DISRUPTIONS OF THE TRIPARTITE STRUCTURE OF SYSTEM USAGE: EXPLORING FACTORS INFLUENCING THE EFFECTIVE USAGE OF INFORMATION SYSTEMS IN GERMAN HOSPITALS

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Abstract

As the employment of health information technology steadily increases the quality of care as well as the safety of patients increasingly depends on if and how information systems (IS) are used in clinical contexts. Still little insight exists in IS research about what determines and hinders the effective use of IS, especially in hospital contexts. By conducting comparative case-studies in two German hospitals, this research investigates how disruptions of the interaction between the three dimensions of usage (user, system, and task) impede the effective use of clinical systems. Although the results indicate that the impact on effective use varies across different disrupting factors, it is also shown that high degrees of effective use can only be reached when all dimensions of usage smoothly interact. This study, therefore, shows that characteristics of user, systems, and tasks have to be simultaneously aligned in order to improve outcomes of clinical IS usage.

Keywords: hospital information systems, effective use, physicians' usage habits, case study

1 Introduction

In the light of increasing medical knowledge, ever-changing clinical and administrative management strategies, and growing mobility and maturity of patients, the challenges of managing healthcare are constantly growing and will continue to change. Healthcare systems as a whole, as well as their underlying operating entities such as hospitals, face a trade-off between the provision of excellent healthcare and low costs (Winter et al., 2011). To meet these challenges one particular need is to store, retrieve, share, and use health-related information, data, and knowledge for communication and decision making (Brailer and Thompson, 2004). The medical care provided in hospitals is considered to be one of the most sophisticated and expensive forms of healthcare (Glaser, 2013). As it consists of many complex interdependent processes, effective information management is directly depended upon the understanding of these processes. Especially the computerization of cross-sectional medical documentation processes requires a thorough understanding of the entire medical care process. These facts elucidate that the management of information within a hospital is of great significance for improving quality and efficiency issues in clinical contexts (Winter et al., 2011).

There are several weaknesses regarding the structured acquisition and use of patient data and management of information in many hospitals. The lack of transparency and insufficient data quality leads to poor documentation and can result in other inefficiencies like duplicate examinations. Inadequate documentation of treatments, as well as inefficient control of treatment resources, do not just cause time losses and higher costs but frequently lead to major implications. E.g., in the course of treatment missing or (even worse) wrong information can lead to serious errors in medical and therapeutic decisions (Behrendt, 2009).

The effective usage of health information systems (HIT) can contribute to solving these problems. Many benefits are associated to the employment of HIT improving health and well-being for the general population (Devaraj and Kohli, 2003; Goldzweig et al., 2009; Wu et al., 2006). These are

- the lowering of costs of healthcare delivery,

- the freeing up of scarce healthcare professionals from administrative tasks,

- the amelioration of efficiency,

- the improvement of quality of care for patients, and

- the reduction of medical errors and adverse patient events.

However, despite these potential benefits, the usage of HIT is still impeded by several factors within clinical contexts. These include a mismatch of return on investment between those who pay and those who benefit, challenges to improve the workflows in hospitals, a lack of interoperability and standards, and worries about privacy and confidentiality. Moreover, the focus on the characteristics of the employees as end-users is often neglected (Mantas et al., 2010). But, similar to complex enterprise systems the successful implementation of health information systems (HIS) alone is not sufficient to realize the expected benefits and to increase individual as well as organizational performance. The users have to employ the systems to their full extent (Barki et al., 2007; Blumenthal, 2010; Fadel, 2012; Hsieh and Wang, 2007; Jasperson et al., 2005). However, as several studies show, clinicians often do not employ available information systems (IS) as planned, work around it, or only use a limited number of the features the systems provide (bvitg, 2012; Fadel, 2012; Holden, 2010; Holden and Karsh, 2009). Even in cases when employees use the whole breadth of functionality available, their actual usage differs in terms of effectiveness which in turn leads to the problems mentioned earlier. That means; the realization of the benefits mentioned is dependent upon both, *if* and *how* the medical staff of hospitals uses IS. Thus, assuming that the IS provided are suitable for the intended purpose it must be ensured that these systems are also used effectively and efficiently to obtain the potential benefits awarded to them (Burton-Jones and Grange, 2012).

Following Burton-Jones and Straub (2006) the usage of IS is a frequently studied phenomenon in the research field of IS. Its structure is tripartite comprising a user, a system, and a task. Taking into account the interaction and interdependence between these three parts as a basis and involving the definition of effective use of Burton-Jones and Grange (2012), this study seeks to identify and understand factors influencing the effective use of IS in the context of German hospitals.

In order to address these research objectives, a multiple-case study approach is deployed. First, a review of the literature about IS usage to identify actual conceptualizations and measures of the usage construct as well as the meaning of effective use and its shaping factors is conducted. Next, qualitative data are collected in two German hospitals. In the following the data collected is coded, summarized, and analyzed in order to find factors influencing the effective use of the systems investigated. To close the paper the results are summarized, and conclusions are drawn.

2   Theoretical background

The usage of Information Systems (IS) is a frequently studied phenomenon in IS research (Barki et al., 2007). Information system use is often conceptualized as dependent variable and a key success measure of the adoption, acceptance, and diffusion of information technology (IT) (Agarwal et al., 2000; Burton-Jones and Straub, 2006; Straub et al., 1995). Nonetheless, researchers recognized that the usage construct is both: not well conceptualized and often badly operationalized. In particular the value of using so-called 'lean measures,' such as frequency, duration, or variety of system functions used is under discussion (Burton-Jones and Straub, 2006). The established conceptualizations of usage and their measurements widely ignore *how* systems are actually used in organizations and do not take into account that usage is of multidimensional nature (Doll and Torkzadeh, 1998). Moreover, these conceptualizations overlook the richness of organizational contexts (Lassila and Brancheau, 1999). They often lack relevance in mandatory usage settings (DeLone and McLean, 1992; Delone and McLean, 2003) and ignore what levels of use should be considered sufficient for successful IS (Szajna, 1993). In addition, they are not capable of capturing the relationship between usage and the realization of expected outcomes (Delone and McLean, 2003).

Most studies in IS literature focusing on adoption utilize models that aim to predict adoption on the basis of user perceptions in relation to intention toward use (Davis, 1989; Venkatesh et al., 2003). Since most of these perception-based adoption models concentrate on intention to use an IS for predicting adoption, phenomena that go beyond the initial usage of the systems are not captured. Furthermore, established adoption models are typically not appropriate to examine other important issues associated to the usage of IS like improving organizational performance with IS (Benbasat and Barki, 2007). Further research on post-adoption phenomena is needed to take into account these issues.

First, it is important to take a look on post-adoption behavior in order to gain a deeper understanding of what determines continued usage of an IS. Research should take into account that users differ in their interaction with IS. While some users only employ a small amount of the features a system provides, others may use more functions, and therefore, the usage of the system gains importance in the way the users accomplish their tasks (Saeed and Abdinnour, 2013). Second, organizations frequently invest large sums of money to introduce new IS in order to improve their performance. However, the performance gains provided by an IS is contingent upon activities of users in post-adoption phases (Jasperson et al., 2005; Kwon and Zmud, 1987), which reinforces after adoption. In this regard, Jasperson et al. state that "organizations underutilize the functional potential of the majority of this mass of installed IT applications: users employ quite narrow feature breadths, operate at low levels of feature use, and rarely initiate technology- or task-related extensions of the available features" (Jasperson et al., 2005, p.526). Subsequently, it is expected that low degrees of utilization lead to underperforming IS (Jasperson et al., 2005) and typically to situations the systems creating more trouble than benefits.

As outlined above, it is essential that the systems are used effectively in order to obtain maximum outcomes from their usage. In this regard, Burton-Jones and Grange (2012) stated that organizations never implement IS just 'for the sake of usage'. Instead, the organizations pursue certain targets with the employment of IS such as to improve the quality or to reduce costs. Only if these goals are reached with the system, the usage of the system can be considered as effective. Therefore, the authors defined effective use as "using a system in a way that helps attain the goals for using the system" (Burton-Jones and Grange, 2012, p. 633). In addition, the authors relate the term effective use to both the effective and the efficient use of IS. Moreover, Burton-Jones and Straub (2006) claim that every examination of system usage should include three dimensions, namely: user, system, and task. Furthermore, Burton-Jones and Straub (2006) state that the richness of conceptualizations and measures of IS usage is contingent upon the integration of these three elements into any examination of the usage construct. The more elements –that are related to the usage phenomenon– are integrated, the richer is the conceptualization and measurement of IS usage. Another related concept in this context is task-

technology fit (TTF). TTF posits that individual performance and utilization are more likely to be influenced positively if the capabilities of the technology are well aligned to the tasks the user must perform (Goodhue and Thompson, 1995).Taking into account the definition of effective use and in line with the tripartite structure of usage, it is assumed that disruptions of the smooth interaction between the three dimensions of usage impede the effective use of information systems.

3 Research context

Based on the theoretical background outlined above, gaining understanding of the factors influencing effective use requires identifying disruptions within the reciprocal interaction between the users of a system, the task or process that has to be accomplished, and the system that is used to perform the task. Since user, task and system are mostly context dependent; a brief introduction to the research context is given in this section.

3.1 Hospital context

Hospitals –as opposed to other organizations–show some special characteristics regarding the usage of information systems. Following characteristics of users, tasks, and systems are expected to induce frictions between the three dimensions of usage and, hence disrupting their reciprocal interaction.

First, physicians as **users** of information systems are often reported to resist available information systems, work around it, or only use parts of the functions the system provides (e.g. Kane and Labianca, 2011). This is in part because many physicians fear the technology-enabled potential of third parties to monitor their performance and place restrictions on diagnosis and treatment decisions. As a result, the physicians' see their professional autonomy threatened (Blumenthal, 2002; FitzHenry et al., 2000). Moreover, the strict hierarchical structures within a hospital can substantially influence the usage behavior of subordinate physicians (Kane and Labianca, 2011). This is in particular relevant as physicians' professional careers are significantly dependent upon the benevolence of their supervisors (Vogd, 2004). Second, the processes and **tasks** that are executed under support of information systems by physicians in a hospital are directly related to the safety of patients. The medical information processing has a tremendous impact on the treatment of patients and subsequently their healing process. Decisions based on system-generated information can mean the difference between life and death. Therefore, processes and tasks have to be mapped well in the systems. Third, as the medical care provided in hospitals belongs to the most sophisticated, complex, and expensive forms of healthcare (Winter et al., 2011), it has to be ensured that the **systems** employed are suitable for the intended purposes, provide adaptability to changing structures and workflows, and guarantee in a very particular way data security and data protection.

3.2 Research sites and objects

The analysis of the study is carried out at the case level, incorporating four cases across four different departments of two hospitals (two departments at each hospital). Thus, the department is the unit of analysis. The research sites chosen for this study are two hospitals in southern Germany. The first hospital (Hospital A) has 17 clinics and 39 departments with about 1,500 beds. It provides care for approximately 67,900 in-patients and 336,000 out-patients annually. In this study, data was collected among physicians from the department of general, visceral and transplant surgery (Case 1) as well as physicians of the department of neurology (Case 2). The system under investigation is a medical findings system, which is a subsystem of the clinical workplace system and, hence, part of the hospital information system. The medical findings system was implemented recently before this study was conducted. At the time of data collection, all physicians used the system to sign medical findings documents electronically. The objective of the system is to ensure that all requested medical findings are noticed by a physician after the final document was released. With the abolition of the paper-based

approach, the organization pursues two central purposes with deploying the system. First, the usage of the system offers a certain kind of legal safeguarding. Second, the usage of the system improves the quality of treatment of patients as well as their safety.

The second hospital (Hospital B) is a maximum care hospital with a focus on orthopedics and neurology. The hospital unites acute care and subsequent medical and professional rehabilitation of orthopedic and neurological patients under one roof and has about 300 beds. It provides care for approx. 7,300 in-patients and 18,000 out-patients per year. Physicians of the department of anaesthesiology, intensive care medicine, and pain therapy (Case 3) as well as the paraplegic center (Case 4), are part of the study. In Hospital B, the system under investigation is a document management system. The system's purpose is to completely computerize the management of the process of writing discharge letters from the physicians' point of view, including the electronic forwarding and correcting of discharge letters. Before the actual version was introduced, the system only covered the process of writing discharge letters electronically. The process of correcting and releasing discharge letters was done paper-based. In terms of discharge letter writing, the main purpose of the recent version of the document management system is to facilitate and quicken the process of creating discharge letters. It is expected to improve the information transfer between physicians, wards, or medical institutions enabling more efficient and targeted further treatments.

The physicians across both hospitals are experienced computer users as both hospitals implemented a hospital information system years ago. However, the systems under investigation differ in its basic intended purposes as well as in the period since the systems are deployed. On the one hand, in Hospital A the medical findings system was recently implemented to replace the hitherto paper-based process of signing medical findings. On the other hand, in Hospital B the electronic process of discharge letter writing that has been implemented for some time, before it was extended by new functions. By means of the newly introduced functions, discharge letters cannot only be written electronically but also forwarded and corrected within the system. This was previously done by printing out the discharge letters and sending them to the supervisors who made their corrections, sent the document back with their annotations, and the author of the discharge letter incorporated the corrections electronically.

Despite their differences, the common goal of the systems is to map existing paper-based processes to information systems. However, the cases differ in regard of system types and period of time since the systems have been introduced and used by the physicians. For our study it seemed to be interesting to compare these different cases as it is assumed that the interaction between the user, the system, and the task is evolving over time by adaptation processes across the three dimensions of usage. Moreover, it is assumed that *disrupting factors* influencing the smooth interaction between the three dimensions of usage impede the effective use of the examined systems.

4 Research methodology

To examine physicians' effective use of information systems in a clinical context, this study uses a qualitative research method, specifically a multiple-case study. The application of case studies has a long standing tradition in testing and expanding initial propositions (Benbasat et al., 1987; Eisenhardt, 1989; Yin, 2009). Conducting multiple-case studies can be justified by two basic arguments: (one) this research is not focused on a typical and obvious case, and, (two) results from multiple-case approaches in contrast to single-case designs are expected to be more meaningful (Yin, 2009).

4.1 Data collection

The purpose and advantage of the case study approach is to uncover various nuances, patterns and latent elements that would be difficult to find with other (e.g. quantitative) research methods (Yin, 2009). In this study, data collection was carried out by applying two different methods (data triangula-

tion). First, physicians (mostly assistant physicians) who were part of this study were observed while using the information systems under investigation. A total of 12 physicians across four cases were observed during the study. In the cases 1 and 2 (Hospital A) four physicians were part of the observation process while in the cases 3 and 4 (Hospital B) two physicians were observed working with the system. The goal of the observations was to detect specific forms of individual usage behavior, as well as problems concerning the usage of the systems under realistic conditions. Second, expert interviews with all 12 physicians, who were observed before, and one medical information specialist from each hospital were conducted. The latter were conducted in order to validate statements of physicians concerning certain attributes and characteristics of the systems. The interviewees were often not aware of all attributes of the system. Additionally, meaningful indicators for the assessment of the effective use of the systems were identified during the discussion. Furthermore, for each case an interview partner in an executive role, mostly assistant medical directors, was chosen in order to get insights about managerial opinions about the usage of the systems. The observations should support the interpretation of the interviews as well as avoid bias due to reflexivity, as respondents tend to say what the interviewer actually wants to hear (Schnell et al., 2011). Following the suggestions of Yin (2009), the interviews were conducted in the form of guided conversations and not as structured queries. To structure the interviews, an interview guide was prepared. It consisted of general questions regarding the initial assumptions and, depending on the interview, questions on specific issues individually for each hospital or clinic. The interviews and observations were conducted in spring 2014. All interviews were recorded and subsequently transcribed for analysis (about 50,000 words, including observation notes).

4.2   Data analysis

To identify disrupting factors that may negatively influence the alignment between the elements of usage, interview and observation data were analyzed in a two-step process. First, all sections in the interview data showing indications and evidences on disrupting factors were coded. In the next step, the codes were analyzed, and similar codes were grouped into categories. Furthermore, each of the categories of disrupting factors was clearly assigned to pairs out of system – user – task, dependent on the direct negative effect asserted by the respective factors. Then each case was validated again to examine the occurrence of each disrupting factor previously identified. Next, the impact on the effectiveness of each disrupting factor was assessed. Following Burton-Jones and Grange (2012), effective use relates to using a IS in a way that helps attain the goals for using the system. The assessment of the factors was conducted twofold. First, the physicians were asked to estimate how critical the disrupting factors are regarded with respect to the goals one wants to reach by using the system. In addition, the experts were asked to assess how much more time is needed to circumvent the problems that arose from the disrupting factors. The participants were requested to assign their estimates on a scale ranging from *Low* to *Rather Low* to *Rather High* and *High*.

To assess the effectiveness of the medical findings system in Hospital A, two indicators which are derived from the examination of medical findings documents were combined. The first indicator represents the share of signed medical findings in relation to the total number of medical finding documents that were entered into the system. The second indicator represents the time between the entry of the document into the system and the signature of the document in the system and is termed wait time. Both indicators were discussed with the IT department of the hospital and confirmed as useful by two assistant medical directors of the hospital. Categories, ranging from *Effective Use* to *Ineffective Use* with two categories *Rather Effective Use* and *Rather Ineffective Use* are introduced. Effective Use in terms of the first indicator is given if the share of the signed documents in relation to the documents in total sums up to 95-100%. Rather Effective Use is reached if the share amounts 75-95%, and Rather Ineffective Use reflects a percentage between 50-75%. Ineffective Use is associated with a share that is smaller than 50%. Effective Use in terms of wait time, which is the second indicator, is associated with the share of documents that have been signed within 24 hours. Rather Effective Use is associated with those between 24 and 48 hours, Rather Ineffective Use is associated with those between 48 and

72 hours, and Ineffective Use is associated with those which were signed after 72 hours. Both indicators will be combined to derive one meaningful indicator.

The assessment of the document management system in Hospital B, in terms of effectiveness is based on one indicator. The indicator represents the share of patients who received a discharge letter right at the day of their discharge from the hospital (the indicator is derived from the examination of discharge letters). As with the other system, this indicator was discussed with a representative of the IT-Department and the assistant medical directors who were involved in the study. The categories for the first indicator stated above were adopted. Table 1 provides an overview of the interviews and observations conducted, as well as of the number of documents examined for each case.

Case	System	Observed and interviewed Physicians	No. of examined documents	Period (documents)
1	Medical findings	4	615	3 months
2	Medical findings	4	1465	3 months
3	Document management	2	221	3months
4	Document management	2	68	3 months

Table 1. Overview of observations, interviews, and examined documents

5 Findings

The following section discusses the major findings of our analysis, including the assessment of the effectiveness of the examined systems as well as an explanation of the observed disrupting factors.

5.1 System usage effectiveness

For Case 1, the share of signed documents in total amounts 98% (corresponds to 605 signed documents). That means that Case 1 can be assigned to the category Effective Use regarding the share of signed documents in relation to the total amount of documents. Considering Case 2, the share of signed documents amounts 63% (corresponds to 928 signed documents). Consequently, Case 2 can be allocated to Rather Ineffective Use regarding the total amount of signed documents.

The second part of the assessment takes into account the wait time between the entry of the documents into the system and the signature. In Case 1, on the one hand, a third of the signed documents that can be found in the system have been signed by a physician within 24 hours. But, on the other hand, the majority of 49 % was signed after 72 hours. Because of this, Case 1 can neither be termed effective nor ineffective. But, as the majority of the documents have been signed after 72 hours, the assignment tends more towards Ineffective Use. Therefore, it is at the end assigned to the category Rather Ineffective Use. In Case 2 the situation is similar. That means that 33 % of the signed documents have been signed within the first 24 hours after entry. In this case again the majority of documents have been signed after 72 hours. Thus, also Case 2 cannot clearly be designated effective or ineffective. As in Case 1, in Case 2 the assignment also tends to Ineffective Use. Therefore, Case 2 is assigned to the category Rather Ineffective Use.

Combining the results of the effectiveness assessments leads to following outcomes. Since the first part of the assessment resulted in the assignment to the category Effective Use and the second part has resulted in the assignment to the category Rather Ineffective Use, IS Utilization in Case 1 was scored as Rather Effective Use. In contrast, IS usage in Case 2 was scored as Rather Ineffective Use, since both assessed utilization as Rather Ineffective Use. As discussed above, for Hospital B utilization is assessed by the share of discharge letters that were on time. That means that the patients who were

discharged or transferred to another station get a discharge letter right at the time they are leaving the hospital or ward. This share lies across both Cases 3 and 4 above 95%. According to that, Case 3 and Case 4 are assigned to the category Effective Use. The results are summarized in Table 2.

Case	Assessment of the share of signed documents in total	Assessment of the wait time	Total Assessment
1	Effective Use	Rather Ineffective Use	Rather Effective Use
2	Rather Ineffective Use	Rather Ineffective Use	Rather Ineffective Use
Case	Assessment of share of discharge letters on time		Total Assessment
3	Effective Use		Effective Use
4	Effective Use		Effective Use

Table 2. Assessment of the effectiveness of the examined systems

5.2 Disrupting factors

Content analysis revealed several disrupting factors concerning the reciprocal interaction between the three elements of usage. The factors and their associated impact on the effectiveness of the usage of the system under investigation are depicted in Table 3 and discussed in detail subsequently.

The disrupting factors that were identified in Hospital A emerged in Case 1 as well as in Case 2 but not in Hospital B. That means that the two hospitals differ in the occurrence of disrupting factors. An assessment of the effectiveness of the system in Cases 1 and 2 showed a disparate picture. While in Case 1 the usage of the system was assessed as being rather effective, the usage in Case 2 was said to be rather ineffective. In both cases, the effective usage of the system is severely impeded by problems that arose from the occurrence of four disrupting factors (U-S 1, U-S 2, S-T 1, and S-T 2). These factors have an on average relatively high impact on the effectiveness, thus hindering the assessment to be totally effective. The disrupting factors causing the most critical issues in these cases are *Impeded Integration Capability* (U-S 2) and *Wrong Assignment* (S-T 2). In terms of *Impeded Integration Capability,* the medical findings system requires ways of working that are opposed to the work processes the physicians are used to. Especially that the physicians are forced to use workarounds to overcome the problems has to be seen critically. As a consequence, physicians are not able to effectively integrate the usage of the medical findings system into their daily work routines. *Wrong Assignment* refers to the fact that medical findings documents are not assigned to the right person or functional unit/ward.

Disrupting factors between user and system (U-S)			Impact on Effectiveness	Occurrence in Cases
U-S 1	Impeded Interoperability	The system provides the function of signing documents also with other systems (e.g. the patient organizer). But to sign documents within the other systems is difficult for the physicians due to laborious ways to do this.	Rather High	1; 2
U-S 2	Impeded Integration Capability	As the system requires ways of working that are contradictory to the usual work procedures and needs extra steps, it cannot be effectively integrated to the usual workflows.	High	1; 2

U-S 3	Opaque Designation	The patient information that is scanned into a digital dictation machine is in the form of an assigned number and not in the form of the patients' name.	Low	4
U-S 4	Lack of Intelligent Adaptation	The system doesn't automatically prioritize the frequently used functions or instances for the individual user.	Rather Low	3; 4
U-S 5	Cumbersome Request	The process to request a certain kind of examination is cumbersome.	Rather Low	3
Disrupting factors between system and task (S-T)				
S-T 1	Missing Button	Medical finding documents that were opened via the patient organizer system the physicians are used to in their daily work cannot be signed in the opened document due to a missing button.	Rather High	1; 2
S-T 2	Wrong Assignment	The medical finding documents are not assigned right to the responsible person or functional unit / ward.	High	1; 2
S-T 3	Impeded Integration of Data	It is not possible to integrate documents (e.g. medical finding documents) electronically into discharge letters.	Rather High	4
S-T 4	Access Restrictions	Sometimes discharge letters that were sent back to the physicians in order to correct them cannot be opened because the document is write-protected by the system.	Rather High	4
Disrupting factors between task and user (T-U)				
T-U 1	Misunderstood Purpose	Some physicians were not aware of the purpose of the system and therefore resist using it as it is seen as duplicate work with no additional benefit.	High	2

Table 3. Disrupting factors and their impact on the effectiveness

This jeopardizes goal attainment as it can happen that nobody feels responsible for a certain document which potentially leads to negative consequences regarding the effective use of the system.

These critical issues have not occurred throughout the Cases 3 and 4 in Hospital B. The problems (due to U-S 3, U-S 4, U-S 5, S-T 3, and S-T 4) the physicians faced in these cases also influenced the effectiveness of system usage but not to that extent as it was observable in Hospital A. In more detail, this is supported by the assessment of the impact of the disturbing factors on the effectiveness. Although all five disrupting factors affected the degree of usage effectiveness, only two were rated rather high. For instance, one of the most serious problems that emerged in Case 4 is related to *Access Restrictions* (S-T 4), which, in turn, is related to write-protected discharge letters. To solve this problem, the physicians have to request the IT department to re-release the discharge letter. This process is time-consuming and impedes physicians' work processes. In summary, it can be said that the physicians across both cases in Hospital B face rather minor problems with rather little impact on the effectiveness as opposed to the physicians in Hospital A.

Besides these findings the study indicates that the participating physicians perceive the information systems, they commonly employ in their daily work, as useful. However, the physicians also empha-

size that the systems itself should have to be improved and not the physicians' usage of the systems. As the doctors see their main focus on the treatment of the patients, which is by sure right, they request the systems to be aligned to the patient-centered approach they follow. For the same reason, the physicians also claim to have no time for extensive training. This is also supported by the statements of the employees of the IT departments. The IT departments regularly offer trainings and workshops, but the participation rate of such events is usually very low. In both hospitals, the physicians are also trained by own colleagues who were in turn trained by employees of the IT. And very often the physicians reported that they teach themselves in the concrete usage cases, which is learning-by-doing.

5.3 Interaction effects and impacts on usage

The physicians' way of working is primarily oriented on the needs of the patients. Thus, the characteristics of the physicians' work processes can be seen as patient-centered. As a consequence, physicians commonly utilize systems in a patient-centered fashion (e.g. go through the patients one by one using the patient organizer system, which enables them to have an overview of all relevant data of each patient). The physicians either reported this approach or it was obvious during the observations. Another central point that emerged in the study was that the systems often lack usability. The resulting restrictions hinder the physicians to take full advantage of the systems. Most of the disrupting factors that emerged during the study can be traced back either to the misalignment of the systems with the physicians' habitual workflows, i.e. the patient-centered approach, or to the limited usability of the functions of the systems. This leads to disruptions of the smooth interaction between the three dimensions of usage (user, system, and task) and has in turn negative impacts on the effective use of clinical IS. Thus, the problem-free integration of IS into habitual workflows and in turn the effectiveness of systems can be significantly improved by eliminating disrupting factors between pairs of elements out of the usage triad. Especially the alignment of the systems along the patient-centered approach the physicians usually proceed, can be seen as a very important factor to ensure the smooth interaction of the three elements of system usage.

In Hospital A both cases found to be less effective facing more serious problems than the cases in Hospital B. This is due to the presence of disrupting factors between all elements of usage with a significant impact on effectiveness. Between the user and the system, for instance, *Impeded Integration Capability* (U-S 2) relates to the system-induced requirement of ways of working that are contradictory to the usual work procedures and the need for extra steps hindering the effective integration into the usual workflows, hence, impeding effectiveness. Moreover, in connection with disruptions of the smooth interaction between the system and the task, the factor *Missing Button* (S-T 1) describes cases in which physicians are forced to deviate from the patient-centered approach they are used to. This is because the function of signing medical finding documents is implemented but not sufficiently integrated with the system the physicians normally use in their daily work. Beside these disrupting factors which occurred in both cases of Hospital A, the disrupting factor *Misunderstand Purpose* (T-U 1) emerged only in case 2. This factor reflects a poor alignment between task and user, as physicians resist using the system because they are not aware of its purpose, but blame the system to produce duplicate work with no additional benefit. Thus, this factor leads to serious problems endangering the attainment of the goals of system usage and has, therefore, a significant impact on the effective use of the system.

In Case 3 and 4 of Hospital B, the situation is quite different. The physicians in Hospital B were able to integrate the system effectively into their work. This demonstrates that the system is well-aligned with the needs of the physicians concerning their opportunity to execute their tasks mostly unimpeded from significant problems. Despite this, certain parts of the user interface could still be refined in order to achieve better usability and a higher user-friendliness. In addition, the expert of the IT department stated that the physicians do not take full advantage of the already existing possibilities which is again prompting calls for adequate user participation and training.

6   Discussion

This study was set up to gain insights on disrupting factors within the tripartite structure of usage influencing effectiveness of IS. Subsequently, implications for theory and practice as well as limitations and inspiration for further research are presented below.

6.1   Theoretical implications

Our work provides evidence that disruptions of the smooth interaction between three elements of usage (user, task, system) hinder the effective use of IS in a hospital context. Moreover, we found that the described interaction progressively improves over time dependent upon the elimination of the disrupting factors that negatively influence the reciprocal interaction between pairs of the elements. The study contributes to theory as the results confirm the approach that the validity of conceptualizations of usage progressively increases dependent upon the extent to which examinations integrate more elements of the tripartite structure of usage into the measurement. In addition, results show that the impact on effective use varies across different disrupting factors. Furthermore, findings of the study indicate that an efficient usage is not necessary for goal attainment; however it is critical for attaining the goals economically. Thus, to get meaningful results, researchers should involve both in their examinations; the assessment of effectiveness *and* efficiency of the systems.

6.2   Practical implications

Since disruptions between each of the pairs emerged in Hospital A and, hence, led to effectiveness issues, the case of Hospital A underlines the importance of aligning them. Based on the findings regarding the impact of poor alignment between user, task, and system, following advices are given to managers. First and foremost, since physicians usually follow a patient-centered approach, disruptions between the system and the task should lead managers to improve alignment of the system with the predominant work processes (i.e. the task) of the physicians. Therefore, the system has to be adapted in terms of the assignment of medical findings to relevant places or responsible persons (e.g. a physician or a ward). In the case of Hospital A, the right recipients of medical findings have to be identified. Hints in regard to this were given from the IT-consultant of Hospital A who stated that there cannot be two opinions. As from a legal point of view the physician who had requested the medical finding also has to sign it. Despite this, there is a discussion about who is the right recipient, as the preferences and opinions of the different clinics and wards within the hospital are substantially different in regard to this. Some of them say that it would be useful to assign the medical findings to a functional unit or ward while the others insist on the direct assignment to an individual physician. Generally Speaking, IT managers should pay attention to gain a thorough understanding of the processes and tasks the physicians execute in their daily work. Such understanding will help them to find adequate ways of mapping these processes in their systems. Furthermore, IT managers are advised to reflect the way physicians approach tasks when developing new or enhancing existing systems. In terms of that, most critical issues tackling physicians usage of IS can be solved by aligning the characteristics and attributes of the system with the needs of the physicians that arise from their working principles by eliminating the disrupting factors between the users and the systems. In general, practitioners should strive for user-friendly systems by encouraging physicians to participate in the development of new systems as well as in the process of refining existing systems. In addition, in the context of hospitals and in particular with respect to IS usage, physicians' time and willingness for training is limited. The development of adequate and effective training concepts in consultation with the physicians' needs is another advice for hospital managers emerged from this study. Training is also expected to help to overcome disruptions between the users and the tasks or processes, such as a lack of understanding regarding systems purposes. Moreover, the system designers should spend time observing the physicians' daily work activities and design a system that fit the physicians' needs instead of asking to ad-

just daily routines to the system's workflow. In summary, the alignment of every pair of elements out of the tripartite structure of usage by progressively eliminating the disrupting factors will most likely facilitate the integration of IS into physicians' work systems.

6.3 Limitations and further research

As this study examined effective use under the lens of the tripartite structure of usage, a natural direction for further research is to expand the research to other, possibly more complex systems. The study followed a consequent qualitative approach, leading to significant findings and contributions. In further research, it would be useful to validate or strengthen the findings by taking the advantages of quantitative research approaches or in particular by deploying analytical tools and utilities such as Data Envelopment Analysis (DEA) to broaden the understanding about the effectiveness of health IS. It could also be appropriate to combine qualitative and quantitative research designs under the umbrella of a case study approach. In the present study, 15 physicians from two hospitals are involved as well as two employees from the IT departments of each hospital. Although the number of physicians has proven to be adequate for this study, integrating a bigger number of physicians into the examination in the course of a quantitative study would possibly lead to a deeper and better understanding of the reciprocal interaction between the three usage dimensions as well as of the outcome of the systems in terms of effectiveness. Furthermore, it would be possible to expand the study by integrating other stakeholders like nurses and administrative staff which would be beneficial in getting a more holistic picture of the effective use of IS in hospital settings. Another limitation is that the IS under investigation are not exactly the same. This has possibly influenced the types of disrupting factors identified across the two hospitals. To overcome this limitation in future studies it is recommended to investigate more similar IS to check for particular IS-related disrupting factors.

7   Conclusion

This study aimed at assessing the effectiveness of IS deployed in German hospitals and to identify factors that hinder their effective usage. As such, this study is –to the authors' best knowledge– one of the first giving insights into the relationships between the alignment of users, systems, and tasks and the effective use of IS in a hospital context. Building on Burton-Jones and Straub's understanding of usage as well as Burton-Jones and Grange's definition of effective use, this study hypothesized that the occurrence of disrupting factors leading to misalignments between pairs out of system – user – task has an impact on the effective use of IS. By conducting comparative case-studies, this study identified factors inducing disruptions of the smooth interaction between the three dimensions of usage and showed that the presence of such factors interferes the effective use of clinical IS. Major findings indicate that the elimination of disrupting factors (e.g. by aligning the systems to the predominant patient-centered workflow of the physicians, adequate training and the involvement of users into systems' development and adaptation) leads to a better alignment of usage elements which in turn has a positive impact on effective use. Knowledge acquired from this study is in particular beneficial for practitioners' seeking to improve IS usage as it helps them to identify relevant barriers and as it gives hints on possible approaches to overcome them. Beyond its valuable practical implications, this study motivates further research on the determinants of IS usage.

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