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AN APPROACH TOWARDS THE INTEGRATION OF BUS INFORMATION SYSTEMS IN VIETNAM

Case study: Ho Chi Minh City Bus Information System project

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ABSTRACT

The bus information system in Vietnam is evolving, and it is therefore necessary to develop a robust and sustainable integrated bus information system. More and more people are using buses for transportation everyday all over the world. There is growing need for an integrated bus information system. Information system integration (ISI) is not a new concept, and has been well documented and developed. However, developing an integrated bus information system is still a question. Such a system has its own characteristics which influence the integration process.

The thesis aims to understand uncertainties related to ISI contribute to the success of a bus information system integration. An integrated bus information system helps to enhance the productivity and efficiency of the system; however, it is also a solution which contains many challenges. The authors of the thesis discuss the integration of a bus information system in Vietnam by analyzing the integrated bus information system in Ho Chi Minh City.

The thesis presents a deductive study in which data is collected from available books and articles. In addition, interviews were conducted with some of the stakeholders of Ho Chi Minh City's bus information system project in order to gain an overview of the integration of a bus information system integration and its characteristics and challenges. Finally, data collected through participant observation and non-participant observation was analyzed and divided according to particular criteria to support the authors in making a final conclusion. The results reveal how a bus information system is implemented in the Ho Chi Minh Bus Information System Project. However, due to the limitations of this study, further research is needed.

Keywords: Bus information system, integration, Ho Chi Minh City, FPT, integrated bus information system, integration implementing process, Vietnam, information system

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LIST OF ABBREVIATIONS

BIS	Bus information system
BISI	Bus information system integration
BMS	Bus management software
CITC	Center for Information Technology and Communications Ho Chi Minh City
HCM	Ho Chi Minh City
ISI	Information system integration
IT	Information Technology
MOCPT	Management and Operations Centre for Public Transport
MOT	Ministry of Transport
PC	Personal computer
TIMD	Transport and Industry Management Department
TUPWS	Transport and Urban Public Works Services
VN	Vietnam

1 INTRODUCTION

This chapter introduces the thesis topic and the authors' motivation and purpose for writing the thesis. In the first part of this chapter, a thesis background is proposed to give readers a general understanding of the thesis topic. Next, the case study is introduced. In addition, the environment in which the business operates is described in the business context part of this chapter. After that, the specific objectives and research questions are introduced based on the authors' motivation, the thesis background and the business context. Finally, a detailed table is presented to illustrate the structure of the thesis.

1.1 Thesis background

Information System Integration (ISI) is an innovative adoption intended to complement a legacy system by combining it with other components, which are usually information technology (IT) components. ISI is becoming a critical part of many system revolution projects. In this technology, Vietnam is a follower as the adoption of such technology is still at the very early stage. In European or American countries, the integration is no longer a new process and it has taken place at a higher level. The integration of IT systems in Vietnam could be similar. However, the country's economic situation, cultural differences and many other factors can greatly contribute to the adoption.

Due to the advances in information technology (IT), information system integration (ISI) has become a noticeable topic. When computer systems were still relatively simple, there was no real need for integration, and legacy systems seemed to handle all the necessary tasks. However, when IT has become more powerful, it has also become the heart of integration projects and plays a critical role in the success and failure of integration. Correspondingly, the demand for using information systems for integration is significantly escalating. For instance, this applies to information systems applications (e.g., centralized database management systems, electronic data interchange (EDI), information system infrastructure (e.g., data communication tools, network connection, standard data structure, and unified coding standards), information systems software (e.g.,

enterprise-wide information system such as SAP), and web-based or internet-based information systems (Thawatchai Jitpaiboon, 2005, 2). A combination of the transformation in organizational structures and working format has boosted the amount of information. Moreover, information technology has greatly contributed in creating new types of data and information (e.g., electronic record, barcode). In Vietnam BIS, paperbound documents are still used frequently to record passenger information, bus route information, bus schedules and so on. However, the more complex the system becomes, the more problematic the paperbound system is. As other systems, BIS is evolving and the need for integration is significant.

Even though the topic of ISI is well documented, most of the studies have been made from a functional perspective. Research about ISI in bus systems is limited, and in Vietnam no research-based support is found to determine the challenges and characteristics of BISI. It is also difficult to find well-written documents or articles on bus systems.

In Vietnam, the bus information system is old and extensive. Replacing it is not easy, and the cost for replacing the system would be unexpectedly high. It is unrealistic to replace the system with a single new one, because the development of a system of this size is massive and complicated. Keeping the old system and integrating it with new components would be a more reasonable choice.

The current bus information system, however, has characteristics that would greatly influence the integration process. Notwithstanding the wide adoption of information system integration, Vietnamese bus companies appear to not yet fully exploit the power of integration or completely understand the challenges that follow the benefits provided by ISI. Information system integration can be a serious challenge, particularly if information exists in such a heterogeneous environment as in this case. Nowadays, instead of batch integration, many information systems need real-time integration, which changes and upgrades the information in real time when the business is running. For example, an information system at a hospital needs to work real time, since people's health is priority. It is obviously unappropriated to ask a patient to wait for updating the

system, for instance, to get his/her blood test results. The bus information system is also similar because the service needs to run daily to serve a large number of people. Therefore, instead of a single run, (information) updates have to be constant.

1.2 Business contexts

Because of the rapid development of public transportation in Vietnam, more and more people are using buses daily. As a result, bus routes will adapt according to passengers' demands. According to the statistics of Ho Chi Minh City People's Committee (Nov 2010), bus ridership in HCMC has grown significantly since 2003. The ridership has increased from 130,000 passengers per day in March 2003 with 42 bus lines to 605,000 passengers per day in 2006 with bus 110 lines. This has resulted from the development of a subsidized public transportation network in HCMC. The daily ridership was estimated to be around 675,000 passengers in July 2007.

The result shows a significant change in passengers' awareness and passengers' trust in the bus system. However, this change leads to complexity and disorganization that confuse both drivers and passengers. The existing system becomes outdated and cannot handle people's requirements productively and efficiently. Despite the efforts of the Vietnamese government to change the present situation, such as improving the bus system and increasing bus network patronage, the bus information system is still below the required standards.

Recent studies have claimed that HCMC will suffer from heavy traffic congestion, traffic accidents and air pollution problems similar to other big Asian cities such as Beijing, Jakarta and Manila if the current concentrations are not offset by improving transport infrastructure and public transport systems. Vietnamese authorities decided to carry on an extensive project with the purpose of raising the share of public transport to cover 25% of all daily motorized trips by 2010 and 50% by 2020. In this project, system integration is considered as an innovative solution to effectively adapt to the change in the public transport environment.

In addition to giving many advantages to organizations, integration includes challenges. That is, integrating an existing system infrastructure often presents many technical challenges. Integration may result in a largely incompatible and inconsistent information system, and there may occur serious conflicts between the old and the new system. Moreover, integration requires substantial changes in organizational structures and business processes which may be potentially negative without accurate attention from the organization. This means that to fully get the advantages of ISI and accurately evaluate its challenges, it is necessary to consider the integration process from various perspectives. Even though ISI's usefulness and the nature of the implementation process are well documented in many areas, for instance in health-care and parking systems, integration in relation to bus information systems is not well developed. The bus information system in Vietnam has its own characteristics that need a thorough research. Determining the bus information system characteristics that influence integration may help to evaluate the results more accurately.

The Ho Chi Minh City Bus Information System Project (the BIS project) started three years ago, and it is now at its final stage of implementation. The BIS project is the first one in a big campaign whose purpose is to change and improve the public transportation services in urban areas in Vietnam. Therefore, this project's success is critical as it is a pioneer that contributes necessary resources to support and improve the following projects. In other words, the project creates standardization for the adoption and efficient usage of technology.

1.3 Research objective and research problem

Despite the advantages of ISI, there are still many obstacles and challenges that cause uncertainties influencing the implementation process. When the adoption of ISI technology to BIS is still at its first stage, the importance of identifying these uncertainties is significant to develop Vietnamese bus information system integration in the future.

The research problem is as follows: ***What are the uncertainties influencing bus information system integration in Vietnam?*** The research problem is solved by answering research questions in Chapter 4.

The objective of this thesis is to present an overview of the bus information system integration in Vietnam by determining the nature of Vietnamese BISI. The thesis focuses on ISI challenges and the characteristics of the bus system integration in Vietnam.

The research results contribute to the interests of FPT Solution (the company conducting the BIS project) and the Management and Operations Centre for Public Transport (MOCPT).

1.4 Practical and theoretical relevance

From the practical point of view, this study contributes to the approach towards technology adoption with regard to information system integration. This can create a better understanding of the bus information system in Vietnam and encourage system integration in this area.

From the theoretical point of view, the study contributes to the existing literature on information system integration in Vietnam. On the national level, research on the characteristics of bus information systems and their integration does not exist. Even though there are several studies about bus information systems in Vietnam, there is no substantial research on bus information system integration.

1.5 Structure of the thesis

The thesis is divided into seven chapters. This section finalizes the first chapter (Introduction), which introduces the authors' motivation, the thesis background, the business context, the research objective, the research problem and the practical and theoretical relevancy of the thesis.

The following chapter introduces related literature and a literature review of studies on ISI and BIS in Vietnam. In addition, the main concepts and keywords

of the study are discussed in order to narrow down the topic of the study. Finally, based on the literature review, the main research questions are introduced here.

Chapter 3 presents the theoretical framework after listing existing research frameworks. This is needed in order to ensure the theoretical framework derives and progresses from the prior frameworks.

In Chapter 4, the main research problem is narrowed down to three separate research questions. In addition, this chapter discusses the validity and reliability of this study and introduces the research method.

Chapter 5 outlines the case study, the Ho Chi Minh Bus Information System project. This chapter also discusses the current situation of bus systems in Vietnam and the integration of BIS.

Chapter 6 describes the interviews and how data was acquired and also presents research results. The results are divided into two parts. The first part presents the integration characteristics of the bus information system in Vietnam. In addition, the technological, organizational and environmental aspects are explained. The second part introduces the challenges of ISI by applying the above-mentioned three aspects.

Finally, Chapter 7 presents a conclusion, introduces the research results and answers the research question. Suggestions for further research are also discussed here.

The following table introduces how the thesis is organized

<i>Chapter</i>	<i>Content</i>
<i>Introduction</i>	An introduction of the thesis contents including the thesis background, the business context, research problems, research questions and research objectives is presented
<i>Literature Review</i>	This chapter demonstrates the current knowledge related to the topic (definition, types and levels of

	information system integration; a definition of the integrated information system; Vietnamese bus system in literature review)
<i>Development of a theoretical framework</i>	This chapter presents the existing frameworks found in the literature review and the framework the authors developed based on the advantages of these existing frameworks.
<i>Research Methodology</i>	The purpose of this chapter is to provide readers with information about the methods used to approach the topic, and how data was collected and analyzed
<i>Case study: HO CHI MINH Bus information system project</i>	The case study about Ho Chi Minh city Bus Information System project is described here. This chapter includes the project background, the present situation of Vietnamese bus systems and an overview of the integration of a bus information system.
<i>Case analysis</i>	Using a data analysis method, the analysis of the case study is presented here.
<i>Conclusion</i>	The results of the study and suggestions for further research are discussed here

TABLE 1. Structure of the thesis

2 LITERATURE REVIEW

This chapter reviews the literature regarding information system integration and bus information systems in Vietnam. First, a general understanding about information system integration is presented, including a definition of information system integration and integrated information system, types and levels of information system integration. Secondly, literature review related to Vietnamese bus information systems is explained to have an overview of the bus systems' characteristics.

2.1 The methods of literature review

In order to conduct a literature review regarding the topic of ISI and BIS in Vietnam, the authors adopted Webster and Watson's (2002) recommendations. Accordingly, the literature review is conducted according to the following steps:

1. Keywords search.

The keywords for this study include the following: information system integration, integrated information systems, system integration, and bus information system. Because the study is about Vietnamese bus systems, the above keywords are also searched in Vietnamese using the database of Vietnamese universities.

2. Review of relevant journals.

3. Review of relevant conferences.

4. Identification of publications citing the key publications.

2.2 Information system integration

2.2.1 Definition of Information system integration (ISI)

Information system integration is not a new concept. The topic has been studied for a long time in Europe and the US. However, in Vietnam studying ISI is still in its early stages.

The meaning of ISI varies, and the definition of ISI has not been uniformly acknowledged (Nurul, 2010). At the beginning, studies about ISI mostly focused on business areas such as supply chain, business performance, and business readiness. Over the years, the meanings of ISI have evolved together with the development of technologies. ISI has expanded to other areas such as electronic business, electronic government or healthcare systems. ISI can sometimes be called by different terms such as Enterprise System Integration, Data integration, System Integration, Organizational Integration and Electronic Integration. However, no matter how many kinds of integration there exist, the basis is the exchange of data between two or more information systems (Vernadat, 1996, 83).

To help the readers of the thesis to have an overview of ISI, the authors list down several definitions of ISI, starting from the study of Mudie and Schafer (1985). They stated that ISI is process-oriented. ISI does not only function by smoothening and assisting the technology process (e.g. developing information systems application, data usages, and developing information system software), but also provides a given system adaptability to meet the business demand. Venkatraman (1991), however, sees ISI as a strategic level, in which businesses' activities are automated and business processes are reshaped and improved.

In early studies, ISI was confined to a technical and operations task - a part of the wider area of engineering. For example, Wyse and Higgins (1993) divided ISI into two types: data integration and technical integration which stops at the engineering level. Today, ISI is a strategic task which refers not only to the engineering level but also management level (Hobday, Prencipe & Davies, 2002, 1). According to Bhatt (2000, 2005), ISI refers to data integration, and communication network integration which included networks connectivity and communication network flexibility. He stated that data integration refers to data standard to support the need for sharing databases among departments in the organization or many organizations. Communication network connectivity refers to local area network (LAN) and wide area network (WAN) to support data integration while communication network flexibility refers to the utilization of standard and protocols. Through communication network connectivity and flexibility, different systems can communicate with each other. Bhatt studied the

effects of ISI on business process improvement and the relationship between ISI and business process improvement. Myerson (2002) argued that system integration means more than just a technology. System integration cannot be solely defined in terms of technology, but it also involves a complete system of business processes, managerial practices, organizational interactions and structural alignments, and knowledge management.

When ISI is used widely, the term “integrated information systems” is also used more and more regularly. The concept of **integrated information systems (IISs)** is defined as follows:

An expansion of a basic information system achieved through system design of an improved or broader capability by functionally or technically relating two or more information systems, or by incorporating a portion of the functional or technical elements of one information system into another.

(McGraw-Hill Dictionary of Scientific & Technical Terms 2003)

According to Marcus (2009), IISs was defined as computer based systems for information processing. In such system, contents are semi-automatically organized and displayed on integrative screen. IISs normally *include* computers. These computers can be smartphones or embed products/services inside other systems. These systems are described in the list below:

- Vehicle systems (bus, car, train...)
- Software (application and operation system)
- Database
- Telecommunication network

2.2.2 Types and levels of ISI

In this part, the authors describe certain types of information system integration that they have found in related literatures. Traditionally, concerns of ISI were

confined as functional integration, data integration or processing integration. Nowadays, the advances of new technologies have led new forms of ISI.

Communication network integration

Communication network integration is marked by “transmitting information around the globe in structured data, text, visual forms or audio format, via flexible standards including satellites, cable or fibers” (J. Yates and R. I. Benjamin, 1991, 61-69). Communication network integration brings back to the company great benefits such as reduced expenses, enhanced competitiveness, improved administration quality and productivity by strengthening the organization’s inner-relations (Bhatt, 2000).

Data integration

This type of integration is characterized by the data consistency in both technical and business processes. In data integration, data from various forms are combined into a valuable one, which is then shared within an organization. (Bhatt, 2000). For both communication network integration and data integration, standardization plays a significant role for the success and failure of the integration process.

Meredith and Hill (1990) have introduced a four-level taxonomy of integration (Grant & Tu, 1990). The four levels of integration can be seen in Figure 1 below:

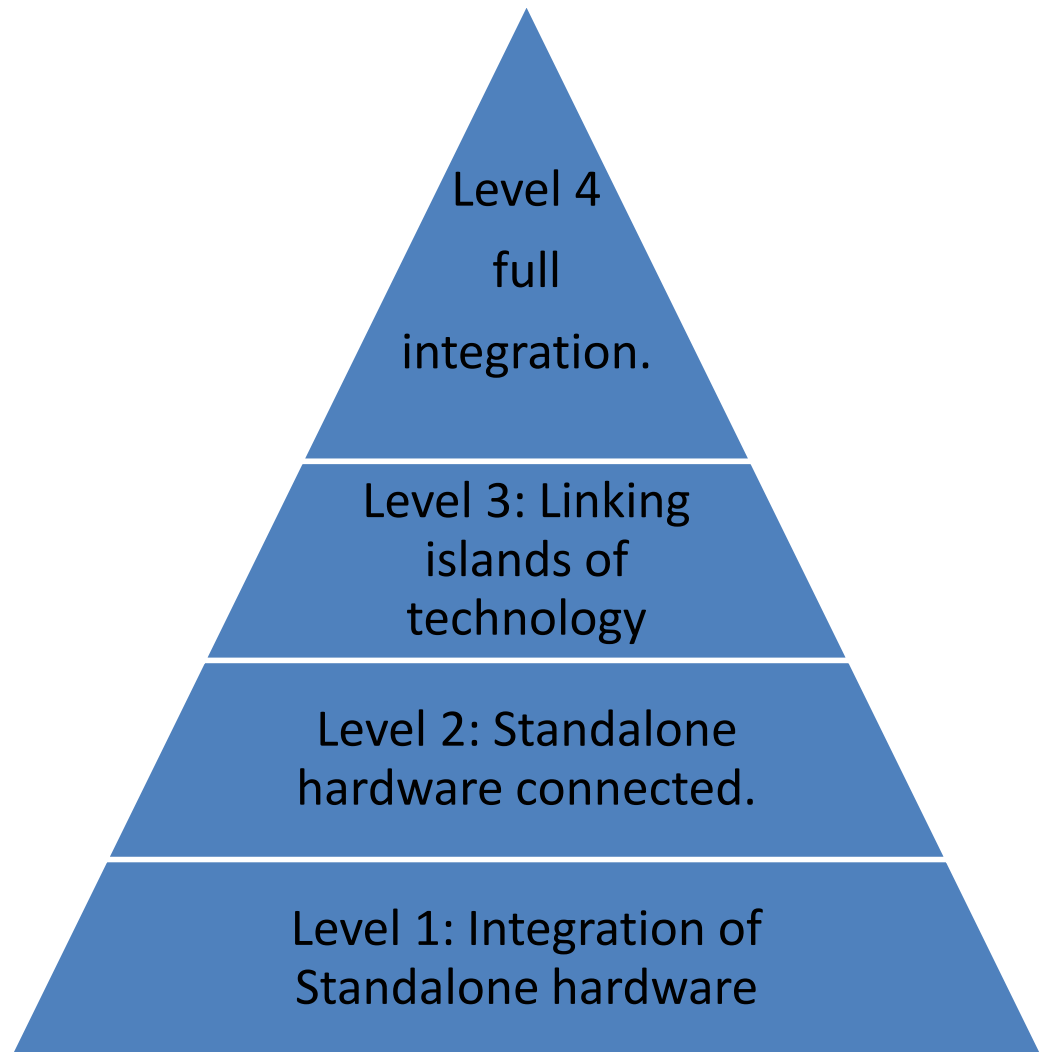


FIGURE 1. Four-level taxonomy of integration (modified from Meredith and Hill, 1990)

However, this taxonomy has limitations when setting its boundaries within manufacturing system. The taxonomy ignores the fact that an integration process may extend to the larger scale and is affected by other social-external factors.

Later, in 2007, Grant and Tu proposed a list of integration levels which can be considered as fuller and more up-to-date. According to them, there are six levels of information system integration. Each level of integration relates to several specific types of integration.

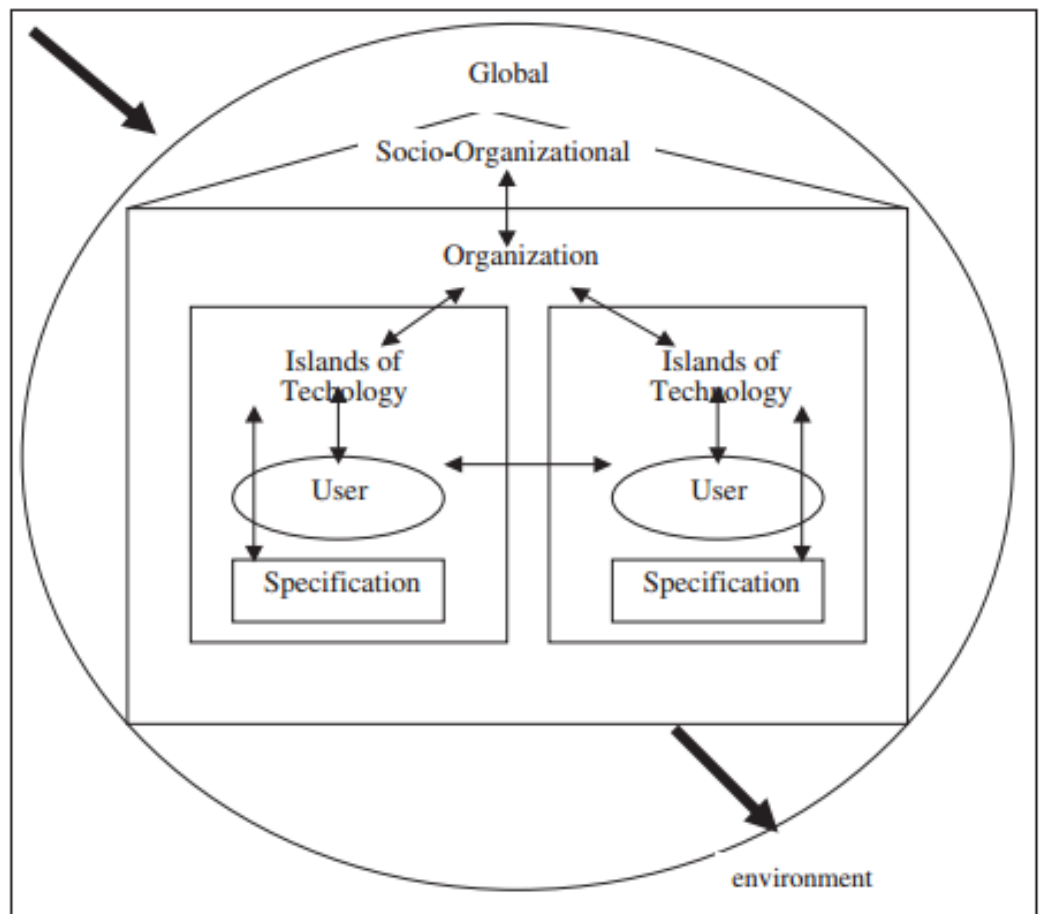


FIGURE 2. Six levels of ERP integration (Grant & Tu, 2005, 318)

Level I: System-specification integration

This is the lowest level of integration. The systems are integrated about compatibility and specification in a stand-alone basis. This level is also the foundation for higher levels of integration. There are two type of integration involving this level: *compatibility integration* and *specification integration*.

In compatibility integration, the implementation has to satisfy the level of compatibility between different system components. Human resources play an integral role in compatibility integration (Besen & Saloner, 1994).

Specification integration, on the other hand, is related to providing the specifications or configuration of the system at the hardware, software, and application level.

Level II: System-user integration

At this level, the integration is marked by the integration of users with environment and technology. The integration creates communication of information system and users and user-friendly environment by using Graphical user interface, software, hardware. This level is characterized by *ergonomic integration*, which has similar functions. *Vertical integration* is also a type of integration relating to this level. Vertical integration is considered as a method of integration in which subsystems are integrated in relation to their functions and are controlled by a single functional entity (Lau and Edwin, 2005, 52)

Level III: Islands of technology integration

At this level, the integration refers to the process of sharing information between islands of technology. Islands of technology are connected geographically throughout the firm at this level. This level is specified by two types of integration: vertical integration and horizontal integration.

Horizontal integration is opposed to vertical integration. Horizontal integration is “evident in manufacturing function and coordination amongst them” (Bullers and Reid, 1990, 56-67). So that, horizontal integration deals with how data is transmitted among islands of technology and also their cooperation, management, administration.

Level IV: Organization integration

Organizational integration is the integration carried on in the entire company rather than integration in only technology and specification. Organization integration is characterized by value chain integration regarding various functions across the value chain. Organization integration involves four types of integration: internal vertical integration, internal horizontal integration, internal temporal integration and strategic integration. *Internal integration* is considered as integration takes place within the boundaries of organization.

Strategic integration: In this integration, the integration process is viewed as business perspective in which the integrated information systems has to support overall strategic goals of the organization. (Grant & Tu, 2007.)

Internal temporal integration refers to ability to using historical data for facilitating future planning process. The integration help in evaluating the existing coordination within functions, departments... in terms of effectiveness (Grant & Tu, 2007.)

Level V: Socio-organizational integration

This integration level encompasses the company with other social-external environment such as strategic partners, civic institutions or government. It involves four types of integration: external horizontal, external vertical, external temporal and shared-vision integration. *External integration* is considered as integration takes place outside the boundaries of organization such as integration with other systems, other industry partners. *Shared-vision integration* refers to the sharing of visions among business partners (Grant & Tu, 2007.)

Level VI: Global integration

This is the highest level of integration where integration is conducted across the national and cultural boundaries. At this level, the integration has to concern various matters such as differences in language, time, culture, management style, political problems. It is related to three types of integrations: internal horizontal, internal temporal and cultural integration.

Cultural integration requires an adequate understanding in culture differences that affects the implementation.

Types of integration at each of 6 levels

Each level of integration related to several specific types of integration. The table below showed specific types of integration at each 6 level.

Levels of Integration	Types of integration

Global integration	Internal horizontal Internal temporal Cultural
Socio-organizational integration	External horizontal External vertical External temporal Shared-vision
Organization integration	Internal vertical Internal horizontal Internal temporal Strategic
Islands of technology integration	Horizontal Vertical
System-user integration	Ergonomic Vertical
System-specification integration	Specification Compatibility

TABLE 2. Types of integration at each of 6 levels (Grant & Tu, 2007, 318)

2.3 Literature review of Bus Information system in Vietnam

Even though there are not many studies about the bus information system in Vietnam and most of them generally focus on bus services, there are relevant literatures to the research topic.

Vo Trung Hung (2012) studied the demand for bus transit in Vietnam urban areas. The study shows that an increase in bus routes, bus services' quality and passenger safety lead to an increase in number of bus passengers. Vu Trung Hung suggested improving the bus information systems as a solution for current public transport situations.

Vu Hoai Nam and Ngo Thi Mi (2012) presented sequence procedures to select, calibrate and validate the variables to define service coverage for the bus transit in the context of Vietnamese urban areas. In their study, the authors claimed that one of the reasons for unqualified bus services is that the BIS in Vietnam is weak and below standard. In addition, they pointed out the need for integration in the future.

Le Van Trung (2012) studied only on the usage of GPS and GIS technology in bus system management in Ho Chi Minh City. In his study, Le presented the difficulties in finding appropriate solution for inefficiency problems of the Vietnamese BIS. Le Van Trung suggested GPS and GIS technology as a solution for real-time data integration and provide the availability of data sharing and automatic bus schedule management.

The recent study conducted by Nguyen Thai Son (2013) presents the quality of bus service and satisfaction of passengers and bus drivers in Hanoi, Vietnam. The study discusses solutions to enhance the service in term of resource management.

According to the above literature review, there are no studies regarding information system integration. The integration is only suggested as a solution for future project. Most of the studies focus on describing the bus system limitation, unsolved problems and solutions only in a single aspect of the system. (E.g. quality of bus service, bus technology, maintenance system).

Characteristics of bus information system in Vietnam in literature review

Heterogeneous environment:

In the last 35 years, the bus system network in Vietnam has been developed spontaneously. Le Van Trung (2012) presented that 57% current bus routes

overlap with each other because of the spontaneous development of the city bus networks. However, only 30% of the buses are used efficiently.

Uneven diffusion of technology and inequality in access to technologies constitute problems for improving the system. Many buses in the central of the cities use more advanced technology (e.g. GPS, GIS, Black boxes, e-ticket) while bus systems in suburban areas still lean on subjective information of operational staffs. As a result, the quality of bus services could not be fully monitored.

Moreover, in Vietnam, the wide of streets can fluctuate greatly between 5-12m. According to statistics of Ministry of Transport on 02/06/2011, there are 3315 street routes in Ho Chi Minh City with the length of 3200km; the average street wide is 9m. Only 14% of the streets have the width of 12m which is suitable for bus to travel, 51% have the width of 5-7m and 35% of them have the width of under 7m. This cause difficulties in expanding bus systems in Vietnam.

3 DEVELOPMENT OF A THEORETICAL FRAMEWORK

Two roads diverged in a wood, and I –

I took the one less traveled by,

And that has made all the difference.

Robert Frost, The Road not taken (1920)

In this chapter, existing frameworks with regard to innovation technology adoption and information system integration are discussed. The advantage of existing frameworks are used to develop the most suitable framework for the present study.

3.1 Existing framework

3.1.1 Composite Information System framework

In this study, to determine the challenge of ISI in meeting organizational effectiveness, the authors adopted Composite Information System (CIS) framework for strategic advances of Madnick & Wang (1988). This model helps to identify the characteristics of information system and organizational and technological obstacles. The framework help in articulating the strategic goals of organizations and identifying the relationship among strategic goals, technology obstacles and organization obstacles. A Composite Information System refers to as a system which integrates component systems reside inside or outside organization boundaries.

Madnick & Wang, 1988.

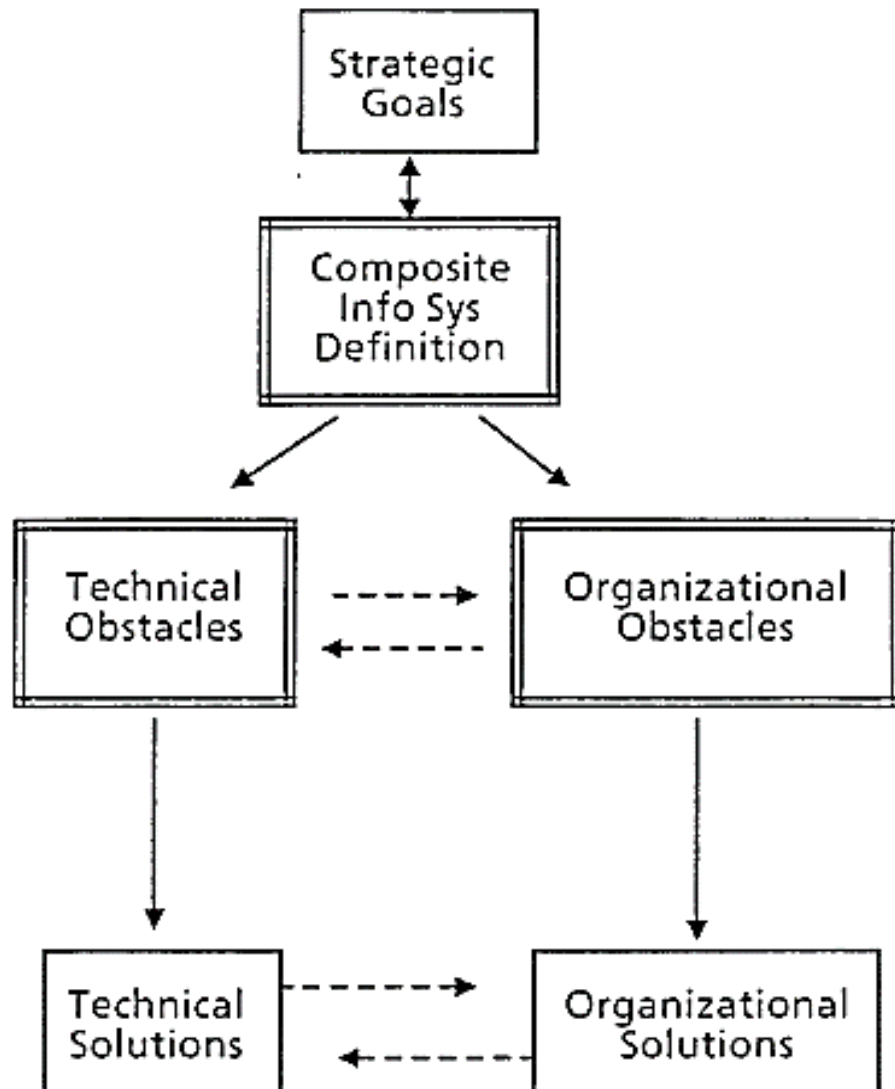


FIGURE 3. Composite Information System Framework (Madnick & Wang, 1988).

The difference between Composite Information System Framework and other frameworks discussed in this study is strategic goals are identified and are linked with technology and organizational factors. Recognizing the importance of strategic management helps to provide configurations for the design and use of CIS.

According to Madnick & Wang (1988), to identify the characteristics of the composite information system, it is necessary to have a good understanding in systems environment. The systems environment can be investigated by two main factors: directionality of constraints and system environmental factors

Directionality of constraints

The researcher presents that there are 3 types of system related to the constraints on development of CIS (historical, future imperfect and future perfect). The constraints are often considered as incompatibility among different operating systems, computer systems, database systems, data formats.

Historical (A): the information systems to be integrated already exist and in the near future there is no intention for the integrated systems to be changed.

Future Perfect (C): the information systems to be integrated do not yet exist or they are considered being replaceable.

Future Imperfect (B): in this category, some systems already exist, however, in the future, other systems will be developed. In this case, exist systems have got their own historical constraints. Before the new systems are developed, the future standards should be considerate because the new systems also imposed the new constraints as well.

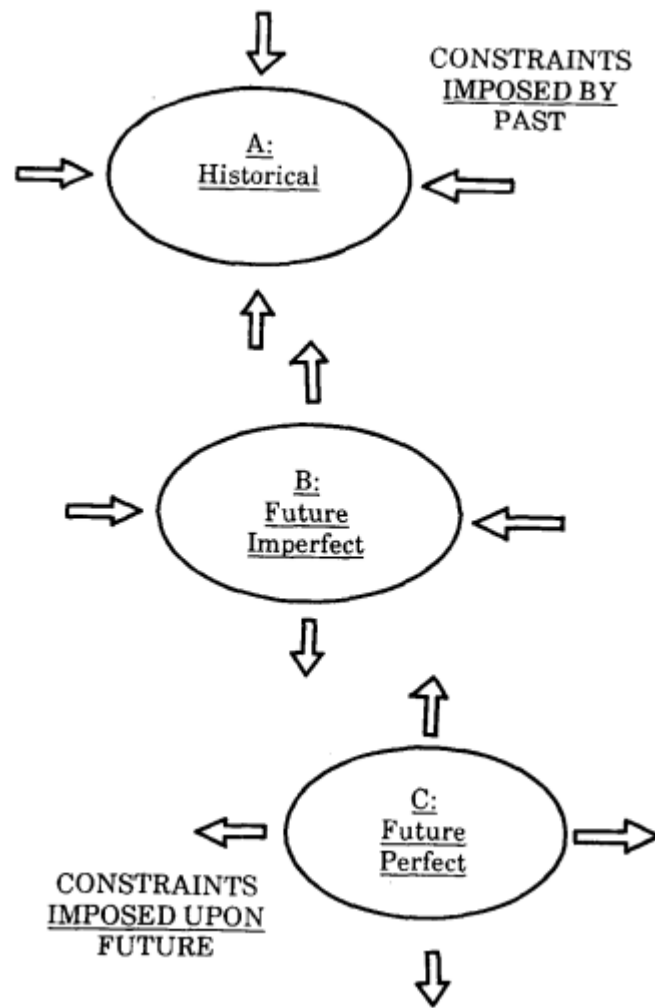


FIGURE 4. Directionality of Constraints in Composite Information Systems (Madnick & Wang, 1988).

Environmental Factors

The system environment is influenced by three factors: autonomy, integration, and evolution. The autonomy factor and integration factor are conflict with each other. The autonomy requires the systems to satisfy technology requirements, organization requirements and strategic requirements, which means that technology and other factors used in the systems are able to maximize each individual system's functions. Otherwise, integration factor may require harmony of all individual components/systems regarding standardization or interdependence. The final factor-evolution can influence the balance between

integration and autonomy factor. Evolution concerns the changing of systems in the future.

3.1.2 T.O.E Framework

Despite the advance of linking strategic goals with CIS environment, Composite Information System Framework does not include other external-social factors. Because bus information system integration is influenced by knowledge challenges and burdens and other social factors, the adoption cannot be explained with a generalized model of ISI.

The Technology-organization-environment framework (T.O.E framework) give a good basis to define which factors contributes to the technological innovation adoption (Tornatzky & Fleischer, 1990). The framework explained both intra- and inter-organizational factors. Besides technology and organizational aspects, the authors concern environment as one of factors contributing to technology innovative adoption. Technological aspect considers to both the existing technologies and new technologies that are relevant to the organization. Organizational aspect gives a description of the resources and characteristics of the organization such as:

- The organization's size
- Degree of centralization
- Degree of formalization
- Managerial structure
- Human resources
- Communication among employees.

Environmental aspect refers to the arena in which business is conducted (e.g. regulatory environment, society adaption) (Tornatzky and Fleischer, 1990.) In early studies, the T.O.E framework has contributed greatly in various studies about Information Systems (e.g., Iacovou et al., 1995; Chau and Tam, 1997; Thong, 1999). "As a generic theory of technology diffusion, the TOE framework can be used for studying different types of innovations" (Zhu et al. 2005).

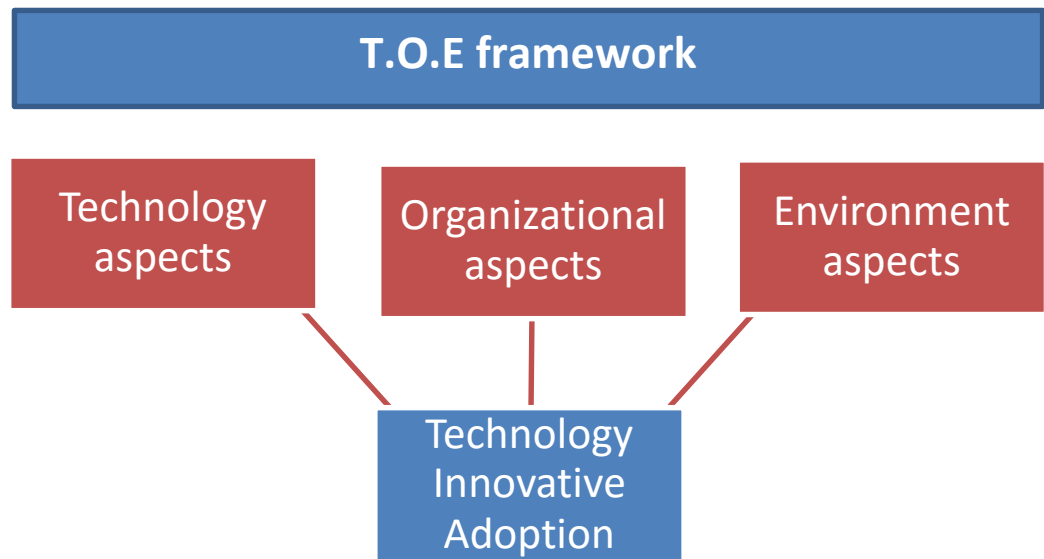


FIGURE 5. T.O.E. framework (Modified from Tornatzky & Fleischer, 1990)

3.2 Developing theoretical framework

While the existing frameworks could not be fully applied, in order to identify the uncertainties that influence to BISI in Vietnam, a theoretical framework needs to be developed by taking the advantages of the existing ones.

The Composite Information System framework looks at the integration process as a strategic perspectives but it only focuses on technical and organizational matters while bus information system integration is also affected by other external factors. The T.O.E framework adds an environmental element to help in analyzing the integration process. The T.O.E framework is consistent with the innovation diffusion theory of Rogers (1995), which concentrates on technological characteristics. Because of the overlap of diffusion research with technology innovation, in his research, Roger used the word “technology” and “innovation” as similar concept. According to Roger “a technology is a design for instrumental action that reduces the uncertainty in the cause-effect relationships involved in achieving a desired outcome” (Roger, 2005, 13). To investigate the characteristics of bus information system integration in technological aspect, the authors use the innovation diffusion theory of Rogers (1995). According to Roger, technological

aspect is investigated using five variables: relative advantage, compatibility, complexity, trialability and observability.

- Relative advantage refer to the degree to which the new technology solution is perceived as better the existing ones.
- Compatibility refer to the degree to which a technology solution is perceived as suitable for the present organization situation.
- Complexity refer to the degree to which a technology solution is easy or difficult to implement.
- Trialability refer to the degree to which a technology solution is experimented on previous trial.
- Observability refer to the degree to which the result of the technology solution is observable

Overview of the theoretical framework

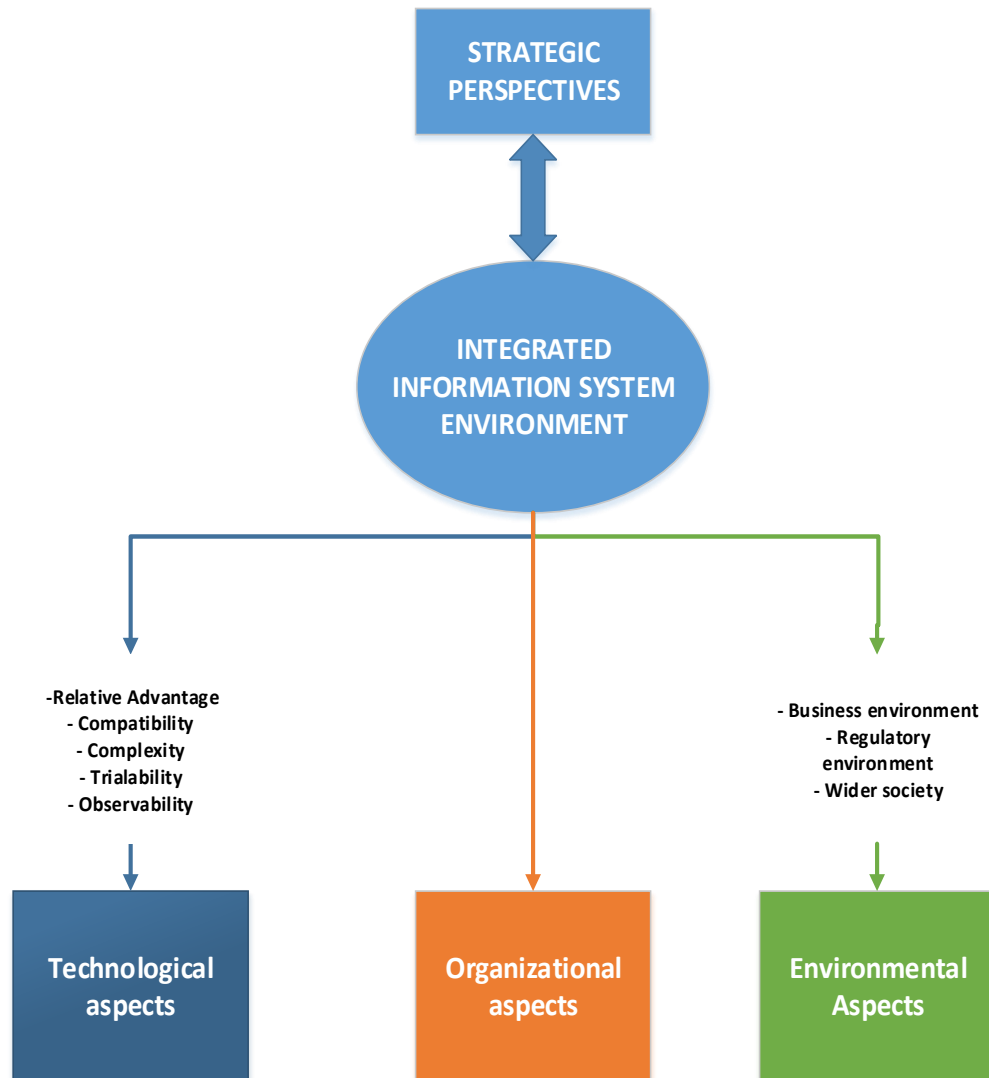


FIGURE 6. Theoretical framework of information system integration.

The theoretical framework provides a top down process in which the strategic goals are identified and are linked to organizational aspect, environmental aspect and technology aspect. The technology aspect is investigated using five variables: relative advantage, compatibility, complexity, trialability and observability (Roger, 1995). The organizational aspect are investigated by the characteristics and resources of the organization. The environment aspect is investigated by the arena in which business is conducted such as business environment, regulatory environment and wider society (Tornatzky & Fleischer.)

4 RESEARCH METHODOLOGY

This section describes the organization of the study, which is captured by three main components: literature review, case study and research problems. Additionally, the research method applied in this thesis is also described together with the study framework. In the next part, the authors mention about the data collection. Finally, research limitations and threats to external validity are presented.

4.1 Research questions

In order to investigate the research problems and achieve the research objective, two research questions have been formulated. The research questions are to be used to identify the main matters that should be taken into account when approaching the bus information system integration in Vietnam.

1. Which characteristics of Vietnamese BIS influence BISI?
2. What are the challenges of implementing BISI in Vietnam?

4.2 Organization of study

The three components: literature review, case study and research problems interact together during the whole research process. (Figure 1)

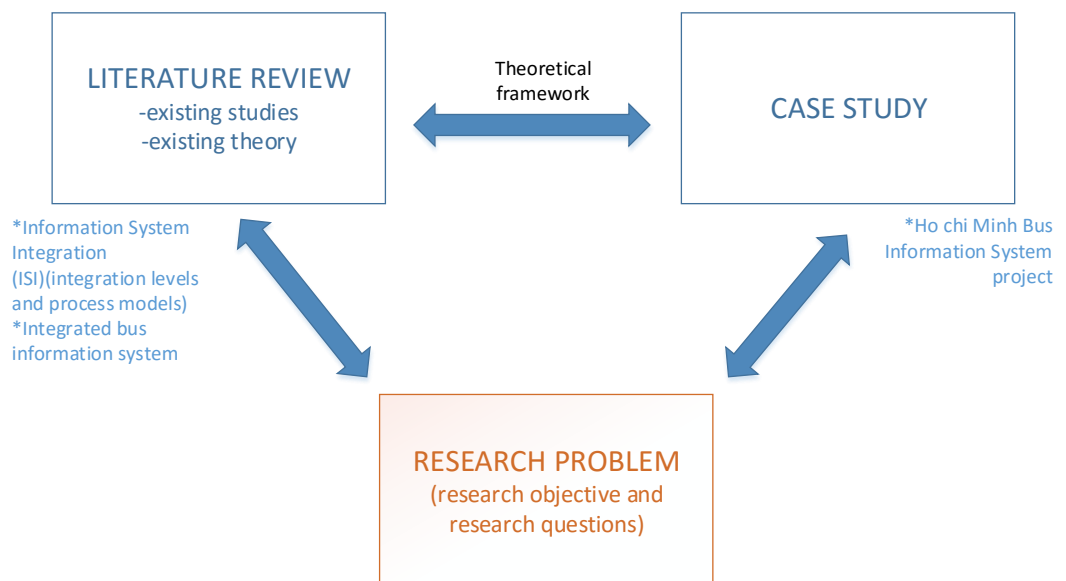


FIGURE 7. The research process

4.3 Research method

There are two research approaches: deductive and inductive. Inductive research is based on exploring the phenomenon, collecting data to form a concepts or theory. (Saunders et al. 2012.). For this study, the authors has no interest in developing new theory or concepts, so deductive research method which works from a more general matter to a more specific one is chosen. In deductive method, the arguments base on available theory or concepts studied through books or academic materials. (S. M. Aqil Burney; Nadeem Mahmood, 2006). Deductive method can be called a waterfall or a “top-down” method. (Figure 2)



FIGURE 8. Deductive research

In this thesis, the study started from information system integration definition and ISI theory to determine the nature of integration in bus information system. The authors developed an appropriate theoretical framework based on the existing frameworks found in literatures.

This thesis is conducted based on the qualitative research method. The authors choose this method because it allowed the authors to study the phenomenon as a specific object. Creswell (1998) defines qualitative research as

An inquiry process of understanding based on distinct methodological traditions of inquiry that explore a social or human problem. The author builds a complex, holistic picture, analyzes words, reports detailed views of informants, and conducts the study in a natural setting.

(Creswell, 1998, 15)

Descriptive case studies theory is used as part of an iterative process of data collection and analysis.

For this study, authors decided to use single case study as their case study strategy because the purpose of this study is to explore the specific factors of bus information systems in Vietnam. Single case is normally used for unique, critical and extreme case and multiple case study is used to compare relationships among cases.

4.4 Study framework

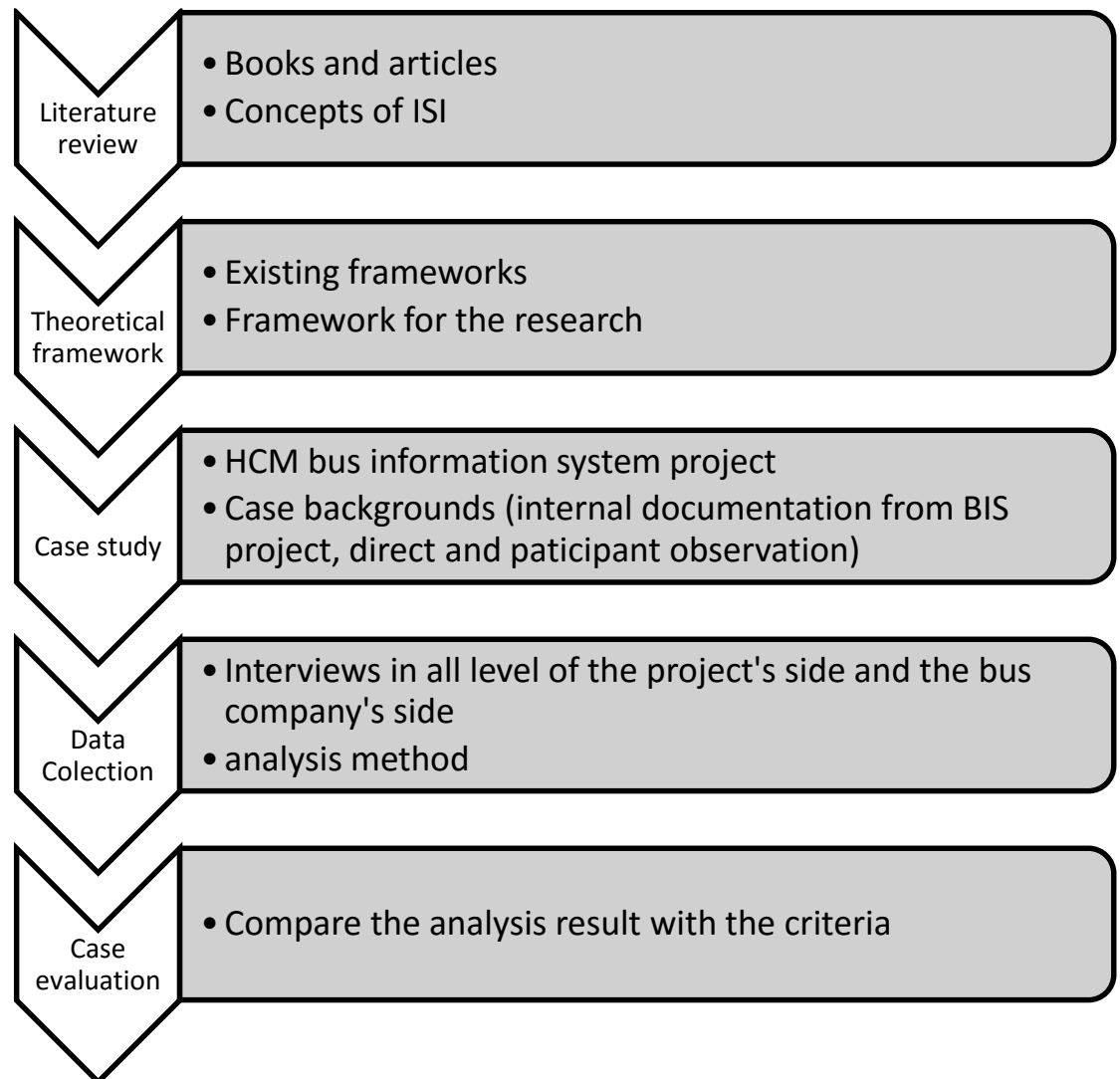


FIGURE 9. Study framework

The research framework comprises the concepts of information system integration which are presented in literature review part. The literature review is addressed after generated the information from available books and articles.

After that, using the understanding of literature review, the authors develop new theoretical framework as extend of existing ones. This framework is used as the main tool to answer research questions.

The research data is mainly collected through the case study by semi-structured and in-depth interviews, document collected using participant and non-participant

observation methods. After that, the data is analyzed and to make the final conclusion.

The conclusion will summary the thesis and answer the research questions. This is the outcome of the present study.

4.5 Data Collection

In this thesis, the authors focus on longitudinal nature of the study, so data have been collected during a long period of time. Actually, the case study project started 3 year ago (June 2012) and now the project team is implementing the project in its final stage (April 2015).

Data collection methods are mainly semi-structured interviews and in-depth interview, participant observation and non-participant observation.

For participant observation method, one of the authors became a member of the project group. The data that the author got is mostly related to strategic decisions, implementation barriers and technologies used in the integrated system.

For non-participant observation method, the authors collected written materials in form of technical notes, and magazine articles directly from managers of the project.

To address the research problem, semi-structured and in-depth interviews was conducted among all level of the project team and also from the representatives of the Management and Operations Centre for Public Transport. For semi-structures interviews, a list of questions was sent to the interviewees. This may be a good way to enhance the interviews' quality. The interviews was also recorded carefully so they can be analyzed later.

People at the executive level such as product manager, project manager and represent of Management and Operations Centre for Public Transport are interviewed first to get an overview about the project. Information from these interview are analyzed before interview with leaders from technical and analysis team are carried on to ensure information is attained as detail as possible.

4.6 Research Limitations and Threats to External Validity

While acknowledging the importance of integration theory in areas such as integration methodologies, integration models..., the integration in bus information systems was undertaken and have not been documented and developed well. However, this area is identified as a promising area and can be study further.

Moreover, the thesis is conducted about Vietnamese bus systems which is required the authors to review also books and articles in Vietnamese. Language barriers may exists and affect the thesis's accuracy.

The next limitation is that the data collection focus solely in a single organization. Even though the case was chosen after consideration of many available resources and research purposes, a research in more bus systems in Vietnam can help the study to be more informative from research perspective.

5 CASE STUDY: HO CHI MINH BUS INFORMATION SYSTEM PROJECT

This chapter aims to study the case study to fully understand the integration implementation of bus information system in Vietnam. The first subchapter summarizes the Ho Chi Minh City public transportation current situation, and project background are then presented in the second subchapter. Finally, the third subchapter discusses the limitations of this study and introduces ideas for future study.

5.1 Public Transportation in Ho Chi Minh City

Vietnam's robust economy growth is accompanied by an urgent need for good transportation network and infrastructure. Heavy congestion and a huge number of traffic accidents are unavoidable consequences of rapid increase in the use of means of vehicles. These are also social issues that are attracting attention from the Party, government and citizens. In recent years, Ho Chi Minh City had made a lot of efforts to promote the synergy of political system and the people involved in preserving order and safety of traffic in the area of city. Besides the remarkable results achieved, it is showed that the number of traffic accidents and traffic congestion still remains relatively high (based on the actual situation and the statistics of traffic accidents and traffic congestion in 2011). Noticeably, public transport only takes less than 5% of Ho Chi Minh total motorized trips. The motorcycles trip on another hand contributes as a major share of total motorized trips (75%). With the incentives of balancing the share of motorized trip, Vietnamese authorities decided to focus on strongly developing and improving productivity and effectiveness of public transportation system. The government believed that this will decrease the frequency of traffic congestion and traffic accidents.

Vietnam's public transportation is in a worrisome state, with largely weak, complicated and below technological standards system. While other mass transportation system (urban rail and bus rapid transit) is still under construction phase, common bus service is the only mean of public transport that MOPCT operates. Despite the fact that MOPCT has to operate enormous bus network, the

center still lacks of IT equipment, software and applications to support the monitoring and management activities effectively. The quality of bus services is still low and unable to meet the travel needs of passengers. Some problems still exist and have not been completely overcome such as improper driving routes, skipping stations or wrong drop-off stations. Besides that, the information service that provides bus schedules to passengers via the Internet and mobile services are still not developed well.

5.2 Project background

BIS project is part of the larger project: “Establishment of operation system and bus information system”. The initial stage of the case study project was 3 year ago (June 2012) and now the team is implementing the project in its final stage (April 2015). The goal of “Establishment of operation system and bus information system” project is to study and establish appropriate management model of bus information system in Ho Chi Minh City and deploy of ICT solutions to support the management model effectively.

To support this main goal, BIS project take responsibilities for developing management and operation software. Besides that, the project is responsible for building the information system based on the synchronous connection between MOPCT and real-time bus monitor devices. In the project explanation of MOPCT, it is stated that the project will focus on building an integrated ticket system and three software:

- Software to manage bus stops, bus terminals and bus station information.
- Software to manage and optimize the information service of bus operation.
- Software to manage and operate bus activities online.

Investment in system hardware infrastructure is emphasized to serve the deployment of software.

(Company document-2015)

5.2.1 Structure of organizing parties

This diagram illustrates the overall structure of organizing parties of Ho Chi Minh City Bus Information System project, which has been checked and modified by Mr. Anh Minh (product manager of the project)

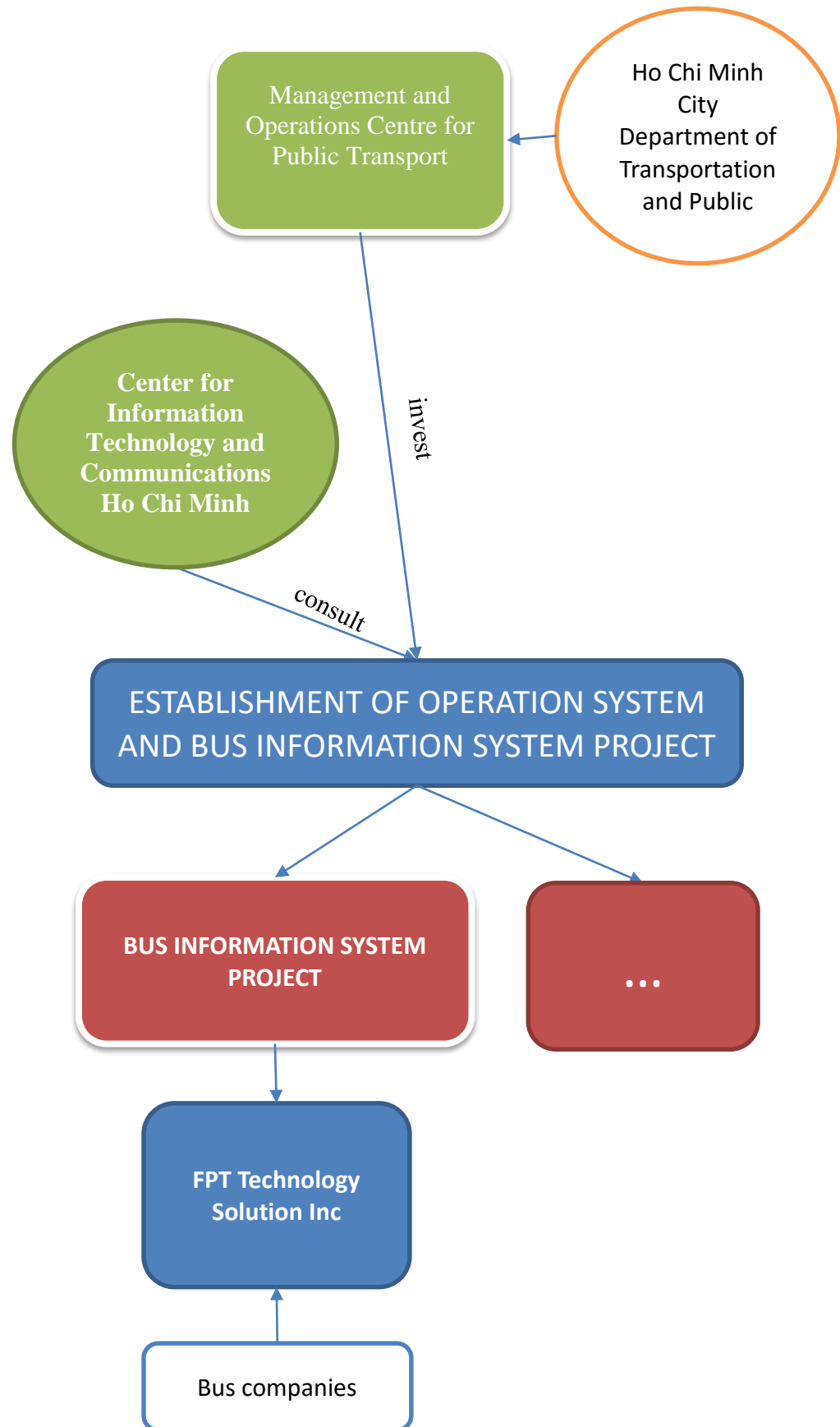


FIGURE 10. Structure of HCM City Bus Information Project

FPT Technology Solution Inc.

The company conducting the integrating project of Bus information system in Ho Chi Minh is *FPT Technology Solution Inc.*

The company was founded in 1988 and has been keeping the leading position in IT and telecommunications in Vietnam. The company is considered as the pioneer of system integration in Vietnam and still keeps number 1 position in the area until now. Recently, the company has conducted many information system integration project for backbone organizations of the Vietnamese economy such as the People's Supreme Court, the People's Supreme Jurisdiction, Ministry of Finance, General Department of Taxation, the State Treasury, the General Department of Vietnam Customs, Ministry of Public Security, Ministry of Information and Communication, the State Bank of Vietnam ... (About us – FPT Technology Solution Inc. 2015).

For HCM BIS Project, the integrated team project is divided into 4 sub-team: developing team, analyzing team, hardware team and product control team. Each team has its own function and cooperates well with other team.

Bus companies

There are many bus companies in HCMC (e.g. Saigon bus, Saigon Passenger Transportation Company). The companies are responsible for monitoring and operating drivers and fleets, directly contacting with the drivers when necessary (emergency, alert violations), and intelligently reporting cost-effectiveness analysis operation of each bus and each route.

Management and Operations Centre for Public Transport (Trung Tâm Quản Lý & Điều Hành Vận Tải Hành Khách Công Cộng) (MOCPT)

MOCPT is founded in 1996 by Ministry of Transport and located right in the heart of Ho Chi Minh City – District 1. The center takes responsibility for operating all activities of the whole bus system in Ho Chi Minh City. Specifically, the center reports information about bus routes, bus schedules, bus companies' activities and violations for Ho Chi Minh City Department of Transportation and Public Works

following strictly requirement criteria. The main function of MOCPT relevant to BIS project is playing the investor role.

Center for Information Technology and Communications Ho Chi Minh City
(Trung Tam Cong Nghe Thong Tin & Truyen Thong Thanh Pho Ho Chi Minh)
(CITC)

The center is established in 2009 and is administered by the Department of Information and Communications Ho Chi Minh City. Center for Information Technology and Communications Ho Chi Minh City is selected as consultant of the project on the basis of scope of work, workload, quality as well as qualification and ability of consultants.

Ho Chi Minh City Transport and Urban Public Works Services (So Giao Thong Cong Chanh Thanh Pho Ho Chi Minh) (TUPWS)

This is the city department which develops cities' transport strategies, manages and controls transportation and public works projects. The department is also responsible for operating public bus system of Ho Chi Minh City.

5.2.2 Strategic goals of BIS project

The strategic goals was set by MOPCT and all activities of BIS project was mean to support these goals

- The introduction of integrated bus information system will help strengthen the administrative capacity of MOCPT and improve qualification of public passenger transport. Specifically, the management capacity MOCPT been consolidated by the support of integrated software which are provided with fully operational information of bus network. Qualification of public passenger transport is improved by being provided with adequate and instant information about bus schedules.
- The evaluation results of the BIS project will be the premises for broadly implementing this management model across the public bus network in Ho Chi Minh City.

5.2.3 Level of BISI

In regard to organization integration and level of ISI, the literature review present the MOCPT is making efforts to achieve level 3 (Islands of technology integration) and level 4 (Organization integration).

5.3 An overview of bus legacy system

Bus transportation services in HCMC were provided by many bus companies. The only government-owned enterprise is the Saigon bus travel Company, which operated mostly public transit services within HCM City via various routes. The other companies, which provided services mainly to surrounding towns. All the bus companies were heavily subsidized by the government like other bus companies in the country.

The status of the organization

The number of personnel of MOCPT is 229. There are 7 departments: Operational department, Infrastructure management department, Terminal department, financial department, Human resources department, Safety assurance department and Violation control department.

MOCPT is under the guidance of Ho Chi Minh City Department of Transportation and Public Works. The current MOCPT structure is showed in Figure.

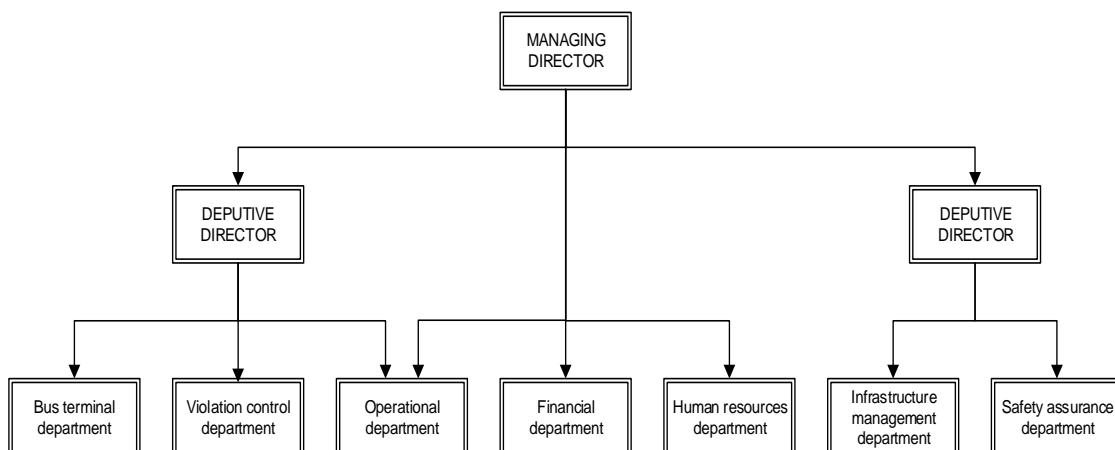


FIGURE 11. The current structure of MOCPT (Source: interview with MOCPT)

The number of personnel working directly at bus terminals accounts for about 50% of center's human resources

However, all the departments currently have not collaborated well with each other. Some department's functions still overlap with other department's functions and cause great confusion in managing process.

In the future, the center will take more responsibilities for management of operations and maintenance. The number of employees in MOCPT is forecasted to increase to 35% of total staff number in 2012. It is also understood that the current structure of MOCPT is proposed to reform in the near future to better reflect the management and operational functions.

The status of IT infrastructure

The number of client PC in MOCPT is currently about 100. However, there are PC with very low configuration (RAM less than 1GB). Most of the computer is in demand of upgrading or replacing with higher configuration PC.

In addition, the deployment of 03 new software requires approximately 10 personnel to operate the software. Hence MOCPT has to be equipped with 10 more PC.

The status of server

The number of server: 01

Server name	Function	Configuration	Year of investment
IBM X	Process data (Web server) and store data (SQL server)	Xeon E5520 x 2, DDR Ram 18G, HDD 140G.	2009

TABLE 3. The status of server (Source: MOCPT)

Initial server is used to support the main website of Ho Chi Minh city bus system www.buythcm.com.vn and 2 other software. However, after one year of operating the system, the server did not satisfy the requirements due to a rapid increase in database. As a consequences, the operating system run slower than the initial time.

The status of network system

There are 2 main transmission systems using in MOCPT currently:

- Fiber optic cable transmission 32MB Viettel
- Fiber optic cable transmission 16MB Viettel

The status of software applications

	Name	Technology	Year of investment	Database
1	Bus Management Software (BMS)	ASP.NET 4.0	2011	yes
2	Website www.buytphcm.com.vn	ASP.NET 2.0	2007	yes

TABLE 4. The status of software applications (Source: MOCPT)

MOCPT is now only equipped with two software supporting passengers to locate bus stations and determine the number of bus to pick to go from station A to station B. In addition, the website www.buytphcm.com.vn assists passengers with necessary information such as ticket prices, departure time, end time, change (route).

MOCPT is not equipped well with software support for the administration and management of bus activities while the demand for executive, management has grown steadily.

The status of journey time monitoring system

Currently, city bus systems is using GPS tracking systems for fleet tracking. The GPS tracking devices mounted on most buses are provided by 5 companies:

- Tít Telecommunication and Information Technology L.L.C
- Vinh Hiên Electron L.L.C
- Liên Á Commerce L.L.C
- Viettel
- Việt Map application L.L.C

Commonly, GPS tracking devices are basically black boxes which provides periodic information (information about location of each bus and driver, bus number, company name, station name, time leaving the station ...). The information is sent to the center by bus companies every 1-2 hours after completing each bus route. Because each bus company using different GPS tracking devices for their bus, the information sent to the center is mostly inconsistent. The problem is that MOCPT is not equipped with any GPS tracking software supporting for the synthesis of data from 5 providers. That is why data collected is only raw data and the filtering process has to be carried on manually. This increase the change of making frequent mistakes when input information.

In additional, the function of the current GPS tracking system are basically determining bus and driver location. Other functions such as overload warning, speed warning... has not been enabled or not been equipped.

Future development plan is integrating bus sensor to manage the warning information and report to the Center.

The status of ticket system

Semi-automatic ticket system is used widely in the legacy system. However, the using system is considered as tedious, stressful and involves a lot of time, effort and manpower. Most of the bus drivers reports that they face concentrating troubles when drive and involve in the ticket sale at the same time, especially in complicated and chaos traffic of Vietnam. Another disadvantage of current ticket system is that the traveler has to spend lots of time in queue for buying tickets, tokens which potentially causes traffic congestion.



FIGURE 12. Semi-automatic ticket system in HCMC (Source: FPT Solution Inc.)

5.4 HCM BIS Integration

The BIS will ideally be operated as an integrated system from the perspective of MOCPT and passengers. This will require:

- Integration of Global Positioning System (GPS) on bus so that MOCPT can manage bus activities more accurately.
- Integrated ticketing for the BIS so that passengers can use a single ticket such as a stored value card to access any bus without queuing for a long time to buy tickets.
- Integrated software and database: to ensure that the management and operation of MOPCT run smoothly without arguing mistakes cause by incompatibility of the old system. The desired outcome can be achieved by setting appropriate technical standards and choosing appropriate technology to ensure the necessary level of integration.

Given the previous discussion, it is better to describe the integration of HCMC bus information system primarily by the scope of BIS components. On this basis,

four main integrated components for improved bus information system for HCMC are identified

5.4.1 Integration of GPS tracking software to GPS tracking system

After integration process, the information system of public buses are operated as following description:

- Based on the fact each bus has been installed GPS tracking equipment to gather information about location, velocity, air-conditioner status, and door-opening status of current bus routes, all information will be collected and sent to MOCPT. The integrated information system allows the information to be send in real-time (each 2s) instead of each 1-2 hour as before.
- At MOCPT, the data will be processed, synthesized, analyzed for different purposes, both for management and administration. The data is displayed on digital map to assist the management of bus routes, actual running time of each bus. This information supports the moderator in making decisions on changing bus routes, bus schedules in case of traffic congestion, traffic accident...
- In addition, a data portal is integrated to the previous software to provide users with ability to access the internet to manage information about bus stops, shelters and yards, from designation, location to maintenance schedule... At the same time, information about management of bus companies are centralized. Other information such as ticket price, time charts are collected to create appropriate evaluation criteria and effectively evaluate the system based on data derived from actual operations.
- The data is also shared immediately to the Agency of bus companies and other management departments in need.

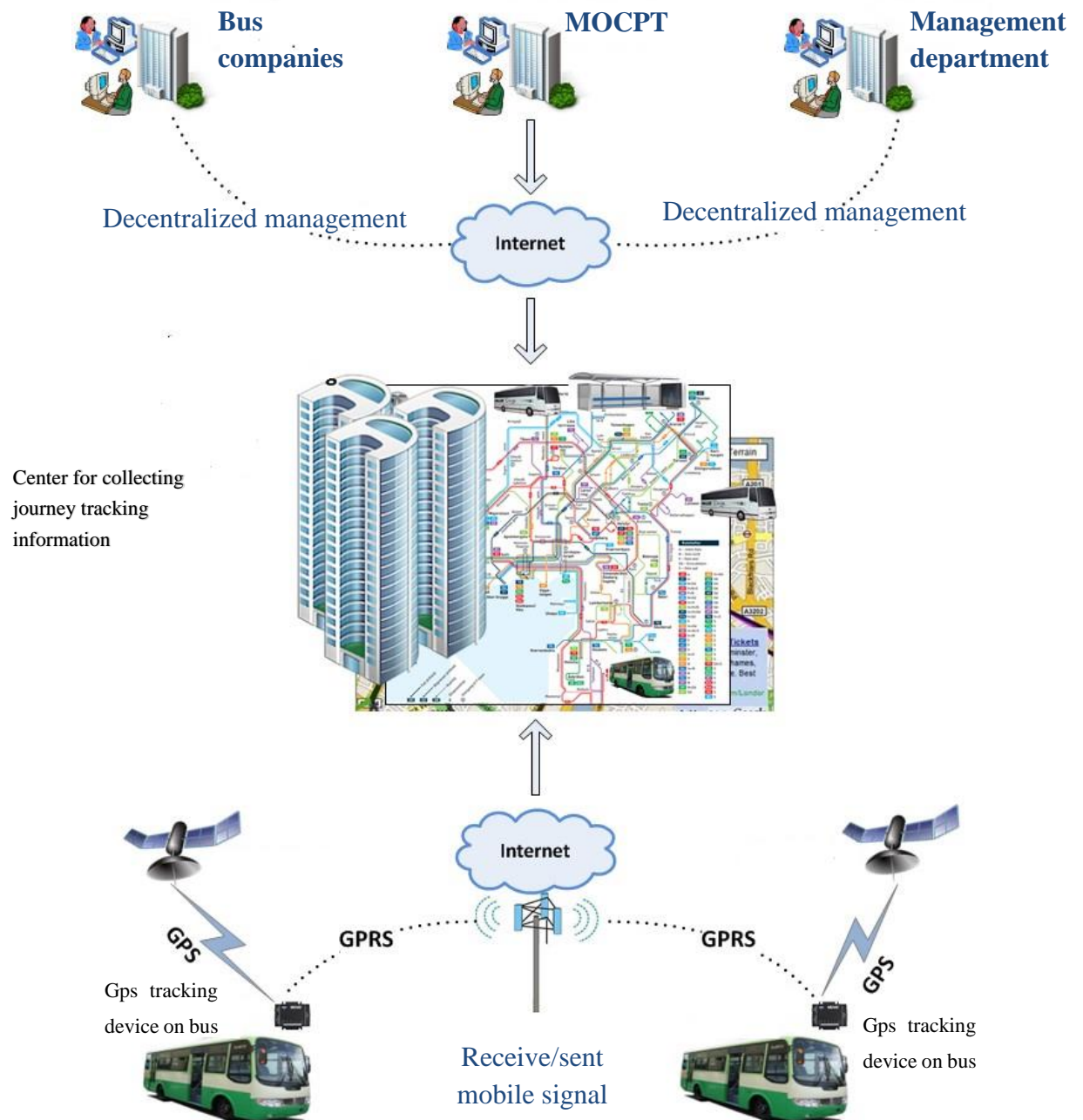


FIGURE 13. Model of integrated journey time monitoring system (FPT Solution Inc)

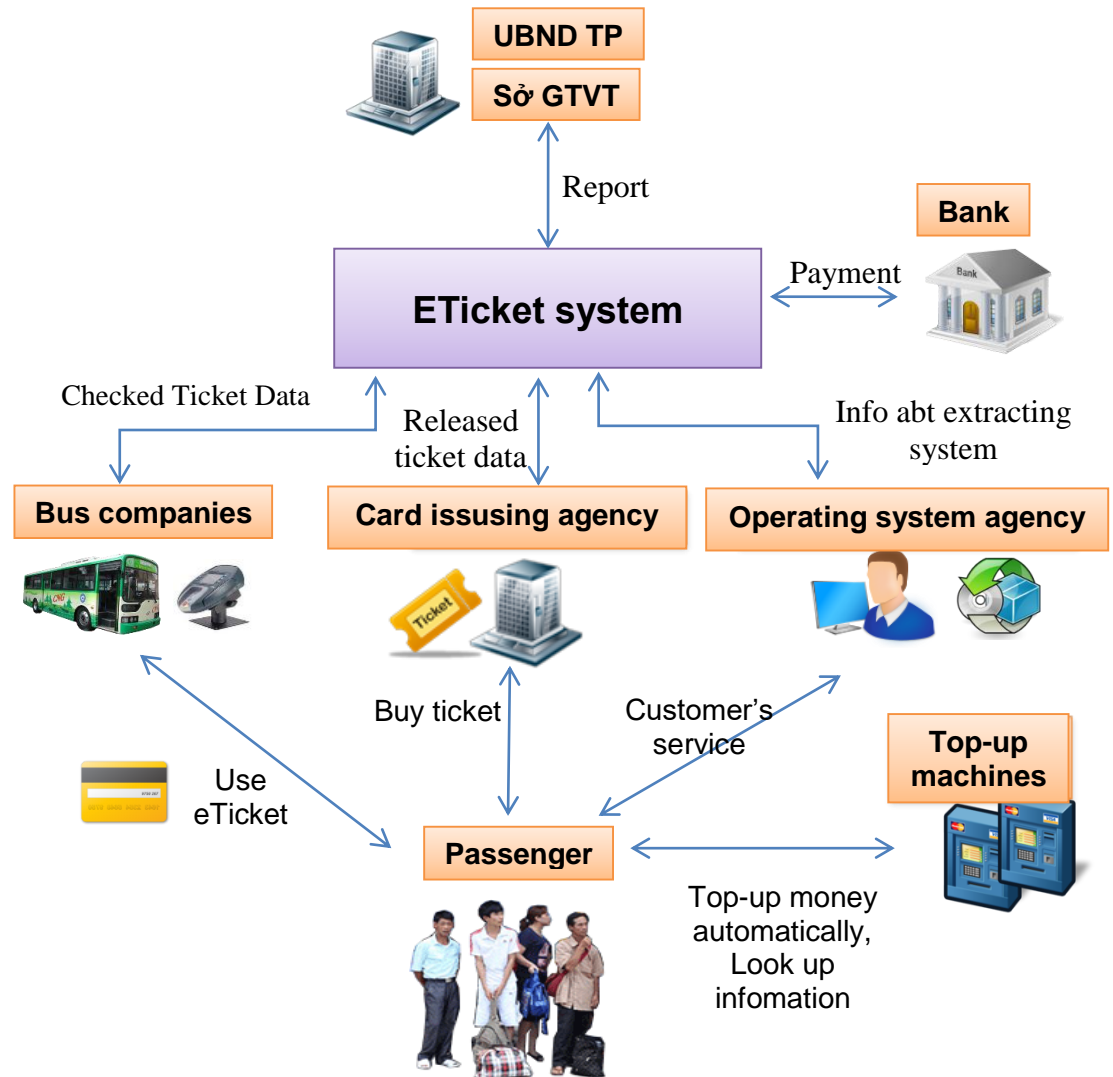
5.4.2 Integration of ticket system.

A new intelligent eTicket system is integrated to the existing one and the two systems will be operated together. The reason to integrate them together instead of replacing totally the old system is that each system have its own advantages and disadvantages and together, the two system can maximize the productivity and

effectiveness of the ticket system. The eTicket system help to create convenience for passengers, save time while queuing to buy tickets, easily load payment into the card value from the electronic payment channels such as Internet banking, mobile... However, awareness of new system is still low and the new system is actually less convenient for people who travel by bus unregularly.

The eTicket system will use smart cards which is integrated electronic circuits and microprocessors. The smart cards have capable of storing and processing data, such as reading, writing; the cards communicate with others device through transmission lines using radio waves. Checking ticket device will be installed into the bus without removing the existing devices. The system have to meet technical standards issued by MOT: ISO / IEC 14443, ISO / IEC 7810, ISO / IEC 18 092; security standards such as system reaches a minimum level of EAL 3 evaluation, using data encryption.

The following figure show an overview of eTicket system operation



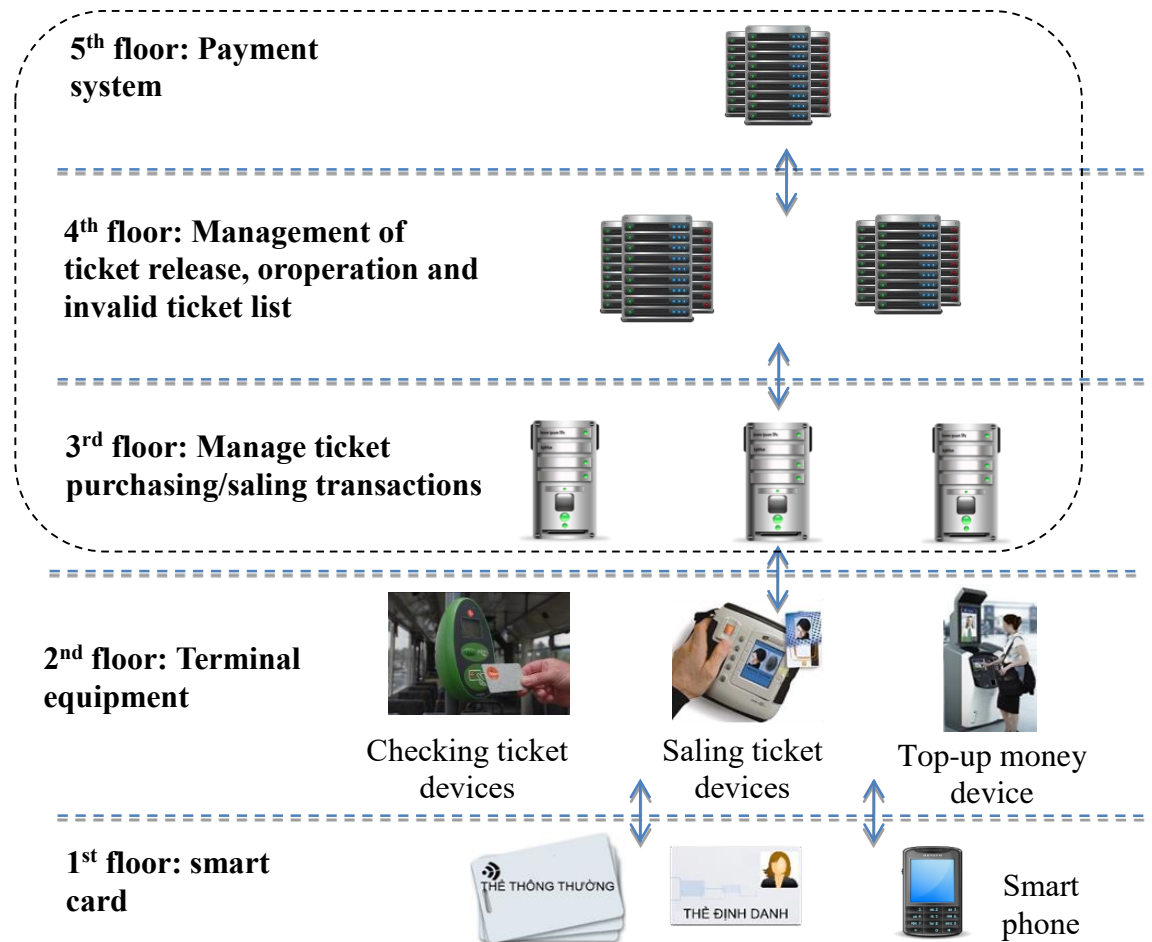


FIGURE 14. ETicket system model (Source: Miss. Van – FPT Solution)

5.4.3 Integration of software and database

3 new software are integrated to the bus management system are described as flowing chart

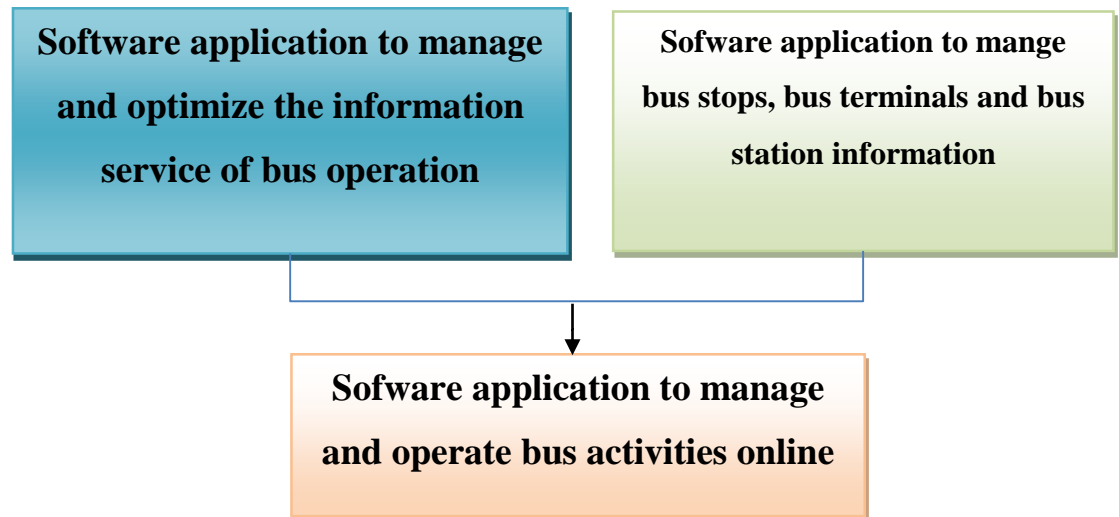


FIGURE 15. Three integrated software of BIS

Software application to manage bus stops, bus terminals and bus station information (1st software) helps to manage information of bus stops, bus terminals and bus station by integrating existing visual digital map platform. This software help to store, query, and analyze information which is used for existing BMS software.

Software application to manage and optimize the information service of bus operation (2nd software) and software to manage and operate bus activities online (3rd software) also work on the visual digital map platform, using the local graphical design to enhance the using ability of staffs.

In addition, the software application to manage and operate bus activities online integrates and load data from GPS tracking devices on bus.

The data using for 3 software applications is centralized and shared seamlessly between systems software. The data extraction occurs in the following order:

Data bus stops, bus terminals and bus stations are digitized and put into the system through 1st software. Through that, 3rd software analyzes data sent instantly to the center from GPS tracking devices on bus to monitor online roadmap and bus stops. Besides that, other system processes collect data and statistically analyze daily activities of MOCPT and create reports and indicators as a basic for improving the bus operation and optimizing MOCPT's activities.

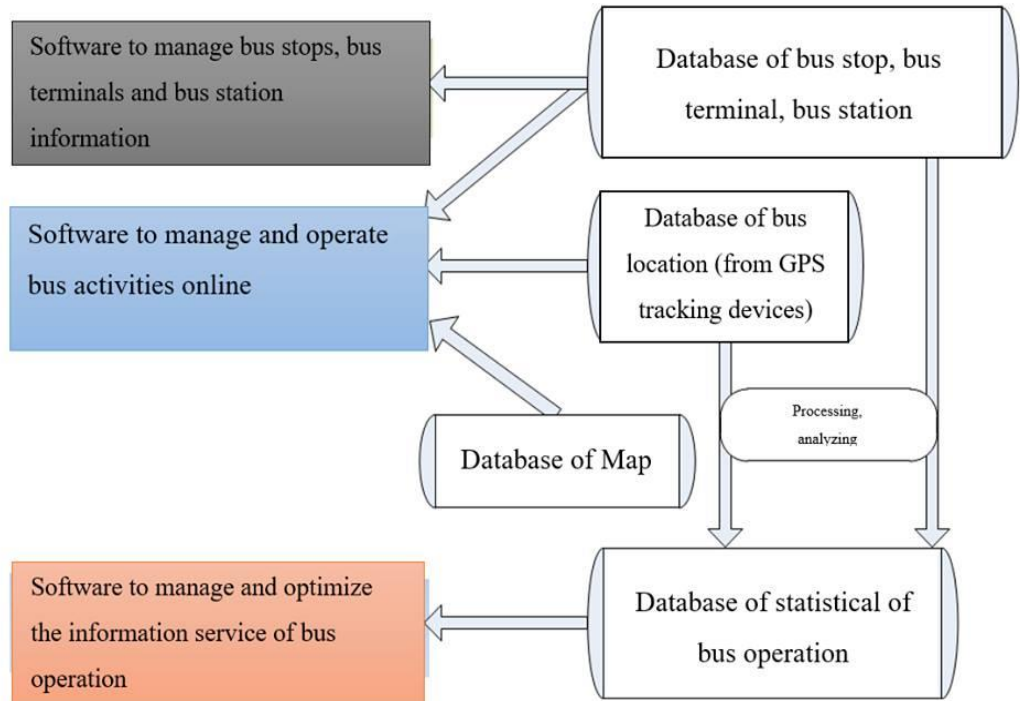


FIGURE 16. Data extraction among 3 integrated software (Mr. Ha Cong Bang – FPT Solution In.)

Main requirements:

- Integrate successfully different data sources and different data management systems, different versions of each one (Microsoft SQL Server 2005, Microsoft SQL Server 2012, Foxpro ...) and XML data standards;
- Support for querying, updating data from all data sources through a single service;
- Ensure security of database systems and other the safety factors.
- Use modern technology to easily upgrade in the future.

6 CASE ANALYSIS

In this chapter, the case study is demonstrated in terms of data collection method, data analyzing method and the result of analyzing process.

6.1 Interview Designation and Data Acquisition

As mentioned in chapter 3, data collection methods are mainly semi-structured interviews, participant observation and non-participant observation. By the time the author participated in the BIS project as a member, he has provided with many information and data related to the research topic. Moreover, by contacting stakeholders of the project via email, more information of the project was collected. Thus, what the authors did were to review and analyze available information. Alternatively, qualitative research in form of interviews was conducted to investigate deeply the BISI, explore bus characteristics of BIS which influences integration process and also the challenges of BISI in Vietnam.

“With qualitative research interviews you try to understand something from the subjects point of view and to uncover the meaning of their experiences. Interviews allow people to convey to others a situation from their own perspective and in their own words. Research interviews are based on the conversations of everyday life. They are conversations with structure and purpose that are defined and controlled by the researcher.”

(Kvale, Steinar, 1996)

Interviews can be conducted in an informal and conversational way, whereby no predetermined questions are given to remain as open as possible to interviewee's nature and priorities. There are also interviews where questions are highly structured and formalize. Depending on the purpose of the interviews, the interviewers can also choose to use a combination of both methods. Hence, interviews can be categorized into 3 fundamental types by one common typology as follow:

- structured interviews;
- semi-structured interviews;
- Unstructured or in-depth interviews.

(Saunders et al. 2012.)

Structure interviews are, essentially administered questionnaires, in which interviewees are asked by a list of standardized and predetermined questions. The interviewers may need to “read out the questions exactly as written and in the same tone of voice so that you do not indicate any bias”. Consequently, this interview method facilitates faster interviews and the interview results can be more easily analyzed and compared. Structured interviews are also referred to as ‘quantitative research interviews’. Conversely, unstructured or in-depth interviews are performed with little or no organization. The questions are asked with great variation. This type of interview allows the interviewee as freely and adaptively as possible to express their thoughts about the topic. In another words, during the interview, the interviewers “*goes with the flow*”. However, unstructured or in-depth interviews can be really time-consuming if the interviewee does not have relevant and adequate knowledge about the topic. Lastly, semi-structured interviews can be considered as providing more focus than unstructured interviews but still allow a level of freedom from getting information form the interviewed. In semi-structured interviews, several key questions are asked to explore the areas. The questions can be changed flexibly and there is the scope for follow-up questions to responses that warrant further exploration. (Saunders et al. 2012.)

The purpose of this study is to explore the views, experiences of individuals on specific matters. Semi-structure interviews and in-depth interviews are believed to provide a 'deeper' understanding of research topic than would be obtained from purely quantitative research interviews, such as questionnaires. The authors decided to conduct interviews firstly with top managers of BIS project: product manager (Mr. Tran Hong Minh), project manager (Mr. Vu Hong Viet) and Represent of MOCPT (Mr. Hoang Nhut Minh) to have an overview of BIS

project. This position has an influencing role in exploring the project in strategic level. And then in-depth interview was conducted with 4 leader from 4 departments of the project team for deeper exploration: developing leader (Mr. Ha Cong Bang), analyzing leader (Ms. Nguyen Thi Y Nhi), and quality assurance manager (Mrs. Hong Van), consultant (Mr. Mai Thanh Cuong). This is a requirement in order to get reliable data from the interviews. Because of differences in time zone and geographical location, the authors chose to conduct the interviews via Skype using video or audio function. All the interviews were recorded to analyze later. There are several interviews are conducted by email due to conflict in interviewers and interviewees schedules.

Date	Informants	Interviews topics	Interview method and length
10.04.2015	Tran Hong Minh - Product manager	<i>In-depth interview</i> Introduction of BIS project. General information about the status of integrated bus information system. Strategic goals of the project Instructions and permission to get information from the project team .	60 min Interview via Skype (video)
13.04.2015	Hoang Long - Represent of MOCPT	<i>Semi-structures interview</i> Bus legacy information system. Bus system's characteristics.	Represent of MOCPT

14.04.2015	Vu Hong Viet - Project manager	<i>Semi-structured interview</i> Information about the running project. Bus system's characteristics that influences integration.	90 min Interview via Skype (video)
17.04.2015	Vu Hong Viet - Project manager	<i>In-depth interview</i> To clarify unclear information To ask for advices to approve or modify analyzed data To get the commissioner updated about the thesis process	45min Interview via Skype (audio)
21.04.2015	Ha Cong Bang - Developing leader	<i>In-depth interview</i> Challenge of integration process in technical (infrastructure) level. Bus system's characteristics that influences integration.	30 min Interview via Skype (video)
21.04.2015	Nguyen Thi Y Nhi - Analyzing leader	<i>In-depth interview</i> Challenge of integration process in technical (infrastructure) level. Bus system's characteristics that influences integration.	Email
24.04.2015	Hong Van – Quality	<i>In-depth interview</i>	30min

	assurance manager.	Challenge of integration process. Bus system's characteristics that influences integration.	Interview via Skype (video)
24.04.2015	Mai Thanh Cuong Consultant	<i>In-depth interview</i> Challenge of integration process in organizational level. Strategic goals	Email
27.04.2015	Vu Hong Viet - Project manager	<i>In-depth interview</i> To clarify unclear information To ask for advices to approve or modify analyzed data To get the commissioner updated about the thesis process Get more information about challenges of integration process in organizational level.	Email

TABLE 5. Interview's History

6.2 Result and Discussion

In this part, the authors draw conclusions based on data collected from personal observation, documentation receiving from related organizations and from interviews, in combination with their own knowledge about the thesis topic. The results of the thesis are discussed below

6.2.1 Characteristics of Ho Chi Minh BIS

The characteristics of Ho Chi Minh BIS is investigated using theoretical framework discussed in chapter 3. According to the framework, characteristics of Ho Chi Minh BIS is analyzed by strategic perspectives, integrated system environment and 3 T.O.E aspects (technological aspect, organizational aspect and environmental aspect)

Strategic perspectives

As HCM BIS is a public sector and is under the administration of Vietnam authority, its governance structure is not as similar as other commercial organizations. The system is operated by departments, faculties, main center, and administrative offices. The BIS has various committees such as MOCPT, TUPWS at the executive level that make strategic and operational decisions in conformity with the assistance it receives from the authority. Key feature of the HCMC BIS are:

- *Centralized* decision-making
- *Formalization* through legal procedures.

(Mr. Vu Hong Viet – project manager of BIS project)

System environment

The characteristics of BIS in system environment aspect is distinguished into 3 variables: directionality of constraints and environmental factors (Madnick & Wang, 1988)

Directionality of constraints: The bus information system to be integrated is considered as existing and will be change in the near future. In other words, a higher level of integration will be taken place after the completion of BIS project. As a result, the need for creating a standardization for the whole system and the openness of the system in upgrading in the near future is significant. (Mr. Vu Hong Viet – project manager of BIS project)

Environmental factors can be influenced by three factors: autonomy, integration and evolution. In BISI, the trade-off of autonomy and integration is huge. For example, to maximize the efficiency of GPS tracking system, the integration required all the GPS tracking devices to be uniformed so that the data received is consistent and data is transmitted in the fastest way. However, this may greatly affect the autonomy factor in term of organization requirement. GPS tracking devices on bus is distributed by five different tele community companies. The uniform of all GPS tracking devices requires the replacement of thousands GPS devices. Integration in this point is considered as cost-consuming and violating the bus companies' benefits. The replacement of GPS tracking devices is also influenced negatively to the business of GPS devices distributors. The evolution of GPS technology can influence the balance between integration and autonomy in the future. However, this factor is still somehow unpredictable. (Hong Van – Quality assurance manager of BIS project)

Technological aspects

These aspects viewed by comprising current technological situation of bus information system and integration implementation of BIS is going to bring. According to Rogers (1995), there are five variables affecting the technological aspects. In below these variables are discussed.

Relative advantage

The relative advantage of BISI is characterized by the awareness of new technology. Actually, the GPS tracking systems has been used for tracking buses and enhance the productivity and effectiveness of MOCPT's management. Moreover, the company which is responsibility for implementing the integration - FPT Solutions have conducted which many government integrations before. (Mr. Tran Hong Minh – Product manager of BIS project)

Compatibility

In compatibility of BISI is identified by the degree of adaption of integration solution to meet organizational values such as resources, capitals, culture or social image.

MOPCT identify themselves with Bus Information System integration, it adapts in their operations in the inside and their image from the outside. They see BISI as the most appropriate solution and BISI is now a strategic technology for HCMC BIS to enhance their values. (Tran Hong Minh - Product manager of BIS project)

Complexity

According to Rogers (1995) complexity is “defined as the degree to which an innovation is perceived as relatively difficult to understand and to use”. During the interviews with Mr. Vu Hong Viet – project manager of BIS project, the complexity is differentiated in two particular features: maturity of BISI and the IT infrastructure.

- Maturity of BISI: In the theme of current Vietnamese bus systems situation, BISI is a rising technology, so it is still not sufficiently mature. The integration is evolving and as a result, may involve many technological matters. BIS project can be considered as one of the first step in BISI arena in Vietnam. While MOPCT can benefit internally somehow from the BISI, the awareness of passengers and drivers about the new integrated systems is still questionable.
- The IT infrastructure of BIS in HCM are mostly undeveloped. Most of PCs using in MOPCT have pretty low configuration. The main server’s capability is under demand of system and storage requirements. Consequently, system failures can and should be expected daily.

(Tran Hong Minh - Product manager of BIS project)

Trialability

Trialability is the quality or degree of being verified or tested by means of a trial. Because BIS project is the first step in integration in Vietnamese BIS, there is no available integration implementation cases to review. This is also the reason why the overall project – “Establishment of operation system and bus information system” was planned for a long time ago but only ready to start recently. The BIS project success is a connection between ISI and other waiting projects. The project is promised to provide more information and experiences for other

projects to take the initiative and drive ISI implementation. (Tran Hong Minh - Product manager of BIS project)

Observability

According to Mr. Tran Hong Minh, observability is really important for the successful of BISI. Before each integrated component is ready to use broadly, there are always several trials. The real project is experimented on the evaluation of these trial.

Organizational aspects

Economical capital: Bus system is a government-owned sector so it is not driven by any economical capital. No commercial organizations can use their position to rule out the implementation of BISI.

Strategic capital: Nationally, the mandates by MOT requiring the bus information system in big cities such as Da Nang, Hanoi, and HCM to implement BISI have sparked the recent uptake of ISI. Hence, the whole BISI is strongly affected by strategic plan of the government.

(Hoang Long -Represent of MOCPT)

Environment aspects

“Environmental aspects characterize the arena in which a company conducts its business - its industry, competitors, and relationship with government”

(Tornatzky and Fleischer, 1990).

According to Deuten et al. (1997), the environment factor is characterized by 3 variables: business environment, regulatory environment and wider society. However, the interview result show no result in business environment. The BISI characteristics in environment aspects is discussed below:

Regulatory environment: One characteristic of Vietnamese bus system is that it is heavily subsidized from the government, not only on ticket fares but aslo in

operation costs. In ticket fares, subsidy amount is calculated by a travel distance basis (km/bus) with the bus companies. Normally, the bus ticket fare is 10000VND (approximately 0.4 euro) without the subsidization. The government will decide which bus routes to subsidize and subsidy amount is about 50% of the ticket fares. For other investment, the plan and financial report is done by TUPWS and after really long and complicated regulation procedure, the subsidy is accepted. Moreover, during the implementing process, if there any change in project plan, the project plan need to be approved again by the government. As a result, the government require adequate report from the bus companies to ensure their effective subsidy. (Hoang Long -Represent of MOCPT)

However, the managements and administrations of the government is not strictly enough. For instance, a bus company has to register the vehicle number, route number before the bus is allowed to be operated. Many bus company break the law by take advantages of the fact that many bus routes overlap each other's; one bus may registered for 2 bus routes. The data from GPS tracking system cannot identify which route the bus is running. (Tran Hong Minh - Product manager of BIS project)

In general, the integration project heavily depend on authority in term of finance and making decision.

Wider society

According the interview result, this variable is described by two matters: social responsibilities and awareness of ISI. Firstly, the integration in HCM bus system results a great cut in labor force while the parts of the legacy system are run manually. The government consider the big project of changing public transport in Vietnam as the image. And reaction of community in this matter can affect the government decision in implementing process. Secondly, passenger's awareness of ISI and MOCPT staff's awareness are still low. Before integration is taken place, a good communication strategy need to be done to promote the technology widely (Hoang Long -Represent of MOCPT)

6.2.2 Challenges of BISI

Strategic perspectives

Because of the national mandates of BISI, each step of BISI project have to be considered thoroughly. A failure in choosing integration solution can cost the government a lot of money. In strategic perspectives, project team have to take more responsibilities in ensuring budgetary support is used appropriately.

Challenges of BISI is identify how to align operational activities to strategic directions. (Vu Hong Viet -Project manager & Tran Hong Minh - Product manager)

Technological aspects

Data challenges: While using the legacy system, data is sent from GPS tracking devices every 1-2 hours. The integrated GPS tracking system allows the data to be sent every 2 seconds. This offers a great opportunity to be able to use real-time data for real-time business. As a result, decision is made more easily and quickly. However, the growth of data also brings back challenges. There are approximately 1800 buses operated everyday. If we make a quick calculation, there are 77,760,000 files sent every days. Moreover, data is not simply deleted every day, it has to be stored for a long period of time for management purposes. For the project team, the size of data is one of their challenges in technological aspects. Another challenges is how to handle multiplicity of types, sources and formats. Data that project team works with in BISI project comes from various sources and in various forms. There is data input manually (normally Word, Excel... files or paper-bound documents) and digitized data (digital map, digitize graphical data...). Because data structure is not coherent and not unifying, digitization process is necessary to standardize the data. However, this process takes a lot of time and human resources (Tran Hong Minh - Product manager).

Differences and uneven in existing system: The legacy system use different data management systems, different versions of each one (Microsoft SQL Server 2005, Microsoft SQL Server 2012, Foxpro ...). This causes difficulties in integrating existing systems. (Nguyen Thi Y Nhi -Analyzing leader)

Organizational aspects

The BIS integration requires a significant shift in corporate politics. The integration focuses on management and operation functions which requires a smoothly communication not only between information systems but also between business departments. Coordination requires enhancing in technological and management skills among employees for BIS projects.

Another challenge in organization aspects is how to handle effectively human resources. The integrated system required more people for handle new functions, but also cut down jobs because some components has been automated. (Mai Thanh Cuong – Consultant)

Environmental aspects

Because public bus transport is a public sector, MOCPT are responsible for report to TU and MOT. BIS project is subjected to requirements as imposed by authority. MOT planned to integrate the whole public transport system in the future (level V: Socio-organizational integration). Consequently, BISI have to follow a strictly standardization for future integration. (Mai Thanh Cuong – Consultant)

7 CONCLUSIONS

In this chapter, the authors conclude the problem formulated in Chapter 1. The first subchapter summarizes the results of the case study, and research questions are then answered in the second subchapter. Finally, the third subchapter discusses the limitations of this study and introduces ideas for future study.

7.1 Thesis summary

The thesis aimed to identify uncertainties which can affect bus information system integration in Vietnam. These uncertainties were identified by investigating the characteristics of BISI and the challenges of BISI. These factors were examined by studying related literature and by conducting interviews. According to the related literature, ISI can be categorized into various types and integration takes place on many levels. There is a noticeable relationship between these levels and types of ISI. In general, ISI can be understood as a process of combining different component subsystems and software programs into a single system so that all the subsystems function together as a coordinated whole.

As the authors mentioned in the case analysis part, the Vietnamese government is trying to solve the country's traffic problem by implementing "Establishment of operation system and bus information system" project. The case study, the Ho Chi Minh City Bus Information System project, is the first step in a larger project. Because the public transport system and the bus information system are substandard, system integration is implemented to enhance the effectiveness of MOCPT's operations. The integration includes GPS tracking system integration, eTicket integration, software applications and database integration. The IT infrastructure also need to integrate to adapted integration requirements.

As was written in the case analysis part, the characteristics of BISI were investigated to fulfill the research objectives. The characteristics of BISI and the challenges of it are determined by using the theoretical framework developed in Chapter 3. Even though BIS project is in its final stage and there are positive signals showing in the project results, the implementation has faced many

challenges. The challenges involve challenges in handling big data, challenges in processing, challenges in environment factor...

7.2 Answers to research questions

The research questions mentioned earlier in the paper are answered briefly below

Which characteristics of Vietnamese BIS influence BISI?

Based on the findings, it is clear that the Vietnamese BIS is a heterogeneous environment in which parts of the system develop unevenly and spontaneously. The results of the conducted interviews explore the characteristics from various aspects. From strategic perspectives, the BISI strategic and operational decisions have to fit in the support it received from the government. While top management is driven by the integration, translation between system environment and global standardizations is needed. The BIS has the characteristics of an evolving system where the implemented integration is part of a whole in the public sector. Standardization is a compulsory factor to reduce future systems' constraints

When looking at the business case, technological characteristics are considered as the most important characteristics of BISI. Currently ISI is promoted as an IT solution for bus operations, and enhancing bus operation effectiveness is the driving force of BISI. In terms of compatibility, BIS is considered as fitting with the external exposures such as culture and resources. However, the complexity of the BIS is high when the BISI is not completely mature and an IT infrastructure is relative inadequate. Another characteristics of BISI is that it requires a high level of trialability and observability.

The most noticeable characteristic of BISI is that the Vietnamese BIS is heavily subsidized by the government. The BIS is affected significantly by a regulated environment.

What are the challenges of implementing BISI in Vietnam?

The challenges accounted for implementing BISI mainly relate to dealing with the pressure from the government, solving technological problems (big data, differences in existing systems, standardization), handling human resources effectively and fitting the project into the government's plan to change the public transport system in Vietnam.

7.3 Limitations and Suggestions for futures research

During this thesis process, the author aware of much knowledge about bus information system integration in Vietnam. Apparently, there are always uncertainties besides visible opportunities in implementing bus information system integration. Accordingly, with this study, the authors believe to provide a deeper understanding about the bus information system information as well as provides information for future projects.

It would be beneficial to gather more information for investigating the adoption of integration system. Because the Ho Chi Minh City Bus Information System project is the first and only project at the moment, the results of this study may be inadequate. Their characteristics and effects are still unknown. Therefore, the authors believe that much research should be done to explore the influences of information system integration. These following are some suggestions:

- What are the key challenges of implementing integration and identifying means to overcome barriers in BISI?
- What are the reasons lead to failure in BISI?
- How does ISI affect the Vietnamese BIS?

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APPENDICES

INTERVIEW QUESTION

1. Can you describe the legacy bus information system? Why does it need to be integrated?
2. Which level the integration take place? (the interviewer describe briefly about the levels of integration if necessary)

Note: question 3-5 to determine the type of integration

3. Are there any committees (bus companies, Ftp) the top management level that make strategic and operational decisions in line with the support it receives from government?
4. Can you give a comparison (information system category) of legacy and current description of information systems integration?

IS components	Legacy system	Integrated system
Data center		
Global position system		
Maintaining system		
Sign display system		
Ticket system		

5. How information technology does contributes to the integration?
6. Bus information system is a real time business when data of bus routes and traffic status need to be updated instantly. How is it effect the integration process?
7. Can you list down some noticeable characteristics of bus information system?
8. How these characteristics affect integration process?
9. What is the strategic goals of the integration?
10. How does organization factor affect the integration and does it bring back any challenges?

11. How does technical factor affect the integration and does it bring back any challenges?
12. How does environment factor affect the integration and does it bring back any challenges?

NOTE: These question will be used to ask the project manager, product manager. These people will be interviewed first. Based on the result of these interviews, more detail question will be created for leaders of other departments.

