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Examining the pre-adoption stages of healthcare IT: A case study of vital signs monitoring systems

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ABSTRACT

Pervasive healthcare systems can reduce the costs and improve the quality of healthcare. However, insufficient care in managing the process before the organizational decision to adopt information technology (IT) can result in poor outcomes. With most previous research focusing on IT adoption, this paper develops a multi-stage theoretical framework for the pre-adoption phase of healthcare IT to address this practical challenge and gap in the literature. With a priori concepts identified from previous multi-stage models, our framework was developed by analyzing two cases of the introduction of vital signs monitoring systems in hospitals to identify the important stages and influencing factors for healthcare IT pre-adoption.

1. Introduction

The use of information technology (IT) has the potential to improve the efficiency and quality of care and to streamline healthcare processes [3,30]. A promising application of IT in healthcare is *pervasive healthcare*, which is defined as "healthcare to anyone, anytime, and anywhere by removing locational, time and other restraints while increasing both its coverage and quality" [45, p. 114]. Pervasive healthcare involves the wide-scale deployment of wireless networks to improve communication among healthcare professionals and with patients. Examples of pervasive healthcare applications include mobile telemedicine and wireless patient monitoring.

Pervasive healthcare systems have the potential to reduce long-term costs and improve patient care and safety. Recent concerns about infectious diseases have led to recommendations to improve communication effectiveness within healthcare systems using new communication tools [46]. Specifically, healthcare workers are vulnerable to infectious diseases such as avian influenza and severe acute respiratory syndrome (SARS) [1]. Pervasive healthcare IT might be invaluable in reducing the spread of communicable diseases because it allows remote monitoring and communication between healthcare professionals and patients, as illustrated by systems such as vital signs monitoring systems.

Vital signs monitoring is a salient activity conducted by nurses to monitor patient progress and any irregularities [12]. Nurses typically visit each patient and manually record vital sign readings, such as blood pressure, temperature, respiratory rate and pulse rate. However, this process is prone to errors. A study conducted by Gearing et al. [17] indicated that 25.6% of vital signs recorded in paper medical records contained at least one error. A 36-hospital time and motion study [21] found that nurses spent 7.2% of their time reading vital signs and 35.3% of their time completing documentation. This pattern suggests an urgent need to adopt techniques to reduce both errors and time spent on monitoring vital signs. The application of pervasive computing to vital signs monitoring might reduce the time spent manually recording vital signs and improve accuracy.

While healthcare IT such as vital signs monitoring systems can provide various benefits, research has shown that barriers in managing healthcare IT adoption can result in poor outcomes [32,37]. Specifically, the steps preceding the organizational adoption decision, commonly referred to as the *pre-adoption* phase, are important. The pre-adoption phase typically refers to the period from the time organizational decision makers become

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aware of the innovation until a decision about adoption is made [15,36]. This phase comprises several activities, such as becoming aware of innovations, acquiring the innovation to perform trials, and conducting feasibility analyses to assess the value of the innovation [20]. These activities are vital because poor management of the pre-adoption process can lead to erroneous decisions, such as adopting a poor quality system or not adopting a system with potential benefits. Therefore, there is a need for a deeper understanding of the influences of the activities and conditions that precede an organizational decision to adopt a system.

While there is considerable research on IT adoption in general, certain characteristics of healthcare IT demand research that is specific to this sector. Generally, the adoption of IT in healthcare has been slower than in other major industries [29]. This lag occurs because the healthcare industry poses major social and technological challenges to the development and use of information systems (IS) [5,6]. Additionally, the multiple groups of actors in the healthcare industry, e.g., physicians, nurses, allied healthcare professionals, and administrators, increase the complexity of the adoption decision relative to other industries [29]. Among these groups, medical personnel who are largely autonomous [26] tend to differ from administrators in their attitude toward and requirements for IT due to their different objectives and skills [35]. Thus, healthcare IT must meet the needs of the various types of users. Furthermore, it is particularly challenging to justify the use of healthcare IT because most benefits accrue to external parties, such as patients, making the adoption decision difficult for organizations [44]. Hence, it would be valuable to study the healthcare IT pre-adoption process and adoption decision in relation to the different stakeholders in healthcare settings.

To investigate the pre-adoption process, we employ a multi-stage approach, which is useful in identifying and detailing the various phases of organizational technology adoption. Specifically, multi-stage models can contribute insights into the complex nature of technology adoption in organizations by revealing the linkages and temporal relationships among events as implementation processes unfold [16]. In this regard, taking a multi-stage approach allows the influence of various activities at different stages of the pre-adoption phase to be investigated. This approach also provides a means to study the roles played by different stakeholders during the pre-adoption phase, which can affect technology adoption decision outcomes [25]. The vast majority of previous multi-stage models (e.g., [15]) have focused on the technology adoption process in general, and few models have been developed for the healthcare context or the organizational IT pre-adoption process in particular. The latter models are valuable due to the specific characteristics of healthcare IT previously described. Hence, we develop a multi-stage framework for IT pre-adoption that is specific to the healthcare context, as recommended in previous research [5].

We develop our theoretical framework that illustrates the stages from pre-adoption to a healthcare IT adoption decision in organizations using a process approach. This study draws on the contrasting vital signs monitoring system adoption projects of two hospitals to answer the following research question: "*How can healthcare IT pre-adoption be conducted to obtain beneficial outcomes?*" In our context, a beneficial outcome implies the adoption of a high-quality system that is useful or the non-adoption of a poor-quality or not useful system.

Because our purpose is theory building, we adopt an exploratory case study approach [9]. We first review concepts from relevant existing multi-stage models to identify a priori concepts of innovation pre-adoption to shape the initial research design, as recommended by Eisenhardt [11]. Subsequently, we develop a theoretical framework based on our case analysis to explain the process of healthcare IT pre-adoption in organizations. The framework, with its stages and sub-stages, is intended to improve understanding and facilitate organizational adoption decisions about emerging healthcare IT, such as pervasive healthcare systems.

2. Conceptual background

2.1. Multi-stage models

We begin with a general introduction of multi-stage adoption models followed by a review of well-established multi-stage models of organizational IT adoption. The popular approach to studying IT adoption in previous research has been the variance approach [4]. While the *variance* approach enables the understanding of characteristics that explain technology adoption, it limits the number of variables that can be investigated and is unable to explain dynamic interactions between stakeholders or stages of adoption [4,27]. Conversely, the *process* approach can describe the sequence of events leading to an outcome [43], capturing the richness of the organizational adoption process, but it is limited in its ability to explain the extent of effects on outcomes [27].

To complement the dominant variance approach to technology adoption, Benbasat and Barki [4] proposed the development of multi-stage models to describe the influence of salient belief variables on system use during different stages of adoption. Multi-stage models describe the various stages of technology adoption from initiation into the organization to eventual adoption (e.g., [8,40]). This approach also provides a means to study the impact of contextual factors (i.e., task, technological and organizational characteristics) on stakeholders at various stages, which can explain organizational technology adoption outcomes [25]. Because organizational technology adoption is more complex than an individual adoption decision [23], the value of multi-stage models is demonstrated when we open the "black box" of pre-adoption to reveal the stages and sub-stages within this phase to aid in the organizational technology adoption decision. Therefore, a multi-stage theoretical framework is appropriate to our study.

We review two commonly used multi-stage models used in the IS and management literatures that take the perspective of the adopting organization, i.e., Fichman and Kemerer [15] and Meyer and Goes [36], to identify the a priori concepts for our case analysis [11]. While we recognize that there are numerous multi-stage adoption models (e.g., [8,22]), we reviewed Fichman and Kemerer [15] and Meyer and Goes [36] because these models identified distinct stages that span the pre-adoption phase and provided descriptions of the stages preceding the organizational decision to implement an innovation.

Fichman and Kemerer [15] proposed a model of the technological innovation assimilation life cycle, which describes the various stages of organization innovation deployment, from awareness and adoption to general deployment or routinization [14]. Originally used to examine the assimilation of software process innovations, recent research has adapted the model to other contexts, e.g., inter-organizational business process standards assimilation [2], electronic procurement innovations [38], and assimilation of electronic medical records [39]. Although this model has been used in the healthcare context [39], there has not been an in-depth examination of the stages and sub-stages leading to the organizational adoption decision. To gain insights about the healthcare IT organizational adoption decision, we investigate the stages of pre-adoption in detail. While this model [15] describes six stages, ranging from awareness to general deployment of a new IS, our research focuses on the first four stages, i.e., awareness, interest, and evaluation/trial, which relate to pre-adoption, and commitment, which represents the organizational decision to

adopt the technology. Because the two remaining stages relate to implementation, we will not examine them. The four stages of the Fichman and Kemerer [15] model that are relevant to pre-adoption are described in Table 1.

The second model that is relevant to our study is that of Meyer and Goes [36], which describes the stages of medical innovation assimilation in hospitals. Moreover, it explains various decision-making processes that occur within each stage, e.g., awareness and evaluation. Although this model has been used to study innovation adoption in health service delivery [19], it is not specific to IT adoption and applies to medical innovations in general. Because the Meyer and Goes model [36] was designed for the healthcare context, we find it useful to provide context for the Fichman and Kemerer model [15]. The pre-adoption phase is the focus of our study; therefore, we describe the stages and sub-stages of the Meyer and Goes model [36] that are relevant to our research (see Table 2). Specifically, the adoption implementation stage in [36] is excluded because it does not relate to pre-adoption.

Table 2
Decision-making stages in the assimilation of medical innovations (pre-adoption) adapted from [36].

Stage	Description
Knowledge awareness	
■ Apprehension	■ Individual organization members learn of an innovation's existence.
■ Consideration	■ Individuals consider the innovation's suitability for their organization.
■ Discussion	■ Individuals engage in conversations concerning adoption.
Evaluation choice	
■ Acquisition proposal	■ Adoption of the innovation is formally proposed.
■ Medical-fiscal evaluation	■ The proposed investment is evaluated according to medical and financial criteria.
■ Political-strategic evaluation	■ The proposed investment is evaluated according to political and strategic criteria.

2.2. A priori concepts

In this section, we identify a priori concepts (i.e., stages and sub-stages) for our study of the healthcare IT pre-adoption process. These initial stages and sub-stages ground the development of our framework for healthcare IT pre-adoption and will be retained if the case findings indicate their importance [11]. Table 3 provides these potential stages and sub-stages of healthcare IT pre-adoption identified by mapping the stages of the Fichman and Kemerer [15] and Meyer and Goes [36] models. The table describes the following tentative stages: *Awareness*, *Interest*, *Pre-Trial Deliberation*, *Trial* and *Post-Trial Evaluation* (with some sub-stages).

The *Apprehension* sub-stage of the *Knowledge Awareness* stage of the Meyer and Goes model [36] corresponds to the *Awareness* stage of the Fichman and Kemerer model [15]. In Meyer and Goes' model [36], the *Apprehension* sub-stage describes an initial period during which organization stakeholders learn that a medical innovation exists. Similarly, Fichman and Kemerer [15] describe their *Awareness* stage as a period during which the existence of new IT is made known to key decision-makers. As per [15] and [36], during this period, the organization is aware of opportunities to use new IT, but information about the ability of a technology to meet organizational needs is lacking and no action has yet been taken to determine whether the technology matches these needs.

Interest indicates an organizational commitment to actively learn more about an IT innovation in the near future, as per the Fichman and Kemerer model [15]. Meyer and Goes [36] do not describe such a commitment in their model. However, this stage could be an important intermediate step between Awareness and Pre-Trial Deliberation, and thus, we consider it an a priori concept for our case analysis [15]. During this period, the organization is committed to learning more about the innovation and plans to investigate possible implementation in the near future. Building on this commitment to explore the possible uses of an innovation, the organization will proceed to evaluate its suitability.

The *Consideration* and *Discussion* sub-stages of the *Knowledge Awareness* stage of the Meyer and Goes model [36] do not have a corresponding stage in the Fichman and Kemerer model [15]. Nevertheless, because they are thought to be important in medical innovation pre-adoption [36] and serve as intermediate steps between the Interest and Trial stages, we consider them a priori concepts for our case analysis and group them into a *Pre-Trial Deliberation* stage. The *Consideration* and *Discussion* sub-stages are the deliberation process during which an organization considers whether the innovation is compatible with the requirements of the organization through formal data collection or informal discussions [36].

The *Acquisition Proposal* sub-stage of the *Evaluation Choice* stage of the Meyer and Goes model [36] corresponds to the *Evaluation/Trial* stage in the Fichman and Kemerer model [15]. Both the *Evaluation/Trial* stage in [15] and the *Acquisition Proposal* sub-stage in [36] are similarly described as the formal acquisition of the selected innovation to conduct a trial. We label this the *Trial* stage because the evaluation of the innovation began during the previous stage, while this stage concentrates on the trial of the IT innovation.

The *Medical-Fiscal Evaluation* and *Political-Strategic Evaluation* sub-stages of the *Evaluation-Choice* stage of the Meyer and Goes

Table 1
Technological innovation assimilation process model pre-adoption stages adapted from [15].

Stage	Description
Awareness	■ Key decision-makers are aware of an innovation
Interest	■ The organization is committed to learning more about the innovation
Evaluation/trial	■ The organization has acquired specific innovation-related products and has initiated formal evaluation and trial
Commitment	■ The organization has committed to use a specific innovation in a significant way

Table 3
Tentative stages of healthcare IT pre-adoption derived from [15] and [36].

Stages of Healthcare IT Pre-Adoption	Stages from Fichman and Kemerer [15]	Stages from Meyer and Goes [36]
Awareness	Awareness	Knowledge awareness - Apprehension
Interest	Interest	–
Pre-trial deliberation	–	Knowledge awareness - Consideration - Discussion
Trial	Evaluation/Trial	Evaluation choice - Acquisition proposal
Post-trial evaluation - Medical-fiscal evaluation - Political-strategic evaluation	–	Evaluation choice - Medical-fiscal evaluation - Political-strategic evaluation
Organizational decision on adoption	Commitment	–

model [36] do not have a corresponding stage in the Fichman and Kemerer model [15]. Nevertheless, because they are thought to be important in medical innovation pre-adoption [7,36], we consider them and group them in a *Post-Trial Evaluation* stage in our analysis. This stage occurs after the *Evaluation/Trial* stage but before the *Commitment* stage of the Fichman and Kemerer model [15]. The purpose of this stage is to assess the trial based on certain criteria to decide whether to adopt the technology and proceed with organization-wide implementation. According to Meyer and Goes [36], during the early stages of the organizational evaluation of innovation trials, medical and financial concerns tend to predominate, i.e., medical-fiscal evaluation, followed by political and strategic concerns, i.e., political-strategic evaluation.

The *organizational decision on whether to adopt* the technology is subsequently made, i.e., the *Commitment* stage of the Fichman and Kemerer model [15], which marks the beginning of technological diffusion within the organization given a decision to proceed with organization-wide adoption of the technology. We stop at this point because our focus is on the pre-adoption stages of new healthcare IS. The tentative stages and sub-stages listed in Table 3 (first column) are derived from previous models, [15] and [36], and serve as the a priori concepts for our case analysis.

3. Research methodology

3.1. Research design

As previously noted, there is limited existing knowledge of the pre-adoption process for healthcare IS. This fact prompted us to use a case study method that allows the study of the phenomenon in a natural setting and answers the "how" aspect of the phenomenon [47] identified in our research question. A qualitative case study approach provides rich data and enables us to understand the dynamics present within a setting [9] as per our process objective. The case study approach is *positivist* and *exploratory*, i.e., the objective is building theory. Here, a priori concepts can help guide theory building but new themes emerge from the case analysis and a priori concepts are retained only if indicated by the case findings [11]. This method was chosen to reveal insights into the pre-adoption stages of a healthcare IT innovation in hospitals.

The case studies were conducted in two public hospitals, OneHospital and TwoHospital,[2] which were implementing vital signs monitoring systems. Both hospitals belong to the same healthcare group (StarHealth), which reduces extraneous variation [47] because their innovation orientations are likely to align with the vision of the group. Thus, examining hospitals in the same group provides a consistent setting for comparing technology pre-adoption processes. Furthermore, these hospitals were selected because both were conducting projects to implement wireless technologies for vital signs monitoring but made different adoption decisions, i.e., one proceeded to full-scale adoption while the other did not. Therefore, our multiple-case design adopts a *theoretical replication* logic [9,47] in which the conditions of the cases lead to contrasting predicted outcomes in terms of the organizational decision to adopt the vital signs monitoring system. Through an in-depth analysis, we examine the stages and sub-stages preceding the adoption decisions of two hospitals. Using two cases for comparison allows similarities and differences to be derived and allows more robust theory development [11].

[2] The organizations and individuals in this paper are anonymized to protect their identity.

3.2. Data collection and analysis

Two authors collected the data and an additional author participated in the data analysis. The use of multiple investigators can improve confidence in and reliability of the results [9]. Multiple data collection methods were used to allow for triangulation of sources and increase the reliability of the findings [47]. The primary data collection method was interviews with project members performing various roles from both hospitals. Interviews were conducted shortly after both hospitals concluded their trials of the vital signs monitoring systems. Secondary data collection was based on project documents and presentation slides provided by both hospitals. The project documents included details on project objectives; schedules; specifications; data collected by the hospitals during the projects, such as feedback from nurses and patients; and results of timing studies. Additionally, the researchers conducted three days of field observations at the hospitals. These field observations provided the researchers with context for the interview questions asked of project team members and familiarity with clinical jargon.

Table 4 lists the interviewees. All key project personnel as well as nurses who were available during the data collection period were interviewed. The number of interviewees for each case differed because the project team for TwoHospital was smaller. Nevertheless, we were able to capture the entire sequence of sub-stages for both cases. The sessions were semi-structured to allow the interviewers to probe themes and opportunities that arose during the conversation with interviewees. The interview questions were tailored according to the project role of the interviewee, beginning with questions about the events that occurred in the project followed by questions to probe the various stages of the project (see the Appendix for the interview guide). The interview data were analyzed after each session to adjust subsequent data collection [9]. Each interview session lasted an average of 60 min for project managers and technology solution providers/vendors and 45 min for nurses. All interviews were recorded and transcribed. A total of 225 pages of transcripts resulted from this process. Subsequently, QSR (QSR International Pty Ltd, Victoria, Australia) NVivo 9 software for qualitative analysis was used to code the interview data.

The data from each case were first analyzed separately. This within-case analysis encouraged the development of insights about each case first to avoid generalizing sequences of sub-stages too quickly [11]. The a priori concepts identified were used to guide coding for each case, i.e., to search for the key stages and sub-stages, with the possibility for new concepts to emerge from the

Table 4
List of interviewees and project roles.

Interviewees	Project role	Number of interviewees
Interviewees from StarHealth	Research and Policy Director (for OneHospital and TwoHospital)	1
	Total	1
Interviewees from OneHospital	Project Managers (Clinician)	3
	Project Champion (Clinician)	1
	Senior Nurses	8
	Junior Nurses	2
	Technology Solutions Provider	1
	Total	15
Interviewees from TwoHospital	Project Manager	1
	Project Champion	1
	Senior Nurses	3
	Junior Nurses	3
	Technology Solutions Provider	1
	Total	9

analyses [9]. For example, coding for the *Post-Trial Evaluation* stage was based on two sub-stages, i.e., medical-fiscal evaluation and political-strategic evaluation. Furthermore, the relevant stages were grouped to develop our process framework in accordance with the strategies recommended in [28].

After coding both cases, a cross-case analysis was conducted to identify similarities and differences in the stages and sub-stages of the two settings. Comparing case studies enabled us to discover insights beyond initial impressions of the data. This analysis offered the opportunity to capture novel findings and identify important differences between the cases along each concept that might influence the organizational adoption decision. As a result, we were able to derive a theoretical framework to describe the stages of healthcare IT pre-adoption based on the stages and sub-stages present in both cases. The contrasting cases enabled us to compare the factors that influence organizational adoption decisions. At the end of this study, we solicited both project managers' views to assess the credibility of our interpretations and findings [47].

4. Case study description

4.1. Background

StarHealth, a public healthcare group in Asia, has been experimenting with technology through an Innovation Steering Group (ISG). For example, one StarHealth technological initiative is the InfoWard Initiative. This initiative consists of a broad plan to deploy innovative technologies throughout the patient care process so that clinicians (doctors and nurses) can access clinical information quickly and easily, providing patients with higher quality care.

An ISG and StarHealth's subsidiary, OneHospital, explored the use of wireless sensors to transform vital signs monitoring, which we refer to as the OneVS project. At the time of our study, the OneVS project had been in progress for 17 months. Because hospitals under StarHealth are given autonomy in decision-making and project management, TwoHospital (another StarHealth subsidiary) also embarked on an examination of the wireless monitoring of patient vital signs over a similar period, which we refer to as the TwoVS project. The timeline for the projects is shown in Fig. 1.

4.2. The wireless vital signs monitoring system

The wireless vital signs monitoring system is a web-based, integrated software system that consists of several components, i.e., vital signs monitoring devices (biosensors) worn by the patients, a web-based graphical user interface used by the clinicians, a database server and a web server at the backend. The system makes use of the hospital wireless network infrastructure. This system monitors six vital signs: blood pressure, pulse, temperature, electrocardiogram, oxygen saturation,[3] and respiration rate. Each patient wears an RFID tag for identification. Through this system, digital vital sign charts are generated automatically, replacing the patient charts manually maintained by nurses. This system also enables clinicians to view digital charts anytime and anywhere. Fig. 2 describes the general architecture the wireless vital signs monitoring systems. Although the technology solution vendors for both cases were different, the solutions worked similarly. Because wireless biosensors are portable, patients are allowed to move freely around the hospital during monitoring.

[3] Oxygen saturation (SpO_2) is a measure of the amount of oxygen attached to the red blood cells in the circulatory system.

5. Case analyses and findings

Similarities and differences between cases were identified. While both projects had similar intentions to transform the vital signs monitoring process through wireless technology, their outcomes differed significantly. At the time of our study, one system was being considered for hospital-wide deployment while the other project was discontinued. The dissimilar outcomes might be due to the differences in the IT pre-adoption process described below. The sequence of stages and sub-stages of the OneVS and TwoVS projects will now be analyzed using the a priori concepts identified as initial guides and compared. Emergent concepts will be discussed as they appeared from the case analyses.

5.1. Awareness

While the Awareness stage in prior research [15] refers to the period during which the existence of new IT is made known to organizational decision makers, our analysis suggests that awareness involves not only a recognition of the technological innovation but also the organizational needs the technology is meant to address. In terms of broad *technology awareness*, members of both projects in our study had prior experiences with other wireless technologies. For example, in a previous project, StarHealth and OneHospital collaborated on a wireless temperature monitoring project and gained knowledge about the hospital's capabilities through OneVendor. Similarly, TwoHospital had experimented with other wireless technologies and was aware of pervasive healthcare.

Furthermore, both hospitals were aware of their organizational needs, but their project documents indicated that the order and emphasis of technology awareness compared to needs awareness differed, leading to different awareness approaches to the projects. OneVS Project was conducted in collaboration with StarHealth because both StarHealth and OneHospital had needs that provided a rationale for a joint study. The needs include a foreseeable shortage of healthcare workers, a need to reduce documentation time and medical errors, and a need to protect healthcare workers from contracting contagious diseases (e.g., avian influenza), which drove their search for the wireless technology targeted in this project. At TwoHospital, the new wireless vital signs technology was considered an update of the system they were using, i.e., the telemetry system,[4] rather than driven by an assessment of organizational needs.

Thus, our analysis revealed two *awareness* approaches for the hospitals. The OneVS project reflected the healthcare *issue-driven* approach followed by StarHealth and OneHospital. In an issue-driven approach, the organization is aware of organizational needs before finding technology solutions to meet those needs. OneHospital was keenly aware of various concerns that required improvements in patient care, in particular, vital signs monitoring. A project manager of OneVS explained the needs as follows:

> "...Most of the things are...done manually and nurses have to plot vital signs on the chart and...write notes, which might not be very legible...With the automated system, things are captured automatically and the accuracy rate is higher."

The risks to nurses' health also concerned StarHealth and OneHospital. The SARS epidemic [1] placed many nurses at risk of contracting the disease as they attended to patients. This event

[4] The telemetry system, which was used in the ICU and Cardiology wards of TwoHospital, only monitors patients' heart conditions. Apart from being bulky, the telemetry system could only monitor 20 patients in a ward at a time.

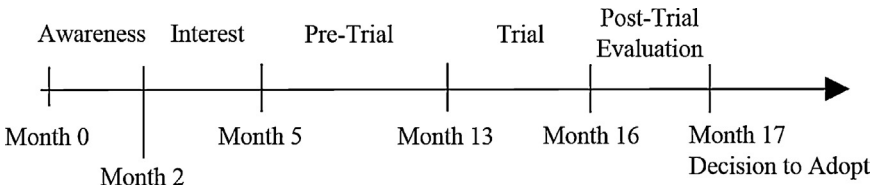

Fig. 1. Timeline for the OneVS and TwoVS projects (not to scale).

highlighted a critical need for monitoring devices that can effectively shield nurses from contagious diseases, which was a stated project objective.

In contrast, TwoHospital followed an *IT-driven* approach. In this approach, the organization first identifies the availability and capabilities of technologies and then explores organizational needs to apply them. The TwoVS project manager described their approach as follows:

> "We have been trying wireless RFID, wireless handheld PDA, Intel Tablet, throughout the hospital with different projects. This is one such project... for us we are trying to use IT in a positive way."

Specifically, the additional benefits of wider coverage achieved through wireless technologies suggested to Two Hospital that their limited coverage telemetry system should be replaced. Similarly, in a separate project implemented by TwoHospital, management was introduced to the benefits of wireless RFID over conventional barcodes before a review was conducted to identify processes that would have a substantial positive impact if the RFID technology were adopted. In other words, IT features rather than healthcare issues drove both projects.

5.2. Interest

The Interest stage in prior research refers to the organizational commitment to actively learn about the innovation [15]. Rather than a monolithic *interest* stage, we noted two sub-stages, i.e., *triggers* and *developing an organizational mandate*, mentioned by interviewees in response to our questions regarding the project phases (see the Appendix). A government healthcare funding initiative to subsidize collaborations between healthcare organizations and solution vendors was an initial trigger in both cases, according to project documents. This initiative encouraged the partnership between StarHealth, OneHospital, and OneVendor (a local technology solutions provider) in the OneVS project and between TwoHospital and TwoVendor (a multi-national technology company) in the TwoVS project. While the funding initiative was a trigger for both projects, another *trigger* for the projects differed.

Specifically, the later *trigger* for each project differed, which led to differences in hospital commitment to learn about the new technology. The OneHospital Chief of the Medical Board, a clinician, saw the potential of wireless temperature monitoring and was a subsequent *trigger* for the OneVS project. The project champion of OneVS noted the following:

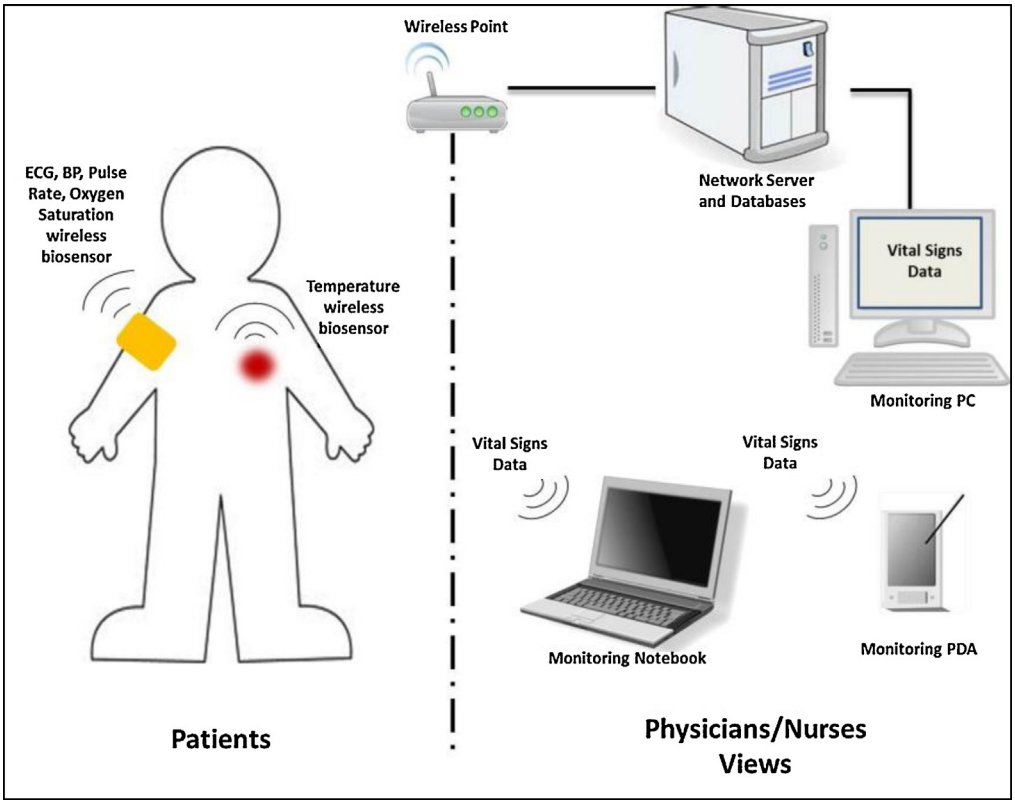

Fig. 2. General architecture of wireless vital signs monitoring systems.

"...he [the chief of the medical board] was looking at it [wireless temperature monitoring] and saying why don't we do all the parameters at one go... And then from there, we...expanded into the use of the latest technology [WIFI] for transmission recording [of the other vital signs]."

In contrast, the *trigger* for TwoVS was TwoVendor, which possessed a proprietary technology that they thought was appropriate for TwoHospital and approached TwoHospital for a joint study (as per project documents). TwoVendor's technology was deemed appropriate to replace the existing telemetry system and its feasibility was considered worth studying.

Thus, OneVS can be considered *clinically triggered* while TwoVS was *vendor-triggered*. Subsequently, the different *triggers* led to diverging roles of the technology solution vendors in the two projects. In OneVS, OneVendor performed a support role to develop a technology solution that was customized to the needs of the clinical department (as per the system specifications). This role gave OneHospital more control over the direction of the project. In contrast, the presence of a ready technological solution from TwoVendor only allowed TwoHospital to configure the system, which restricted how TwoHospital could alter the technology to suit its needs. Thus, TwoHospital had limited control over the project.

After the triggers, both hospitals experienced the *development of an organizational mandate* stage mentioned earlier. Here, a comparison between the two projects revealed a significant difference in terms of the organizational mandate and support (as per project documents). The level of organizational support of the OneVS project was higher; its management consisted of two project managers who were from ISG because OneVS was positioned as an important project in the StarHealth InfoWard initiative. In contrast, the project management in TwoVS consisted of personnel entirely from the departments of TwoHospital and the vendor. Thus, we could characterize the differences in the organizational mandates for the projects as OneVS being *centrally led* while TwoVS was *department led*.

5.3. Pre-trial deliberation

The pre-trial deliberation stage in prior research refers to the deliberation process during which an organization considers whether the innovation is compatible with its requirements [36], which occurs after committing to find out more about the innovation and before a trial. In our cases, the interviews (see Appendix) revealed three sub-stages within this stage, i.e., *Project Team Formation and Championing*, *Goal Unification and Resource Contribution*, and *Requirement Gathering*. We also renamed this stage pre-trial preparation to better represent the sub-stages that we identify in the cases, which extend beyond deliberation. Next, these sub-stages are elaborated.

5.3.1. Project team formation and championing

Both OneVS and TwoVS projects saw the formation of their project teams after the development of an organizational mandate. However, examining the project team composition indicated two differences in the membership of the OneVS and TwoVS projects. The first difference was the job designations and roles of project members. Clinical personnel held leadership roles in OneVS. For example, the project champion and nurse representatives in OneVS were the head surgeon and head nurses of their wards, respectively. However, administrative and departmental staff members made up the TwoVS project team. This difference is characterized as *steering roles* versus *supporting roles* within OneVS and TwoVS project teams, respectively.

The second difference between the project teams is the contrasting influence of the project champions. The OneVS project team realized the importance of having a clinician to champion the project rather than appointing an administrator. Hence, the head surgeon was asked to champion the project. The project manager of OneVS noted the following:

"If the innovation is related to medical [use], then we need the clinicians to... validate and be the champion for that innovation."

In addition, OneVS stressed the importance of choosing a clinician who is interested and familiar with technology to champion the project. This criterion of OneVS project proved useful in subsequent sub-stages. The project manager of OneVS explained as follows:

"We have to find innovators...which means usually they are very proactive and like to play with gadgets...very technology savvy and would sacrifice their time because what they are doing now, they actually don't make money...those times could be used for clinics... but they choose to sacrifice their time to build innovations with us."

In contrast, the TwoVS project champion was a nursing administrator in TwoHospital whose role was to manage nurses and coordinate nursing tasks. In considering the type of project champion required for the project, the project champion of TwoVS observed the following:

"The IS department, they [had] already identified the person to be the manager of the project and then they approach us, nursing. So I am the champion to introduce this to the department...and we will select the appropriate ward... and so we gathered a team of people and we started."

The case analyses revealed differences in how both champions conducted their roles and influenced their project process. OneVS's project champion, being inclined toward technology, was more effective in influencing the vendor. His capacity as a recognized physician in OneHospital also allowed him access to publicize the project to higher authorities (e.g., the Chief of the Medical Board) as well as to influence important financing and technology decisions. His was a *decision-making* role. In contrast, the TwoVS project champion served as a coordinator for clinical input from the nurses when required by the project team. As a result, his influence was limited and he played a *supporting role*.

5.3.2. Goal unification and resource contribution

Our analysis of the cases indicated that the sub-stage of *Goal Unification and Resource Contribution* followed project team formation and championing sub-stages, as per our interview questions on project phases. However, the goal unification and resource contribution differed between the OneVS and TwoVS projects. Although both projects had similar aims to develop a wireless vital signs solution to aid in the nursing care process, TwoVendor had an additional goal. The project manager of TwoVS revealed that TwoVendor's objective in testing their proprietary communications solution within TwoHospital was to eventually make their communications solution an industry standard. This goal drew attention away from the wireless biosensors that were provided by third-party vendors. The project champion of TwoVS noted the following:

"The vendor wants to test the equipment... But for us, we not only want it to work, we want it to work on the bigger scale and be effective for what we set out to achieve...There is a limit [to what] vendors wanted to do but if [the hospital] really wants to

introduce the project, [the technology] must meet our need first. So there is a gap there."

In contrast, the stakeholders in the OneVS project had *unified goals*. OneVendor was relatively new to wireless vital signs technology, and they hoped to use the clinical input from OneHospital to guide the development of the technology. As a result, OneVendor and One Hospital shared the goal to produce a technological solution. Our interview data indicated that the project champion helped cultivate the *unified goals* of OneHospital and OneVendor. The project champion of OneVS noted the following:

"So after talking to him [the boss of OneVendor], we have quite a few things in common because they are interested in developing these devices that are dedicated for medical use, and...I quite like his way of handling business. Because they're a startup company they are not that focused on profits, or whether the thing can definitely sell...so I gave them some ideas."

The project champion of TwoVS had a smaller influence and helped develop *partly unified goals* among stakeholders because his role was mainly to coordinate the use of the new technology among the nurses. Overall, OneVS was characterized by *unified* goals, while TwoVS possessed *partly unified* goals.

The case analyses also indicated dissimilar *resource contributions* between the two projects, which could influence the adoption decision. In OneVS, OneHospital was willing to contribute financial resources toward the project in addition to what was provided through the government healthcare funding initiative and OneVendor. The project champion of OneVS explained the following:

"[We] help them out with the funding...We just do it, like a collaboration. ...To me, it's more of a win-win situation...because [if] you're always talking about cost...the project will never take off. They won't be able to meet the budget constraint."

In contrast, funding for TwoVS was mainly provided by TwoVendor and the government healthcare initiative. The project champion of TwoVS revealed the following:

"...the commitment and amount of money was from the vendor not the hospital...because this funding is not done by them [the hospital]. So the project hinged on whether the vendor [was] willing to commit."

We distinguish between the *resource contributions* of both projects because the resource contributions to OneVS were *shared* while the resource contribution to TwoVS was *unilateral*.

5.3.3. Requirement gathering

The *requirement gathering* sub-stage before the trial involved information gathering about both task and technology needs in our cases. For both OneVS and TwoVS, *requirement gathering* was conducted through multiple meetings over a period of eight months to understand the task and technology requirements. Participation in the meetings allowed clinicians and nurses to provide clinical input about the features they preferred in the technology. Although OneVS developed the technology from scratch, the process was facilitated by their project champion who drew on his previous experience with IT. His IT knowledge and capacity as a *decision-maker* allowed him to make technology decisions that resulted in clear technology requirements. He played a *boundary-spanning* role, bridging the gap between the clinical and IT domains. The Project Champion of OneVS elaborated as follows:

"...we gave [OneVendor] some input in terms of the requirements...like...I specified that I wanted the device to have...an open system and WIFI. So they did...develop a product to suit what we required..."

In contrast, due to less experience with technology, the project champion from TwoVS relied heavily on the expertise of the vendor to determine whether the available technology could meet clinical requirements because he represented only the clinical domain. To sum up the difference, the project champion of OneVS played a *boundary-spanning* role, while the project champion of TwoVS played a *non-boundary-spanning* role. Completion of this sub-stage allowed the project teams to proceed to the *Trial* stage.

5.4. Trial

The trial stage is described by prior research as the formal acquisition and trial of the target innovation [15,36]. Both projects in our study performed trials of wireless vital signs monitoring systems over a period of 3 months with two sub-stages, i.e., *Training Users* and *Feedback Assessment*, as described next. These sub-stages were also obtained from the interview questions regarding project phases.

5.4.1. Training users

In both hospitals, vendors conducted onsite group training sessions with clinicians. However, the ways in which nurses were motivated to learn and use the new technology differed. In OneVS, the senior nurses were assigned the role of change agents, who played salient roles in the trial ward and were present at every training session (as per the project documents). Their constant and visible presence as change agents among the nurses who were learning and using the new technology reinforced the social norms within the ward. One of the OneVS nurses noted:

"[The nurses] have confidence using the device; they can help each other. Even though the [vendor] trainers are not around, [the nurses] can learn from each other. Our seniors are also always around to teach."

In contrast, the TwoVS project champion performed the role of change agent among the nurses as part of his administrative role. In addition, because his work was not situated in the wards, his presence during the ward trial period of the new system was minimal. Therefore, there was no dedicated change agent in this project. The project champion of TwoVS described his role as an addition to his main administrative duties as follows:

"My role [as change agent] is mainly to encourage people to participate, teach them how to use [the technology], and promote it in the ward."

After training the nurses, both projects proceeded with actual trials in the wards. Again, the effectiveness of senior nurses as change agents was displayed during the OneVS trial. The senior nurses at OneHospital continued to guide their juniors and ensure that they adhered to the use of the new technology, while the project champion of TwoVS assumed that additional role along with his other tasks, which resulted in less time and effort being expended on nurse training. In OneVS, user training was *change-agent influenced* while training at TwoVS had *no dedicated change agent*.

5.4.2. Feedback assessment

The trials proved to be a learning experience for both project teams as they saw how this technology could affect processes and discovered additional system requirements. Over the course of the three-month trial, feedback was obtained from the trial

participants. At TwoHospital, the TwoVS team collected *feedback from clinicians*, i.e., nurses, only. In contrast, the OneVS project team also collected extensive feedback from patients through surveys. Analysis of the *feedback from patients and clinicians* helped OneVendor improve the technology. For example, patients provided feedback to improve comfort because some felt that the biosensors could be uncomfortable when pasted on their body. Nurses also provided feedback on the device features, such as the need for a longer battery lifespan, improved usability and smaller device size. A nurse clinician from OneVS provided the following comment:

> "The equipment is user friendly; we just have to paste it on the patient. However, one drawback is that you have to register the patient again. We prefer that the system retrieve patients' particulars [automatically] from other systems"

5.5. Post-trial evaluation

The aim of the post-trial evaluation stage in both cases was to assess the trial based on prescribed criteria to decide whether to adopt the technology and proceed with organization-wide implementation. Our case analyses (based on interview questions about the project phases) indicated that the evaluation upon completion of the trial involved two sub-stages, i.e., *Medical Evaluation* and *Managerial Value Analysis*. During the first sub-stage, clinicians evaluated the suitability of the IT system after the trial using medical criteria. For example, the OneVS project team conducted a careful *medical evaluation* of the vital signs monitoring system trial and was satisfied that the vital signs readings produced by the system were accurate. This sub-stage is consistent with the medical aspect of *medical-fiscal evaluation* from our a priori concept [36].

The *partly unified* goals of the TwoVS project team diverged at the end of this stage when TwoHospital requested a larger-scale trial to rectify the problems identified from the first trial and to test the technology on more patients. The project champion of TwoVS noted the following:

> "[TwoVendor's focus is on] the software, to make sure that the solution works. But we need to improve on the hardware. For our hospital, we need everything, the software and the hardware."

TwoHospital wanted to ascertain whether TwoVendor could provide a complete solution before they decided on organization-wide adoption, which differed from TwoVendor's goal. TwoVendor was unwilling to commit additional resources for a second trial. As a result, the TwoVS project stalled.

During the second sub-stage, which only occurred in the OneVS project, organizational management (which had the authority to make the adoption decision) conducted a value analysis of the IT from the results of the trial based on financial, strategic, and operational objectives. At the conclusion of our data collection process, the hospital management of OneVS had completed their *managerial value analysis* and the project team of OneVS was formulating a business proposal for organization-wide adoption to be presented to the upper management of OneHospital. This sub-stage is consistent with the fiscal aspect of *medical-fiscal evaluation* and *political-strategic evaluation* from our a priori concepts [36]. In other words, the medical evaluation was conducted separately by clinicians and followed by the fiscal evaluation, which was combined with the political-strategic evaluation, conducted by management.

6. A framework for the healthcare IT pre-adoption process

Based on the findings from both cases, we present a theoretical framework (see Fig. 3) that explains the organizational healthcare IT pre-adoption process. Following Fichman and Kemerer [15], our

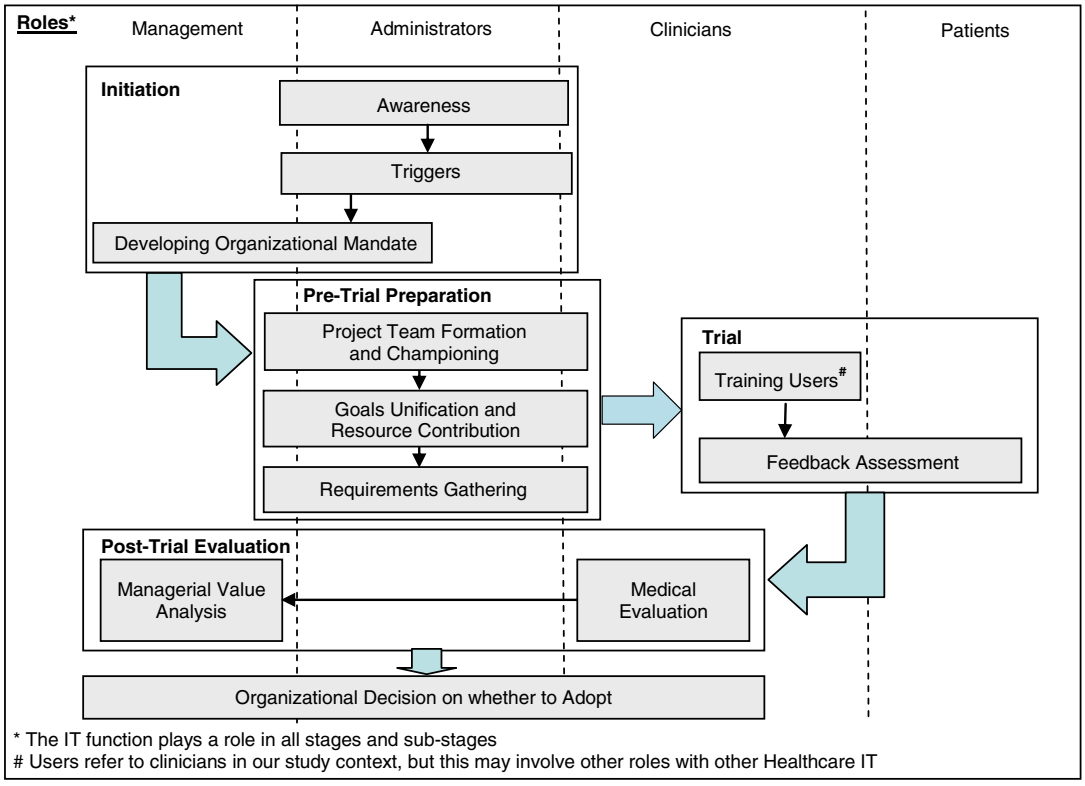

Fig. 3. Framework for the healthcare IT pre-adoption process.

framework proposes a linear progression through the stages of healthcare IT pre-adoption. However, organizations may diverge from this progression for reasons such as incompatibility of an innovation with functional requirements or failure to initiate a trial, i.e., they may decide not to proceed with adoption at any stage. We used the a priori concepts from the literature, refined them and added new concepts based on our case analyses to derive the framework.

The framework also includes roles that are unique to healthcare organizations, which responds to prior research stressing the importance of identifying the healthcare actors involved in the adoption of IS [34]. In our framework, *management* includes personnel who have the authority to make adoption decisions within organizations and direct the strategic, operational and financial goals of the organization. *Administrators* are hospital personnel who are tasked with non-patient care roles but are essential to the daily operations of the hospital. *Clinicians* include the doctors and nurses who are at the frontline of patient care services, while *patients* are the receivers of healthcare services. The *IT function* of the hospital plays a role across all stages and sub-stages of the framework.

Overall, our cross-case analysis highlighted similar stages and sub-stages during the pre-adoption phase that might influence the healthcare IT adoption decision (see Fig. 3). However, the approaches taken during the sub-stages were different, as summarized in Table 5. Based on the different organizational decisions for the two cases, we suggest that specific approaches during the pre-adoption phase might produce beneficial outcomes. The stages and sub-stages of the framework are now described.

6.1. Initiation stage

In our framework, we combine the Awareness and Interest stages from our a priori concepts into an *Initiation* stage that includes the *Awareness*, *Triggers*, and *Developing an Organizational Mandate* sub-stages. This stage represents the first step of IT initiation into the healthcare organization and consists of three sub-stages that span the period from when the organization first becomes aware of the innovation until it commits to learn more about the innovation to meet organizational needs.

Our findings indicate that healthcare organizations benefit from developing a broad plan in which it projects itself into the future and is aware of the challenges to achieving its goals. *Healthcare issue-driven awareness* encourages stakeholders to be alert for IT innovations that meet organizational needs and prevents an IT-driven approach in which stakeholders encounter a technology and attempt to tailor it to organizational needs. A healthcare issue-driven awareness approach is more likely to be goal-directed and help unify intentions across organizational levels during subsequent sub-stages compared to an *IT-driven awareness* approach.

Additionally, our findings suggest that awareness might not lead to a management commitment to learn about an innovation without triggers. Previous research defines triggers as internal or external events that initiate a change in the equilibrium state [18]. In our cases, triggers occurred in the form of external funding and

Table 5
Summary of the main differences between the OneVS and TwoVS projects.

Stages and sub-stages	Approach		Findings
	OneVS project	TwoVS project	
Initiation			
■ Awareness	Issue-driven	IT-driven	Issue-driven awareness fostered better alignment with organization needs than an IT-driven approach
■ Triggers	Clinically triggered,	Vendor-triggered,	A clinically triggered approach produced more beneficial outcomes than a vendor-triggered approach
■ Developing an Organizational Mandate	Centrally led	Department led	A centrally led mandate provided stronger support for project continuance than a department led mandate
Pre-trial preparation			
■ *Project team formation and championing*			
○ Project Members	Steering role	Supporting role	A project team with steering roles drove the project toward the organization goals more effectively than one with supporting roles
○ Project Champion	Decision-making role	Supporting role	A project champion with a decision-making role garnered more support from the hospital board than one with a supporting role
■ *Goal unification and resource contribution*			
○ Goals	Unified	Partly unified	Stakeholders with unified goals led to better project outcomes than those with partly unified goals
○ Resource Contribution	Shared resources	Unilateral resources	Shared resources fostered collective ownership of project outcomes compared to unilateral resource contributions
■ Requirement Gathering	Boundary spanning role	Non-boundary-spanning role	A project champion with a boundary-spanning role facilitated requirement gathering more effectively than a champion who is non-boundary-spanning
Trial			
■ Training Users	Dedicated change agent	Non-dedicated change agent	Dedicated change agents offered considerable value over non-dedicated change agents in training users and conducting the trial effectively
■ Feedback Assessment	Feedback from clinicians and patients	Feedback from clinicians	In addition to clinicians, it was important to obtain feedback from patients as the ultimate end users of the IT and receivers of healthcare services
Post-trial evaluation			
■ Medical Evaluation	Positive	(Stalled)	Favorable medical evaluation and managerial value analysis positively influenced the decision to adopt the technology
■ Managerial Value Analysis	Positive	–	

individuals who initiated information gathering about the new technology for subsequent trial and evaluation. In the healthcare IT pre-adoption context, we observed clinically triggered and vendor-triggered approaches during the initiation. Our findings suggest that a *clinically triggered* approach can increase the likelihood of beneficial outcomes compared to a *vendor-triggered* approach.

Finally, our findings suggest that a *centrally led* organizational mandate is needed for an innovation project to progress from initiation through the pre-trial, trial and post-trial evaluation stages. A centrally led mandate can provide stronger support for continuance compared to a *department led* organizational mandate. A centrally led mandate for the innovation project communicates throughout the organization that upper management is seriously considering the IT innovation and includes it as part of their agenda. Upper management participation signals commitment throughout the organization and has been associated with innovative use of IT [24].

6.2. Pre-trial preparation stage

Based on our case analyses, the Pre-Trial Preparation stage consists of three sub-stages, i.e., *Project Team Formation and Championing*, *Goal Unification and Resource Contribution*, and *Requirement Gathering*. A project team formed at this stage helps oversee the later stages of pre-adoption, where team composition and championing will influence outcomes.

Specifically, our findings suggest that a centrally led organizational mandate followed by the formation of a *project team with steering (leadership) roles* might propel the innovation project toward the organization's goals. In contrast, a narrower, department led mandate followed by a *team* performing *supporting roles* might not be able to provide sufficient impetus for the project. Additionally, a *project champion with a decision-making role*, possessing both medical and IT expertise, can provide recommendations regarding the IT innovation to improve acceptance compared to a champion with a *supporting role*, possessing only medical knowledge. Such a champion can garner involvement and support from the hospital board, which plays a key role in hospital IT innovation [31].

Furthermore, *shared resource contributions* from various stakeholders allow collective ownership of project outcomes compared to *unilateral resource contribution*, e.g., funding provided only by the vendor. Our findings suggest that shared resource contributions promote stakeholder commitment to *unifying* their *goals* to attain a beneficial outcome rather than pursuing goals that are only *partly unified*. A commitment from all stakeholders leading to a collective intention can produce positive outcomes for IT adoption (e.g., [10]). With unified goals and shared resource contributions, a project team can proceed with *requirement gathering* from users for the subsequent trial, where task and technology requirements are elicited [41]. Here, a project champion with a *boundary-spanning* rather than a *non-boundary-spanning* role can help accurately identify the organizational requirements. Specifically, our findings suggest that a clinical project champion with IT knowledge could perform such a boundary-spanning role effectively. Such expertise coordination is considered salient in IT development [13].

6.3. Trial stage

Trials enable an organization to evaluate the feasibility of implementing new healthcare IT as well as to obtain an initial assessment of whether the technology can meet organizational needs. Our findings highlight the importance of dedicated change agents for *user training* during the trial. These change agents can facilitate IT learning by providing user support during the trial, which helps new users overcome the learning costs of switching to the new healthcare IT. Our findings suggest that a *dedicated change agent* who works closely with the users (e.g., a senior nurse working with junior nurses) can offer considerable value over a *non-dedicated change agent*.

Additionally, comprehensive feedback should be obtained during the trial to accurately assess the value and suitability of the IT. Here, the feedback from both *clinicians and patients* is important, as the latter are the ultimate end users of the IT and receivers of healthcare services [42]. Hence, it is beneficial to obtain feedback from *clinicians and patients* rather than *clinicians* only. Our findings suggest that a comprehensive *feedback assessment* during the trial stage allows user requirements to be refined and new requirements to be identified, leading to enhancements in the innovation.

6.4. Post-trial evaluation stage

Our findings suggest that upon the completion of the Trial Stage, new healthcare IT should be *evaluated using medical criteria* involving mainly clinicians. This focus is important because clinicians have the primary responsibility for and expertise to deliver medical care assisted by the new technology. The adoption of healthcare IT can then be formally proposed to upper management for consideration and *value analysis*. The management should consider the remaining (fiscal, political, and strategic) criteria in their *managerial value analysis* to make a more informed decision about adopting the new IT. Our healthcare IT pre-adoption framework ends when a decision on adoption of the new technology is made.

7. Implications

7.1. Research contributions

Our multi-stage framework for healthcare IT pre-adoption offers several contributions to the existing body of literature. First, the framework is unique in its focus on the organizational pre-adoption process and decision, which is a challenging phase during which healthcare organizations evaluate and justify the need for new IT. However, there is a lack of research that explicates the pre-adoption stages of healthcare IT innovations. With the development of our framework for healthcare IT pre-adoption, this study contributes to healthcare-IS research,[5] which "represents perhaps the most promising opportunities to push the contextual envelope of IS research" [5, p. 175], yet constitutes less than one-fifth of healthcare IS papers over the past two decades [33].

Specifically, we developed an IT pre-adoption framework for the healthcare context, which extends previous multi-stage model research that was limited to either IT adoption models (e.g., [15]) or models for adoption of healthcare innovations that are not IT-based (e.g., [36]). Compared to the a priori concepts identified from previous multi-stage models, i.e., [15] and [36], our theoretical framework provides more details and identifies the stages and sub-stages that are important and specific to healthcare IT. In particular, we refined the stages (i.e., initiation and pre-trial preparation) and added various sub-stages (i.e., developing an Organizational Mandate, Project Team Formation and Championing, Goal Unification and Resource Contribution, Training Users,

[5] Chiasson and Davidson [5] proposed a classification of healthcare information systems research studies based on how IS theory and the healthcare context were addressed. Their classification consists of IS studies (primary focus is theory without consideration for the healthcare context), IS-healthcare studies (primary focus is theory with some consideration for the healthcare context), healthcare-IS papers (emphasis on the contextual influences of healthcare using IS theories or concepts), and healthcare studies (emphasis on healthcare without application of IS theories).

and Feedback Assessment) to our framework. The Medical Evaluation and Managerial Value Analysis sub-stages were also refined. In this manner, our study integrated IT project management concepts into the framework that are typically missing from multi-stage models of innovation adoption.

Second, specific healthcare roles (i.e., management, administrators, clinicians, patients, and IT) are introduced in this framework, which extends the medical innovation framework by Meyers and Goes [36]. By identifying the healthcare roles played by the various stakeholders at each stage/sub-stage, our framework helps to explain their involvement at different stages of the healthcare IT pre-adoption process. This contributes to an improved understanding of the interactions between stakeholders during the pre-adoption phase, which can affect IT adoption decision outcomes.

Third, our earlier discussion mentioned an over-reliance on the variance method in studies of IT adoption and its determinants. This research complements the variance method by developing a process framework for organizational healthcare IT pre-adoption. Our framework helps explicate the stages and sub-stages of healthcare IT pre-adoption, and at each sub-stage, we have indicated the conditions (e.g., healthcare issue-driven vs. IT-driven awareness) that contribute to beneficial outcomes. Because these conditions are represented as binary based on the findings of our two cases, we are unable to measure the degree to which each factor can influence the pre-adoption process. Therefore, it would be beneficial for future research to extend this work into a variance model using these and other potential factors as antecedents.

7.2. Practical implications

In addition to research contributions, this paper provides several practical suggestions and implications. First, the proposed framework in Fig. 3 is relevant to practitioners because it is developed to be implemented in organizations conducting their healthcare IT pre-adoption processes. The four main stages include sub-stages and approaches that are prescriptive and promote organizational best practices based our case studies (see Table 5). These approaches can collectively increase the likelihood of a beneficial outcome in the organizational healthcare IT adoption decision. For example, within the initiation stage, a clinically triggered project might give medical practitioners more control over the direction of the project, which may lead to additional customization and improved acceptance of the system. Within the Pre-Trial Preparation Stage, organizations can manage their IT adoption process to form a project team with steering roles and enlist a project champion with a decision-making role to encourage a beneficial outcome.

Second, this paper provides specific examples and guidance for hospitals considering the adoption of pervasive healthcare systems, such as wireless vital signs monitoring systems. As this IT innovation is being implemented in hospitals, practitioners should find that the framework and case findings provide valuable guidelines.

7.3. Limitations and future research

The following limitations must be considered when applying the findings of this study. First, this framework is based on two public hospitals, which may not represent other healthcare organizations. To mitigate this problem, the findings that emerged from case data were analyzed with a priori concepts from the literature to develop the framework depicted in Fig. 3. Moreover, despite efforts to reduce the variation between cases, other differences that might influence the outcome of the pre-adoption process e.g., culture of the organization, might exist. Therefore, the inclusion of a larger sample of hospitals in future studies might provide additional insights.

Second, the framework was derived from the pre-adoption of vital signs monitoring systems and, though it is not confined to a specific type of healthcare IT, application to other systems should be cautious. Future research can validate and extend the framework by considering other types of healthcare IT. Third, future research could adopt a variance approach to provide insights into the influence of these or other factors on the adoption decision or the relationships among the factors. In addition, longitudinal studies can be conducted to evaluate whether each stage of the pre-adoption phase precedes another and whether the outcomes of each stage influence subsequent stages.

8. Conclusion

As healthcare organizations assess new IT to improve the quality of medical services, they must obtain an adequate understanding of the pre-adoption process to adopt and reap the benefits of such systems. The pre-adoption stages help the organization understand the potential benefits of the new technology before the decision to invest in the technology is made. This paper offers a healthcare IT pre-adoption multi-stage framework, which includes the main stages of (1) Initiation, (2) Pre-Trial Preparation, (3) Trial and (4) Post-Trial Evaluation and sub-stages within each stage. The sequence and description of stages and sub-stages in the framework provides guidance on how healthcare IT pre-adoption could be conducted to encourage beneficial outcomes.

Although variance models explain that an easy to use and useful system can lead to IT adoption and acceptance, qualitative methods, such as the process approach, reveal the complexities behind the pre-adoption decision that can affect the IT adoption process and outcome. Understanding these complexities is essential for healthcare organizations to develop their capabilities and practices to manage their IT pre-adoption processes. This paper has taken a step in this direction.

Appendix

Interview Questions for Project Managers

1. What is the process of introducing new IT to the hospital?
2. How was the project initiated? What were the project phases?
3. What were the healthcare problems that led to the need for a vital signs monitoring system?
4. Who was involved in the trial and what were their roles? How were users involved?
5. How was the vendor chosen? What was the vendor's role?
6. What were the difficulties you faced in this project (e.g., finance, labor)?
7. How was the training conducted?
8. What were the challenges faced during the trial?
9. How did you measure the outcome of this project?
10. How did you obtain feedback from clinicians and patients?
11. What are the plans for the use of the vital signs monitoring system?

Interview Questions for Project Champions and the Research and Policy Director

1. What is the process of introducing new IT to the hospital?
2. Why does the hospital need a vital signs monitoring system?
3. How was the project initiated? What were the project phases?

4. How did hospital management show their support and commitment to the project? Did you hope that management would contribute more?
5. How was the project team formed? Where did the team members come from? What roles did they play?
6. Who was involved in the trial and what were their roles? Can you describe their involvement in and enthusiasm for this project?
7. How was the vendor chosen? How was the technology solution chosen?
8. How did you determine the requirements for this project?
9. What were the difficulties you faced in this project (e.g., finance, labor)?
10. How did you resolve disagreements between the vendor and the hospital?
11. How was this IT introduced to the nurses?
12. How was the training conducted?
13. What were the challenges faced during the trial?
14. What are the plans for the use of the vital signs monitoring system?

Interview Questions for Nurses

1. How were vital signs taken before the monitoring devices were introduced?
2. When did you first hear that the hospital would be using vital signs monitoring devices and how did you feel about it?
3. What is your opinion about this IT?
4. How were you trained to use this IT? Was the training effective?
5. With the use of the vital signs monitoring devices, how did your job process change?

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