How to Foster Compliance in Non-Integrated IT-Landscapes? The Case of Manual Medical Data Transfers

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Abstract

Due to the slow pace of digital transformation in many industries, IT-landscapes are still often non-integrated. Therefore, in industries with non-integrated IT-landscapes professionals still transfer data manually. One prominent example is the healthcare sector. Medical professionals often need to transfer medication data between different Health Information Systems (HIS) manually. Errors that occur during this manual procedure often go unnoticed and can have far-reaching health-consequences for patients. Based on the Deterrence Theory, we plan to examine how different formal sanction mechanisms are related to various types of medication errors. In doing so, we aim to demonstrate how sanction mechanisms can foster compliance in non-integrated IT-landscapes. In investigating medication errors from an organizational lens, we aim to extend current research on medication errors.

Keywords

Compliance in Healthcare, Formal Sanction Mechanisms in Digital Health, Medication Errors

1. Introduction

In many industries digital transformation is progressing slowly. As result, a significant share of Information Systems (IS) is still non-integrated. This means that these IS are not interoperable and data often cannot be exchanged in a standardized way. As result, data needs to be transferred between different IS manually, making the process of data transfers more prone to errors [1]. One prominent example for an industry with many non-integrated IT-landscapes is the healthcare sector. Although there is a multitude of digitalization initiatives aiming to integrate the healthcare IT-landscapes, medication data still need to be transferred between different Health Information Systems (HIS) manually. The manual medication data transfers often lead to errors [2].

In healthcare, medication errors are one of the most frequently occurring error type [3]. According to the World Health Organization (WHO) 10% of hospitalizations are a direct result of medication errors. Furthermore, the WHO estimates the costs associated with medication errors to exceed 40 billion USD each year globally [4]. Medication errors can occur in the manual procedures of prescribing, transcribing, dispensing, administering, and monitoring of medications (e.g., missing data) [5]. Medication errors can result in serious health consequences for patients and may even lead to a patient's death [5].

It can be assumed that in integrated IT-landscapes errors occur significantly less often, since the data can be transferred automatically [1,6]. However, as it will take some time until more IT-landscapes in healthcare are fully integrated and not all stakeholders may will be willing to integrate their systems, further research on the avoidance of medication errors is necessary.

Medication errors were identified as potential problems within Information Systems research years ago. However, in IS research, medication errors have only been investigated to a limited extent. Most studies in IS research investigate how Health Information Systems need to be designed to avoid medication errors (e.g., [7]). There is a rich body of literature on medication

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errors investigating how to prevent medication errors in medical science and the field of medical informatics. Many of these studies conduct real-world interventions and investigate the phenomenon in retrospective examinations, for example by analyzing medical documentations [5,6,8]. This approach is often applied in IS research as well [5,6]. Thus, there is still a lack of research that investigates organizational mechanisms that can help to prevent medication errors.

Primarily, research shows that time constraints, interruption during the manual data transfer, and inattention are reasons for medical errors [8]. In addition, as manual data transfers are time-consuming, it can be assumed that errors occur because medical professionals want to save time and risk to transferring the data inaccurately. Generally, medical professionals are responsible for the correctness of the medication data when transferring it. Thus, errors in the data transfer can be considered as a medical professionals' non-compliance. As medication errors are rarely identified, the probability that this non-compliance will be detected is low [8]. Therefore, missing sanctions may foster medical professionals' non-compliance.

Compliance research has shown that organizational sanction mechanisms may help to avoid professionals' non-compliance [9]. In healthcare, organizational sanction mechanisms are for instance implemented by defining and reviewing clinical guidelines [6]. Violating the guidelines can be sanctioned by disciplinary actions. To this background, we aim to study how sanctions can be utilized to avoid medical errors. By doing so, we contribute to compliance research by linking sanction mechanisms to different forms of non-compliance. Furthermore, we extend the literature in the domain of digital health by presenting organizational mechanisms that can help to prevent medications errors. Our research offers valuable insights to define policies that can help to prevent medication errors and can be transferred to other areas with non-integrated IT-landscapes. Accordingly, this paper aims to answer the following research question:

> RQ: *How do organizational compliance mechanisms affect different kinds of data transfer errors in non-integrated IT-landscapes?*

This research-in-progress paper introduces the identified research problem and outlines the planned research approach. The remainder of this paper is organized as follows: First, we provide an overview of the contextual background and the theoretical foundation. Second, we present our research model. Lastly, we outline our planned research design.

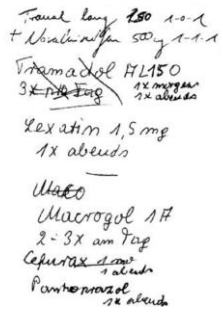
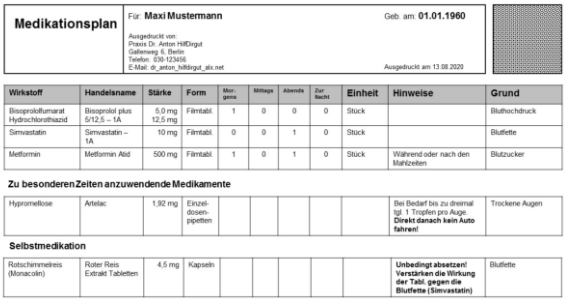
2. Contextual Background and Theoretical Foundation

2.1. Medication Data Transfers in Practice

In general, healthcare IT infrastructures involve different stakeholders such as primary care, hospitals, and health insurances. The healthcare sector faces the problem of many stakeholders operating their own IT systems which merely coexist. These HIS often store health data in different formats. Furthermore, many processes in healthcare are still paper-based. As mentioned before, that has the consequence that health data often cannot be exchanged in a standardized way [10].

In the healthcare sector, there is a multitude of digitalization initiatives such governmental initiatives that aim to allow patients to collect their health data in electronic health records (EHR) exist in many countries [10]. This for instance provides the opportunity to integrate the patients' medication data into HIS automatically. However, digital transformation is progressing slowly, and it will take some time until all healthcare stakeholders are integrated efficiently. For example, the rollout of the electronic health records in Germany started in 2021 and the rollout is still continuing [11]. This means, for instance, that medical data cannot be transferred digitally when patients are admitted to a hospital. Until EHR are rolled out completely, healthcare stakeholders are instructed to print out standardized medication plans in Germany [11] (see Table 1). Since not all healthcare stakeholders even have HIS, medication data still need to be transferred manually most of the time.

Table 1
Types of Medication Plans

Hand-written	Standardized-Printout
	
[11]	[12]

Medication data generally contains the following information: the names of the prescripted medications, information on the dose in which the medications are provided and, the frequency the patient receives the medications [8]. As the types of medication plans in Table 1 suggest, manual transfers of medication are accompanied by the risk of data being transferred incorrectly or incompletely. According to Callen et al. 2010 the following errors in manual medication data transfers can occur: *data is omitted, data is transferred inaccurately, and data is listed addionally* [8].

2.2. Research on Medication Errors

Research on errors in digital health distinguishes between interpretive and procedural errors [6]. Interpretive errors are based on the subjectivity of a decision [6]. An example for this are false diagnoses, as diseases are not always clearly identifiable. Procedural errors refer to deviations from norms and standards [6]. Since physicians are responsible for transferring the medication data correctly, medication errors are procedural errors.

To reduce procedural errors, corresponding literature suggests specifying procedural rules, observing and recording clinical actions, and reviewing medical professionals' compliance on a regular basis [6]. From this approach it becomes apparent that besides technical factors such as the design of HIS, it is also relevant to consider human, socio-technical, and organizational factors to prevent medication errors [14]. In line with that, studies on medication errors identified a wide range of causes which go beyond the design of HIS. Examples for human factors that cause medication errors are a lack of physical well-being and the resulting lack of concentration. A prominent socio-technical factor is physicians' missing attitude towards the use of HIS. From an organizational perspective, physicians often face heavy workloads which result in time pressure [8]. Design factors for instance refer to the structure and design of the HIS interfaces (e.g., [7]).

Although human and organizational factors are of particular interest to prevent medication errors, most of the existing research in the context of medical errors aims to avoid errors by improving the design of HIS. As one of the key approaches, corresponding literature explores the validation of the medical professionals' input and system notifications that display identified errors [7,15].

Since medication errors also depend on whether medical professionals even enter the data into the system, we argue that organizational mechanisms need to be defined in addition to implementing system notifications for incorrectly input content.

2.3. Deterrence Theory

Although medication errors can have far-reaching consequences for patients and are relevant, medication errors will rarely be identified [5,8]. Based on those circumstances, it can be assumed that medical professionals perceive the risk of errors being detected as low [7]. To ensure medical quality, healthcare organizations rely on formal compliance mechanism such defining clinical guidelines. To explain why these formal compliance mechanism work, research often draw on the Deterrence Theory (DT) [9,16].

Following the DT, people compare the probable costs and benefits of an undesired behavior. The DT originates from the field of criminology and aims to explain how people decide whether they commit a criminal act or not [16]. In this manner, the DT argues that the lower the external punishment, the more likely an individual decide for commit the criminal act [17].

The DT assumes that the expected punishment is influenced by the sanction certainty, severity, and celerity. The perceived certainty describes how likely an individual belief a potential sanction occurs. The perceived severity determines how strong the potential sanction is expected to be. The perceived celerity refers to the individuals' assessment how fast the sanction is given [18].

3. Hypotheses and Research Model

We aim to study the influence of medical professionals' perceived sanction severity, certainty, and celerity on human errors in manual medical data transfer. In particular, we aim to investigate whether perceived sanction severity, certainty, and celerity relate to different kinds of human errors in the medical data transfer.

Based on the three formal sanction mechanisms from the DT and the three error types mentioned in section two, we propose a research model with nine hypotheses (see Figure 1).

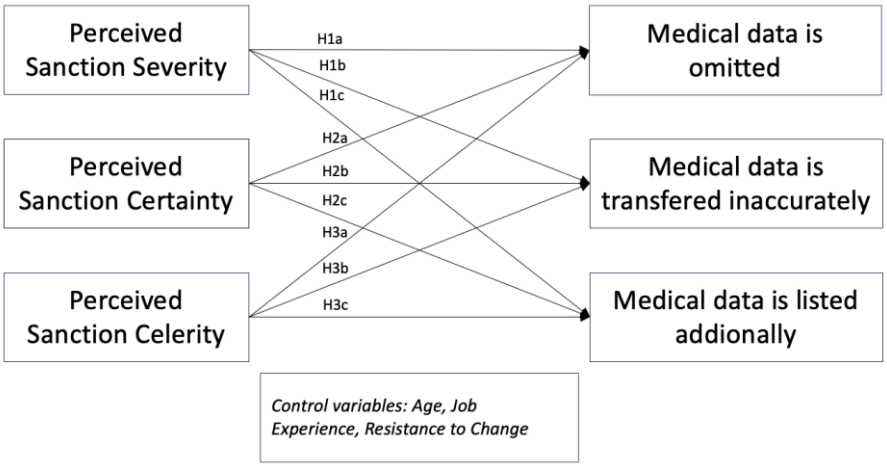


Figure 1: Research Model

Compared to other fields of compliance research, non-compliance can have far-reaching consequences for medical professionals. Medical professionals can be sanctioned internally (e.g., a hospital or the department of a hospital) but also externally (e.g., responsible authorities). In certain cases, medical professionals even risk losing their professional license. We therefore assume that medical professionals weigh the potential sanctions and benefits, such as time saved, in the process of transferring data.

In the context of manual medical data transfers, the severity of sanction describes the perceived impact a medical professional believes the potential sanction will have. Corresponding literature shows that a high perceived sanction severity discourages employees from non-compliant behaviors [9]. In the context of medication errors, it can be assumed that this mechanism is particularly effective as formal sanctions can have serious consequences for medical professionals (see Section 1). Hence, we derive the following hypotheses:

H1a: *The higher the perceived sanction severity, the less medical data is omitted.*
H1b: *The higher the perceived sanction severity, the less medical data is transferred inaccurately.*
H1c: *The higher the perceived sanction severity, the less medical data is listed additionally.*

Perceived sanction certainty refers to the degree of likelihood a medical professional believes a sanction holds. Recent studies reveal that perceived sanction certainty is negatively associated with non-compliance, as the high likelihood of being detected increases the costs of non-compliant behaviors increase (e.g., [19,20]). As mentioned before, medication errors often remain unnoticed and medical professionals therefore assess the risk of being detected as low (see Section 1). Thus, increasing the sanction certainty seems to be a promising mechanism to avoid medication errors. Thus, we formulate the following hypotheses:

H2a: *The higher the perceived sanction certainty, the less medical data is omitted.*
H2b: *The higher the perceived sanction certainty, the less medical data is transferred inaccurately.*
H2c: *The higher the perceived sanction certainty, the less medical data is listed additionally.*

Perceived sanction celerity relates to the period of time between the occurrence of the medication error and the sanction being pronounced. Studies found that swift sanctions affect employees' compliance positively since the sanction costs are decreasing with the time [9]. As outlined earlier, one important approach to avoid medication errors is validating the medication data input (see Section 2.2). In doing so, errors are identified immediately. Hence, medication errors can potentially be avoided by identifying and sanctioning these errors shortly after they appeared. Thus, we posit:

H3a: *The higher the perceived celerity, the less medical data is omitted.*
H3b: *The higher the perceived celerity, the less medical data is transferred inaccurately.*
H3c: *The higher the perceived sanction celerity, the less medical data is listed additionally.*

4. Research Design and Method

4.1. Data Collection

To test the hypotheses, we plan to conduct an online experiment with medical professionals in a between-subject design. In the experiment, a manual medical data transfer from a medication plan to a HIS is simulated. The target participants are physicians and nurses because they are commonly involved in the manual transfer of medical data. Most importantly, physicians and nurses are able to assess the potential sanctions that result from human errors in the medical data transfer.

The data collection procedure is as follows. First, each participant receives a short introduction with explanations on the task. The task will be to enter medical data from a medication plan to an online formular within a given time. To provide a realistic scenario, the online formular includes key design-elements of a HIS. Each medication plan contains six prescripted medications. For each of these medications, the participants are advised to transfer the name of the medication, the dosage, and the frequency of use. After the tasked is performed, the participants will be asked to complete a questionnaire which contains the sanction mechanism constructs of the DT.

To manipulate the three sanction mechanisms from the DT, the experiment is structured in a 3x2 design (see Table 2). For each mechanism two scenarios (low and high) are defined through different representations of policy elements. The policy elements will be represented in the formular. Thereby, we rely on the suggestions of corresponding literature to review medical

professionals' compliance on a regular basis [6]. Furthermore, we bring our experiment in line with IS research on medication which mainly focuses on the interface of HIS (see Section 2.2).

Table 2
Experimental Design

Sanction	Scenario	Head 3
Severity	Low	Indication that in case an error is identified, the input need to be corrected
	High	Indication that in case an error is identified, the medical professional receives a warning by regulatory authorities
Certainty	Low	No indication of monitoring
	High	Indication that transfers are monitored on a random basis
Celerity	Low	Indication that sanctions will be imposed within six months after the error was detected
	High	Indication that sanctions will be imposed immediately after the error was detected

4.2. Measurements

The in-task behavior will be measured by the total number of errors committed by participants. Although, compliance research most likely relies on scenario-based approaches by presenting a scenario and measuring the prospective behavior, we chose an experimental setting to shed light on the interplay between formal sanction mechanisms and different kinds of human errors. Table 3 shows exemplary errors that can occur.

Table 3
Exemplary Medication Errors

Type of Error	Name	Dosage	Frequency
Original	Misoprolol	5mg	1-1-1-0
Data is omitted	-	-	-
Data is transferred inaccurately	Misoprolol	10mg	
Data is added additionally	Metformin	500mg	1-1-1-0

The sanction severity, certainty, and celerity constructs will be measured on a 7-point Likert-scale. Therefore, we will use previously validated items from the information security and compliance literature [19,21]. We plan to add the three control variables age, job experience, and resistance to change.

As the independent variables are reflective constructs, we will use the partial least square (PLS-SEM) method for analysis. In the first step, we will perform an assessment of the measurement model by evaluating the constructs' reliability (composite reliability and items' factor loadings) as well as the convergent and discriminant validity. The medications errors will be evaluated by their respective factors' relevance and will be tested for multicollinearity [22]. In the second step, the structural equation model will be assessed by performing a variance-based PLS approach and using the bootstrapping method [22].

Research Continuation

This research-in-progress paper introduces our identified research problem on medication errors and summarizes our research approach to answer the question of how organizational compliance mechanisms affect different kinds of data transfer errors in non-integrated IT-landscapes. With the study, we aim to contribute to the literature on the DT by investigating the relationship between perceived sanction severity, certainty, and celerity and the occurrence of various types of non-compliance. Furthermore, we aim to show how formal sanction mechanisms

can be used to prevent medical errors. Practitioners shall be able to use the results to define policies that help to prevent errors in manual data transfers. To validate our research model and research approach, we invite other researchers to provide feedback on our study.

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