Improving the Performance of Hospital Information System Usage: Adaptive Structuration Theory and Job Demand-Control Perspectives

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Research

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Abstract

Background: More healthcare facilities have been forced to introduce hospital information systems (HISs) aimed at integrating daily clinical and administrative concerns. As a result, China begun to implement HISs with basic functionalities among large and medium-sized hospitals. Although still in the initial stages of HIS usage, the performance of adopting HISs has yet to be evaluated. These applications are suitable for investigating user-system performance issues but seldom been utilized in a healthcare context. Even though models such as the technology acceptance model incorporates the determinants of technology use, the predictors assembled by these models largely focuses on interindividual user characteristics, yet none of them comprehensively exhaust other complex user adaptation characteristics relating to structure and task. We fill this gap by empirically investigating the motivators for improving Chinese physicians’ performance through HIS usage, based on the lens of adaptive structuration theory and job demand-control model.

Methods: Using survey methodology, 305 valid responses were collected and analyzed via partial least squares.

Results: The eight proposed hypotheses were supported in their entirety. Further, a moderating analysis was undertaken and it was determined that the associations of technology adaptation-task adaptation, technology adaptation-job demand, task adaptation-job demand, and job demand-attitude showed significant differences occurring between residents and attending physicians.

Conclusions: Based on the findings, administrators are suggested to increase the training of physicians regarding their use of an HIS, and to grant physicians sufficient discretion necessary to improve the level of job demand and job control. This must be done in order to improve the performance of current HIS usage.

Introduction

The rapid development of various emerging information technologies has brought unprecedentedly profound changes to the healthcare industry[1]. Today as never before, more healthcare facilities are harnessing the benefits of health information technologies (HITs) as they integrate daily clinical and administrative concerns into a single spine digital platform consistent with the specific architecture of their digital needs. The differing types of HITs currently utilized include hospital information systems (HISs), integrated information systems that support the differing information requirements of hospital administration and clinical services [2]. They are highly expected to improve both the efficiency and effectiveness of healthcare services by providing professional IT access to hospital administration. Consistent with global best HIT practices, the digital transformation at the healthcare organizations has led to the creation of commensurable “digital backbone based on the enterprise-specific architecture needs and corresponding agile processes, cloud-based services, smart platforms, and automation
capabilities that enable the kind of digital insights hospital need and the kind of interactive experience today's patients and other healthcare customers expect\textsuperscript{[3, 4]}.

To this end, health informatics has evolved over the years as a contiguous discipline with its own body of knowledge. Thus with information systems discipline, a plethora of studies, mostly based on the Information Systems Success Model (ISSM)\textsuperscript{[3, 4]}, have been conducted to investigate the performance of business information systems, as well as HISs\textsuperscript{[5–7]}. The primary constructs of ISSM include system quality, information quality, service quality, actual use/intent to use, user satisfaction, and net benefits\textsuperscript{[3]}. These ISSM-based studies have certainly added to knowledge regarding IS performance among healthcare organizations. However, ISSM primarily focuses on technological aspects (i.e., system quality, information quality, and service quality) of an IS, in such a way that factors pertaining to human side are often neglected. Unless the important factors that contribute to better IS performance are specified, the heavy investment for an IS may be in vain. The adaptive structuration theory appears to fill this adoption void because it is focused on the interplay between social structures, resources and rules created by technologies and institutions to understand human activity in general including technology adoption. This is because the technological structures and organizational systems are continually intertwined and continuously shape each other.

Moreover, the use of HITs is quite different between developed and developing countries\textsuperscript{[1]}\textsuperscript{[8]}\textsuperscript{[8]}. Developed countries usually have implemented sophisticated HISs in the health sector, and the performance of those HISs has already received serious evaluation. On the other hand, it is not easy for developing countries to build appropriate ISs for their health sector given the limited resources and experience\textsuperscript{[8]}. Many countries, including China, have started to implement HITs on a regular basis. These systems possess basic functionalities among large and medium-sized hospitals\textsuperscript{[9]}. Being in the initial stages of HIS usage, it is necessary for China to evaluate the performance of the adopted HISs. Further, some evidence has reported a negative relationship existing between HITs and hospital performance\textsuperscript{[10]}.

The purpose of this study is therefore to empirically investigate the motivators for improving physicians’ performance of HIS usage in China, based on the lens of adaptive structuration theory and job demand-control model, which is suitable for investigating user-system performance issues\textsuperscript{[11, 12]} but being less utilized in a healthcare context.

### Theoretical foundation, research model and hypotheses

#### Adaptive structuration theory

Attempts to theoretically conceive how technology diffuses among different groups of people and institutions date back to several years ago. Earlier attempts to understand the phenomenon of user acceptance and use of technology were hewn from the field of behavioral psychology and includes theories such as uses and gratification, reasoned action, technology acceptance model, motivational model, theory of planned behavior, model of personal computer use, diffusion of innovations theory, and
social cognitive theory and others \cite{3,4}. The Unified Theory of Acceptance and Use of Technology (UTAUT) has also been developed through a review and consolidation of the constructs of eight models that earlier research had employed to explain information systems usage behavior. With time, the Adaptive Structuration Theory (AST) emerged as in the work of Scott Poole as a major theory of group communication based on the ground breaking work of Giddens McPhee and David Seibold as cited in \cite{3,4}. Unlike the plethora of linear models of communication that dominated theoretical discourse of group communication at the time, the Adaptive structuration theory believed that predictable chain of events and few propositions were insufficient to explain the complex dynamics of intra-group and inter-group communication \cite{3,4}. An adaptive theory in which group members intentionally adapt rules and resources to accomplish effective communication was a more feasible exposition. Thus Adaptive structuration theory grounded on institutional and decision-making theory, social technology theory \cite{11}, is effective in explaining the relationship between individual actions and social structure. The structure that exist in the individuals’ activities refers to the rules and resources that are constantly involved in the reproduction process of a social system or group communication, while the individual actions refer to the flow or patterns observed as the subject's behavior \cite{13,14}. Adaptive structuration theory focuses not only on the antecedents of behaviors but also upon the outcomes of behaviors, and it emphasizes the dynamic interactions occurring between the subject and the structure, which is especially suitable to investigate the complex phenomenon of using an IS \cite{11}. These attributes has made the AST a useful theory for understanding how advanced information technologies influences changes in an organization and vice versa. Theory AST, it is possible to understand the types of structures provided by advanced technologies and the structures that actually emerge in human action as people interact with these technologies. Recently, adaptive structuration theory has been adopted to investigate differing ISs \cite{15–18} and also HISs \cite{19–21}.

**Job demand-control model**

To understand the sources of work pressure in organizations, Karasek \cite{12} proposes the job demand-control model comprising two primary constructs: job demand and job control. Job demands are factors concerned with the difficulty and the number of work tasks performed by employees under a given working situation. Job control refers to the extent to which employees perceive they have the potential ability to exert influence on their work environment in terms of work methods, schedule and work boundaries \cite{12}. Job demands often entail employees to concentrate on their jobs, which are often regarded as a source of work pressure \cite{22}. On the other hand, job control is a kind of protection mechanism, which can relieve the pressure of job demands since employees have a greater discretion related to their jobs \cite{12}. When the job demands and the job control are both simultaneously of a high level, there is a positive working state where a new mode of behavior can be developed \cite{23,24}. In recent years, many scholars have further applied the job demand-control model towards investigating various work pressure situations among healthcare professionals \cite{25–27}. In the field of technology adoption, a plethora of studies have offered insight into direct and interact interplay between the job demand-control model and diffusion of technological innovation. For example in Carayon-Sainfort as cited in \cite{3,4} the
authors assert that the technical problems and intensity of use a particular technology positively associated with the perceived workload, perceived and work pressure. Similarly the technical problems and intensity of use a particular technology is inversely related to perceived job control which exacerbate the potential stress from the job.

**Research model and hypothesis formulation**

To examine the factors that improve physician's performance in using an HIS, this study hybridizes the adaptive structuration theory and job demand-control model as theoretical bases for effective user system performance. Figure 1 illustrates our proposed research model. Previous studies that employs Adaptive structuration theory in explaining adoption and use of technology postulates that organizational change can result from a use of information technologies \[13\]. The role and utility of the information technology may evolve as users begin to access the information technology \[13\]. Similarly, the job demand-control model posits that job demands and job control interact and result in psychological strain and various physiological outcomes \[12\]. Among those differing outcomes, positive outcomes such as motivation, satisfaction, and healthful recovery are achievable if jobs are significantly high in terms of both demands and control \[12, 28\].

In figure 1, the endogenous variable in the proposed model is the user system performance, which refers to the ability of the physicians’ to use the hospital information systems to optimize their performance. We argue that physicians’ attitudes toward using an HIS can influence their performance or rate of usage of the HIS. Further, a physician's attitude towards using the hospital information systems is predicted by his or her perceived job control and job demands as postulated in the job demand-control model \[12\]. Both job control and job demands are predictable by means of technology adaptation and task adaptation, respectively hence providing seamless linkage between job demand-control and adaptive structuration theory. Finally, task adaptation is predicted by technology adaptation according to adaptive structuration theory \[13\]. The rationale of the proposed model, along with the research constructs and their relationships within the proposed model, is shown as follows.

**Technology Adaptation and Task Adaptation**

In our study, technology adaptation refers to a physician's ability to adapt to a new HIS when the HIS is adjusted or altered \[14\], and, task adaptation means a physician’s ability to adapt to the new task, work structure or new work process \[14\]. Based on adaptive structuration theory, technology can impose a return of different structures into the technology itself which will eventually change how that technology should be used \[13\]. Introducing any new technology to an existing task can result in task adjustment in order to acclimatize users to the new technology \[29\]. Transferring this rationale to our study, we postulate that as physicians gain more knowledge of the features of the HIS, they will be able to use health information system in an innovative way to support their professional tasks. Prior literature supports the notion that technology adaptation is positively associated with task adaptation \[14, 30, 31\]. We therefore hypothesize that:
H1: In physicians’ use of an HIS, technology adaptation has a positive association with task adaptation.

Relationship between Technology Adaptation and Job Demand-Control

Job demands assess the degree to which physicians perceive how they must work harder and faster, usually with a large amount of work to do in a limited amount of time [12]. Job control measures the extent to which physicians perceive that they have the ability to influence his or her work environment with respect to the timing, method, and boundaries of their work [28, 32]. In our study context, when physicians adapt to an HIS, an association may be expected between technology adaptation and the physicians’ job control because technology adaptation can improve the fit between physicians’ requirements of caring task and the functionalities of an HIS. In turn, this enables physicians to improve the handling of their jobs. Likewise, another positive association may be expected between technology adaptation and job demands when physicians are at a higher level of concentration with their caring jobs because they can finish their jobs efficiently and effectively with the assistance of an adapted HIS. In other words, high technology adaptation contributes to a higher level of job control and higher job demands. Up to now, few studies have investigated the associations between technology adaptation using the notions of job control and job demands. Despite the limited number of studies investigating the associations of technological adaption with job demand and job control, Bala and Venkatesh [28] however found significant relationships between perceived technology characteristics (i.e., perceived technology re-configurability, perceived technology complexity, and perceived technology customization) and perceptions of change in job characteristics (i.e., increase in job demands and decrease in job control). Conceptually, Bala and Venkatesh [28] confirmed the relationships of task adaptation with job control and job demand. We therefore postulate the following hypotheses:

H2: In physicians’ use of an HIS, technology adaptation has a positive association with job control.

H3: In physicians’ use of an HIS, technology adaptation has a positive association with job demands.

Relationship between Task Adaptation and Job Demand-Control

According to adaptive structuration theory [13] when users are confronted with a new technology, they simultaneously adapt to the new technology and the social structures interacting with the new technology. In our study, social structures are considered to be the physicians’ work patterns and habits. Transferring this logic to our study, physicians not only adapt to an HIS but also adapt to their jobs to an HIS. When physicians know how to make the most of an HIS to assist their jobs, they can fully control their jobs, and finish their jobs both efficiently and effectively. In addition to examining the relationship between technological adaption with job control and job demands, Bala and Venkatesh [28] further examined and found significant associations between perceived work process characteristics (i.e., perceived process rigidity, perceived process complexity, and perceived process radicalness) and
perceptions of change in job characteristics (i.e., increase in job demands and decrease in job control).

Transferring the logic of such findings\(^{33}\) to our study, relationships of task adaptation with job demands and job control may exist. Based on previous evidence and discussions, we hypothesize that:

H4: In physicians’ use of an HIS, task adaptation has a positive association with job control.

H5: In physicians’ use of an HIS, task adaptation has a positive association with job demands.

**Relationship between Job Demand-Control and Attitude to HIS**

According to the job demand-control model, when both job control and job demands are simultaneously at a high level of incidence, such a job is considered to be an active job\(^ {12}\). With the function of higher job control and demand, physicians are more likely to believe that they can get the required information from an HIS in order to better diagnose and treat patients. In other words, physicians will foster positive attitudes toward their performance using an HIS. Chiu, Tsai\(^ {34}\) found a positive and significant link between job control and nurses’ attitudes toward web-based continued learning experiences. Although Chiu, Tsai\(^ {34}\) didn’t report a significant association between job demands and nurses’ attitudes toward web-based continued learning, we however hold that physicians will develop a positive feeling towards the use of an HIS in order to diagnose and treat more patients efficiently and effectively. Based on the above discussions, we therefore propose the additional hypotheses:

H6: In physicians’ use of an HIS, job control has a positive association with attitude.

H7: In physicians’ use of an HIS, job demand has a positive association with attitude.

**Relationship between Attitude to HIS and Users Performance**

Prior evidence\(^ {35}\) argues that people form intentions to undertake behaviors towards which they have positive feelings. Further, Parkes\(^ {36}\) found that users’ attitudes towards a decision support system can predict their decision performance. That is to say, users’ positive attitudes toward an IS not only increase users’ intention to use that IS but also to lift users’ performance of using that IS. In our study context, if physicians develop a positive feeling that using an HIS can improve their job performance, they will be more inclined to use an HIS when they diagnose and treat patients, so their performance will, in turn, be improved when using that HIS. We therefore proposed the following hypothesis:

H8: In physicians’ use of an HIS, attitude has a positive association with their performance while using an HIS.

**Methods**

**Measures**
We conducted an online survey to collect data. The questionnaire used in our study included two parts: 1) respondents’ demographic information; and, 2) respondents’ perceptions concerning technology adaptation, task adaptation, attitude, job demand, job control and physicians’ performance in using hospital information systems. The second portion of the selected items was adapted from prior validated instruments [14, 28, 32, 35]. All items used five-point Likert scales.

Items for measuring technology adaptation and task adaptation were adapted from Schmitz, Teng [14], and they were measured with six and three items, respectively.

Job demand, containing four items, assesses the extent to which a physician perceives that he/she is required to work hard and fast, and there is much work to do, often in a limited time [12]. Job control measures, containing four items, the extent that a physician perceives that he/she has the ability to influence his/her work environment with respect to the timing, method, and boundaries of his/her task [28, 32]. Items for assessing job demand and job control were both adapted from Bala and Venkatesh [28].

Attitude (in this case, toward the use of an HIS) refers to the degree of a physician's positive feelings toward subsequently using an HIS, comprises three items, adapted from Davis, Bagozzi [35]. Physicians’ performance of using an HIS, referring to the improvement of working time, work efficiency and work quality after using an HIS, contained five items, adapted from Wall, Corbett [32]. A pilot test was conducted via a sample of 36 physicians, and slight modifications of wording and phraseology were made (see Appendix for a full description of the survey items).

Sampling

Physicians, the primary users of HISs, represent the target population of this study. Our research model was tested on Chinese physicians by means of a survey. To better represent the targeted population, five hospitals of different operational levels were selected, including two provincial tertiary general hospitals, two municipal tertiary general hospitals and one tertiary specialized hospital from the Nanjing City, Jiangsu Province, China. The reasons we chose these five hospitals was mainly due to their current sophisticated utilization of hospital information systems. We recruited physicians to voluntarily and anonymously participate in our survey by using convenience sampling. Totally, we distributed 400 online survey invitations and 380 responses were returned. Seventy-five questionnaires were removed due to incomplete responses. As a result, 305 responses remained for subsequent analysis.

Results

Descriptive statistics

Of the 305 responses, female respondents (56.72%) were slightly more than males (43.28%). Nearly 85% of the respondents were aged between 23-39 years old. In addition, the majority of respondents have 1-5 years of work experience in a hospital (60.98%). The number of residents (53.11%) was slightly more than attending physicians (46.89%). In terms of physicians’ specializations, the majority of the
physicians practiced internal medicine and surgery (57.38%). In terms of the type of hospital, nearly 87.54% of the physicians were from general hospitals. Details of the physicians are shown in Table 1.

<table>
<thead>
<tr>
<th>Category</th>
<th>Characteristics</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>Male</td>
<td>132</td>
<td>43.28</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>173</td>
<td>56.72</td>
</tr>
<tr>
<td>Age</td>
<td>23-29</td>
<td>138</td>
<td>45.25</td>
</tr>
<tr>
<td></td>
<td>30-39</td>
<td>121</td>
<td>39.67</td>
</tr>
<tr>
<td></td>
<td>40-49</td>
<td>30</td>
<td>9.84</td>
</tr>
<tr>
<td></td>
<td>50-59</td>
<td>15</td>
<td>4.92</td>
</tr>
<tr>
<td></td>
<td>Missing</td>
<td>1</td>
<td>0.33</td>
</tr>
<tr>
<td>Experience (years)</td>
<td>1-5</td>
<td>186</td>
<td>60.98</td>
</tr>
<tr>
<td></td>
<td>6-10</td>
<td>59</td>
<td>19.34</td>
</tr>
<tr>
<td></td>
<td>11-15</td>
<td>25</td>
<td>8.20</td>
</tr>
<tr>
<td></td>
<td>16-20</td>
<td>20</td>
<td>6.56</td>
</tr>
<tr>
<td></td>
<td>&gt;= 20</td>
<td>15</td>
<td>4.92</td>
</tr>
<tr>
<td>Title</td>
<td>Resident</td>
<td>162</td>
<td>53.11</td>
</tr>
<tr>
<td></td>
<td>Attending physician</td>
<td>143</td>
<td>46.89</td>
</tr>
<tr>
<td>Speciality</td>
<td>Internal medicine</td>
<td>114</td>
<td>37.38</td>
</tr>
<tr>
<td></td>
<td>Surgery</td>
<td>61</td>
<td>20.00</td>
</tr>
<tr>
<td></td>
<td>Obstetrics and Gynecology</td>
<td>3</td>
<td>0.98</td>
</tr>
<tr>
<td></td>
<td>Pediatrics</td>
<td>4</td>
<td>1.31</td>
</tr>
<tr>
<td></td>
<td>Others</td>
<td>100</td>
<td>32.79</td>
</tr>
<tr>
<td></td>
<td>Missing</td>
<td>23</td>
<td>7.54</td>
</tr>
<tr>
<td>Respondents of three levels of hospitals</td>
<td>Provincial tertiary general hospitals</td>
<td>105</td>
<td>34.43</td>
</tr>
<tr>
<td></td>
<td>Municipal tertiary general hospitals</td>
<td>162</td>
<td>53.11</td>
</tr>
<tr>
<td></td>
<td>Tertiary specialized hospitals</td>
<td>37</td>
<td>12.13</td>
</tr>
<tr>
<td></td>
<td>Missing</td>
<td>1</td>
<td>0.33</td>
</tr>
</tbody>
</table>
Measurement model

Partial least squares method was adopted for testing the hypotheses proposed in our study. We first assessed the reliability and validity of measurement items and constructs adopted in our study. As depicted in Table 2, the factor loadings of all items were all higher than 0.7 and composite reliability of the six constructs were larger than 0.7, indicating sufficient measurement reliability\(^3\). Further, the average variance extracted (see Table 2) of the six constructs was above the 0.5 threshold, demonstrating satisfactory convergent validity\(^3\). Finally, the square root of average variance extracted from each construct was higher than its corresponding correlations with remaining constructs (see Table 3), demonstrating the existence of adequate discriminant validity.

Table 2
Reliability and validity

<table>
<thead>
<tr>
<th>Construct</th>
<th># of items</th>
<th>M</th>
<th>SD</th>
<th>Loadings</th>
<th>CR</th>
<th>CA</th>
<th>AVE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technology adaptation</td>
<td>6</td>
<td>3.17</td>
<td>0.76</td>
<td>0.73-0.88</td>
<td>0.92</td>
<td>0.90</td>
<td>0.67</td>
</tr>
<tr>
<td>Task adaptation</td>
<td>3</td>
<td>3.69</td>
<td>0.68</td>
<td>0.86-0.90</td>
<td>0.92</td>
<td>0.86</td>
<td>0.78</td>
</tr>
<tr>
<td>Job control</td>
<td>4</td>
<td>3.44</td>
<td>0.68</td>
<td>0.76-0.90</td>
<td>0.91</td>
<td>0.87</td>
<td>0.73</td>
</tr>
<tr>
<td>Job demand</td>
<td>4</td>
<td>3.56</td>
<td>0.77</td>
<td>0.88-0.92</td>
<td>0.95</td>
<td>0.93</td>
<td>0.82</td>
</tr>
<tr>
<td>Attitude</td>
<td>3</td>
<td>3.69</td>
<td>0.82</td>
<td>0.90-0.96</td>
<td>0.95</td>
<td>0.92</td>
<td>0.86</td>
</tr>
<tr>
<td>User system performance</td>
<td>5</td>
<td>3.56</td>
<td>0.79</td>
<td>0.93-0.95</td>
<td>0.97</td>
<td>0.96</td>
<td>0.87</td>
</tr>
</tbody>
</table>

Note: M means average score, SD means standard deviation, CR denotes composite reliability, CA denotes Cronbach’s \(\alpha\), and AVE denotes average variance extracted.

Table 3
Inter-correlations among constructs

<table>
<thead>
<tr>
<th>Constructs (Abbreviation)</th>
<th>TEA</th>
<th>TAA</th>
<th>JC</th>
<th>JD</th>
<th>AT</th>
<th>USP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technology adaptation (TEA)</td>
<td>0.82</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Task adaptation (TAA)</td>
<td>0.45</td>
<td>0.89</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Job control (JC)</td>
<td>0.49</td>
<td>0.39</td>
<td>0.85</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Job demand (JD)</td>
<td>0.34</td>
<td>0.49</td>
<td>0.32</td>
<td>0.91</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Attitude (AT)</td>
<td>0.36</td>
<td>0.45</td>
<td>0.38</td>
<td>0.25</td>
<td>0.93</td>
<td></td>
</tr>
<tr>
<td>User system performance (USP)</td>
<td>0.43</td>
<td>0.44</td>
<td>0.45</td>
<td>0.30</td>
<td>0.68</td>
<td>0.93</td>
</tr>
</tbody>
</table>
Structural model

Based on the results of the structural model, all eight hypotheses proposed in our study were supported (see Fig. 2). Technology adaptation was positively and significantly associated with task adaptation ($\beta = 0.45, p < 0.001$), job control ($\beta = 0.39, p < 0.001$), and job demand ($\beta = 0.21, p < 0.001$), hypotheses 1, 2, and 3 were therefore supported. Task adaptation was positively and significantly linked with job control ($\beta = 0.14, p < 0.01$) and job demand ($\beta = 0.43, p < 0.001$), thus supporting hypotheses 4 and 5. Further, both job control ($\beta = 0.33, p < 0.001$) and job demand ($\beta = 0.15, p < 0.01$) were significantly related to attitude in a positive direction, hypotheses 6 and 7 was supported. Finally, attitude positively and significantly correlated with user system performance ($\beta = 0.68, p < 0.001$).

Technology adaptation and task adaptation jointly explained about 64.09% and 73.82% of the variance of job control and job demand, respectively. Job control and job demand collectively accounted for about 76.05% of the variance of attitude, while attitude explained about 84.80% of variance of user system performance. Table 4 summarizes the results of the hypotheses testing.

Table 4
Summary of hypothesis testing results

<table>
<thead>
<tr>
<th>Hypotheses</th>
<th>Path coefficients</th>
<th>T-value</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>H1 Technology adaptation → Task adaptation</td>
<td>0.45***</td>
<td>8.72</td>
<td>supported</td>
</tr>
<tr>
<td>H2 Technology adaptation → Job control</td>
<td>0.39***</td>
<td>7.10</td>
<td>supported</td>
</tr>
<tr>
<td>H3 Technology adaptation → Job demand</td>
<td>0.21***</td>
<td>3.85</td>
<td>supported</td>
</tr>
<tr>
<td>H4 Task adaptation → Job control</td>
<td>0.14**</td>
<td>2.61</td>
<td>supported</td>
</tr>
<tr>
<td>H5 Task adaptation → Job demand</td>
<td>0.43***</td>
<td>7.69</td>
<td>supported</td>
</tr>
<tr>
<td>H6 Job control → Attitude</td>
<td>0.33***</td>
<td>5.92</td>
<td>supported</td>
</tr>
<tr>
<td>H7 Job demand → Attitude</td>
<td>0.15**</td>
<td>2.66</td>
<td>supported</td>
</tr>
<tr>
<td>H8 Attitude → User system performance</td>
<td>0.68***</td>
<td>16.33</td>
<td>supported</td>
</tr>
</tbody>
</table>

Note: * indicates $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Moderator analysis

To better understand the potential moderating effects of physician level on the proposed eight hypotheses, we further conducted a multi-group analysis between attending physicians ($n = 162$) and resident physicians ($n = 143$). As shown in Table 5, the associations among technology adaptation and task adaptation, task adaptation and job demand, technology adaptation and job demand, and job demand and attitude showed significant differences between resident and attending physician groups.
Among the four significant associations that demonstrated significant differences between resident and attending physicians, the path coefficients for resident physicians are higher than those of attending physicians, including the links between technology adaptation-task adaptation, task adaptation-job demand, and job demand-attitude. The path coefficient of the relation of technology adaptation and job demand for resident physicians was higher than that of attending physicians.

### Table 5
Comparison of research model by resident and attending physician

<table>
<thead>
<tr>
<th>Path relationships</th>
<th>$\beta_{\text{Resident}}$</th>
<th>$\beta_{\text{Attending}}$</th>
<th>$\beta_{\text{Resident}} - \beta_{\text{Attending}}$</th>
<th>$p$ value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technology adaptation $\rightarrow$ Task adaptation</td>
<td>0.53</td>
<td>0.34</td>
<td>0.18</td>
<td>0.044</td>
</tr>
<tr>
<td>Technology adaptation $\rightarrow$ Job control</td>
<td>0.50</td>
<td>0.27</td>
<td>0.23</td>
<td>0.053</td>
</tr>
<tr>
<td>Technology adaptation $\rightarrow$ Job demand</td>
<td>0.02</td>
<td>0.27</td>
<td>-0.25</td>
<td>0.032</td>
</tr>
<tr>
<td>Task adaptation $\rightarrow$ Job control</td>
<td>0.18</td>
<td>0.23</td>
<td>0.06</td>
<td>0.425</td>
</tr>
<tr>
<td>Task adaptation $\rightarrow$ Job demand</td>
<td>0.55</td>
<td>0.31</td>
<td>0.24</td>
<td>0.024</td>
</tr>
<tr>
<td>Job control $\rightarrow$ Attitude</td>
<td>0.36</td>
<td>0.29</td>
<td>0.07</td>
<td>0.254</td>
</tr>
<tr>
<td>Job demand $\rightarrow$ Attitude</td>
<td>0.23</td>
<td>0.02</td>
<td>0.21</td>
<td>0.023</td>
</tr>
<tr>
<td>Attitude $\rightarrow$ User system performance</td>
<td>0.70</td>
<td>0.66</td>
<td>0.04</td>
<td>0.227</td>
</tr>
</tbody>
</table>

Note: $\beta$ denotes path coefficient.

### Discussion

The primary purpose of this study is to empirically investigate the motivators for improving physicians’ performance of HIS usage via the lens of adaptive structuration theory and job demand-control model. Based on the results of 305 valid responses, our study found that technology adaptation is significantly associated with task adaptation in a positive direction. In other words, physicians may first undergo a period of time to adapt to a new HIS. After physicians are familiar with and have adapted to an HIS, they may start to adapt their caring tasks by means of HIS usage. This finding was reported by prior evidence \[14, 30, 31\]. This finding may further suggest that hospitals should provide sufficient training regarding the use of an HIS in order to diminish the physicians’ learning curve. By doing so, physicians may become acquainted with an HIS more easily and shortly, physicians can similarly adapt their caring jobs as well with an HIS.

Another finding of our study is that technology adaptation is significantly and positively related to job control. After physicians have adapted to an HIS, and even mastered the intricate use of an HIS, physicians would therefore become better able to control their patient care. In words, physicians should have a certain discretion related to their patient care and treatment work with the help of an experienced use of an HIS. This finding is also in accord with prior literature \[28, 38\]. An implication of this is that
hospitals could acquaint physicians with every possible aspect of an HIS usage, thus allowing physicians to have greater control over their work pacing and work quantity.

In addition, technology adaptation is found to be significantly linked with job demands in a positive direction. Once physicians have adapted to the use of an HIS, they will be able to handle their caring jobs not only more efficiently but also more effectively. For physicians, treating a greater number of patients may indicate more income. Physicians are therefore required to work more expeditiously to treat as many patients as possible in a limited amount of time. This finding broadly supports the work of other studies [28, 38]. This finding draws our attention to the importance that hospitals place in providing physicians with sufficient support to quickly learn and familiarize themselves with the use of an HIS.

Our study confirmed that task adaptation has a significant and positive association with job control and job demand, respectively. The results corroborate the findings of prior evidence [29, 38], whereby efforts to adapt technologically can improve overall work performance. This study found that job control and job demand are significantly associated with physicians’ attitude towards the use of an HIS, respectively. It is reasonable to assume that when physicians possess a certain degree of control over their work and have higher requirements for their own work, physicians may hold a positive attitude toward using an HIS. The finding of the relationship between job control and attitude is in accord with prior evidence [34].

A positive relationship between attitude and performance with using an HIS was also confirmed in current study. When physicians hold positive attitudes towards the use of an HIS, physicians should be more proactive in using an HIS which they believe facilitates their patient care. This result is in agreement with prior literature [36]. Generally speaking, the primary responsibility of a resident physician is to provide professional medical care for patients within their clinical privileges correspondent to the level of training they have received. Therefore, clinical tasks such as diagnosis, prescribing attending physician's orders, delivering test results, assisting in surgery, or writing medical records are all responsibilities residents must bear [39, 40]. Residents must spend more time than attending physician do in using an HIS to accomplish clinical tasks effectively. Further, residents are generally younger than attending physicians, the adaptability to technology or tasks of residents should be stronger than those of attending physicians as a result of exposure. It is therefore reasonable that technology adaptation has a strong effect on task adaptation for residents than that of attending physicians. Further, we also found that task adaptation has a stronger effect on job demand for residents than that of attending physicians.

Attending physicians, on the other hand, primarily supervise the patient care of residents, and they have used an HIS less frequently than residents [39, 40]. Therefore, attending physicians are less familiar with an HIS than that of residents, but attending physicians possess a deeper medical knowledge than residents. When attending physicians become familiar with an HIS, they can still improve upon meeting their job demands through using an HIS. Finally, the effect of job demand on residents’ attitudes is stronger than that of attending physicians. Once residents understand that an HIS can be of great help to their patient case load, they might foster a more positive attitude toward the use an HIS.
This study adopts Adaptive structuration theory and the Job demand-control model to empirically analyze the influence of the use of an HIS on physicians' task performance, which provides a new perspective when studying user-system performance. China possesses a wide-range of differences in the use of an HIS due to both the scale and scope of medical care demands in a population of 1.4 billion people. Most importantly, the potential influence of an HIS usage on user performance among physicians and residents has been largely under-explored. Our study diminishes this research gap in part. Further, understanding the effect of using an HIS on the physicians' job performance can be of help for health care administrators to foster corresponding strategies and take suitable measures to improve user-system performance.

Finally, the sample hospitals are all large-scale hospitals in cities, and there is a lack of small-scale hospitals represented in this data. In other words, the generalizability of our findings is limited to large-scale hospitals located in urban areas. Future research can focus on this issue and collect a wider range of hospitals to advance the topic.

**Conclusion**

The primary purpose of this study is to empirically investigate the motivators in order to improve physicians' performance of HIS usage. To achieve this goal, we adopted Adaptive structuration theory and Job demand-control model as the theoretical underpinning. A total of 305 responses were collected and analyzed. Results demonstrated that all 9 proposed hypotheses were supported. We further conducted a moderator analysis and found that the associations of technology adaptation-task adaptation, technology adaptation-job demand, task adaptation-job demand, and job demand-attitude showed significant differences between residents and attending physicians.

**Limitations And Future Studies**

It should be pointed out that the study is based solely on a sample of respondents from China. Therefore, the results may not be generalizable to all users of HISs. It is recommended that future studies consider sampling from more extensive geographic areas, including other countries. In addition, our study used an online survey to recruit participants numerically, which could induce sample selection bias. Future studies may use alternative data collection methods and sampling strategies to achieve a generalizable sample to a broad range of HIS users.

In this study, no specific HIS was examined, but the general concept of a HIS was studied. For instance, it would be interesting to investigate how a specific HIS usage influence user performance and compare the distinctive effects of different HIS on the user performance.

**Declarations**

**Ethics approval and consent to participate**
The study was approved by the Ethical Review Committee (IRB) at Jiangsu University, Zhenjiang, China.

**Consent for publication**

Not applicable

**Availability of data and material**

The datasets used or analysed during the current study are available from the corresponding author on reasonable request.

**Competing interests**

The authors declare that they have no conflict of interest.

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**Authors' contributions**

Data curation, Change Zhu; Formal analysis, Change Zhu; Funding acquisition, Baoxiang Song and Lulin Zhou; Methodology, Change Zhu; Resources, Change Zhu.

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**References**


Appendix

Measurement items

<table>
<thead>
<tr>
<th>Constructs (Source)</th>
<th>Items</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technology adaption [14]</td>
<td>I have tried to use some of the new features of HIS.</td>
</tr>
<tr>
<td></td>
<td>I have made appropriate adjustments to the original functions of HIS to meet my work requirements.</td>
</tr>
<tr>
<td></td>
<td>I have found a new way to use HIS.</td>
</tr>
<tr>
<td></td>
<td>I changed the default settings of HIS so that I could use one of its specific functions.</td>
</tr>
<tr>
<td>Task adaptation [14]</td>
<td>I try to find ways to use HIS to better complete the existing diagnosis and treatment work.</td>
</tr>
<tr>
<td></td>
<td>I try to find a way to complete the diagnosis and treatment work faster through HIS.</td>
</tr>
<tr>
<td></td>
<td>Generally speaking, I am trying my best to use the functions of HIS to better complete the current diagnosis and treatment work.</td>
</tr>
<tr>
<td>Job control [28]</td>
<td>I can plan my caring work in advance.</td>
</tr>
<tr>
<td></td>
<td>I can change the way I work.</td>
</tr>
<tr>
<td></td>
<td>I can decide when to finish a caring job.</td>
</tr>
<tr>
<td></td>
<td>I can decide on my own how to finish the caring work.</td>
</tr>
</tbody>
</table>
### Constructs (Source) | Items
--- | ---
**Job demand** [28] | I have to work fast.
 | I have too much caring work to do.
 | I have to work harder to finish the caring task.
 | I work under the pressure of time.
**Attitude** [35] | It's a good idea to use hospital information systems.
 | It's interesting to use hospital information systems.
 | I like to use hospital information systems to help me finish my caring work.
**User system performance** [32] | Using hospital information systems enables me to accomplish my patient-caring tasks more quickly.
 | Using hospital information systems improves the quality of patient-caring work I do.
 | Using hospital information systems makes it easier to take care of patients.
 | Using hospital information systems enhances my effectiveness on caring patients.
 | Using hospital information systems gives me greater control over my caring work.

### Figures

[Diagram showing relationships between constructs and hypotheses]

**Adaptive structuration theory**
- **Technology adaptation**
  - $H_1(+)$
- **Task adaptation**
  - $H_2(+)$
  - $H_4(+)$

**Job demand-control model**
- **Job control**
  - $H_3(+)$
- **Job demand**
  - $H_5(+)$
- **Attitude**
  - $H_6(+)$

**User system performance**
- $H_8(+)
Figure 1
Research model

![Diagram showing the research model with relationships and coefficients]

$p < 0.01^{**}, p < 0.001^{***}$

Figure 2
Structural model results

![Diagram showing the structural model results with relationships and coefficients]