5Understanding the Impact of Indirect System Use in the Hospital: A Control Perspective

Research-in-Progress

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Abstract

In the hospital, designated system users (i.e., principal physicians) are usually found to delegate system-related tasks to other people (i.e., agent physicians). This behavior is termed as indirect use. Despite the prevalence of indirect use, the understanding of its clinical impacts is limited. In this research, we first propose different effects of indirect use on clinical care quality and physician–patient interaction care quality. We then draw on the agency theory and organization control literature to identify the moderating effects of three control mechanisms: input control, process control, and outcome control. A total of 242 physicians from a general public hospital were surveyed to verify the proposed hypotheses. The results show that three control mechanisms moderate the impacts of indirect use in different manners. Implications and plan for future research are then discussed.

Keywords: Indirect use, clinical information systems, quality of care, control mechanisms

Introduction

With the promise of improving quality of care, hospitals worldwide have made substantial investments to embrace clinical information systems (CIS). Despite the wide adoption of CIS, prior literature has reported a significant discrepancy between how the system is expected to be used and how it is actually

used by the designated users (Ash and Bates 2005; Tong et al. 2008). With their high work autonomy, physicians are usually found to engage in the indirect use of CIS (Kane and Alavi 2008; Tong et al. 2008), which denotes the employment of a CIS through one or more intermediaries (e.g., subordinates or interns) to accomplish the work task (Boffo and Barki 2003; Kane and Alavi 2008). To the extent that the value of an information system hinges on how the system is actually used by users (DeLone and McLean 2003; Hsieh et al. 2011), this research focuses on exploring the impact of the indirect use of CIS on the quality of care.

Extant literature on information system (IS) use typically focuses on direct system use (i.e., system users personally employ a system to accomplish work) and posits that direct use can improve user performance (DeLone and McLean 1992; Jasperson et al. 2005; Kim and Malhotra 2005). However, the understanding of work impact of indirect use is limited. Without direct involvement, indirect use can free users from their heavy workload (Kraemer et al. 1993). Some researchers have recognized the importance of the indirect use of CIS in improving both the efficiency and quality of care in healthcare organizations (Kane and Alavi 2008; Sykes et al. 2011). For example, Kane and Alavi (2008) and Kane and Labianca (2011) verified that indirect use can alleviate designated users' busy workload as well as improve quality of care at the group level and compensate for the negative effect of IS avoidance at the individual level.

Despite the promises, the literature on agency theory alerts that the behavior of the intermediary user (i.e., agent) who actually performs system-related tasks may depart from the expectation of the designated user (i.e., principal) because of the information asymmetry and goal conflict between these two parties (Eisenhardt 1989). On the one hand, principal physicians probably do not clearly know the computer literacy and clinical competence of agents, who are not fixed for designed users. On most occasions, agents are junior physicians and interns who rotate among different hospital departments. Moreover, what agents are doing during the process of indirect use is unclear (Austin 2001). Given the information asymmetry, principal physicians cannot guarantee that system-related tasks are conducted to their expectations. On the other hand, principal physicians seek to use CIS in a quick and effective manner through indirect use; however, the attitude of agents toward indirect use may be different because doing work for others can cause additional work burden and work interruption among agents. This conflict can negatively affect the indirect use performance of principal physicians. With the seemingly contradictory results, theoretically understanding the impact of indirect use is crucial. Specifically, this study aims to address two research questions: What are the performance impact of the physicians' indirect use of CIS? What mechanisms can be employed to induce the desirable performance outcomes for the indirect use of CIS?

Organization control literature have posited that core challenges in an agency relationship can be effectively suppressed by control mechanisms (Austin 2001; Kirsch et al. 2002; Tiwana and Keil 2009). We identify three types of control mechanisms, i.e., input control, process control, and outcome control, which are suggested to govern the cooperation between principal and agent (Cardinal 2001; Jaworski 1988).

A theoretical research model is proposed and validated through a survey on 242 physicians from a general public hospital. The results show that indirect use exhibits different effects on a physician's clinical care quality and patient–physician interaction care quality. Interestingly, the three control mechanisms moderate the impacts of indirect use in different manners.

Theoretical Foundation and Hypotheses

Adapted from Tiwana and Keil (2009), control mechanism in this study refers to behaviors and activities that a principal physician employs to govern an agent's actions in order to promote desirable indirect use consequences. On the basis of Cardinal (2001) and Tiwana and Keil (2009), we identify three control mechanisms in the process of indirect use behavior (i.e., input control, process control, and outcome control) to understand their effects on the relationship between indirect use and quality of care. *Input control* denotes the control behaviors implemented by the principal before the agent starts performing the tasks (Snell and Dean 1992). In the context of this study, input control can be in the form of principal physicians clearly prescribing CIS-related tasks before these tasks are undertaken by the agent. This control can restrict and improve the agent's performance to some degree, but it cannot avoid the unexpected outcome without evaluations. *Process control* refers to the behaviors a principal physician

performs to monitor and direct an agent's actions when the agent executes the task. This can effectively curb the errors caused by information asymmetry (Elie-Dit-Cosaque et al. 2011) but can undermine the advantages of indirect use in releasing physicians from heavy workloads. *Outcome control* is exercised in the form of result evaluation and correction (Ramaswami 1996). A principal physician can check the outcome (e.g., ordering list) to ensure that the agent behaves in his/her interest. Conducting outcome control takes less time than performing the above control mechanisms.

Based on control theory, IS-use literature, and healthcare practice, this study proposes a theoretical research model (see Figure 1) to address the identified research questions. With the trend of delivering patient-centered services, hospitals have greatly emphasized the clinical care quality that physicians provide to patients and the relationship between physicians and their patients (Cheraghi-Sohi et al. 2008; Donabedian 1988; Venkatesh et al. 2011). Thus, we examine two forms of quality of care in this research: clinical care quality (i.e., technical quality that physicians provide to deal with a specific aspect of care) and patient–physician interaction care quality (i.e., physicians' interpersonal interaction and communication quality with their patients and their relational continuity). Technical performance depends on the skill and the time physicians use in implementing patient care strategies, and interaction performance depending on the information the physicians provide their patients in terms of management (Donabedian 1988).

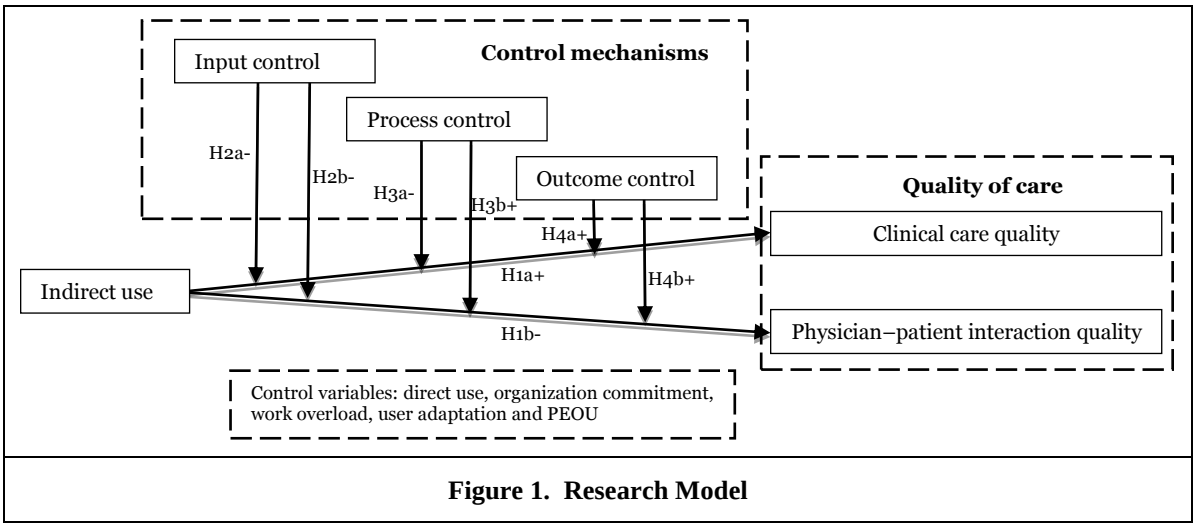

Figure 1. Research Model

Indirect Use and Quality of Care

Initially, differentiating indirect use from similar notions, such as no use or limited use is important, because under all these three conditions, users do not personally interact with the system. No use means that the user avoids interaction with the system completely. Limited use is conceptualized as the behavior that utilizes only a limited portion of all the available system functions (Jasperson et al. 2005). When a user engages in indirect use, the user can still complete all of the system-related tasks while avoiding directly interacting with the system. Under such circumstances, the principal user can arrange time in a more flexible manner to support his/her work (Kraemer et al. 1993).

In the hospital context, a principal user can indirectly use CIS with an agent who enters, searches, or view patient-related information (Boffo and Barki 2003; Kane and Alavi 2008). Kane and Labianca (2011) found that indirect use can compensate for principal users' CIS avoidance to some degree. When engaging in indirect use, principal physicians who do not need to personally interact with the CIS can accomplish system-related tasks (e.g., obtaining patient information recorded in the CIS) in a time-efficient manner. Therefore, they can focus and spend more time on core patient care activities (e.g., working out treatment plans and performing operations). This situation is considered the main cause affecting clinical care quality (Cheraghi-Sohi et al. 2008). Thus, we hypothesize:

H1a: Indirect use is positively related to the principal physician's clinical care quality.

Prior IS and healthcare literature has recognized that long-term direct interaction with the system can help users obtain a relatively rich understanding of the system and its information (Hsieh et al. 2008; Wager et al. 2009). Accordingly, physicians with more indirect use tend to be less familiar with the patient medical information stored in CIS than those with less indirect use. Given the importance of physician's knowledge of a patient in the physician–patient interaction and relational continuity (Cheraghi-Sohi et al. 2008), minimal familiarity with patient information of the principal physician directly affects the principal physician's physician–patient interaction quality. Once a patient comes to a physician for advice, the principal physician with minimal knowledge of the patient must refer to others or to a system to recall information. On the one hand, doing so delays communication and knowledge delivery. On the other hand, when patients observe that physicians do not personally check their record carefully, they may think that the physicians are insincere. All these deficiencies eventually affect the physicians' interaction and relational continuity with their patients. Therefore, we consider the following:

H1b: Indirect use is negatively related to the principal physician's physician–patient interaction quality.

Moderating Effect of Input Control

Input control refers to control behaviors taken by principal physicians before commencing with the system use tasks (Jaworski 1988). That is, principal physicians explicitly prescribe the methods and/or procedures to be adopted by agents in undertaking system use tasks (Tiwana and Keil 2009). In this manner, principal physicians regulate agent behaviors by instructing them on how to perform the work. However, evaluation procedures for input control are unavailable. Thus, principal physicians cannot ensure whether agents follow their instructions. Information asymmetry remains between these two parties. Meanwhile, input control can weaken the agents' freedom in decision making. Given the high priority on the autonomy of healthcare professionals (Emanuel and Pearson 2012), agents' attitude toward indirect use worsens. The negative feeling finally results in decreased effort and extended time in accomplishing these tasks for principal physicians. The provision of CIS-stored information to principal physicians through agents is delayed. Patients need to wait more when consulting with principal physicians, thereby affecting their attitude toward physicians. This situation not only undermines the time advantage that comes along with indirect use in clinical care quality but also weakens the physician–patient interaction quality. In other words,

H2a: Input control reduces the positive influence of indirect use on the principal physician's clinical care quality.

H2b: Input control increases the negative influence of indirect use on the principal physician's physician–patient interaction quality.

Moderating Effect of Process Control

Process control is conducted during the process of indirect use; this can govern the behaviors of agents through by monitoring and directing agent activities and operations toward indirect use (Jaworski 1988). Monitoring and modification can suppress the opportunistic behaviors of agents to some degree (Kirsch et al. 2002). However, significant efforts for governing agent behaviors during the process are needed. As the original intention of principal physicians' indirect use is to reduce heavy workloads and to spare more time for patient care activities, the time spent on monitoring and guiding how agents complete the work counteracts a portion of the time saved through indirect use. Despite the undesirable effect for clinical care quality, process control can avoid the information deficiencies caused by indirect use to a large extent. Thus, both principal physicians and patients can enjoy satisfying and sufficient information for the physician–patient interaction with process control. In this manner, the negative effect of indirect use on physician–patient interaction can be compensated. Thus, we propose the following:

H3a: Process control reduces the positive influence of indirect use on the principal physician's clinical care quality.

H3b: Process control compensates for the negative influence of indirect use on the principal physician's physician–patient interaction quality.

Moderating Effect of Outcome Control

Outcome control focuses on agent operation outcomes with CIS use rather than on how they accomplish these tasks (Tiwana and Keil 2009). In the outcome control situation, principal physicians only ask agents to do the system use work and to check the outcomes of accomplished work (Cardinal 2001). If the outcome has errors, principal physicians will ask agents to correct them (Ramaswami 1996). Compared with the process control that conducts many efforts to ensure that agents behave as expected, outcome control saves time and effort. With outcome control, principal physicians ensure that agents act in their interest with minimal effort and time. Therefore, outcome control can induce better clinical care quality performance. Moreover, outcome control provides agent physicians with increased freedom and trust in independently doing tasks, which improves the satisfaction of agent physicians. Under these circumstances, agents under this control mechanism are likely to be collaborative and willing to spend considerable effort to do the work to provide timely qualifying patient information to principal physicians. Once they communicate with patients, principal physicians can obtain high-quality information promptly and patients are satisfied. This qualifying information and patient satisfaction can enhance physician–patient interaction quality. As a result, principal physicians can guarantee both time for patient care and continuity relationship with patients through outcome control. Therefore,

H4a: Outcome control increases the positive influence of indirect use on the principal physician's clinical care quality.

H4b: Outcome control compensates for the negative influence of indirect use on the principal physician's physician–patient interaction quality.

Research Methodology

Research Setting and Data Collection

We aim to understand the effect of indirect CIS use on individual physicians' performance with regard to different control mechanisms. The focal CIS is an electronic medical record system (EMRS) employed in the inpatient department by a major hospital in China. As this study focuses on individual physicians' behaviors and performance, choosing a single organization helps control the effects of organizational-level variables. The focal EMRS includes the basic functions of clinical documentation and viewing, order tracking and management, and result management, thus, indicating its generalizability in other healthcare organizations (Wager et al. 2009). Every resident physician needs to accomplish daily work with system. Thus, we believe that the EMRS in the focal hospital is appropriate for this study.

The unit of analysis is the individual physician. We collected data primarily through on-site observation, interview, and survey. First, we collected qualitative and observational data to obtain a thorough understanding of the research context. We interviewed 1 information technology staff and 10 physicians (including 5 principals and 5 agents), as well as observed their work. Based on the dialogues with interviewees and the culled documents, we determined that each physician (excluding interns) in the hospital is given a system account to access the system through which they note clinical progress and issue orders for their patients. Physicians generally perform these system-related tasks after their ward rounds, before and after operations, and before and after patients leaves the hospital. In addition, they may access the system based on patient-specific requirements. Many physicians regard system-related tasks as a burden as they are already loaded with heavy patient care workloads and time constraints. Thus, they may choose to employ the system through intermediates such as interns. Our qualitative data confirmed that indirect use liberates principal physicians from heavy workloads, thereby enabling them to focus on other main clinical care activities. For instance, one intern informed us that his supervisor would take more than three hours a day to input clinical notes without his help, which seriously interfered the delivery of patient care Out of the five principal physicians who performed much indirect use every day, four admitted that they employed the three control mechanisms in their indirect use. For example, they can clearly observe their agents' behaviors, including how they use the system, as all regular physicians and interns of the same department sit in one large shared office.

We then conducted a field survey to test the proposed research model. Each participating physician in the survey was required to be a designated EMRS user in the inpatient department. As a token of appreciation,

50 yuan (equivalent to about US$7.73) was given to each participant who completed the questionnaire. Before the regular survey, we conducted a pilot test to evaluate the reliability and validity and to ensure that the questionnaire was easy to understand. Several alterations were made on the basis of the pilot test. The physicians who participated in the previous interviews and the pilot test were excluded from the study. A total of 300 survey questionnaires were sent out, and we received 242 valid responses across 25 departments, yielding a response rate of 80.7%. The responses were satisfactory considering the busy work schedules of the physicians.

Measurements

To ensure the reliability and validity of measures, validated questions were adapted from previous studies when possible. When previous suitable measures were unavailable, we developed new questions through context and literature study. In designing the questionnaire, we consulted several senior researchers to identify and rectify potential problems in the framing and phrasing of questions. Afterwards, we conducted sorting by recruiting eight research students. Minor modifications were made on certain items based on their suggestions. Before the formal survey, we conducted a pilot test and several modifications in the phrasing and framing of the questions were made according to the suggestions of the physicians.

As no appropriate measurements were available for indirect use, we developed new items based on the definitions and previous IS usage measurements. These new items were operationalized as formative constructs consisting of major EMRS-related tasks and captured as the frequency of use. Formative constructs provide a diverse perspective to understand the focal research context (Cenfetelli and Bassellier 2009). We identified four basic tasks (i.e., enter diagnoses and summaries, mark progress notes, view patient information such as history, diagnoses, or medication orders performed by doctors, and track and view test results) based on the primary observations, interviews, and System User Manual. One example item of indirect use is "In doing your own job in the inpatient department, how often do you ask others (e.g., subordinates or interns) to use the system for you to view laboratory/imaging results in EMRS?" Individual user work performance was used as the dependent variable. As stated previously, we examined the clinical care quality and physician–patient interaction quality in this study (Cheraghi-Sohi et al. 2008). The items of the dependent variables were adapted from Tong et al. (2015), Sirovich et al. (2006), and Venkatesh et al. (2011). One example item of clinical care of quality is "The quality of clinical care I provided is satisfying," and one example of physician–patient interaction care quality is "It is possible to maintain a kind of continuing relationship with patients over time." The items of control mechanisms were adapted from Tiwana and Keil (2009), Ramaswami (1996), and Kirsch et al. (2002). The example items of the three control mechanisms respectively are "I pre-specify the understandable sequence of steps toward accomplishing the goals of system-related tasks for persons using the system for me", "I monitor the extent to which the persons using the system for me follow established procedures provided by the hospital", and "I monitor the extent to which the persons using the system for me attain the performance goals of these system-related tasks." In addition, direct use, organizational commitment (Angle and Perry 1981), work overload (Ahuja and Thatcher 2005), user adaptation (Barki et al. 2007), and perceived ease of use (Venkatesh and Davis 2000) were included to control the effects of individual differences.

Data analysis result

Partial least squares (PLS) methods were used to conduct the measurement model analysis, and the test results showed the strong convergent and discriminant validities of our data. The formative constructs were measured by following the guidelines proposed by Cenfetelli and Bassellier (2009) and Petter et al. (2007). As the data were self-reported, we used Harman's single-factor test and correlation matrix analysis to test the potential common method bias. Through Harman' single-factor test, 12 factors were extracted, and the first factor explained 13.415% of the variance. These findings show that these indicators do not form a single higher-order factor. We then examined the latent variables correlation matrix to determine whether the presence of the common method variance. The latent variable correlations range from -0.2850 to 0.5777. Therefore, common method bias should not be a problem in this study, based on the above evidences.

Given that the independent variables are formative, we used the latent variable scores obtained by the PLS path model as the input to the hierarchical multiple regression analysis in our hypotheses test (Henseler

and Fassott 2010). Table 1 presents the results. Seven out of eight hypotheses were supported. Indirect use showed an expected significant relationship with clinical care quality, but did not have significant effect on physician-patient interaction quality, i.e., H1a was supported, whereas H1b was not. The positive effect of indirect use on clinical care quality was negatively moderated by the input control, and was positively moderated by the outcome control, i.e., H2a and H4a were supported. But we did not see the significant moderating effect of process control on this relationship, i.e., H3a was not supported. The relationship between indirect use and physician-patient interaction quality was significantly moderated by all the three control mechanisms, and we plotted the interactions in Figure 2 to clearly understand them. Figure 2 (a) shows that an increase in indirect us worsens the performance on interaction quality when the input control is high. In contrast, an increase in indirect use leads to better performance when the input control is low. That is, input control increase the negative effect of indirect use. Figure 2 (b) illustrates that when a user engages in a high level of process control, the increasing extent of indirect use enhance performance. However, this relationship tends to be negative given a low process control. Figure 2 (c) presents similar patterns for the moderating effect of the outcome control on indirect use. Thus, H2b, H3b, and H4b were supported. In conclusion, the outcome control not only increased the positive effect of indirect use on clinical care quality, it also reduced the negative effect of indirect use on physician-patient interaction quality; hence, we believe the outcome control works better than input and process control in inducing better indirect use performance.

Table 1. Regression Analyses Results: Path Coefficients and Significance

	Control Variables Only	Theoretical model with control variables (main effects)	Theoretical model with control variables and moderator (moderating effects)	Hypothesis testing results
Dependent variable: Clinical care quality (CCQ)				
Indirect use (IDU)	-	0.092*	0.108*	H1a was supported
Input control (IC)	0.024	0.037	0.059	-
Process control (PC)	0.057	0.060	0.086	-
Outcome control (OC)	0.059	0.066	0.024	-
Direct use (DU)	-0.072	-0.075	-0.075	-
Organization commitment (OCM)	0.183**	0.175**	0.183**	-
Work overload (WO)	0.205**	0.197**	0.208**	-
PEOU	0.062	0.056	0.065	-
User adaptation (UA)	0.079	0.087	0.075	-
Positional Power Legitimacy (PLP)	0.174**	0.161**	0.131**	-
IDU*IC	-	-	−0.153*	H2a was supported
IDU*PC	-	-	-0.049	H3a was not supported
IDU*OC	-	-	0.139**	H4a was supported
Dependent variable: Physician-patient interaction quality (PIQ)				
IDU	-	-0.024	-0.032	H1b was not supported
IC	0.015	0.011	-0.001	-
PC	0.068	0.070	0.136	-
OC	0.067	0.065	0.041	
DU	0.106*	0.107*	0.133*	-

OCM	0.087	0.089	0.067	-
WO	0.004	0.006	0.031	-
PEOU	0.286**	0.287**	0.307**	
UA	0.107*	0.104	0.096	
PLP	0.003	0.007	-0.166	-
IDU*IC	-	-	−0.236**	H2b was supported
IDU*PC	-	-	0.151*	H3b was supported
IDU*OC	-	-	0.164**	H4b was supported

∗ Significant at 5% level of significance ∗∗ Significant at 1% level of significance.

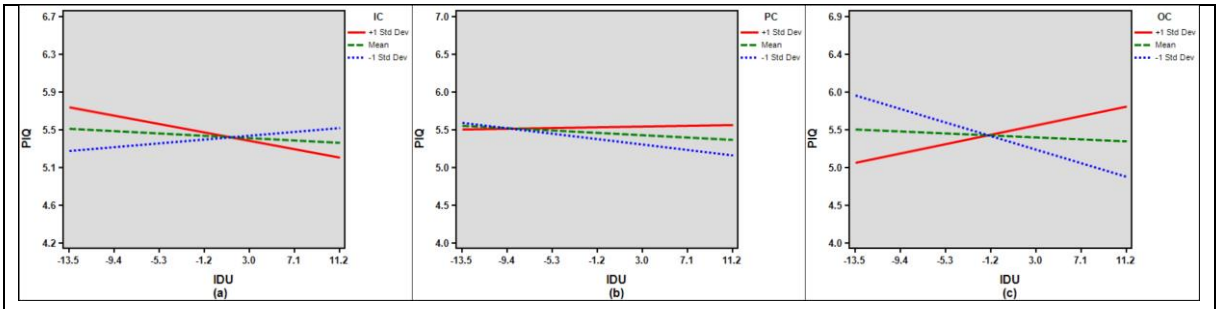

Figure 2. Plots of Interaction Effects

Discussion and Implications

This study is one of first few empirical studies that systematically test the influences of indirect use on individual user's performance relative to different control mechanisms in the healthcare context. This area has received scant attention by previous IS and healthcare literature. Consistent with our hypotheses, we observed the expected positive effects of indirect use on clinical care quality. Although no significant effect of indirect use on physician-patient interaction quality is observed, the results confirmed their negative relationship (β = -0.024) as we hypothesized. This finding can be attributed to the negative effect compensated by the users' direct use which is positively related to physician-patient interaction quality (β = 0.107, $p < 0.05$).

As expected, input control negatively affected indirect use performance. Process control worked well for physician-patient interaction quality but showed no significant effect on clinical care quality in despite of the negative (β = -0.049). A possible reason is that long-term process control improves agent performance and reduces the time for control, which eases the inhibiting effect of process control. The empirical support for our objective to highlight the effect of outcome control in inducing better indirect use performance is also strong. Outcome control not only improves the indirect use performance in clinical care quality, it also reduces the negative effect of indirect use on interaction quality. Given the high autonomy-valued reality in the hospital, it is ideal to perform indirect use with outcome control for physicians.

Our study has significant theoretical implications. First, the results of this study unveil the important role of the indirect use on individual user performance. Despite its importance, there is limited empirical evidence examining the influence of indirect use. This work opens the black box between indirect use and individual user performance, as well as complements the research on IS usage and IS success. Therefore, future study could further explore the influence of indirect use at different levels. Second, this study enriches our understanding about the impact of CIS use on physician performance. As a workforce with high autonomy and heavy workloads, physicians have the powers and needs to ask others (e.g., interns) to use system for them. By demonstrating the empirical relationship between the indirect use of CIS and physician performance (i.e., patient care quality), we provide important evidences regarding the value of

indirect use in the healthcare setting. Finally, this study also advances the current understanding of indirect use in terms of different control mechanisms. Prior literature capturing indirect use through IS centrality, ignored the goal conflict and information asymmetry between principal physicians and agents. Thus, it is imperative to study different control mechanisms that can govern the agent physicians' behavior. This study adds to the body of knowledge related to organization control literature by highlighting the important effects of control mechanisms in inducing better indirect use performance.

This study has significant practical implications. First, hospital management should be aware that increased direct use does not always lead to more IS benefits. On the contrary, the results show that indirect use can help individual physicians obtain improved clinical care quality. Therefore, managerial interventions in balancing direct and indirect uses to induce improved quality of care are necessary. Second, given the potential to be undermined by agency problems, individual physicians should conduct indirect use with control mechanisms. Employing appropriate control mechanisms when employing system through others, the principal physicians can enjoy a better performance. The empirical evidences show that outcome control not only increases the positive influence of indirect use on the principal physician's clinical care quality, but also compensates for the negative influence of indirect use on the principal physician's physician–patient interaction quality. Therefore, individual physicians should ideally conduct indirect use with outcome control. In sum, this study will provide valuable knowledge for healthcare shareholders to know how to employ CIS more effectively and efficiently through indirect use.

Conclusion and Future Research

Although the indirect use of systems is prevalent among physicians, previous literature on IS use was built on the assumption of users' direct interaction with systems. Research aiming to understand the effects of indirect use on the desired organizational and user performance remain scarce. Therefore, obtaining a comprehensive understanding of the indirect use of CIS and its influence is imperative. This study is part of a large-scale research evaluating the effects of indirect use in a hospital setting. Drawing on agency theory and organizational control literature, this study aims to contribute to the extant IS literature by examining the effects of individual physicians' indirect use of CIS in terms of different control mechanisms (i.e., input control, process control, and outcome control). As our results show, physicians who engage in high-level indirect use tend to achieve improved clinical care quality. Given the existence of information asymmetry and goal conflict between principal physicians and agents, the three different control mechanisms moderate the effects of indirect use in different manners. Outcome control helps increase the positive influence of indirect use on clinical care quality, whereas input control reduces this positive effect. Moreover, outcome and process control compensate for the relationship between indirect use and physician–patient interaction quality, whereas input control negatively moderates such a relationship.

The current study focuses only on individual-level indirect use and its consequences. The behaviors of single users may not sufficiently explain the performance effect of indirect use, and some research has emphasized the importance of social network measures (e.g., centrality) on system use behaviors (Kane and Labianca 2011; Sykes 2015; Sykes et al. 2014). Therefore, we should not neglect the effects of broader structure units within which individual physicians are located. Previous research has suggested that users and systems can be integrated as equivalent nodes into a single network (Callon et al. 1986; Kane and Alavi 2008). Following such a viewpoint, we are in the process of collecting another round of survey data from the same respondents to establish the indirect use networks within different medical groups. Given that a principal may contact the system through multiple agents, such a multimodal network view can help us track the direct and indirect user–system dyads in terms of the tie strength and distance. Moreover, we can observe the variation of agency roles and behaviors as the distance from the principal lengthens in indirect use networks. As this study focuses on the individual-level effects of indirect use, further mixed-level analysis is essential for us to establish a comprehensive understanding of indirect use within an organization. Collecting patient satisfaction data using other methods to verify the IS benefits from different perspectives in further studies is also necessary.

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