Change Management in Interorganizational Systems for the Public

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Abstract: It is recognized that change management is necessary for information technology implementation success. While there are a growing number of interorganizational systems (IOS) designed for the public, there is little study of and lack of clear guidelines on managing change related to their implementation. This research explores the phenomenon through the case study of a country-wide farecard system implemented in Singapore's public transportation system that involved several organizations and the public. Through the case analysis, we identified critical success factors (CSFs) for change management in IOS for the public and interrelated them using a causal loop diagram (CLD). These factors included refinements of existing CSFs identified from the literature as well as new CSFs from our case study. Our case analysis showed that communication through senior management and cooperation of affected organizations in the system implementation was able to overcome resistance to change in these organizations. We also found that while comprehensive publicity could initiate change in the public, a critical mass had to be built up for managing public change by coopting public opinion leaders as well. By interrelating CSFs identified in the case via a CLD, this study provides a preliminary theoretical framework for

studying change management in IOS for the public and aims to guide practitioners in implementing such systems.

KEY WORDS AND PHRASES: causal loop diagram, change management, critical success factors, IOS for the public.

IT IS WELL RECOGNIZED THAT CHANGE MANAGEMENT is essential for the success of information technology (IT) implementations. IT-related change management involves countering resistance to change by organizations, groups, or individuals who perceive the new system negatively [20]. Within an IT implementation context, critical success factors (CSFs) are the essential managerial factors to ensure a successful system implementation [17]. When a new intraorganizational system such as an enterprise resource planning (ERP) system is introduced in an organization, it can be resisted in many ways by multiple parties in the organization since it requires changes in business processes and employee roles [2, 46, 53]. In response, a considerable amount of research has been conducted to identify CSFs for managing internal change for intraorganizational systems (e.g., [1, 2, 3, 4, 5, 10]).

Managing change for a new interorganizational system (IOS), such as an electronic data interchange (EDI) system, can potentially be even more challenging than for an intraorganizational system with the involvement of multiple organizations whose needs and objectives may conflict [21, 52]. In addition to managing internal change, firms introducing the IOS must also deal with the affected organizations' resistance to change, which includes managing their different motives and interests [24, 43, 54]. The relatively few studies on IOS change management have proposed CSFs for leaders to manage such external change (e.g., [32, 43]).

While resistance toward a new IOS or intraorganizational system mainly affects the organizations involved, resistance in the implementation of intraorganizational systems (e.g., e-filing system [51]) or IOS for the public may attract nationwide or even worldwide attention. If the resistance is significant, it may not only damage the reputation of the organization introducing the new system—that is, the change agent—but also have implications for the ruling party in power. The possibility and consequences of public rejection can add to the difficulty and sensitivity of managing the change. Accordingly, the greatest hurdle for managing such change is to convince the public to use the system without inviting scrutiny [51]. In response, the few studies on change management of intraorganizational systems for the public have proposed CSFs to overcome resistance to change in the public (e.g., [33, 51, 57]).

Managing resistance to change for a new IOS for the public can be significantly challenging because firms must overcome internal as well as external resistance to change from the affected organizations and in the public. While the barriers have been described, relatively little is known about how to effectively counteract them

and manage the implementation of a new IOS for the public. Among the few studies in this area, findings have been ambiguous. For example, McHenry and Borisov [36] suggested that a system with a strong relative advantage can overcome resistance without top-down management, and Larsen and Klischewski [31] noted that even when the new system has a strong relative advantage, it can still be discontinued because of poor interorganizational relationship change management. Also, the findings vary from studies on IOS change management (e.g., [32, 54]) that advocate a top-down approach to manage change in the affected organizations. This implies that identifying the CSFs for managing change for a new IOS for the public is not as simple as combining the CSFs in literature on change management of intraorganizational systems, IOS, and intraorganizational systems for the public. Rather, it is important to study the phenomenon in-depth in order to understand how to effectively overcome resistance to change for a new IOS for the public.

In addition to being impelled by the lack of guidelines for managing resistance to change for a new IOS intended for the public use, this paper is also practically motivated by the increasing numbers and importance of such a system. Among private organizations, the financial sector is seeing a growing number of IOS for the public, which range from credit card authentication systems to trading portals [15]. In the public sector, worldwide e-government initiatives are moving toward integrating various government agency systems to provide public services through one single entry point [35]. Among these, smartcard system implementations, ranging from smart medical cards to smart farecards, are being undertaken around the world that involve multiple organizations and the public (www.swrpa.org/pdf_files/SWRPA--Task1--TechnologyyAlternatives.pdf). Driven by the large number of such systems being implemented with varying degrees of success, this paper focuses on understanding how to manage change for a new IOS for the public through a case study of Singapore's successful public transportation smart farecard system implementation.

When studying IT-related change management, CSFs are required to assess the state of the change and the likelihood of success of the change. Because the CSFs are unlikely to work in isolation [1], instead of proposing "laundry lists" of CSFs, this study also aims to interrelate the CSFs to show how they interact and affect one another. Considering that organizations need to manage internal resistance to change in addition to external resistance during the implementation of IOS for the public, we reviewed and identified common CSFs on IT-related change management for both intraorganizational systems and IOS, and used them as a starting point for our study. We then investigated the CSFs through our case study of Singapore's public transportation farecard system change, which involved several organizations and the public. Occurrences of the common CSFs in the IT-related change management literature were coded along with the discovery of additional CSFs. Subsequently, we interrelated the CSFs in a causal loop diagram (CLD) [48]. The CLD explains the dynamics of the change management process—that is, how the CSFs interact and work together. From the CLD, we further identified the core loops (loops leading to institutionalization of system-related change) for managing the affected organizations' and public's resistance to change. Based on the core loops, we propose a framework of effective

change management in the implementation of IOS for the public to guide practice as well as contribute a preliminary theoretical basis for future research.

Conceptual Background

Based on the implementing organization and users, literature on IT-related change management can be classified as studies of intraorganizational systems, IOS, intraorganizational systems for the public, and IOS for the public.

Change Management for Intraorganizational Systems

Among IT-related change management studies, the majority are concerned with CSFs for intraorganizational system change management. After reviewing and synthesizing the literature, six common CSFs for intraorganizational system change management emerged (see Table 1).

CSF-1A: Need for Change and Feasibility Analysis of the New System

Recognizing the need for change is the first step of a system change effort [37]. Most studies start off at the point that the need is already established, but in many cases the need for change must first be justified. Once the need for change is recognized, it is also important to investigate the feasibility of the new system, which entails balancing business and technology constraints to choose a cost-effective solution. Feasibility analysis involves matching the new system to organizational goals in terms of deliverables, budgets, and time frames [47].

CSF-2A: Shared Vision for System-Related Change

The goal of intraorganizational system–related change management is to map out an IT solution based on both the current business process and the vision for the future business process [26]. For successful intraorganizational change management, this vision should be strongly advocated across the organization [27]. Because shared vision is important to direct the system change effort and serve as a foundation from which to develop specific strategies for arriving at a future end-state, the change agents must ensure that the organizational stakeholders understand the vision of how the system would be able to transform the organization [38].

CSF-3A: Systematic Plan for Project and Change Management

An organization may not be able to gain acceptance for a new system if it does not perform systematic project and change management. Project management involves managing human and other resources such that system goals are achieved within time and cost constraints [12, 39]. While project management activities span the life of

Table 1. Common CSFs for Intraorganizational System Change Management

CSFs	Example studies	Remarks
CSF-1A: Need for change and feasibility analysis of the new system	[23, 37, 47]	
Clear definition of system demand	[22, 34]	Captured by CSF-1A: Investigating the need for/demand and feasibility of new system include clear understanding of the current business processes, the expected changes and the risk of the proposed IT, careful selection of the appropriate system, and managing the expectation of the new system.
Identifying the imperative for system change	[38]	
Clear understanding of the current business processes and the expected changes as well as the risk of the proposed IT	[12]	
Assessing the present situation	[38]	
Careful selection of the appropriate system	[47]	
Management of expectation	[47]	
CSF-2A: Shared vision for system-related change	[2, 3, 5, 26, 27, 38, 39]	
Clear understanding of strategic goals and objectives	[4, 47, 56]	Captured by CSF-2A: When the direction is clearly articulated, and the strategic goals and objectives are clearly understood, the vision is likely to be clear as well.
Articulating a shared direction	[38]	
CSF-3A: Systematic plan for project and change management	[11, 39, 47, 56]	
Prioritize program and project portfolio in line with business objectives	[12]	Captured in CSF-3A: Project and change management include prioritizing the project, developing lines of accountability, developing systematic change process, analyzing size of the change required, gathering competent project team members,
Develop a clear decision-making structure with agreed lines of accountability	[12]	

Systematic and well-planned change	[8, 19, 22, 26, 34, 38]	and planning for user training and education.
Analyze size and scale of the change effort	[8]	
Change management team composition	[9, 10, 11, 28, 37, 39, 41, 47, 56]	
User training and education	[22, 47]	
CSF-4A: Energy for system-related change	[5, 8, 56]	
Building capacity and capability to change	[12]	Captured by CSF-4A: One way of creating enough energy to change is to instill urgency to change.
Create project urgency	[9]	
CSF-5A: Top management support	[2, 3, 4, 8, 9, 11, 12, 18, 19, 20, 22, 34, 37, 39, 41, 45, 47, 56]	
Project champion	[39, 47]	Captured by CSF-5A: Project champion should be someone with the authority to move large and complicated projects through the transition. Thus, project champion should be from the top management, e.g., CIO, CEO (even better), or vice president in charge of IT.
CSF-6A: Institutionalization of system-related change	[26, 38]	
Consolidating and sustaining the system change	[38]	Captured by CSF-6A: All of these activities are part of institutionalizing the system-related change.
Consolidating improvements and producing more change	[8]	
Monitoring and evaluating the new system performance	[3, 39, 56]	
Optimize the benefits	[12]	

the project, change management activities need to do the same and may start before or continue after the project [8]. A clearly documented system change management process serves two purposes—that is, as a road map of the tasks and resources required, and as a common reference for managing the system change [8].

CSF-4A: Energy for System-Related Change

A climate for change can be created when there is a common sense of urgency among the people involved so that they are willing to commit to the change [56]. When the urgency is not strong enough, the transformation process cannot succeed [5]. In extreme cases, the change agents may manufacture crises to pump up energy for system change [12].

CSF-5A: Top Management Support

Even with a shared vision, well-planned change management, and creation of energy for change by the implementers of the new IT, there may be resistance to change during the actual implementation [18]. Top management support provides sufficient influence, power, and resources to push the system change through [8]. Without adequate support from top management, the opposing influences may act to slow down or stop the system changes from happening [39]. Top management support was found instrumental in facilitating intraorganizational system–related change in a number of studies (e.g., [2, 3]).

CSF-6A: Institutionalization of System-Related Change

In current IT practices, the task of managing post-deployment system changes often falls in no-man's-land. To derive long-term benefits from IT-related change, both future expectations and feedback from real-world testing during the production use require management attention and follow-up [26]. Some organizations do this through a steering committee of key stakeholders to review and institutionalize the system change. Institutionalizing system change may involve articulating the connections between the new system and corporate success and developing the means to produce further system change [8] as well as to optimize the benefits [12].

Change Management for IOS

After reviewing and synthesizing the CSFs proposed in studies on change management for IOS, five common CSFs emerged (see Table 2). Two observations can be made from Table 2. First, the proposed CSFs include four common CSFs for intraorganizational system change management: (1) need for change and feasibility analysis [42, 43], (2) shared vision for system-related change [32], (3) systematic plan for project and change management [32, 42], and (4) institutionalization of system-related change [42]. Second, to successfully manage the affected organizations' resistance to change,

Table 2. Common CSFs for IOS Change Management

CSFs	Example studies	Remarks
CSF-1B: Need for change and feasibility analysis of the new system		
Assess the business strategy	[42]	Captured by CSF-1B: The assessments of business strategy, constituents' needs, and external environment are part of the investigation process.
Assess the external environment	[42]	
Investigate the needs of many constituents	[43]	
CSF-2B: Shared vision for system-related change	[32]	
CSF-3B: Systematic plan for project and change management		
Implementation team composition	[32]	Captured by CSF-3B: Project and change management include composing the implementation team, and planning for the technology infrastructure.
Well-planned technology infrastructure	[32, 42]	
CSF-4B: Constellation of leaders' support	[54]	
Genuine commitment from all organizations	[24]*	Captured by CSF-4B: The constellation of leaders should consist of top management from the organizations introducing and affected by the system change.
Strong internal and external commitments	[32]	
CSF-5B: Institutionalization of system-related change		
Plan for next level of integration	[42]	Captured by CSF-5B: Planning for the next level of system integration is part of institutionalizing the system-related change.

* Using Kumar and van Dissel's [30] IOS classification, Howard et al.'s [24] study on extraorganizational system can be classified as a study of a networked IOS.

these studies highlight an additional CSF—constellation of leaders' support [24, 32, 54]. To avoid repetition, we now only describe this additional CSF.

CSF-4B: Constellation of Leaders' Support

For the change agent, IOS implementation involves managing internal and external resistance to change. To overcome external resistance to change, it is important to gain support from top management of all organizations affected by the system change. These leaders should have sufficient influence, power, and resources to negotiate, compromise, and push the IOS change through in their respective organizations [32, 54]. The support from the constellation of leaders was found instrumental in facilitating IOS change in a number of studies (e.g., [24, 32, 54]).

Change Management for Intraorganizational Systems for the Public

As in the case of IOS change management, few studies were found on change management of intraorganizational systems intended for the public use. The CSFs proposed by these studies are reviewed and synthesized in Table 3. Here also some of the common CSFs for managing internal resistance to change were identified, such as systematic plan for project and change management [57], top management support [49, 51, 57], and institutionalization of system-related change [49, 57]. Moreover, these studies proposed an educational CSF for managing resistance to change in the public [33, 51, 57], which will be described in detail below.

CSF-3C: Public Education

One factor overlooked by some organizations introducing intraorganizational systems for the public is the technology anxiety in the public [33], which may lead to their resistance to change. While age, gender, and education may not necessarily be related to technology anxiety [33], there is a negative correlation between anxiety and learning to use a new system [16]. Interestingly, while public education and training may overcome anxiety toward the new system [33, 51, 57], Teo and Wong [51] state that other measures may also be required to convince the public to use the system.

Change Management for IOS for the Public

In addition to managing public resistance to change, organizations introducing new IOS for the public must also manage the affected organizations' resistance to change. Studies on change management for IOS for the public are summarized in Table 4. The review indicates that there are relatively few studies of change management of IOS for the public and there is no clear guideline for managing such system change. According to McHenry and Borisov [36], when a new IOS for the public has strong relative advantage, it can enjoy successful diffusion without extensive top-down

Table 3. Common Change Management CSFs for Intraorganizational Systems for the Public

CSFs	Example studies	Remarks
CSF-1C: Systematic plan for project and change management	[57]	
Skilled team	[51]	Captured by CSF-1C: Project and change management include composing system implementation team, planning for users' involvement in system requirement analysis and design, and determining the technology infrastructure.
Actively involve end users in capturing general systems requirement and design	[33, 49, 51]	
Determine the technology infrastructure	[57]	
CSF-2C: Top management support	[49, 51, 57]	
CSF-3C: Public education	[33, 51, 57]	
CSF-4C: Institutionalization of system-related change		
Continuous forward planning and analysis of the operations	[49]	Captured by CSF-4C: Forward planning and performance measurement are part of institutionalizing the system-related change.
Continuous performance measurement	[49, 57]	

Table 4. Summary of Change Management Studies for IOS for the Public

Authors	Context of the study	Methodology	Key findings
Larsen and Klischewski [31]	E-government portal	Case study	Despite the successful public acceptance of the system, it was discontinued due to the ambiguity of the IT-enabled interorganizational process ownership.
McHenry and Borisov [36]	E-government (public–private partnership) change management	Case study	When the system has strong relative advantages, it can enjoy successful diffusion without an extensive top-down management.

management. However, what CSFs are needed to effectively communicate the system's relative advantage are not clear. In fact, in Larsen and Klischewski's [31] study, it appears that regardless of how beneficial the new system is for the public, it can still be discontinued due to poor interorganizational relationship management.

The common CSFs identified from previous studies of change management for intraorganizational systems, IOS, and intraorganizational systems intended for the public serve as a starting point for our study on CSFs for change management for IOS for the public.

Research Methodology

A POSITIVIST EXPLORATORY CASE STUDY METHODOLOGY was considered appropriate for this study for several reasons. First, since the phenomenon is complex and needs to be studied within its context, a case study approach is suitable [7, 58]. Because change management in IOS for the public involves multiple organizations and a large number of users, it is intertwined with the environment in which the change takes place. Second, as the existing body of knowledge is insufficient to test or confirm causal questions, an exploratory case study is more appropriate than a confirmatory or explanatory case study approach [7]. Finally, since the study objective is to propose a framework of effective change management in IOS for the public, a positivist exploratory case study methodology is deemed appropriate for the study. Epistemologically, positivist studies are premised on the existence of a priori fixed relationships within phenomena capable of being identified via hypothetico-deductive logic and analysis [13]. While the common CSFs identified from previous studies of IT-related change management were useful to shape the initial design of our framework, we allowed for new CSFs to emerge that could redefine our initial perspective [14]. To ensure rigor, we closely followed Dube and Pare's [13] suggested guidelines for positivist exploratory case study research.

Case Introduction

An important class of IOS intended for the public is smartcard systems, such as smart medical card systems and smart farecard systems. A smartcard is an electronic device about the size of a credit card that typically contains electronic memory, an embedded integrated circuit, and contact or contactless interfaces. Smartcards have storage, processing, and security capacities to support multiple applications ranging from storing digital cash to generating digital identification. Consequently, smartcard systems enable multiple application partnerships with banks, government agencies, vendors, and other entities.

One of the salient applications of smartcards is in public transportation systems. Smartcards in public transportation systems are interesting to study because they are gaining popularity worldwide and serve potentially the entire population (locals and tourists), having a wider reach than other IOS for the public such as smart medical card systems.

While a number of public transportation systems in different countries have implemented smartcards, these efforts have met with varying degrees of success. The implementation of the Hong Kong Octopus Card (www.octopuscards.com/consumer/general/global/en/aboutus.jsp) has been recognized as a success with more than 410 organizations being able to serve the public through it and over 14 million cards in circulation. It enables the public to pay fares on public transportation systems, to pay for purchases in retail outlets, and to identify themselves to gain access to buildings. In contrast, the introduction of a smartcard system in Seoul's public transportation system was less accepted. Poor change management led to confusion among commuters [55].

This study aims to investigate CSFs for change management for IOS for the public through a case study of the successful transition from a magnetic farecard system to a smartcard system in Singapore's public transportation system. The Singapore smartcard implementation is considered a success with 83.2 percent of public transportation rides paid through these cards while other payment options are available and currently more than 9 million cards being issued (www.ezlink.com.sg/pressReleases.htm). The introduction of the smartcard was not a mandated change and the public has the option to use other means of payment such as cash. The study explores how Singapore's Land Transport Authority (LTA) managed the change with the three public transport organizations (PTOs), and how LTA managed the change in the public sector.

Data Collection

To understand how the transition from the magnetic farecard to the smartcard system was managed, we collected data from multiple sources for triangulation. Our first data source was semistructured interviews with key personnel related to the system implementation. Since the study objective is not only to identify the CSFs but also to understand the chronology of events as well as the causal relationships of the identified CSFs, the interview questions were developed to inquire about the sequential order of change management events (see Appendix A). We conducted three interviews with a senior manager in LTA (the organization that introduced the system change), one interview with a relevant manager in LTA, and one interview each with PTOs' senior managers (the affected organizations). Each interview lasted for about one and a half hours. We also conducted interviews (each lasting for about ten minutes) with two bus drivers in their thirties and forties who had experience with the previous fare collection systems. For the interviews that we were not allowed to record, extensive notes were taken and summarized.

A major strength of case study data collection is the opportunity to combine qualitative (e.g., interviews) and quantitative (e.g., surveys) data sources as quantitative data can keep researchers from being carried away by false impressions in qualitative data [13, 14]. With this objective in mind, we surveyed 296 randomly selected commuters through online and offline surveys in two bus terminals to gauge the effectiveness of the system change as well as to understand the public's response to the change. Accordingly, the survey questions asked about the usage and attitude to the system change. The survey results are shown in Appendix B.

Table 5. Data Source Details

Information derived	Sources
History of Singapore's public transportation fare collection systems	Interviews with key personnel from LTA and PTOs National Library archives
Information on the magnetic farecard system	Interviews with key personnel from LTA Survey randomly selected 296 commuters National Library archives, LTA's internal documents Brochures explaining the usage and mechanisms of the magnetic farecard system
Information on the smartcard system in other countries	Interviews with key personnel from LTA LTA's internal documents, National Library archives Other countries' Web sites, direct observations
Information on the comparison of magnetic farecard and smartcard systems	Interviews with key personnel from LTA and PTOs Interviews with bus drivers
Information on the implementation of the smartcard system, including the change management strategies	Survey randomly selected 296 commuters National Library archives, LTA's internal documents Brochures explaining the usage of the smartcard Direct observations
Information on improvements made to the smartcard system	Interviews with key personnel from LTA and PTOs Survey randomly selected 296 commuters National Library archives, direct observations

Apart from this primary data, secondary data sources such as the National Library archives (e.g., formal studies/evaluations, newspaper articles), internal LTA documents, other country Web sites, and brochures were studied. Finally, direct observations of the farecard system change process were triangulated with the primary (interviews and surveys) and secondary (articles and documents) data sources. Table 5 lists the details of the data sources.

For reliability, we assigned different roles for multiple investigators to encourage the development of distinct views that can then be compared [13, 14]. In our study, three authors were directly involved in the data collection process while two authors remained as detached outsiders to challenge the objectivity of the study.

Data Analysis

Viewing the physical and social world as objective entities, a positivist researcher should play a passive, neutral role, and should not intervene in the phenomenon of interest [13]. Keeping this in mind, we took an etic perspective when analyzing the data. The data analysis strategy for positivist exploratory case study is explanation building, in which the analysis is carried out by building a textual explanation of the case [13]. Yin [58] refers to this procedure as a hypothesis-generating process to develop ideas for further study. In this study, beyond the textual explanation of the CSFs for change management in IOS for the public, we carefully constructed a CLD to explain how the CSFs interact and affect one another.

We began our data analysis with template coding. Template coding helps the researcher to begin the analysis process with more structure by developing a priori constructs [29]. Based on the understanding of the case, the researcher will then refine the template by making some of the constructs more specific to better represent the actual situations in the case, add in some new construct, or remove some irrelevant ones [14, 29]. In this study, we first generated the template based on the common CSFs identified from previous studies of IT-related change management (Step 1). Through careful data triangulation, we refined the template by adding in new CSFs as they were identified (Step 2). These CSFs were then causally interrelated with the mapping technique of a CLD [48] (Step 3). Finally, we identified the core loops in the CLD [48] to generate propositions for future research (Step 4). For reliability, at any one time, there were at least two authors who coded the data. Any disagreements were discussed and immediately sorted out. To ensure construct validity, the findings were sent to the key contact person for review.

Step 1: Code Occurrences of Known CSFs from the IT-Related Change Management Literature

After compiling the data from the various sources, we coded the occurrences of known CSFs from our literature review on change management for intraorganizational systems, IOS, and intraorganizational systems for the public. For example, the *need for change and feasibility analysis* CSF is evident from the interview with LTA's senior manager:

> With the introduction of the light rail system, there were a lot of problems due to the lack of space on the magnetic farecard. Fortunately [LTA] managed to get around these problems. However, with the advent of the introduction of the North East Line, [LTA] had to change the farecard system to [a] smartcard system. . . . [A] smartcard system has higher data storage and transaction processing capacities, lower life cycle cost, and much higher reliability. . . . [LTA] constantly sources for well-established technologies which will help improve the fare system in Singapore. . . . After evaluating the systems overseas, LTA has decided to implement the smartcard system in Singapore with modifications to suit the fare system in Singapore.

Step 2: Code Additional CSFs Found in the Data

Apart from coding the known CSFs from the IT-related change management literature, we also identified additional CSFs for managing the affected organizations' resistance to change (between LTA and PTOs) and the public's resistance to change (between LTA and the public). As in Nissen's [40] study, we identified the CSFs by constantly comparing the responses of the interviewees across the organizations and refined them repeatedly through triangulation with the secondary data sources (i.e., articles and documents). For example, in our interview, LTA and PTOs' key personnel always stressed on their collaboration in deciding the smartcard system's software and hardware, implementing, and managing the system change. The collaboration was also described in LTA's internal document. By triangulating these multiple sources of evidence, we coded an additional CSF, which is the *cooperation of LTA and PTOs' employees to implement and manage the system change.* Another example is that while going through the news articles, we discovered many advertisements about the smartcard system. Further we discovered an internal LTA document that stated:

> To prepare for the launch, there was extensive publicity. User guides were distributed . . . [LTA] bought television time, press advertisement and put up publicity posters in the residential estates. Road shows were held at train stations and bus interchanges where there is a high volume of commuter traffic.

The advertisements in the newspapers coupled with the internal LTA document, and our observations during the system change led us to derive another CSF on managing public's resistance to change, which is *comprehensive publicity.*

Step 3: Causally Interrelating the CSFs

The interview questions, which were designed to tap the chronology of the events, enabled us to understand the sequence of the change management events. This in turn was triangulated with the secondary data sources (i.e., articles and documents) to help us derive the causality of the identified CSFs in a CLD [48]. A CLD consists of variables—in this case, the identified CSFs—connected by arrows denoting their causal influences. Each causal link is assigned a polarity, either positive (+) or negative (–), to indicate how the dependent variable changes when the independent variable changes. A positive link means that if the cause increases, the effect increases above what it would otherwise have been, and if the cause decreases, the effect decreases below what it would otherwise have been. A negative link means that if the cause increases, the effect decreases below what it would otherwise have been, and if the cause decreases, the effect increases above what it would otherwise have been. Each loop in the CLD has a loop identifier that shows whether it is a positive (reinforcing) or negative (balanced) feedback loop. For example, we discovered a positive causal relationship between *systematic plan for project and change management* CSF and *comprehensive publicity* CSF from an internal LTA document:

> Preparation for the launch began . . . with the formation of the Public Relations [PR] Steering Committee. The committee put together a PR plan to determine the schedule and range of activities. . . . The comprehensive PR activities included press releases several months before the launch. Stories of the upcoming new ticket media and how the public transport operators were preparing for the change were featured in the newspapers to generate interest.

Step 4: Formulate Propositions

The last step was to identify the important or core loops in the CLD. The core loops are those that have a main effect on the target goal or on the desired state of the phenomenon (i.e., effective change management for IOS for the public). We made use of the above definition to identify the core loops as the loops that had a main effect on the institutionalization of system-related change (considered as the target goal of the system-related change management effort). Based on the identified core loops, propositions were generated for future research.

Findings

Case Background

THE FOCUS OF THIS STUDY IS ON THE TRANSITION from the magnetic farecard to a smartcard in Singapore's public transportation system. The case background was derived from the National Library archives, interviews, and direct observation (see Appendix A for more details).

In 1990, Singapore's bus and train companies[1] established a jointly owned company called Transitlink to integrate bus and train fares. The fare integration project involved implementing a common stored-value magnetic farecard. Commuters had to insert their farecard into the slots in a box-like device inside the bus and key in the fare to be deducted from their farecard. Commuters who wanted to pay cash for their bus fare could do so. For travel on trains, commuters would insert the farecard into the ticket slots at the entry and exit gates at their destination and the fare amount would be deducted automatically. The commuters could electronically transfer funds from their bank accounts to top-up the stored value on their farecards.

In 1995, LTA was founded as a government agency to plan and regulate land transportation. Since the plan was to expand the public transportation network by adding new routes and light rail systems, LTA realized that the magnetic farecard would be unable to provide an integrated ticketing service due to its limited data and processing capacities. Hence, a new contactless smartcard system called Ez-Link was conceived. To implement Ez-Link, smartcard readers were installed at the entrance and exit doors of buses. When commuters board the bus, they must tap their Ez-Link on a card reader mounted at the entrance; when alighting from the bus, they need to tap their Ez-Link on a card reader at the exit. The Ez-Link system calculates and deducts the correct fare from the stored value on the card. If a commuter fails to tap the card when alighting

from the bus, the system penalizes the commuters by deducting the maximum fare from the stored value. Commuters who desire to pay cash for their bus fare can do so. For travel on trains, commuters tap their Ez-Link cards on card readers mounted on the entry and exit gates. In addition to linking to bank accounts, commuters can link the card to their credit card for automatic value top-up. To manage the system, LTA established a subsidiary called Ez-Link.

Based on the interviews, internal LTA documents, archives, and brochures, the interactions among the parties involved in the sale and usage of the magnetic farecard (before change) and the new smartcard (after change) are shown in Appendices C and D. Although PTOs' roles and responsibilities appear somewhat similar before and after the change, the money collection became more complex and time-consuming due to the involvement of additional parties. Previously, Transitlink was the only entity that processed PTOs' fare transaction information before issuing the claimed money. After the system change, PTOs' fare transaction information needs to be processed by two more entities (i.e., Ez-Link and a bank) before they can receive their money. The role of Transitlink became that of a clearing house while Ez-Link took on the job of card issuer. Ez-Link also interacts with Citibank as the official bank to manage the fare and deposit float (prepaid fares and card deposit). The need for introducing the bank came about due to the intention to introduce nontransit smartcard applications such as linkage to fast-food chains.

The more complex and time-consuming money collection, together with the training and system implementation costs resulted in resistance to change in the PTOs. Drivers had to be retrained since they needed to update the current location information at each bus stop as well as fix any problems with the card readers on the buses. Resistance to change also came from the public due to the likely change in the mode of payment for their transport fare. While the movement in and out of buses became easier, there was less opportunity to cheat on fares and potential of losing money on lost or stolen smartcards. There was also the potential for privacy intrusion due to the ability of the Ez-Link system to record commuters' trip history. Thus, the PTOs had to be persuaded by LTA (the change agent) to accept the new system, and the public had to be convinced to use the new card, especially on buses.

CSFs and CLD for Change Management in IOS for the Public

Figure 1 shows the CSFs identified in our study and their causal links.

Managing Internal Resistance to Change

When the *need for change* from a slow, low data storage capacity magnetic farecard system to a relatively fast, "contactless," high data storage capacity smartcard system in Singapore's public transportation system was first proposed, it was accompanied by a *feasibility analysis* in which a prototype was built. The smartcard prototype was the size of two credit cards with a little battery in it. The idea for a "contactless" smartcard

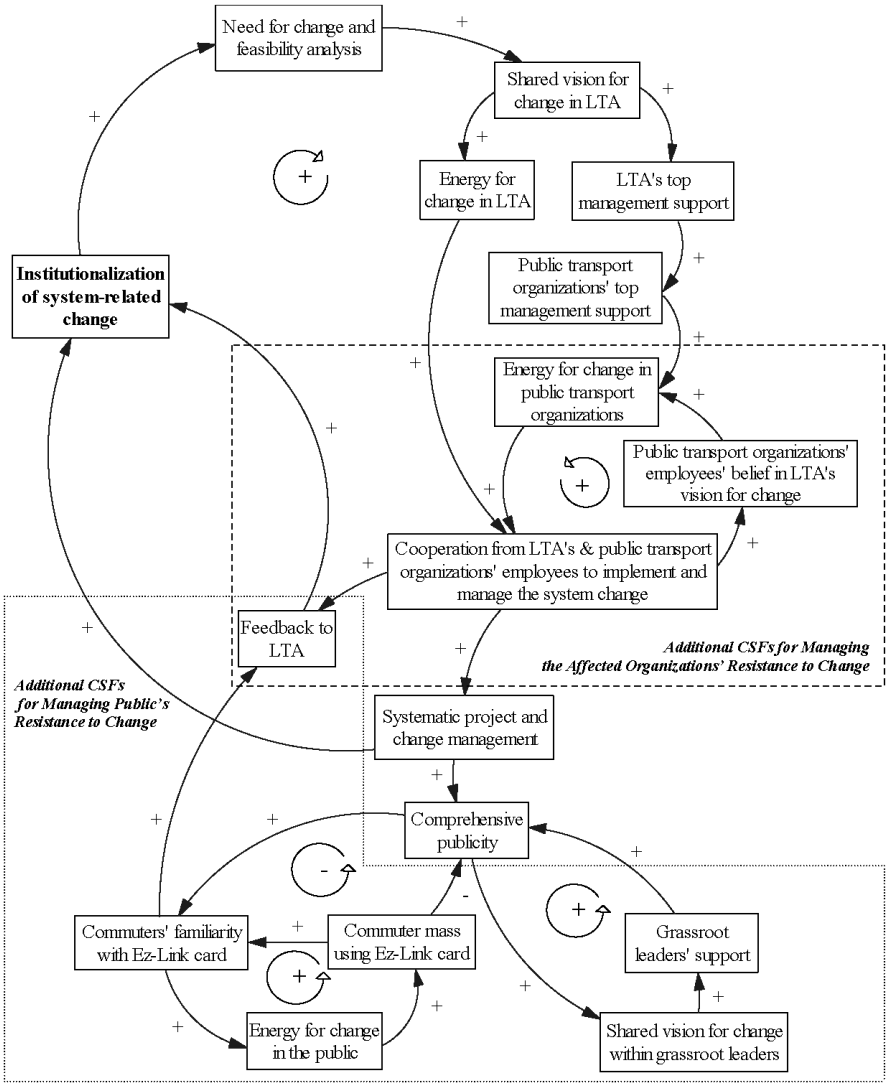

Figure 1. CLD of the CSFs for change management in IOS for the public.

was later dropped because the technology at that time did not support the creation of such a smartcard. This is indicated from the interview with LTA's senior manager:

> LTA recognized that there will be a data storage problem with the magnetic farecard system. LTA thought about the smartcard technology but was reluctant to establish it. . . . The card was originally battery operated, however, having batteries was not feasible. Singapore wouldn't want to be at the biting edge of the technology.

When the first light rail system was built in 1997, the magnetic farecard could not cater to the newly constructed system because of its limited data storage and processing capacity. LTA then came up with alternatives and implemented software solutions to support the light rail system. Further, as the public transportation network in Singapore was rapidly expanding with the construction of another light rail system and a North East Line to add to the existing train system, the old magnetic farecard had insufficient capabilities for supporting an integrated ticketing service. Thus, the *need for change* to smartcard system was strongly voiced by LTA's fare system department to LTA's top management by highlighting the limitations of the magnetic farecard and the benefits offered by the smartcard for future development and growth of Singapore's public transportation system. This was evident from the interview with LTA's senior manager:

> With the introduction of the light rail system, there were a lot of problems due to the lack of space on magnetic farecard. Fortunately [LTA] managed to get around these problems. However, with the advent of the introduction of the North East Line, [LTA] had to change the system to [a] smartcard system . . . [A] smartcard system has higher data storage and transaction processing capacities, lower life cycle cost, and much higher reliability.

The awareness of the need to change was accompanied by a rigorous *feasibility analysis* of the smartcard system by visiting other countries that have used similar systems (such as Hong Kong) as well as developing and beta testing another prototype. At this time, it was concluded that technology was no longer a barrier to implement a smartcard system. The feasibility analysis results grew a *shared vision for change in LTA,* which consequently created *energy for change in LTA* as well as gained *top management support* in LTA. The LTA senior manager commented:

> [LTA] constantly sources for well-established technologies which will help improve the fare system in Singapore. . . . After evaluating the systems overseas, LTA has decided to implement the smartcard system in Singapore with modifications to suit the fare system in Singapore. To begin with, LTA creates a vision [for system change] to look at the big picture. . . . There was urgency to change in LTA as the magnetic farecard system would have problems coping with a through-ticketing service with an added operator and extended public transport network. . . . LTA's fare system department requested financial support to implement the smartcard technology. The request was approved by a few important figures in LTA.

Managing PTOs' Resistance to Change

With LTA's top management support, LTA's fare system department pitched the system change idea to the PTOs by highlighting the benefits of the smartcard system (despite a more cumbersome fare collection procedure), as evident from the interview with LTA's senior manager:

> After getting support from a few important figures in LTA, the [top management of the] public transport operators were persuaded to adopt the system with the following possible benefits: (1) They will be able to prevent fare leakage from happening as the [new] system automatically calculates the fares compared to the magnetic farecard system where the commuters choose the fare to pay. . . . (2) They will be able to reduce the waiting time of a bus to stop at the bus stop.

Gaining *PTOs' top management support,* who are opinion leaders in their respective companies, was important to initiate *energy for change in PTOs.* With energy for change developed within LTA and the PTOs, LTA could obtain better *cooperation from LTA and PTO employees to implement and manage the system change,* as evident from the interview with LTA's manager:

> The public transport organizations agreed to cooperate with LTA by participating in the team that managed the change from the magnetic farecard system to the [new] system. . . . It is a collective innovation decision [to build the system]. . . . [PTOs] are part of the team to write the specifications for the (new) system. [PTOs] are attached to LTA to help run the project and determine the requirements of the [new] system and the [PTOs] say what they want.

LTA's fare system department worked closely with several employees from the three PTOs to design and develop the smartcard system. Together, LTA and PTO employees visited Hong Kong to further study its smartcard system. A number of joint working committees were formed to monitor project progress, formulate policies/procedures, and draft publicity programs and a business continuity plan. One of the joint working committees was a public relations steering committee whose role was to plan for and conduct public change management, which will be elaborated in the next subsection.

This close cooperation increased *PTOs employees' belief in LTA's vision for change* that once implemented, the smartcard system would cater well to the needs of commuters and the PTOs themselves, such as the optimization of fleet utilization. This belief created more *energy for change in PTOs,* which in turn resulted in more cooperation in implementing and managing the system change. This was evident from the interview with PTO's senior manager:

> [PTOs'] employees might not be 100 percent in congruence with LTA's employees due to disagreements in the system specification and design. However, through close cooperation, [PTOs' employees] became more aware of the operational problems with the magnetic farecard, and there was urgency to change. The [disagreements] were then quickly sorted out so that we could move on with the system implementation.

Cooperation in the joint working committees resulted in a more *systematic project and change management* plan as a common frame of reference for employees from the different organizations to work together on the smartcard system implementation and

public change processes. As part of the smartcard system implementation plan, bus drivers were trained on how to use the new system. Through close *cooperation* with the PTOs, employees in LTA gained a better understanding of the possible limitations of the new smartcard system. The limitations were informed as *feedback to LTA,* as evident from the interview with LTA's manager:

> As PTOs were aware of and informed us about the potential problems [of the smartcard system], the problems were minimized.

Managing Public's Resistance to Change

As previously mentioned, preparation for the launch of the smartcard began with close *cooperation* between representatives from the LTA and PTOs who together formed several working committees to devise a *systematic project and change management* plan. As part of the plan, the public relations steering committee organized a competition for the public to name the new smartcard. A winner was chosen, and the new smartcard was named Ez-Link. Shortly afterward, a soft launch referred to as a selective preview was performed as evident in a news archive:

> Some 45,000 participants . . . have been invited to preview the new ez-link card before its official launch . . . the selected participants will be able to buy and use the ez-link card on the MRT/LRT [Mass Rapid Transit/Light Rail Transit] system and selected bus services. . . . participants can top up the value of their ez-link Card at any Transitlink Ticket Office and the new General Ticketing Machines at all MRT/LRT stations.

Based on the observations during the selective preview, the public relations steering committee refined their previously developed change plan to publicize the Ez-Link card. Particularly, special attention was given to senior citizens because of their higher resistance to change as compared to younger commuters, as evident in our interview with LTA's manager:

> The public relations steering committee is most worried about the senior citizens as they feel that this age group will take the longest time to adapt to the new system. [The committee] . . . will collect inputs from community centers to understand how the elderly react to the new system.

The *systematic project and change management* process determined a range of publicity activities to introduce Ez-Link to the public. With a well-planned public relations exercise, there was *comprehensive publicity* about the Ez-Link card. Stories of the upcoming card and how PTOs were preparing for the changes were featured in local newspapers to generate public interest. User guides were distributed, press conferences were held, posters were put up in residential estates, and road shows were held at train stations and bus interchanges. Ambassadors who wore Ez-Link badges (staffs from the train stations and bus interchanges) were at the road shows to educate the public on how to use the Ez-Link card. Instructional videos were shown during

the road shows. Computers equipped with interactive software were made available to familiarize the public with the new system. Commuters could also visit the Ez-Link Web site for more information. Catchy tunes in television commercials promoted the convenience of Ez-Link compared to the magnetic farecard and the benefits of using Ez-Link versus paying the fare by cash. These *comprehensive publicity* efforts increased *commuters' familiarity with the Ez-Link card.*

As part of the publicity efforts, the public relations committee also held several briefings for grassroots leaders to build a *shared vision for change within the grassroots leaders.* With the shared vision, the committee could gain *grassroots leaders' support* for the new system. These leaders then helped generate more *publicity,* which eventually increased *commuters' familiarity* with the card in their communities, as evident from the interview with LTA's senior manager:

> The public relations committee got the support from the grassroot community leaders to explain and spread the awareness and how-to knowledge.

Familiarity with the card and its relative advantages in turn bred *energy for change in the public.* Based on our survey of 296 commuters, about 68.23 percent expressed their readiness to switch to the Ez-Link card during the transition time. The commuters' *energy for change* increased the *commuter mass using the Ez-Link card.* Once a critical mass of commuters using the Ez-Link card was reached, commuters' familiarity with the Ez-Link card became self-sustaining, and the level of publicity was reduced. This created a reinforcing (positive) link from *commuter mass* to *commuters' familiarity* and a balancing (negative) link from *commuter mass* to *comprehensive publicity.* Of the 296 commuters that we surveyed, 215 responded that they learned to use the Ez-Link card by observing other commuters.

Once commuters became more familiar with the Ez-Link card, more *feedback to LTA* was generated to improve the Ez-Link system, as evident from the interview with LTA's manager:

> There were entry and exit problems. Due to crowded buses during rainy days and peak hours, some commuters may have to exit at the entrance of the buses. Initially, commuters could not exit at the entrance and had to request the bus driver to switch the entry mode of the card reader to exit mode. This had to be done for each commuter. However, after a lot of feedback, LTA decided to implement such a feature. The feature was implemented after careful consideration as it could aid people to cheat the system.

With the *systematic project and change management* plan and *feedback* from the PTOs and the public (in addition to feedback from within LTA), LTA could make necessary improvements, which helped *institutionalize system-related change.* More features were added to the core features of the smartcard system which increased the relative advantage of the smartcard system as compared to the magnetic farecard system. As *institutionalizing system-related change* involved assessing whether the new system contributed to corporate success and improving upon the system, it led

to greater *need for change and feasibility analysis* of the smartcard system. This was evident from a news archive:

> Commuters in Singapore have come to rely on the Ez-Link card . . . approximately 4 million transactions processed each day. In the near future, Ez-Link cards can also be used in non-transit, contactless payment environments [such as to make payments in food centers, supermarkets, and libraries].

Five months after the launch, 83.2 percent of public transportation rides were paid with the Ez-Link card when the option of payment via magnetic farecards and cash was still available. It was, hence, a clear signal to LTA to proceed with closing the curtain on the sale of magnetic farecards. LTA believed that the high usage of Ez-Link cards proved that the majority of the public was comfortable with the Ez-Link card. Thus, seven months after the introduction of the Ez-Link system, the magnetic farecard was terminated. The public now had two alternatives to pay for their transportation—that is, pay with cash or use the Ez-Link card—as quoted from our interview with LTA's senior manager:

> LTA did not insist that commuters use the Ez-Link card but presented benefits to entice commuters to use the Ez-Link card. . . . It is an optional innovation decision for the public to adopt the system. The cash collection system will not be phased out in the future. This is because people can't be forced to buy the Ez-Link cards. The cash collection system also caters to infrequent users such as tourists for bus traveling. Although people can still opt for [a] single trip ticket for train traveling, after the introduction of the Ez-Link system, there are only 4 to 5 percent [of] commuters using the single trip ticket for the rail system daily as compared to 8 to 10 percent on average during the magnetic farecard system era.

Framework for Effective Change Management in IOS for the Public

Based on the CLD of Figure 1, we propose a framework for effective change management in IOS for the public (see Figure 2) by identifying core loops for managing the affected organizations' and public's resistance to change. Core loops are the loops that lead to the institutionalization of system-related change.

Managing the Affected Organizations' Resistance to Change

There are three types of influence tactics—rational persuasion, hard influence, and soft influence [59]. Rational persuasion relies on the use of logical arguments to persuade the target that a proposal is viable and likely to attain the objectives. Hard influence includes pressure, coalitions, and legitimating, whereas soft influence is characterized by open exchange and power sharing. During the transition to the smartcard system, LTA's vision-driven leadership served to gain *the affected organizations' top management support.* A vision-driven strategy tends to inspire creativity, allowing the vision

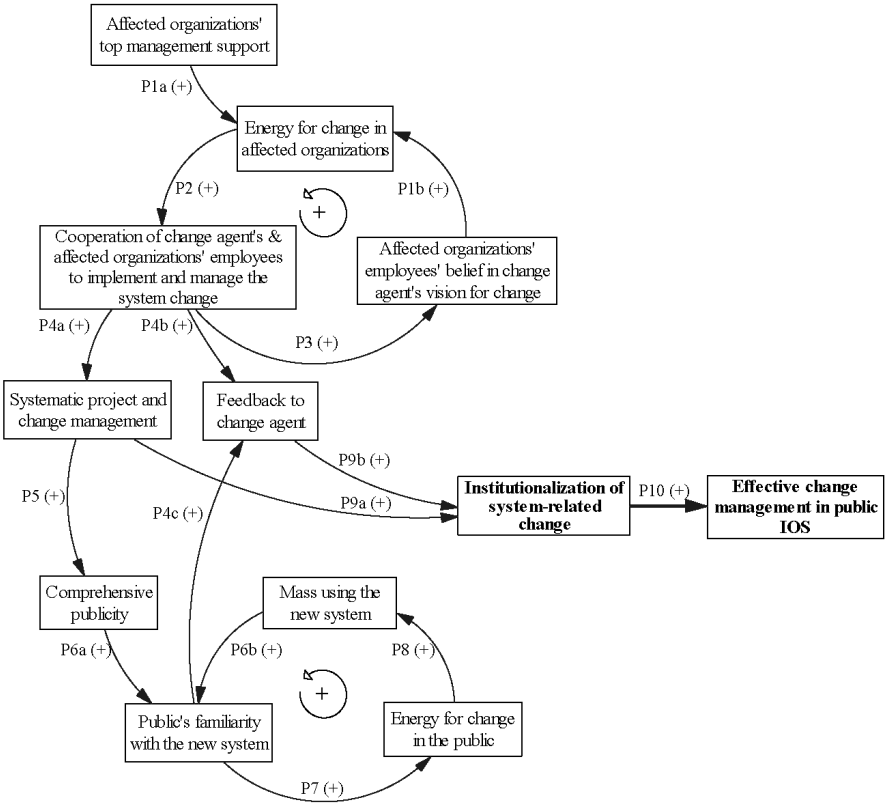

Figure 2. Proposed framework for effective change management in IOS for the public.

to be realized through enthusiastic management [50]. With support from LTA's top management, LTA's fare system department exercised the rational persuasion tactic to gain support from PTOs' top management by explaining the relative advantages of the new system for the PTOs. Once the leaders had shown their support for the system change, they would initiate *energy for change* in their respective organizations with hard influence through a commanding form of intervention [59]. However, for a more lasting effect, energy for change should be reinforced from within the affected organizations' employees themselves by *increasing their belief in the change agent's vision for change.* Thus, we propose that

> *Proposition 1: (a) The greater the affected organizations' top management support and (b) the greater the affected organizations' employees' belief in the change agent's vision for change, the higher the energy for change in the affected organizations will be.*

To increase PTO employees' belief in LTA's vision for system change, LTA utilized a soft influence approach through engineering, learning, and socializing forms of intervention [25, 59]. With the *energy for change* already initiated by the PTO leaders,

LTA employees worked together with PTO employees to engineer the new system. During their cooperation, they learned from one another and socialized with one another. Through the close *cooperation,* employees in the affected organizations obtained firsthand knowledge of the new system (its features and benefits), which increased their appreciation of the new system. These sense making and social bonding activities directly targeted the values and attitudes of PTO employees with the aim to increase their belief in the change agent's vision for change. Hence, we propose that

Proposition 2: The higher the energy for change in the affected organizations, the greater the cooperation will be between change agent's and affected organizations' employees to implement and manage the system change.

Proposition 3: The greater the cooperation, the stronger will be the affected organizations' employees' belief in the change agent's vision for change.

This growing belief in turn enhanced energy for change within the PTOs, and increased PTO employees' cooperation with LTA to implement the new system.

As cooperation between LTA and the PTOs increased, this resulted in better coordination and joint planning of the system change process. Also, the increased cooperation and communication ensured that feedback about the limitations of the new system was conveyed back to LTA by the PTOs. Therefore, we propose that

Proposition 4a: Cooperation of change agent's and affected organizations' employees to implement and manage the system change results in more systematic project and change management.

Proposition 4b: Greater cooperation between the parties facilitates feedback about the new system from the affected organizations to the change agent.

Managing Public's Resistance to Change

Apart from guiding the system implementation, another purpose of the systematic project and change management plan was to draft the publicity program. With a well-planned public relations exercise, there was comprehensive publicity about the Ez-Link card. Accordingly, we propose that

Proposition 5: More systematic project and change management results in more comprehensive publicity of the new system.

Publicity is crucial to raise awareness of the new system and how it can be used. There must be sufficient information on the benefits of the new system and how the public can make use of the new system. Thus, we propose that

Proposition 6a: The more comprehensive the publicity of the new system, the higher the public's familiarity with the new system.

While the energy to change within the affected organizations is enhanced by their belief in the change agent's vision for change, it may not be feasible to create a shared

vision for change in the entire public. According to diffusion of innovation theory, the first people to adopt the new system do so because they know that they can obtain benefits from the new system [44]. Hence, energy for change in the public can be nurtured by increasing the public's familiarity with the new system (e.g., its benefits and usage procedures). Thus, we propose that

> *Proposition 7: The higher the public's familiarity with the new system, the higher will be the energy for change in the public.*

Subsequently,

> *Proposition 8: The higher the energy for change in the public, the higher will be the mass using the new system.*

The transition from the old system to the new system could be called successful if there is a critical mass using the new system. The essence of critical mass theory is that once a certain proportion of users (critical mass) have been attracted, the usage would rapidly spread throughout the community. Critical mass occurs at the point at which enough members of the public have adopted the new system so that the new system's further rate of adoption becomes self-sustaining [44]. The reason it can become a self-sustaining innovation is because the first individuals who adopted the new system contribute resources (information and help) needed by nonadopters to adopt the new system. With initial comprehensive publicity to increase the public's familiarity with the new system, once the critical mass of people using the new system was reached, nonadopters could become familiar with the new system even without intensive publicity efforts. Thus,

> *Proposition 6b: The higher the mass using the new system, the higher will be the public's familiarity with the new system.*

> *Proposition 4c: When the public becomes more familiar with the new system, they will be able to generate more feedback to the change agent.*

Feedback from users requires management attention and follow-up because often the end users will be able to identify certain system limitations that are not so obvious to the developers. With this feedback (in addition to the feedback gathered within the change agent itself and from the affected organizations), necessary improvements could be made to the new system, which in turn increase the relative advantage of the new system and *institutionalize system-related change* for a long-lasting effect.

Unlike the feedback from the PTOs that was easier to capture, channel, and respond to, public feedback may come from various sources (e.g., phone calls, newspaper letters, and e-mail) and be more voluminous, which makes it more difficult to respond to and address. A member of the steering committee recalled that for the first few days after the official launch of the Ez-Link card, they spent the whole day replying to e-mail feedback. Nevertheless, change agent's openness and responsiveness to public feedback are important to institutionalize the system change in the public. A well-managed change process could increase the effectiveness of capturing and

responding to public feedback as well as increase the effectiveness of incorporating the smartcard system–related changes into LTA and PTO's organizational routines. Thus, we propose that

> *Proposition 9: (a) A more systematic project and change management and (b) feedback to the change agent facilitate the institutionalization of the system-related change.*

Finally,

> *Proposition 10: The institutionalization of the system-related change suggests that change management for the public IOS is effective.*

Discussion and Implications

Theoretical Implications

Our study of the successful transition from the magnetic farecard system to the smartcard system in Singapore's public transportation system has several theoretical implications. First, while previous studies on change management for IOS for the public did not provide CSFs for managing such change, this study identified and interrelated CSFs for such complex change accompanying a new IT implementation. The study first identified common CSFs from change management studies of intraorganizational systems, IOS, and intraorganizational systems for the public to provide a starting point for our case analysis.

Based on the analysis of the case, we found that six CSFs for managing internal resistance to change (CSF-1A to CSF-6A) were apparent during the change management for IOS for the public, though in a somewhat modified manner. For example, to overcome resistance to change in the affected organizations, top management support should be established not only in the change agent's organization but also in the affected companies. Further, to overcome resistance to change in the public, it is important to create a shared vision for change within the public's opinion leaders (grassroots leaders), who can influence the public to accept the new system.

The common CSF proposed by IOS studies (CSF-4B) to manage the affected organizations' resistance to change is the constellation of leaders' support [24, 32, 54]. Based on the case analysis, we found that top management could only initiate energy to change in their respective organizations, but could not sustain it. Rather, it is the interorganizational collaboration in implementing and managing the system change that sustains energy to change in all of the organizations involved.

Studies on change management for intraorganizational systems for the public highlight public education (CSF-3C) to alleviate resistance to change in the public. This study found that public education could be attained through comprehensive publicity. The publicity should focus not only on training the public to use the system but also on educating the public of the system's relative advantages. In this way, publicity will not only minimize technology anxiety but also convince the public to use the new system.

While all CSFs from previous studies on IT-related change management were found in our study (though somewhat modified), we also found additional CSFs for managing external resistance to system change. Three additional CSFs for managing resistance to system change in the affected organizations are creating energy for change in the affected organizations, cooperation of change agent's and affected organizations' employees to implement and manage the system change, and affected organizations' employees' belief in change agent's vision for change. The interrelationships of these three additional CSFs form the core or important loop in managing the affected organizations' resistance to change. Five additional CSFs for managing the public's resistance to system-related change are shared vision for change within public opinion leaders (grassroots leaders), grassroots leaders' support, public's familiarity with the new system, energy for change in the public, and increasing mass using the new system. The interrelationships of the last three CSFs form the core or important loop in managing public's resistance to change. Finally, we found one additional CSF for managing both the affected organizations' and public's resistance to system change, which is feedback to the change agent.

Apart from identifying and interrelating the CSFs for change management of IOS for the public, we also propose a framework for such change management for future research to build on and validate. Based on the proposed framework (see Figure 2), a company introducing a new IOS for the public could overcome the affected organizations' resistance to change through interorganizational communication and collaboration. This finding is similar with Akkermans and van Helden's [1] study that found interdepartmental communication and collaboration as the core process in implementing an ERP system that integrates different business functions. However, while their study found that top management support could establish a clear vision for system change to increase interdepartmental collaboration, our study found that attaining support from top management in the affected organizations could only initiate collaboration between their employees and the change agent's employees, but could not create a shared vision for change within their respective organizations. We discovered that the close cooperation helped communicate the relative advantage of the new system to the employees of the affected organizations, which enhanced their belief in the change agent's vision for change, and increased interorganizational collaboration in implementing the new system. Thus, while top management plays an active role in interdepartmental system change [1], the constellation of top management in an IOS implementation only acts as an enabler to the system change. Thus, this study builds on and extends previous IT-related change management literature by refining existing CSFs and identifying CSFs for an understudied phenomenon—that is, change management related to IOS implementation for the public.

Practical Implications

Our study of the successful transition to the smartcard system in Singapore's public transportation system has several practical implications. Besides informing implementers of such initiatives of the CSFs they should focus on, it also shows how the

factors interrelate such that practitioners can make use of the dependencies. Instead of discussing each CSF, which would be repetitive, we highlight a few of the key lessons below.

First, organizations introducing change in IOS for the public would benefit from adopting a cooperative bottom-up approach rather than a top-down approach in managing the affected organizations' resistance to change. When relevant employees of all the affected organizations closely cooperate with each other in implementing and managing the system change, there will be a growing sense of ownership of the new system. For example, when PTOs' employees had firsthand knowledge of the smartcard system, their appreciation of the smartcard system increased, which in turn increased their belief in the LTA's vision for change and minimized their resistance to change.

Second, in managing system change in the public, organizations need to realize the significance of critical mass. Critical mass is important because once it has been attained, the new system's further rate of adoption becomes self-sustaining [44]. To reach a critical mass using the new system, organizations should publicize the relative advantages and usage procedure of the new system. In addition, organizations should seek support from community opinion leaders to help publicize the system in their respective communities. Once the critical mass of people using the new system is reached, those who have not adopted the system can easily observe the users/adopters and become familiar with the new system without intensive publicity efforts. For example, to reach critical mass using the smartcard, LTA comprehensively publicized the smartcard system with the help of community leaders (grassroots leaders). However, once the critical mass was created, the less intensive the publicity became.

Third, organizations introducing new IOS for the public must effectively capture and address feedback from the affected organizations and the public. When employees in the affected organizations and members of the public perceive that their feedback is appreciated and acted upon, it helps institutionalize the new IOS for the public for a long-lasting effect. For example, although it was an expensive and time-consuming process for LTA to address the large amount of public feedback that came from various sources, with the feedback, LTA could make previously unseen improvements to the smartcard system to optimize its benefits for the public.

Limitations and Future Work

The study has certain limitations that need to be considered when interpreting the results. First, a CLD can never be completely comprehensive in enumerating all causal relationships of the phenomenon [48]. Nevertheless, our CLD of IT-related interorganizational and public change management can provide a better understanding of the phenomena. The CLDs could help in answering how and why questions by understanding the cause and effect relationships of the CSFs for change management of IOS for the public.

Second, this study suffers from the usual limitations of case study research. Findings are largely interpreted from qualitative data such as interview transcripts, LTA files, and news archives, which need to be statistically tested or simulated in the future to

increase external validity. Moreover, because this study looks into a single case, more cases should be taken into consideration in the future in order to obtain a more generalizable understanding of the phenomenon. For example, future work may attempt to extend these findings to other countries where the role and perception of government may be different than Singapore. Nevertheless, the case study approach provides rich data for a more in-depth understanding of the phenomenon.

Since this study investigates an IOS for the public in which the change agent is a public organization (LTA), the affected organizations are private organizations (PTOs), and the users are the public (commuters), future studies may also attempt to test the applicability of the proposed frameworks to other configurations. A configuration of interest is a system where the change agent and affected organizations are private and the users are public, such as the UK's credit card PIN-authentication system where the change agent is private (Association for Payments Clearing Services Ltd.), the affected organizations are private (credit card companies and banks), and the users are the public (merchants and credit card holders) (www.paymentsnews.com/2006/02/uk_transitions_.html).

Conclusion

In today's rapidly changing business environment, failure to capitalize on a new IT can be especially costly. The inability to assimilate the new IT may cause investment in the system to be fruitless [6]. This stresses the need for and importance of effective change management efforts to accompany the IT implementation. This need becomes particularly challenging in the case of IOS for the public where multiple stakeholders with possibly conflicting interests are involved and where the potential consequences of failure can be severe. While there is a practical need to understand how change management can be effected in such complex IT implementations, there is a lack of study of and clear guidelines for this phenomenon.

Thus motivated, we conducted an in-depth study of an IT implementation involving multiple organizations and the public. We identified the CSFs and interrelated them to indicate their causal relationships—that is, how one CSF could follow from or reinforce/curb another. The findings clearly have practical implications for managers and implementers of such initiatives by indicating the critical factors on which they should focus. This study also contributes to research by proposing a framework to explain the effectiveness of change management in an IOS for the public.

The system studied was a public transport smartcard, which belongs to an important class of IOS intended for the public. These cards include smart social security card systems, smart medical card systems, and other multifunction smartcards. As more systems are being implemented, such as a biometric identity card (www.zdnet.com.au/news/security/soa/An-ID-card-by-any-other-name-/0,130061744,139253868,00.htm?feed=pt_biometric), our results may be useful in these contexts. Overall, studies of this nature can help in throwing light on how to facilitate change management for IOS for the public.

NOTE

1. The bus and train companies are jointly referred to as the public transport organizations (PTOs).

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Appendix A

Case Study Questions

Brief History of Fare Collection of Land Transport in Singapore

Q: What were the different methods of fare collection in the past in Singapore?

Sources of data: National Library archives, interview key personnel from LTA.

Sample strategies: (1) Extract information from formal studies/evaluations and newspaper clippings. (2) Interview key personnel from LTA to verify the information found.

Q: Do people prefer to use smartcard, or magnetic farecard, or other methods of fare collection?

Sources of data: National Library archives, interview key personnel from LTA and PTOs, direct observation.

Sample strategies: (1) Extract opinions from newspaper articles. (2) When interviewing key personnel from LTA and PTOs, observe the interviewees' reactions.

Q: When and why have the fare collection methods changed over time?

Sources of data: Interview key personnel from LTA, National Library archives.

Sample strategies: (1) Extract information from the interviews regarding the reasons behind each change in fare collection method. (2) Extract information from formal studies/evaluations and newspaper clippings.

Magnetic Farecard System in Singapore

Q: How long has the magnetic farecard system been around and what are the advantages and disadvantages?

Sources of data: National Library archives, interview LTA and PTOs' key personnel.

Sample strategies: (1) Extract information from formal studies/evaluations and newspaper clippings. (2) Extract information from the interviews (e.g., What were the complaints involving magnetic farecards?). (3) Tabulate the advantages and disadvantages of the system.

Q: What were the software and hardware of the magnetic farecard system?

Sources of data: National Library archives, interview key personnel from LTA, LTA's internal documents, brochures.

Sample strategies: (1) Extract information from formal studies/evaluations, newspaper clippings, and interviews. (2) Extract information from LTA's internal

documents posted on its Web site or shown by the interviewees. (3) Brochures explaining the usage and the mechanism of the magnetic farecard system. (4) Draw a diagram showing the interaction among the organizations in magnetic farecard distribution and fare collection.

Smartcard Systems Available in Other Countries That Were Studied by LTA

Q: Why did LTA want to implement the smartcard system in Singapore?

Sources of data: Interview key personnel from LTA, National Library archives.

Sample strategies: (1) Extract information from the interviews (e.g., When was the decision to implement the system made? What are the criteria for choosing such a system?). (2) Extract information from formal studies/evaluations and newspaper clippings.

Q: What were the smartcard systems studied by LTA?

Sources of data: Interview key personnel from LTA, National Library archives.

Sample strategies: Extract information from the interviews, formal studies/evaluations, and newspaper clippings.

Q: What prompted LTA to study the smartcard systems in other countries and why did LTA choose the smartcard systems in those countries?

Sources of data: Interview LTA's key personnel, National Library archives, direct observation, other countries' Web sites.

Sample strategies: (1) Extract information from the interviews (e.g., Are there any other smartcard systems in other countries that were not studied? Why were these smartcard systems not being studied?). (2) Extract information from formal studies/evaluations and newspaper clippings. (3) Tabulate the smartcard systems studied (and not studied) and the usage of the smartcards in those countries. (4) Observe the interviewees' reactions.

Q: What are the features implemented in the smartcard system that are similar to or different from the smartcard systems studied?

Sources of data: Interview key personnel from LTA, National Library archives, other countries' Web sites.

Sample strategies: (1) Extract information from the interviews (e.g., How are the systems studied similar to the smartcard system? What are the adjustments made to smartcard systems?). (2) Extract information from formal studies/evaluations and newspaper clippings. (3) Tabulate the similarities and differences.

Comparison Between Magnetic Farecard System and Smartcard System

Q: What are the pros and cons of the magnetic card system and the smartcard system?

Sources of data: National Library archives, interview key personnel from LTA and PTOs, LTA's internal documents.

Sample strategies: (1) Extract information from formal studies/evaluations, newspaper clippings, LTA's internal documents, and interviews. (2) Draw a table to compare the pros and cons.

Implementation of the Smartcard System in Singapore

Q: What were the phases of the smartcard system implementation?

Sources of data: Interview key personnel from LTA, National Library archives, direct observation.

Sample strategies: (1) Extract information from formal studies/evaluations, newspaper clippings, and interviews. (2) Observe the interviewees' reactions. (3) List the implementation phases and the reasons behind the division of the phases.

Q: How did LTA persuade PTOs to accept the change?

Sources of data: Interview key personnel from LTA and PTOs, National Library archives, direct observation.

Sample strategies: (1) Extract information from the interviews (e.g., Was there any resistance toward the change? Why was there resistance (if any)? What did LTA do to minimize resistance? What made PTOs accept the change?). (2) Extract information from formal studies/evaluations and newspaper clippings. (3) Observe the interviewees' reactions.

Q: What was the IT/business strategy used by LTA to implement the change?

Sources of data: Interview key personnel from LTA and PTOs, National Library archives.

Sample strategies: (1) Extract information from the interviews (e.g., Why did they use that strategy instead of others? Did they achieve the aim after using the strategy?). (2) Extract information from formal studies/evaluations and newspaper clippings.

Q: What was the public's reaction to the change?

Sources of data: National Library archives, survey randomly selected commuters, interview bus drivers, direct observation.

Sample strategies: (1) Extract information from formal studies/evaluations, newspaper clippings, survey results, and interviews. (2) Observe the interviewees' reactions.

Q: What were the feedback and improvements done during the trials of using the smartcard?

Sources of data: National Library archives, interview key personnel from LTA and PTOs, including the bus drivers.

Sample strategies: (1) Extract information from formal studies/evaluations and newspaper clippings. (2) Extract information from the interviews (e.g., How many people were involved in the trial? Who were the targeted group of trial users? How were they selected? How long were the trials? What feedback was gathered during the trials? What were the improvements done to the smartcard system during the trials?).

Q: What are the software and hardware of the smartcard system?

Sources of data: National Library archives, interview key personnel from LTA and PTOs.

Sample strategies: (1) Extract information from formal studies/evaluations and newspaper clippings. (2) Extract information from the interviews (e.g., Can any hardware/software of the magnetic farecard be reused?). (3) Draw a diagram showing the interaction among organizations involved in smartcard distribution and fare collection.

Q: What were the changes within the PTOs?

Sources of data: Interview PTOs' key personnel, including the bus drivers, direct observation.

Sample strategies: (1) Extract information from the interviews and tabulate the order of the changes made, and who made the changes. (2) Observe the interviewees' reactions.

Q: How did LTA coordinate the changes?

Sources of data: Interview LTA key personnel, National Library archives, LTA's internal documents, direct observation.

Sample strategies: (1) Extract information from formal studies/evaluations, newspaper clippings, LTA's internal documents, and interviews. (2) Observe the interviewees' reactions.

Q: What difficulties did LTA encounter when managing the smartcard system implementation?

Sources of data: Interview key personnel from LTA and PTOs, National Library archives, direct observation.

Sample strategies: (1) Extract information from formal studies/evaluations, newspaper clippings, and interviews. (2) Observe the interviewees' reactions.

Q: Why did LTA set up Ez-Link to handle the smartcard transactions, why didn't LTA appoint Transitlink?

Sources of data: Interview key personnel from LTA, direct observation.

Sample strategies: (1) Extract information from the interviews. (2) Observe the interviewees' reactions.

Q: What were the changes in the interactions between LTA, PTOs, and the public?

Sources of data: Interview key personnel from LTA and PTOs, National Library archives, direct observation.

Sample strategies: (1) Extract information from formal studies/evaluations, newspaper clippings, and interviews. (2) Observe the interviewees' reactions. (3) Draw the interaction diagram in the purchasing, usage, and reimbursement of the smartcard. (4) Ask LTA's key personnel whether the diagram is correct.

Improvements Made to the Smartcard System in Singapore

Q: What are the improvements that have been made to the smartcard system in Singapore?

Sources of data: Interview key personnel from LTA and PTOs, National Library archives.

Sample strategies: Extract information from formal studies/evaluations, newspaper clippings, and interviews.

Q: What is the public's feedback about the smartcard system?

Sources of data: National Library archives, survey randomly selected commuters, direct observation.

Sample strategies: (1) Extract information from formal studies/evaluations, newspaper clippings, and survey results. (2) Observe the respondents' reactions.

Q: Are there other ways to improve the current smartcard system?

Sources of data: National Library archives, survey randomly selected commuters.

Sample strategies: Extract information from formal studies/evaluations, newspaper clippings, and survey results.

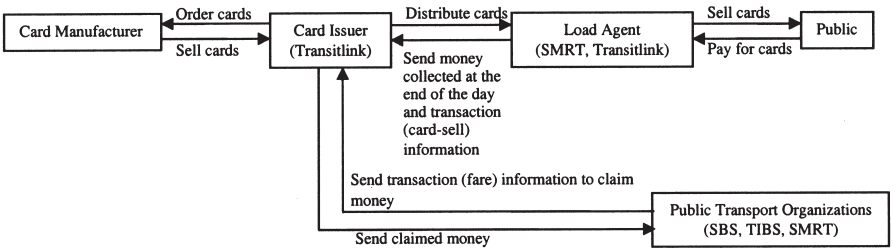
Appendix B: Survey Results ($N = 296$)

	Frequency (percent)	
Respondents' characteristics		
Sex		
Male	175	(59.12)
Female	121	(40.87)
Highest education obtained		
Primary school	3	(1.01)
Secondary school	8	(2.7)
Junior college	129	(43.58)
Polytechnic	26	(8.78)
University	125	(42.22)
Others	5	(1.68)
Age		
10–20	74	(25)
21–30	218	(73.64)
31–40	2	(0.67)
41–50	2	(0.67)
IT skills		
Basic	117	(39.52)
Very good	158	(53.37)
Extremely good	21	(7.09)
Survey items		
Involved in pilot scheme?		
No	279	(94.25)
Yes	17	(5.74)
Differences between pilot and actual?		
Able to exit at the entrance	9	(52.94)
More functions	6	(35.29)
Others	2	(11.76)
How did you learn to use the smartcard? (You can check more than one)		
Through TV commercials	120	
Through newspapers advertisements	47	
Through observation	215	
By visiting Transitlink Web site	4	
By visiting the Web site of Ez-Link	6	
Someone taught me how to use	53	
Others	16	
Have you used a fare system that is similar to the smartcard system before?		
Yes	42	(14.18)
No	254	(85.81)

(continues)

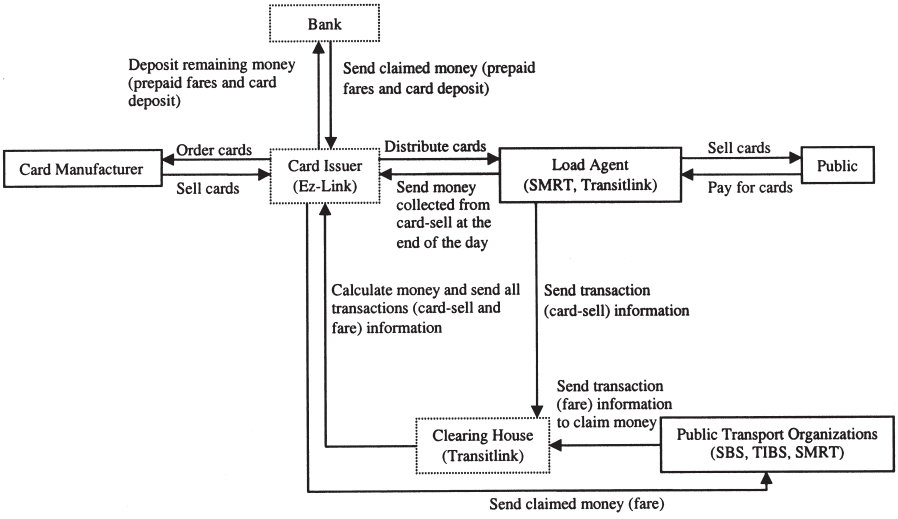
Survey items	Frequency (percent)	
How easy is it to learn to use the smartcard?		
Extremely easy	233	(78.71)
Easy	62	(20.94)
Difficult	1	(0.33)
How often do you use the smartcard?		
Every day	183	(61.82)
More than once a week	78	(26.35)
About once a week	22	(7.43)
About once a month	5	(1.68)
Rarely	8	(2.7)
Is it easy to top-up your smartcard?		
Extremely easy	102	(34.45)
Easy	175	(59.12)
Difficult	18	(6.08)
Extremely difficult	1	(0.33)
What do you like about the smartcard system? (You can check more than one)		
Ease of use	237	
Ease of topping up	121	
Convenient	207	
Cheap	13	
Others	6	
None	20	
What do you dislike about the smartcard system? (You can check more than one)		
More expensive (more deposit)	159	
Incorrect deduction of fare	71	
Must tap card before alighting from bus	142	
Others	35	
None	57	
Do you find that the smartcard is easier to use as compared to the magnetic farecard?		
Yes	156	(61.17)
No	24	(9.41)
The same	75	(29.41)
In your experience, the transition from the magnetic farecard to the smartcard was		
Extremely problematic	9	(3.52)
Problematic	39	(15.29)
Fairly problematic	94	(36.86)
Without problems	113	(44.31)
Were you ready to switch over to the smartcard during the transition?		
Yes	174	(68.23)
No	40	(15.68)
Not sure	41	(16.07)

Appendix C: Interaction Diagram for Magnetic Farecard System



Source: Developed based on interviews and documentation.
Notes: SBS = Singapore Bus Service; TIBS = Trans-Island Bus Services; SMRT = Singapore Mass Rapid Transit

Appendix D: Interaction Diagram for Smartcard (Ez-Link) System



Source: Developed based on interviews and documentation.
Notes: SBS = Singapore Bus Service; TIBS = Trans-Island Bus Services; SMRT = Singapore Mass Rapid Transit.