L'effet modérateur de la littératie numérique dans l'adoption des technologies de santé connectées pour le traitement des maladies chroniques

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Résumé :

Les technologies numériques ont pris une grande importance dans la santé. Le vieillissement de population dans les pays fortement développés mène à des pathologies chroniques impliquant un besoin de suivi régulier et des contraintes. Pour répondre à ces enjeux, des objets connectés (IoT) traquant des données de santé en continu sont de plus en plus adoptés. Ils permettent un suivi plus régulier de l’état de santé des patients, améliorant ainsi leur traitement et suivi à moindres frais. L’intention d’utiliser un objet connecté médical (IoHT) dans le cadre d’un parcours de soin peut être considérée comme de l’adhésion thérapeutique. La confiance est reconnue comme un des leviers dans l‘adoption d’une technologie et de l’adhésion thérapeutique. L’asymétrie de connaissance médicale particulière à la relation patient-médecin implique que la confiance est souvent médiée par celle portée au médecin et au système de santé. Dans le cas d’une technologie numérique, nous pensons que cette asymétrie de connaissance et le niveau de confiance qui en découle sont fonction du niveau de littératie numérique des patients. Et ainsi, leur perception des enjeux et risques liés à l’utilisation de telles technologies. Cette recherche vise à mesurer l’effet modérateur de la littératie numérique du patient dans cette adoption. Les questions de l’adoption des objets connectés de santé grand public ont déjà fait l’objet de nombreuses études. Cependant, leur adoption par des populations souffrant de maladie chronique dans un parcours de soin est peu étudiée. Mieux comprendre les leviers qui favorisent leur bonne adoption et usage dans le contexte d’un traitement présente donc un intérêt pour permettre un meilleur suivi thérapeutique.

Mots clés :

Santé, iot, confiance, littératie numérique, adoption

Introduction

Digital technologies have become central in healthcare systems worldwide (Makava, 2021), especially in the last few years due to the pandemic crisis (Amankwah-Amoah et al., 2021). France released in February 2022 a new digital service called "Mon espace santé"[1] described as a "trustful digital service co-developed with the healthcare ecosystem and citizens."[2] According to the World Health Organization (WHO), health care services will represent a significant challenge in the following decades, both for low-income countries and highly developed ones (World Health Organization, 2010). The latter is notably facing a significant rise in costs due to the evolution of non-communicable diseases such as heart diseases, cancers, and chronic conditions. The aging population and pathology such as obesity are among the main reasons for such evolution (Martínez-Caro et al., 2018). Thus, many efforts and investments are put in information and communication technologies (ICT) or e-Health (Baker et al., 2017; Jiang & Cameron, Ann-Frances, 2020; Lie & Brittain, 2015; Tun et al., 2021; Yin et al., 2016). e-Health is generally defined as the use of emerging information and communications technology to enable or improve health and health care (Arfi et al., 2021; Jung et al., 2022; Yin et al., 2016). New technologies allow improvements in connectivity, data analysis methods, or miniaturization of sensors enabling innovative technologies such as the Internet of Things (IoT). IoT "is a paradigm that connects real-world objects to the Internet, allowing objects to collect, process and communicate data without human intervention." (Pattar et al., 2018, p. 1). We use the expression "Internet of Health Things" (IoHT) to describe IoT in healthcare Information Systems. It is defined as a connected health device with health information systems, allowing remote healthcare. They are helpful in modern times regarding medical deserts, the increase of chronic diseases due to the aging in well-developed countries (Martínez-Caro et al. 2018), or life course (Ben-Shlomo & Kuh, 2002; Lynch & Smith, 2005). The Personal Health Information resulting from such technologies allows more personalized, preventive, predictive, participative and prevision medicine services often declared as 5P medicine (Blobel, 2019). At the same time, the use of the IoHT also answers the need to reduce costs in healthcare (Ilan, 2021; Kumar, 2011; Noel et al., 2004; Tortorella et al., 2020). However, to match this promise, IoHTs need to be considered reliable enough, practical, and easy to use to be widely adopted in care pathways and used consistently by the patient to provide reliable measurement for the care provider. The complexity of a technology, which might result in technostress for some patients, can lead to improper use of IoHT or non-compliance in monitoring or treatment protocol. On the other hand, the patient's Digital Literacy (DL) level may then be at stake in the adoption and post-adoption use of an IoHT. It induces a better perception of the pitfalls of such an adoption, such as data privacy and potential misuse of personal health data.

This paper aims to understand better the moderating effect of Digital Literacy in adopting IoHT. The author hypothesizes that Digital Literacy will increase the awareness and

[1] For more information, monespacesante.fr

[2] “Un service numérique de confiance co-construit avec l’écosystème de santé et les citoyens” Translated by author, https://assurance-maladie.ameli.fr/presse/2022-02-03-cp-lancement-mon-espace-sante

perceived risk of using IoHT, but lower the perceived complexity. This research will help healthcare professionals and technology providers to anticipate their potential reluctance or appetence for technology and better address it.

1. Theoretical Background

1.1 Adherence to Treatment and IoHT Adoption with Chronic Conditions

Patients do not necessarily respect the physician's prescriptions. This low compliance in treatment has been well studied in the medical literature due to the negative impacts. This lack of adherence is considered problematic for patients with chronic illnesses. (Vermeire et al., 2001). Adherence, or compliance, to treatment have been measured to significantly impact the positive outcome of a patient with chronic illness and healthcare cost (Sokol et al., 2005). According to the World Health Organization, adherence to long-term therapy is "*the extent to which a person's behavior — taking medication, following a diet, and/or executing lifestyle changes — corresponds with the agreed recommendations from a healthcare provider*." (WHO, 2003, p. 3). “Adherence to treatment in a chronic condition is central due to the specificities of such pathologies. The cognitive changes relative to aging people, often prone to chronic illness (Dunbar-Jacob & Mortimer-Stephens, 2002), the longevity of the treatment and sometimes its tediousness, or the global burden of chronic conditions leading to denial (Nam et al., 2008) are factors that are recognized to prevent adherence.

Information and Communication Technologies are increasingly used to improve the patient healthcare pathway. The technology may be used to assist the patient in treatment compliance, self-management, or remote monitoring (Istepanian & Al-anzi, 2018; Malasinghe et al., 2019). However, to benefit from these technologies, the patients need to adopt and use the IoHT as the physician prescribed it. The adoption and post-adoptive usage of the technology have to be considered an extension of treatment adherence. The extant model in adopting technology such as UTAUT (Venkatesh et al., 2003) or post-adoptive usage has to consider the specific patient-physician relationship.

1.2 The Role of Trust in IoHT Adoption and Adherence to Treatment

1.2.1 The nature and role of trust

Trust is recognized as a significant construct in most interpersonal and inter-organizational relation studies (Mayer et al., 1995) and, most recently, in Management Information System (MIS) literature. Luhmann (1979) presented trust to manage social and technical complexities. He also fostered the relationship between the risk taken by an agent when it is dealing with another. The bigger the risk, the more important is the role of trust. Lewis & Weigert (1985) presented risk as necessary for trust to arise. When an agent, person, group of individuals, or organization engages in a relationship with another agent, it may be difficult, even impossible, to monitor or control its behavior. This lack of control may result in opportunistic or unpredictable behavior from the trusted party. To overcome this perception of risk and pursue in collaborative or business relationship, trust is a fundamental construct to analyze (Mayer et al., 1995). Rousseau et al. (1998) presented the complexity of this construct, differently conceptualized according to science disciplines and very context-dependent (Palmer et al., 2000). Consequently, many researchers have pointed the fuzziness in the conceptualization of trust in the extant literature (Mcknight & Chervany, 2000)

Trust is conceptualized in the extant literature as a willingness (Gefen et al., 2008; Mayer et al., 1995; Tams et al., 2018), a belief (Fang et al., 2014; McKnight et al., 2002; Söllner et al., 2016; Xiao & Benbasat, 2002), or confidence (Huang et al., 2019; Rose & Schlichter, 2013). The most used definition of trust is "*the willingness of a party to be vulnerable to the actions of another party based on the expectations that the other will perform a particular action important to the trustor, irrespective of the ability to monitor or control that other party*." (Mayer et al., 1995, p. 712)

The literature is relatively consistent in the formative components of trust, namely competence (or ability), benevolence, and integrity. Some researchers include these components in defining trust itself, turning around the causality between trust and its dimensions.

Extant literature has analyzed many types of trustees, such as individuals, groups of individuals such as teams (Altschuller & Benbunan-Fich, 2013), institutions like third-party certification (Gefen et al., 2003) or organizations (Rousseau, 1998). Some researchers also suggested the possibility to trust an IT artifact (Lankton et al., 2015, 2016) such as an online website (Kim & Benbasat, 2006), a computer agent (Weiquan Wang & Benbasat, 2005), or knowledge management systems (Thatcher et al., 2011). These different objects of trust coexist and interact with each other. Muir (1994) developed the concept of "network of trust," a complex system where different parties interact and trust in each other. Söllner et al. (2016) demonstrated such a network with four targets of trust, IT itself, the provider of the IS, the community of the Internet, and the Internet. Wenbo et al. (2021) then proposed to go beyond the traditional assumption of dyadic trust to triadic, tetradic or more trust, conceptualized as "*the joint confidence between microsourcers and microsourcees in each other and the microsourcing platform, the overall purpose of which is to successfully fulfill a set of microsourcing transactions*" (ibid, p. 1314). Trusting an institutional structure will allow institution-based trust in an artifact such as an online marketplace, diminishing, for example, the perceived risk to be deceived (Pavlou & Gefen, 2004) or trust in a person such as a physician where ability is guaranteed by healthcare education systems and benevolence by third parties online reviews and ratings (Gong et al., 2021). This mechanism is necessary for situations with high risks, such as treatment adherence and compliance. The perception of risk in the following treatment, thus trust in that very treatment, will be mediated by the patient's trust in the physician and its expertise (Fan et al., 2021; Wei et al., 2020). When the care pathway involves IoHT, trust in technology, its reliability, and privacy protection are affected by another network of trust called attribution (McKnight et al., 2020). To be stored, processed, and shared, the data collected by the IoHT transit through multiple servers belonging to external providers with no ability to monitor where the data is stored and who will access it. Trust is then affected by attribution. "*While one may or may not ascribe motives or dispositions to a digital system, one can and does ascribe them to the person(s) behind the system, and this may affect trust in the system*." (McKnight et al., 2020, p. 1019)

Considering the multiplicity of context and objects of trust in IT-enabled contexts and the complexity of their relationships, this article excludes the traditional way of conceptualizing trust as an interpersonal, dyadic system. We then retained the definition proposed by Liping Liu et al. (2012, p. 958) for trust in online stores. "*An individual's beliefs of security, privacy, opportunism, and transaction accuracy that reflect the merchant's ability and responsibility in managing the concerns.*" This definition, applied for the e-commerce context, is interesting

since it highlights the concerns of an agent dealing with a connected artifact. The resulting issue of data collection shared by multiple actors is close to IoHT matters.

1.2.2 Importance of patient-physician trust for treatment adherence

The patient's relationship with the care professional is central for patients' recovery and treatment adherence. Due to asymmetry in health literacy, the patient depends on the physician's ability, benevolence, and integrity, the formative componentd of the perceived trustworthiness of a physician. To be straightforward: a patient trusts the physician with his or her life. Trust in the physician leads to a positive impact on risk perception in treatment (Wei et al., 2020), treatment adherence (Halepian et al., 2018), patient satisfaction (Ditto et al., 1995), and even the use of technology artifacts such as Artificial Intelligence (Nundy et al., 2019). Recently, e-Health literacy and online resources for self-medication are slightly closing the knowledge gap between the patient and the care professional. However, new information-seeking behavior is expected to improve the patient-physician relationship, with higher involvement of the patient in its recovery, impacting their compliance to treatment. (Tan & Goonawardene, 2017)

1.3 e-Health Literacy: Digital Literacy in Health context

Digital literacy in Health context, or e-Health literacy, which includes the component of health literacy, "effectively *links health consumers to the outcomes typical of Internet use —that is, opportunities, possible harm, and inequalities (eg, being part of a minority or disenfranchised group, education, age, and gender)*" (Neter & Brainin, 2012, p. 1-2). However, they did not identify significant links with gender disparities. Age and socio-economical differences variables are to consider when evaluating the effect of digital literacy on IoHT adoption. The recognized effects of age and experience in technology adoption are consistent with these observations. Another aspect of digital literacy is Self-efficacy. It refers to people's beliefs in using a computer system successfully to support their work or daily activities. Recent studies showed the importance of self-efficacy in post-adoptive usage. In the case of e-Health, this post-adoptive usage is essential in the good adherence of the patient in the use recommendation of the IoHT. Lack of digital literacy may lead to technostress and risk awareness in using IoHT.

Healthcare information systems cope with private and sensitive data (Hsu et al., 2013, p. 6; Katsikas, 2000). Due to this sensitivity and privacy concerns, patients may refuse to give authorization to register personal health data in electronic health records (EHRs) (Angst & Agarwal, 2009). Using IoHT implies recording, storing, processing, analyzing, and distributing Personal Health Information (PHI). Due to its dynamic and often invisible process, this privacy concern is also considered when dealing with IoHT. The resulting Perceived Risk (PR) is then a parameter to consider in adopting IoHT (Hsu et al., 2013). However, the perceived risk or security is not necessarily reflecting the actual risk or security. Hsu et al. (2013) highlighted how Perceived Security is positively affected by Information Security literacy, a digital and e-Health literacy subcategory.

2. Research Model and Hypotheses

This paper adopts the UTAUT framework developed by Venkatesh et al. (2003) adapted by Arfi et al. (2021) for IoT adoption in e-Health in a consumer context. This UTAUT model

has been developed to propose a predicting model of intention to adopt technology voluntarily. It includes four variables predicting intention to use: performance expectancy (PE), effort expectancy (EE), social influence (SI), and (FC). Venkatesh et al. (2003) also measured the moderating effects of age, gender, experience, and voluntariness of use on all these relationships. We decided to keep these results in our model. However, since gender is not considered as significant in digital literacy, we only retained age as a moderator of the effect of PE, LE, FC, SI, and PR on BI

H1 PE will positively affect BI

H2 EE will positively affect BI

H3 FC will positively affect BI

H4 SI will positively affect BI.

Arfi et al. (2021) included in their model the risk-trust relationship. The added Perceived Risk variable (PR) fully mediates the positive impact of Perceived Trust (PT) in IoT on BI. This model improves the understanding of intention to use IoT for health purposes in a consumer context. They only used age and gender moderators identified in the literature as significant in a medical context. The paper is willing to build on this model with the addition of Digital Literacy as a moderating effect on the impact of EE and PR on BI, as suggested by the research of Hsu et al. (2013).

H5 PR will partially fully mediate the positive impact of PT on BI

H6 e-Health literacy will positively impact PR and EE

Since our research is not based on a consumer approach but patient adoption in a healthcare track, we will limit SI to the trust in healthcare professionals. We hypothesis that trust in the healthcare provider's recommendation is moderating PR. Moreover,

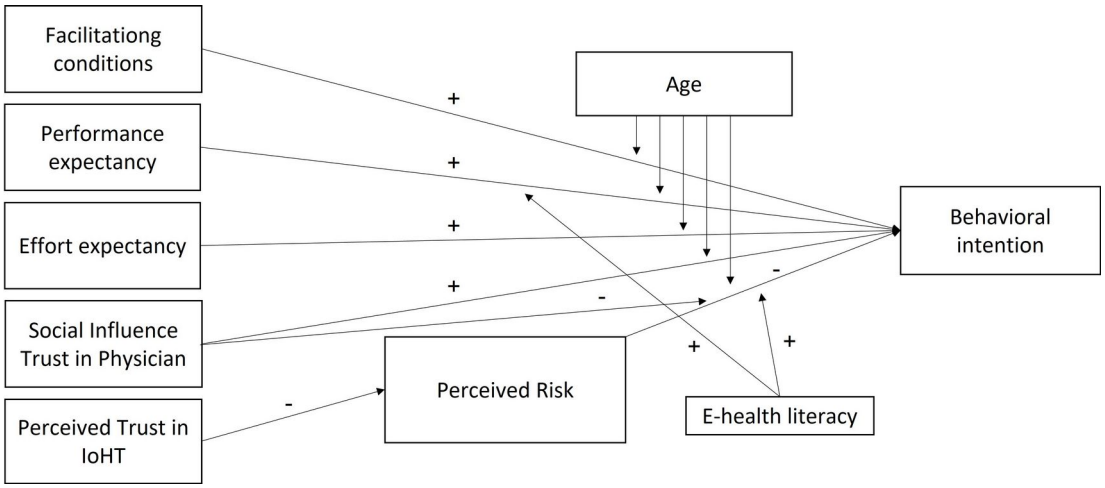
H7 SI will negatively moderate the negative effect of PR on BI

Literature identified age to moderate the standard UTAUT model. Since age is also correlated with the level of digital literacy, we expect age to moderate PR's effect on BI.

H8 Age moderates the effect of PE, EE, FC, SI, and PR on BI

Figure 1. presents the research model

Figure 1: Framework Model of the determinants of behavioral intentions relating to IoHT



3. Considered Research Methods and Analysis

3.1 Data collection

The author will use a non-probability convenience sample collected in cooperation with French hospitals and Liberal arts physicians for the sampling strategy.

3.2 Measurements

To be consistent with the previous research used to build our model (Arfi et al., 2021; Hsu et al., 2013; Venkatesh et al., 2003), our analysis will use the Partial Least Squares Structural Equation Modeling (PLS-SEM) following the method proposed by Saerstedt et al. (2017).

The scale used to measure PE, EE, FC, and PR will be inspired by the same articles. DL will be adapted from Hsu et al. (2013) scales for Perceived security and Information Security Literacy, and from Jung et al. (2022) for general e-Health literacy. SI will be using well-recognized scales proposed in Health literature (Anderson & Dedrick, 1990; Thom et al., 1999). Perceived trust in IoHT will use the scales proposed by Montague et al. (2009).

To identify relevant questions to answer our hypothesis in our specific medical context, preliminary interviews will be conducted with healthcare professionals who frequently deal with patients with chronic disease and recommend IoHT in the Healthcare pathway. A few patients with chronic and various e-Health literacy and age for whom IoHT is often recommended will also be interviewed.

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