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Technology-induced anxiety: Manifestations, cultural influences, and its effect on the adoption of sensor-based technology in German and Australian hospitals

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ABSTRACT

Sensor-based systems have healthcare transformation potential but acceptance problems jeopardize their diffusion. We theorize that perceived technology threats induce anxiety and diminish usage intentions. We use data from the pre-implementation phase in German and Australian hospitals to explore the formation of three types of anxieties, their impact on usage intentions, and the relationships between them and national culture. We find negative effects of relational and work-related anxieties on usage intentions while surveillance anxieties show no association. The anxieties can be partially linked to national culture characteristics. Our findings support implementation initiatives and offer a deeper understanding of technology-induced anxieties.

1. Introduction

The introduction of information systems has been plagued by failure because of missing acceptance [40,159], user resistance [88], or outright rejection [31,56]. Implementations of system innovations in healthcare provide a case in point, with many studies demonstrating acceptance problems and failure to adopt and use information systems that support healthcare operations [65,108]. A large body of research has sought the reasons for such failure in order to improve user acceptance (e.g., [159,160]) and implementation success (e.g., [109,133]) and to identify the reasons for inhibitions (e.g., [31,88]).

One perspective that has largely been ignored or examined only simplistically is the formation of *anxiety* in response to perceived threats from technology and anxiety's role in affecting users' decisions to accept or resist a technology. Technology-induced anxiety encompasses negative emotions, apprehension, and even fear associated with computerized systems [139]. While anxiety is by no means a novel concept in IS research [24,38,116,149,159], few studies examine specific technology-induced anxiety, focusing instead on general attitudes toward technology [116]. However, anxiety is a substantial driver of human behavior [20], p. 37–63; [153], so the failure to examine them presents a significant gap in the research.

In studying anxiety during technology adoption, we make two key contributions. First, we develop a *detailed account* of technology anxiety by distinguishing three types of anxiety and examine their effect on systems' adoption during the pre-implementation phase. This phase is particularly important, as it is characterized by design freedom, enabling sound responses to the anticipation and management of potential conflicts and barriers to users' acceptance that could jeopardize the implementation success [99]. We focus on sensor-based healthcare systems because this technology is particularly prevalent in health services. These systems have the potential to transform the healthcare sector and improve business value by increasing efficiency and effectiveness through automation and transparency of tasks [11,33,124]. However, their adoption in hospitals is also challenging [22,29,87]. Understanding the effects of anxiety in relation to this topic will help to ensure the success of their implementation.

Our second key contribution is our exploration of anxiety about sensor-based systems *across two cultural settings*. Most theoretical models in IS research – including IS models in relation to system development [95], decision support [113], and technology

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acceptance [115] – are examined in one country, so they may or may not apply to other cultures. Sensor-based systems in hospitals are globally important, as healthcare-related challenges are present in many countries, so understanding their acceptance and anxiety is a global challenge.

Instead of comparing two cultures, we explore national culture's direct influences on technology-induced anxiety in relation to sensor-based systems. The examination of direct cultural influences is a relatively new research approach to national cultural effects, as it measures culture on an individual level in order to derive general relationships that can explain cross-country differences in general [96]. Reinecke and Bernstein [130], for instance, identify a direct effect of cultural values on website-design preferences. In the context of our study, direct cultural influences could indicate that countries with certain cultural values are more likely than other countries to have technology-induced anxiety. This research paves the way to a global model that can explain the root causes of cultural differences.

We examine data gathered from nursing wards in Germany and Australia. The work context in both settings is comparable, and the two sets of data allow us to explore whether the effects of anxiety on user acceptance occur only in a particular national culture or they can be replicated in another national cultural environment. The cross-cultural setting increases the external validity of our study as the results indicate that our model is robust even in highly dissimilar national cultural settings.

We seek to answer two research questions:

1) Do different types of technology anxiety exist that impact the adoption of sensor-based medication support systems?
2) Does the national culture influence the formation of anxiety related to sensor-based medication support systems?

We proceed as follows: Next, we introduce sensor-based medication support systems and review prior research on behavior related to technology implementation, and technology anxiety. We further theorize about the influence of national culture on different types of this anxiety. Then we develop our research model, which explains the formation of technology-implementation anxiety and their association with national culture. We then discuss research design and measurement, followed by the results from our empirical study. We outline the findings to identify the influence factors that hospital managers can use to improve the chances of corresponding implementations' success. Finally, we discuss the main contributions and implications of our results.

2. Sensor-based medication support systems

The medication process consists of five phases [74]: drug prescription, drug transcription, drug preparation, drug dispensation, and administration of the drug. Medication errors can happen in all five of the phases of medication, but most of the errors occur in the administration phase, presenting a significant risk factor for hospitals [94]. Estimates suggest that fatalities that are directly ascribable to medication errors are among the top ten leading causes of death in hospitals, while the related economic burden reaches billions of U.S. dollars annually [163]. This problem is widespread and not limited to a single country [84,121]. About half of all medication errors are preventable [102].

Sensor-based medication support systems are information systems that collect and process real-world data to guide the phases of the medication process. Thus, they contribute to hospitals' risk management [86]. While drug prescription, transcription, and preparation phases (phases 1–3) depend heavily on the type of disease, drug dispensation and administration (phases 4 and 5) as well as the related documentation requirements are highly standardized processes that are executed identically in nearly all hospital wards. We define a sensor-based medication support system as an information system that monitors, records, and controls work activities via sensors like RFID and other mobile devices in order to support phases 4 and 5 of the medication process. Peris-Lopeza et al. [124] provide a technical description of a corresponding system using RFID sensors.

In a sensor-based medication support system, sensors tag patients and medications, and nurses and physicians use mobile devices to scan the sensors to identify the patients and medications. The patient's medical information is displayed on the mobile device, including diagnosis and administrative orders. This process reduces the risk of misinterpreting handwritten information, which is often a problem in healthcare [10,63]. Before the medication is administered, the mobile device compares the order with the prescribed medication, and if the two do not match, an alarm informs the medical staff. The documentation of the medication process (e.g., patient ID, remedy, dose, nurse ID, date, and timestamp) can be conducted automatically, which reduces paperwork and improves efficiency [124]. The system also provides functionality for monitoring electronic performance [122], as the recorded data can be used to assess staff performance. Table 1 provides an overview of the different objectives and related functions of these systems.

3. Theoretical background

3.1. Behaviors during IS adoption

Research on user acceptance uses several theoretical streams to explain how and why users adopt new technologies. Most studies in the healthcare domain build on the technology acceptance model (TAM [40] or more recent models, such as the unified theory

Table 1
Functionality of sensor-based medication support systems.

Objective	Functionality	Technology	Related References
Prevention of medication errors	Control identity of the patient.	Patient identity is determined via sensors (e.g., in bracelets) before drugs are administered.	[12,14]
	Ensure that the correct remedy is administered.	Drugs are pre-packed in containers tagged by sensors. Drugs and patient identity must match.	[17,73]
	Ensure that the correct dose is administered.	Sensors on drug containers refer to dose information. During medication the dose is compared with the medical records of the patient.	[14,124,164]
Authorization	Ensure that only authorized staff can administer remedies.	Staff uses mobile devices that determine whether the user is authorized to administer drugs to a particular patient.	[89,90]
Documentation	Recording of the medication.	Staff uses mobile devices that record relevant data such as staff ID, patient ID, drug, dose, time and date.	[28,32,37]
Performance measurement	Measurement of employee's work performance.	The recorded data is analyzed in order to determine staff efficiency.	[50,118]