APPLYING BUSINESS INTELLIGENCE IN HIGHER EDUCATION SECTOR: CONCEPTUAL MODELS AND USERS ACCEPTANCE

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ABSTRACT

Advances in emerging ICT have enabled organizations, such as universities, to generate, collect, and distribute data that may not be possible before. However, this leads to the explosion of data and unprecedented challenges in making strategic and effective use of available data. As a result, individuals who work for higher educational institutions (HEIs) are struggling to make sense of multi-dimensional and huge volume data available for them. The current student information systems in HEIs appear to mainly collect and store data in databases, thus serve as merely an information source rather than a decision support environment. Business Intelligence (BI) aims to enable interactive and easy access to diverse data, enable manipulation and transformation of these data, and users the ability to conduct appropriate analyses and perform actions (Turban *et al*., 2011). However, there appears very limited research on the acceptance and use of BI by individual users in universities.

Therefore, this study aims to promote BI applications in HEIs by designing a demonstrational portal to introduce the concept of Educational Intelligence (EI) and its applications, and to investigate the factors affecting EI acceptance by academic individuals in a Chinese university using Technology Acceptance Model (TAM). To achieve the research aims, the study adopted two approaches: one is to design a BI portal to demonstrate BI concepts and potentials by introducing the concept and benefits of EI to the potential users. The other approach is to conduct a survey based on TAM model to understand the factors influencing user's acceptance of EI. Data of

the questionnaire survey is gathered from the academic staff in a key Chinese university in Beijing. Based on the 85 valid responses, factor analysis is used to examine the validity of all research instruments after the test of reliability. The Structural Equation Modeling (SEM) technique is employed to verify the theoretical model and test the research hypotheses.

The main finding of the SEM results indicate that the perceived usefulness of EI system strongly influence behavioral intention to use. The result suggests that user's willing to utilize EI system depends on how well the ability of EI system improves their job performance. In addition, there is no insignificant influence between perceived ease of use of EI system and attitude towards to use the EI system. It means whether users decide to adopt EI system does not depend on the ease of use of EI system. That may be because EI will be an evitable trend to the evolution of student information systems in HEIs.

In summary, this study identified a gap in terms of understanding the acceptance of BI in Higher Education sector. It introduced the concept of EI based on the previous literature, and attempted to explore and demonstrate the EI concept and potentials through a demonstration portal. The study revealed the factors determining the acceptance of EI from the technology acceptance perspective. The survey findings will help practitioners to take effective measures to improve user acceptance and usage of the BI systems in HEIs. In addition, the EI demonstration portal can be further improved in the future to serve as a one stop knowledge base to help users apply EI techniques and tools for supporting their decision making and planning.

Key words: Business Intelligence (BI), Technology Adoption, Technology Acceptance Modeling (TAM), Educational Intelligence (EI), Structural Equation Model (SEM)

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LIST OF ABBREVIATIONS

A	Attitude toward Use
BI	Business Intelligence
BIU	Behavioral Intention to Use
BPM	Business Performance Management
DSS	Decision Support Systems
DW	Data Warehouse
EDM	Educational Data Mining
ICT	Information and Communications Technology
JISC	Joint Information Systems Committee
OLAP	Online Analytic Processing
PEU	Perceived Ease of Use
PU	Perceived Usefulness
RFID	Radio-Frequency Identification
SRM	Student Relationship Management System
TAM	Technology Acceptance Model
TDWI	The Data Warehousing Institute
TPB	Theory of Planned Behavior

TRA	Theory of Reasoned Action
UNESCO	United Nations Education, Scientific and Cultural Organization

Chapter 1: Introduction

1.1 Research Background

With the rapid advancement and development of Information and Communication Technologies (ICT), organizations are now able to generate, collect and distribute huge amount data from internal and external sources. This is also happening in Higher Educational Institutions (HEIs). As a result, many universities have evolved in abundance of information, and some even suggest that educators are "drowning" in massive data (Celio and Harvey, 2005; Ingram *et al*., 2004). Meanwhile, according to JISC (2011), today's further and higher education institutions (HEIs) are facing a multitude of pressures: they are coping with rapid and radical developments in ICT which have the potential to fundamentally alter the way in which teaching, learning and research are conducted. Also, JISC (2011) points out that most of the current student information systems in universities mainly collect, process and store data in databases, thus they serve as merely an information source rather than a decision support environment. Therefore, it is imperative for HEIs to explore the value of their data warehouse and make better use of data available.

As the “the concept of 'Business Intelligence' (BI) is steadily rising up the priority list within many institutions”, it is necessary to explore the potential of BI in making better use of student data in support of student management and decision making. It is hoped that the applications of BI systems will help managers and academic staff take a more proactive approach in student management and strategic planning through well informed and evidence-based decisions.

Organizations' requirements to improve quality of decision-making and quality of partner service should turn to the development of information technology infrastructure that will represent a holistic approach to business operations, customers, suppliers, etc. (Wells and Hess, 2004). Theory and practice from many studies show that the above-mentioned requirements are largely met by BI systems (Liautaud and Hammond, 2002; Olszak and Ziemba, 2004): BI has the strong ability to eliminate redundant data extraction processes and duplicate data housed in independent data marts across the enterprise; and application areas of BI can be seen from sales and marking analysis, planning and forecasting, financial consolidation, statutory reporting, budgeting, and profitability analysis (Thompson, 2004; Watson and Wixsom, 2007). All of above applications play critical roles in business operations. Therefore, BI has become a strategic initiative, and many business leaders now regard BI as instrumental in driving business effectiveness and innovation (Watson and Wixsom, 2007). Moreover, BI has been used in many other sectors, for instance, in manufacturing companies for order

shipment and customer support, in retailing sector for user profiling to target grocery coupons during checkout, in financial services for claims analysis and fraud detection, in transportation for fleet management, in telecommunications for identifying reasons for customer churn, in utilities for power usage analysis, and health care for outcomes analysis.

However, BI technologies have not been widely used in Higher Education sector, despite that BI can also play an important role in student data analysis for decision making and strategic planning as mentioned before in JISC's report. Most of the current student information systems in universities are just a collection of student data. For example, one UK university has developed and implemented a Radio-frequency Identification (RFID) based Student Engagement tracking System (SES) to collect data on student engagement activities in a number of areas, such as: lectures, library, BREO, university online log in, etc.. But data generated from SES have not yet been used to support institutional decision making and planning. It is believed that BI systems can improve academic staff with better access and use of accurate and reliable data in real-time resulting in effective engagement monitoring, risk identification, and evidence based student engagement data in order to meet educational goals.

1.2 Research Problem

Introducing BI to HEIs maybe faces a number of challenges. For individual staff, BI can be utilized as a new technology to support their work and improve the efficiency and effectiveness of work performance. Therefore, the acceptance and subsequent use of BI by individual staff can be essential for BI success. More seriously, if the investment of technology is failed, that may not only cause universities' financial losses, but also lead to dissatisfaction among staff and students in universities (Venkatesh, 2000). Thus there are two major challenges in applying BI in HEIs, firstly, how to raising awareness and educate the potential users, secondly, what factors may determine the acceptance of BI in HEIs.

Extensive research has been conducted on adoption of information systems and technologies (King and He, 2006). According to Porter and Donthu (2006), in explaining technology adoption and acceptance, a research paradigm is given. It focuses on how a particular technology's attributes affect users' perception to an information technology, thereby influence the usage of the specific technology. Where technology acceptance model (TAM) is the most wide used model for this paradigm (Venkatesh *et al*., 2003; Bruner and Kumar, 2005; King and He, 2006; Porter and Donthu, 2006; Lee *et al*., 2006).

Davis *et al*. (1989) propose two beliefs about the technology in TAM, perceived

usefulness and perceived ease of use, these two items aim to determine an individual attitude toward using that technology, which in turn determine his or her intention to use it. Perceived usefulness is the degree to which one believes that using the technology will enhance his or her performance.

Regarding BI adoption in HEIs, there seems no attempt to study the BI acceptance in HEIs. Thus it is important and necessary to investigate individuals' acceptance of BI in order to promote and make best use of BI systems in HEIs. Therefore, the intention of thesis is to promote BI concepts among university staff and understand the factors determining the acceptance to BI systems in supporting individual users.

1.3 Aims and Objectives

This research aims to promote BI applications of BI in HEIs.

The specific research objectives are:

(1) To understand the BI systems and the current applications and challenges of BI systems in the HEIs.

(2) To clarify and define the BI concept and systems in the context of HEIs, which is defined as Educational Intelligence (EI), and develop a demonstration portal to

introduce and demonstrate EI concept and applications.

(3) To investigate factors determining the potential users' acceptance of the EI system, and provide recommendations and implications for research and practice in improving BI success in education environment.

To achieve the research aim and objectives, this research will adopt two approaches: one is to design an EI demonstration portal to demonstrate EI concepts and potentials. The other approach is to conduct a survey based on TAM model to understand the factors influencing user's acceptance of EI. It is hoped that the survey results will help to improve user acceptance/usage of the BI systems in HEIs.

1.4 Structure of the Thesis

This thesis includes six chapters: introduction, overview of BI and its application in HEIs, overview of adoption of technology and technology acceptance model, research methods and techniques including the development of demonstrational portal and survey questionnaire, data analysis and discussion, results and analysis, and conclusion of this research.

Chapter 1 provides a brief overview of the research. It introduces the background of the topic, describes current situation of the research and illustrates the

significance of this study. Then this chapter outlines the objectives of this study and the structure of the whole thesis. Finally, this chapter maps the layout of the thesis (see figure 1-1).

Chapter 2 reviews literature. It begins with the BI from its definition, process models, tools and current application situation. Then this chapter focuses on the application of BI in a higher educational environment and then it gives rise to the concept of EI. The fourth section explores theories of technology adoption in particular the model and applications of TAM. Finally, the conceptual model of the acceptance behavior to EI is depicted.

Chapter 3 presents the research methods and techniques including the research process, design, and the development of the instrument. It starts with the discussion of research design and research methods. Secondly, this chapter gives the justification of choices and uses of demonstrational portal and provides the process of developing the web portal. Following it the questionnaire survey is employed to collect primary data. Finally, this chapter gives a brief introduction to the Structural Equation Model (SEM) which is adopted for analyzing the data by using software AMOS.

Chapter 4 presents the detailed process of development of demonstrational portal by using web design software: dreamweaver, and there is a brief introduction to EI

systems according to the structure of the EI demonstrational portal.

Chapter 5 presents main data analysis and interpretation about results of hypothesis model. It begins with testing the reliability and validity analysis by using SPSS. Then the hypotheses testing results of SEM is given. Following it, this chapter discusses the results the based on the theoretical model which is becoming the main findings of the whole thesis.

Chapter 6 highlights the key findings that contribute to our understanding of EI adoption in HEIs, which leads to the application of BI systems in HEIs. Then the research implications generated from the investigation are presented. Finally, the limitations of the study and suggestions for further research are given at the end of this thesis.

1.5 Summary

This chapter presents the background of this research, aims and objectives, as well as the process of this research. The process of the whole thesis is diagrammatically presented in Figure 1-1 below. The next chapter will present a literature review relating to BI.

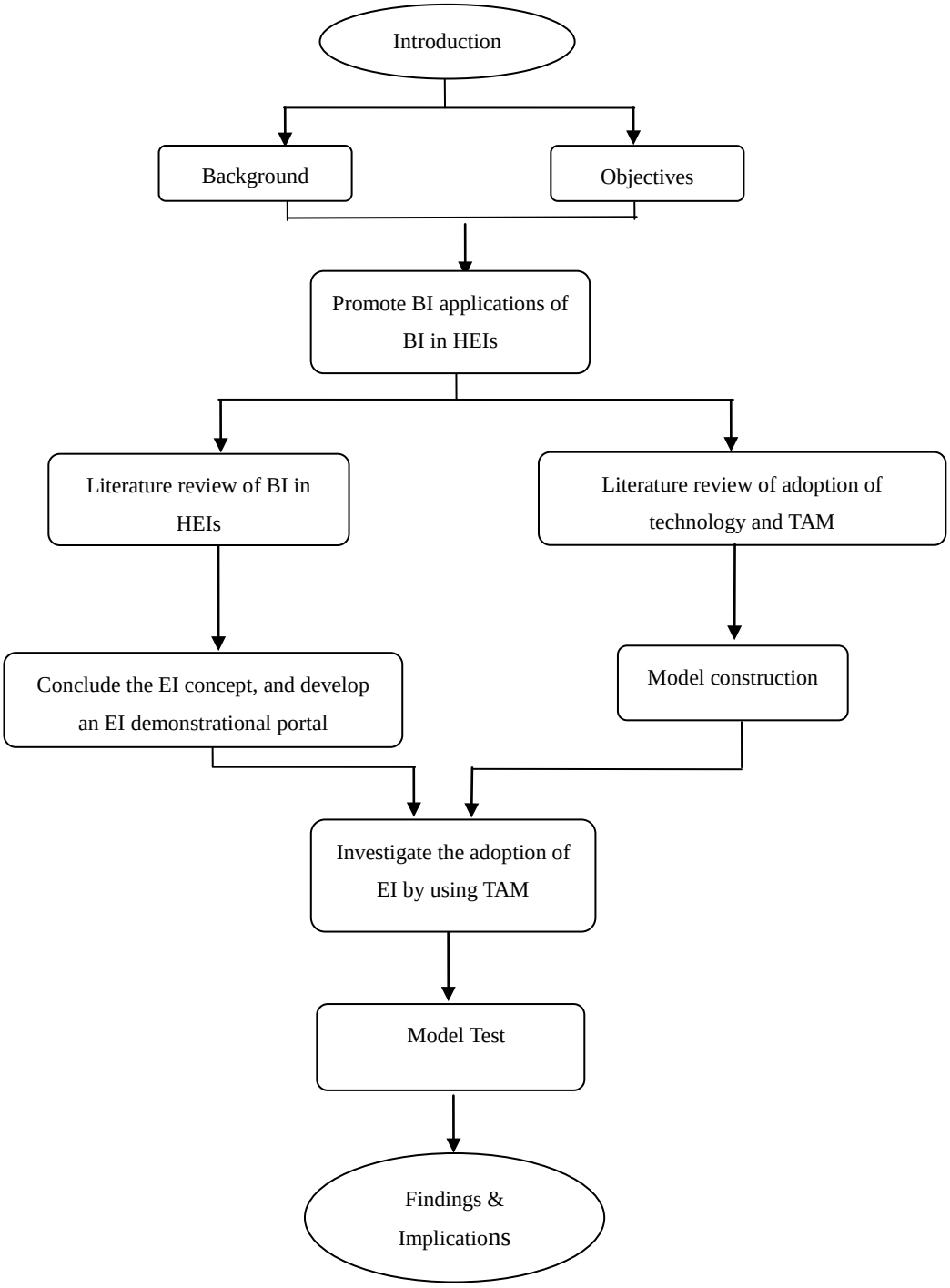

Figure 1- 1 Research process

Chapter 2: Overview of BI and its application in HEIs, IT adoption and the conceptual model

This chapter presents definitions of Business Intelligence (BI), its process model and some introductions of BI technologies. Then, a briefly review of BI application in HEIs is provided in the second section. Then this chapter gives a definition of BI applications in HEIs. Finally the needs to investigate IT adoption are discussed along with reviews of adoption models. Lastly, the conceptual model and hypothesis for this research are proposed.

2.1 Review of BI and BI technologies

2.1.1 The definition of BI

In the literature, the original BI is evolved from Decision Support Systems (DSS) which is a computer based support system for management decision makers (Watson, 2009). DSS belongs to independent systems within an organization and had a shaky relationship with other systems (Rouhani *et al.*, 2012). With the development of decision support applications, a term BI is introduced by Howard Dresner in 1989, which is based on DSS and its related techniques (Rud, 2009).

Compared with DSS, BI creates comprehensive decision-support environment for management (Lönnqvist and Pirttimäki, 2006).

Many researchers have defined BI in a different context, but none of the definitions is universal. One of classic BI definitions category is proposed by Ghazanfari *et al*. (2011) who classify BI definitions into three approaches, and they are managerial approach, technical approach, and an approach which referred BI as an enabler of enterprise systems. More specifically, firstly, a managerial approach definite BI as a process in which data collected from internal and external the enterprise, then integrated for generating information related to the decision-making process. Secondly, the technical approach is the way of using BI as a collection of tools that supports the strategic decision-making process, which focuses on the technologies, algorithms and tools relevant to the analysis of data and information instead of strategic decision-making process itself (Petrini and Pozzebon, 2008). BI definitions in most literatures go to the previous two approaches, while the enabling approach concentrates on value-added capabilities in support of information (Rouhani *et al*., 2012).

Table 2-1 shows some of BI definition collected from literatures. The definitions are classified based on Ghazanfari's (2011) research.

Table 2- 1 Definitions of Business Intelligence and its category

Approach	Original Literature	Definition of Business Intelligence
Managerial Approach	Ghoshal and Kim (1986)	BI is a system that assists organizations to manage and transfer data into useful business information in order to make more effective business decisions.
	Hannula and Pirttimaki (2003)	BI systems are an important class of systems whose data analysis and reporting tasks provide timely, relevant, and easy to use information to managers at various levels of the organization in order to make better decisions.
	Power (2008)	A BI system refer as a data-driven DSS that basically supports querying of a historical database and aims to benefit decision makers in organizations by providing periodic summary report.
	Jalonen and Lönnqvist (2009)	BI is a system which generates analyzes and reports on trends in the business environment and on internal organizational matters.
Technical Approach	Berson and Smith (1997)	BI is an analysis mechanism that provides for enterprises through large database system analysis as well as mathematical, statistical, artificial intelligence, and data mining etc. thereby conduct automated decision-making.
	Watson and Wixom (2007)	Their research focus on data flow, where BI refers to a process which contains two primary activities: getting data in and getting data out. Namely, by using data from the data warehouse BI systems provide reporting, OLAP, querying, and predictive analytics for enterprise.
	Turban *et al*. (2011)	BI can be seen as an umbrella term that combines architecture, tools, databases, analytical tools, applications, and methodologies.
Enabler Approach	Sahay and Ranjan (2008)	A combination of computerized tools, databases, and vendors that provides initial solution according to business issues and enables enterprises change with the business and current marketplace
	Vedder *et al*. (1999)	BI can be explained as "both a process and a product". Whose process incorporates methods that organizations use to product useful information, or intelligence, that can assist organizations survive and thrive in the global economy. Where the worthy information allows organizations to predict the behavior of their "competitors, suppliers, customers, technologies, acquisitions, markets, products and services, and the general business environment" with a degree of certainty.
	Thomas Jr. (2001); Wiseman (1988)	A BI system regards as a kind of strategic information system aiming to enhance decision making and competitive advantages of organizations.

From the view of the managerial approach, definitions from Ghoshal and Kim (1986); Hannula and Pirttimaki (2003); Power (2008); Jalonen and Lonnqvist (2009) are in line with this approach. Considering BI's managerial definition, it can be embedded in enterprise systems to obtain a competitive advantage such as: Enterprise Resource Planning (ERP), Customer Relationship Management (CRM), and Supply Chain Management (SCM) systems (Sharma and Djiaw, 2011). This kind of definition mainly severs for situations when considering business environment, organization, markets, customers, competitors and economic issues (Lönnqvist and Pirttimäki, 2006).

When speaking technical approach, Turban *et al*. (2011) give an explanation that BI is an umbrella term that combines architecture, tools, databases, analytical tools, applications, and methodologies. There are not only given researches (Berson and Smith, 1997; Watson and Wixom, 2007), but also some other researches (Wu *et al*., 2007; Petrini and Pozzebon, 2008) show the similar definitions, BI is regarded as an assemble term that used to describe applications and technologies that are used to gather, provide access to, analyze data and information about the organization to assist managers make better business decisions. In short, definition of BI in technical approach can be always seen when discussing some specific BI's technologies, algorithms and tools.

The approach treated BI as an enabler of enterprise systems which focuses on value-added features on supporting information. This definition can be found in literatures from Wiseman (1988); Vedder *et al*. (1999); Sahay and Ranjan (2008); Thomas Jr. (2001). Moreover, Ghazanfari *et al*. (2011) suggest that if adopting value-added features and functionalities in enterprise systems, the organizations will have a better decision support environment.

This study follows the managerial approach to define BI: a process by which data collected from the entire organizations, and then integrated in order to generate useful information to improve managers' decision-making. More specifically, BI can be seen as a hybrid system combined with computerized technologies and management concepts. By efficiently and effectively analyzing historical and current data, it can support and improves decision-making in organizations.

2.1.2 Process model of BI

After discussion about BI definition, to know how BI systems run in organization, this section introduces BI process models. BI process refers to a continuous and systematic process, which concludes organizational needs analysis, production process of intelligent information and dissemination of related information to business activities (Hannula and Pirttimäki, 2003). Thereby BI process models are referred to a symbolic tool to demonstrate how a BI system enables business information management. Here it presents four process models below:

(1) Choo's (2002) BI process model

Figure 2-1 shows a BI process model from Choo (2002). Actually, Choo proposed the process model to describe information management processes which he defined as a continuous information management cycle. Hannula and Pirttimäki (2003) treat Choo's information management process model as the basis for all the business intelligence processes. This process model provides a practical way for BI to deal with managing information and knowledge efficiently therefore make better decisions.

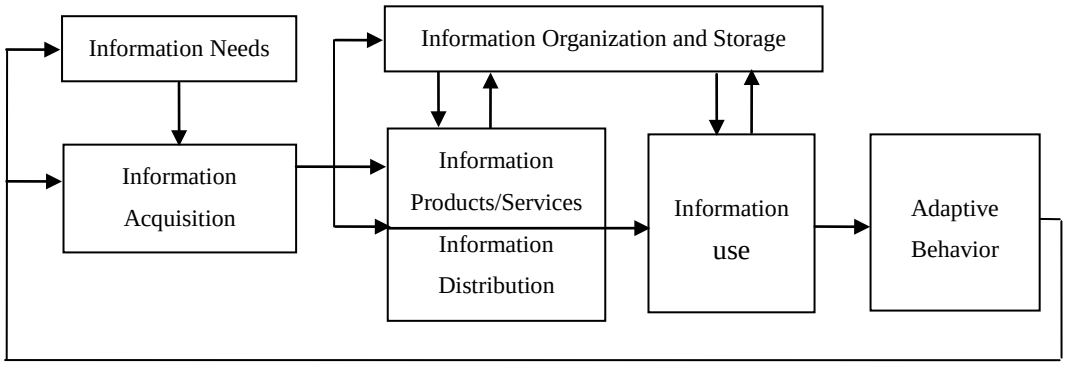

Figure 2- 1 Choo's (2002) BI process model (information management process)

（2）Novintel' s BI process model (Viva Business Intelligence Inc., 1998)

Novintel Inc., one of BI vendors with whose former name is Viva Business Intelligence Inc., came up a BI cycle process model as Figure 2-2 shown. The whole process can be divided into eight phases and begins with the phase: need analysis.

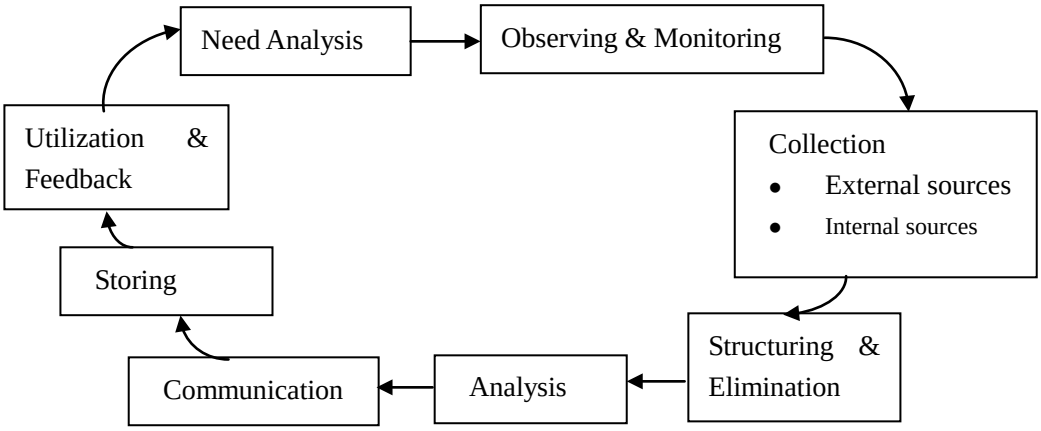

Figure 2- 2 Novintel's BI cycle process model (Viva Business Intelligence Inc., 1998)

(3) Thomas Group's BI process model (Thomas Jr., 2001)

Another famous BI process model is proposed by Thomas Jr. (2001), who developed a cycle BI process model which includes six phases as well. They are: planning and direction, data collection, information processing and storage, analysis and production, dissemination and intelligence users and decision-makers respectively (see figure 2-3).

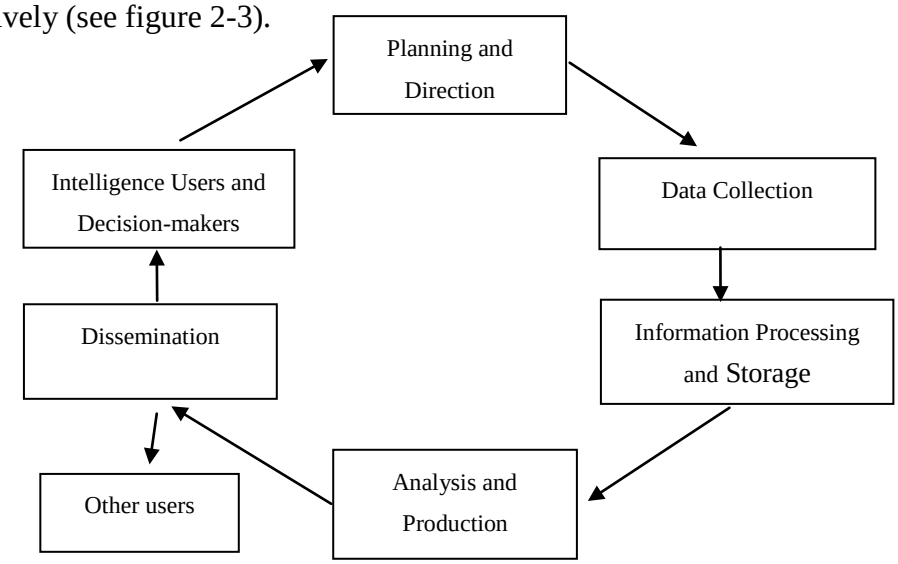

Figure 2- 3 Thomas Group's BI cycle (Thomas Jr., 2001)

(4) Microsoft's BI process model (Vitt *et al.*, 2002)

Figure 2-4 shows a BI process which is proposed by a BI vendor Microsoft. Microsoft is a well-known software vendor and has presented its own model for a BI process in 2001. This model seems simpler than above ones. The whole BI process cycle can be simplified into four phases which are insight, action, measurement and analysis.

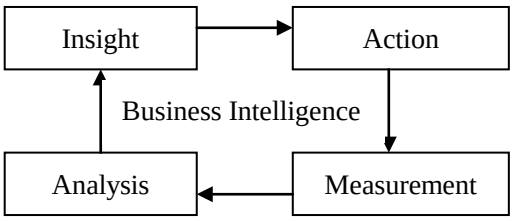

Figure 2- 4 Microsoft's BI process model (Vitt *et al*., 2002)

Viewing from above four successful BI process models, the common features are concluded as follows. Firstly, all models presented shows that BI is an ongoing cycle, which means BI is more than a management philosophy or an enabling technology (Vitt *et al*., 2002). Secondly, BI process begins with the needs analysis. It is a critical phase and only when the requirements are described in an accurate way, effective information management in whole process can be run successfully. Moreover, data analysis, collection and storage phases do not make a big difference. However, the process models from Novintel's and Thomas Group's

emphasize the dissemination of information. Thomas Jr. (2001) interprets that when intelligence is valuable that information should be disseminated in a form which is advisable to be clear enough for organizational managers. All in all, they have the same structure which makes BI process keep going in a cycle way.

Choo's model focuses on the practical problems. Choo considers that the gathered information and produced knowledge have to be applied to practical problems to make decisions in an efficient way, while Novintel's model highlights utilization and feedback phase. Without this phase, users cannot utilize information efficiently and become lack of understanding of their over external and internal organizational environment. Thomas Jr. (2001) states that: a BI process is a cyclical process where sources of data play a critical role. Moreover, Microsoft's BI process simply consists of four phases. However, it demonstrates BI in a brief way and makes the whole BI process easy to understand to individuals. Maybe because this model is proposed to customers who tend to purchase BI related tools.

BI is a continuous and systematic process, produce intelligent knowledge to make better decisions through utilization of organizational information. It is better to find a process model which integrates the use of BI tools like online analytic processing (OLAP), data warehouse and data mining etc., by which individuals can better understand the BI process not only in a view of information

management, but also a view of specific technology.

2.1.3 BI techniques and tools

Since BI process model has been presented above, this section's purpose is to explore information technologies tools that involved in entire BI cycle process. BI aims to enable interactive and easy access to diverse data, enable manipulation and transformation of these data, provide business managers and analysts the ability to conduct appropriate analyses, and perform actions to improve strategic and tactical decisions (Turban *et al*., 2011). To accomplish the above functions, BI adopted a set of concepts, methods, techniques and processes by which BI can improve business decisions, using information from multiple sources and applying past experience to develop an exact understanding of business dynamics (Maria, 2005). In addition, such BI tools provide the right information to the appropriate persons throughout the organization. Eckerson (2005) and Rouhani *et al.* (2012) identify that a good BI system should provide the following tools: production reporting, end-user query and reporting, OLAP, dashboard/screen tools, data mining tools, and planning and modeling tools. Moreover, Langseth and Vivatrat (2003) suggests that a BI system consists of real-time data warehousing, data mining, automated anomaly and exception detection, proactive alerting with automatic recipient determination, seamless follow-through workflow, automatic learning and refinement, geographic information systems and data visualization.

Turban *et al.* (2011) give a summary that BI, in general, has four major components: a data warehouse (source data), business analytics (a collection of tools to deal with source data), business performance management (monitoring and analyzing performance) and a user interface (e.g., a dashboard). Turban's classification of BI tools presents a friendly and brief way to enable people understand BI tool, so that the following parts will briefly introduce some main BI tools according to Turban's work.

Data warehouse (DW)

Data warehousing (DW) is playing a major role in the integration process in BI (Turban *et al.*, 2011). The concept of data warehouse was came up with in the late 1980s, which is regarded as a data collection of current and historical data, which is subject-oriented, integrated, non-volatile and time-variant with its aimed to support decision-making process in managements (Inmon, 2005). Specifically, a data warehouse can support the physical propagation of data by dealing with the numerous enterprise records for integration, cleansing, aggregation and query tasks (Ranjan, 2008). A data warehouse contains two main components: one is the integration component which is responsible for collecting and maintaining the materialized views which are computed in integrated form from multiple data sources. The other one is the query and analysis component for feeding the information and analysis needs of specific end users (Labio *et al.*, 1997).

Moreover, a data warehouse supports OLAP data structure by providing the large-scale data infrastructure (Inmon and Hackathorn, 1994).

Online analytic processing (OLAP)

Online analytic processing (OLAP) efficiently provides the multidimensional view of data to applications or users and enables the genetic BI operations such as filtering, aggregation, drill-down and pivoting (Chaudhuri *et al*., 2011). OLAP refers to the techniques of performing complex analysis of the information from data warehouse. The complexity of queries required to support OLAP applications makes it difficult to implement using standard relational database technology, so that OLAP in BI works with data warehouse (Zeng *et al*., 2006). By using OLAP, organizations can simply provide resources to end-users or to guide end users in making a better decision (Silver, 1990).

Data Mining (DM)

Data mining represents the highest level of the business intelligence hierarchy and the research line that join several disciplines like: mathematics, artificial intelligence, data bases, decision theory, information and communication technologies (Turban *et al*., 2011). Zeng *et al*. (2006) suggest that data mining supporting BI including classification, estimation, prediction, time series analysis,

unsupervised clustering, and association analysis like market basket analysis. The rapidly expanding volume of historical and real-time data contributes to the demand for and provision of data mining tools and it has become a critical role for advanced analytics in BI (Shim *et al*., 2002).

Business Performance Management (BPM)

BPM is a promising portfolio of applications and methodologies with BI architectures and technologies at its core (Hurbean, 2006). Many group users give the different names to define BPM, like "Corporate Performance Management", "Corporate Performance Management Business" or "Enterprise Performance Management". Although BPM has different name to different industry experts, the process of "BPM"s are the same which is considered as a series of processes and applications designed to optimize the execution of business strategy (Mojdeh, 2005). Specifically, BPM refers to provide feedback for management on key performance indicators through usage of the data. Now BPM has become the biggest growth area in BI analysis.

Dashboard

With the limitations of previous systems and dynamically changing business requirements, a need for a new tool came to be considered that would enable

decision makers view the organization's performance without navigating through complex databases. More specifically, it is aimed to find such a BI model which allows senior decision makers to conduct OLAP and offers good data quality, light architecture and indicators, so that the dashboard is created (Golfarelli *et al.*, 2004).

Dashboard are defined as a visual and interactive performance management tool that displays on a single screen the most important information needed to achieve one or several individual and/or organizational goals. A good dashboard allows users to identify, explore, and communicate problem areas that need corrective action. (Yigitbasioglu and Velcu, 2012).

BI dashboards enable users perform tasks: like spreadsheets, enterprise portals for searching, BPM applications offer visual dashboards for decision makers tracking key performance indicators of the business (Chuaudhuri *et al.*, 2011). A study from The Data Warehousing Institute (TDWI) showed that almost one-third of organizations that already have a dashboard and use it as their primary application for reporting and analysis of data (Eckerson, 2005). Moreover, dashboards have evolved from the intrinsic purpose of monitoring performance to more advanced analytical objectives, incorporating new features such as scenario analysis, drill down capabilities, and presentation format flexibility. Considering the rapid developments in business technologies, the trend probably is to bring additional

novelties to dashboards such as their integration with work flow management systems (Yigitbasioglu and Velcu, 2012).

BI is technically a combination of numerous disciplines and techniques instead of an independent, novel or original approach (Zeng *et al*., 2006). Only with the combination of the entire applications, BI makes better decisions for organizations.

2.1.4 Current and Future trend of BI

To stay competitive, companies have to meet or exceed the expectations of consumers. And it is BI systems that companies rely on to stay ahead of trends and future events. According to Watson (2007), goals in many companies are to make BI more real-time and pervasive BI. The real time BI system supports the classical strategic functions of data warehousing for deriving information and knowledge from historical data, and also provides real-time tactical support to drive enterprise actions that react to abrupt event (Grivic, 2012). On the other hand, some recent survey shows businesses organizations that had adopted a BI tool, and only 25% of employees in those businesses had access to that tool (KPI, 2012). So that an increasingly tend to find an easier way to adopt EI is processing like cloud BI and mobile BI.

Heizenberg (2012) suggests that one trend of BI trend is the application of BI in

cloud technology. Cloud technologies aim to find a both temporary as well as permanent use for information technologies. A cloud service enables BI runs in a managed environment in the Internet. Plus it makes all of BI functions like reporting and analytics in a web environment. In addition, it is accessible via any web browser in a BI system that makes companies save a substantial amount of money for purchase of any hardware.

Others like mobile BI which allows BI apply in telecommunication technologies. To develop mobile BI, organizations deploying and vendors need to consider the implications of working in a remote environment (KPI, 2012).

To BI tools market, According to IDC's (2010) research, BI tools market got 8.9 billion dollars in software license and maintenance revenue in 2010, in which the top five BI vendors in 2010 were SAP, IBM, SAS, Oracle and Microsoft respectively, which accounted for 64.9% of the total market.

With increasing capability requirements of BI and consumer expectations, it is therefore imperative that BI will evolve into a more intelligent information system which assist users make better business decisions by making accurate, current, and relevant information available to them whenever and wherever they need it.

2.1.5 Applications of BI

Powerful transaction-oriented information systems are now commonplace in every major industry, effectively leveling the playing field for corporations around the world (Ranjan, 2009). That means the application of the BI system is not only can be seen in business environment, but also in other critical areas and industries. Since BI systems have the ability to achieve large volumes of data relevant to their customers and services into actionable information, many telecommunication industries who have implemented BI systems retained large existing customers and drive new business (Ingres, 2008). Then turn to healthcare industries, current hospitals share the same one of the goals which is to provide efficient, quality care to patients. Therefore there is a need to access to existing data to make sure goal is achieved or not (Dwight, 2012). BI systems which are appropriate for healthcare area provide functions such as provider productivity, turnaround of CT exams and bed tracking for staff and senior managers to make decisions about patient care and hospital operations. While to banking industries, they are suffering from huge amount of data which is collected from clients on their personal, psycho-social, property and financial features, and all their accounts information (Ubiparipović and Đurković, 2011). Some researchers blended BI solution with the concept of Bank asset and liability management (ALM) which aim to reporting profit and risk balance, and conduct banking risk management (Ubiparipović and Đurković, 2011). The solution has applied in

banking industries by which users benefit from the high-quality and timely decision making for asset and liability management.

BI systems provide solutions to those above industries by dealing with organizational data. Results from BI systems improve decision making for the whole organizational operations. Especially, they have taken advantages of BI's keen ability to deal with data by which managers can make better decisions. It is believed that with the increasingly growing trends of IT-enabled business demands, BI systems are becoming wide spread information systems and playing a critical role in various areas. The next section is reviews on BI applications in education sectors.

2.2 Reviews on BI application in HEIs

2.2.1 The needs for BI in HEIs

JISC (2011) points out that HEIs are facing a multitude of pressures: they are coping with rapid and radical developments in Information and Communications Technology which have the potential to fundamentally alter the way in which learning and research are conducted. Meanwhile, the challenges of operating are happening with an increasingly competitive market. Moreover, a large increasing pressure is the resources of wastage. Kelly (2005) states that HEIs collect a large amount of data and knowledge, but individuals who work for HEIs cannot find an

effective way to manage and utilize the information. Some collections even remain for years and they are becoming difficult management with the larger it growing. Therefore it is necessary to find such a solution that can deal with the redundant data and assist educators' information management practices.

The concept of BI is steadily rising up the priority list within various institutions (JISC, 2011). Considering BI benefits, BI makes large amounts of raw data more accessible, understandable, and useful by providing computer-based tools for users to directly process, organize, manipulate, integrate, and analyze that data. And its tools help users turn basic data into information and knowledge (Kelly, 2005). It is hoped that the applications of BI systems will help managers and academic staff take a more proactive approach in student management and strategic planning through well informed and evidence-based decisions.

2.2.2 Overview of BI application in HEIs

Since HEIs are under a lot of pressure from such a productivity and efficiency perspective, some HEIs have introduced BI technologies as a solution to it. It makes BI becoming the key can open the door to the value of historical and existing data to assist decision-making for persons who work in HEIs. Here this study will present some previous research which related to this research either directly or indirectly.

JISC (2011) conducted a survey of BI solutions in Higher and Further Education aims to explore means by which senior managers can be improved where the current states of BI application in HEIs were investigates. Among 102 validated responses, the table shows 56% of respondents state BI systems or dashboard from BI are a reality now, or is coming next year for their university. Where only 9% of respondents show 'no interest' in BI and some of these is replies from institutions where other employee reported an active or imminently planned system. In addition, many organizations who intended to help institutions to use technology to support their strategic priorities have realized the benefits of BI systems and advised HEIs to consider BI systems like JISC who initiated projects which aim to 'help senior managers and decision makers make better use of both internal and external data in support of institutional management and decision making' (JISC, 2011). Also TSI who assist Higher Education by providing specialized experience in (ETL) Extract Transform Load, data modeling, data warehousing and analytics/decision support. TSI has helped created educational data warehouses which enhance decision-making quality and capabilities to HEIs in Malaysia (Transforming Higher Education, 2007). Moreover, IT vendors stepped in the market of BI solution to HEIs. Some even have provided specific software to universities, like Oracle, SAP, IBM and SPSS.

The BI solutions to HEIs are becoming an evitable trend for current higher education areas. Now some universities have applied BI systems as their

educational university systems, while others focus on the research of BI techniques and tool. Following sections presents the current status of BI application in HEIs from the terms of BI systems and its tools application.

2.2.3 BI systems structure in HEIs

Some universities have adopted BI systems as their educational information systems. Here are some cases for better understand whole BI systems as a backbone of information systems to universities. In Piedade and Santos's (2010) research, a student relationship management system (SRM) is applied to enhance the teaching learning process. The SRM system is associated with BI concept and techniques used to achieve knowledge about the students and to support the decision making process. Another case is Aziz *et al*. (2012) research. In his research, a conceptual frame of the BI system is proposed working for the whole university. It combined BI technologies with various EDM algorithm techniques and the whole structure was built based on the Data warehousing technologies. In the proposal system, data from the transactions systems are extracted to a data warehouse which is designed for the university. Then OLAP techniques are utilized to obtain students' achievements and to conduct a descriptive analysis. Moreover, EDM algorithms are applied to predict potential areas of studies for the students. The next section focuses on the application of BI tools and its distinctive benefits in HEIs.

2.2.4 BI tools in HEIs

Head (2010) states that some universities in Australia have adopted BI systems to identify which students are at risk of dropping out. Those BI systems allow individuals who work with BI to intervene prompt to maintain both student engagement and fee based income. One function is that students are encouraged to utilize a system, which is called e-motion system and allows them to select which emotion best reflects their mood. After selected, the messages were sent into a word cloud. When the cloud shows "stressed" for one student, academic staff who works for student support will give some tips and relaxation advice to the student via updating blog. In addition, the information above is fed into a management system called student relationship management system (SRM). SRM can be seen as one of the data sources, which communicate with other university computer systems finally sending data into the university's central data warehouse, then analyzed by a BI systems system. After analysis, an alert identifying some students group thought to be most at risk is subsequently sent to academic staff team with an automatic email. Some universities already have benefited from the BI solution from terms of retention, income, student satisfaction and so on. Also, some universities in America use BI analyzing add/drop information and class failure patterns to identify at-risk students and direct them to support services (Durso, 2009). Moreover, Setiz's research (2010) aims to find a BI solution to predict the path of students and alumni. More specifically, BI provides data-driven

analysis of student behavior so by using predictive analytical model which can be realized via data mining. Next section is the other area for reviews of BI solutions in HEIs, where researchers show strongly interested.

2.2.5 Educational Data Mining

Educational Data Mining (EDM) is a new growing research area where data mining concept is used to mine useful information from educational data (Ramaswami and Bhaskaran, 2009). An international EDM community (http://www.educationaldatamining.org/) defines EDM as an emerging discipline which mainly aims to explore methods to better understand students and the setting which students learn in.

EDM process

For how EDM works in an educational environment, Romero and Ventura (2007) present an iterative cycle which elaborates a process of using EDM (see figure 2-5).

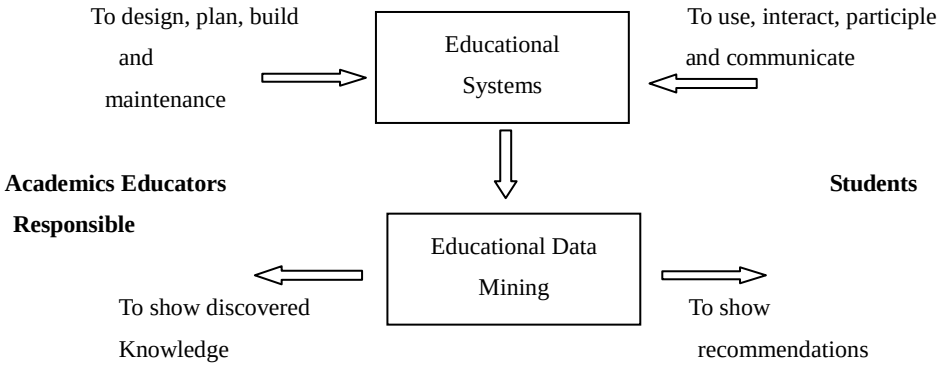

Figure 2- 5 The cycle of applying EDM (Romero and Ventura, 2007)

Figure 2-5 shows that it is the educator and academic responsible duty to plan and maintenance of the educational systems. The whole process starts with the student's data coming into the educational system through students' use of educational systems like student engagement system, student management system and e-learning systems etc. Then educational data mining techniques are applied in order to mine useful information that can help individuals who need to make evidence-based decisions. In the cycle process from Romero and Ventura's research, EDM results are recommended not only utilized for educators, but also to students, which are in accordance with some researchers who think EDM can be oriented to different actors with their own purposes (Zorrilla, *et al*., 2005).

EDM methods

Data Mining has been proven to be a very useful tool capable of handling decision

making and forecasting techniques (Ranjan and Khalil, 2008). However, Apart from the classic data mining method like classification, clustering, association-rule mining, sequential mining, text mining, etc., EDM applies other techniques like regression, correlation, visualization which are not considered to be DM methods (Romero and Ventura, 2007). Moreover, a new trend of EDM method research is discovery with models (Baker and Yacef, 2009). By which EDM provides sophisticated analysis such as benefits from learning material sub-categories of students and intelligent tutor research etc (Beck and Mostow, 2008; Jeong and Biswas, 2008).

The application of EDM

Romero and Ventura (2007, 2010) collected 300 papers from journals and conference journals till 2009 which is related to the application of EDM in HEIs. They established task categories for the main educational tasks that have employed data mining techniques, which come from different research communities.

In their survey, most researchers focus on four areas, they are analysis and visualization, providing feedback, recommendation and predicting performance. Where the application to analysis and visualization of data aims to highlight useful information and support decision making. It is worth to note that

information visualization is to use graphic techniques thereby help people to understand and analyze data (Mazza and Milani, 2009). More specifically, statistical graphs about assignments complement, questions admitted, results and student's attendance allow academic staff understand student's performance at once (Mazza and Dimitrova, 2003; Mazza and Milani, 2005; Shen *et al*., 2002). Then the other two applications: providing feedback and recommendation aim to support decision making to improve students' learning. Thirdly, another popular task for EDM is to estimate the unknown value of a variable that describes the student like performance, knowledge, score, or mark, which is chiefly applied in e-learning systems as well.

In addition, the survey also shows that the detecting student behaviour is not the main trend of EDM research however there is still larger amount research which focuses on discovering those students who have some type of problem like dropout. Some classic DM methods have been used to make a prediction of student's behavior, such as classification and clustering. In addition, decision tree, bayesian classifiers, logistic models, the rule-based learner, and random forest can be used to predict student's dropout (Dekker *et al*., 2009; Kotsiantis *et al*., 2003).

In summary, some organizations have come to realize the importance of adoption of BI systems and have taken practice. On one hand, most researchers focus on the BI tools application like predict the possibility of dropout, although there are

some researchers who care about the whole educational information systems can be replaced by BI systems. On the other hand, some BI techniques like data warehouses and data mining which has become a very popular area for researchers. Particularly, there are increasingly researches having been involved in EDM study where many researches concentrate on EDM algorithm. EDM already have been adopted in adaptive and intelligent web-based educational systems (Tang *et al*., 2000). However, many systems applied EDM methods are e-learning systems. It is hoped EDM can play a critical role in BI systems which allows educators benefits from both BI and EDM that could improve educational decision making by analyzing data which collected from campus computer systems, so that the application of BI and BI techniques can be seen as a whole. Following it, a concept of BI solutions in HEIs is proposed.

2.3 The concept of Educational Intelligence

Aziz *et al*. (2012) was the first one proposed Educational Intelligence in their research. The concept of Educational Intelligence in their research is a framework of an educational information system, which includes three main features: data warehouse which is designed to HEIs and the implement of EDM along with the OLAP engine for educational data reporting; the ability to perform multiple analytic processes of descriptive analysis and predictive analysis; a friendly reporting user interface. Only when one educational system achieves these three

features at the same time in its systems framework, it can be called Educational Intelligence.

However, the definition of Aziz's Educational Intelligence is limited. In his research, they simply focus on BI techniques that only dealing with data to HEIs instead of BI's most benefits which can improve decision-making. Here the definition of Educational Intelligence (EI) in this study can be proposed as below:

EI concept in this study evolves from BI concept. EI is a information system which enables manipulation of collected data, whilst to give decision makers in universities and colleges the ability to conduct evidence-based decision-making through the application of BI framework, tools, databases, analytical tools, and methodologies in HEIs. Actually, EI can be considered as the application of BI in HEIs. Comparing with BI, EI is suitable for educational sectors and all EI processes are based on the educational environment instead of the business environment. The objective of EI is to achieve a higher intelligence when making decisions in HEIs by efficiently and effectively analyzing historical and current educational data. Moreover, EI is realized by the adoption of BI systems. Like BI, EI systems share the same meaning with EI. It is hoped that finding such an EI system that unable educators put all the educational data from a variety of sources into a single information system that decision makers can use as a useful tool.

EI process

Generally like BI, EI is a continuous and systematic process as well. It produces intelligent knowledge to make better decisions through utilization of educational information. According to BI process presented in the previous section, EI process starts with needs analysis to make sure the effective information management in HEIs. Then through educational data analysis, collection and storage phases which accomplished by intelligent tools like OLAP, data warehouse and EDM. Specifically, Outcomes of EI process support evidence-based decision-making for the whole HEIs by report information consistently through all levels, from executive to operational; benchmark against other institutions and organizations and some other functions which can drive decisions and actions.

EI benefits

EI can make large amounts of raw data more accessible, understandable, and useful by providing computer-based tools for individuals who work for HEIs to speedily process, organize, manipulate, integrate, and analyze that data. The proper implementation of the EI system can deliver many benefits. Combined with JISC (2011) and BI at Indiana university (2009), some of the key advantages include:

- *Fast, evidence-based decision making. When analytical data is readily available and understandable, people who work for HEIs can more easily act in ways that improve performance and support the overall strategy of the university.*

- *Reliable presentation of needed information. Having all educational data integrated, and with clear, easily accessible definitions will allow users to spend less time finding and figuring out the data and more time analyzing and making informed decisions based on the data.*

- *Maximize the use of student information and data. Through the EDM in EI process, educators achieve a better understanding of the student life cycle, pathways and experience. Thereby the understanding of the situation of students gets improved and student those at risk like who has a trend to drop is identified.*

The above advantages are realized by the BI techniques which can be seen as EI techniques. Like EDM which analyzes data looking for patterns and relationships that can be used to predict students' future performance; Data Warehouse that can manage and store information that has been extracted, cleaned up, filtered, reorganized, and integrated from several electronic sources of data like student engagement tracking system; OLAP allows for multidimensional analysts of

educational data and dashboards like monitors which provides real-time digital visual indicators of how well predetermined aspects of an university are working. Those EI tools help users turn basic data into information and knowledge to support evidence-based decision making in HEIs in order to meet educational goals.

2.4 Information technology adoption and its theoretical models

2.4.1 Needs to investigate information technology adoption

User's acceptance of IT will becoming increasingly significant as IT having been playing a critical role in the global economy, researchers in the area of IS and IT show strong interest in investigating the theories and models that could predict and explain behavior across many domains (Pervan and Schaper, 2004). A successful investment in technology can lead to enhancing productivity. On the contrary a failed system will contribute to undesirable consequences such as financial losses and dissatisfaction among employees (Venkatesh, 2000). Namely, if the new IT can be accepted and adopted, the possibility of investments in this IT is greatly enhanced and investors can obtain better investment return (Behrens *et al*., 2005). Accordingly, it is necessary to understand the user's acceptance to new IS before it is adopted. Moreover, a good understand of determinants of information systems use can ensure effective and successfully deployment of the EI system in HEIs. Thereby the application of BI systems in HEIs is improved.

2.4.2 Theoretical models to investigate technology acceptance

Since the importance to understand the determinants of IT adoption is discussed above, it is necessary to know the theoretical models. Venkatesh and Davis (2000) note that significant progress has been made over the past decade in trying to understand and explain user acceptance of IT.

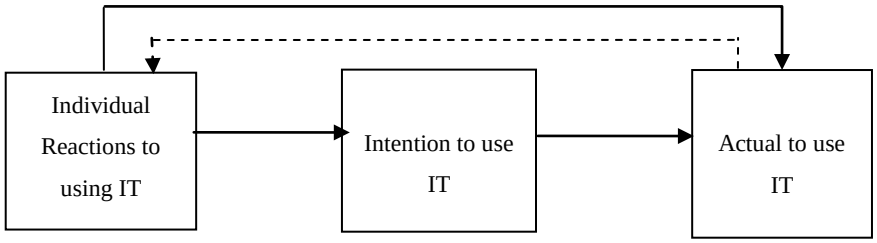

Figure 2-6 Basic Concept Underlying User Acceptance Models (Venkatesh *et al*., 2003)

As can be seen from the figure above, the model presents a process of users' acceptance to an information system. Individual reaction to use the information system directly influences individual's intention to use it. Sequentially, intention to use contributes to actual adoption of IT (Venkatesh *et al.*, 2003). The basic conceptual framework is shown above underlying the class of models which explain users' acceptance of an information technology and forms the basis of following research.

There are many theories models with a varying degree of impact on the evaluation of user acceptance in information technology research which refers to areas of information systems, psychology, and sociology (Davis *et al*., 1989; Venkatesh and Davis, 2000). The popular theories are the theory of reasoned action (TRA)

(Ajzen and Fishbein, 1980) theory of planned behavior (TPB) which is proposed by Ajzen (1985, 1991), and Technology Acceptance Model (TAM) (Davis, 1989). Each technology acceptance theory or model has different premises and benefits. It is therefore important to study them intentionally. It is hoped that from discussion of these diverse theories a comprehensive understanding of individual acceptance to technology can be achieved thereby the theoretical framework for this study can be formalized.

The next section will introduce three classic theoretical models of technology acceptance, and they are TRA, TPB and TAM. After the discussion of the comparison of three models, the theoretical model which will apply in this study is presented.

Theory of Reasoned Action (TRA)

Theory of Reasoned Action (TRA) shown in figure 2-7 is proposed based on social psychology, and it defines the factors that underlie individual's intentions to perform a specific behavior, which makes TRA become one of the most influential theories to predict a wide range of behaviors (Adham and Ahmad, 2005).

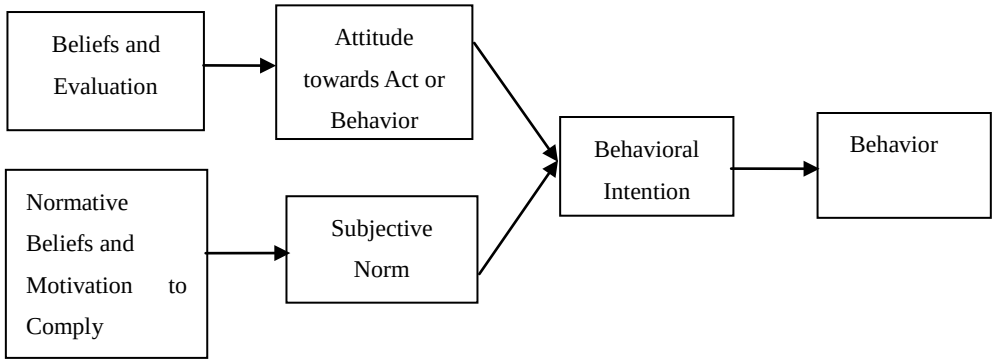

Figure 2- 7 Theory of Reasoned Action (TRA) (Ajzen and Fishbein, 1980)

The core constructs of TRA is attitude toward act or behavior and subjective norm. Fishbein and Ajzen (1975) define an individual's positive or negative feelings (evaluative affect) about performing the target behavior. While subjective norm refers to an individual's perception of what other people think of his or her behavior in question (Ajzen and Fishbein 1980). Now, TRA is widely used to study the determinations of information systems use behavior especially in management information systems acceptance research (Davis, 1986; Han, 2003). Although many models to investigate technology acceptance are based on different theoretical perspectives, considerable research related to technology acceptance starts studied with TRA.

The limitation of TRA as Davis *et al.* (1989) pointed out, there is no any direct relationship between four external variables (see figure 2-7) and the behavioral target which however directly influenced by user's behavioral intentions to use. Owing to the limitation, researchers introduce another model which is theory of Planned Behavior (TPB).

Theory of Planned Behavior (TPB)

The Theory of Planned Behavior (TPB) is proposed as an extension of the TRA. TPB introduced another independent determinant of intention behavioral to use which is perceived behavior control.

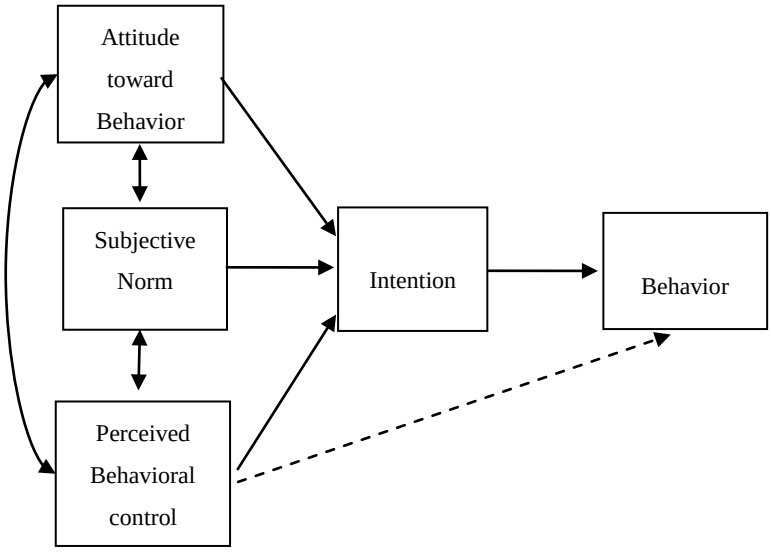

Figure 2- 8 The Structure of Theory of Planned Behavior (TPB) (Ajzen, 1991)

Figure 2-8 presents the simplified structure of TPB. Considering the original theory of reasoned action, a crucial factor in TPB is the user's intention to use the technology. Ajzen (1991) reviewed TPB study and suggested that TPB introduces an additional variable in order to account for situations where the user lacks the control or resources necessary for carrying out the targeted behavior freely. In addition, with behavior being deliberative and planned, TPB predicts deliberate behavior, and TPB is considered to be more general than TRA because of

perceived behavior control (Chau and Hu 2002). Numerous studies adopt TPB to predict intention and behavior in many different settings (Ajzen, 1991).

Technology Acceptance Model (TAM)

TAM suggests the belief of attitude, intention and behavior with their causal relationship to explain and predict technology acceptance among potential users. TAM was introduced by Davis (1989) who combines two theories in social psychology which are presented above: Theory of Reasoned Action (TRA) (Ajzen and Fishbein, 1980) with the Theory of Planned Behavior (Ajzen, 1985).

Davis (1989) proposes two major decisive elements influencing TAM: perceived ease of use (PEOU) and perceived usefulness (PU). He defines perceived ease of use as "the degree to which a person believes that use of a particular system would be free of effort" which determines potential users' intention to use it. Whereas,, perceived usefulness is "the degree to which a person believes that use of a particular system would enhance his or her job performance". It is suggested that perceived ease of use is instrumental in interpreting the variance in perceived usefulness as well (Ha and Stoel, 2009). Thereby users' attitude towards using a new technology will be more positive. Such attitudes will have an impact on the user's behavioral intention and actual system use (Pai and Huang, 2011).

A large and growing body of literature has investigated the application of TAM. TAM is used to understand the users' adoption of particular technology, which is adopted in a variety of area: e-government learning (Shyu and Huang, 2011), Internet banking and banking technology (Adamson and Shine, 2003; Chau and Lai, 2003); email technology (Huang *et al*., 2003); online games (Hsu and Lu, 2004); e-commerce (Henderson and Divett, 2003); internet usage in HEIs (Kripanont, 2007). At present, TAM plays a critical role for object-oriented technology that needs to put effort to maximize its effectiveness (Lee *et al*., 2006).

2.4.3 Comparison of theoretical models

Davis *et al*. (1989) compared TRA and TAM with a survey in the MBA student's relative facility, specifically the survey was taken within-subjects model comparison of intention and use of a word processor across two time periods with the term of 14 weeks. After survey, they found that TAM better explained the acceptance intention of the users than TRA (Lee *et al*., 2003). Where the variance in intention and use explained by TRA was 32% and 26%, and TAM was 47% and 51% respectively (Venkatesh *et al*., 2003). In addition, to variable which construct the model, the confluence of TAM and TRA led to a structure based on only three theoretical constructs: behavior intention, perceived usefulness and perceived ease of use. Social norms in TRA as an important determinant of behavioral intention however were found to be ineffective in Davis's research (Davis *et al.*, 1989;

Karahanna *et al*., 1999).

On the other hand, Hubona and Cheney (1994) did research which compared both TAM and TPB and found that TAM experience a slight empirical advantage. More specifically, the variance in intention to explain by TAM was 70% and TPB was 62% (Venkatesh *et al*., 2003), although TPB investigates more specific information and provides deeper analysis of why users might not use a technology. However, TAM is easier to use than TPB, and offers a quicker way to gather general information about users' perception of a technology.

In addition, Lee *et al*. (2003) reviewed TAM and classified over 30 different types of information systems which are used as target systems into four major categories and have been investigated for its adoption by TAM; they are communication systems, general-purpose systems, office systems, and specialized business systems. According to the categories, the EI system belongs to specialized business systems. In his research, 30 percentages of studies are related to specialized business systems which exceed other categories. Namely, TAM has been largely used to understand users' acceptance to information systems like EI. Moreover TAM can explain more than 40% of the use intentions for an information system (Legris *et al*., 2003).

In conclusion, on the one hand the comparisons confirmed that TAM is

parsimonious and easy to apply across diverse research settings and which is widely applied in researches of investigations to acceptance to information systems like EI. Namely, TAM has both a well-researched and validated inventory of psychometric measurements, making its use operationally appealing. That makes TAM much simpler, easier to use, and more convincing to explain users' technology acceptance than other models (Paul and Pearlson, 1999). On the other hand, TAM is a dominant model for investigating user's acceptance to IT, and also, it has accumulated fairly satisfactory empirical support for its overall explanatory power, and bas posited individual causal links across a considerable variety of technologies, users, and organizational contexts (Paul and Pearlson, 1999). Consequently, in this research, the theoretical model is based on TAM with four major items are: three variables are perceived usefulness (PU), perceived ease of use (PEU) and attitude towards to use (A) is used to predict behavioral intention to use (BIU) EI which directly influence the actual usage of EI.

2.5 Theoretical framework for the acceptance behavior of EI

The relation between TAM and EI is argued via hypotheses concerning internal elements of the models. Namely, this research uses the original TAM for the purpose of this research. The original TAM tests the impact of four internal variables upon the actual use of the technology. These four internal variables are: perceived ease of use (PEU), perceived usefulness (PU), attitude toward use (A)

and behavioral intention to use (BIU). BIU is used as both a dependent variable and an independent variable. When it comes to predicting the actual usage, BIU is regarded as a dependent variable to test the validity of the independent variables PU and PEU (Davis *et al.*, 1989). Combined with the EI system, the figure 2-9 illustrates the original TAM model utilized in this research.

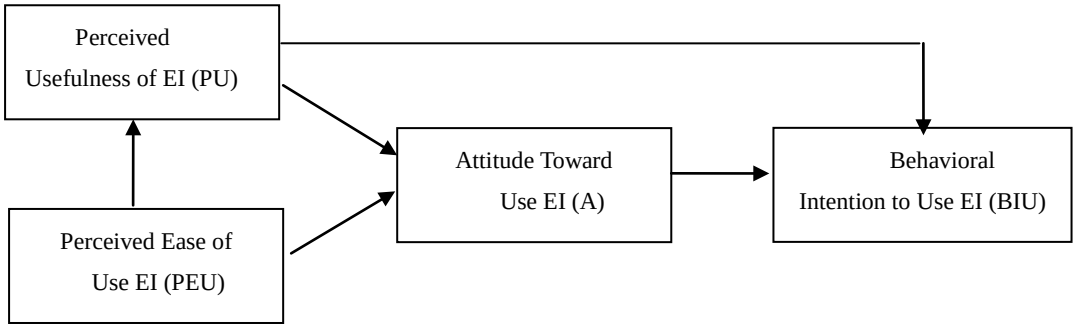

Figure 2- 9 The conceptual model for this research (adapted from Davis, 1989)

Definitions of Variables

TAM delineates the causal relationships between perceived usefulness, perceived ease of use, attitude, and behavioral intention to explain user acceptance of new technologies.

Perceived usefulness (PU) is defined as "the degree to which a person believes that using a particular system would enhance his or her job performance" (Davis, 1989). This definition comes from the word "useful". Davis also suggests that a system with high perceived usefulness, whose users believe in the existence of a positive use-performance relationship (Lee *et al*., 2009). Moreover, Tan and Teo (2000) consider that the perceived usefulness is an important factor in determining

adaptation of innovations. To this research, some of benefits of perceived usefulness refers to characteristics of systems that can improve academic staff' job performance quicker task completion, like: easier work; increased quality of care or quality of work; more accurate or more objective accomplishment of tasks; better evidence-based decisions; support of critical tasks and others to the outcome, to name just a few.

Perceived ease of use (PEU) is seen as a predictor of PU by many researchers (King and He, 2006). PEU is explained as the degree to which users believe that utilizing a computerized system will be free of physical and mental efforts (Davis, 1989). Moreover, according to Davis (1989), four items in this study have an influence on this variable, they are whether EI is easy to use; whether EI is easy to do with what users desire; will user's skills increased by using EI and finally will EI is easy to operate.

Attitude towards use (A) is the user's evaluation of the desirability of employing a common information systems application (Lederer *et al.*, 1998; Ajzen and Fishbein, 1980). Some previous literatures have proven that A is influenced by both PU and PEU (Davis, 1993). In this research, attitude towards to use EI refers to users positive or negative feelings toward adopting the EI system.

Behavioral intention to use (BIU) is a measure of the likelihood a person will

employ the application (Lederer *et al.*, 1998). In TAM, the variable BIU is influenced by both PU and A, which have been indicated by numerous researchers (Venkatesh and Davis, 1996; Shyu and Huang, 2011). Finally, the basic concept underlying user acceptance models in the previous section support that actual usage is determined by BIU. Since all above relationships between four variables have been carefully investigated in TAM literature, this research invalidates those relationships in adoption of the EI system.

Research hypothesis for this study：

According to this theoretical framework and above discussions, the research hypotheses that will be set up as follows:

H1. Perceived ease of use (PEU) EI positively affects perceived usefulness (PU) of EI.

H2. Perceived ease of use (PEU) EI positively affects a user's attitude towards use (A) EI.

H3. Perceived usefulness (PU) of EI positively affects a user's attitude towards use (A) EI.

H4. Perceived usefulness (PU) of EI positively affects the behavioral intention to

use (BIU) EI.

H5. Attitude towards use (A) EI positively affects a user's behavioral intention to use (BIU) EI.

The following subsections explain the hypotheses in more detail.

Perceived ease of use (PEU), perceived usefulness (PU) and attitude towards use (A)

There is a large amount of literatures supporting that PEU directly influenced PU and A (Davis *et al*., 1989; Kim *et al*., 2008). Specifically, the easier a technology is to use, the more useful it is perceived to be, and the more positive individual's attitude and intention toward using the technology (Davis *et al*., 1989). Therefore two of hypotheses to this research are concluded below:

H1. Perceived ease of use (PEU) EI positively affects perceived usefulness (PU) of EI.

H2. Perceived ease of use (PEU) EI positively affects a user's attitude towards use (A) EI.

Perceived usefulness (PU), attitude towards use (A) and behavioral intention

to use (BIU)

Previous research suggested that PU has a positively effect on attitudes towards use (Kim *et al*., 2008; Davis *et al*., 1989). And many researchers state that PU has a significant effect on BIU of information systems (Kim *et al*., 2008). The two hypotheses are:

H3. Perceived usefulness (PU) of EI positively affects user's attitude towards to use (A) EI.

H4. Perceived usefulness (PU) of EI positively affects the behavioral intention to use (BIU) EI.

Attitude towards use (A) and behavioral intention of use (BIU)

Some studies on technology acceptance have indicated that there is a positive relationship between A and other variables mentioned before, where one of them is the variable what can be used as either an independent or dependent variable is the BIU that can predict actual usage of information technology (Davis, 1989). Thereby the hypothesis is:

H5. Attitude towards to use (A) EI positively affects a user's behavioral intention to use (BIU) EI.

2.6 Chapter Summary

This chapter reviews BI concept, process models, BI technologies and its applications. Besides, the application of BI in HEIs is investigated. Along with it, the EI concept is proposed with its benefits to HEIs. To explore EI acceptance, finally, TAM is used for proposing a conceptual model along with the hypothesis to support the foundation for empirical investigation of the EI system pre-adoption. The next chapter will introduce research methodology and methods for this study.

Chapter 3: Research methods

This chapter describes the chosen research methods and analytical techniques. Research methods for this thesis are selected in order to successfully achieve the research objectives. Also, the justification of choices and uses are presented in this chapter. The first section introduces research methodology and discusses general issues about research philosophy and approaches. The second section introduces the research methods adopted in this study and its process. The final section explains Structural Equation Modeling (SEM) technique used for hypothesis tests.

3.1 Research methodology

The purpose of this study is to promote BI applications of BI in HEIs. In order to fulfill this study and achieve this purpose, a certain research methodology has to be adopted or used as a tool or vehicle as Tabachnick and Fidell (2007) described it to be, a structured set of guidelines or activities to assist in generating valid and reliable research results. Hussey and Hussey (1997) listed different types of research methodologies which include exploratory, descriptive, analytical, predictive, quantitative, qualitative, inductive, deductive, applied and basic research. The research methodology and methods selected for this research were

chosen due to their relevance in order to successfully achieve the research objectives. These two types of business research: applied and basic research (Sekaran, 2003). Research which is done with the intention of applying the result of the findings to solve specific problems is named applied research. Since this research aims to take some measurements to improve the adoption of BI systems in HEIs, therefore this research can be seen as a piece of applied research on the application of BI in HEIs.

There are essentially two approaches with respect to the research process: quantitative and qualitative approaches. Neuman (2006) defined quantitative approach as "an organized method for combining deductive logic with precise empirical observations of individual behavior in order to discover and confirm a set of probabilistic causal laws that can be used to predict general patterns of human activity", whereas qualitative research is defined as non-numerical examination and interpretation of observations, for the purpose of discovering the underlying meanings and patterns of relationships (Creswell, 2003; Patton, 2002).

To this study, the approach involves statistical analysis which is based on numerical evidence to test hypotheses model and focuses on the measurement and analysis of causal relationships between variables. Since Amaratunga *et al*. (2002) suggested that quantitative approach assists the researcher to establish statistical evidence on the strength of relationships between both exogenous and endogenous

constructs. As a result, quantitative approach was followed in the course of research.

3.2 Main steps in this research

Research methodology is referred to as a general approach to studying research topics. There is therefore a need to design specific research techniques to fit well with theory, hypothesis and methodology (Silverman, 1994). Research methods are chosen to achieve this research's objectives.

In chapter 1, it states that this research aims to enhance the adoption of BI in HEIs. Then three objectives are proposed for enhancing this adoption, which have been listed: the first objective is to understand the BI systems and the current applications and challenges of BI systems in the HEIs. To fulfill this objective, in chapter 2, the literature review is derived from BI and its future trend. Secondly, chapter 2 reviews current situations of BI applications in HEIs. All processes have accomplished along with the literature review process.

The second objective is to clarify and define the BI concept and systems in the context of HEIs, and develop a demonstration portal to introduce and demonstrate key BI concepts and applications. This objective has been achieved in chapter 2 as well where the EI concept is proposed based on the BI concept and its application in higher educational sectors according to previous study. Along with the shaping

of the EI concept, EI process, EI benefits and tools are discussed and presented. In addition, this objective's work will service for the third objective.

The third objective is to investigate factors determining the potential users' acceptance of BI systems, and provide recommendations and implications for research and practice in improving BI success in the education environment. This study mainly concentrates on the third objective. In conclusion, there are two major stages to achieve this objective as explained below.

Stage one – Developing an EI demonstration portal.

One of these research objectives mentioned above is to clarify and define the BI concept and systems in the context of HEIs. Through literature review in chapter 2, this research defines the concept of EI. It is then necessary to create a place not only for demonstration of EI but also to serve as a point of access to the relevant EI information.

Considering that internet is known for its wide use, it is advisable to utilize internet as the best measurement to demonstrate the EI concept. The following section about the development of an EI demonstration portal will present a brief introduction of development of the web portal which demonstrates the key BI concept and applications to users.

EI demonstration portal will be a bridge to investigation of user's intention to use EI. Moreover, it also processes a collection of theories and models from literature and online resources about the EI concept, which come to complete and enhance the EI concept structure. Later, the EI demonstration portal will be a part of investigation to EI acceptance.

Stage two – Conducting a survey on EI adoption by academic staff in a Chinese University to understand the factors affecting their adoption intention.

Through literature review in chapter 2, this research adopted the TAM theory as the conceptual model to investigate the users' acceptance to EI concept and systems. This study adopted TAM to propose the hypothesis and design the questionnaire. Following that approach, this research further used SEM to test and examine the hypothesis so that this research is conducted in accordance with a research process based on the deductive approach.

The research process for stage two can be summarized into five steps:

1) Information gathering for the theory formulation: Through literature review in chapter 2, the researchers discussed different theories to investigate the adoption of IT and come to use TAM model as the theoretical model for this thesis.

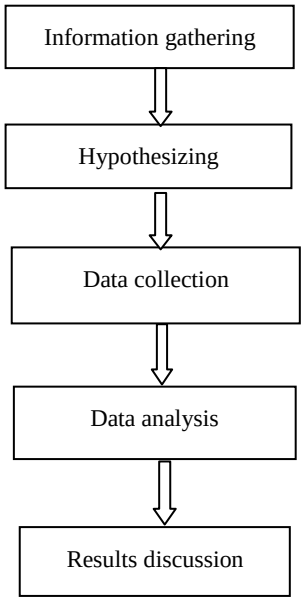

Figure 3- 1 Research process for stage two

2) Hypothesizing: This step is used to generate various hypotheses for testing intention to use EI demonstration portal.

3) Data collection: A questionnaire is developed, based on various theorized factors, to determine intention to use the EI system.

4) Data analysis: Data analysis includes the primary data analysis which determines how well the questionnaire and data is. Namely, the reliability and validity of data will be tested next chapter. Then, data obtained through the questionnaire is analyzed to see what factors influence behavior intention to use by using SEM.

5) Results discussion: This section focuses on theoretical justification and

interpretation of causal relationships of the theoretical model based on the SEM results.

The following section presents a brief process of development of the EI demonstration portal.

3.3 Development of the EI demonstration portal

This section aims to present a brief introduction of the process to build an EI demonstration portal. Before explaining users' analysis and the approaches to build EI portal, benefits of web portal is going to be discussed at first.

3.3.1 Benefits of portal

Simply, the portal is a web site that brings together information from diverse sources in a unified way. And usually, each information source gets its dedicated area on the page for displaying information. The widespread adoption of internet networks has largely increased the ability to store, transfer and generate knowledge, enabling and accelerating the emergence of an economic, organizational and technological landscape (Schwartz *et al.*, 1999; Romano *et al.*, 2001; Benbya *et al*., 2004). Web portals are used in many areas. For example, portals improve e-business by providing a unified application access, information management and knowledge management both within enterprises, and between

enterprises and their trading partners, channel partner and customers (Gartner Group, 1998). Simply, the portal is a web site that brings together information from diverse sources in a unified way. And usually, each information source gets its dedicated area on the page for displaying information.

In particular, a portal provides a function that users could log into the portal and meanwhile, the portal offers personalized services: a best example in this category is Yahoo (www.yahoo.com). However, today the term is used widely to describe many different types of products with different purposes. What distinguishes the approach of the EI demonstration portal from other ordinary portals realized by standard techniques, is that this EI demonstration portal does not need users to log in and support or store personal data. It is intended instead to focus on demonstrating the EI concept as mentioned above. In this way, users who are interested in the EI concept just need the browse the information in the portal and achieve the information he or she wants.

Information portals have been proven to be successful gateways to information in the World Wide Web (Brunkhorst and Henze, 2005). An information portal like the EI demonstration portal provides collections of relevant information on specific topics, group and structure information, and support the user in selecting and accessing information in a convenient way. In conclusion, it is advisable to demonstrate the EI concept in a demonstration portal format, which can be treated

as an information portal with its web browser allowing the user interface access virtually any information source.

3.3.2 A brief introduction to EI demonstration portal

Next, before building the demonstration portal, users group to this web site should be considered. When making decisions, to a different user group, the educational data they need differs from each other's. The EI demonstration portal aims to map EI concept to specific users. More specifically, sources of the EI web portal focus on a specific user group and it will be discussed in the next chapter. This EI demonstration portal will provide some tools and instructions to guide academic staff to make their decisions which is going to be presented and discussed explicitly in the next chapter as well. Also, this web-portal is going to be part of an investigation to acceptance of EI. This demonstration web portal link will be attached to the following survey.

3.3.3 Process of developing EI demonstration portal

The main process of building EI demonstration portal can be divided into five steps outlined in figure 3-2 below:

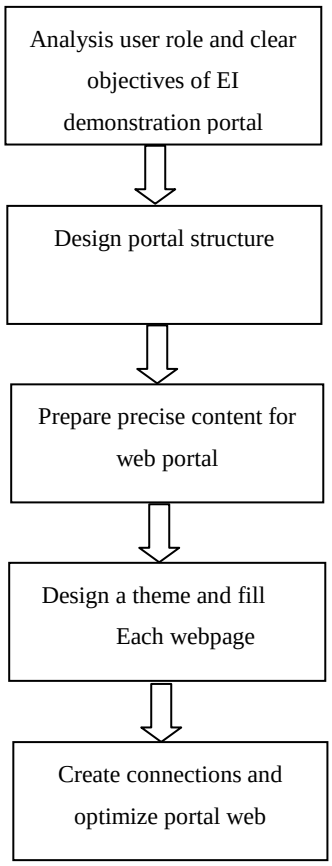

Figure 3- 2 Procedures of developing the EI demonstration portal

The first step is to identify the target users, and clarify the portal's objectives. According to the EI users introduced in chapter 2, a target user group to this EI demonstration portal should be determined. EI web portal aims to provide a service for the academic staff, and then the web portal's objectives will be presented after that (see chapter 4). It is by accomplishing both these two processes, that the next step can be conducted.

The second step is to design the portal structure. In this step, designers should build the whole structure. The next step of setting up the portal which is going to show up in the internet will be based on the structure. Therefore the development of a website is a critical part.

The third step is to prepare the precise content for the web portal. What will be presented in chapter 4 are content of this portal included EI concepts and systems and some external links to other websites related to BI technologies and the application of BI in HEIs. In addition, some free resources on the web will be provided.

The fourth step is to design a theme and fill each webpage. After the precise content for the web portal is ready, the designer needs to distribute the content into each part of this website structure. When designing a theme, it is better to choose a clean and brief dominating tone which could make a good impression to users. The content design where texts are used should be made easy for the visitors to understand what author's want to highlight. Alongside the content design, the aesthetic design has to be very attractive and logical. Moreover, proper icons for links, pictures, navigation bars etc. must be used and color combination has to be kept consistent. At the same time, make sure each webpage be linked in order.

When all portal design work is done, the fifth step comes with its mainly jobs are creating connections and optimizing the portal web. To be specific, all the pages will be assembled into a whole independent web portal and allowing the users access information through browsing it online.

The following part presents the other main stage of the thesis, which is the process

to investigate users' adoption to the EI system by way of a questionnaire survey.

3.4 Questionnaire design

3.4.1 Data type

To investigate user's acceptance to EI, this research adopts two kinds of data to conduct quantitative research: primary data and secondary data. Primary data are those which are collected by the researcher his/herself, and thus are original in character (Kothari, 2008). One the other hand, secondary data refers to obtaining data from the existing data which have been collected by pervious researchers already like records, publications, and data bases. This research is going to use secondary as additional information to help the research analysis.

3.4.2 Data collection

Saunders *et al*. (2009) identified that data collection is a process which offers a reliable method for scientific research through obtaining information which include opinions, beliefs, feelings and attitudes from people.

To obtain primary data, individuals, focus groups, panels and other unobtrusive measures can be used. On the other hand, secondary data is derived from the existing sources which have been gathered through records, publications, and data bases by others already. Sekaran (2003) suggested that if the research topics adopt

appropriate data collection methods, the value of the research will achieve greatly enhancement. Thus it is critical for researchers to choose appropriate data collection methods that refer to the types of data they will use in their research.

Sekaran (2003) also addressed that there are three primary data collection methods in survey researches, which are interviewing, administering questionnaires, and observing people and phenomena respectively. Whereas others think questionnaires and interviews are specific methodologies used to conduct survey research (Gay and Diehl, 1992; Veal, 2005). Primary data in this research is collected by using questionnaires.

1) Questionnaire Design

Questionnaire design is the advance question setting which records respondents' answers and it is normally within closely defined alternatives (Saunders *et al*., 2009). The purpose of the questionnaire for this research is to survey and investigate users' acceptance of EI.

The questionnaire is composed of three parts. (See the questionnaire in APPENDICES)

The first part begins with the EI demonstration portal link to let users generally understand the EI concept and the EI system, then gives a brief detail of the EI

system tasks. The second part is personal information. Finally, the third part of the questionnaire was based on the structure of TAM discussed above comprising of 5-point Likert-type scales with end-anchors (1= strongly disagree, 2 = disagree, 3 =neither agree nor disagree, 4 =Agree, 5= strongly agree). Table 3-1 shows the structure of the questionnaire and their supporting literatures.

Table 3- 1 The Questionnaire Structure

Items for measuring for perceived usefulness (PU) of EI	
EI would provide valuable service to me	Davis (1989, 1993);
Using EI would enable me to better understand students	
Using EI would enhance the quality of my work	
Using EI would make it easier to do my job	
Using EI would enhance my effectiveness on my job	
I would find EI useful in my job	
Items for measuring for perceived ease of use (PEU) of EI	
Learning how to use the EI system would be easy for me	Davis (1989, 1993); Venkatesh and Davis (1996);
I would find it easy to acquire targeted information by using EI	
I wound find EI easy to use	
Items for measuring for Attitude towards (A) to use EI	
Using EI is a good idea	Davis *et al*. (1992); Hu *et al*. (1999); Taylor and Todd (2001)
Using EI is a wise idea	
Using EI would be beneficial to my work	
Items for measuring for behavioral intention (B) to use EI	
I intend to use EI when it becomes available	Davis *et al*. (1992); Hu *et al*. (1999)
To the extent possible, I would use EI to help make decisions	
I intend to use EI to acquire target information	
I intend to use the serves offered by EI	

2) Questionnaire Pre-testing

Sekaran (2003) defines pre-testing is a trial run with a group of respondents for

the purpose of detecting problems in the questionnaire instructions or design, whether the respondents have any difficulty understanding the questionnaire or whether there are any ambiguous or biased questions. Pre-testing can significantly reduce survey development time, improve the quality of data collected, and can minimize non-sampling error.

Before distributing questionnaires, the pre-testing was conducted within three Chinese academic staff in University of Bedfordshire (UoB), to gauge whether the questionnaire is appropriate or not in terms of its structure, language, and questions designed before as stipulated by Sekaran (2003). After pre-testing, questions in the second part of Perceived Usefulness (PU) of EI were reduced from 7 to 6, and two of the questions were similar in semantics so the two questions were combined into one. Furthermore, the first part - introduction of EI in pre-tested questionnaire was too long and some sentences were deleted that made it easier to be read and understood.

3) Questionnaire Administration

This survey was conducted within a university in Beijing China. Before the analysis of the reason to conduct survey in a university in China, the following section presents a brief introduction of the current situation of ICT application in HEIs in China.

According to UAECO (2011), to higher education, most Asian countries including China focus their ICT development on three main areas, and they are open and distance learning, blended learning, and administration and management, where the first two areas belong to e-learning sector. In China, ICT has been popularly applied to education in the last two decades (Zhao, 2009). In early 90s, a small group of top universities in China set up the first education network protocol named China Education and Research Network (CERNET). CERNET allows numbers of educational institutions share safe and high-speed information both at home and abroad. Based on CERNET, Chinese HEIs moved into a new era of the e-campus by which educators benefit from campus network and the integration of digital resources like e-educational administration portal, e-learning, distance education and multimedia broadband network, campus management information system, etc. Which forms an optimal digital environment so as to gradually extend the application of ICT throughout the whole campus (Li and Lei, 2005; Zhao and Jiang, 2010).

Specifically, the construction of e-campus in Chinese HEIs are composed by systems like management information system, bulletin board system, search engine for campus information resources campus, card system and campus portal system and so on (Hu and Zhang, 2008). Along with the rapid development of e-campus, educators come to use ICT in their classrooms, which lead to the implement of e-learning which has become the tendency of teaching reform in

Chinese HEIs. Zhao (2009) classified e-learning in higher education in China into three approaches: conventional model, blended model and distance model. Now, researchers focus on to apply e-learning more actively (Zhao and Jiang, 2010).

On the other side, some researchers focus on ICT application in HEIs which are used for administration and management purpose, where administrative functions refer as student registration, grades, course schedules and even staffing evaluation. Chen and Zhu (2009) suggest that the current management systems in HEIs in China are facing some problems which become obstacle to increase the working efficiency: Firstly, most management systems were designed to meet the needs for different departments of an university, which leads to the limitation of the data and information sharing between departments. Secondly, the processing of the majority of management systems only offers low end operations, which are the input, the revision, the inquiry, the deletion and so on instead of functions to analysis data. Thirdly, the databases of systems store large amount of data and barely make better use of those data which can be used to understand students' performance. With the challenges above, some researchers introduce BI concept to cope with the current situation (Chen and Zhu, 2009; Li et al., 2010). Viewing the background of this research which is presented in Chapter 1 and 2, HEIs are all facing such data-abundant problems regardless of China or UK, meanwhile BI techniques are proposed by many researchers to cope with the challenges. In this background, this research investigates the user' acceptance to EI in a university in

China.

To this research, there are two reasons to select that university as the sample: One is that, according to the introduction of the selected university, the distribution of the staff meets the demands for the average staff distribution in universities in China and the selected faculty shares the same staff distribution to the entire university. Meanwhile, its facilities and infrastructure are in the upper level of universities in China. The other one is that it is easy to access data to the selected faculty. Therefore, such a representative population is selected as the sample for this research. Chinese academics normally use Chinese in everyday life so it was inappropriate to conduct this survey in English but in Chinese and to save reading time as well. The Chinese questionnaires were sent and received by email.

The survey was conducted over a short period of around 10 days in March 2012. All the questionnaires were responded by academic staff in one key university in China. At the end of the survey, 89 questionnaires were collected, 4 questionnaires were eliminated for incompleteness, resulting in 85 useful responses. To obtain the above data, SPSS software is adopted. The output of the analysis in SPSS shows the questionnaires. According to the output, researchers can identify those questionnaires and decide on what to do with them later on.

4）Analysis of Descriptive Characteristics Respondents profile

Through SPSS process, respondents' information is shown in Table 3-2 below:

Table 3- 2 Respondents' Profile and Statistic Results of Questionnaire

Items	**Detail variables**	Frequency	Percentage (%)
Gender	Male	42	49.4
	Female	43	50.6
Age	18-29	19	22.4
	30-39	24	28.2
	40-49	27	31.8
	50-59	15	17.6
Education level	Bachelor	24	28.2
	Master	26	30.6
	PHD	35	41.2
Position	Lecturer	43	50.6
	Academic tutors	24	28.2
	Administer	18	21.2
The teacher in charge of a class	Yes	45	52.9
	No	40	47.1
Understanding of the degree to EI	Never heard	10	11.8
	Know little	48	56.5
	Generally know	25	29.4
	Know well	2	2.4

3.5 Introduction to Structural Equation Modeling (SEM)

Since one of the objectives of this research is to generate a theoretical model that investigates intentional usage behavior to EI among academic staff in university, Structural Equation Modeling (SEM) will be adopted to investigate the impact of moderators on the generated model.

3.5.1 Definition of SEM

SEM is a method which has been used extensively in measuring relationships among latent variables since it was originated by Sewall Wright's work in the early 20th century (Bollen, 1989). Savalei and Bentler (2010) describe SEM go beyond ordinary regression models to incorporate multiple independent and dependent variables as well as hypothetical latent constructs that clusters of observed variables might represent. In other words, SEM is a method to test the specified set of relationships among observed and latent variables as a whole and able theory testing although sometimes experiments are not possible. Therefore SEM is attached great importance widely in areas of social and behavioral sciences (MacCallum and Austin, 2000).

3.5.2 Advantages of using SEM

Several technical characteristics of SEM set it apart from other multivariate data analysis methods (Hair *et al*., 1995). Comparing with other multivariate techniques, Byrne (2006) listed some significantly main advantages: Firstly, SEM takes a confirmatory approach rather than an exploratory approach to the data analysis, although SEM can also address the later approach. Most other multivariate techniques are essentially descriptive by nature and that makes hypothesis testing difficult to conduct, However SEM lends itself well to analysis of data for the purpose of inferential statistics. Secondly, different from other

multivariate techniques' lack of assessing or correcting for measurement error, SEM offers explicit estimates of error variance parameters. Thirdly, data analysis using SEM procedures can incorporate both unobserved and observed variables. Therefore, it makes the model more realistic and greatly enhances the validity of data (Byrne, 2006). Since SEM provides a comprehensive analysis to deal with a lot of interrelated research questions by modeling the relationships among multiple independent and dependent constructs simultaneously, and combined this work, SEM is used to test hypothesized model.

3.5.3 Stages of SEM

Through using SEM, the hypothesized model can be tested statistically in a simultaneous analysis of the whole system of variables to determine the extent to which it is consistent with the data. To conduct SEM, 7 stages are followed in the analysis process which is listed by Hair *et al*. (1995):

1) develop a theoretically based model;

2) construct a path diagram, and define causal relationships;

3) convert the path diagram into structural equations and measurement models;

4) choose the input matrix type and model estimation procedure;

5) identification of the model: if the model cannot be identified, then go back to the first stage to revise the theory model;

6) evaluate the goodness-of-fit which refers to the examination of the proposed relationships and the whole model structure;

7) Model interpretation and modification.

Before the stage of SEM, Firstly, confirmatory factor analysis (CFA) is used to test the measurement model (i.e. the relationships between latent factors and measurement variables) convergent and discriminate validity and the presence of common method bias in collected data. Based on knowledge of the theory, empirical research, or both, researchers postulate relations between the observed measures and the underlying factors a priority and then tests this hypothesized structure statistically. On the other hand, SEM is used to test the casual effect relations among latent constructs. To conduct SEM analysis, software AMOS is used.

3.6 Chapter summary

This chapter concerns with issues of research methodology and research methods. Then two main stages of this research are described. One is to build an EI demonstration portal. The other stage is to investigate the EI system pre-adoption

by conducting a survey on EI acceptance. The next chapter will focus on data analysis: the validity and reliability of the data and the results from SEM analysis will be presented and discussed.

Chapter 4: Developing an EI demonstration portal

This chapter describes the EI demonstration portal and EI systems. It begins with analyzing users group for the EI system and then introduces the target users role to EI demonstration portal. Secondly, it concludes aims and objectives of EI demonstration portal. The final part of the chapter presents the details about developing process of EI demonstration portal, which includes the introduction of its structure and techniques in building the website, and some screen shots of this web portal.

4.1 EI user analysis

Before building the EI demonstration portal, it is critical to analyze the users. In other words, it is necessary to know who would be the visitors browsing this website and eager to know more about EI knowledge and information.

4.1.1 EI users group and EI data source

An EI system aims to help the decision makers who work for HEIs make better use of both internal and external data in support of educational management and decision making. Nevertheless, a new question comes along with the definition of

EI: whom does the EI system serve for? Namely, it is necessary to know who will become actual users whom the EI system can assist in decision making. The next section gives a discussion about the EI users group and the problems the EI could solve.

HEIs, in many respects, are similar to any large organization with respect to the allocation of decisions throughout the organization. Anthony's hierarchy divides decision making into three broad categories and identifies different levels of focus and interest for each level (Anthony, 1965). In his theory, Anthony called them strategic planning, management control and operational control, although more recently the terms strategic, tactical and operational decisions are often used instead. His theory can be described through a triangle called Anthony's triangle (see figure 4-1). Anthony's triangle takes a hierarchical view of the management structure. With many operational decisions at the bottom, some tactual decisions in the middle and few but important strategic decisions are at the top of the triangle. In this research, users group will be divided based on Anthony's theory.

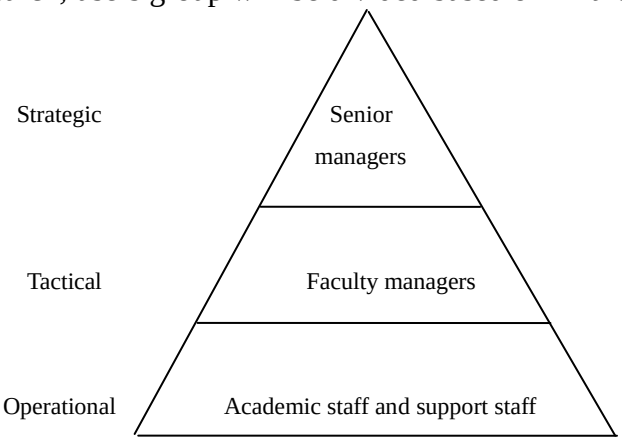

Figure 4- 1 Distribution of EI users group based on Anthony's Triangle (1965)

Anthony (1965) pointed out data on the operational level is basically internal, current, and detailed like organizational operating scheduling. Meanwhile, decisions are largely narrow in scope. In universities and colleges, the major decision makers should be academic staff and support staff and they concern about students data. By using student data they could carry out student management activities, such as benchmarking students' achievement in their study and predicting drop-out tendency. Meanwhile, academic staff needs to make decisions on research project management as well. To the EI, academic staff and support compose a large users group.

In the management control or at the tactical decision level, strategic goals are interpreted into targets and operating criteria. In the HEIs, faculty managers like deans and heads of service departments compose of decision makers at this level. Those decision makers should provide strong leadership in the implementation of a strategic vision that will position the department as a leader. On the responsibilities, they concentrate more on their department's targets. The decisions should include recruiting and major managements, etc. Moreover, data for this users group include financial data and staff data.

Strategic planning level is designed to answer the long-term integrity of the organization by defining the goals and nature of the organization. Namely,

decision characteristics at this level are external issues which focus on the operations of the whole organization. At this level, decision makers are suggested to be senior managers, such as chancellors and vice chancellors, heads of academic departments and heads of service and other departments (e. g. estates, human resources, student information, information services, and finance). Accordingly, senior managers are interested in such areas as salary commitments for the next financial year, future modeling of student numbers to show the impact on finances which is able to model the cost of programming. Therefore, decisions individuals whose position at this level made are related to the university's future. In conclusion, EI users can be divided into three groups based on Anthony's theory. They are:

(1) Academic staff and support staff, where academic staff deal with students data such as assignment, engagement data and results, etc.

(2) Faculty managers including deans and heads of service departments who concern about finial data and human resources data.

(3) Senior managers who are interested in financial data, future modeling of student numbers to show impact on finances, and to be able to model the cost of programs.

Combined with the discussion above and Alnoukari's (2009) study, the data

collected as EI data source which is becoming the evidence for the decision-making process are:

•Student academic data and engagement data (registration, examination, enrollment, engagement records, etc);

• Financial data (student fees, staff salaries, orders, etc.); and

• Human Resources data (staff personal information).

To different EI users groups, the data which need to be analyzed by EI component are different from each other according to the above discussion and the decisions they need to make. This research focuses on how the EI systems help improve decision makings by academic staff.

In addition, based on the above discussion and EI technologies and process which is mentioned in chapter 2, a concept model for EI can be concluded as below:

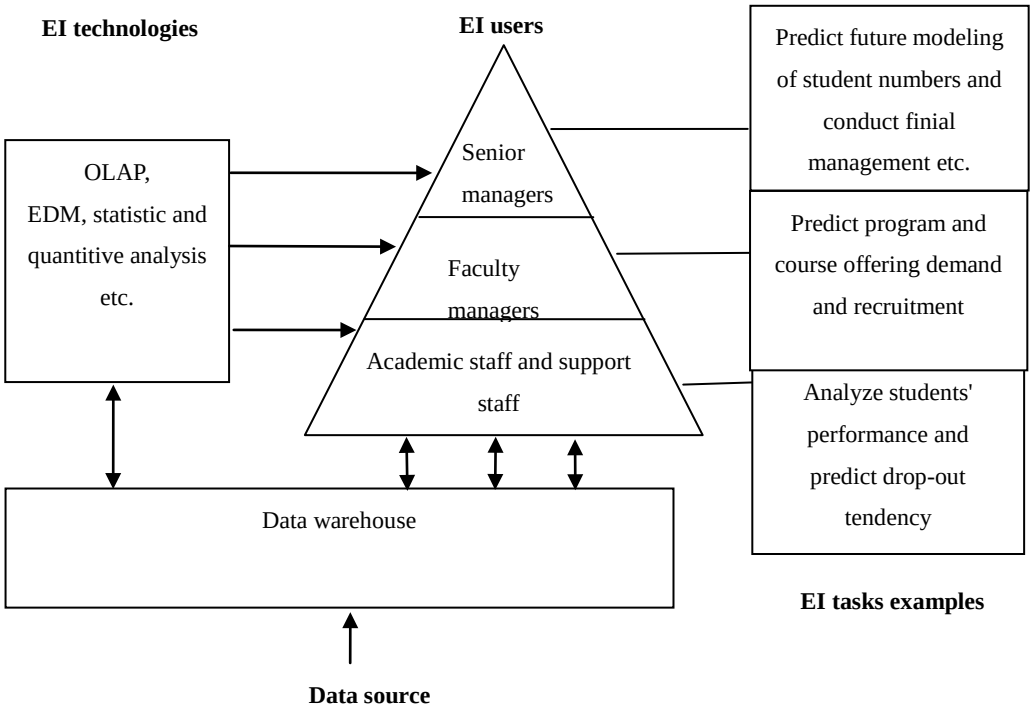

Figure 4- 2 EI conceptual model

Figure 4-2 illustrates a conceptual EI model. It utilizes both top-down and bottom-up approaches. Comprehensive EI encompasses the following: (1) Information integration activities: Data sourcing and data warehousing. Data analysis activities: OLAP, statistical analysis, educational data mining and data visualization etc, (3) Monitor and measures: the specific tasks are presented on the dashboard of EI and allow EI users make evidence-based decisions.

4.1.2 The target users of the EI demonstration portal

As mentioned above, according to Anthony's theory, the EI system users can be divided into three groups. Thereby, users who are going to browse EI demonstration portal should be those three groups: academic staff, senior

managers, and chancellors.

In addition, JISC's (2011) survey result reveals a wide range of areas of interests to individuals who work for the HEIs, clearly indicating the breadth and depth of information that ideal institutions would like to access in order to function proactively and effectively. The specific results show most people who work in HEIs show that they are interested in student data, information and performance measurement, except finance and costing. All above the information are what academic staff face and have to deal with everyday. Another situation should be considered is that: to HEIs, academic staff is a core group who take up the majority of the entire staff in universities and colleges, and they carry out student management activities.

It is concluded that it is that group which consists of academic staff requires an EI system in order for them to make better decisions. So that the EI demonstration portal treat academic staff as the target users who need the most effective planning to know more about students depends on evidence-based decision-making.

4.2 Aims of the EI demonstration portal

This EI demonstration portal aims:

- *To provide users with easier access to the EI concept*. Through browsing EI

portal, users can achieve information easier. The EI demonstration portal plays a potential role between users and information collection and enables users to acquire knowledge quickly and directly.

- *To elaborate a detailed introduction of EI concept.* A well organized website can map EI concept in a logical way. That framework of EI demonstration portal is the basic structure, which will be developed into a rich and constructive educational environment.

4.3 Structure of the EI demonstration portal

A successful portal has to be genuinely useful to target audience, meeting their needs and expectations without being too hard to use, so that the finished portal must be user-friendly and easy to use (Friedlein, 2001). Thereby senior executive can quickly understand the features and access the benefits of the system without wasting time learning EI concept. Meanwhile, a clear purpose is the keys to success in setting up a portal (Burdman, 1999). Since this EI demonstration portal aims to demonstrate a concept and aims to play an educative role, it is needed to build a clear and logical structure as the cornerstone for the website.

The EI demonstration portal structure is graphically presented below:

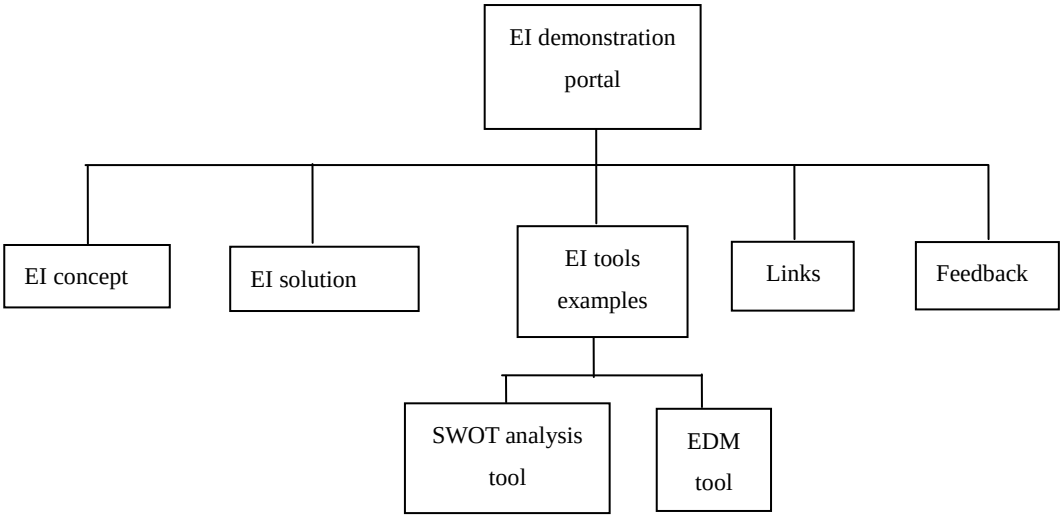

Figure 4- 3 The structure of EI demonstration portal

As the figure shows, this web portal is separated into three layers. Actually, the home page is the entrance of the EI demonstration portal. The EI portal shows five main parts, and each page's description is described in the form below:

Table 4- 1 Introduction of the EI demonstration portal structure

Feature	**Description**
EI concept page	It is the index page which gives a brief introduction to the EI demonstration portal and a definition of the EI.
EI solution page	This page presents a brief introduction to EI benefits and EI techniques.
EI tools examples page	Aimed at EI solution, this page provides two specific EI tools to interpret how EI tools improve academic staff's decision makings.
Links page	It is the collection of existing related websites what provides BI solution to HEIs and some information related to EI.
Feedback page	It is an interactional place where users can make suggestions and report problems.

The home page is the initial page when users access to EI demonstration portal. On this page, there is a brief introduction to the EI concept and this web portal. By selecting the options in the navigation bar, users can go onto each branching pages.

The following section presents a brief introduction to each web page：

1) The EI concept page

This page enables users to understand in details the EI concept and the EI process which have been defined in chapter 2. Because the EI concept comes up with the application of BI, it also provides some BI knowledge to make users easier access to EI area, where BI knowledge is presented via offering several links to authoritative BI web sites. Meanwhile, this page leads to a page which includes interpretation of users groups to the EI system that have already been summarized in the previous section in this chapter. By browsing this page, users come to acquire an idea of EI and the EI system.

2) The EI solution page

This page lists EI benefits to HEIs which have been discussed and concluded in chapter 2. More specifically, an EI system provides fast, evidence-based decision making, reliable presentation of needed information. Meanwhile it also can maximize the use of student information and data. Moreover, this page also presents a general introduction to BI tools task that can positively impact all campuses, all departments, and all areas of responsibility particularly to academic staff to support decision making.

Users who access this page will provide users with a better understanding of the benefits of the EI and the functions of its system. Subsequently, this page as part of the introduction to the EI systems contributes to the investigation of EI adoption survey. In addition, considering readability of web page, more information about EI technologies are linked to external website.

3) The EI tools examples page

Following the introduction of EI solution, the EI tools examples page are given. This page provides specific EI tools examples which are designed for the target users: academic staff. Technically, EI tools provided here should be shown on the dashboard of the EI system with a form of Java application. With academic staff, they deal with student's information and routine of their department.

There are two EI tools examples presented in this page, one of tools' task is:

- **Predicting students future performance and achievement such as the probability of drop-out**

As mentioned by Aziz (2012), EDM techniques will be adopted to conduct the predictive analysis. However, the model to be used in this project is not decided yet. It is hoped to find the best EDM model to be implemented in the multidimensional model in the EI system such as Analytic Hierarchy Process (AHP) models. Moreover, some previous researches have provided various

techniques of educational data mining such as classification, fuzzy rule induction, and neural network, which can be used to classify data. Others study association rules and clustering approach (Romero *et al*., 2008; Hung and Zhang, 2008). The chosen algorithm for a predictive project, which is suggested to be the best method, comes with the highest predictive confidence (Alnoukari, 2009).

Through the EI process, the results of analysis can be presented in the dashboard. Evaluation of the results shows the probability of the student automatically. Meanwhile, the EI system will send alarm emails to academic staff when student's index of drop-out probability beyond a certain threshold. This function assists academic staff in tracking student situation and thereby they can take measures on time.

The other tool's task is:

- **To improve strategic decision making for academic staff**

Herring (1988) suggested BI system cannot only support the strategic decision making process of the corporation, but also support organizations in SWOT analysis. SWOT is short for strengths, weaknesses, opportunities, and threats, and it has been frequently used to design strategic plans since the 1950s (Hung, 2006). By listing factors related to four-group items which will have an influence on the decision going to be made, the results of the SWOT analysis compose of the framework for choosing a project oriented to meet the requirements of the

external and internal environment (Christensen, 1997).

Cameron (1983) stated that universities and colleges require sets of administrative and organizational responses. Consequently, institutional decision makers in HEIs are needed to identify their strengths, reduce their weaknesses, take advantages of the opportunities, and minimize the effect of threats (Hung, 2006). Considering one of EI's keen abilities to improve decision making, EI can provide HEIs with some tools to support evidence-based decision making. Accordingly, it is hoped that EI can provide some functions which allow users to conduct SWOT analysis on the dashboard.

According to the two tasks presented above, EI tools example page provides two tools to fulfill the tasks.

One of EI tools shown on the page aims to support decisions for academic staff, such as predicting potential students' retention through some techniques already applied in the BI systems. The page gives an introduction to EDM. Along with it, a popular tool that can realize data mining function is provided s well. More specifically, the content begins with the demonstration of the EDM concept in terms of definition, application, and method. To enable users to experience EDM, an open source of DM tool is offered with its named Waikato Environment for Knowledge Analysis (WEKA). WEKA contains a collection of visualization tools

and algorithms that allow users to conduct data analysis and predictive modeling, together with graphical user interfaces for easy access to the functionality (Sunita and Lobo, 2011). Moreover, this DM tool uses Java as its base and is compatible with both Windows and Linux. The users of this EI web portal can access to the provided links and they can download this DM tool and install it on their own personal computer WEKA shows how useful EDM can be in higher education, the tool which allows users to predict students' future performance through data inputs. In addition, the EDM tool is provided for the purpose of experiencing the EDM functionality.

Another EI tool is the SWOT analysis. On this page, an introduction to SWOT and how it works in HEIs are described. In the EI system, the evaluation algorithm for SWOT is suggested to be a mission for future researchers. It is hoped that the whole functions can be finished at the dashboard. For instance, academic staff in a university needs to make a decision such as to introduce a new master course. There should be some questions options related to the views of the SWOT theory based on the university itself. By answering the questions and SWOT algorithm, the recommended suggestion will be presented as an evaluated level which shows to what extent the results agree with the original decision.

This page presents detailed tasks which EI tools can accomplish. The same to the EI solution page, The EI tools examples page will become the main parts of the

investigation of EI adoption survey. Next section presents an introduction of Links page.

4) The Links page

(1) This page allows academic staff to explore EI relevant information. This web page provides some links to websites. Here it introduces two of the web sites through which users can achieve enormous amount of information they would be interested in. One of them is the JISC, which was introduced in chapter 1 and chapter 2 and which is intended to provide an introduction to the area of BI for those working in the UK further and higher education sectors. JISC attempts to uncover what it is that senior institutional management wants to know which may be answered through improved BI and provides an overview of some of the stages involved in achieving this. Another useful website is International Working Group in EDM which is mentioned in chapter 2 and has achieved the establishment of an annual International Conference on Educational Data Mining in 2008, EDM'08, EDM'09, EDM'10 and EDM'11. This conference has evolved from previous EDM workshops at some other conference. The next section introduces the function of the feedback page.

5) The Feedback page

This page is created for users who want to leave their comments to the website contact person. It is an easy form to be used for general comments about EI demonstration portal. Via sending feedback about the contents of this web portal and their ideas about the EI system, the designer could contact visitors in an attempt to improve EI demonstration portal based on their constructive feedbacks.

4.4 Development of the EI demonstration portal

The EI demonstration portal was developed with Dreamweaver 8.0 developed by Macromedia who is a software tool used to build and manage websites and Internet applications.

According to Gilbert (2006), one of the best benefits about Dreamweaver 8.0 is the built-in CSS features which allow designers to build their websites easily, without having to face with complicated coding process. Moreover, Dreamweaver 8.0 provides template files for people to design complicated structures. It is useful for updating site layouts, as well.

Some screen shots of EI demonstration portal are given below:

1) Figure 4-4 is a view of the index page. It gives the definition of EI and some guides on this EI demonstration portal.

Figure 4- 4 Screen shot 1 of the EI demonstration portal - Index

2) This following screen shot is part of the EI solution page.

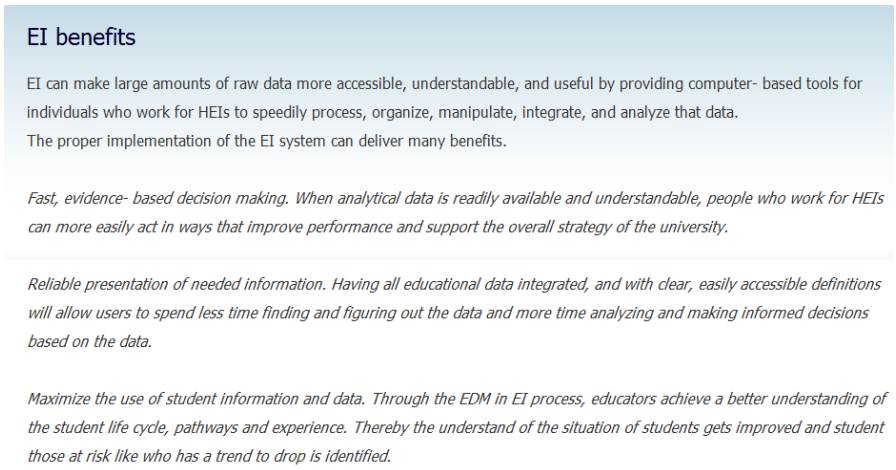

Figure 4- 5 Screen shot 2 of the EI demonstration portal - EI solution

3) This shot comes from the EDM page which belongs to the EI tools examples page. After viewing the EI tools examples page, there are two options, either of which will lead users to the MS models tools or the EDM tools.

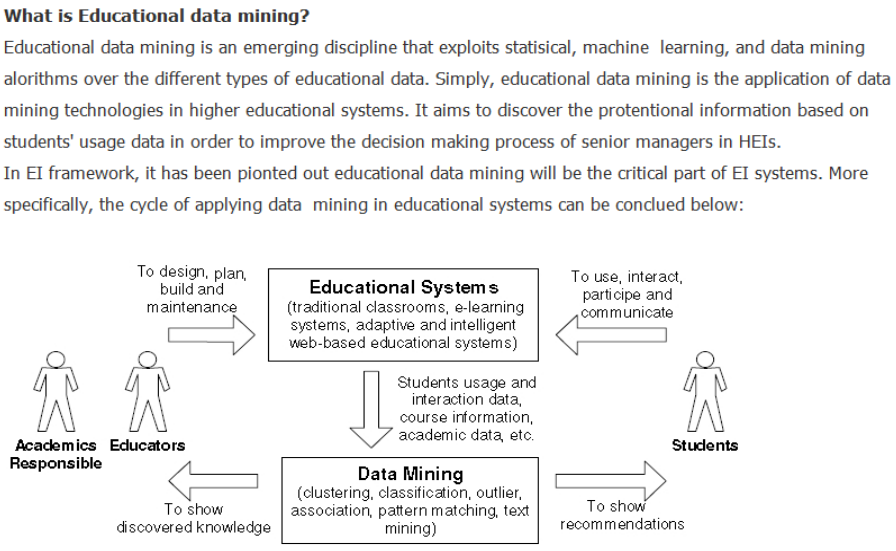

Figure 4- 6 Screen shot 3 of the EI demonstration portal - EDM

4.5 Chapter summary

This chapter describes the development of EI demonstration portal including user group analysis, EI portal content, design and structure. The next chapter will analyze the data from the EI acceptance survey and discuss the result of it.

Chapter 5: Survey data analysis and discussion

This chapter will analyze data and discuss the result the EI acceptance survey. Firstly, the reliability test of questionnaire will be processed, and the factor analysis will be conducted to confirm the validity of the measures employed in this study. Secondly, the detailed SEM analysis conducted using Amos will be presented. Finally, this chapter provides discussions of the results based on the hypotheses.

5.1 Reliability and validity

To ensure the accurate and precise instruments developed for the following study, it is necessary to test the quality of data for measurement. Skaran (2003) lists two criteria approaches for testing the goodness of measures, which are validity and reliability. This section tests the reliability and validity of the instrument and confirms that the instrument can be used in the main survey.

5.1.1 Reliability analysis

Ticehurst and Veal (2000) conclude that reliability is the extent to which research findings would be the same if the research were to be repeated at a later date or

with a different sample of subjects. In other words, the reliability instrument tests accuracy, precision and stability of questionnaires (Sekaran, 2003; Saunders *et al*, 2009).

To assess the inter-item consistency and reliability of the measurement scale, this research chooses the Cronbach's coefficients alpha (α) as the technique to calculate all of the subscales (Cronbach, 1951; Sekaran, 2003). Cronbach's alpha was developed by Lee Cronbach in 1951 to provide a measure of the internal consistency of a test or scale. The Cronbach's alpha index always falls between 0 and 1. The higher the Cronbach's alpha is, the more correlated the items are within the relevant variable.

According to George and Mallery (2003), if $\alpha \geq 0.9$ the internal consistency is excellent. When α is located between 0.8 and 0.9, the internal consistency is good. Nunnaly (1978) indicated that if the value of α should be higher than 0.7, it is an acceptable reliability coefficient.

It is worth to note that internal consistency describes the extent to which all the items in a test measure the same concept or construct, and it is connected to the inter-relatedness of the items within the test. So that internal consistency should be determined before a test can be employed for research or examination purposes to ensure validity (Tavakol and Dennick, 2011). Hatcher (1994) pointed out that

Cronbach's alpha is an index of reliability associated with the variation accounted for by the true score of the "underlying construct". In addition, construct is the hypothetical variable that is being measured.

By adopting the Reliability Analysis function in SPSS 15.0, the results in Table 5-1 show Cronbach's alpha score of each dimensional scale. To summarize, results show the questionnaire has the sufficient homogeneity (internal consistency) by exceeding the acceptable coefficient alpha of 0.90.

Table 5- 1 Cronbach α

	Measuring items	**Cronbach α**
PU	6	0.865
PEU	3	0.804
A	3	0.928
BIU	4	0.846
Whole	16	0.936

The following section conducts reliability of each factor in the theoretical model:

1) Perceived Usefulness

As shown in table 5-2, the "Corrected Item-Total Correlation (CITC)" is a way to assess how well one item's score is internally consistent with composite scores from all other items that remain. Vaus (2004) suggested that anything less than 0.30 is a weak correlation for item-analysis purposes. Furthermore, the value of Cronbach's-Alpha-if-item-Deleted item in table 5-2 represents the alpha value if

the given item were not included. Only when one item of CITC value is less than 0.30, and meanwhile the value of Cronbach's-Alpha-if Item-Deleted item is more than the value of the whole Cronbach's alpha shows in table 5-1. Therefore the item should be removed and not used to form a composite score for the variable in question.

As shown in table 5-2, none of CITC values are less than 0.3, and Cronbach's-Alpha-if-item-Deleted item is less than the value of the whole Cronbach's alpha. So there is no need to delete any of those questions from the scale.

Table 5- 2 PU's CITC and reliability analysis

	Corrected Item-Total Correlation (CITC)	**Cronbach's Alpha if Item Deleted**
EI would provide valuable service to me	0.591	0.854
Using EI would enable me to better understand students	0.649	0.845
Using EI would enhance the quality of my work	0.638	0.846
Using EI would make it easier to do my job	0.689	0.838
Using EI would enhance my effectiveness on my job	0.753	0.824
I would find EI useful in my job	0.655	0.844

2) Perceived Ease of Use

As shown in table 5-3, none of CITC values are less than 0.3, and Cronbach's-Alpha-if-item-Deleted item is less than the value of the whole Cronbach's alpha. Thus there is no need to delete any of those questions from the scale.

Table 5- 3 PEU's CITC and reliability analysis

	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Learning how to use the EI system would be easy for me	0.594	0.796
I would find it easy to acquire targeted information by using EI	0.694	0.691
I wound find EI easy to use	0.671	0.711

3) Attitude towards use

As shown in table 5-4, none of CITC values are less than 0.3, and Cronbach's-Alpha-if-item-Deleted item is less than the value of the whole Cronbach's alpha. As a result, there is no need to delete any of those questions from the scale.

Table 5- 4 A's CITC and reliability analysis

	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Using EI is a good idea	0.849	0.899
Using EI is a wise idea	0.899	0.857
Using EI would be beneficial to my work	0.811	0.928

4) Behavior Intention to Use

As shown in table 5-5, none of CITC values are less than 0.3, and Cronbach's-Alpha-if-item-Deleted item is less than the value of the whole Cronbach's alpha. Thus there is no need to delete any of those questions from the scale.

Table 5- 5 BIU's CITC and reliability analysis

	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
I intend to use EI when it becomes available	0.661	0.813
To the extent possible, I would use EI to help make decisions	0.642	0.823
I intend to use EI to acquire target information	0.697	0.810
I intend to use the serves offered by EI	0.777	0.769

5.1.2 Validity analysis

Validity is the extent to which the data collected truly reflect the phenomenon being studied. Sekaran (2003) provides several types of validity tests in order to test the extent participants can understand task and every question in the questionnaire, which include content validity, criterion-related validity, and construct validity. Here this study focuses on content validity testing and construct validity testing.

1) Content validity assesses the correspondence between the individual items and the concept through ratings by expert judges, and pre-tests with multiple sub-populations or other means (Hair *et al*., 1995). The items in questionnaire from previous literature have been described which are the process to ensure content validity and face validity of the measuring instruments (see chapter 3).

2) Construct validity is used to testify how well the results obtained from the use of the measure fit the theories around which the test was designed. In other words, construct validity testified that the instrument did tap the concept as theorized.

Construct validity can be established through (1) correlational analysis (convergent and discriminant validity), (2) factor analysis, and (3) the multitrait -multimethod type matrix of correlations.

The following section will adopt factor analysis to investigate construct validity which testifies how well the results obtained fit the theories around which the test is designed.

Before factor analysis, it is necessary to address concerns which strengthen the inter-correlations among the items. Pallant (2005) lists two statistical measures which could be generated by SPSS which can help assess the adequacy of their correlation matrics for factor analysis. They are: Bartlett's test of sphericity, and the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy. Moreover, the Bartlett's Test of Sphericity should be significant ($p<0.05$) for factor analysis to be suitable (Hair *et al.*, 1995; Tabachnick and Fidell, 2007).

The KMO measure of sampling adequacy provides an index of the proportion of variance among the variables that might be common variance with its index ranging from 0 to 1. The SPSS software package suggests that a KMO near 1.0 supports a factor analysis and that anything less than 0.5 is probably not amenable to useful factor analysis.

More specific, Kaiser (1974) has refined the index further and suggested that anything in the 0.90s is ‘marvelous’, in the 0.80s ‘meritorious’, in the 0.70s ‘middling’, in the 0.60s ‘mediocre’, in the 0.50s ‘miserable’ and below 0.5 ‘unacceptable’. The following section presents the construct validity of each factor.

(1) Validity analysis for Perceived Usefulness (PU)

Table 5-6 shows the KMO value is 0.841 which is greater than 0.5; and Barlett sphericity is significant (Approx. Chi-Square=222.958, p=0). These statistics indicate that those items can be (could be derived from (a suggestion if you want to add this to highlight conduct factor analysis) conduct factor analysis. Then table 5-6 presents results of factor analysis: only one component is extracted. Therefore the solution cannot be rotated. Moreover, eigenvalue is 3.598 and the one component accounts for 59.961% of the total variance inherent in the data. Factor analysis results also show that the loading of all the items are greater than 0.5. It indicates that construct validity is good.

Table 5- 6 PU factor analysis

Items	**Component1**
EI would provide valuable service to me	0.716
Using EI would enable me to better understand students	0.764
Using EI would enhance the quality of my work	0.753
Using EI would make it easier to do my job	0.795
Using EI would enhance my effectiveness on my job	0.842
I would find EI useful in my job	0.771

Eigenvalues	3.598
Extraction Sums of Squared Loadings % of Variance	59.961
Extraction Sums of Squared Loadings Cumulative %	59.961
KMO=0.841	
Bartlett's Test of Sphericity Approx. Chi-Square =222.958	
Df =15	
Sig.= 0.000	

(2) Validity analysis for Perceived Ease of Use (PEU)

The results show that, KMO is 0.698, Barlett sphericity Approx. Chi-Square is 83.156, and p is 0, so that factor analysis can be processed. One component is extracted and that solution cannot be rotated. The one component accounts for 72.160 % of the total variance inherent in the data. Moreover, all item loadings are greater than 0.5, thus a good structure validity can be seen.

Table 5- 7 PEU factor analysis

Items	**Component1**
Learning how to use the EI system would be easy for me	0.808
I would find it easy to acquire targeted information by using EI	0.863
I wound find EI easy to use	0.875
Eigenvalues	2.165
Extraction Sums of Squared Loadings % of Variance	72.160
Extraction Sums of Squared Loadings Cumulative %	72.160
KMO=0.698	
Bartlett's Test of Sphericity Approx. Chi-Square = 83.156	
Df =3	
Sig.=0.000	

(3) Validity analysis for Attitude towards use (A)

Table 5-8 shows the KMO value is 0.735 which is greater than 0.5. Barlett

sphericity is Approx. Chi-Square is 205.658, and p is 0. Then factor analysis is conducted. One component is extracted and accounts for 87.420% of the total variance inherent in the data. Table 5-8 shows that the loading of all the items are greater than 0.5, it can be concluded that construct validity is good.

Table 5- 8 A Factor analysis

Items	**Component1**
Using EI is a good idea	0.933
Using EI is a wise idea	0.957
Using EI would be beneficial to my work	0.914
Eigenvalues	2.623
Extraction Sums of Squared Loadings % of Variance	87.420
Extraction Sums of Squared Loadings Cumulative %	87.420
KMO=0.735	
Bartlett's Test of Sphericity Approx. Chi-Square = 205.658	
Df =3	
Sig.= 0.000	

(4) Validity analysis Behavior Intention to Use (BIU)

Table 5-9 shows the KMO is 0.814; and Barlett's sphericity is Approx. Chi-Square is 143.250 with p=0. Thereby factor analysis is conducted. One component is extracted and the solution cannot be rotated. The one component accounts for 69.563% of the total variance inherent in the data. Furthermore, factor analysis showed that the loading of all the items are greater than 0.5 and it indicates that construct validity is good.

Table 5- 9 BIU Factor analysis

Items	Component 1
I intend to use EI when it becomes available	0.811
To the extent possible, I would use EI to help make decisions	0.798
I intend to use EI to acquire target information	0.837
I intend to use the serves offered by EI	0.886
Eigenvalues	2.783
Extraction Sums of Squared Loadings % of Variance	69.563
Extraction Sums of Squared Loadings Cumulative %	69.563
KMO=0.814	
Bartlett's Test of Sphericity Approx. Chi-Square = 143.250	
Df =6	
Sig.= 0.000	

5.2 Structural Equation Modeling (SEM)

The Previous section tests validity and reliability of data by using SPSS, and the results says that the measures of this study are valid and reliable. After that, the fitness of the assumption model will be analyzed by the structural equation modeling software Amos. The generated model is expected to be a model that is both substantively meaningful and statistically well-fitting through using structural equation modeling (Jöreskog, 1993). The purpose of SEM analysis is to inspect and verify the hypotheses, and then test the causal-effect relations among latent constructs.

SEM is used to investigate the relationship between criterion variables of intention to use EI systems and the respective predictor variables of perceived ease of use, perceived usefulness, and attitude towards use. In this study, the

goodness-of-fit and the parameter of the SEM were estimated adopting maximum likelihood estimation.

5.2.1 Model development and identification

According to the hypotheses model, there are 12 items recorded as exogenous observed variables and 4 items as endogenous observed variables. Meanwhile, there are 3 items listed as exogenous latent variables, which are namely Perceived Usefulness (PU), Perceived Ease of Use (PEU) and Attitude towards Use (A), while Behavioral Intention to Use (BIU) is the endogenous latent variable. The variables of the structural equation model of this study are presented in table 5-10 and the path diagram of the structural equation model is given in Figure 5-1:

Table 5- 10 Variables of Structural Equation Modeling

Exogenous Observed Variables	**Exogenous Latent Variables**
b.2.1.1 b.2.1.2 b.2.1.3 b.2.1.4	PU
b.2.1.5 b.2.1.6	
b.2.2.1 b.2.2.2 b.2.2.3	PEU
b.2.3.1 b.2.3.2 b.2.3.3	A
Endogenous Observed Variables	**Endogenous Latent Variable**
b.2.4.1 b.2.4.2 b.2.4.3 b.2.4.4	BIU

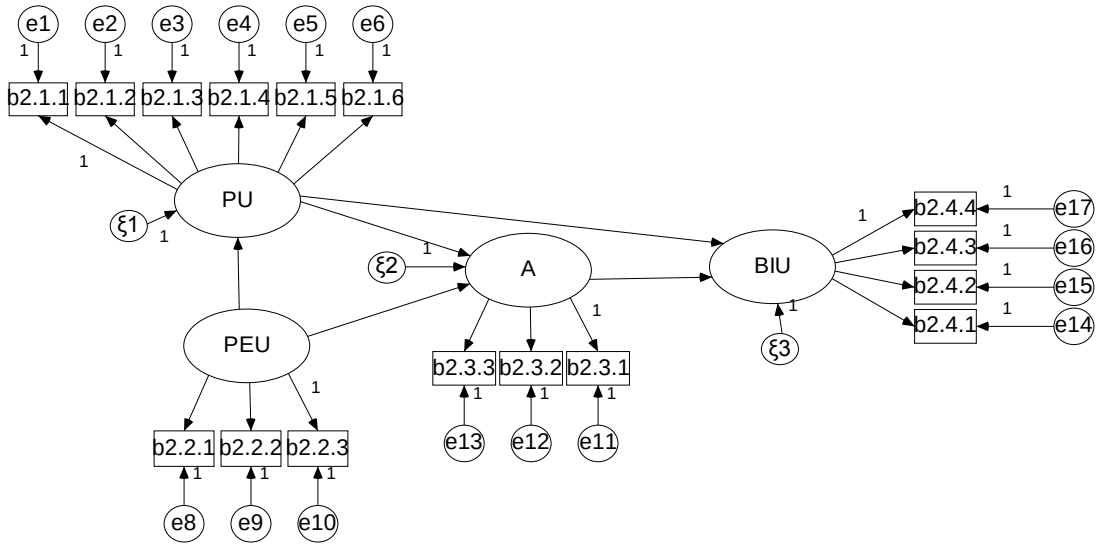

Figure 5- 1 Path Diagram of the Research Model

5.2.2 Model estimation and evaluation

1) After completing the SEM modeling, it is necessary to know how to evaluate the model. More specific, fit statistics are used to determine the goodness of fit between the hypothesized model and the sample data. Different types of a model fitting index can be used for the specific tests of the theoretical model in terms of complexity, sample size, relativity and absolute quality (Hair *et al*., 1995). The goodness-of-fit index measurement are explained included in table 5-11 below:

Table 5- 11 Goodness-of-Fit Indices

Index	**Meaning**	**Fit Measures' Indications**	**Original Literature**
CMIN/DF (χ^2 / df)	The minimum discrepancy divided by its degrees of freedom.	The value not exceeding 3 indicates a good fit.	Byrne (2006)

GFI	The goodness-of-fit index (GFI) calculates the proportion of variance that is accounted for by the estimated population covariance.	The value is less than or equal to 1 and close 1 indicates good fit.	Tabachnick and Fidell (2007); Sharma *et al*. (2005)
AGFI	AGFI is used to adjust the GFI index. It can be taken into account the degrees of freedom available for testing the mode.	The value is less than or equal to 1 and close 1 indicates good fit.	Hu and Bentler, 1995
RMSEA	Root-mean-square-error-of-approximation (RMSEA) index indicates how well the model, with unknown but optimally chosen parameter estimates would fit the populations covariance matrix if it is available.	The value is less than 0.08.	Byrne (1998); Browne and Cudeck (1993)
NFI	The normed-fit-index (NFI) and CFI are consistent in suggesting that the hypothesized model represented an adequate fit to data.	The value is less than or equal to 1 and close 1 indicates good fit.	Bentler (1990)
IFI	The incremental-index-of-fit (IFI) is used to address the issues of parsimony and sample size which is known to be related with NFI.	The value is less than or equal to 1 and close 1 indicates good fit.	Bollen (1989)
CFI	The comparative-fit-index (CFI) is proposed to revise NFI.	The value is less than or equal to 1 and close 1 indicates good fit.	Bentler (1990)

Hair *et al.* (1995) suggest that different types of goodness-of-fit index can be utilized for the specific tests of the theoretical model in terms of complexity, sample size, relativity and absolute quality. The above goodness-of-fit measures are selected to evaluate goodness of fit of the models in this research. Table 5-12 shows the goodness-of-fit statistics yielded from AMOS.

Table 5- 12 Goodness-of-fit indexes

Fitting Index	χ^2 / df	GFI	AGFI	RMSEA	NFI	IFI	CFI
Real value	1.422	0.838	0.765	0.071	0.869	0.957	0.956

The final modified model in table 5-12 yields χ^2/df (CMIN/DF) 1.422, GFI=0.838, AGFI=0.765, RMSEA=0.071, NFI=0.869, IFI=0.957, CFI=0.956. Compared with measurement, all indexes satisfy the measurements, thereby indicating that the model fits the data well.

5.2.3 Hypotheses tests and examination of the theoretical model

In this section, the finding of influences between relationships is described as follows. The figure 5-2 shows structural equation model analysis and hypotheses testing results.

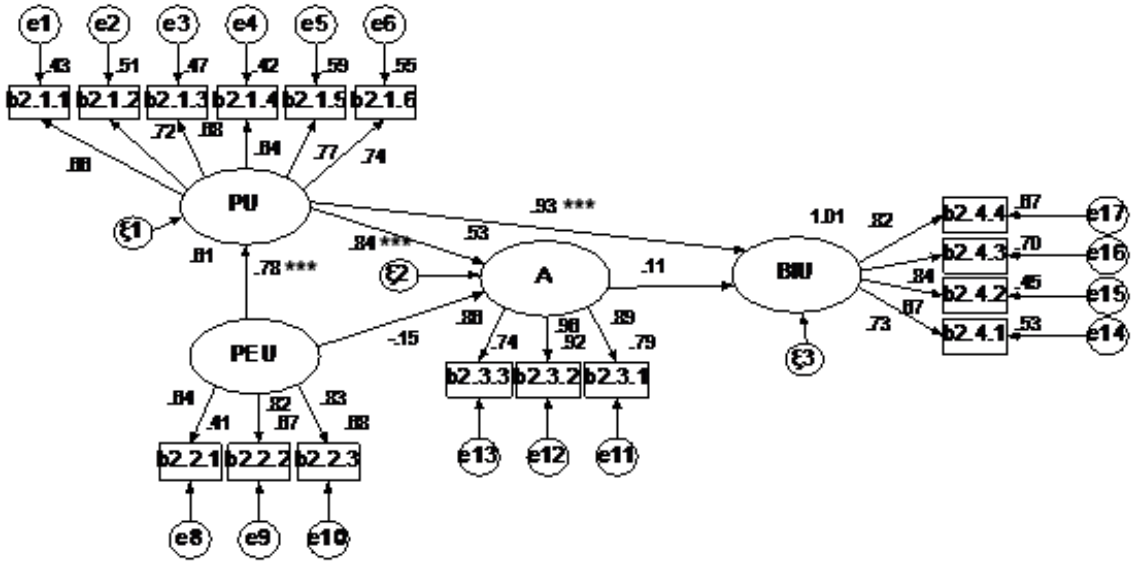

Figure 5- 2 Model Testing Results

According to figure 5-2 shown, direct effects of PEU on PU is 0.780 ($p < 0.01$, two tailed). Moreover, to PEU and A, absolute value is 0.153. In other words, the regression weight for PEU in the prediction of A is not significantly different from

zero at the 0.05 level (two-tailed). Direct effects of PU on A is 0.840, and PU to BIU is 0.925 ($p < 0.01$, two tailed). Furthermore, the regression weight for A in the prediction of BIU is not significant at the 0.05 level (two tailed).

5.2.4 Result of model tests

According to figure 5-3, the findings confirm the good model fits by supporting three out of five hypotheses where dash lines represent SEM results are against the hypotheses. On the contrary, the full lines indicate results are in line with the hypotheses.

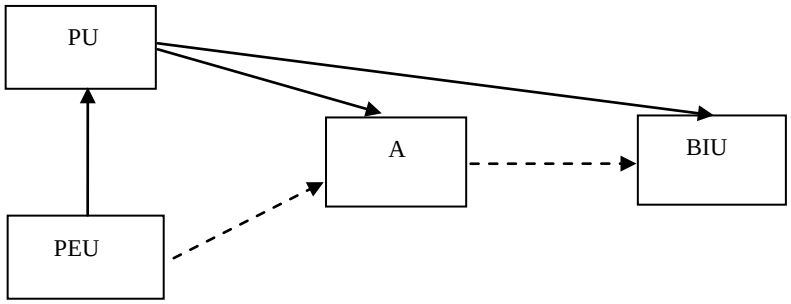

Figure 5- 3 Simplified Model Testing Results

The hypotheses model contains three latent constructs as shown in figure 5-3 where the following relationships have been confirmed (see figure 5-2):

H1. Perceived ease of use positively affects perceived usefulness.

According to the results of SEM, the correlation between perceived ease of use and perceived usefulness is 0.780, which is positive and significant. Therefore

hypothesis H1 is supported.

H2. Perceived ease of use positively affects a user's attitude.

Results show the correlation between perceived ease of use and attitude toward use is -0.153, and 0.403 at the 0.05 level. Therefore, hypothesis H2 is not supported as shown by the path coefficient. Therefore, hypothesis H2 is not supported.

H3. Perceived usefulness positively affects a user's attitude.

The results of SEM shows the path estimate between perceived usefulness and affects attitude toward use is 0.840, which is positive and significant. Therefore, hypothesis H3 is supported.

H4. Perceived usefulness positively affects behavioral intention to use.

The results of SEM shows the path estimate between perceived usefulness and behavioral intention to use is 0.925, which is positive and significant. Therefore, hypothesis H4 is supported.

H5. Attitude toward use positively affects a user's behavioral intention to use.

The results of SEM show the path estimate between attitude toward use and behavioral intention to use is 0.109, which is 0.353 at the 0.05 level. Therefore,

hypothesis H5 is not supported.

5.3 Discussion

One of the objectives this research is to explore the acceptance of the EI system based on the TAM model. Technologies can improve the productivity of organizations if they are accepted and utilized by the employees of that organization. Following data analysis, some of the results were judged against those of previous studies, identified in the literature. The following discussion will concentrate on the theoretical justification and interpretation of causal relationships of the theoretical model based on the SEM results.

5.3.1 Perceived Ease of Use and Perceived Usefulness

SEM results show that hypothesis H1: perceived ease of use positively affects perceived usefulness is supported. It is in alignment with not only the original TAM model but also previous studies that demonstrates perceived ease of use has been identified as consistently important in perceived usefulness. Therefore, it can be concluded that the easier of use the EI system is, the more useful an individual perceives it to be.

5.3.2 Perceived Ease of Use and Attitude towards Use (Not supported)

The results show that hypothesis H2 is not supported, which means perceived ease

of use is found to have no significant effect on attitude toward the use of EI. In other words, when the system is easy to use, users will not have stronger attitude towards the use of EI. This result is contrary to the original TAM model, which has been derived by Venkatesh and Davis (1996). The reason probably is that most information systems are designed with the objective to facilitate users. Since friendly dashboard and interface of designed EI allow users to operate it easily, there is not any significant relation between PEU and A.

5.3.3 Perceived Usefulness and Attitude toward Use

According to results of SEM, perceived usefulness positively affects a user's attitude. Prior researches indicate perceived usefulness has been identified as consistently important in attitude formation (Hu *et al*., 1999). Considering challenges academic staff are facing today, particularly the need to make better decisions based on students' information, it is obvious that if the EI system provides a stronger ability to solve academic staff' problems and helps them make better decisions, they will be keener to use the EI system.

5.3.4 Perceived Usefulness and Behavioral Intention to Use

From the results of SEM, this study shows that perceived usefulness of EI influence behavioral intention to use in a positive and significant way, which is in accordance with many studies (Chuttur, 2009; Hu *et al*., 1999). This result may

suggest that if academic staffs want to use the EI system, they will mainly consider the usefulness of the technology itself. When first adopting the EI system, a strong demonstration of EI' keen ability to deal with practical issues they are facing today is needed. The measurements of perceived usefulness in the research methods section defines perceived usefulness as the ability to enhance job performance and competence in solving problems. Holden and Karsh (2010) list the specific items related to perceived use and what they concluded from many studies. It is all about the following outcomes of use: quicker task completion; easier work; increased quality of care or quality of work; more accurate or more objective accomplishment of tasks; better evidence-based decisions; support of critical tasks and others to the outcome, to name just a few. Therefore, when recommending a real EI system, it is advisable to consider the way to demonstrate benefits of EI system in those specific items mentioned above. For instance, a training lesson or workshop is supposed to be given where an instructor explains to academic staff how to use EDM tools and what type of data should be put in, ways to operate it, and how to analyze outcome graphs.

5.3.5 Attitude toward Use and Behavioral Intention to Use (not supported)

The results show that attitude towards use does not affect behavioral intention to use, with a path coefficient of 0.109 and p-value at 0.353. That goes against one of the hypothesis H5. In this research, attitude can be defined as academic staff's

positive or negative responses to the EI system. Walker and Johnson (2008) pointed out that attitudes can also be referred to as voluntary or non-voluntary readiness and the aspiration for personal contact. Many previous studies show that there is a strong association between computer attitude and behavioral intention to use (Chuttur, 2009; Hu *et al.*, 1999). However, the result presents that the respondents' trend is to use EI whatever the attitude they have. The reasons for this status are discussed below: the development of computer and information technologies is processing at high-speed in HEIs. Therefore an intelligent student management system like EI has become an inevitable trend in HEIs. In other words, it is the rapid information technology development that utilizes an individual's intention to use new technology.

5.4 Chapter summary

This chapter tests the reliability and validity of the instrument by SPSS. After that, this chapter analyzes the fitness of the assumption model by SEM software Amos. SEM results are discussed, where three of five hypotheses were supported. The next chapter will mainly discuss the findings and the significance of the theoretical and practical implications of these findings.

Chapter 6: Conclusions

Chapter 6 presents conclusions of this study. Firstly this chapter summarizes the rationale and objectives of the study. It then highlights the key findings. Lastly, the limitations of the study and future research directions are discussed and identified.

6.1 Summary of this study

BI techniques and tools have received increasing attention from business organizations in their attempts to make better use of business data warehouses which are growing at an astonishing rate in recent years. Although BI is making its impact on higher education sector, its applications are not widespread and successful. There is a growing need of exploring the BI potentials and applying BI techniques in higher education to improve student management and learning. Limited studies about BI in HEIs are mainly focusing on the technological development of specific techniques and methods (e.g. JISC's BI projects in 2011). And there seems no attempt to investigate the individual academic staff's attitudes and acceptance of the BI system.

Individuals who work in universities, especial academic staff, are facing a multitude of pressures and information overload. They have to deal with not only rapid and radical developments in information technology which have the potential to alter the

way how learning and research are conducted, but also redundant student data which is collected from internal sources. A BI system can encompass applications such as data warehouses, data mining and OLAP. The main purpose of BI is to enable interactive and easy access to diverse data, to enable manipulation and transformation of these data, and to provide business managers and analysts the ability to conduct appropriate analyses and perform actions (Turban *et al.*, 2011). Therefore, it is imperative to consider adopting emerging BI tools in universities which enable evidence-based decision-making and planning.

Therefore, this research aims to promote BI applications of BI in HEIs. More specifically, this study attempts:

1. *To understand the BI systems and the current applications and challenges of BI systems in the HEIs.*
2. *To clarify and define the BI concept and systems in the context of HEIs, thereby a concept of Educational Intelligence (EI) is proposed. Following it, an EI demonstration portal to introduce and demonstrate key BI concept and applications is built.*
3. *To investigate factors determining the potential users' acceptance of the EI system, and provide recommendations and implications for research and practice in improving BI success in an education environment. To achieve this objective, it conducts a survey based on TAM to understand the factors influencing user's acceptance of EI.*

To achieve the research aim and objectives, this research has adopted two main approaches: one is to design an EI demonstration portal to demonstrate the EI concept.

The other approach is to a thorough literature review that has been carried out to review the current applications of BI and its potentials in HEIs, as well as relevant theories on technology acceptance and adoption. More specifically, after the concept of EI is introduced, an EI demonstration portal is built aiming to demonstrate how an EI system works in HEIs and its aiming users group is academic staff. Following that, to investigate academic staff' acceptance to the EI system, a questionnaire survey instrument is designed based on the conceptual model based of TAM. Where the questionnaire was distributed to academic staff in a university in China and 85 valid respondents were received. To examine the validity and reliability of the research instruments, factor analysis is adopted. After that, SEM is used to verify the theoretical model and test the five hypotheses.

6.2 Key findings

The key findings can be highlighted according to the three main research objectives outlined in the list section. The first research objective has been completed and the outcomes are presented in chapter 2. Then, the second research objective of this study has been accomplished and the results are presented in chapter 4. The last research objective is fulfilled by the questionnaire survey and the findings are discussed in chapter 5.

6.2.1. Findings from literature review and designing of EI demonstration portal

Firstly, through literature review of BI and its application in HEIs, it is founded that

current educational information systems in HEIs gather a large amount of data and knowledge, but individuals who work for HEIs cannot find an effective way to manage and utilize the information. Some collections of educational data and information even remain for years and they are becoming difficult management with the larger it growing. Therefore it is necessary to find such a solution that can deal with the redundant data and assist educators' information management practices (JISC, 2011; Kelly, 2005). Considering BI's benefits, BI is steadily rising up the priority list within many institutions. The reasons for this are several-fold and include a growing realization of the importance of informing institutional strategic planning with evidence-based decisions, a desire to be able to 'benchmark' performance against rival or peer institutions and the ever-increasing need to be able to better target resources in a climate of financial contraction (JISC, 2011). As a consequence, it is necessary to adopt BI systems in HEIs.

Some universities have come to realize the importance of using BI systems and some have taken practice. More specifically, most researchers focus on the BI tools application like predict the possibility of dropout which can be accomplished by educational data mining (EDM). Other researchers care about the whole educational information systems can be replaced by BI systems. It is worthy to note that there are increasingly researches having been involved in EDM study where many research focus on EDM algorithm. EDM already have been adopted in adaptive and intelligent web-based educational systems (Tang *et al*., 2000). Where many research related to

EDM methods focus on e-learning study. Considering EDM playing a critical role in BI systems, it allows educators benefits from both BI and BI tools like EDM that could improve educational decision making. Future on, the application of BI and BI techniques can be seen as a whole. Following it, a concept is proposed.

Educational Intelligence (EI), the application of BI in HEIs that assists decision makers in HEIs make better use of both internal and external data in support of institutional management and decision making. The EI concept is proposed by Aziz (2012) before this study. However, his EI concept is limited. The definition of EI here is proposed after an investigation of BI application in HEIs, that makes it more suitable for HEIs.

Secondly, the literature about the technology adoption and its theoretical models are reviewed in chapter 2. After the introduction of three theoretical models of IT adoption, they are Theory of Reasoned Action (TRA), Theory of Planned Behavior (TPB) and Technology Acceptance Model (TAM) respectively. It is founded that: compared with TRA and TPB, TAM has both a well-researched and validated inventory of psychometric measurements, making its use operationally appealing. That makes TAM much simpler, easier to use, and more powerful to explain users' technology acceptance than other models (Igbaria *et al*., 1997; Paul *et al*., 1999). In addition, TAM is a dominant model for investigating user's acceptance to IT and has accumulated fairly satisfactory empirical support for its overall explanatory power, and bas posited individual causal links across a considerable variety of technologies

and users. As a result, TAM is chosen to be the conceptual theory to the investigation of EI adoption in HEIs.

Thirdly, to the design of EI demonstration portal, along with the process of building web portal, EI system, together with its users, data type, process, and solutions are presented as well. At first, target users group of EI system is analyzed, which can be divided into three level groups based on Anthony' theory (1965), they are (1) academic staff and support staff, (2) faculty managers and (3) senior managers respectively. Along with it, the target users to this web portal are introduced and they are academic staff. Meanwhile, the data collected as EI data source is discussed, which is becoming the evidence for the decision-making process. Those data are student academic data and engagement data, financial data and human resources data. Combined with pervious EI concept and process, an EI conceptual model is proposed which demonstrate how EI works in HEIs. Furthermore, since the EI demonstration portal provides two EI tools examples to support user's decision making along with two of tasks of EI system are presented. One is to predict students' future performance and achievement like the probability of drop-out, which can be achieved by EDM tools. The other task is to improve strategic decision making for academic staff. To demonstrate how it works, a SWOT case is introduced in the web portal. It is hoped that EI can provide some function which allow users conduct SWOT analysis on dashboard.

6.2.2. Key findings from EI adoption survey based on TAM

Before the distribution of the questionnaires, the ICT application in HEIs in China is investigated. It is found that ICT has been widely spread in universities in China. Also, educators in HEIs are facing the same challenges in UK, the barely use of the abundant data in educational management systems. So that to apply BI in HEIs is proposed by Chinese researchers to solve the problems out.

After the survey of users acceptance to EI, following five hypothesis and outcomes of the test are discussed:

H1. Perceived ease of use EI positively affects perceived usefulness of EI. (Supported)

H2. Perceived ease of use EI positively affects a user's attitude towards use EI. (Not supported)

H3. Perceived usefulness of EI positively affects a user's attitude towards use EI. (Supported)

H4. Perceived usefulness of EI positively affects behavioral intention to use EI. (Supported)

H5.Attitude towards use EI positively affects user's behavioral intention to use EI. (Not supported)

One of the important objectives of this study is to understand users' acceptance of the EI system. Through the SEM analysis, the theoretical model has been tested which

illustrates that three of five hypotheses of this study are supported, whereas the rest two hypotheses are not supported. The results show that perceived ease of use positively affects perceived usefulness. That means if EI is more convenient and easier to use, the system can improve the ability of academic staff to performance their jobs. The findings also suggest that the perceived usefulness has significant effect on the positive attitude towards the use of EI. Which can be interpreted that if the EI system is useful to academic staff' work, they will hold a positive attitude to use it. The result also reveals that the perceived usefulness of EI influence directly the behavioral intention to use EI in a positively significant way.

On the other hand, two hypotheses are not supported. One is that perceived ease of use has no significant effect on attitude toward the use of EI. Probably the reason is that current information systems are designed to facilitate target users. The other finding is that the attitude towards use EI does not affect behavioral intention to use EI. This result shows the individual's positive or negative feelings about using the EI system has no influence on users' intention to use EI. The reason probably because the EI system has already been an evitable trend to the evolution of educational information systems, that is to say, the current information systems in HEIs will be replaced by the EI system in the future. So that it makes the attitude towards use EI system not that important. In addition, to the investigation of EI adoption, the attitude towards use of the EI system is probably the abundant factor to behavioral intention towards to use the EI system.

It is believed that the insights gained from this study help to promote BI adoption in HEIs. The study and its findings will encourage HEIs build BI systems which help decision makers in HEIs make better use of both internal and external student data in support of institutional management and decision making to meet educational goals.

6.3 Implications

6.3.1 Research implications

There are a number of implications for research based on the work reported in the thesis. At first, the study identifies a number of gaps in BI applications in HEI and calls for more research into successful BI applications in terms of developing applicable BI solutions for education sector, and examining the adoption behavior of BI users. Secondly, this study believes that it is important to introduce the EI concept and demonstrate its potentials and key benefits widely to HEI communities. EI is derived from the definition of BI application in HEIs, thus EI enables BI concept more suitable to educational environment. Moreover, a targeted BI concept and system for educational sectors, like EI, can provide context specific tools and techniques for educational data management purpose. Currently, most BI demonstration portals are developed for business organizations, Promoting BI application in HEIs through web portals is still very limited. It is believed that the EI demonstration portal can serve as a bridge to link for the BI solutions to the users in the HEIs community.

6.3.2 Practical implications

The implications of the key findings provide significant benefits to the application of the EI system in HEIs. Based on the hypothesis test outcomes of the TAM model using SEM, a number of key the implications can be derived: firstly, the EI system must be useful to support users' decision making effectively and efficiently. Ease of use will affect the users' assessment on the system's perceived usefulness, but not their attitudes towards the use of EI. Therefore the EI system promoters and developer should focus on both system supporting functionalities as well as the ease of use. If the system is perceived useful, academic users will not be deterred by potential problems caused by ease of use because academic staff has sufficient confidence and experiences to use the educational information systems. Moreover, since the result shows perceived usefulness of EI influence behavioral intention to use in a positively significant way, users will mainly consider how well EI enhance job performance and competence in solving problems when adopting EI. As a consequence, it is important for BI prompters to demonstrate how EI allows academic users improve their job performance and the ability of decision making. Apart from showing the functions of EI, case studies about EI successes should also be used as a show case in the portal.

6.4 Limitations and future research

As with all research, the current study has two main limitations: one is related to the EI demonstration portal, and another one is the sample size.

As to the EI demonstration portal, what target users benefit from this web portal can be concluded as follow: firstly, the EI demonstration portal conduct target users systematic study of the BI knowledge and EI system. Secondly, this portal provides an platform for the information related to BI applications in HEIs and EI technologies. However the existing EI demonstration portal is only a demonstration portal, which introduces EI concepts, users analysis and tools that could improve academic staff' decision-making. Subsequently, this portal can be a repository of information and knowledge related to EI applications. In addition, the target users of this web portal are academic staff in universities. In chapter 4, through user group analysis, individuals who are supposed to be EI users can be dived into three groups according to Antony's (1965) theory. For different levels of decision makers, EI provides different approach to support them. The limitations of this EI demonstration portal are that it only focuses on a specific group of users (academic staff) and has limited specific information for this target group.

Future EI demonstration portal can provide a repository that contains relevant EI data analyzing and reporting tools and techniques instead of only serving as a demonstration web portal. The portal can be easily extended to allow for additional tools to be integrated into the website. Those tools provide back-end servers for different levels of decision makers in HEIs, where EDM tools allow users easily to mine student data for meaningful and actionable information, creating scenarios and evaluating results. The interactive user interface allows educators to visualize

complex algorithms and make them easy to understand. Moreover, this EI portal can offer real-time reporting, charts, 3D Support, etc. These are just some of the features that can be integrated into the future portal that allow users to better analyze and visualize the data warehouse.

One the other hand, the research survey has certain inevitable limitations. For this study, the survey sample is limited to a university in China, so that caution should be taken when applying findings to other countries, such as the UK HEIs. However, it is argued that universities over the world are facing similar problems and challenges now that means, not mention to in China. Although it is easy to access data from the universities in China and the questionnaires can be received in short time, one of the main constrains of the selection sample also cannot be ignored which is: the EI demonstration portal is designed in English, so that it takes respondents' some time to browse the web and understand EI concept. So that to build a Chinese version pages is supposed to be considered in the future. Nevertheless, there would be a need for more investigations to cover diverse sample of respondents in the future research. Another limitation for the survey is the sample size which might be small for looking at a populations' acceptance to EI systems. Ahmad (2005) pointed out that Structure Equation Models (SEM) can be applied when the sample size is large. However Bentler and Chou (1987) considered that there are at least five cases per parameter used in testing SEM. So that SEM can be adopted in this research. If possible, future research is needed to expand the sample size.

To conclude, the application of BI in HEIs can have an enormous positive effect on the student management and learning experience. The EI system can be used to support a wide range of users across all management levels. However, before the promise of BI applications in HEIs can be fully realized, the potential users' attitude and acceptance of the EI system should be fully investigated and understood. This research represents a worthwhile attempt towards promoting BI applications in HEIs.

Appendix A- Questionnaire (Chinese Version)

关于用户接受 Educational Intelligence (EI) 影响因素调查问卷

尊敬的女士/先生:

您好！非常感谢您能参与这项问卷调查。由于调查样本有限，您的回答将成为此项研究的重要依据，恳请您花几分钟时间如实填写，非常感谢您的大力支持！敬祝您事业有成，万事如意！

教育智能(Educational Intelligence，EI)， 即商务智能概念在高等教育机构的应用。采用商务智能的核心技术，如数据仓库、数据集市、查询报表、联机分析、数据挖掘以及数据备份和恢复等信息技术帮助高校进行决策。教育智能系统为高校提供了一个统一的分析查询平台，在高校内部建立统一的、智能化的教务系统。

教育智能系统的数据来源自现有的高校教务系统中收集来的各种学生数据信息，还有通过各种其他辅助设备采集的学生活动状况。学生的活动状况即学生上课考勤、每日登陆图书馆次数、参与学术讲座次数、网上学习、网上咨询以及学生上交作业、查收学校邮件等反应学生参与学校教学活动的情况。系统会对这些收集来的数据进行处理加工，挖掘出隐含的信息，从而进行分析、预测学生的情况的工作。

例如：当教师和班主任登入该系统，界面上不仅可以完成原有教务系统查询学生的各种信息的功能，还可以提供预测功能。在预测功能里，EI 系统可根据收集来的数据预测学生的期末成绩、学生有无退学风险，学生处于什么样的学习状态（好，中，差）等，并且可以通过在线分析用图表的形式呈现出来。如选择退学风险预测工具，只需要输入学生姓名或学号，系统就会出现该学生在该学期或该学年（或几学期、几学年）的活动参与趋势饼状图。如果该学生处于好的学习状态显示为绿色，如有退学风险即为红色，如同温度计一般简单明了的显示出该学生当前或在一段时间内的状态。当学生有退学风险时，系统会自动给班主任和相关管理人员发送邮件，提醒老师和相关管理人员做出相应措施。

不仅如此，为了进行科学决策，教育智能系统还通过“决策帮助选项”工具提供了一些管理科学模型。为了便于教师和管理人员使用，每组模型下面都有详细说明该模型适合什么类型的决策。例如，教师要分析是否开设新专业，只需要从“决策帮助选项”中选择相应的模型，通过对高校内外环境、影响因素等等问题进行简单的选择判断，系统就会进行计算，并得出开设新专业后该专业有无竞争力等状态的结果，从而帮助教师进行决策工作。

邮件附件中所提到的 EI 网站会使您详细了解 EI 的概念。

一、您的基本信息:

您的性别:□男 □女

2、您的年龄:□18—29 岁□30—39 岁□40—49 岁□50—59 岁

3、您的教育程度:□本科□硕士□博士

4、您的岗位:□教师□教辅人员□行政人员

5、您是否还担任班主任？□是 □否

6、您对 EI 的了解程度：□没听说过□略微知道□基本了解□非常熟悉

二、对 EI 的接受

“1”表示完全不同意，“2”表示不同意，“3”表示有点同意，“4”表示同意，“5”表示完全同意

项目	内容	完全不同意	不同意	不确定	同意	完全同意
		1	2	3	4	5
EI 的有用程度	1、学校实施的 EI 将给我提供有价值的服务					
	2、EI 将使我方便、快捷地了解学生的行为					
	3、EI 提高了我的工作质量					
	4、EI 可以让我更快的完成工作					
	5、EI 可以让我更效率地完成工作					
	6、我觉得 EI 非常有用					
EI 的易用程度	1、我想学习使用 EI 会很简单,易于操作					
	2、我相信使用 EI 获取目标信息非常容易					
	3、我觉得 EI 使用起来很方便					
对 EI 的使用态度	1、我认为使用 EI 是一个非常好的主意					
	2、在我看来 EI 是件非常可取的事情					
	3、我对 EI 的实施持有积极地态度					
对 EI 的使用意愿	1、我打算在将来使用 EI					
	2、我打算尝试使用 EI 来帮助我进行决策					
	3、我将使用 EI 来获取目标信息					
	4、我将使用 EI 提供的服务					

Appendix B- Questionnaire (English Version)

Questionnaire of EI Adoption Intention

Dear Respondents,

I am inviting you participate in a research project to investigate EI adoption intention. Thank you for taking the time to fill in this questionnaire, you will remain anonymous.

Educational Intelligent (EI) concept in this study evolves from Business Intelligence (BI) concept. EI aims to enable manipulation of collected data, whilst to give decision makers in universities and colleges the ability to conduct evidence-based decision-making. Actually, EI can be considered as the application of BI in HEIs. Through educational data analysis, collection and storage phases which accomplished by intelligent tools like online analytic processing (OLAP), data warehouse and data mining, outcomes of EI process support evidence-based decision-making for the whole HEIs.

An EI system can provide fast, evidence-based decision making. More specific, when analytical data is readily available and understandable, people who work for HEIs can more easily act in ways what improve performance and support the overall strategy of the university. Also, EI provides reliable presentation of needed information. Moreover, EI maximizes the use of student information and data.

For example, one of EI function is to predict students' future performance and achievement such as the probability of drop-out. Through the EI process, the results of analysis can be presented in the dashboard. Evaluation of the results shows the probability of the student automatically. Meanwhile, the EI system will send alarm emails to academic staff when student's index of drop-out probability beyond a certain threshold.

In addition, one of EI tools can improve strategic decision making for academic staff. For instance, academic staff in a university needs to make a decision such as to introduce a new course master. There should be some questions options related to the views of the SWOT theory based on the university itself. Through SWOT algorithm, the recommended suggestion will be presented as an evaluated level which shows to what extent the results agree with the original decision.

To achieve more information about EI, please visit the EI demonstration portal provided in attachment.

Basic Information

Gender: ☐Male ☐Female

Age: ☐18-29 ☐30-39 ☐40-49 ☐50-59

Education level: ☐Bachelor ☐Master ☐PHD

Position: ☐Lecturer ☐Academic tutors ☐Administer

The teacher in charge of a class: ☐Yes ☐No

Understanding of the degree to EI: ☐Never heard ☐Know little ☐Generally know ☐Know well

EI Adoption Intention

1=strongly disagree, 2=disagree, 3=neither agree nor disagree, 4=agree, 5=strongly agree (5-point scale: 1 to 5 points respectively)

Items	Measurement Items	1	2	3	4	5
PU of EI	EI would provide valuable service to me					
	Using EI would enable me to better understand students					
	Using EI would enhance the quality of my work					
	Using EI would make it easier to do my job					
	Using EI would enhance my effectiveness on my job					
	I would find EI useful in my job					
PEU of EI	Learning how to use the EI system would be easy for me					
	I would find it easy to acquire targeted information by using EI					
	I wound find EI easy to use					
A to EI	Using EI is a good idea					
	Using EI is a wise idea					
	Using EI would be beneficial to my work					
BIU of EI	I intend to use EI when it becomes available					
	To the extent possible, I would use EI to help make decisions					
	I intend to use EI to acquire target information					
	I intend to use the serves offered by EI					

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DECLARATION

I declare that this thesis is my own unaided work. It is being submitted for the degree of Master of Science by research at the University of Bedfordshire.

It has not been submitted before for any degree or examination in any other University.

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