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How Do User Participation and IT Self-Efficacy Influence User Attitudes Towards Smart Hospital Technology?

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Abstract. Smart hospitals aim to advance digitalization to provide better and safer care and increase user satisfaction by minimizing documentation burden. The aim of this study is to investigate the potential impact and its logic of user participation and self-efficacy on the pre-usage attitude and behavioural intention towards IT for smart barcode scanner-based workflows. A cross-sectional survey was conducted in a system of 10 hospitals in Germany that are in the process of implementing intelligent workflow technology. Based on the answers of 310 clinicians, a partial least squares (PLS) model was developed which explained 71.3% of the variance in pre-usage attitude and 49.4% of the variance in behavioural intention. User participation significantly determined pre-usage attitude through perceived usefulness and trust, while self-efficacy significantly did so through effort expectancy. This pre-usage model sheds light on how users' behavioural intention towards using smart workflow technology could be shaped. It will be complemented by a post-usage model according to the two-stage model of Information System Continuance.

Keywords. Smart hospital, user participation, self-efficacy, intelligent workflow, documentation burden

1. Introduction

Smart hospitals aim at designing workflows that are defined by seamlessness and intelligence and that are supporting comprehensive information logistics. The concept of a smart hospital should help healthcare professionals focus on better and safer care while increasing user satisfaction by, for example, minimising documentation and administration burden [1]. Putting this concept in place is a demanding long-term organisational undertaking that needs to bring together technology and people from early on. Building on the well-studied role of user participation [2], it can be expected that extensive involvement of the clinical workforce allows the development of smart technology to learn from human experience. Alike, it is the aim of user participation to develop a sense of ownership among the users and hereby increase their acceptance and motivation to use the technology. In addition, user participation is expected to generate a number of management-related, methodological, and cultural benefits [3].

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However, there are more factors fostering the behavioural intention and use of smart technology as suggested by acceptance theories that emphasize the role of perceived usefulness and effort expectancy [4]. Modifications of these theories extended them by a variety of other factors characterising the user. They include IT self-efficacy [5] which is defined as one's own capacity to know that one can handle IT successfully. It has been shown that individuals with a high level of self-efficacy are more likely to facilitate goal achievement and that perceived overall self-efficacy contributes significantly to the motivation and performance of the individual [6].

The aim of the overall study is to better understand underlying mechanisms that influence the behavioural intention and use of technology and applications for smart workflows. In this part of the study, we sought to identify relevant factors determining the pre-usage attitude and intention to use the system in a pre-usage stage. The research questions, therefore, asked (i) whether user participation and self-efficacy can make a difference in positively influencing the clinical workforce's pre-usage attitude and if yes (ii) what the underlying mechanisms are that can explain this influence.

2. Methods

2.1. Project description and user participation

To pursue this aim, a long-term formative evaluation study was initiated to accompany a group of hospitals on their way towards becoming a smart hospital. The Klinikum Region Hannover (KRH) is a system of seven general hospitals and three special hospitals in the Hannover region (Lower Saxony, Germany). KRH has approx. 8,500 employees, 3,400 beds and 100,000 cases per year. KRH's activities to implement smart workflows were bundled in the "ScanProCare!" project to automate routine activities and intelligently guide user management in selected processes. Twenty-six processes and tasks related to clinical materials management and documentation were chosen as examples of highly relevant processes by the KRH management that can be standardized and automated across the hospital system. The clinical materials management workflows comprised amongst others "material requests" and "inventory management", clinical documentation processes included "material consumption during an operation" and "implants used". Information embedded in the various processes was linked through the patient/visit ID.

"ScanProCare!" was launched by six one-day workshops. One of them on 30th Sept 2019 with 15 employees from the administration, five partly parallel sessions on 16th/30th Jan and 27th Feb 2020 with 55 clinical key users of the hospital units concerned (operating room, endoscopy, radiology, and cardiac catheterization laboratory (20), normal ward and intensive care units (21), delivery room and anesthesia (14)). The workshops were organized by KRH and moderated by two KRH managers, two researchers of Hochschule Osnabrück and two software engineers from the IT vendor. The goal was to identify (i) the current practice of the selected processes in the various units, (ii) further processes that should be considered in the project and to herewith lay the foundation (iii) of the requirement concept of the different project modules. In addition, all selected processes were studied by interviewing 25 clinical experts in all units concerned in four hospitals for two days each while observing them performing their tasks. The observations and the resulting process modelling were performed by a researcher from Hochschule Osnabrück

Software development, installation and rollout are conducted by GSG mbH Hannover Germany. The digital workflows enabled by the software are controlled using a set of rules in a central intelligent hub. It triggers the application systems to deploy messages intelligently to the subsystems and to capture the data at the point of care in the sense of smart information logistics. The end-users are working with an android-based mobile device – similar to a smartphone with an additional in-built barcode scanner. The software was implemented in two pilot institutions and accompanied by on-site training of the users. User feedback concerning the functionality and usability of the software app was immediately incorporated in an agile manner.

In summary, user participation was enabled through the six key user workshops with 70 key users, 25 expert interviews combined with the process observations and an agile programming style at the two pilot sites.

2.2. Data collection and conceptual model

A cross-sectional web survey methodology was employed to capture the data for answering the research questions. To this end, a questionnaire with 31 closed questions on the constructs *user participation*, *self-efficacy*, *perceived usefulness*, *effort expectancy*, *social influence* (covariate), *facilitating conditions* (covariate), *trust*, *pre-usage attitude* and *behavioural intention* was designed in accordance with the expanded two-stage model of Information System Continuance [7], which also includes the core constructs of the unified theory of acceptance and use of technology (UTAUT). The target group was the clinical staff in the relevant units of KRH (n = 4742) irrespectivly of wether they would use the system in the immediate or later in the far future. 310 participants (response rate = 6.5 %) returned a complete questionnaire. The survey took place anonymously and voluntarily in the period from May 2021 to September 2021. Figure 1 shows the conceptual model underlying the questionnaire with a total of 9 constructs. We applied structural equation modelling (SEM) to test the interrelationships between the constructs. Partial least squares structural equation modeling (PLS-SEM) was used to test the effects of *user participation* and s*elf efficacy* on the pre-usage belief and the attitude towards using barcode scanners.

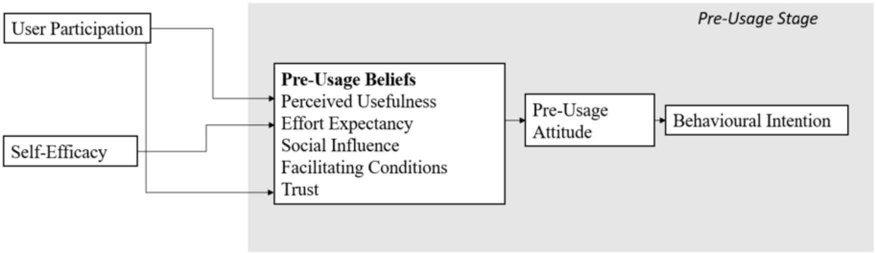

Figure 1. Conceptual model

3. Results

The sample consisted of data from 310 participants (female: 74.8%; male: 24.5%; divers: 0.7%). The median age was 47.3 years and median professional experience was 23.3 years. The occupational group was composed of nurses (78.7%), (medical) technical assistants (7.3%), and others (14.0%).

The structural equation model (Figure 2) explained 71.3% of the variance in *pre-usage attitude*, 49.4% of the variance in *behavioral intention*, and 35.5% of the variance in *effort expectancy* (Fig. 2). *Self-efficacy* and *user participation* were found to exert a positive influence. *Self-efficacy* influenced *effort expectancy* (β=0.596) and *user participation* determined both *trust* (β=0.264) and *perceived usefulness* (β=0.203). *Pre-usage attitude* was influenced by *trust* (β=0.388), *perceived usefulness* (β=0.273), *social influence* (β=0.209) and *effort expectancy* (β=0.178). It in turn determined the *behavioural intention* to use the scanner (β=0.570). Contrary to our initial assumptions, there was no significant effect of the *facilitating conditions* on the *pre-usage attitude* towards using the technology.

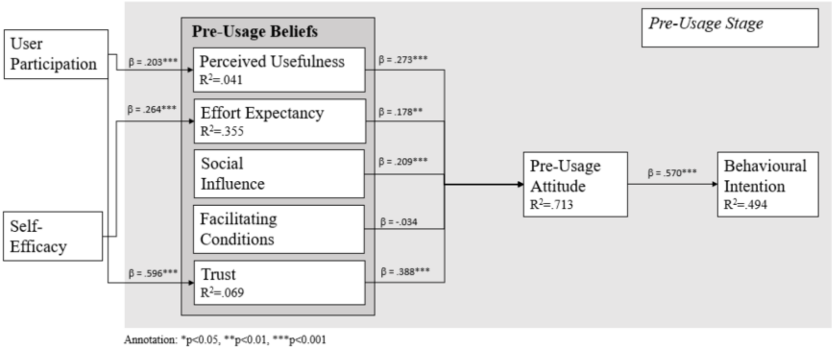

Figure 2. Structural equation model

All parameters assessing the measurement models pointed to valid specifications of the reflective models as well as the formative model in terms of convergent validity and internal consistency. In addition, sufficient discriminant validity was established according to the heterotrait-monotrait ratio of correlations. Also, no collinearity was found in the structural model, as all the inner variance inflation factor values ranged within the limits of 0.20 and 4. This model thus meets all requirements and can be regarded as formally valid.

4. Discussion and conclusion

The model proposed is able to explain a large percentage of the variance in *pre-usage attitude* and *behavioural intention*, the two main dependent variables. From an input perspective *user participation* shaped the *perceived usefulness* of the application and the *trust* that users laid in the system, whereas *self-efficacy* determined *effort expectancy*. With regard to research question (i), it can be summarized that both *user participation* and *self-efficacy* positively influence the *pre-usage attitude* towards the new technology. While *user participation* exerts this influence by building *trust* and allowing the users to develop an idea about the usefulness of the system (*perceived usefulness*), *self-efficacy* facilitates *effort expectancy*. It is through these mechanisms (research question (ii)) that *user participation* and *self-efficacy* promote the *pre-usage attitude* and eventually the *behavioural intention*.

The strong impact of user participation revealed in this study reflects the variety of measures taken in this project to involve the users. The involvement embraced explaining the need for the technology as well as giving users the opportunity to define the target processes and how the technology should ease their work. The active role they played combined with deep insights given to the users equipped them with an understanding and trust in the "why" and "how". The fact that user participation is paramount is not new [8,9], however, the explanations found in this study add further substance to its logic.

While user participation is an active measure at the organisational level, self-efficacy that determines effort expectancy is a characteristic of the individual. Its role regarding technology acceptance is not new [10] - alike user participation, however, this study contributes to revealing the underlying mechanism. Contrary to our expectations and prior research [4], facilitating conditions did not affect acceptance in this study.

The low response rate may be due to the fact that only persons responded who felt that this project had an immediate impact on their work. As a pre-usage concept, this model cannot explain the actual use of the technology. Its value for the entire technology adoption process is therefore limited and has to be extended regarding the post-implementation and usage phase as proposed by the Information System Continuance model [7]. This part of the overall study is a work in progress: the post-implementation questionnaire has been recently deployed to the clinicians who now actually use the system. Modelling the post-implementation situation at various points of time and hereby stepwise capturing behavioural usage of the technology will render a complete picture of smart workflows in a future smart hospital.

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