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Meaningful Smart Health Data: A Design Guide for Transparent Data to Enhance Self-Reflection

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ABSTRACT

The value of meaningfulness could adopt from individuals' reflective thinking. In the field of 'Smart Healthcare', the raising concerns regarding meaningfulness and awareness of health data require specific attention to the issues of lacking long-term use and losing the trust of the Internet of Medical Things (IoMT). This paper intends to propose a transparency-enhanced framework to facilitate self-reflection based on summarizing the related design attributes, which incorporates human perception of meaningful health data, the interconnection of self-reflection and meaningful health data, and design approaches. The proposed framework could contribute as a practical guide for designers to create and explore transparent and meaningful health data in future IoMT.

Keywords: User experience, Transparency, Human-centred design, Reflection, IoMT, Health

INTRODUCTION

Since the characteristic of the Internet of Medical Things (IoMT) is featured with connectivity, distribution, and context-awareness (Rowland et al. 2015, Chin et al. 2019), it has become a common understanding of constant monitoring from the surrounding "Ubiquitous" Environment. Concerning such sensing and monitoring situations for humans, devices, and the context, this study tackles a raising concern of tracking personal health data without awareness and lack of sufficient understanding of meaningful data.

In this context, meaningful data refers to useful information that can be enhanced the self-reflection of human activities to facilitate behaviour change. To reach various healthy living goals, meaningful health data aims to help users quantify and understand their health data and conditions. Meanwhile, the abundance of health data being collected and transferred continually through the network between different smart devices in any place and anywhere. The awareness of self-reflection, behaviour change, and privacy protection are limited perceived by users. Because data representation or recommendations are obscured, abstracted, and unexplainable.

The challenge has two folds. On one hand, users perceive useless data and negative experiences of IoMT devices, which lead to a large percentage of abandonment (Clawson et al. 2015). Ideally, high convenience should be achieved for supporting self-reflection of daily activities and vital health signals through meaningful health data. On the other hand, how transparent data can enhance users' awareness from a user experience (UX) perspective has limited evidence been provided (Hepworth 2019). Existing approaches demonstrate solutions for data transparency from legal and technic perspectives, such as the General Data Protection Regulation (GDPR) and blockchain. However, health data transparency (including data privacy, data security, and data visualization for various stakeholders etc.) is not only lacking awareness by users but also leads to the negative user experience of connected devices.

This paper explores the meaningful health data from three aspects: 1) Human perception, 2) Interconnection of self-reflection and meaningful health data, and 3) Design for meaningful health data. Besides such a review, a 'data transparency' based guiding framework is proposed to contribute and explore the relationship between UX design and health data.

RELATED WORKS

The gulf between user expectations and understanding of meaningful health data leads to negative experiences in the long-term using IoMT devices. To address abandoned issues, this study bridges the lens of Hassenzahl's model of user experience (Hassenzahl 2018) with reflection models to reorganize abandonment reasons, and abstract design attributes to explore the values of health data (Figure 1).

Human Perception of Meaningful Health Data

The perceived pragmatic level aims to achieve usability goals. The most conducted reasons are inaccuracy data and useless data (Clawson et al. 2015, Hermsen et al. 2017). Collected health data are shown as inaccurate records due to technic issues or are considered useless due to inconsistency with users' expected data type. Second, unclear feedback and insufficient explanation are others discontinued reasons (Lazar et al. 2015). Health data can serve as a useful tool for users to understand their activities and set better goals. However, demonstrating numbers does not make sense to users. Why feedback is recommended and what actions should do to fix issues are considered to be important information (Li et al. 2011, Feustel et al. 2018). Lastly, uncontrollable using is a widely concerned reason for abandonment (Attig and Franke 2020), since raising awareness of privacy protection. Users like to know what data are collected, what are the purposes of collecting, and who is data shared with. Without clearly tracing and controlling, they give up using their smart devices.

On the other hand, do not perceive authority, unwilling to take action, easily influenced by the environment (Lazar et al. 2015), and insufficient social communication (Hermsen et al. 2017) are abandonment reasons proposed at the perceived hedonic level. Despite most IoMT devices claim that

UX	Abandonment Reasons	Design Attributes
Perceived Pragmatic Level	Inaccuracy data	**Purpose of collection** (Personal use; Co-use)
	Useless data	
	Unclear feedback	**Content of expectation** (Demographic information; Similarity; Discrepancy; Trends; Baseline; Comprehensibility)
	Insufficient explanation	
	Uncontrollable using	**Awareness raising** (Notification; Traceability)
Perceived Hedonic Level	Do not perceive authority	**Content of expectation** (Explanation)
	Unwilling to take actions	**Behaviour change** (Timeline; Traceability; Personalization)
	Easily influenced by the environment	
	Insufficient social connection	**Social connection** (Comparison; Competition; Sharing; Conversation)

Figure 1: Summary of abandonment reasons and design attributes.

their algorithms or recommendations are based on research by authoritative sources, it is still difficult for users to trust the system due to a lack of transparency and accountability (Barth et al. 2022). Moreover, users also face barriers in maintaining motivation to change behaviours, since levels of goal and behaviour change are influenced by a variety of factors over time (Li et al. 2011). They are eager to find social connections through the same type of users to facilitate the achievement of goals (Feustel et al. 2018).

Interconnection of Self-Reflection and Meaningful Health Data

Since proper reflection can enhance critical thinking and increase awareness, prior research efforts investigated theories of reflection to contribute meaningfulness of data. Fleck & Fitzpatrick (2010) proposed five levels of reflection that inspired design strategies for reflection. In the beginning, the revisiting level (R0) and reflective description level (R1) present information descriptively with limited analysis. Human explores if the purpose of data collection and content fits their expectations. Further, the dialogic reflection level (R2) refers to the ideation of relationships. Human investigates similarities and discrepancies of data from multiple perspectives. To achieve fundamental behaviour change, the transformative reflection level (R3) and the critical reflection level (R4) describe a more abstract level of reflection. Human seeks critical thinking their behaviour data and take actions to maintain their goals. What's more, the extended work by Li et al. (2011) utilises an iterative stage-based model to investigate that purpose, context, history, factors, status, and differences are mostly concerned with data by users. Feustel et al. (2018) argued that social connection plays a critical role in personal health data. Human perceives others' data as a baseline, which motivates the user to explore and reflect.

Design for Meaningful Health Data

Limited prior research involves designing for reflection, which can be classified into three categories: data visualization, data physicalization, and conversational system. Visualizations of tracking data are the most widely

used approach since individuals can directly perceive patterns of data through visual appearance. Data can be presented in various graphical patterns. For instant, peak and valley, similar trends, and abnormal points can be easily recognized by users (Feustel et al. 2018, Bussone et al. 2019). Gamified style is another component of data visualization, which enhances social relationships between users. Through different shades of colours and elements in game design to emphasize ranking and competition, improving users' engagement (Hepworth 2019). At the same time, the visual comparison is also evidenced that peer health data could provide insight and enhance higher levels of reflection (Bussone et al. 2019). On the contrary, data physicalization is recognized as a non-visual sense, which provides an intuitive interaction approach with lower cognitive barriers. By manipulating physical representation, individuals can understand, learn, and perceive more complex and deeper information (Jansen et al. 2015). Moreover, studies have demonstrated that physicalization could empower users' desire for exploration and engagement, which conveys a playful approach to reflective thinking (Stusak et al. 2014).

With the development of natural language processing (NLP) techniques, personal counselling is indicated as a potential approach for enhancing self-reflection. Kocielnik et al. (2018) designed a conversational system to present individuals' health data through dialogues from human-AI interaction. According to their investigation, the form of dialogue delivers effective reflection to empower humans to a deeper understanding of their health data at the dialogic reflection level (R2), meanwhile, motiving and persuading individuals to take actions to achieve behaviour change purposes.

Recently, transparent and comprehensible data are suggested to provide explanations of behaviour. Human is not just exploring what makes sense of their health data but are also seeking the reasoning and decision-making processes within the intelligent system. Schelenz et al. (2020) proposed a practical guideline for increasing the transparency of the intelligent system. They demonstrated that transparency refers to intelligible information to users, explainable outcomes with why and how it makes, and controllable and interactive data. Therefore, transparency can also serve as a reflective tool to enhance autonomy and increase trust.

CONCEPTUAL FRAMEWORK

Based on Fleck & Fitzpatrick's reflection levels (2010) and Schelenz's checklist for transparency (2020), a design guide framework is constructed. As shown in Figure 2, design attributes (orange) reorganize key features from human perceptions, which map to the iterative reflection phases (grey) based on the human-centred process. To boost deeper reflection, transparency recommendations (blue) are overlapped on the design attributes to further facilitate.

First, in the discovery phase, the user explores the goals, context, and content of data collection to match their expectations. Designers should focus on providing information related to the revisiting level (R0) and reflective description level (R1). Information representation should be disclosed and

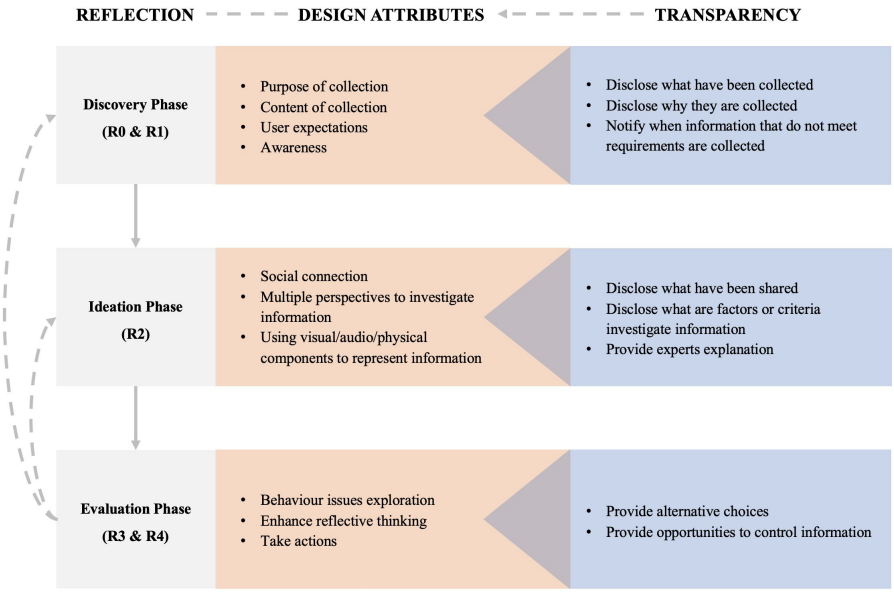

Figure 2: Framework for transparent data to enhance self-reflection. According to Fleck & Fitzpatrick's five reflection levels (2010), R0: Revisiting level, R1: Reflective description level, R2: Dialogic reflection level, R3: Transformative reflection level, R4: Critical reflection level.

notified what and why has been collected to raise users' awareness. Second, in the ideation phase, exploring and understanding personal health data from multiple perspectives is the major purpose of this phase, which is positioned in the dialogic reflection level (R2). Designers should consider the tradeoff between social connection with personal privacy. On one hand, shared data empower users to reflect on their behaviour from peer data and comparison. On the other hand, users have the right to trace and protect their privacy. Transparent data plays a critical role in this phase. Lastly, higher reflection levels (R3 and R4) are required in the evaluation phase. To address fundamental behaviour change and reflective thinking, users need to explore issues and take action to fix problems. Experts' recommendations, instructions, and user engagement could serve as practical approaches. Designers should provide alternative options to help users understand how system recommendations are decided and controllable operation to engage in the system based on their requirements. Through these transparency design approaches, delivering interactive information to help the user maintain self-reflection and percept the meaningfulness of their health data.

DISCUSSION

Reflection models provide a theoretical perspective to explore the meaningfulness for users. To make sense of a myriad of health data, this study proposes that transparency could provide a more intelligible approach to facilitate deeper reflective thinking, which enhances not only raise awareness of data privacy but also understanding of meaningful health data. In addition,

this paper reorganises design attributes based on prior works from the user experience perspective, which maps to iterative human-centred reflection phases. These attributes provide applied guidance for designers to consider in different contexts. In addition, presenting transparent and comprehensive information cannot guarantee the outcome of enhancing the understanding of the data. Instead, it may load additional cognitive requirements that confuse users into abandonment. Following this logic, further analysis should focus on the tradeoff between human perception and appropriate transparent information to avoid frustration and discouragement caused by overthinking. Moreover, the proposed framework should be validated from different perspectives. Our future studies intend to evaluate it from user perception of different scenarios, and design practices of utilizing the framework to figure out the potential of transparency to enhance the self-reflection.

CONCLUSION

This paper aims at ensuring make sense of data and transparency to enhance the IoMT experience. Meaningful health data is argued from human perception, self-reflection, transparency, and design approach aspects. Design attributes under such context are summarized to address issues of meaningfulness and awareness from the user experience perspective. Moreover, a human-centred conceptual framework is proposed to explore the interconnection of transparency and reflective thinking. The presented framework could be a design practice tool for future extension.

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