Towards the Design of a Mobile Mental Health Self-help System for Emergency Rescuers
A Pilot Study

Manning Li and Jie Hou
School of Business Administration, Northeastern University, Shenyang, China
School of Information Science and Engineering, Northeastern University, Shenyang, China

Keywords: Social Impacts of Information Systems, Human Computer Interaction, Design Science Paradigm, Emergency Rescuers, Mental Health Self-help Systems.

Abstract: This study explores the psychological need of emergency rescuers and proposes a strategy for addressing these needs through intelligent virtual advisory tools named ERMS. Drawing on the design science paradigm in the information systems discipline, we explore the key design principals that influence the value of the mental self-help system, through iterations of the user requirements elicitation, system design, development and theory testing. This paper focuses on a systematic review of the contemporary research work that weave together to inform our research emphasis and system design. In the next stage, we will propose our research framework, then testing the framework further through large scale experiments. This paper contributes to the advancement of Information Systems theories in the design of virtual advisory systems. It also highlights to practitioners a few important practical guidelines for the design and development of virtual advisory systems.

1 INTRODUCTION

When disaster happens, a large number of emergency rescuers need to urgently react to this situation and rush to the field of disasters. In face of extreme stressors such as catastrophic scenes, disaster victims and intense work-load, there is a high chance (around 1/3) that they will suffer from Acute Stress Disorder (ASD), which, without timely and proper intervention, can develop into life-long chronic mental problems(Te Brake et al., 2009). However due to a lack of qualified psychologists in developing countries, we do not have enough resources to carry out large-scale intervention strategies.

Inspired by the recent champion of online psychological therapies in developed countries such as UK and Australia, our study sets out to explore, following the IS design science paradigm, how to design an effective online mental health self-help system to empower rescuers in developing countries – so that it facilitates their healing, personal growth and mental well-being to be able to continue their invaluable service to the community.

This study is also enlightened by the recent emergence of a large number of virtual advisory services in many fields, such as healthcare, travel, commerce and academia. These virtual advisory services play a vital role in people's lives by providing timely and effective advice for users to accomplish a variety of tasks. However, to our knowledge, there is little study that systematically studied the design principals and the social impact of mobile mental health self-help systems for emergency rescuers.

Motivated by the urgent need in practice and the gaps in literature, we propose a mobile Emergency Rescuer Mental health Self-help system (ERMS) to provide psychological first-aid to rescuers, in terms of personalized stress-relief and health promotion strategies. With the mobile ERMS, people can have access to self-help information anytime, anywhere and anyhow, which ensures interoperability, ubiquity, security and adaptivity (Yahmed et al., 2013). Consequently, in this paper we mainly explore: *What are the key factors in the system design that influence the value of ERMS?*

Overall, we expect that the study of the design principals for online mental health self-help system for emergency rescuers through the lens of design

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science theory has significant contributions to both theory and practice. Besides, it is important to note that mental self-help systems are frequently used to complement existing psychological resources in the national health framework, rather than aiming at replacing those health services provided by professionals.

In the following sections, we first review the theoretical background related to the design of ERMS. Following the design science paradigm, we present the detailed design principals for ERMS which evolve from the elicitation of insights from emergency rescuers using semi-structured in-depth interviews. Finally, we discuss the implications of the research and future research directions.

2 THEORETICAL BACKGROUND

2.1 Existing Work

Virtual advisory services have been widely adopted in many areas such as commerce, healthcare, travel and education. With their interactive nature, people can easily adapt to such services. In the modern society, especially in developing countries that strive for fast pace of growth, stress from career and life are common for many people. Virtual health advisory services have been well received by people with various health concerns. Consequently, there is a continued and growing research emphasis on the virtual advisory services in the healthcare area (Riva, 2005). Several representative studies are briefly discussed below.

The virtual doctor 'freeMD' looks like a real physician, underneath which is an expert system and a comprehensive medical database (Schueler, 2013). FreeMD performs medical interviews like a real doctor, users should answer questions about symptoms, after the interview, it will generate a report about the cause of your symptoms and when and where you should seek care. It mainly helps users determine the most appropriate time and place to receive care from a healthcare professional. However it has limited functionality and lengthy questions.

Another interesting example is the website named depressed little prince, established by the University of Hong Kong (DLP, 2013). Through the website, users can know some basic knowledge of depression and check their own emotional health. Users can also share their experiences and gain insights from other users. The website also provides some FAQs about depression, you can learn more by opening the "Door of Answers". This website is quite attractive and very helpful to the depressed person, but it only fits for people with depression and lacks of interactivity.

Those discussed virtual services above are all based on the personal computer (PC), as the rapid development of mobile device, people pay great attention on the mobile applications services, using of mobile computing and communication technologies in healthcare, which called the m-health (Phillips et al., 2010). Through m-health, people can establish a relationship with the health experts, who can provide efficient and timely medical assistance.

There have been many researches in m-health. Mattila and her colleagues (Mattila et al., 2010) propose a mobile application for personal health management named Wellness Diary (WD). Self-observation and feedback are WD's two main mechanisms. It can record self-observations related to health and behaviour, such as sleep, stress, smoking, weight, blood pressure and alcohol consumption. The application can automatically generate the graphical feedback based on the collected data to users. Because of WD's simplicity, mobility and fast and easy usage independent of location and time, WD is quite popular with people.

Another interesting mobile application is called UAHealth, which is designed and developed by Milošević and colleagues (Milošević et al., 2011). The application communicates through a set of sensors (low power ANT+ wireless standard with commercially available off-the-shelf sensors) in the wireless environment, it can work both online and offline. UAHealth is designed to monitor people's physiological signals, such as people's weight, heart activity and physical activity. These collected data can be accessed by users and medical professionals, in order to get some professional advices from the professors.

Table 1 in the appendix presents a summary of some relevant empirical studies in the healthcare self-services area, outlining the context, major functions, advantages and disadvantages. The table compares the strengths and weaknesses of each design constructs, so that we can keep the positive attributes and remove the negatives. Inspired by these researches, we design and develop ERMS based on the Android platform, in order to research the key factors in the system design that influence the value of the virtual advisory service.

2.2 Design Principals for the Virtual Advisory System

Design science research (DSR) has become an

increasingly important paradigm in the Information System research field (Gregor and Hevner, 2013). Design science is inherently a problem solving process, which aims at creating new and innovative artifacts, and expanding the boundaries of human and organizational capacity. In the DSR, knowledge and understanding of a problem domain and solutions can be achieved in the building and application of the design artefact (Hevner et al., 2004). Hevner proposed a view of design science, which is an embodiment of three closely related cycles of activities. The discussed three cycles are the Relevance Cycle, the Rigor Cycle and the central Design Cycle (see Figure 1).

The relevance cycle uses the requirement for the research from the application context as the inputs, and introduces the acceptance criteria for the research results' evaluation. It bridges the contextual environment with the design science activities. The rigor cycle provides the grounding theories and past knowledge to the research projects and adds the knowledge to the growing knowledge base. It connects the design science activities with the knowledge base of the research project. The internal design cycle is the heart of the design science research project, which iterates between the core activities and evaluation of design 'artifacts' and processes of the research. The hard work of design science research is mainly done in the design(Hevner, 2007).

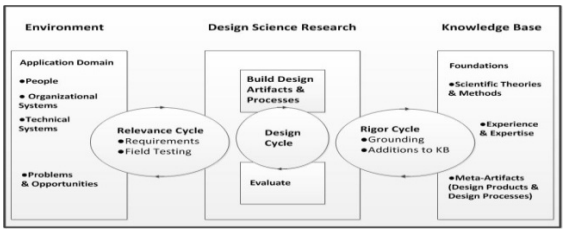

Figure 1: Design Science Research Cycles(Image based on (Hevner, 2007)).

Following the design science paradigm, we design our system prototype and explore the key values of mobile mental self-help system (See Table 2 in Appendix).

3 THE DESIGN OF MOBILE MENTAL HEALTH SELF-HELP SYSTEM

Following the design science paradigm, we take an iterative/innovative approach in system requirements elicitation, design and testing/feedback. Following the publication schema for a design science research study in MIS Quarterly (Gregor and Hevner, 2013), the artifact description section gives a description of the design artifact and the design search process, which leads to the discovery of the artifact design and demonstration of its credibility. We elaborate this non-linear and iterative process based on the three cycles as proposed by (Hevner, 2007).

3.1 Relevance Cycle

In order to design the mobile ERMS, we begin with interviewing ten emergency rescuers working in the fire brigade in Dandong, China. The average age of the participants is 25 years old. When we arrived at the interview site, we were told that due to the special nature of this occupation, most of the on-site rescuers are male. Thus, our interview participants are males and most of their education levels are senior high school (eight), with only two people graduated from colleges. Their working experiences in the rescue field ranges from 2 to 10 years. We took a semi-structured and in-depth approach to interview each emergency rescuer, lasting from 30 minutes to 50 minutes. Open, axial and selective coding methods were used to analyze the transcribed interview data (Glaser and Strauss, 2009). Based on the feedback from the respondents, we found several important themes emerged from these in-depth discussions:

• Emergency rescuers, especially novice employees, frequently experience fear, lack of confidence and feelings of anxiety. They frequently experience nightmare that reproduce the event after rescue tasks.

• The emergency rescuers have a pressing need to have more convenient access to relevant support and knowledge for maintaining their psychological well-being. However, most people being interviewed have biased attitudes towards mental health knowledge, they can't treat psychological problems properly. They have concerns about the psychological counselling, and often conceal their ailment and refuse to consult the doctor. Further, most of the new recruits haven't received sufficient formal training on mental health.

• Meanwhile, there is a lack of effective observation and treatment for new recruits' psychological situation in most cases. Many people mainly rely on themselves or talking to friends and fellow employees to alleviate their negative emotions, which frequently can't obtain the expected effect. It is also mentioned that some people resign or change their positions on account of the great psychological

pressure. Finally, there are no effective measures to monitor rescuers' physical and mental condition in terms of large-scale intervention strategies.

To address these afore-mentioned issues, respondents suggested the below functionalities for ERMS, including:

- Providing tailored professional psychology knowledge targeted at the rescuer occupation, displaying these information and knowledge lively and intuitively either in form of text, video or animation to give them a sense of human warmth and support.
- Having functions that support psychological self-assessment, and capabilities to generate personalized health evaluation report for further references.
- Monitoring the emergency rescuers' physical and mental indices with mobile devices or portable hardware devices.
- Displaying physiological data that reflects the mental status of rescuers intuitively in the form of graph or column diagram, and providing practical advices timely and effectively.
- Taking precautions to adjust psychological pressure for rescuers, such as communicating with an intelligent virtual advisor to enhance their sense of control and self-efficacy in dealing with negative emotions.

3.2 Rigor Cycle

Design science is born from a large number of scientific theories and engineering knowledge base. The knowledge base contains the experiences and expertise that define the state-of-the-art in the research domain, and the existing artifacts and processes in the application domain (Hevner, 2007). In this research, we mainly explore from the information systems literature, the key factors in the system design that influence the value of virtual advisory system (see Table 2), as elaborated in detail below.

Social presence refers to the extent to which an artifact is perceived as sociable, warm, personal, or intimate when interacting with it (Gefen and Straub, 2003). Cyr empirically showed that people have a higher sense of involvement when contacting with a human-like element in the virtual environment, which result in a sense of social presence(Cyr et al., 2009). This design theory is just suitable for emergency rescuers. In the relevance cycle, we investigate that the rescuers hope to communicate with a virtual advisor, who can make users feel warm and sociable.

Personalization is applicable to any browsing activity, it can be defined as any action that tailors the experience to a particular user. The action can range from making the presentation more pleasing to providing customized information and anticipating the needs of a user (Mobasher et al., 2000). Theng has proposed that the design should be made more user-focused and centered. Designers of the systems should allow users to build trust, but also to encourage trustworthy behaviour among users (Theng et al., 2012). This design theory caters for users' requirements, which can make emergency rescuers feel personalized when communicating with the virtual advisor.

Perceived transparency refers to the extent to which the content is perceived by the user as easy to read and understand. This relates to people's background knowledge, presentation of the content, use of examples in explanation and the inclusion of graphics (Xu and Chen, 2006). This design method can reduce the communication barriers, which can enhance the sense of social presence, so as to learn the psychological knowledge better.

Self-efficacy plays an important role in determining people's choice of strategies in face of challenging situations. Literatures suggested that virtual advisory systems for domestic violence victims can help with enhancing their self-efficacy in getting out of abuse. Consequently, we expect that emergency rescuers can gain higher self-efficacy in dealing with negative emotions after using the ERMS.

Furthermore, engagement (Sidner et al., 2005), sense of control (Koufaris, 2002), trustworthiness (Al-Natour et al., 2011) and perceived persuasiveness (Mazzotta et al., 2007) are all considered key factors by prior studies in information system design that potentially influence the value of ERMS.

These design principals from existing theory inform the design of ERMS, as discussed below.

3.3 Design Cycle

In Section 2 we reviewed existing work in the virtual advisory system, analyzing the advantages and disadvantages in designing the healthcare self-service systems. In addition, we conducted semi-structured and in-depth interviews with emergency rescuers to probe for insights for the system design. Synthesizing these findings from literature and practice, we propose the design for the mobile ERMS, which is a tool that specifically targeted at supporting the psychological need of emergency

rescuers. The ERMS is developed based on the Android platform. Users can access the service whenever and wherever they wish to, due to the high portability of the mobile end-user devices. This corresponds to the ubiquitous design features on account of the mobile platform as raised in user requirements. The system should support emergency rescuers in easing their psychological pressure timely and conveniently to ensure sustained mental health wellbeing of these rescuers.

The ERMS primarily contains six important functions, including consultation service, self-assessment, supplementary answer, self-testing and physiological monitoring (see the picture on the left in Figure 2). Several exemplar screenshots of the system are presented below.

After interviewing the emergency rescuers, we found that they would like the system to incorporate psychological assessment functions. Consequently, we design the self-assessment function. Through self-testing, users can obtain timely and personalized understanding towards their own psychological status， and the system will give some further professional advices for user reference (see the picture on the right in Figure 2), which can make users feel a sense of control over their personal situation through reading the detailed personal analysis report.

Figure 2: Main menu and self-assessment quizes in ERMS.

Except for the need of self-assessment, emergency rescuers are also eager to learn about psychological knowledge. Figure 3 shows the function of knowledge inquiry, which is mainly used for learning some fundamental psychology knowledge, such as depression, insomnia and anxiety. When the user clicks on the corresponding entry, he/she can explore the knowledge more in-depth. In this way, the system is designed to cater for individual users' need for learning. Furthermore, emergency rescuers can gain a better sense of support and control over their own situations after experiencing the ERMS.

Prior discussions on literature and rescuer insights indicate that the virtual advisory services should include the interactive function, which can

Figure 3: Knowledge inquiry functions in ERMS.

make users perceive a sense of social presence. Our mobile ERMS is also a kind of virtual advisory service that can provide the psychological knowledge and advices for emergency rescuers. Hence, our system should design a virtual advisor who has rich three-dimensional animated facial expressions and can communicate through both voice and text, which can make users feel like interacting with a real person to enhance the sense of social presence and transparency. Figure 4 shows exemplar screenshots for the consultation service. The virtual advisors can communicate with the users by voice and text. We choose the voice package of company iFLYTEK, which can make the users enjoy the fluent speech communication. In addition, the advisor can show different facial expressions and movements. This corresponds to the requirements of interactive system design and the rescuers' need for communicating with a virtual advisor who can adjust their pressures. Such a system design can enable users to feel social presence, personalized and engagement so as to relieve their own psychological problems effectively.

Figure 4: Interactive virtual advisory functions in ERMS.

During the process of communicating with the virtual advisor, if the advisor doesn't know how to answer, the system will submit the questions into the supplementary answer functional module (Figure 5). Users can provide their own answers or inquire other users' solutions. If the user is satisfied with the answer, he/she can click the 'support' button to

increase the probability of the answers to be adopted. This function can produce a sense of interactivity and replenish detailed knowledge for users.

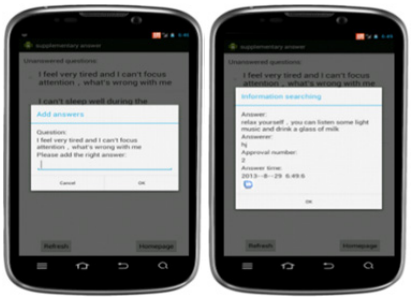

Figure 5: Functions of trainig the virtual advisor in ERMS.

Figure 6: Monitoring psysiological signs.

From existing studies and rescuer interviews, we found that it is important to allow emergency rescuers to monitor their physiological and mental indices anywhere and anytime. Thus, in order to monitor emergency rescuers' physiological signs, we use a medical device that can measure heart rate (HR) and heart rate variability (HRV), which can be read by mobile smartphones with bluetooth data communication (see figure 6). These physiological data is presented in the form of graphs and tables, thus users can understand their own health condition at a glance. According to these collected data, we analyze and come up with personalize measures for emergency rescuers. In exceptional situations, if there is something more serious with a emergency rescuer, the system will help him/her determine the appropriate place and time to receive professional advice. Then this ERMS become a complementary support for the existing mental health support framework in the society.

Overall, the ERMS uses the design science philosophy from literature for reference, and considers the 'grounded' requirements from potential system users. We believe that the proposed ERMS can assist the emergency rescuers in resolving the psychological problems effectively.

4 DISCUSSIONS AND CONCLUSIONS

There is an increasing frequency of natural disasters happening worldwide. Due to the high density of population, especially in developing countries, such incidents frequently result in great pressure on the limited rescue resources. Suffering from enormous emotional pressure, emergency rescuers may develop serious psychological problems. Moreover, the interviews conducted in this study revealed that emergency rescuers are hoping for timely and effective professional advices to ease their psychological pressures. Consequently, we propose a mobile ERMS to support emergency rescuers.

In order to optimize the value of ERMS, we have followed the design science paradigm in the Information Systems discipline in guiding the non-linear and iterative processes of user requirements elicitation, theory building, system artifact design and development, which will be followed by field testing in the next stage of the work. DSR is an important paradigm in the Information Systems discipline, it is essential for us to understand and communicate the design science research process, as it can establish the credibility of IS design science research among the various fields. Following Hevner's three cycle view of design science research, we took an innovative method in system requirements elicitation, system design and feedback. In the relevance cycle, we interviewed emergency rescuers to explore the existing problems and system requirements. In the rigor cycle, we reviewed a series of empirical studies to find out design theories that address the needs of emergency rescuers, and to help with establishing the system design requirements. In the design cycle, we discussed the design process of ERMS, which caters for the design theory reviewed in the rigor cycle and the emergency rescuers' actual demands as discussed in the relevance cycle.

To conclude, this position paper describes a pilot study exploring the key factors in the system design that potentially influence the value of mobile ERMS. This study gives interesting insights on the design guidelines for the virtual advisory systems in the mental health self-help area that may encourage further interesting discussions among both researchers and practitioners. For the next stage, we will carry out a series of large scale experiments to quantitatively examine the relationships between different constructs of interest as proposed in the rigor cycle, in order to refine our system design artifact further and to contribute to the body of IS

knowledge particularly in the area of human-computer interaction theories.

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APPENDIX

Table 1: Exemplar empirical studies in the healthcare self-services area.

Source	Context	Functions	Sense of Human Touch	Accessibility	Personalization	Engagement	Others
www.freemd.com	FreeMD based on PC	·Present a variety of symptoms by step-by-step guidance ·Generate a report about the cause of symptoms. ·Help users determine the most appreciate time and place to receive healthcare.	+Interacting with both voice and text +The advisor appears in the form of virtual human +With the rich expressions and actions	+With pictures to elaborate the questions +Giving effective advices -Lengthy questions	+Tailored advice for hospital	+Attractive -Limited functionality	+Fast
www.depression.edu.hk	Depressed little prince based on PC	·Learn some basic knowledge of depression · Check emotional health ·Share experiences and gain insights from other users.	+A sense of affinity -Lack of interactivity	+Helpful to the depressed person +Providing detailed knowledge	+Providing effective advices according to the users' feedback -Only fit for the depressed person	+Attractive +Easily to get engaged in it	+ References to relevant institutions for further support
Mattila, Korhonen et al. 2010	Wellness Diary (WD) based on the mobile platform	· Record self-observations related to health and behavior · Automatically generate the graphical feedback based on the collected data	-Lack of human interaction	+Simplicity +Presenting the information in the form of graph	+Easy usage independent of location and time -Lack of personalization and profiling -Lack of dynamic options	-Lack of sense of control and challenge	+Fast +Mobility
Milošević, Shrove et al. 2011	UAHealth based on the mobile platform	·Communicate through some sensors in the wireless environment ·Monitor people's physiological signals ·These collected data can be accessed by users and medical professionals	-Lack of interactivity	+Presenting the collected physiological signals with graph and table -Lack of diagnose after monitoring user's physiological signals	+Working both online and offline	-Not attractive -Limited functionality	+Monitor multiply signals at a time

Note: +: Advantages -: Disadvantage

Table 2: Key design principals for mobile ERMS from literature.

Study	Construct name	Definition	Influence factors
(Xu and Chen, 2006)	Transparency	The extent to which the content is perceived by the user as easy to read and understand.	·Background knowledge ·Presentation of the content ·Use of examples in explanation ·Inclusion of graphics
(Komiak and Benbasat, 2006)	Personalization	Perceived personalization is a customer's perception of an RA's personalization (i.e., the extent to which the RA understands and represents his or her personal needs).	·Identifying all product attributes important to that particular customer ·Capturing the relative importance among different product attributes ·Helping novice customers by mapping their shopping goals to product attribute specifications
(Sidner et al., 2005)	Engagement	Engagement is the process by which interactors start, maintain and end their perceived connection to each other during an interaction.	·Head gestures ·Facial gestures ·Hand gestures ·Body movements ·Similarity in communication style
(Gefen and Straub, 2003)	Social Presence/ Humanoid	Social presence refers to the extent to which an artifact is perceived as sociable, warm, personal, or intimate when interacting with it.	·Human or human-like elements appearing in virtual environments ·The use of expressive slang and humour
(Koufaris, 2002)	Sense of Control	Sense of control has been defined as the level of one's control over the environment and one's actions.	·Recommendation agents to enable customers to easily find what they need, learn more about it and quickly purchase it
(Al-Natour et al., 2011)	Trustworthiness	Trustworthiness is a belief that concerning the experience of interacting with the artifact relative to the utilitarian outcomes of that interaction, in regard to achieving specific goals (e.g., the shopping assistant is competent in choosing the right product).	·Internal similarity (intangible characteristics manifested through verbal cues such as perceptions, attitudes, and values) ·The decision process similarity ·The personality similarity
(Mazzotta et al., 2007)	Perceived Persuasiveness	Perceived persuasiveness refers to recommend the desired behavior by influencing, at the same time, the attitudes which may affect positively the intention to conform to it.	·By influencing his values and goals ·By enhancing the perceived relevance of attitudes for behavioral changes. ·By strengthening the Recipient's awareness of his ability to conform to the desired behaviour.