). Therefore, the STS project aims to define the network relationships by analyzing a series of identities that form between actors and actants. For example, this technology may be used as an auxiliary tool by mental clinicians, but as a virtual consultant by patients who don't have access to other forms of treatment. This difference can determine how the two user groups adopt to this technology. Based on the analysis of these identities, another part of the paper aims to explore the moral issues that may be brought by this technology based on the ethical processes and factors that influence the stakeholders to adopt mobile healthcare technology.

*Incentives of introducing mobile mental healthcare technology*

As introduced previously, the growth in demand for mental healthcare exceeds available resources (Kessler et al., 2005), and mobile healthcare technology has the potential to offer greater flexibility and to be more patient-centered (Hollis et al., 2015). Because of the nature of its settings, instead of having to go to a clinical room and wait for treatments, patients can receive just-in-time interventions by looking at a device screen. More importantly, this technology has the potential to be a more affordable choice than traditional clinical settings for patients since the software and systems are relatively cheap and the lack of access to mental health care currently suggests a large gap between supply and demand.

*Potential changes brought by this technology*

According to (Kuo, 2011), if this technology can be widely developed, following changes in mental healthcare industry will include: the paradigm shift from wired access to the internet to ubiquitous access on the move, the paradigm shift from clinic-centered delivery system to community-centered delivery system, the paradigm shift from physician-centered decision-making to physician-patient collaborated decision-making, and the paradigm shift from generic healthcare to personalized healthcare. These predictions are avenues to approach not only the identity formation of user and technological system, but also the ethical tradeoffs depending on how the network of actor and actant are arranged.

An analysis of ethical processes and factors that influence the stakeholders to adopt the technology will be conducted in the thesis as part of the defining of technological identities. In order to do so, the method in a literature about technology identity Ulucanlar, Faulkner, Peirce, & Elwyn (2013) gives a method of analyzing the situation for stakeholders. It introduced the concept of technology identity: A narrative or discursive presence of the technology that delineates a particular set of attributed characteristics and performative expectancies as representative of the technology’s distinctiveness and value. Technology identities are with respect to human and non-human actors in the network of technology usage (Robert, Greenhalgh, Macfarlane, & Peacock, 2010). This line of scholarship must be expanded upon as future research. Some of the findings in the paper (e.g, the existence of many different professional groups in healthcare – each with a different perspective, evidence and knowledge base, and skill set – can act as a barrier to the rapid and widespread adoption and assimilation of a beneficial innovation) are valuable ideas to explore in this project. Sun, Wang, Guo, & Peng (2013) also included several related sociotechnical theories that may be relevant in this part (e.g, Technology Acceptance Model, Unified Theory of Technology Acceptance and use of Technology, Theory of Planned Behavior), and these theories offered alternative ways of looking at the adoption processes of this technology in order to understand different identities.

*Methods used in the research*

An interview with a mental healthcare professional in the Mindtrails group can help the project by identifying how the introduction of mental healthcare technology changes the identity of professionals in the healthcare process. Especially, has the introduction of this technology caused any negative influences on their mental states, and how might they overcome it?

The two major evidence sources are: analysis of the Mindtrails users’ response database to reflect how different technology identities influences patients’ adoption, and articles that account for different actors’ roles and perspectives in the medical system and how they change with the introduction of mobile healthcare technology will be used as source data to be reconstructed in the analysis part above. These databases are proprietary, but Mindtrails has allowed for their access and usage for the purpose of this project.

The critical part of this project is examining the different technology identities of mobile healthcare by different actors. Using (Ulucanlar, Faulkner, Peirce, & Elwyn, 2013) as a template for unpacking the formation of technological identities I have begun developing a set of actors present in the network. Some key actors and possible factors in the network are presented as follows:

* + 1. Patients: Patients tend to be less tolerant to the errors from healthcare technologies than from real clinicians. Also, face-to-face consultations, as the traditional form of mental healthcare services, can give patients more comforting medical environments than remote healthcare.
    2. Mental healthcare professionals: The introduction of this technology may impair their sense of medical-individualism. They may not adopt well to a technology that to some extent replaces their roles in the medical system.
    3. \* Hospital Organizations & Government: In terms of regulating of mental healthcare services, some new factors must be considered than traditional clinical settings. This part will go to the discussion and analysis part, so it is not critical at this point.

1. **Conclusion**

Both the technical and STS project have focused on the mobile mental healthcare technology. The technical project focuses on the improvement of study based on the evidence from two previous studies, and hopefully our recommendations can help the Mindtrails group construct the new study with a better interface and structure. The deliverables will be a report about our recommendations on the new user interface, a report of what we have observed according to the user response data with recommendations on the study structure and the Capstone team's presentation.

Through the STS project, the identification of ethical issues in mental healthcare technology can help locating potential ethical concerns in the usage of this technology. Being aware of these ethical concerns, designers and researchers can give more user-friendly designs by keeping these concerns in mind while working on the development of this technology. For example, if a certain technology identity is particularly susceptible to the influence of uncertainty in the treatment process, designers may be advised to give corresponding users more feedback about the system to make them better adopt this technology.

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