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Examining the Stages of Healthcare IT Pre-Adoption:
A Case Study of Vital Signs Monitoring Systems

Abstract

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

Keywords: Healthcare information technology, IT pre-adoption, multi-stage framework, vital signs monitoring system, pervasive healthcare

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1. INTRODUCTION

The use of information technology (IT) has the potential to improve the efficiency and quality of care, and streamline healthcare processes [3,30]. A promising application of IT in healthcare is pervasive healthcare, 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. With the recent concerns about infectious diseases, recommendations have been made to improve communication effectiveness within healthcare systems using new communication tools [46]. Particularly, healthcare workers are vulnerable to infectious diseases such as avian influenza and severe acute respiratory syndrome (SARS) [1]. Pervasive healthcare IT could be invaluable in reducing the spread of communicable diseases since it allows remote monitoring and communication between healthcare professionals and patients, as can be seen from systems such as the vital signs monitoring system.

Vital signs monitoring is a salient activity conducted by nurses to monitor patient’s progress and any irregularities [12]. Nurses typically go to each patient and manually record vital signs readings such as blood pressure, temperature, respiratory rate and pulse rate. However, this process is prone to errors. A study by Gearing et al. [17] indicated that 25.6% of vital sign sets in paper medical records had 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 all documentation. This suggests that there is a strong need to adopt techniques to reduce errors and time spent on monitoring vital signs. The application of pervasive computing towards vital signs monitoring is a possible approach to save time taken to manually record vital signs and to improve accuracy.

While healthcare IT such as vital signs monitoring systems can provide various benefits as mentioned above, research has shown that barriers in managing healthcare IT adoption can result in poor outcomes [32,37]. Particularly, the steps leading to the organizational adoption decision, commonly referred to as the pre-adoption phase, are important. The pre-adoption phase
typically refers to the period starting from when organizational decision makers gain awareness of the innovation until the decision whether to adopt it is made [15,36]. This phase comprises of several activities such as becoming aware of existing innovations, acquiring the innovation to perform trials, and feasibility analysis to assess the value of the innovation [20]. These activities are vital because poor management of the pre-adoption process can lead to an erroneous decision i.e., to adopt a poor quality system or not adopt a system that can bring potential benefits. Therefore, there is a need for a deeper understanding of the influence of the activities and conditions leading up to the organizational decision to adopt a system.

While there is considerable research on IT adoption in general, certain characteristics of healthcare IT demand research specific to this sector. Mainly, adoption of IT in healthcare has been slow compared to other major industries [29]. This is because the healthcare industry poses major social and technological challenges in the development and use of information systems [5, 6]. Particularly, the multiple groups of actors in the healthcare industry, e.g., physicians, nurses, allied healthcare professionals, and administrators, add to the complexity of the adoption decision as compared to other industries [29]. Among these groups, medical personnel who are largely autonomous [26] tend to differ from administrators in their attitude towards and requirements for IT because of their different job objectives and skills [35]. Thus, healthcare IT must meet the needs of the diverse groups of users. Further, it is particularly challenging to justify the use of healthcare IT because most of its benefits accrue to external parties such as patients, thus 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 use a multi-stage approach as it is useful in identifying and explaining the various phases of organizational technology adoption in detail. Particularly, multi-stage models can contribute insights into the complex nature of technology adoption in organizations by showing the linkages and temporal relationships among events as implementation processes unfold [16]. In this regard, taking the multi-stage approach allows the influence of various activities in different stages of the pre-adoption phase to be investigated. This also creates a means to study the roles played by different stakeholders during the pre-adoption phase, which can affect technology adoption decision outcomes [25]. As the vast majority of previous multi-stage models (e.g. [15]) have focused on the technology adoption
process in general, there is a lack of models developed for the healthcare context and focusing on
the organizational IT pre-adoption process in particular. The latter models are valuable because
of the specific characteristics of healthcare IT as described earlier. Hence, we aim to develop a
multi-stage framework for IT pre-adoption, specific to the healthcare context, as recommended
in previous literature [5].

Thus, we develop our theoretical framework that shows the stages during the pre-
adoption till the adoption decision of healthcare IT in organizations using a process approach.
This study draws on contrasting cases of vital signs monitoring system adoption projects in two
hospitals to develop insights to answer our research question, “How can healthcare IT pre-
adoption be conducted to obtain beneficial outcomes?” In our context, beneficial outcome
implies adoption of a system that is useful and of high quality, or non-adoption if the system is of
poor quality and not useful.

Since our purpose is theory building, we adopt an exploratory case study approach [9].
We start off by reviewing concepts from existing relevant multi-stage models to identify a-priori
concepts of innovation pre-adoption to help shape the initial research design, as recommended by
Eisenhardt [11]. Subsequently, based on our case analysis, we develop a theoretical framework
to explain the process of healthcare IT pre-adoption for organizations. The framework, with its
stages and sub-stages, is intended to help understand and facilitate the organizational decision for
emerging healthcare IT adoption, 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. In prior research, the popular
approach in studying IT adoption 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 the dynamic
interactions between stakeholders as well as the stages of adoption [4,27]. On the other hand, the
process approach can describe the sequence of events leading to the outcome [43], capturing the
full richness of the organizational adoption process, though it is limited in its ability to explain
the extent of effects on outcomes [27].
To go beyond the dominant variance approach in technology adoption, Benbasat and Barki [4] proposed the development of multi-stage models to understand the influence of salient belief variables on system use at different stages of adoption. Multi-stage models describe the various stages of technology adoption from its initiation into the organization to its eventual adoption (e.g., [8], [40]). This also provides a means to study the impact of contextual factors (i.e., task, technology and organizational characteristics) on stakeholders at various stages which can be used to understand organizational technology adoption outcomes [25]. Since technology adoption in an organization is complex and involves more than an adoption decision by individuals [23], the value of multi-stage models is demonstrated when we open up 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, we find it appropriate to develop a multi-stage theoretical framework in our study.

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

Fichman and Kemerer [15] proposed a model depicting 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 in other contexts e.g., for inter-organizational business process standards assimilation [2], electronic procurement innovations [38], and assimilation of electronic medical records [39]. However, 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. Therefore, to gain insights about the healthcare IT organizational adoption decision, we aim to investigate the stages of pre-adoption in greater detail. While the model [15] describes six stages from awareness to general deployment of a new IS, our research focuses on the first four stages, i.e., awareness, interest, evaluation/trial, which relate to pre-adoption, and
commitment, which represents the decision to adopt the technology in an organization. As the remaining two stages relate to implementation, we will not examine them. The four stages of the Fichman and Kemerer [15] model relevant to pre-adoption are described in Table 1.

| Stage            | Description                                                                 |
|------------------|-----------------------------------------------------------------------------|
| Awareness        | Key decision makers are aware of a new innovation                          |
| Interest         | The organization is committed to actively learn 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 1: Technological Innovation Assimilation Process Model Stages prior to Adoption adapted from [15]

The second model that is relevant for our study is that of Meyer and Goes [36], as it describes the stages of medical innovation assimilation in hospitals. Moreover, it explains various decision making processes that occur within each stage e.g., awareness, evaluation. However, 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. Thus, as the Meyer and Goes model [36] was designed for the healthcare context, we find it useful to act as a contextual basis for Fichman and Kemerer’s model [15]. As the pre-adoption phase is the focus of our study, we present the stages and sub-stages of their 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.

| 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    | Adoption of equipment embodying the innovation is proposed formally.         |
| Proposal       | The proposed investment is evaluated according to medical and financial criteria. |
| Medical-Fiscal |                                                                              |
| Evaluation     |                                                                              |
| Political      |                                                                              |
| Strategic      |                                                                              |
| Evaluation     |                                                                              |

Table 2: Decision Making Stages in Assimilation of Medical Innovations (for pre-adoption) adapted from [36]

2.2 A-Priori Concepts
In this section, we identify a-priori concepts (i.e., stages and sub-stages) for our study of the pre-adoption process of healthcare IT. These tentative stages and sub-stages provide an initial grounding for the development of our framework for healthcare IT pre-adoption, and will be retained should the case findings prove their importance [11]. Table 3 shows these potential
stages and sub-stages of healthcare IT pre-adoption identified by mapping the stages between Fichman and Kemerer’s model [15] and Meyer and Goes’ model [36]. When we performed the mapping, the tentative stages of Awareness, Interest, Pre-Trial Deliberation, Trial and Post-Trial Evaluation, emerged (with some stages consisting of sub-stages) as described below.

| 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               | -                                    | Evaluation Choice              |
|                                     |                                      | - Medical-Fiscal Evaluation    |
|                                     |                                      | - Political-Strategic Evaluation|
| Organizational Decision on whether | Commitment                            | -                              |
| to Adopt                            |                                      |                                |

Table 3: Tentative Stages of Healthcare IT Pre-adoption derived from [15] and [36]

The first Apprehension sub-stage in the Knowledge Awareness stage of Meyer and Goes’ model [36] corresponds to the Awareness stage of Fichman and Kemerer’s model [15]. In Meyer and Goes’ model [36], the Apprehension sub-stage describes an initial period when organization stakeholders learn of the existence of a medical innovation. In a similar vein, Fichman and Kemerer [15] describe their Awareness stage as a period when the existence of a new IT is made known to key decision makers. As per [15] and [36], in this period, although the organization is aware of the opportunities to use the new IT, information about its suitability to meet organizational needs is lacking and there is no action yet to match them together.

Interest relates to 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 commitment in their model. However, this stage could be important as an intermediate step between Awareness and Pre-Trial Deliberation, and thus we consider it as an a-priori concept for our case analysis as per [15]. In this period, the organization is committed to learn more about the innovation and has plans to investigate it for possible implementation within the foreseeable future. Building on this commitment to explore the possible use of an
innovation, the organization will proceed to evaluate its suitability.

The Consideration and Discussion sub-stages in 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, as they are suggested important for medical innovation pre-adoption [36] and serve as an intermediate step between the Interest and Trial stages, we consider them as a-priori concepts for our case analysis and label them together as the Pre-Trial Deliberation stage. The Consideration and Discussion sub-stages are described as the deliberation process where an organization considers whether the innovation is compatible with the requirements of the organization, either through formal data collection or informal discussions [36].

The Acquisition Proposal sub-stage in the Evaluation Choice stage of the Meyer and Goes’ model [36] maps 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 for the conduct of a trial. We label this as the Trial stage because the evaluation of the innovation had started in the previous stage and this stage mainly concentrates on the trial of the new IT.

The Medical-Fiscal Evaluation and Political-Strategic Evaluation sub-stages in the Evaluation-Choice stage of Meyer and Goes’ model [36] do not have a corresponding stage in the Fichman and Kemerer model [15]. Nevertheless, as they are suggested important for medical innovation pre-adoption [7,36], we consider them and label them together as the Post-Trial Evaluation stage for our analysis. This stage occurs after the Evaluation/Trial stage but before the Commitment stage of the Fichman and Kemerer model [15]. The purpose is to assess the trial based on certain criteria to decide whether to adopt the technology and then proceed with organization-wide implementation. According to Meyer and Goes [36], in 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.

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

3. RESEARCH METHODOLOGY

3.1 Research Design

As noted earlier, there is limited existing knowledge of the pre-adoption process for healthcare IS. This prompted us to use the case study method as it allows the study of the phenomenon in a natural setting and answers the “how” aspect of the phenomenon [47], as per our research question. A qualitative case study approach adds to richness of the data and also enables us to understand the dynamics present within a setting [9] as per our process objective. The case study approach followed was positivist and exploratory, i.e., with the objective of building theory. Here, a-priori concepts can help to initially guide theory-building but new themes emerge from the case analysis and the a-priori concepts are retained only if the case findings prove their importance [11]. The method was thus chosen to reveal insights concerning the stages prior to the adoption decision of a healthcare IT in hospitals.

Case studies were conducted in two public hospitals, OneHospital and TwoHospital\(^1\) implementing vital signs monitoring systems. As both hospitals belong to the same healthcare group (StarHealth), “extraneous variations” are reduced [47] as their innovation orientation is likely to align closely with the vision of the group. Thus, by examining hospitals in the same group, it provides a consistent setting for comparing the technology pre-adoption processes. Further, these hospitals were selected because both were conducting projects to implement wireless technologies for vital signs monitoring, but had different outcomes in terms of the adoption decision i.e., one proceeded to full scale adoption while the other did not. Therefore, our multiple-case design adopted the theoretical replication logic [9,47], in which conditions of the cases lead to predicting contrasting outcomes, i.e., in terms of the organizational decision to adopt the vital signs monitoring system. Through an in-depth analysis, we could examine the stages and sub-stages leading to the adoption decision within the two hospitals. By using the two cases for comparison, similarities and differences could be derived allowing for more robust theory to be created [11].

\(^1\) The organizations and individuals in this paper are anonymized to protect their identity.
3.2 Data Collection and Analysis

Two authors carried out the data collection 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 as this allowed for triangulation of sources and increased the reliability of the findings [47]. The primary data collection method was through interviews with project members performing various roles from both cases, conducted shortly after both hospitals concluded their trials using 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 the project objectives, schedule, specifications, and data collected by the hospitals during the project, such as feedback from nurses and patients, and results of timing studies. Also, the researchers conducted three days of field observations at the hospitals. The field observations aided the researchers in laying the context for the interview questions for project team members and in understanding the clinical jargons used.

Table 4 shows the list of 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 was different, as the project team in 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 emergent themes and make use of special opportunities which arose during the conversation with interviewees. The interview questions were tailored according to the project role of the interviewee, with initial questions to understand 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 was analyzed after each session to make adjustments to subsequent data collection [9]. Each interview session lasted an average of 60 minutes for the project managers and technology solution providers / vendors, and 45 minutes for the nurses. All interviews were recorded and transcribed. A total of 225 pages of transcripts resulted from this process. Subsequently, the NVivo software for qualitative analysis was used to code the interview data.
| Interviewees from StarHealth | Project Role                                      | Number of Interviewees |
|------------------------------|---------------------------------------------------|------------------------|
| Research and Policy Director (for OneHospital and TwoHospital) | 1 |
| Total                        | 1 |

| Interviewees for OneHospital’s project | Project Role                      | Number of Interviewees |
|---------------------------------------|-----------------------------------|------------------------|
| Project Managers (Clinician)          | 3                                 |
| Project Champion (Clinician)          | 1                                 |
| Senior Nurses                         | 8                                 |
| Junior Nurses                         | 2                                 |
| Technology Solutions Provider         | 1                                 |
| Total                                 | 15                                |

| Interviewees for TwoHospital’s project | Project Role                      | Number of Interviewees |
|---------------------------------------|-----------------------------------|------------------------|
| Project Manager                       | 1                                 |
| Project Champion                      | 1                                 |
| Senior Nurses                         | 3                                 |
| Junior Nurses                         | 3                                 |
| Technology Solutions Provider         | 1                                 |
| Total                                 | 9                                 |

Table 4: List of Interviewees with Project Roles

Data from each case was 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 earlier were used as a guide for coding each case i.e., to search for the key stages and sub-stages, with the possibility of allowing new concepts to emerge from the analysis [9]. For example, coding of the Post-Trial Evaluation stage was based on the two sub-stages, i.e., medical-fiscal evaluation and political-strategic evaluation. Further, the relevant stages were linked in order to develop our process framework in accordance with strategies recommended in [28].

After the coding for both cases, a cross-case analysis was conducted to identify similarities and/or differences of the stages and sub-stages between the two settings. Comparing between case studies enabled us to discover insights which go beyond the initial impressions of the data. The analysis offered us the opportunity to capture novel findings and identify the important differences between the cases along each concept that may influence the decision for organizational adoption. As a result, we were able to derive a theoretical framework to describe the stages of healthcare IT pre-adoption based on stages and sub-stages present in both cases. The contrasting cases enabled us to compare the factors that influence the organizational adoption decision. Finally, at the end of the study, we solicited the project managers’ views (for both cases) 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 innovating with technology through the formation of an Innovation Steering Group (ISG). For example, one of StarHealth’s technological initiatives 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 better quality care.

ISG and StarHealth’s subsidiary, OneHospital, were collaboratively examining the use of wireless sensors to monitor patients’ vital signs to transform vital signs monitoring, referred to as the OneVS project. At the time of our study, the OneVS project had been in progress for 17 months. As hospitals under StarHealth are given autonomy in making their own decisions and managing their projects, TwoHospital (another StarHealth subsidiary) also embarked on their own examination of the wireless monitoring of patients’ vital signs over a similar period, referred to as the TwoVS project. The timeline for the projects is shown in Figure 1.

![Timeline for OneVS and TwoVS projects (not to scale)](image)

Figure 1: Timeline for OneVS and TwoVS projects (not to scale)

4.2 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) to be worn by the patients, a web-based graphical user interface used by the clinicians, a database server and a web server at the backend. It makes use of the wireless network infrastructure in the hospital. This system monitors six vital signs, i.e., blood pressure, pulse, temperature, electrocardiogram, oxygen saturation\(^2\), and respiration rate. Each patient wears a RFID tag for identification.

\(^2\) Oxygen saturation (SpO\(_2\)) is a measure of the amount of oxygen attached to the red blood cells in the circulatory system.
Through this system, digital vital signs charts are generated automatically, thus replacing the patient charts manually maintained by nurses. This system also enables clinicians to view the digital charts anytime and anywhere. Figure 2 describes the general architecture of how the wireless vital signs monitoring system worked in both cases. Although the technology solution vendors for both cases were different, both solutions worked similarly. As the wireless biosensors are portable, patients are allowed to move freely around the hospital while under monitoring.

![Figure 2: General Architecture of Wireless Vital Signs Monitoring System](image)

5. CASE ANALYSIS AND FINDINGS

The evidence from both cases shared several similarities but differed as well. While both projects had a similar intention to transform the vital signs monitoring process through wireless technology, their outcomes differed significantly. At the time of our study, one system was at the stage of being considered for hospital-wide adoption and deployment while the other did not proceed. The dissimilar outcomes could be due to the differences in how the pre-adoption of
the new IT was carried out, as will be described below. The sequence of stages and sub-stages in the OneVS and TwoVS projects will now be analyzed using the a-priori concepts identified earlier as an initial guide and compared for the similarities and differences between the two cases. Emergent concepts will be discussed as they appeared from the case analysis.

5.1 Awareness

While the Awareness stage in prior literature [15] refers to the period when the existence of a 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 it is meant to address. In terms of technology awareness in a broad sense, both projects in our study had prior experiences with other wireless technologies. For example, StarHealth and OneHospital undertook a previous project on wireless temperature monitoring and gained knowledge about its capabilities through OneVendor. Similarly, TwoHospital had been experimenting with other wireless technologies and was aware of the potential of pervasive healthcare.

Further, both hospitals were aware of their organizational needs but the order and emphasis of technology awareness vs. needs awareness was different as was stated in their project documents, leading to different awareness approaches in the two projects. OneVS Project was done in collaboration with StarHealth, as both StarHealth and OneHospital had needs which provided the rationale for a joint study. The needs include the foreseeable shortage of healthcare workers in future, the need to reduce documentation time and medical errors, and to protect healthcare workers from contracting contagious diseases (e.g., avian influenza), which drove their search for the wireless technology targeted in this project. In TwoHospital, the new wireless vital signs technology was seen as an update of the system they were using, i.e., the telemetry system\textsuperscript{3}, rather than driven by an assessment of organizational needs.

Thus, our analysis showed two differing awareness approaches for the hospitals. The OneVS project existed due to a healthcare issue-driven approach followed by StarHealth and OneHospital. In an “issue-driven” approach, the organization is first aware of organizational needs.

\textsuperscript{3} The telemetry system, used in the ICU and Cardiology wards in TwoHospital, only monitors patients’ heart conditions. Apart from being bulky, the telemetry system could only monitor 20 patients in a ward at a time.
needs before finding new technology solutions to meet those needs. OneHospital was keenly aware of various concerns which require improvements in patient care, in particular, vital signs monitoring. A project manager of OneVS explained:

“...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 was also of concern to StarHealth and OneHospital. The occurrence of the SARS epidemic [1] placed many nurses at risk of the disease when they attended to patients in close proximity. This highlighted a critical need to have a monitoring device that can effectively shield nurses from contagious diseases, as was stated in the project objectives.

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

“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 led TwoHospital to identify their present telemetry system had limited coverage and should be replaced. Similarly, in a separate project implemented by TwoHospital, management was first introduced to the benefits of wireless RFID over the conventional barcode, before a review was conducted to identify processes that would have a substantial positive impact if the RFID technology was adopted. In other words, IT features drove both projects rather than healthcare issues.

5.2 Interest

The Interest stage in the prior literature refers to the organizational commitment to actively learn about the new innovation [15]. Instead of interest as a monolithic stage, we found two new sub-stages in our cases i.e., triggers, and developing organizational mandate, as mentioned by interviewees in response to our questions regarding the project phases (see the Appendix). A government healthcare funding initiative to subsidize the collaboration between healthcare organizations and solution vendors was seen as an initial trigger in both cases, as per the project
documents. This encouraged the partnership between StarHealth, OneHospital, and OneVendor (a local technology solutions provider) for the OneVS project, and between TwoHospital and TwoVendor (a multi-national technology company) for 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 between the hospitals in terms of the commitment to learn more about the new technology. In the case of OneVS, OneHospital’s Chief of Medical Board (a clinician), who saw the potential of wireless temperature monitoring, was a subsequent trigger for the OneVS project. The project champion of OneVS noted:

“…he [the chief of 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 later trigger for TwoVS was TwoVendor who had a ready proprietary technology which they thought was appropriate for TwoHospital’s needs, and hence TwoVendor approached TwoHospital for a joint study (as per project documents). TwoVendor’s technology was deemed appropriate to replace their existing telemetry system and its feasibility was considered worth studying.

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

After the triggers, both cases went through the sub-stage of development of organizational mandate as 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 in the OneVS project was visibly higher
as its management consisted of two project managers who were from ISG. This is because OneVS is positioned as an important project in StarHealth’s InfoWard initiative. In contrast, the project management in TwoVS consisted of personnel entirely from the departments of TwoHospital, apart from the vendor. Thus, we could characterize the differences in the organizational mandates for the two projects as OneVS being central-led, while TwoVS was department-led.

### 5.3 Pre-Trial Deliberation

The Pre-Trial Deliberation stage in the prior literature refers to the deliberation process where an organization considers whether the innovation is compatible with its requirements [36], which occurs after the commitment to find out more about the innovation and prior to its trial. In our two cases we found three sub-stages within this stage i.e., Project Team Formation and Championing, Goals Unification and Resource Contribution, and Requirements Gathering, as per the response to our interview questions on the project phases (see Appendix). Further, we changed the name of this stage to Pre-Trial Preparation to better represent the sub-stages that we found in the two cases as they go beyond deliberation. These sub-stages are elaborated next.

#### 5.3.1 Project Team Formation and Championing

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

The second difference between the project teams is the contrasting influence of the project champions. OneVS project team management 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:

“If the innovation is related to medical [use], then we need the clinicians to... validate
In addition, OneVS also 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:

“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 to coordinate nursing tasks. In considering the type of project champion required for the project, the project champion of TwoVS observed:

“The IS department, they [have] already identified the person to be the manager of the project, and then they approach us, the 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 start.”

The case analyses revealed the difference in the way both champions conducted their roles and influenced their project process. OneVS’s project champion, being inclined towards technology, was more effective in exerting influence on the vendor. His capacity as a recognized physician in OneHospital also allowed him access for publicizing this project to the higher authorities (e.g., Chief of Medical Board) as well as for influencing important financing and technology decisions. His role was one of decision-making. In contrast, TwoVS’s project champion served as a coordinator for clinical inputs from the nurses whenever the project team needed them. As a result, his influence was limited and he played more of a supporting role.

5.3.2 Goals Unification and Resource Contribution

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

“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. As OneVendor was relatively new to the wireless vital signs technology, they hoped to use the clinical inputs from OneHospital to guide them in the development of the technology. As a result, OneVendor shared similar goals with OneHospital to make the technology solution work. Our interview data indicated that the project champion had an influence in cultivating unified goals between OneHospital and OneVendor. The project champion of OneVS noted:

“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 much into looking into profits, or whether the thing definitely can sell...so I gave them some ideas.”

The project champion of TwoVS had a smaller influence and helped develop partly unified goals among stakeholders as his role was mainly to coordinate the use of the new technology among the nurses. To sum up the types of goals for both projects, OneVS had unified goals while TwoVS had partly unified goals.

The case analysis also indicated a contrasting level of resource contribution between the two projects which could have an influence on the adoption decision. In OneVS, OneHospital was willing to contribute financial resources towards the project, in addition to what was provided through the government healthcare funding initiative and the contribution from OneVendor. The project champion of OneVS explained:

“[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 on cost...the project will never take off. They won’t be able to meet the budget constraint.”
In contrast, TwoVS’s funding was mainly borne by TwoVendor, apart from the financial subsidies given by the government healthcare initiative. The project champion of TwoVS revealed:

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

We could distinguish between the resource contributions of both projects as, OneVS had shared resource contribution while the resource contribution in TwoVS was unilateral.

5.3.3 Requirements Gathering

The requirements gathering sub-stage prior to the trial involved the information gathering of both task and technology needs in our two cases. For both OneVS and TwoVS projects, requirements gathering was conducted through multiple meetings over a period of eight months to understand the task and technology requirements. The meetings involved the participation of clinicians and nurses to provide clinical inputs about the features they hoped to see in the technology. Although OneVS had to develop the technology from scratch, the process was facilitated by their project champion who drew on his previous experience with IT. His IT knowledge and his 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 clinical and IT domains. The Project Champion of OneVS elaborated:

“…we give [OneVendor] some inputs, in terms of the requirements…like…I specify that I want the device to have…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 if the available technology could meet the given clinical requirements. This happened 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. Subsequently, this sub-stage allowed the project teams to proceed with the Trial stage.

5.4 Trial

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

### 5.4.1 Training Users

In both hospitals, vendors went onsite to conduct 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 a salient role in the trial ward and were present at every training session (as per the project documents). Their constant and visible presence as change-agents in the midst of the nurses who are learning and using the new technology reinforced the social norms within the ward. One of the OneVS nurses noted:

> “[The nurses] have confidence in 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 for the nurses, as part of his administrative role. In addition, as his work is not situated in the wards, his presence at the wards trialing 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 job:

> “My role [as change-agent] is mainly to encourage people to participate, teach them how to use, and push it to the ward.”

After training the nurses, both projects proceeded with the actual trials in the wards. Again, the effectiveness of having senior nurses perform the role of change-agents was displayed during the OneVS trial. The senior nurses at OneHospital continued to guide their juniors and see that they adhered to the use of the new technology, while the project champion of TwoVS had to assume that additional role along with his other tasks which resulted in less time and effort being expended on nurse training. The ways in which user training was conducted can be distinguished as, OneVS was *change-agent influenced*, while the 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 other system requirements not identified earlier. Over the course of the trial that lasted for three months, feedback was obtained from trial participants. In TwoHospital, the TwoVS team collected feedback from clinicians, i.e., nurses, only. In contrast, the OneVS project team also collected extensive feedback from the patients through surveys. Analysis of the feedback from patients and clinicians helped OneVendor to improve the technology solution. For example, patients provided feedback to improve the comfort level of the device, as some felt that the biosensors could be uncomfortable when pasted on their body. Nurses also provided feedback concerning the devices, such as the need for a longer battery lifespan, and possible improvement to the usability and the size of the devices. A nurse clinician from OneVS commented:

“The equipment is user friendly, we just have to paste on the patient. But one minus point is you have to register the patient name again. We prefer that the system [can] 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 then proceed with organization-wide implementation. Our case analysis (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. In the first sub-stage, clinicians evaluated the suitability of the IT system using medical criteria based on the results of the trial. 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 the medical-fiscal evaluation of our a-priori concept [36].

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

“[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 if TwoVendor could provide a complete solution before they decided on organization-wide adoption. This differed from TwoVendor’s goal and they were unwilling to commit further resources for a second trial. As a result, the TwoVS project stalled at this point.

In the second sub-stage, which only occurred for the OneVS project, organizational management (who had the authority to make the adoption decision) conducted the 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 the managerial value analysis of their trial, and the project team of OneVS was formulating a business case to be presented to the higher management of OneHospital for organization-wide adoption. This sub-stage is consistent with the fiscal aspect of medical-fiscal evaluation and the political-strategic evaluation from our a-priori concept [36]. In other words, we found that the medical evaluation was done separately by the clinicians, followed by the fiscal evaluation which was clubbed together with the political-strategic evaluation by the management.

6. A FRAMEWORK FOR HEALTHCARE IT PRE-ADOPTION

Based on the findings from both cases, we present our theoretical framework (see Figure 3) that explains the organizational healthcare IT pre-adoption process. Following Fichman and Kemerer [15], our framework proposes a linear progression through the stages of healthcare IT pre-adoption, though organizations may diverge from this progression for reasons such as incompatibility of an innovation with functional requirements, or a failure to initiate a trial i.e., they may decide not to proceed for adoption at any stage in between. Our study used the a-priori concepts from the previous literature but refined them and added new concepts based on our case analyses to derive the framework.

The framework also includes roles unique to healthcare organizations. This addresses the call from prior research that stresses the importance of identifying 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 personnel within the hospitals who are tasked with non-patient care roles but are still essential to the daily running of the hospital. *Clinicians* include doctors and nurses who are at the frontline of patient care services and *patients* refer to the receivers of healthcare services. The *IT function* of the hospital plays a role in all stages and sub-stages of the framework.

**Figure 3: Framework for the Healthcare IT Pre-Adoption Process**

Overall, our cross-case analysis highlighted similar stages and sub-stages during the pre-adoption phase for the two cases that may influence the healthcare IT adoption decision (see Figure 3). However, the approaches taken during the sub-stages were different as summarized in Table 5. Based on the difference in organizational decision outcomes for the two cases, we suggest that specific approaches during the pre-adoption phase may lead to a beneficial outcome. The stages
and sub-stages of the framework are now described.
Table 5: Summary of Main Differences between OneVS and TwoVS Projects

| Stages and Sub-Stages | Approach | Findings |
|-----------------------|----------|----------|
| Initiation            |          |          |
| • Awareness           | Issue-driven | IT-driven | Issue-driven awareness fostered better alignment with organization’s needs than an IT-driven approach |
| • Triggers            | Clinical-triggered | Vendor-triggered | Clinical-triggered approach increased the beneficial outcomes more than a vendor-triggered approach |
| • Developing Organizational Mandate | Central-led | Department-led | Central-led mandate served as a stronger support for project continuance than a department-led mandate |
| Pre-Trial Preparation | Project Team Formation and Championing | A project team with steering roles drove the project towards the organization’s goals more effectively than one with supporting roles |
| o Project Members     | Steering role | Supporting role | |
| o Project Champion    | Decision-making role | Supporting role | |
| Goals Unification and Resource Contribution | Stakeholders with unified goals led to better project outcomes than those that are partly unified goals |
| o Goals               | Unified | Partly unified | |
| o Resource Contribution | Shared resources | Unilateral resources | |
| Requirements Gathering | Boundary spanning role | Non-boundary spanning role | |
| Trial                 |          |          |
| • Training Users      | Dedicated change-agent led | Non-dedicated change-agent led | Dedicated change agents offered considerable value over non-dedicated change-agents in training users and running the trial effectively |
| • Feedback Assessment | Feedback from clinicians and patients | Feedback from clinicians only | In addition to clinicians, it was important to obtain feedback from patients as ultimate end users of the IT and receivers of healthcare services |
| Post-Trial Evaluation |          |          |
| • Medical Evaluation  | Positive | (Project stalled after this) | Having favorable medical evaluation and managerial value analysis positively influenced the decision on whether to adopt the technology as opposed to the need for further trials or rejection |
| • Managerial Value Analysis | Positive | - | |

6.1 Initiation Stage

In our framework, we combine the Awareness and Interest stages from our a-priori concepts into the Initiation stage that includes the sub-stages of Awareness, Triggers, and Developing Organizational Mandate. This stage was created to represent the first step when the new IT is
initiated in the healthcare organization. It consists of three sub-stages which span the period from when the organization first gains awareness of the innovation till it commits to learn more about it to meet organizational needs.

In terms of the awareness approaches, our findings indicate the benefit of an approach whereby the healthcare organization has a broad plan of where it envisions itself to be in the future and is aware of the issues that pose challenges in achieving its plans. Such a healthcare issue-driven awareness encourages stakeholders to be aware of IT innovations that are aligned with the organization’s needs and avoids an IT-driven approach where stakeholders first come across a technology and then attempt to match it to the tasks at hand. The healthcare issue-driven awareness approach is likely to be goal-directed and could help to achieve a unified intention among different levels of the organization in subsequent sub-stages, as compared to an IT-driven awareness approach.

Second, our findings suggest that awareness may not lead to management commitment to learn more about an innovation unless there are triggers. As per previous research, triggers refer to both internal and external events which initiate a change in the equilibrium state [18]. In our cases, triggers occurred in the form of external funding and individuals who initiated the actions that were important to motivate information gathering about the new technology for subsequent trial and evaluation. In the healthcare IT pre-adoption context we studied, we saw clinically-triggered vs. vendor-triggered approaches during the initiation. Our findings suggest that a clinically-triggered approach can increase the likelihood of beneficial outcomes as compared to a vendor-triggered approach.

Last, our findings suggest that a central-led organizational mandate is needed for an innovation project to progress from initiation through pre-trial to trial and post-trial evaluation stages. A central-led mandate can serve as a stronger support for its continuance as compared to a solely department-led organizational mandate. Such mandate for the innovation project communicates within the organization that the top management are serious about considering the IT innovation and include it as part of their agenda. Top management participation can send signals throughout the organization and has been associated with innovative use of IT [24].

6.2 Pre-Trial Preparation Stage

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

Specifically, our findings suggest that a central-led organizational mandate followed by formation of a project team with steering (leadership) roles could drive the innovation project forward towards the organization’s goals. This contrasts with a narrower, department-led mandate followed by a team formed with supporting roles that may not be able to provide sufficient impetus for the project. Additionally, a project champion with a decision-making role, having both medical and IT expertise, can provide recommendations regarding the IT innovation that would be better accepted as opposed to a champion with a supporting role, having 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].

Further, having shared resource contribution from the various stakeholders allows a collective ownership of project outcomes, as compared to unilateral resource contribution e.g., only from the vendor. Our findings suggest that a shared resource contribution promotes a commitment by the stakeholders that unifies their goals towards attaining a beneficial outcome, instead of goals that are partly unified. A commitment by all stakeholders leading to a collective intention can attain positive outcomes for IT adoption (e.g. [10]). With the unified goals and shared resource contribution, the project team can proceed with requirements gathering from users for the subsequent trial, where task and technology requirements are elicited [41]. Here, a project champion with boundary spanning as opposed to a non-boundary spanning role can help in gathering requirements accurately that meet organizational needs. Particularly, our findings suggest that a clinician project champion who has knowledge about IT could perform such a boundary spanning role effectively. Such expertise coordination is considered salient in IT development [13].

6.3 Trial Stage
Trials enable the organization to evaluate the feasibility of implementing the new healthcare IT as well as obtain an initial assessment of whether the technology can meet organizational needs. Our findings highlight the importance of having dedicated change-agents for user training during the trial. These change-agents can facilitate the IT learning process by providing support to users
as needed for the trial. This helps new users overcome 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., senior nurses working with junior nurses) can offer considerable value over a non-dedicated change agent.

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

6.4 Post-Trial Evaluation Stage

Our findings suggest that on the completion of the Trial Stage, the new healthcare IT should be evaluated using medical criteria that involve mainly the clinicians. This is important as clinicians have the primary responsibility and expertise for delivering medical care assisted by the new technology. The healthcare IT can then be proposed formally to higher management for their consideration and value analysis. The higher management could consider the remaining (fiscal, political, and strategic) criteria in their managerial value analysis for a more informed decision making about the new IT. Our healthcare IT pre-adoption framework ends at this stage when the decision on whether to adopt the new technology is made.

7. IMPLICATIONS

7.1 Research Contributions

Our multi-stage framework for healthcare IT pre-adoption offers several contributions to research. First, the framework is unique as it focuses on an organization’s pre-adoption process and decision, which is a challenging phase for healthcare organizations to evaluate and justify the need for the new IT. Yet, there is a lack of literature that explicates the pre-adoption stages for healthcare IT innovations. Hence, with the development of our framework on healthcare IT
pre-adoption, this study contributes to healthcare-IS research\(^4\), which “represents perhaps the most promising opportunities to push the contextual envelope of IS research” [5, p. 175], yet constitute less than one-fifth of healthcare IS papers in the past two decades [33].

More specifically, as we developed an IT pre-adoption framework for the healthcare context, this adds to earlier multi-stage model research which was confined to either IT adoption models (e.g., [15]) or models for adoption of healthcare innovations which are not IT-based (e.g., [36]). Compared to the a-priori concepts identified from the previous multi-stage models i.e., [15] and [36], our theoretical framework provides more details and identifies 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 a number of sub-stages (i.e., Developing Organizational Mandate, Project Team Formation and Championing, Goals Unification and Resource Contribution, Training Users, Feedback Assessment) in our framework. The Medical Evaluation and Managerial Value Analysis sub-stages were also refined. In this manner, our study brought in IT project management concepts into the framework that are typically missing in such multi-stage models of innovation adoption.

Second, specific healthcare roles (i.e., management, administrators, clinicians, patients, and IT function) are introduced in this framework, which thus differs from the medical innovation framework by Meyers and Goes [36]. By identifying the healthcare roles served 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 a better 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 studying IT adoption and its determinants. This research complements the variance method by developing a process framework for organizational healthcare IT pre-adoption. Our framework

\(^4\) 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 papers (primary attention is theory, without consideration for the healthcare context), IS-healthcare papers (primary attention 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 papers (emphasis on healthcare without application of IS theories).
has helped explicate the stages and sub-stages of healthcare IT pre-adoption and at each sub-stage we have indicated conditions (e.g., healthcare issue-driven vs. IT-driven awareness) that would contribute to a beneficial outcome. As 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
Apart from the research contributions, this paper provides several practical suggestions and implications. First, the proposed framework in Figure 3 is relevant to practitioners as it is shown in a way that is “implementable” by organizations to conduct their healthcare IT pre-adoption processes. The four main stages include sub-stages and approaches that are prescriptive and promote organizational best practices based on the cases in our study (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 could give medical practitioners more control over the direction of the project, which may lead to greater customization and better acceptance of the system. Within the Pre-Trial Preparation Stage, organizations could 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 a specific example and guidance for hospitals considering the adoption of pervasive healthcare systems, such as wireless vital signs monitoring systems. As this is a new IT innovation that is starting to be implemented in hospitals, practitioners should find the framework and the case findings valuable as guidelines.

7.3 Limitations and Future Research
The following limitations need to be considered when applying the findings of this study. First, the framework was based on cases from two public hospitals and may not represent other organizations in the healthcare context. To mitigate this problem, findings that emerged from case data were analyzed together with a-priori concepts from the literature to develop the framework in Figure 3. Moreover, despite efforts to reduce variations between our cases, there may be other differences that can influence the outcome of the pre-adoption process e.g., culture
of the organization. Therefore, the inclusion of a larger sample of hospitals in future studies may provide further insights.

Second, the framework was derived from studying the pre-adoption of vital signs monitoring system, and though it is not confined to a specific type of healthcare IT, the application to other systems needs to be done cautiously. Future research can validate and extend the framework through studies involving other types of healthcare IT. Third, future work may adopt a variance approach to provide insights into the influence of the identified and other factors on the adoption decision and inter-relationships between them. In addition, longitudinal studies can be conducted to evaluate if each stage in the pre-adoption phase precedes another, and if the outcome of each stage will influence subsequent stages.

8. CONCLUSION

As healthcare organizations continue to assess new IT to improve the quality of medical services, they must obtain adequate understanding of the pre-adoption phenomenon to adopt and reap the benefits from such systems. The pre-adoption stages help the organization to understand the potential and benefits of the new technology before the decision to fully invest in the technology is made. This paper offers a healthcare IT pre-adoption multi-stage framework, which describes the main stages of (1) Initiation, (2) Pre-Trial Preparation, (3) Trial and (4) Post-Trial Evaluation, and sub-stages within these. 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, the process approach through qualitative methods reveals 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 capabilities and practices to better manage their IT pre-adoption processes. This paper has taken a step in this direction.
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APPENDIX

Interview Questions for the 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 problems of healthcare which led to the need for the 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, manpower)?
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 the clinicians and the patients?
11. What are the future plans for the use of the vital signs monitoring system?

Interview Questions for the 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 the vital signs monitoring system?
3. How was the project initiated? What were the project phases?
4. How did the hospital management show their support and commitment to the project? Do you hope the 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 and enthusiasm in this project?
7. How was the vendor chosen? How was the technology solution chosen?
8. How did you gather requirements for this project?
9. What were the difficulties you faced in this project (e.g., finance, manpower)?
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 future plans for the use of the vital signs monitoring system?

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