# A DECISION SUPPORT SYSTEM FOR INTERNATIONAL STUDENTS

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# A DECISION SUPPORT SYSTEM FOR INTERNATIONAL STUDENTS

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## ABSTRACT

Effective decision making is a complex process and can be influenced by many factors. When making decisions, people always have to deal with many challenges such as: information overload, too many criteria to consider, etc. Decision Support Systems (DSS) emerged to help people make effective and informed decisions in the 1980s. They have been widely used and enhanced in recent years with new emerging internet technologies and decision models, one of them being Multi-criteria decision support systems (MCDSS). MCDSS aims to aid the decision makers to handle semi-structured decisions with multiple criteria.

This research aims to help individuals understand the decision making process, especially the multi-criteria decision making process, and develop and test a personal decision support system (DSS) to help individuals make better decisions in the context of university selection by overseas students.

The research investigates and analyses the key factors affecting students' decisions when selecting a suitable university using personal interview and questionnaire survey methods; these find out students' needs, and help design and develop a personal decision system prototype for international students using the Analytic Hierarchy Process (AHP) method to aid them to select the best suitable university for their postgraduate study in the UK. Then the system is tested with students and their feedback analysed. This process has implications for developing and using DSS as a personal decision support tool, thus to provide a base for

future research and development.

This research made a number of contributions to DSS research and applications.

Firstly, it addressed a gap in the current DSS research by designing and applying DSS for personal decision making using AHP because personal DSS reported in the literature is designed to serve business users.

Secondly, it identifies key criteria in students' decision making on university selection through student interviews and surveys. The key criteria are University ranking, Subject ranking, Completion rate, Location, Accommodation costs, Tuition fees, and Entry Requirements.

Thirdly, the system evaluation results show that DSS-US is perceived to be effective, efficient and usable. For effectiveness, users believe that DSS-US has the potential to help them make better decision through personalization in terms of decision making criteria and weight allocation. For efficiency, students find that the system can save them significant amount of time when making their decision by helping them tom access the necessary information and data. Regarding the system usability, all the participants indicate that they were satisfied about the function of DSS-US. In addition, user can 'play' with DSUS system to explore different scenarios. They can try different weights to explore different results.

**Key Words:** Personal Decision Support System, Multi-criteria Decision Making, Analytic Hierarchy Process, Higher Education, University Selection

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# Chapter 1: Introduction

The primary aim of this study is to understand the decision making process and to support international students to select Higher Education Institutions in the UK. By reaching the aim, this research will develop and test a personal decision support tool using multi-criteria decision making to help international students make better decisions.

This chapter includes the research background, research aims and objectives, and the research process of the thesis.

## 1.1 Research Background

Effective decision making is a complex process and can be affected by many factors. For example, people who have to make a decision cannot deal with the amount and complexity of information precisely enough with limited cognitive ability (Talor R.N., 1975).They may succumb to a variety of biases (Kahnemann D., 1982). They may have a difficult time agreeing on a single solution that satisfies differing interests (Zigurs I., 1988); the desired results of a known decision could be affected by a lack of certainty (Michael, 1995).

University selection is one of the most important steps that many international students have to face when they try to find a proper university to continue their graduate education. Decision making on what subject or field they should focus on and which university they should apply is a notoriously time consuming

process due to many reasons including information overload and too many criteria to consider. Students may get confused when facing overwhelming information, such as academic excellence, fees, living costs, location, job prospects, facilities, etc.

The emergence of the Decision Support Systems (DSS) was to help people make effective and informed decisions in the 1970s. The systems have been widely used and enhanced with internet technologies which have developed the decision models quickly in recent years. One of them is Multi-criteria decision support systems (MCDSS). MCDSS aims to aid the decision makers to handle semi-structured decisions with multiple criteria (Isikos Y., 1999).

### 1.1.1 Decision Making Process and Development of DSS

The process of human beings making decisions is complicated, especially in complicated situations (Jung D. and Bums J.R., 1993; Newell A. and Simon H.A., 1972; H.A. Simon, 1960). Simon has classified decisions into two classes, structured decision making and unstructured decision making. Those decisions that require a human being’s judgement are categorized in unstructured decision making. Unfortunately, most individuals do not have an ideal environment to make decisions. One significant characteristic is deficiency in information (Basu A., Dutta A., 1989). However, information overload and information accuracy are widespread in modern society. Simon also proposed that, when human beings are enforced to make an unstructured decision, they would try to break the decisions into familiar structure criterion firstly. In addition, they try to 'satisfy' instead of maximizing while reasoning in these situations. As Simon proposed in his theory,

the human reasoning process tends to be increasingly more heuristic (Simon H.A., 1960). Simon's "new science of management decisions" will be described in Chapter 2.

In the early 1970s, decision support systems (DSS) were the first applications focused on supporting and improving managerial decision making. Essentially, DSS is the area of the information systems (IS) discipline that is about developing and deploying IT based systems to support decision processes (Watson, 2007). DSS has been an important area of IS scholarship since it emerged in the 1970s. As it develops, DDS has also been a major area of IT practice and the decisions made using IT-based decision support can have a significant effect on the nature and performance of an organization (Arnott, 2008). DSS is a contrast to transaction-processing or operational applications, such as order entry, inventory control, and payroll systems. Over the years, various decision support applications have emerged and expanded the decision-support domain, such as executive information, online analytical processing (OLAP), and predictive analytics.

### 1.1.2 Challenges in Students Decision Making

When choosing a university to study, the key challenge for students is how to get useful information and how to use it to make effective and informed decisions. There are several problems, such as information overload, lack of information, or inaccurate information. Firstly, university selection is a process which begins with "no idea", then gathering information to minimize the choice to several interesting universities; finally, making a decision by comparing the advantages and disadvantages of each university. It will take a long time to make a decision,

especially for international students. The problem they encountered mostly is due to the lack of knowledge on culture, region, and custom, etc. So it is evident that a personal decision support system will be useful to help them select the most suitable university to meet their personal needs. Also it can save time in gathering, selecting, and comparing as well.

### 1.1.3 The Necessity for a Multi-criteria Decision Making Tool for Students

Higher education plays a key role on career building and development throughout one person's life. Students will benefit from getting educated in the right university with a suitable and promising subject. University selection is one of the most important decisions that many international students have to make when they seek to pursue their postgraduate education. But, university selection is well known as a time and energy consuming process. People usually do not know how or where to collect information at first; then get confused or even lost when facing overwhelming information. Decisions on what subject to study and which university they should apply to is a notoriously time consuming process for many reasons, such as information overload, or too many criteria to consider. Students may get confused by academic excellence, fees, living costs, location, job prospects, facilities, etc. So, developing a multi-criteria decision making tool for students can help them make better decisions and save a lot of time.

## 1.2 Research Aim and Objectives

This research aims to understand the decision support needs of international students, to develop and test a decision support system for international students to select the most suitable university for their postgraduate study in the UK.

Underpinned by Simon's decision making theory, the system will facilitate the decision making process by providing information, generating choices to assist in making the choice.

To achieve the aims, the research will undertake the following research activities:

To investigate and analyse the key factors affecting students' decisions of selecting a university;

To collect relevant data from UK universities and select suitable multi-criteria decision making methods for developing the DSS in this context;

To develop and test a prototype decision support system;

To analyse the feedback and provide implications on developing and using DSS as a personal support tool, to provide a base for future research and development.

## 1.3 The Structure of the Thesis

This thesis is divided into chapters pertaining to each part of the research. The thesis includes six parts: introduction, overview of decision making process and DSS, research method, consideration of key criteria, development of the Decision Support System for University Students (DSS-US) system and conclusions. The research process has been shown in Figure 1.1.

Chapter 1, Introduction. This chapter unfolds a brief overview of the whole thesis. It describes the background of the topic selection, and identifies the research aim and objectives.

Chapter 2, Literature Review of Decision Making Process and DSS. This chapter overviews the decision making process and DSS. It starts with review of definitions of DSS and the decision making process. Then, it introduces multi-criteria decision making. Finally, a DSS review is conducted with details, especially Personal DSS.

Chapter 3, Research Method. This chapter focuses on the research method of this study. First of all, it presents the semi-structured interview and questionnaire survey methods for key decision criteria. Then, the chapter introduces the method of DSS development. Last, it describes the walkthrough method for system testing.

Chapter 4, Consideration of Key Decision Criteria and Database Collection. This chapter discusses the key decision criteria at the beginning, and shows the database collection and data normalization. It has several key decision criteria that students are concerned with. This chapter presents the results of interviews and questionnaires. It also discusses a special criterion which is recognized commonly in Chinese but cannot be analysed by quantitatively.

Chapter 5, System development and Testing. This chapter describes the system development of the Decision Supporting for University Selection (DSS-US). It includes requirements analysis, system design, system development and system evaluation. Some charts are shown in this chapter in order to explain the framework, process and function about the system. Some pictures are shown to

illustrate the user face and how the system work. Last, the thesis presents a careful elucidation discussion about system testing results.

Chapter 6, Conclusions and Future Research. This chapter summarizes this research. It presents the conclusions and intended future research.

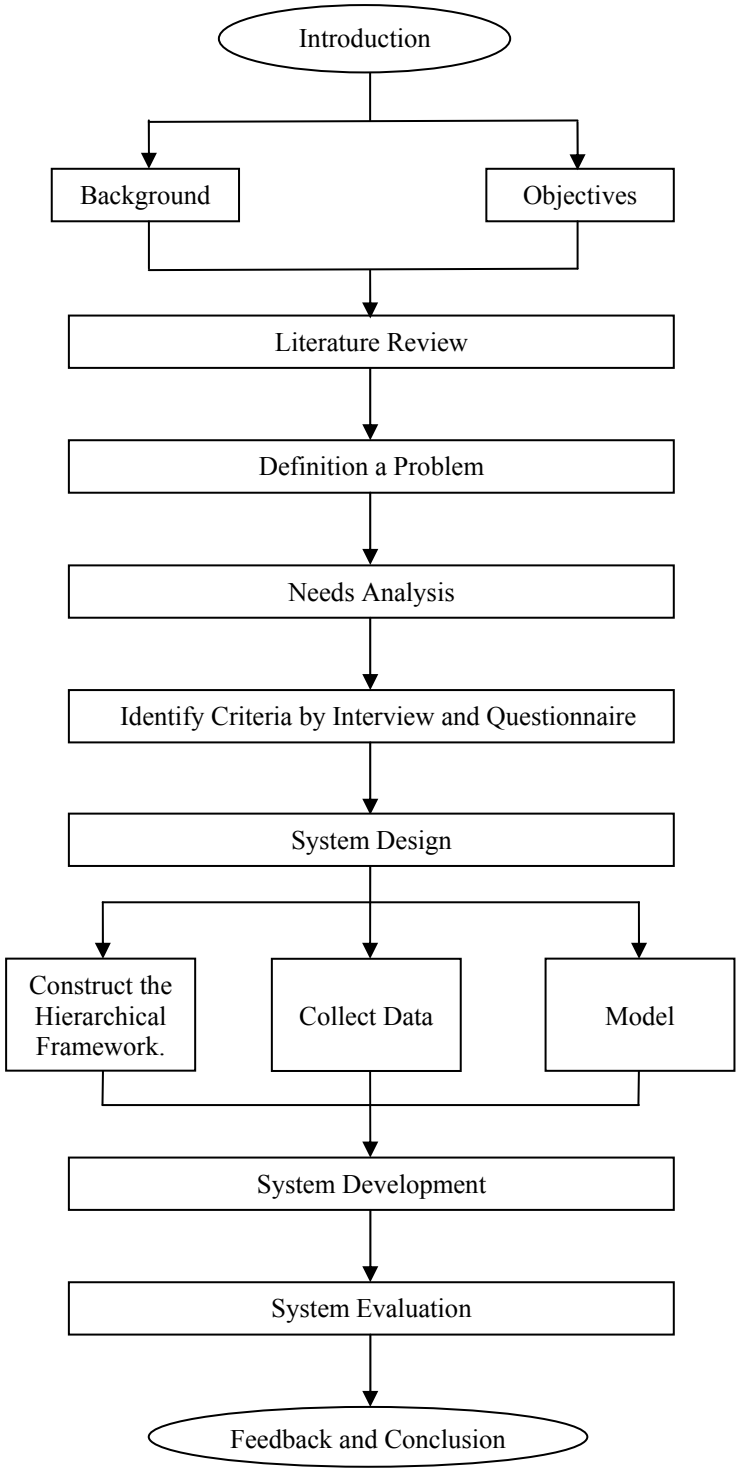



**Figure 1.1 Research Process**

# Chapter 2: Literature Review of Decision Making Process and DSS

This chapter introduces the development of the Decision Support System comprehensively and particularly. There are three parts. The first part describe the decision making process and the three phases. The second part focuses on multi-criteria decision making, including the history of multi-criteria decision making and methods. The last part of this chapter is a review on decision support systems.

Human life is full of opportunities and options, and people make decisions every single day. For a student, choosing a proper university to start the right program is critical for his/her future career development. University selection is a complicated process. To help students complete this process smoothly with a simple system, the Decision Making Process needs to be induced. If a decision is influenced by only one criterion, there is no need to do research. However, most decisions in the actual world are influenced by many different criteria. Multi-criteria Decision Making has also been discussed widely. This research aims to develop a personal decision support tool to help students make decision on university selection. The Decision Support System is another related area needing to be considered.

## 2.1 Review on Decision Making Process

Decision making is a complicated process and not well understood especially in complex environments (Simon H.A., 1960; Newell A., 1972; Jung D. and Bums J.R., 1993). People should be able to make a decision in an effective way. It is also the most challenging task in the whole decision making process. When someone needs to make a decision, some procedure and steps are utilized by the decision maker. A number of scholars have contributed to the decision making process. Simon (1977, 1997) provided a decision making process as a notable and classic model. Simon's work (1977) on the "new science of management decisions" proposed a three phase decision making process that follows intelligence-design-choice phases as shown in Figure 2.1.

Each stage must be completed to be able to move on to the next. Note that the fourth phase of implementation has been added in recent years (E. Turban and J. Aronson, 1998). Simon's decision making process is now widely accepted and one of the classical theories. This is the support theory of the study and the research follows the phases to make a decision support system on selecting university for students.

The intelligence phase includes collecting information and knowledge, searching for a problem, establishing a range of criteria and alternative courses of action. That means decision makers have to spend a lot of time on surveying the organisational environment in order to identify new varieties, so that new actions can be called. In the design phase, decision makers design and develop possible courses of action for handling situations where a decision is needed by themselves

or with their subordinates. In the choice phase, decision makers evaluate alternatives and select the best option to solve an identified problem.

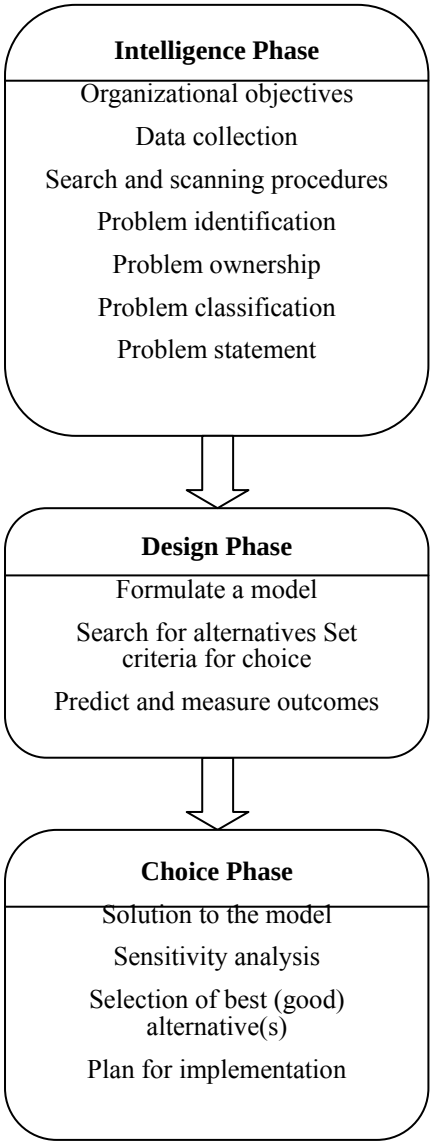



**Figure 2.1 The Phases of Decision Making Process**

## 2.2 Multi-criteria Decision Making

### 2.2.1 History of Multi-criteria Decision Making

Multi-criteria decision making (MCDM) is one of the most active, widely used, and interdisciplinary fields of research in management science and operations

research in the business and engineering world. MCDM has become famous since Charnes and Cooper (1961) developed goal programming and Keeney and Raiffa (1976) developed the theory and methods for multi-attribute utility assessment (Korhonen P. et al., 1992).

In the 1970's, the idea of MCDM research originated from mathematical programming at first (Korhonen P. et.al, 1992). Multiple objective mathematical programming and the development of procedures and algorithms, especially multiple objective linear programming problems and discrete problems, were the most important of the MCDM theoretical foundation. Dyer (1973) and Wallenius and Zionts (1976) developed early prototypical nature systems that often lacked user-friendly interfaces. And the multiple objective algorithms were used mainly for illustrative purposes and were programmed for mainframe computers.

In the next decade, the 1980's, the focus of MCDM research shifted from multiple objective optimization to providing multiple criteria decision support to decision makers (DM) and practitioners. The change signifies the research emphasised the DM's actual decision behaviour, rather than solving well-structured problems under hypothetical and unrealistic assumptions concerning the DM's preference structure and behaviour (Korhonen P. et.al, 1992). As a result, many important issues of decision support have come out, such as the appealing communication facilities, the inter-relationship of problems, and the decision making process that should support the whole process. More specifically, the appealing communication facilities, such as interfaces, should be friendly which could base on colours, spreadsheets, graphical representations and- simple grammar used in

the communication language. The decision making process should support from problem identification to solution implementation, not for only one of these parts. For instance, a DM may not be able to formulate a problem precisely at first. A DM can approach a problem and redefine in several steps, then solve it.

Multiple Criteria Decision Support Systems (MCDSS) allow people to analyze multiple criteria, and to incorporate the DM's preferences over these criteria into the analysis. Traditional systems perform 'what - if' analysis and MCDSS perform 'what to do - to achieve' instead. (Korhonen P. et.al, 1992). That means DMs only operate with the criteria/ objectives of determine and achievement. Then the system informs DM on how to obtain the desired result. MCDSSs also seek to support the modelling and structuring of decision problems, often making use of advanced visualization capabilities (Korhonen P. et.al, 1992).

### 2.2.2 Multi-criteria Decision Making Method

MCDM methods can help to improve the quality of results by making the decision-making process more explicit, rational, and efficient. It is not a coincidence that a simple search (for instance, by using Google’s search engine) online under the key words “multi criteria decision making” returns more than one million results. Some applications of MCDM in engineering include the use of flexible manufacturing systems (Wabalickis R.N., 1988), layout design (Cambron K.E.,1991), integrated manufacturing systems (Putrus P.,1990) and the evaluation of technology investment decisions (Boucher T.O.,1991).

According to Fulop (2005), multi-criteria decision making methods can be classified by four parts. As shown below in table 2.1:

**Table 2.1 Multi-criteria Decision Making Methods (Fulop, J., 2005)**

| | |
|---|---|
| Cost-benefit Analysis | |
| Elementary Methods | Pros and Cons Analysis |
| | Maximin and Maximax Methods |
| | Conjunctive and Disjunctive Methods |
| | Lexicographic Method |
| Multi-attribute Utility Theory (MAUT) Method | Simple multiattribute rating technique (SMART) |
| | Generalized means |
| | The Analytic Hierarchy Process (AHP) |
| Outranking methods | The ELECTRE methods |
| | The PROMETHEE methods |

Multi-attribute decision making techniques can either partially or completely rank the alternatives: a single most preferred alternative can be identified or a short list of a limited number of alternatives can be selected for subsequent detailed appraisal.

In spite of some monetary based and elementary methods, the two main families in the multi-attribute decision making methods are those based on the Multi-attribute Utility Theory (MAUT) and Outranking methods.

The family of MAUT methods consists of aggregating the different criteria into a function, which has to be maximized. Thereby the mathematical conditions of aggregations are examined. This theory allows completing compensation between criteria, i.e. the gain on one criterion can compensate the loss on another (Keeney and Raiffa, 1976).

### 2.2.3 The Analytic Hierarchy Process

The Analytic Hierarchy Process (AHP) proposed and developed the mathematical foundations by Saaty (1980) at the University of Pittsburgh. It becomes one of the most well-known and widely used multi-criteria methods as it has been used successfully to help people make better decisions when faced with unfamiliar problems involving value-based trade-offs between the advantages and disadvantages of two or more options (James G.D., 2008; Golden B, et.al, 1989; Zahedi F., 1986; Forman E., and Gass S., 2001; Vaidya O.S. and Kumar S., 2006).

During the 1980s and 1990s, with the development of the personal computer, some decision support tools (software packages) such as Expert Choice developed by Forman, Saaty, Selly and Waldron (2000) became popular. Increasingly, the power of AHP has been confirmed by empirical use.

AHP is a powerful tool. It is easy to use because of the unique combination of designing characteristics. AHP frames a decision as a hierarchy, an organizational framework that many people are already familiar with and easy to explain to those who are not. All inputs consist of comparisons between just two decision elements at a time; pairwise comparisons like these are generally considered to be one of the best ways to elicit judgments from people (Reynolds T and Jolly J, 1980). The output is easy to understand because it is based on simple scales derived from the pairwise comparisons. Finally, there is a built-in measurement of the consistency of the judgments being made that checks both the reliability of the analysis and reduces the chance of making procedural mistakes.

Decision hierarchy of AHP usually has three levels. The top starting level is the most general objectives. The goal of the decision has to be clearly stated in this hierarchy. And the second level is sub-objectives. The evaluation criteria and sub-criteria (if there are any) are described clearly in this hierarchy. The bottom level is all the alternatives of choice. The decision making process takes place as soon as the hierarchy structure is established. According to Saaty (1988), the decision maker derives ratio-scale (as shown in Table 2.2) priorities reflecting the relative importance of objectives via pairwise comparisons with respect to the goal of the problem. Finally, the judgments are further synthesized to provide a ranking of the alternatives for the best choice.

In university selection, it is desirable to select the best of the proposed universities to be the best choice for students. All the universities should be ranked by a number of criteria. AHP is a suitable method to be used in this decision making problem since it is a qualitative multi-criteria decision making method.

**Table 2.2 Linguistic measures of importance (Saaty,1988)**

| Intensity of importance | Definition |
|---|---|
| 1 | Equal importance or preference |
| 3 | Moderate importance or preference of one over another |
| 5 | Strong or essential importance or preference |
| 7 | Very strong or demonstrated importance or preference |
| 9 | Extreme importance or preference |
| 2,4,6,8 | Intermediate values |

## 2.3 Review on DSS

### 2.3.1 Review on the Development of DSS

Decision Support Systems (DSS) have been a major research area in the Information Systems (IS) field focusing on supporting and improving managerial decision-making for almost 40 years.

At the very beginning, in the 1960s, the research started from decision support. According to Scott Morton (1971), managers get benefit from using a computer-based management decision system. Then, DSS was defined by Keen and Scott Morton (1978) as the use of the computer to assist managers with their decision process in semi-structured tasks; DSS focuses on support, and does not try to replace managerial judgment; DSS concentrates on improving the effectiveness of decision making rather than its efficiency. Other researchers have also contributed to the definitions of DSS, such as Sprague and Carlson (1982), Power (2002), and Marakas (2003). Although there are some minor differences existing among these definitions, other definitions support the one defined by Keen and Scott Morton.

Over the past four decades, DSSs have evolved significantly. DSS changed focus from supporting individual decision makers to supporting communication oriented tasks by teams in the 1980s. Then from main-frame-based DSS to client–server DSS via the use of online analytical processing (OLAP) tools, and the enterprise data warehouses appearing in the 1990s. With the development of the World Wide Web and Internet technologies, researchers were exploring the possibilities for the next generation of DSSs (Bhargava et al., 1997; Bui, 1997; Holsapple and

Whinston,1995). Many researchers were covering the development of Web-based GDSS and Web access to data warehouses (Bhargava et.al, 1995; Ba et al., 1995; Goul et al., 1995; Jeusfeld and Bui, 1995; Bui, 1997).

At first, the decision support tools included ad hoc query and reporting tools, optimization and simulation models, online analytical processing (OLAP), data mining, and data visualization (Powell, 2001). In around 2002, the vendors of both software and hardware began to focus on Grid and Utility computing (Chang et al., 2004; Naik et al., 2004; Ross and Westerman, 2004). Web, as one of the integrated development environments, has also become more common as a DSS development environment. For example, the LAMP Web, combines the LINUX operating system, Apache Web server, the MySQL database application, and PHP middleware, as a very common development environment. Nowadays, Web is the platform of choice to build DSS.

DSS has many sub-fields that include Personal Decision Support Systems (PDSS), Group Support Systems (GSS), Negotiation Support Systems (NSS), Intelligent Decision Support Systems (IDSS), Knowledge Management-Based DSS (KMDSS), Data Warehousing (DW), and Enterprise Reporting and Analysis Systems (D. Arnott, G. Pervan, 2008). PDSS is one of the most popular in practice. PDSS usually is a small scale system developed for individuals, or a small group of independent persons to support one decision task.

Research in the DSS area has typically focused on the efficiency of the decision. They centred on how to improve the effectiveness of the user's decision by using information technology (J.M. Pearson, J.P. Shim, 1995).

DSS can be applied in many knowledge domains, such as business, medicine and agricultural. DSS is extensively used in business and management. There is no shortage of examples, such as applications developed for managers. In the medicine area, clinical decision support systems (CDSSs) form a significant part of the field of clinical knowledge management technologies through their capacity to support the clinical process and use of knowledge, from diagnosis and investigation through treatment and long-term care (http://www.openclinical.org/dss.html). And in the agricultural domain, for example, DSSAT (Decision Support System for Agrotechnology Transfer) (http://dssat.net/,) comprises crop simulation models for over 28 crops in the newest version. As a software application program, it is supported by data base management programs for soil, weather, and crop management and experimental data, and by utilities and application programs. There are many more examples in each domain. Some other applications in Personal DSS are presented in 2.3.2.

### 2.3.2 Review on Personal DSS

Decision Support System for University Students (DSS-US) uses the concept of individual DSS based on many others scientific research studies.

Compared with DSS, Personal DSS (PDSS) is usually designed and developed for managers to make decisions. Sometimes it is designed for only one manager,

while sometimes it is designed for a small group of independent managers to complete one task. So PDSS is usually developed as a small-scale system. It can be seen from the history of DSS that PDSS is the oldest kind of DSS in practice and has become the management support approach of choice instead of Management Information System (MIS). The organizational environment of MIS is large and inflexible while the PDSS is integrated, efficient, and has central control. In the 1960s and 1970s, the overwhelming majority of DSS was focused on a democratisation of decision-making, and for individuals as well in western society. PDSS followed this development trend, and changed the object of DSS from organization to individual. Alter (1980) proposed that PDSS was a successful system with major difference between MIS and PDSS.

Arnott (2004) presented that for IS theory, the important contribution of PDSS is evolutionary systems development. DSS has evolved through an iterative process of systems design and use, which has been central for the theory of decision support systems since the inception of the field. Meador and Ness (1974), were the first to mention the evolutionary development in decision support. Their description of that was middle-out design. For the methodology of the top-down versus bottom-up, it was a strong response concerning the development of transaction processing systems at that time.

In the “evolutive approach”, proposed by Courbon et al. (1978), as the first general statement of DSS evolutionary development, development processes were not implemented in a linear or even in a parallel fashion, but in continuous action

cycles that involve significant user participation. Each evolutive cycle completed the system to make it closer to its final or stabilised state.

According to Arnott (2005), Keen proposed an approach about a framework or model for understanding the dynamics of decision support systems evolution as shown in Figure 2.2. Keen abandoned a more accurate term ‘adaptive development’ and called it ‘adaptive design’ instead. Keen’s work is clear enough to give the concept to a larger audience and Keen’s remains the most cited and thereby the most influential description of the evolutionary approach to DSS development.

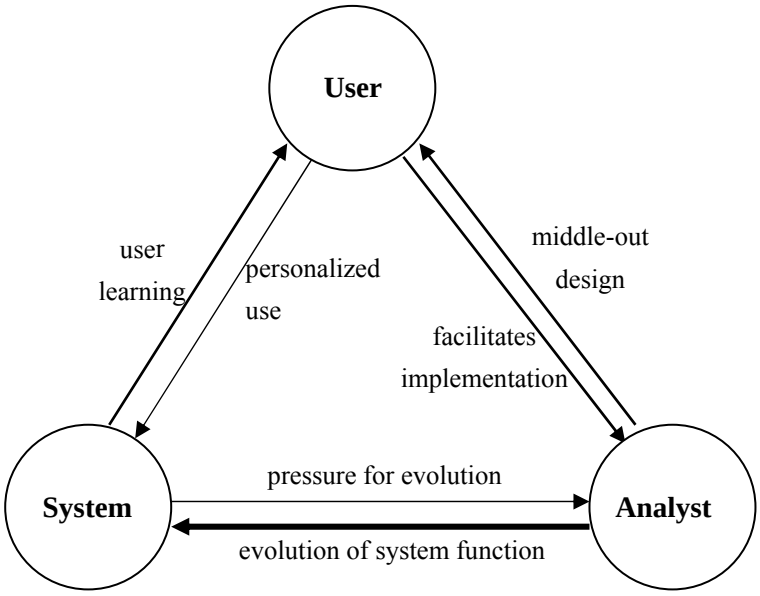



**Figure 2.2 Keen’s Adaptive Design Framework (Arnott,2005)**

Other researchers contribute to DSS development theory as well. Sprague and Carlson (1982) defined an evolutionary DSS development methodology, and Silver (1991) extended Keen’s approach by considering how DSS restricts or limits the decision-making processes.

Minicomputers, such as Digital Equipment Corporation's PDP series, were the technology that enabled the development of PDSS. Besides, relatively user-friendly software applications, especially financial modelling and data base software were the developing technology as well.

With the development of technology in the mid 1980s, the cost of personal computers and spreadsheet software fell and at the same time, PDSS began to be used in all levels of management. Alter (1980) presented the technical foundation of DSS by the taxonomy of decision support systems. Although it was formulated in the late 1970s, it remains relevant, as attested by more recent empirical validation (Pearson and Shim, 1994).

PDSS is an important aspect of IT-based management support in contemporary practice. Modern PDSS can source data from data warehouses and deploy powerful modelling approaches from management science/operations research. The current industry term for the later class of PDSS is 'analytics' (Morris et al., 2003).

Palma-dos-Reis and Zahedi (1999) have designed a personal intelligent financial decision support system. They created a prototype and used it in an exploratory investigation of the impact of investors' individual characteristics on their use of models when making investment decisions. And they reported how the gender of investors, and the attitude towards risk, related to their choice of investment models, and provided evidence for the possibility of personalizing DSS.

Jeong et al. (2011) proposed a Personalized Learning Course Planner (PLCP) that allows students to select the desired learning course easily. E-Learning Decision Support System (ELDSS) in PLCP suggests an appropriate learning course organization, according to calculated results based on the user's profile data.

Muntermann (2009) designed an IT artifact called MoFiN DSS that comprises hardware and software components that provide the basis for a prototype of a financial decision support system (DSS) to support individual investors reacting to unforeseen market events.

Min (1998) presented a personal-computer assisted decision support system (DSS) that aims at aiding logistics managers in selecting the most appropriate transportation choice between private and common carriers.

Bellone et.al (1995) published an article named 'A DSS for personnel career management'. The system was designed mainly to deal with the problem of establishing a training system to make a new employee ready for the job.

Raymond and Bergeron (1992) found that PDSS was successful in small enterprises. Managers were found to be more successful when developing their own numeric applications using spread-sheets to provide greater analytical support for decision-making.

### 2.3.3 Review on Web-based DSS

In the early 1990s, four powerful tools including data warehouse, on-line analytical processing (OLAP), data mining and the technology associated with the

World Wide Web emerged to build DSS. With the development of information technology, there is no doubt that web-based DSS has been, is and will keep being a hot topic in the DSS area. The Web environment has been emerging as a very important DSS development and delivery platform (Shim J.P., 2002).

The original Web tools running environment could trace its roots by the research of Tim Berners-Lee in 1990. He developed a point-and-click hypertext editor, which ran on the ‘‘NeXT’’ machine and released the first Web server in1991 (cf., http://www.w3.org/People/Berners-Lee/ShortHis -tory.html). His innovation also led to the developments in e-business and e-commerce. The primary Web servers used Hypertext Transfer Protocol (HTTP) containing Web pages created with Hypertext Mark-up Language (HTML), and the browsers accessed JavaScript by the user running client software on their personal computer.

Nowadays, the web has become a platform for building DSS. And most applications of DSS are located on an independent computer or are operated in a client server environment. This progress should appreciate the contribution from Bonczek et.al at 1981, who proposed that DSS consisted of three components - user interface, a knowledge processing system and a knowledge base. This structure resulted in extended research in the area of DSS, and also led to the development of the applications industry.

Several changes have come out after web-based DSS appeared. Firstly, the range of users was expanded from managers and experts who work on business-related problems to general consumers who use DSS for consumer decision-making. For

instance, a common usage today is online shopping. The web-based DSS assists customers to configure a product and service in the light of their personal needs. For example, customers buy a computer on the internet (such as www.dell.com) by choosing attributes, components, prices and delivery options. Customers can also specify the full configuration, such as hard-drive and memory capacity. Secondly, the problem domain is changing. It is extended to interest communities such as consumers, students, children, and patients. And the underlying technology architecture is changing too. Besides, Web-based DSS reduced the inconvenience caused by geographical problems, saved time and lowered the cost by the Internet infrastructure.

DSS-US aims to support selection for all the international students who plan to study in United Kingdom. And a web-based DSS can be used globally with access to the internet.

## 2.4 Chapter Summary

This chapter reviewed the literature in three sections. Firstly, the decision making process was presented in detail using Simon's (1977) work. Then, multi-criteria decision making was described, and a review focused on multi-criteria decision making method and Analytic Hierarchy Process (AHP). The last part was a review on DSS.

Through literature review of decision making process, multi-criteria decision making and DSS, it is known that many studies have been done on developing decision support systems for enterprise or managers. Meanwhile, some DSSs were

developed for individuals in the business area, such as personal banking decision support system. It is found that current decision making system has been widely used in various fields by experts, managers, and business people. However, limited systems are developed to support individuals who are not managers or decision makers in business organisations. Even though there are many studies focus on the method of ranking universities, analysing the advantages and disadvantages of each ranking method, or how to improve the method for university ranking. There is no research focusing on how to help students to make better decision on university selection. Therefore, it is necessary to find a solution that can deal with the information overload and the influence from the commercial university ranking information.

# Chapter 3: Research Method

This chapter describes the selection of the research method for the study. The chapter is divided into three parts. Firstly, Section 3.1 presents the research method for the impact factors of university selection. Secondly, section 3.2 comprehensively describes the method for system development that is called prototyping to develop the Decision Support System for University Students (DSS-US). Last, section 3.3 gives a description of the System Evaluation method.

## 3.1 Selection of Research Method for Key Decision Criteria

In order to achieve the aim of finding out the key decision criteria, data collection needs to be completed before designing the system.

The three main data collection research methods are observation, interview, and questionnaire (Saunders et al., 2009). The research methods must meet the demands of the research questions and objectives. One objective of this study is to investigate and analyse the key factors affecting students' decisions on selecting desired universities.

Observation method of collecting data is obviously not suitable for this research as the research requires participation and to become a member of the sample group (Saunders et al., 2009).

According to Saunders et al. (2009), the interview has three types: structured interview, semi-structured interview and unstructured interview. Structured interview, referred as the 'quantitative research interview', is used to collect quantifiable data. Semi-structured interview gives a specific organisational context to interviewees and some questions are allowed to be added in the interview for exploring the research. Unstructured interview is informal.

The questionnaire is one of the most widely used data collection techniques within the survey strategy (Saunders et al., 2009). It provides an efficient way to collect feedback from a large sample prior to quantitative analysis. Each respondent is asked to answer the same group of questions. And it may be better to link them with other methods such as interviews in a multiple-methods research design (Saunders et al., 2009).

As mentioned above, the semi-structured interview and questionnaire survey are considered as the most appropriate methods and are adopted in the study.

Semi-structured interview is often referred to as 'qualitative research interviews' (King, 2004). In semi-structured interviews, the researcher will have a list of themes and questions to be covered, although these may vary from interview to interview (Saunders et al. 2009). The researchers may omit some questions in particular interviews and give a specific organizational context that is encountered relative to the research topic. The interview can help determine whether the Decision Support System for University Students is useful to students, and at the same time, it can make sure of the necessity of the study. And the interviews also

can help determine the range of factors that could be considered as the usual factors.

Questionnaires require each person to respond to the same set of questions in a predetermined order (DeVaus, 2002). And Robson (2002) indicated that questionnaires works best with standardised-question answers so that all respondents can be interpreted the same way. The questionnaire survey identifies the affecting factors precisely, and sort the factors according to importance. At the same time, it also can determine whether the factor weight is necessary when students make a choice on university selection.

Just as a slight clarification, the students in the chosen samples of this research come from an education programme administrated by both the Chinese and UK universities. The students come from International College, Beijing, China Agricultural University (ICB, CAU). The students have to complete courses (credits) in China for the first one or two years before transferring to the university in UK to finish the course to get the Bachelor degree. Experience with a previous cohort indicated that a high proportion of students who obtained a Bachelor degree in the UK desire to continue their post-graduation studies. This is the target group highly relevant to this study. Some participants who graduate from ICB are studying in different universities in the UK as postgraduate students.

### 3.1.1 Semi-structured Interview

#### 3.1.1.1 Interview Design

The interview has two versions. One is for undergraduate students and the other is for postgraduate students. The main body of the interview outline (See Appendix A and B) includes five themes. Only one of the five is common in the two versions. The other four themes in the interview are about the difficulty in university selection, factor concerned, and whether a website or system is necessary. In the undergraduate students group, the interviewees need to answer questions about the applying process of choosing universities, while the other group's interviewees need to answer questions about application experience.

#### 3.1.1.2 Interview Administration

The ten interviewees are made up of five undergraduate students and five postgraduate students and they all accepted to be interviewed. The information of each interviewee is listed in Table 3.1. The interviews were carried out through face to face and via telephone.

**Table 3.1 The information of interviewees**

| | Date | Interview Type | Identity | University |
|---|---|---|---|---|
| 1 | Nov. 24th | Face to face | undergraduate | University of Bedfordshire |
| 2 | Nov. 24th | Face to face | undergraduate | University of Bedfordshire |
| 3 | Nov. 26th | Face to face | postgraduate | Royal Holloway University of London |
| 4 | Nov. 26th | Face to face | postgraduate | University of Birmingham |
| 5 | Nov. 27th | Face to face | postgraduate | University of Surrey |
| 6 | Nov. 29th | Face to face | undergraduate | University of Bedfordshire |
| 7 | Dec. 4th | Face to face | postgraduate | University of Sussex |
| 8 | Dec. 4th | Telephone | postgraduate | London School of Economics |
| 9 | Dec. 6th | Face to face | undergraduate | University of Bedfordshire |
| 10 | Dec. 6th | Face to face | undergraduate | University of Bedfordshire |

### 3.1.2 Questionnaire Survey

Survey questionnaires contribute to confirming the criteria influencing students and the importance of each factor. At the same time, it provides more details on sorting criteria. The questionnaire results are used to decide the criteria by which students use the system to make a choice on university selection.

#### 3.1.2.1 Questionnaire Design

The instrument adopted is a self-administered questionnaire consisting of two parts. The first part is an introduction for participants that explains the purpose of the questionnaire and guarantee that the results will only be used in this study. The second part includes six questions (See Appendix C). The first two questions are about a list of criteria based on the literature review and the results of the semi-structured interviews. The respondents are asked to choose the criteria they are concerned with most and rank those criteria from the most important to the least. The next four questions are about whether the system is useful and what functions should be included.

#### 3.1.2.2 Questionnaire Administration

As described in 3.1, all participants in the questionnaire survey who will finish their third year study in the University of Bedfordshire come from ICB. About 50 survey questionnaires were distributed to students in five different majors in the business field, which are business administration, marketing, advertising and media market, accounting, and international financial and banking.

## 3.2 Selection of Research Method for System Development

One aim of this research is to develop a decision support system for students to select a university. It is important to choose a suitable method to develop the system.

### 3.2.1 Introduction of DSS Development Methodologies

Information Systems (IS) has extensive categories, including Management Information Systems (MIS), Operations Information Systems (OIS), and so on. According to Bocij et.al (2008), DSS is one type of MIS, and the other two are Information reporting systems (IRS) and Executive information systems (EIS).

There are many classic system development models for information systems, which is suitable for DSS too. According to Steven D.S. (2000), all the models currently used can be included under the rubric “Systems Life Cycle” (SLC). “Systems Development Life Cycle” (SDLC) is another title that is also widely used. And SLC and SDLC are often used interchangeably (Davis, 1994; Wetherbeand and Vitalari, 1994).

There are two standard models in SDLC. One is the Waterfall model and the other is Prototyping.

The waterfall model is a linear type framework. It presumes that a system’s creation is the result of a predefined order through the phases of system development. It seems like waterfalls sequentially cascade down with no provision for returning to a previously completed phase. That means each stage must be finished before the next one can start. The waterfall model describes what

actually happens in a system development process, and it provides a good framework for introducing system development, since all of the activities that are identified in the model occur in a typical project (Bocij et.al, 2008).

The waterfall model was the earliest model utilized in software development, so it is also called the traditional SDLC. A traditional SDLC consists of four fundamental phases, planning, analysis, design and implementation (PADI) (Dennis and Wixom, 2003). The four phases lead to a deployed system (Figure 3.1).

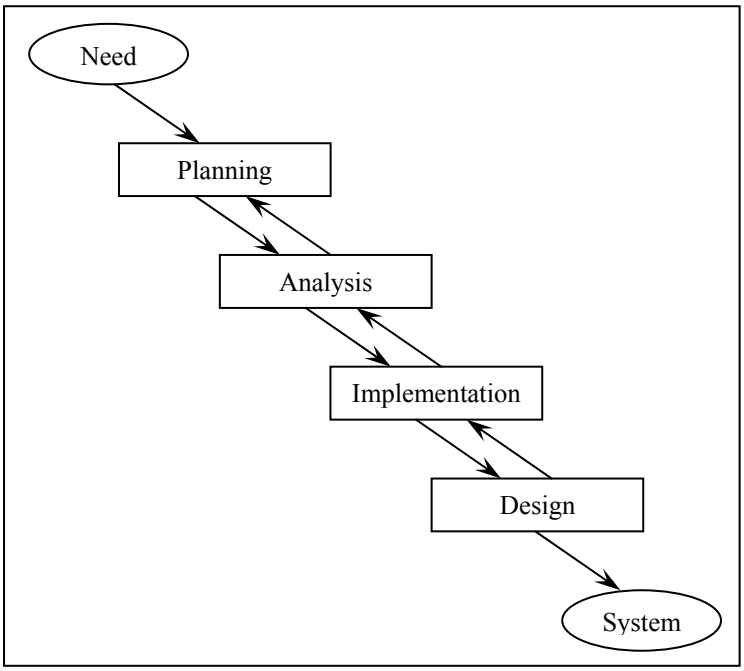



**Figure 3.1 The Traditional System Development Life Cycle (SDLC) (Turban, 2005)**

The Planning phase includes possible opportunities identified through environmental scanning. Project initiation involves a system request that is decided on. In the analysis phase, the system services, constraints, aims and procedure are defined in detail and serve as system specification. The third phase,

design phase, describes the system's process and gives all the details of the system. The user interface, forms, displays, reports and programs, databases, and files are specified. The last implementation phase is integrated to test the system to ensure the functions work well.

It can be seen in many cases that the waterfall model usually results in unsatisfactory systems. More specifically, those systems have much uncertainty and systems needing to be defined by users could not work successfully (Boar, 1984; Martin, 1982; Naumann & Jenkins, 1982). It does not allow much reflection or revision and it needs to be well-thought out in the concept stage as it is very difficult to make changes back in the testing stage.

There are several alternative development methodologies, all of which are based on the traditional SDLC. The one most closely resembling the SDLC is parallel development. In parallel development, the design and implementation phases split into multiple copies following the analysis phase. Each of these copies involves development of a separate subsystem or subproject. They all come together in a single implementation phase in which a systems integrator puts the pieces together in a cohesive system.

The other model, Prototyping, is an iterative framework type. The difference between those two models is whether it allows looping back to an earlier phase when specifications change. Prototyping method will be presented in 3.2.2.

One aim of this research is to develop a decision support system for international students to select the most suitable university for their postgraduate study in the

UK. Since the prototype methodology evolved from the SDLC methodology and has a lot of advantages aforementioned, a prototyping method is used in designing and developing the DSS prototype.

### 3.2.2 Methodologies of Prototyping

The prototyping development methodology aims at building a DSS in a series of short steps with immediate feedback from users to ensure that development is proceeding correctly (Lari A.). According to Bocij et.al (2008), Prototyping is a process of building a "quick and dirty" version of a system. The evolutionary approach starts with overall DSS planning and analysis. Next, the analysis, design, and prototype implementation phases are iterative. In other words, the looping

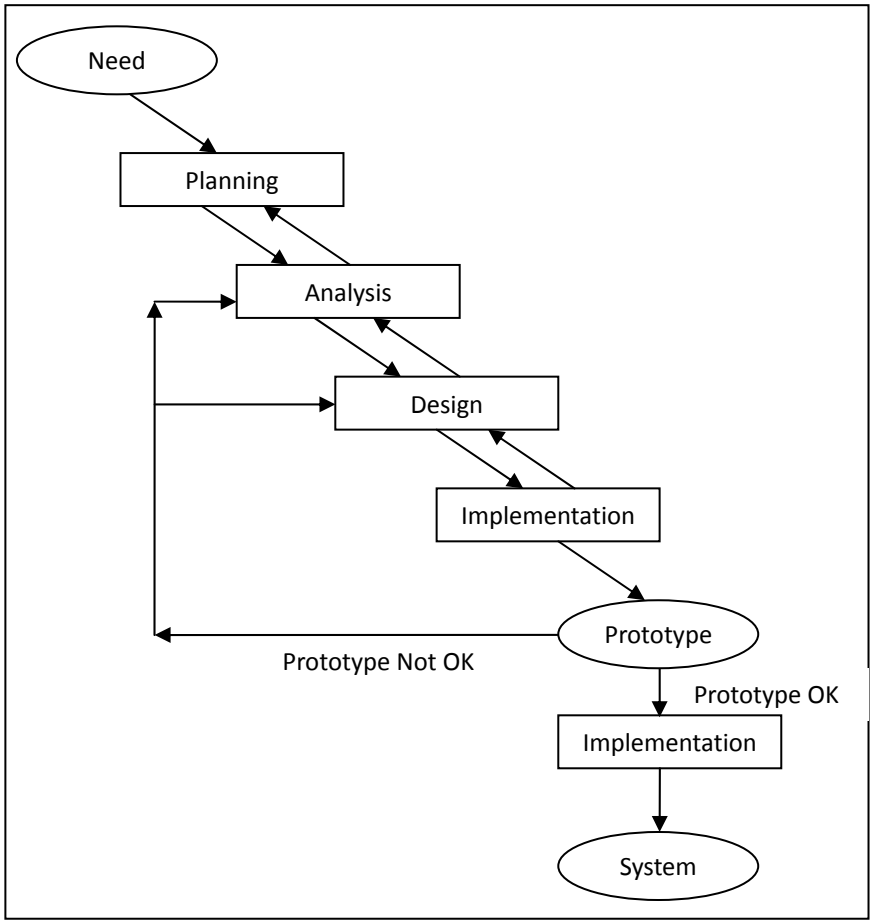



**Figure 3.2 Prototyping Development Process (Turban, 2005)**

back happens between the contiguous two phases till a small prototype is sufficiently developed. Then the final implementation takes place. Simultaneously, further iterations occur in the loop of analysis-design-implementation-system prototype as other subsystems or capabilities are added to the deployed system till a fairly stable, comprehensive system evolves. Figure 3.2 shows the details of the prototyping methodology.

“The prototyping methodology is based on one simple proposition: users can point to features they don’t like about an existing system (or indicate when a feature is missing) more easily than they can describe what they think they would like in an imaginary system” (Jenkins, 1985). When developing a system, the developer should show a series of rough approximations of the computer system to the user, instead of compelling users to understand the details of the system design specification. Although the prototype is often incomplete, it is a working model.

The developer will collect enough information from the user and build a “rough” initial system prototype at first, then show it to the user to modify comments. It is easier for the user to clarify system requirements and express what needs to develop from the initial system prototype. Next, the developer needs to update or modify the initial system prototype according to the user’s comments and build a new system prototype. This process will stop only when no new requirements are identified by the user. Parker (1983) indicated that in the System Life Cycle methodology, the four major phases (analysis, design, program development, and implementation) are combined into one phase and repeated several times until the

final system satisfies the user. That means the final system needs to be refined till there is no error.

The prototype changes in each step and the change can happen at any time in the developing process. Changes in the system design are accepted and regarded as a regular part of the whole development process. Comments coming from the user are a necessary and integral part of the development process.

Because user involvement is involved in the whole developing process, the interest and enthusiasm of the user will have a significant impact on the quality of the final system (Bocij et.al, 2008). If the duration of the project is too long, the interest and enthusiasm of the user will decrease. Therefore, the system development duration should be kept as short as possible. To curtail system development, a software tool, such as DBMS with sophisticated query language processors, report generators, screen design aids, generalized input processors, and a very high level or fourth generation language is needed (Ackoff,1967; Naumann and Jenkins, 1982).

## 3.3 Method for System Testing

System testing is another significant part in the system development process. During this stage, the prototype DSS (DSS-US) is evaluated by the user and its performance is compared with the usability goals using the test data for all the decision scenarios. The testing mentioned in this research is focused on the system usability testing. Think aloud, as a widely used method for the usability testing of software, interfaces, websites and documents (Vandenhaak, 2003), is chosen as

the system testing method. Figure 3.3 shows the systems development based on prototyping and iterative usability testing.

Tests of prototype systems focus on system flaws that need to be repaired before a final design release as mentioned in 3.2.2. According to Monique (2009), there are some different methods that can be used for system testing such as guideline review, heuristic evaluation, consistency inspection, usability inspection and walkthroughs.

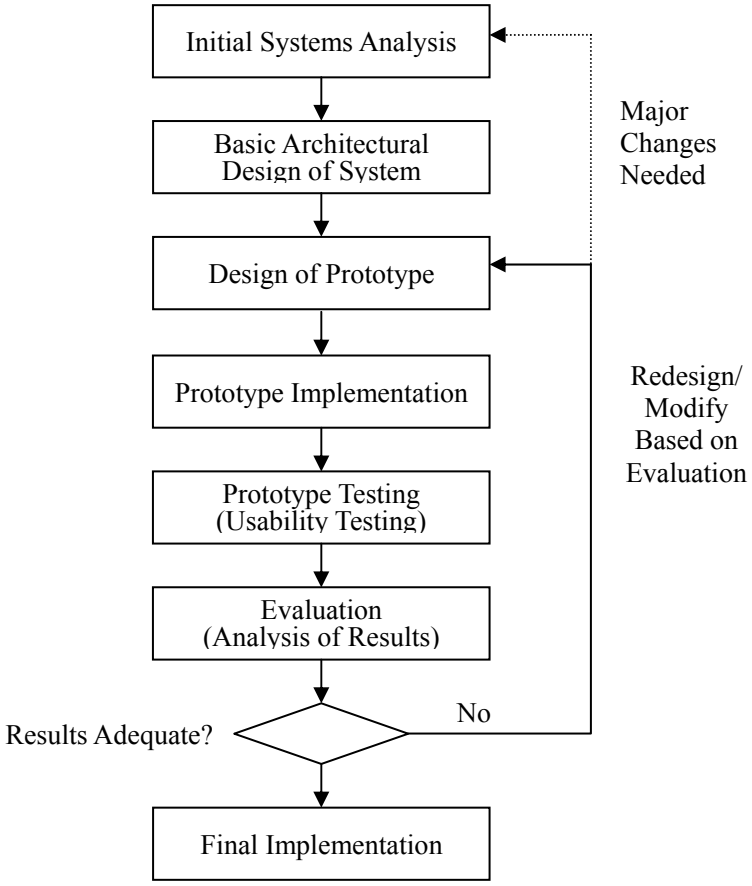



**Figure 3.3 Systems development based on prototyping and iterative usability testing highlighting the role of evaluation in system design. (Kushniruk A.,2002)**

According to Nielsen (1993), the heuristic evaluation and cognitive walkthrough are the two most widely adopted expert-based methods while 'think aloud' is the

most widely applied user-based method. Since DSS-US serves international students for university selection, the think-aloud method is one of the User-based testing methods, which is chosen as the system testing method in this research.

'Think-aloud' is a participatory evaluation method which requires actual end users to use the system and explain what they are doing or thinking, or the feeling when they use the system in a retrospective interview (Monique, 2009). The think aloud method originated from the field of cognitive psychology and formally belongs to the verbal report methods (Monique, 2009). This method is particularly useful in understanding the processes of cognition as it can reflect humans' cognitions concurrently with their occurrence. These cognitive processes have a unique source of information and can help to gain insight into how humans solve problems.

According to Ericsson (1993), the think aloud method has two stages. The first one is collecting think aloud protocols (the recording of a user's speech) in a systematic way, and the second one is analysing these protocols to obtain a model of the cognitive processes that take place while a person tackles a problem. These protocols are collected from users and directly show what they think.

The think aloud method has great value in evaluating a system's usability flaws. And it is also used frequently to gather information on testing systems from potential end users. At the first stage, users verbalize their thoughts according to a predetermined set of scenarios, an 'interaction' between users and a prototype system. At the analyses stage, the verbal reports provide usability problems by the

details the end users mentioned and show the causes underlying these problems by what they encountered.

Because all the information provided by users is subjective, the selection of the sample is very important for collecting valid data with a think aloud method for a system usability test. So it is very important on selecting the real potential end users. That means the users who are selected as samples should be the actual users of the system in the future.

Because the think aloud method provides vast data, the number of subjects should be controlled in a small sample group, approx 8 subjects, and it suffices to gain a thorough understanding of task behaviour (Ericsson, 1993) or to identify the main usability problems with a computer system (Nielsen, 1994). The interview with a list of questions may be designed for the test.

## 3.4 Chapter Summary

This chapter presents all the research methods used in this research. Semi-structured interview and questionnaire are used for finding out key decision criteria in university selection. Prototyping has been chosen as the system development method because it allows looping back to an earlier phase when specifications change. And for system evaluation, the think aloud method is suitable for the research.

# Chapter 4: Consideration of Key Decision Criteria and Data Collection

This chapter will discuss the key decision criteria of selecting a university, the data collection and data normalization. To make the system practically applicable to help students find a suitable university, interviews and questionnaires surveys were carried out to find the key decision criteria. The results of interviews and questionnaires will be described respectively in this chapter.

## 4.1 Key Decision Criteria Influencing Students Choosing University

The university selection process is complicated and confusing. To try to make a correct decision, too many things need to be considered for a student and the family. From the results of the interviews and survey, there are several criteria that students put on the top. These criteria should be included in the Decision Supporting for University Selection (DSS-US).

The sample group of the survey is composed of Chinese students from the International College, Beijing, China Agricultural University (ICB, CAU) as mentioned in 3.1. All students take their degree courses in China for the first two years (“2+1”) or the first year (“1+2”), then they are transferred to the UK in the third year (“2+1”) or in the second year (“1+2”) to finish their undergraduate degree. And most of them will continue their studies to Masters level.

### 4.1.1 Interview Respondent Profile and Result

The research selected ten ICB students for interview. Five of them are undergraduate seniors and the other five are graduate students. Undergraduate students show concerns which are our resource to set the criteria. Graduates who have experienced the selecting process provide their stories and evaluate the criteria.

Nine out of ten students admit that it is a tough job to select a proper university to do graduate study. Mostly, students are not familiar with the procedure and do not have a plan to start research. The student who feels neither confused nor exhausted has a favourite target.

When selecting a university, students collect information from the experienced ones or search online. If they do not have access to experienced persons, they have to search each of the university websites one by one which is notoriously time consuming and tedious.

All ten students would like to use a system or a website, like DSS-US, to help them make decisions on university selection, if it is available.

The key decision criteria of selecting a university that the students mentioned during the interviews are: university ranking, subject ranking, location (geography), tuition fee, completion rate, environment, facilities, weather, city culture, subject, future occupation selection, interest, difficulty level, educational quality, social awareness of the university, personal preference. The results also

show that the system would be useful and helpful for students on university selection.

From the interview we know that there are various criteria impacting on the result of student selection and different students focus on different criteria. Almost all the students have to face the information overload problems when they began to do the university selection. There are so many sources to receive the information but there is a lack of explanation on how to identify the most useful information.

There are some other criteria, university's recognition which could affect student's choice straight without considering other factors, especially in China. As a developing country, people in China do not know the education market very well in developed countries. Sometimes, they determine whether a university is good or not just on their familiarity of the university's name. If so, it will cause problems and probably lead to an unfavourable result. Take the University of Birmingham as an example. Birmingham, as an industrial city in the UK, is one of the most widely known cities in China. No matter the majors, tuition and other important criteria, the University of Birmingham has great approval because of its name. While the University of Exeter, which has a more considerable ranking in some faculties, may not have such a high approval degree.

### 4.1.2 Questionnaire Respondent Profile and Result

Questionnaires have been designed for the semi-structured interviews to explore the students' needs, challenges and decision criteria. As mentioned in 3.3.2.2, about 50 survey questionnaires were distributed to students and 48 questionnaires

were collected in total. Three of them were not usable due to incompleteness. As a result, there were 45 valid questionnaires. The effective response rate was 90%. The questionnaire has been designed according to the results of the interviews. It includes six questions. The first two questions are about the key decision criteria which impact on university selection. The third and fourth questions are about the necessity of the system, and the most commonly used information that should be included in the system. The last two questions are about the function of the system.

The second question is more representative than the first one. Below is the analysis about question 2 with details.

Question 2: Please rank those factors from the most important to the least important by using 1, 2, 3…. Just write 'X' in the box if the factor is not of your concern. You are welcome to add factors not included in the table.

| Criteria | No. | Criteria | No. |
|---|---|---|---|
| Location | | Campus Setting | |
| Facilities | | Tuition fees | |
| Ethnicity | | Completion rate | |
| University ranking | | Living costs | |
| Subject ranking | | School size (students number) | |
| Reputation | | Degree class demand | |
| Gender Mix | | IELTS demand | |
| Graduate prospects | | Parents Opinion | |

There are 16 factors in the question. The most important criterion (factors) record 16 points, and the second most important criterion could get 15 points, and so on. The factors which are assigned X get zero points. The result is shown in table 4.1.

According to the result (from table 4.1), these 16 factors can be divided into three parts.

University ranking, Subject ranking and Reputation are the most important criteria and go in the first parts. Both University ranking and Subject ranking were selected 42 times by students, which is the identical result to question 2. And the criterion of University ranking is a little more significant than the criterion of Subject ranking with 611 vs. 594. Reputation is another consequential criterion for students to select university as it gets 516 points. These three criteria stand out from the others because they are the only three that collect more than 500 points. The fourth most important criterion gets 359 points. We can see a big gap between the third and fourth criteria.

The second part consists of five criteria, which are Completion rate, Location, Degree class demand, Living costs, Tuition fees. Those criteria collect 359 to 290 points, and the biggest gap in those five criteria is only 37 points, between Completion rate and Location. That means those five factors do not have much difference for students when choosing universities.

The last part includes eight criteria which are not as important as the criteria in the first two. These less important eight criteria are Facilities, IELTS demand, Graduate prospects, Campus Setting, Ethnicity, Gender Mix, School size, and Parents Opinion. The points are 246 (Facilities) as the highest and 115 (Parents Opinion) as the lowest.

**Table 4.1 The result of question 2**

| Criteria | Frequency | | | | | | | | | | | | | | | | Cumulative Frequency | Total points | ranking |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | | | |
| University ranking | 23 | 9 | 2 | 1 | 1 | 3 | 1 | | | 1 | | 1 | | | | | 42 | 611 | 1 |
| Subjects ranking | 11 | 14 | 8 | 3 | 2 | 2 | | | | 1 | | | 1 | | | | 42 | 594 | 2 |
| Reputation | 4 | 9 | 14 | 1 | 1 | 3 | 1 | 3 | 2 | | | | 2 | | 1 | | 41 | 516 | 3 |
| Completion rate | 1 | 1 | 3 | 3 | 6 | 6 | 3 | 2 | 1 | 4 | 1 | 2 | 2 | | | 1 | 36 | 359 | 4 |
| Location | 2 | 2 | 1 | 10 | 5 | 2 | 1 | | 3 | | | | | | | | 26 | 322 | 5 |
| Degree class demand | 1 | | 3 | 6 | | 2 | 5 | 2 | 2 | 2 | 3 | 2 | | 2 | 2 | 1 | 33 | 295 | 6 |
| Living costs | 1 | | 1 | 5 | 4 | 4 | 3 | 2 | 3 | 1 | 1 | 1 | 1 | 1 | 3 | 1 | 32 | 291 | 7 |
| Tuition fees | | 3 | 2 | 2 | 3 | 4 | 2 | 3 | 1 | 1 | 1 | 3 | 3 | 2 | | | 30 | 290 | 8 |
| Facilities | | | 2 | 2 | 6 | 4 | 3 | 1 | 2 | 2 | | 1 | | | 1 | | 24 | 246 | 9 |
| IELTS demand | | 1 | 5 | 3 | 1 | | 2 | 2 | | 3 | 1 | 1 | 1 | 3 | 2 | | 25 | 223 | 10 |
| Graduate prospects | 1 | | 2 | 5 | 1 | | 3 | 1 | 2 | 1 | 2 | | 2 | 2 | 2 | | 24 | 213 | 11 |
| Campus Setting | | | | | 2 | 1 | 1 | 2 | 2 | 2 | 4 | 4 | 1 | | 1 | 1 | 21 | 144 | 12 |
| Ethnicity | | | | 1 | 2 | 1 | 2 | 2 | 2 | 1 | 3 | 1 | | 3 | | 1 | 19 | 142 | 13 |
| Gender Mix | | 3 | | | | 1 | 2 | 3 | 1 | | | | 1 | 1 | 2 | 4 | 18 | 126 | 14 |
| School size | | | | | | 1 | | 3 | 2 | 2 | 3 | 3 | 1 | 5 | | | 20 | 120 | 15 |
| Parents Opinion | | 1 | | 1 | 2 | 1 | | | | 1 | 2 | 1 | 4 | | 3 | 6 | 22 | 115 | 16 |

The question 3 is more representative than question 4. Below is the analysis about question 3 with details.

Question 3: If there is a decision support system or a website which can help you make a decision on university selection,

1) Do you think it can help you when you have to deal with vast quantities of information?

□ Yes □ No Why _____

2) Will you use it?

□ Yes □ No Why _____

The result is shown in table 4.2.

**Table 4.2 The result of question 3**

| | Yes | Percentage (%) | No | Percentage (%) |
|---|---|---|---|---|
| The system is helpful | 43 | 95.6 | 2 | 4.4 |
| The system is useful | 43 | 95.6 | 2 | 4.4 |

Most students claimed that the system could help them make a decision on university selection, and they also provide some other reasons, such as “Save time”, “Give me correct information”, “More information, and more competition”, and “search information”. As for the reason why they will use the system, some students point out that “it will lead to successful choice”, “quickest way to find answer”, etc. So there is no doubt that the DSS-US system will give students strong help when making a decision on university selection as the support rate is 95.6%. Only 2 of 45 students (4.4%) think it is not helpful and they will not use it. They claimed that “I can figure it

by myself" and "I know what I need". Even so it can be easily seen from the data that only a small number of students did not admit the advantage of the DSS-US system and maybe had other strong reasons such as they have had a dream university from childhood, or they did not need to make a choice on this problem at all.

From question 3 it can be seen that it is necessary to develop the DSS-US system for students to help them make a decision on university selection. And it also could be used widely for all the students not only the students who want to study in the UK but also other students who plan to study abroad by choosing the different database. Other data can be added to the DSS-US system without any barrier.

Question 5: About factor weight consideration (Please sign √, Single choice),

□I think each of these factors is equally important.

□I think some factors are more important than others.

Result is shown in table 4.3.

**Table 4.3 The result of question 5**

| Choice | Total | Percentage (%) |
|---|---|---|
| I think each of these factors is equally important. | 10 | 22.2 |
| I think some factors are more important than others. | 35 | 77.8 |

Question 6: Which functions should be included in the system or website? (Please select as many as you think is necessary, and you are welcomed to provide your opinions).

□ Universities ranking by authority, such as the *Times*.

□ Basic information of the universities, such as IELTS demand, Location and so on.

□ I can choose the factors I am concerned about, the website then generates a list of candidate universities according to my input.

□ The system or website could score each university according to the factors I am concerned about, to help me make a decision.

□ Others _____

The result is shown in table 4.4.

**Table 4.4 The result of question 6**

| Choice | Total |
|---|---|
| Universities ranking by authority, such as *Times*. | 18 |
| Basic information of the universities, such as IELTS demand, Location and so on. | 20 |
| I can choose the factors I am concerned about, the website then generates a list of candidate universities according to my input. | 27 |
| The system or website could score each university according to the factors I am concerned about, to help me make a decision. | 13 |

Questions 5 and 6 are concerned about the function of DSS-US system.

Question 5 considers if we should weight the factors in DSS-US system. Weight consideration can help the user to make a decision more precisely.

Question 6 is about the function of DSS-US system. The system should have two functions. The main function is to help students make a decision on university selection. The other attached function is to search for information of all the universities in the UK.

The results of questionnaires show that the key decision criteria of university selection of students are University Ranking, Major Ranking, Completion Rate, Location, Accommodation costs, Tuition fees, Degree class requirement, and IELTS requirement. Degree classification and IELTS are entry requirements, so they are used as extra conditions in the system. Table 4.5 shows the key criteria.

**Table 4.5 The Key Criteria on University Selection**

| | | |
|---|---|---|
| Key Criteria | 1 | University ranking |
| | 2 | Subject ranking |
| | 3 | Completion rate |
| | 4 | Location |
| | 5 | Accommodation costs |
| | 6 | Tuition |
| Restricted Condition | 1 | Degree class demand |
| | 2 | IELTS demand |

## 4.2 Data Collection and Normalization

### 4.2.1 Data Collection

As mentioned in 4.2.2, from question 2, it is concluded that there are eight most important criteria needing to be considered when students choose a university for pursuing their masters degree, which are University ranking, Subject ranking, Reputation, Completion rate, Location, Degree class demand, Living costs, and Tuition fees.

Guardian ranking, one of the most famous league tables in the UK, has been chosen for the data resource of University ranking and Subject ranking. The students as the sample group for this research come from ICB. They are majoring in Business and seek to pursue a postgraduate degree, so Subject ranking will focus on Business and Management subjects. And the data of Completion rate and Tuition fees will be collected in the area for masters degree by taught students found in the Guardian too.

The criterion of Reputation cannot be calculated and expressed by numbers or any other existing units of measurement. Besides, any single university's reputation may differ in different countries. There is an obvious difference between big city and countryside or between south and north even in the same country such as China. For example, in China, within the country, people from urban or suburban areas, southern or northern areas, will have different impressions for the reputation of the same university. So, the Reputation will not be chosen as a ranking criterion in DSS-US.

The criterion of Living costs is another imponderable factor. Living costs i include renting cost, utility bill, telephone and internet access, food and drink, commuting expense, and so on. In different places, living costs is various. And different people have different living preferences and affordability. Usually accommodation costs expenditure takes a heavy weight in Living costs, and almost every university provides accommodation for international students; DSS-US will use Accommodation costs as Living costs.

Location is a widely concerned criterion. DSS-US will choose six cities in the UK as samples for location criterion. They are London, Liverpool, Birmingham, Leeds, Plymouth, and Edinburgh. London is the capital, and the political and financial centre of England; Liverpool is located in the northwest of England; Birmingham is the second largest city in the UK; Leeds is located in the middle of the UK; Plymouth is located in the southwest of the UK; and Edinburgh is the Scottish capital. DSS-US will allow the user to choose one city they like the best and give it a rank according to the distance between each university and the city the user selected. All data come from Google Map. If the university is located in the very same city, the distance is zero as default data. For example, University College London, King's College London,

and London School of Economics and Political Science are located in London, no matter whether the location is London downtown or suburban area, the distance between the universities and London is Zero.

The criterion of Degree class demand is different from the other seven criteria. Other criteria have no relationship with student. However, Degree class demand is an important entry requirement in the UK, which could restrict the enrolment. That means, although a student choose a preferred university, he or she cannot be enrolled in the university if the condition is not satisfied. Another important entry requirement in the UK for international students is IELTS demand. So, DSS-US will collect data of both Degree class demand and IELTS demand.

In summary, eight criteria will be used in DSS-US. They are University ranking, Subject ranking, Completion rate, Location, Accommodation costs, Tuition fees, Degree class demand, and IELTS demand. And the last two, Degree class demand and IELTS demand, as entry requirements will be used as extra conditions.

### 4.2.2 Data Normalization

#### 4.2.2.1 Data Normalization Method

In general, Data come from different resources and as a result, data are kept in different styles with different units of measurement usually when collected as primary data. Data integration must be done carefully to avoid redundancy and inconsistency so that in turn improves the accuracy and speeds up the mining process (Han, J. and M. Kamber, 2001). The careful data integration is now acceptable but it needs to be transformed into forms suitable for mining. Data transformation involves smoothing, generalization of the data, attribute construction and normalization (Luai Al Shalabi,

et.al, 2006). Normalization is one of the data transformation methods. Such method provides better results if the data to be analyzed have been normalized; that is, scaled to specific ranges such as [0.0, 1.0] ( Han, J. and M. Kamber, 2001).

For distanced-based methods, normalization helps prevent attributes with initially large ranges from outweighing attributes with initially smaller ranges ( Han, J. and M. Kamber, 2001). There are many methods for data normalization such as min-max normalization, decimal scaling normalization, and z-score normalization. The simplest normalization technique is the Min–max normalization. Min–max normalization is best suited for the case where the bounds (maximum and minimum values) of the scores produced by a matcher are known (Anil Jain et.al, 2005). Min-max normalization data set is the best design for training data set, and it always has the highest priority (Luai Al Shalabi, et.al, 2006).

Min-max normalization performs a linear transformation on the original data. It can easily shift the minimum and maximum scores to a range such as [0, 1]. Suppose that Min and Max are the minimum and the maximum values for a given set of $\{a_k\}$, k=1,2,….n. Min-max normalization maps a value $a_k$ of $\{ a_k \}$ to $a_k$' in the range [Min', Max'] by computing:

$$a_k' = \frac{a_k - \min}{\max - \min} \bullet (\max' - \min') + \min'$$

4.2.2.2 Data Normalization for the Research

In this research, all data including University ranking, Subject ranking, Completion rate, Location, Accommodation costs, and Tuition fees need to be normalized.

University ranking, Subject ranking, Completion rate, data come from the Guardian. University ranking and Subject ranking data will use the Guardian score (0/100) and shift it into a small range [0, 10]. Completion rate, Accommodation costs, Tuition fees and Location will shift to the range [0, 10] as well. What need to be noted is that for some data the higher the better, including ranking score and completion rate. Other data is the lower the better, including Location, Accommodation costs, and Tuition fees.

So the computing formulas are as follows.

The higher the better,

$$ak' = ( ( ak - Min)/(Max - Min) ) * 10$$

The lower the better,

$$ak' = ( (Max - ak)/(Max - Min) ) * 10$$

According to these two formulas, all the data can be normalized into range [0, 10].

The data of Completion rate come from the Guardian on line. The data source is Higher Education Statistics Agency (Hesa). However, some universities data are blank. To solve this problem, blank Completion rate was replaced with average completion rate. More specifically, eight universities (University of Cumbria; University Of Wales, Newport; University of Wales, Trinity Saint David; Canterbury Christ Church University; University College Suffolk; Leeds Trinity University College; St Mary's University College, Twickenham; Queen Margaret University) could not provide

Completion rate, so these universities all use the average completion rate (89%) for calculation.

## 4.3 Chapter Summary

The chapter identifies key criteria in students' decision making on university selection through student interviews and surveys. The key criteria include University ranking, Subject ranking, Completion rate, Location, Accommodation costs, Tuition fees, Degree class demand, and IELTS demand. Because of the different attributes, Degree class demand and IELTS demand will be used as extra conditions in DSS-US. All the data use Min-Max data normalization method for processing.

# Chapter 5: System Development and Testing

This chapter will describe the process of system design and development. The Decision Supporting for University Selection (DSS-US) will follow the prototyping methodology as shown in chapter 3. In the following sections, requirements analysis includes the framework and component of DSS-US. The DSS-US structure will be presented in detail. Some figures will be shown, and the main method of AHP will be described. System development that includes system development environments, development tools, and the interface and system evaluations will be discussed there as well.

## 5.1 Requirements Analysis

This part discusses DSS-US requirements from several aspects including information overload in which the information created by current developments in society was listed and an increasing number of international students were geared up by globalization, development of economy and user's practical needs.

### 5.1.1 Information Overload

University selection is an important step for students' continuing education. It plays a key role in their career path building and professional development. Students educated in a suitable university with a promising major will prepare themselves for the right start in their career, and they will benefit from it their entire life. However, the process of university selection is not an easy, nor a simple procedure. It usually takes a vast

amount of time and energy for students and their parents to collect and then find the helpful and useful information to form the final decision.

The problem of information overload has been widely recognized for many years. With the fast development of information and communication technology, information overload have been exacerbated in recent years. Too much information is a hindrance rather than a help, and it may cover up the potentially useful information (Bawden et al., 1999). Feather (1998) claimed that more and more information is being provided due to technological developments in the last 50 years, and it is more than any other time in human history. More information helps people learn more things than before; however, information overload also leads to stress, loss of job satisfaction and poor physical health (Lewis, 1996). It is apparent that an abundance of information will influence their choice, instead of better enabling a person to make the right choice on university selection. Feather (1998) also describes information overload as the point that information is no longer used electively.

When students are looking for universities, however, information is the key to choose a suitable college successfully. Most of the students have to deal with overwhelming information from various sources. Today is the era of information explosion and information overload is obviously going to be more and more serious. So, finding the solution to information overload is necessary and imperative.

### 5.1.2 Increasing number of international students

According to UK Higher Education Statistics Agency (HESA, 2011), students from China accounted for over a fifth of all non-EU domicile students at UK HE institutions in 2009/10. The data details are shown in table 5.1.

**Table 5.1 Top ten non-EU countries of domicile in 2009/10 for HE students in UK Higher Education Institutions**

| Country of domicile | 2008/09 | 2009/10 | %change |
|---|---|---|---|
| China | 47035 | 56990 | 21.1% |
| India | 34065 | 38500 | 13.0% |
| Nigeria | 14380 | 16680 | 16.0% |
| United States | 14345 | 15060 | 5.0% |
| Malaysia | 1295 | 14060 | 10.7% |
| Hong Kong | 9600 | 9945 | 3.6% |
| Pakistan | 9610 | 9815 | 2.1% |
| Saudi Arabia | 5205 | 8340 | 60.3% |
| Canada | 5350 | 5575 | 4.2% |
| Thailand | 4675 | 5505 | 17.8% |
| All other non-EU countries | 94355 | 100290 | 6.3% |
| **Total non-EU countries** | 251310 | 280760 | 11.7% |

Source: HESA Students in Higher Education Institutions 2008/09, 2009/10

One famous intermediary services website in China, named Chuguoliuxue, which means study abroad, points out that over 60% of Chinese students studying in the UK choose a one-year Masters program (http://www.liuxue114.com/Britain/news/59140.html ).

There are nearly 35,000 students coming from China to the UK for their postgraduate study, and all of them have to face to the problem of choosing suitable universities.

### 5.1.3 Users Practical Needs

From the questionnaire survey results shown in Chapter 4, 95.6% of students believe that the DSS-US system is useful and helpful if available when they make decisions. It is also known from both interviews and questionnaire that everyone has their own ideas about university ranking criteria. More specifically, individuals have various weights on each criterion. As a result, DSS-US has to provide the university ranking due to the different given weights of the criterion. According to the interview results shown in 4.1.1, there are three ways of judging weights. Firstly, students know exactly what they want, and they know each criterion's weight clearly. Secondly, students just have a vague idea about each criterion, and they need help on inputting the weight.

Last of all, some students also want to know other's judgment about weight so that they can test and verify their own idea.

In other words, DSS-US has to include the following functions:

Weights defined by User. It means that users choose the criteria and input each criterion's weight directly, then DSS-US comes out with the result, university ranking.

Weights generated by using AHP. It means that users need to answer some questions (to fill in the Matrix) at first, and then DSS-US calculates by using AHP method to provide a ranking result.

Default Weights. DSS-US result is calculated by default weights that come from the questionnaire results.

All in all, the DSS-US system aims to solve the problem of information overload and help students make a decision when they select a university for postgraduate study. The system is able to solve the problem with users' personal requirement input, such as university's ranking, entry requirements, etc. For example, students choose the factors important to them from the provided list and give weight to each factor they have chosen; the DSS-US system then computes and comes up with a list of suitable universities to help students make better decisions.

## 5.2 System Design

### 5.2.1 The Architecture of DSS-US

For achieving the aim of this research, suitable multi-criteria decision making methods was selected to develop the DSS in this context, and to develop and test a prototype decision support system; the architecture of DSS-US is shown in Figure 5.1.

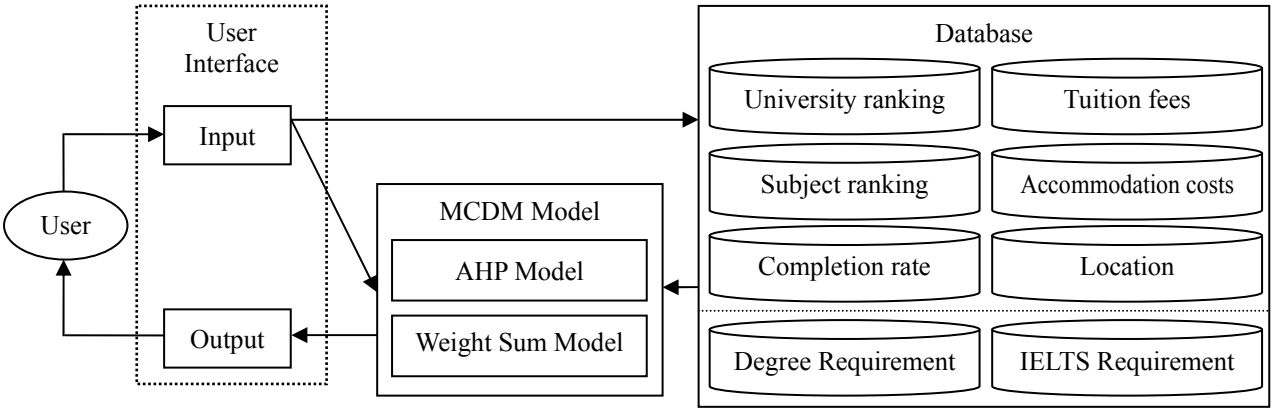



**Figure 5.1 System Architecture**

It can be seen from figure 5.1 that DSS-US system consists of three parts, user interface, MCDM model and Database. And these will be described separately in the following parts of the thesis.

### 5.2.2 System Flow Chart of DSS-US

With the analysis in Chapter 4 and in 5.1, a clear system flow chart is shown in Figure 5.2.

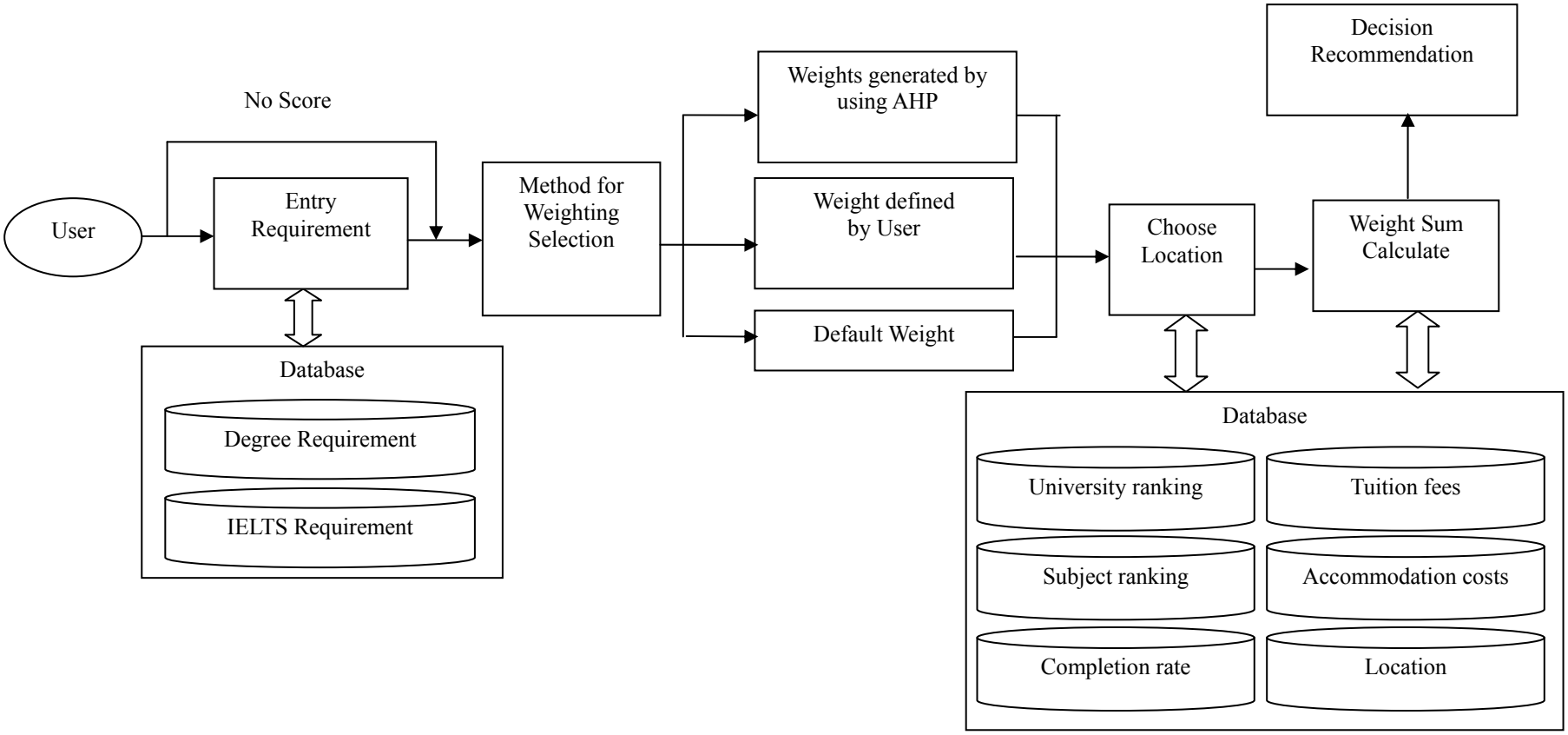



**Figure 5.2 System Flow Chart and Functions**

It can be seen from Figure 5.2, at the beginning of the flow chart, users input personal information, such as Bachelor honours degree level and the score of IELTs, to see if their information meets the requirements of all 108 universities. If the user does not have such information, he or she can skip this step. Next, the user needs to choose a method to give weight for the criteria they have chosen from the weights generated by AHP. The weights used to get personal data are defined by the user based on default weights in the system. Thereafter, the user needs to choose the desired location of the university from six given cities as described in Chapter 4. In the fourth step the system will use WSM to call data from the database to give the score to each university. Finally, the system shows the Decision Recommendation in the last step to help the user find a suitable university.

### 5.2.3 Model Design

The main function of DSS-US is to give a rank of universities due to different needs and demands. To achieve the goal, this research uses a method to analyze the data of a decision matrix and to rank the alternatives. Another simple method is adopted to compare the result with the one derived from the above method.

There are many multi-criteria decision making methods, such as elementary methods, multiple attributive utility theory (MAUT), and outranking method. These methods can partially or completely rank the alternatives, and give a short list of a limited number of alternatives or just give a single most-preferred alternative.

MAUT and Outranking methods are the two main families in the multi-criteria decision making methods. The family of MAUT includes Simple Multi-attribute Rating Technique (SMART), Generalized Means, and the Analytic Hierarchy Process

(AHP). Outranking methods include the ELECTRE methods, and the PROMETHEE methods.

Compared with other methods, Analytic Hierarchy Process Method (AHP) has several advantages. It is easy, comprehensive and logical. It can be used in both quantitative and qualitative multi-criteria decision making problems and it is widely accepted by the decision making community, the academics and the practitioners (Mamat N.J.Z. & Daniel J.K.,2007). With all the advantages of AHP, the study will use it as the main method to develop a prototype of decision support systems. And it also can achieve the aims in a straightforward way.

To provide more choices and different results for comparing the purpose for users, another simple method, Weighted Sum Model (WSM), is chosen as a basic method for this research.

5.2.3.1 Analytical Hierarchal Process (AHP)

According to the literature review in 2.3.3, the Analytic Hierarchy Process (AHP) was proposed and developed by the mathematical foundations of Saaty (1980) at the University of Pittsburgh. It becomes one of the most well-known and widely used multi-criteria methods as it has been used successfully to help people make better decisions when facing unfamiliar problems involving value-based trade-offs between the advantages and disadvantages of two or more options (James G.D., 2008; Golden B, et.al, 1989; Zahedi F., 1986; Forman E., & Gass S., 2001; Vaidya O.S. & Kumar S., 2006).

In university selection, it is desirable to select the best one of the proposed universities since it is the best choice for students. All the universities should be ranked by a

number of criteria. The AHP is a suitable method to be used in this decision making problem since it is a qualitative multi-criteria decision making method.

AHP is based on a hierarchical framework of criteria as mentioned in 2.2.3. The framework usually has three levels. The top level is the goal of the decision making. The middle level is to name the major criteria. The bottom level contains all the alternatives. In this research, the top of the hierarchical is defined as the “Most Suitable University”. The evaluation criteria called objectives are described as six criteria in this research. And they are University ranking, Subject ranking, Tuition fees, Completion rate, Location, and Accommodation costs as defined in Chapter 4. The lowest level contains all alternatives which are 108 universities in the UK. The decision hierarchy is shown in Figure 5.3.

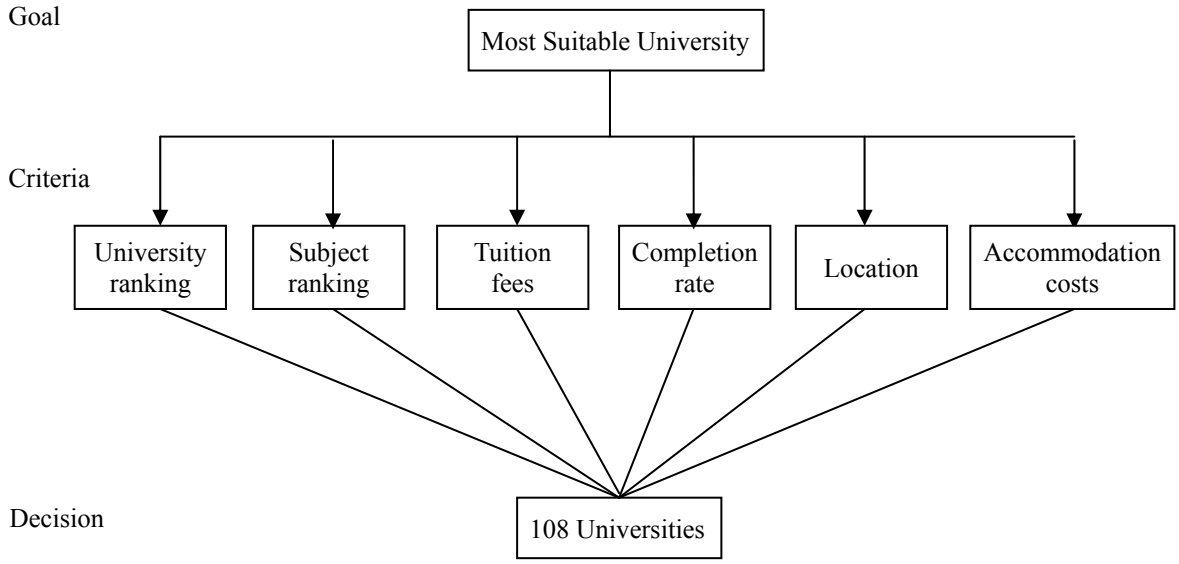



**Figure 5.3 Decision Hierarchy**

Once the hierarchy structure is established, the decision maker needs to do the pairwise between every two criteria. These comparisons are the basis for calculation

of the relative weight of each criterion. In this research, it can be seen from the formula N(N-1)/2 (N=6, N means the number of criteria) that users need to compare 15 times. Users derive ratio-scale (as shown in Table2.2) priorities reflecting the relative preference of alternatives relative to each objective. After that, a compare matrix is formed by the computer and then the weight of each criterion calculated.

To ensure that the pairwise made by users is acceptable, consistency has to be checked. Thus the consistency ratio (C.R.) is set to be less than or in the neighbourhood of 0.10. Otherwise the decision maker needs to re-judge or re-evaluate the judgments in a pairwise comparison matrix. The flow chart of AHP is shown in Figure 5.4.

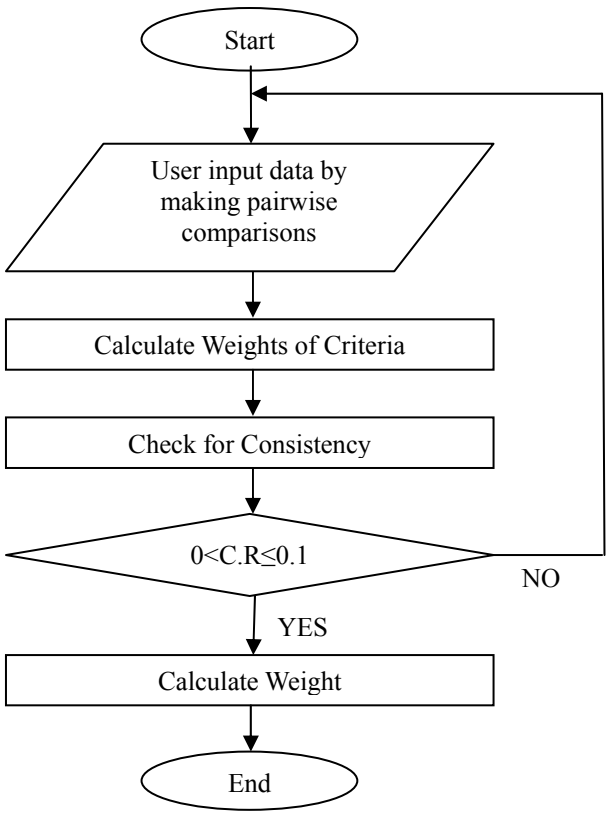



**Figure 5.4 AHP Flow Chart**

5.2.3.2 Weight Sum Model

The “weighted sum model (WSM)” is the best known and simplest multi-criteria decision making method for evaluating a number of alternatives in terms of a number

of decision criteria (Triantaphyllou, 2000): the higher the weight, the more important the criterion.

Let $A_i$ be the weighted sum value, $w_i$ as the weight of each criteria, and $a_i$ as the value of each criteria. The formula is

$$A_i = \sum_{i=1}^{n} w_i \times a_i \quad i=1,2,\ldots n$$

In this research, WSM is implemented in the last step for the system to generate the final results. There are three methods to calculate the weight of each criterion, including the one generated by using AHP, Weight defined by User and Default Weight. Thereafter, the system implements WSM to calculate the value of each criterion, then generates the university ranking to the exact user.

5.2.3.3 Default Weight Model

The research uses the results of the questionnaires presented in Chapter 4, and calculates the default weights using the results of question 2.

Denote $C_i$ as the score of each criterion, and $W_i$ as the weight of each criterion. The calculated formula is

$$W_i = \frac{C_i}{\sum_{i=1}^{n} C_i} \times 100\% \quad (i=1,2,\ldots n,)$$

$$\sum_{i=1}^{n} W_i = 1$$

According to Chapter 4, there are six key criteria, so the value of n is 6 in this research. Table 5.3 shows the weight results based on 48 questionnaires.

**Table 5.2 Default Weights based on Questionnaires**

| criteria | scores | weights |
|---|---|---|
| University ranking | 611 | 24.77% |
| Subject ranking | 594 | 24.08% |
| Completion rate | 359 | 14.55% |
| Location | 322 | 13.05% |
| Living costs (Accommodation costs) | 291 | 11.80% |
| Tuition fees | 290 | 11.76% |
| Total | 2467 | 100.01% |

It should be emphasized that the default weights change with the number of users. That means the more users that use the system, the more accurate the weight value of the system according to the collection of more data. As a result, the value of default weights becomes more and more precise based on default weights. This is one of the characteristics of this research.

Denote $W_{new}$ as the new weight, $W_{old}$ as the old weight, $W_i$ as the result of each user using AHP, i as the number of users. The system uses the formula as shown below to update the default weights.

$$W_{new} = \frac{W_{old} \times 48 + \sum_1^n W_i}{48 + \sum_1^n i}$$

5.2.3.4 Data Normalization Model

As mentioned in 4.3.2, DSS-US system normalizes the data by using the following formula

$$ak' = ( (ak - Min) / (Max - Min) ) * (Max' - Min') + Min' ,$$

Suppose that Min and Max are the minimum and the maximum values for a given set of $\{a_k\}$, k=1,2,….n. Min-max normalization method maps a value $a_k$ of $\{ a_k \}$ to $a_k'$ in the range [Min', Max'].

### 5.2.4 Database Design

The DSS-US system requires universities information and also stores user's results. To achieve this aim, the DSS-US system uses MySQL relational database server to design the database.

The database can be divided into two parts. One is universities information, including universities' name, ranking, subject ranking in business area, tuition fees, costs, completion rate, location (distance between the five selected cites), degree requirement and IELTS requirement. The other is the weights of each criterion and the university ranking results of each user. That could help to update the value of the default weights as presented in 5.2.3.3.

### 5.2.5 System Functions

DSS-US functions like a simple tool for personal university selection. Nonetheless, it contains many functions that will be described in detail as follows.

In the first place, the main function of DSS-US is university selection. There are three different ways to use the function. They are Weights generated by using AHP, Weights defined by User and Default Weights as explained in 5.2.3.

Second, a function of DSS-US can choose the location according to the user's preference. DSS-US chooses locations from six cities as mentioned in 4.2.1; DSS-US uses a different database to match personalize need. When a user chooses different Location from six cities, the results are different. DSS-US is able to personalize the system to meet the needs of users with different location priorities.

Next, DSS-US has Self-learning function by collecting users' results. More specifically, DSS-US records all results from users; then updates the default weight by doing the calculation automatically as mentioned in 5.2.3.3. If a user uses DSS-US more than once, then DSS-US will record all the results and choose the data that has the lowest consistency value to use.

DSS-US can be expanded to other personal selections just by using AHP to calculate and update the database. For example, DSS-US can help people choose the best house from several different options by changing the database, including the names of criteria.

There are also some other functions. Firstly, users need to log in at the beginning, so that DSS-US can send the result of their personal university ranking to their email address upon users' request. DSS-US can store the users' result as well for the reason that they can look it up easily next time. Secondly, users can compare the different results from AHP and weight default by themselves.

## 5.3 System Development

### 5.3.1 Introduction

DSS-US system is developed by Java, a programming language developed by James Gosling from Sun Microsystems in 1991 (Arnold K., Gosling J., Holmes D., 2005). Java language has a great advantage as a slogan claimed "write once, run anywhere" (Martinelli F. & Mori P., 2007). It can run across different and diverse platforms such as Windows, Linux, Solaris, etc (Thriskos, 2007). It is a suitable characteristic for DSS-US because the system can be used widely without environment restrictions no

matter whether the system is used on the internet or a personal computer only. A high level programming language such as Java could provide considerable flexibility.

DSS-US system follows Apache Tomacat, together with Hibernate and Model View Controller (MVC) design paradigm.

The system runs on Tomcat 6.0.26 (http://olex.openlogic.com/packages /tomcat/6.0.26), an open source JSP and Servlet container. It is used for analytical JSP scripts.

Hibernate is free software (http://www.hibernate.org/downloads/) and its object is relational mapping and persistence application.

MVC web development pattern has been used to support web specific development. Model tier has used JavaBeans; View tier has used JSP; and Controller tier has used Servlet. MVC is a very clean pattern that allows the data elements to be collected and managed separately from the form's appearance.

### 5.3.2 User Interface

As a link between the user and DSS-US, the user interface is very important. DSS-US users are unlikely to know all the methods used in this system, especially AHP. The user interface should be a guide to lead users to get an appropriate result.

On the login page, users login or register. The first page is shown in Figure 5.5 and the register page in Figure 5.6.

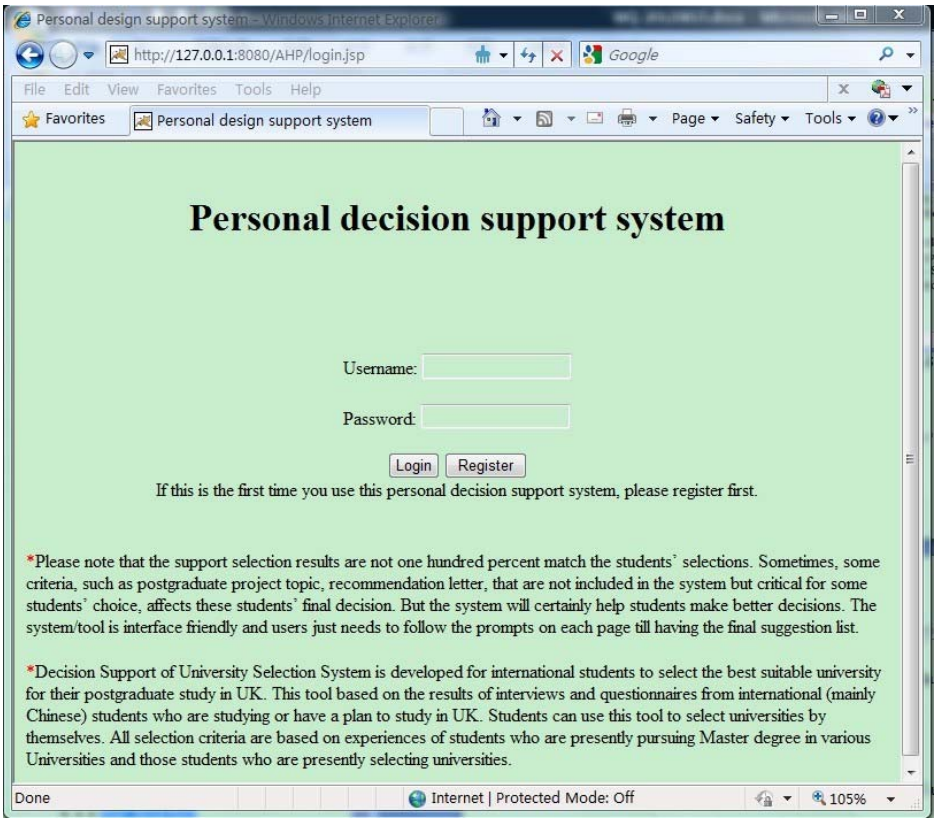



**Figure 5.5 DSS-US Login Page**

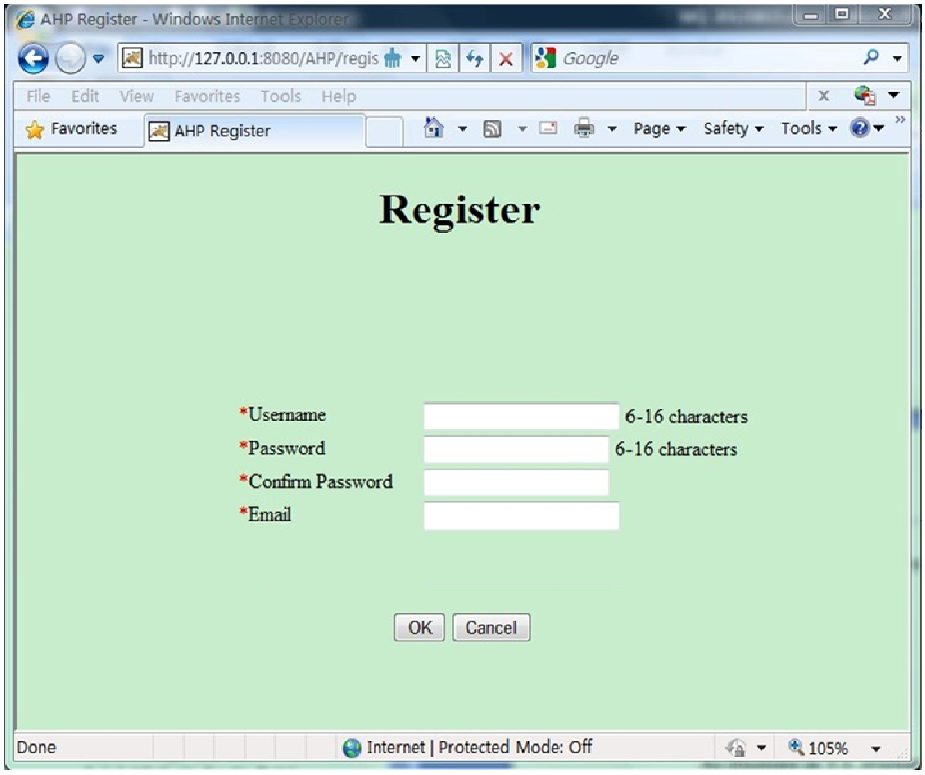



**Figure 5.6 Register Page**

After Login/Register, entry requirements ask users to fill in the information. User can skip this step if there is no IELTS score or degree class available as shown in Figure 5.7.

The next page, as shown in Figure 5.8, is Method Selection page. The user can choose a method to rank universities.

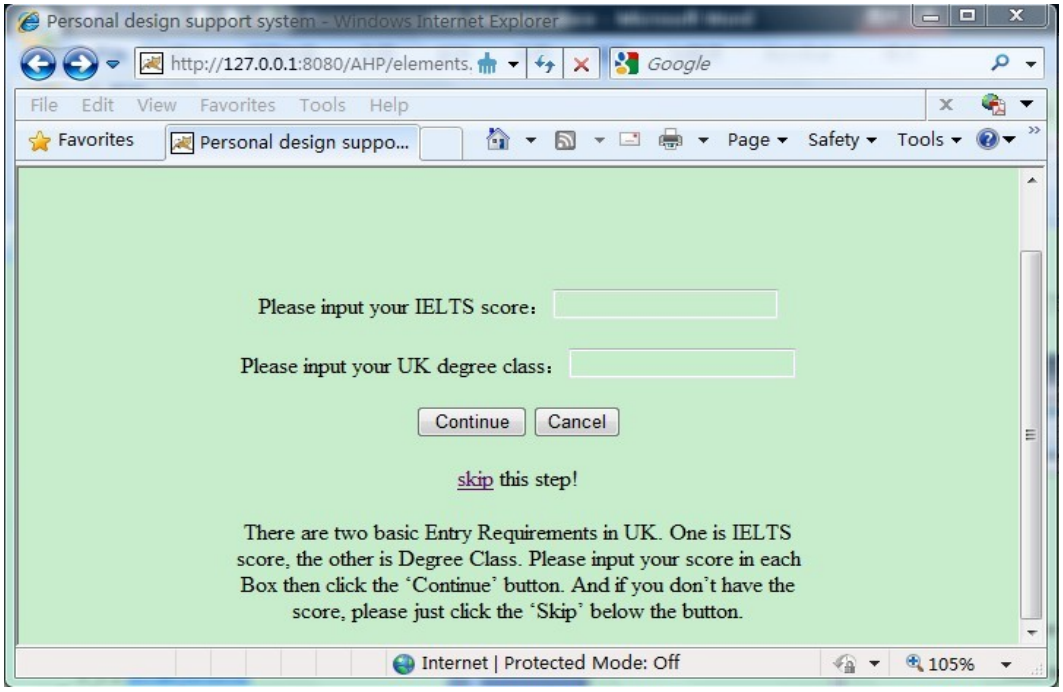



**Figure 5.7 Entry Requirements Page**

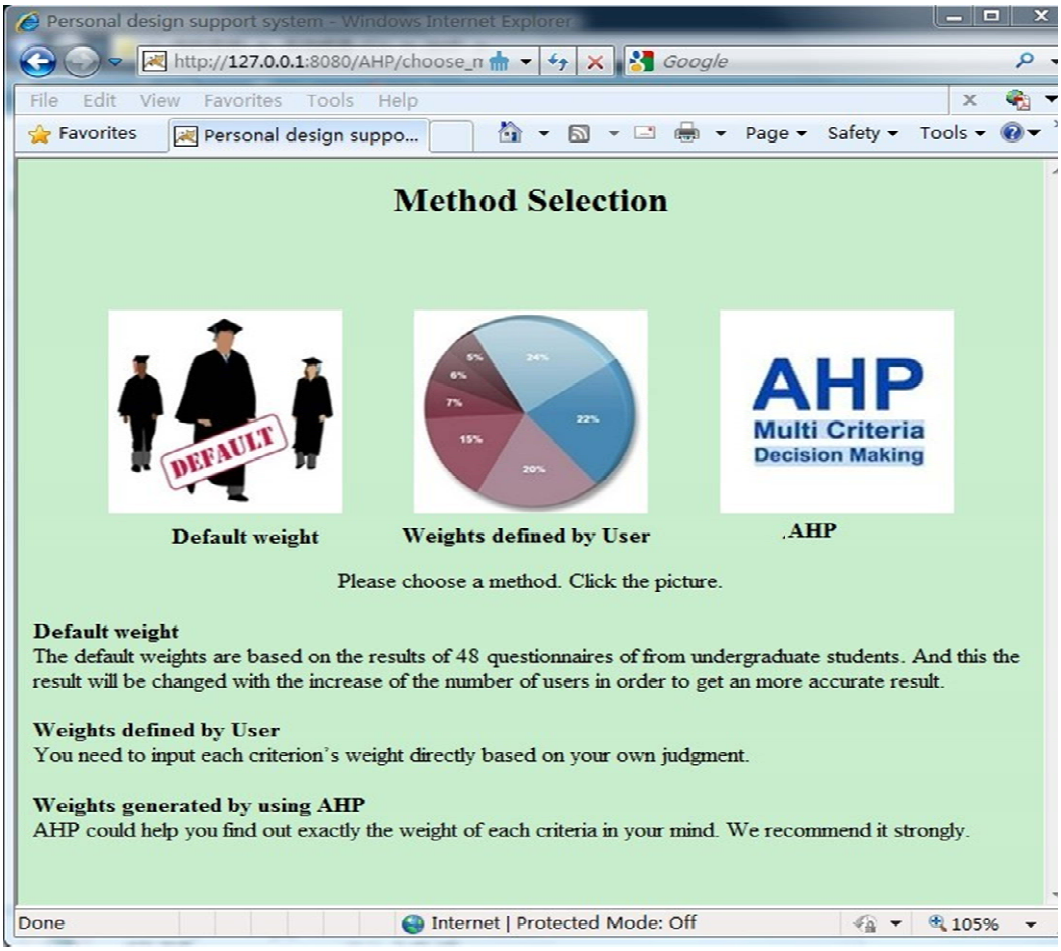



**Figure 5.8 Method Selection Page**

Figure 5.9 shows the default weight value which calculates from questionnaires in 5.2.3.3. The user can get the result after clicking the calculate button and the ranking results are shown in Figure 5.10. The default location is London.

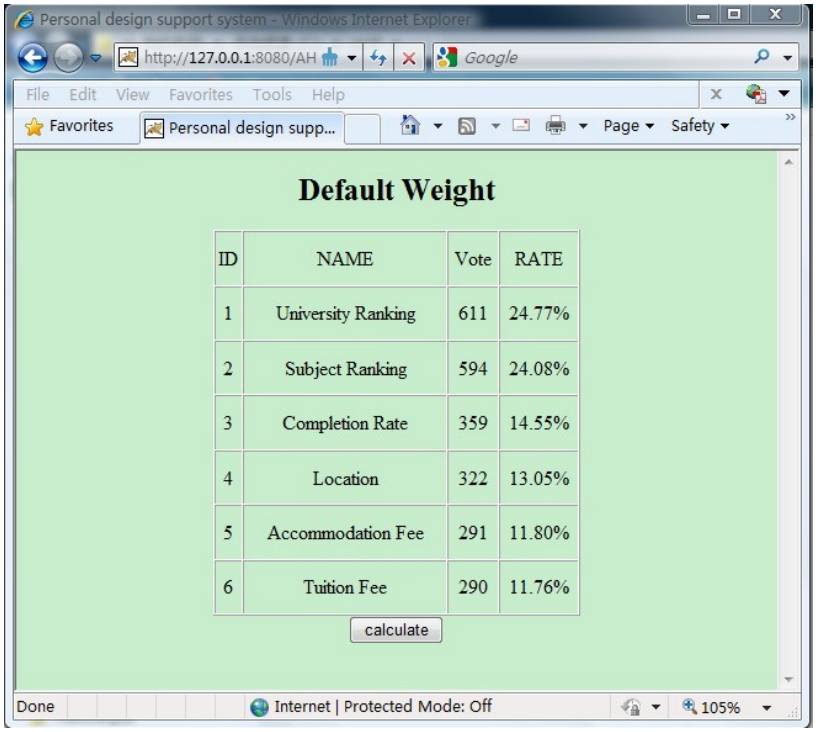



**Figure 5.9 Default Weight Page**

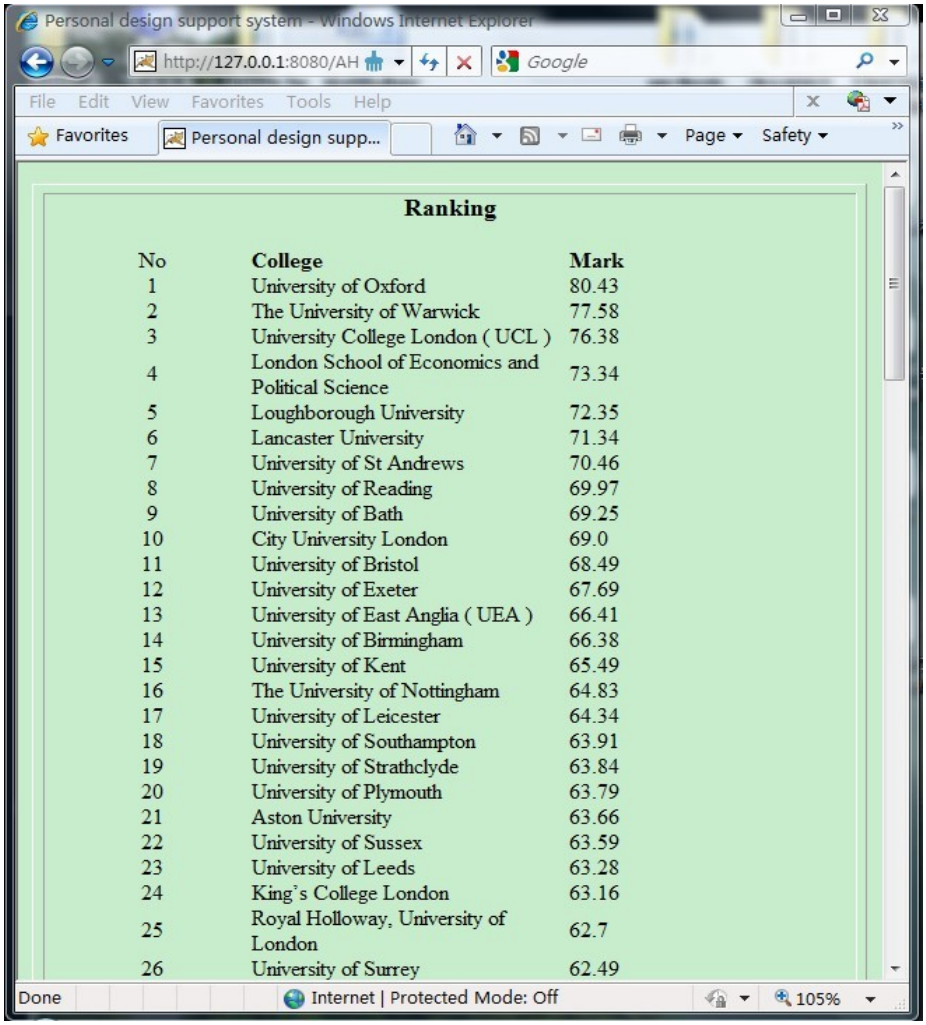



**Figure 5.10 University ranking by Default Weight Page**

The user can choose another method by clicking the button ‘Redo’ as shown in Figure 5.11.

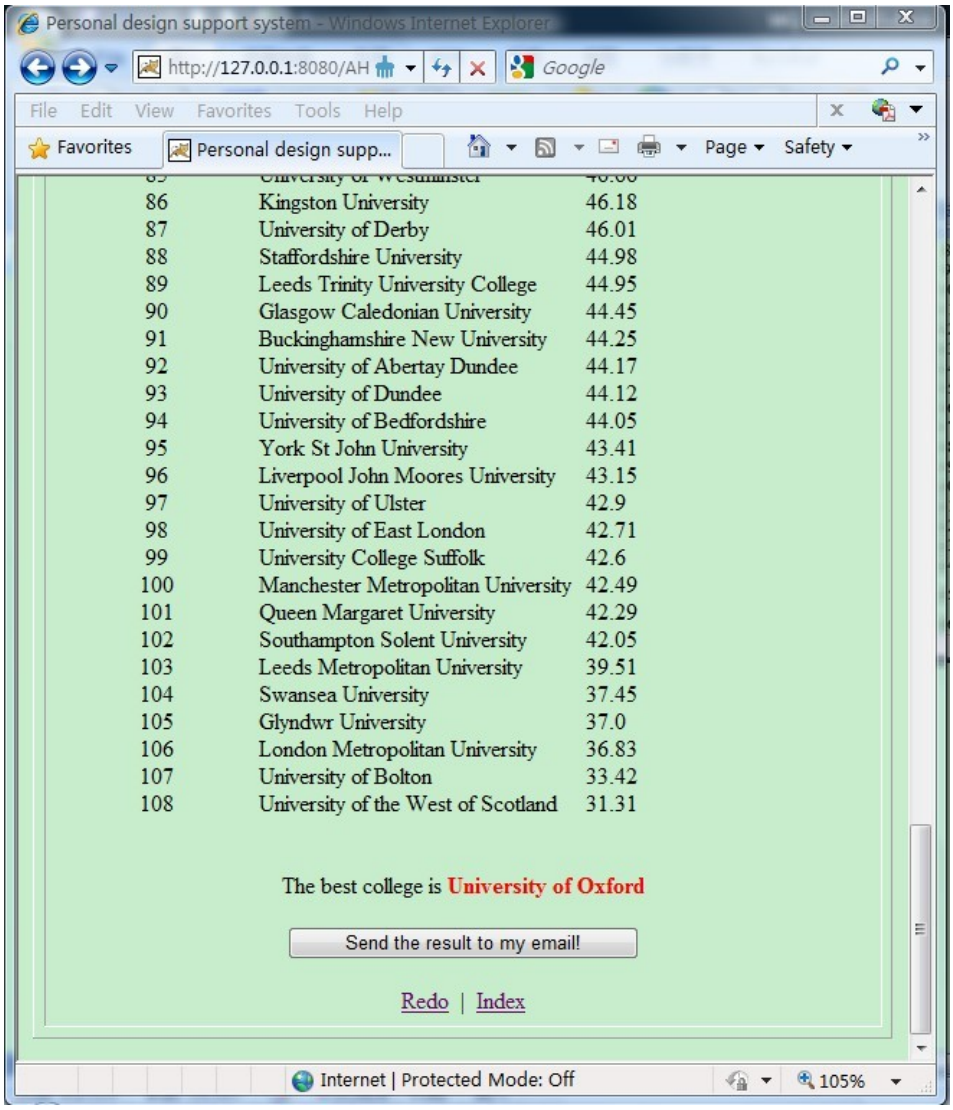



**Figure 5.11 Choose Another Method**

Figure 5.12 shows the page of weights defined by the user, and the result that is calculated by the weight shown in Figure 5.12 and Figure 5.13.

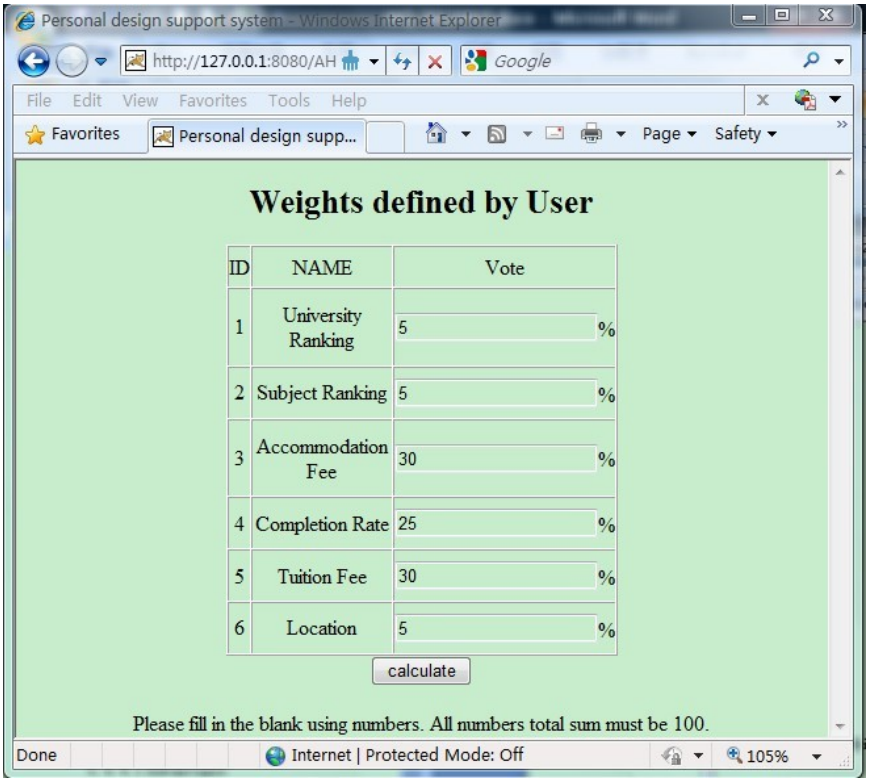



**Figure 5.12 Weights defined by User Page**

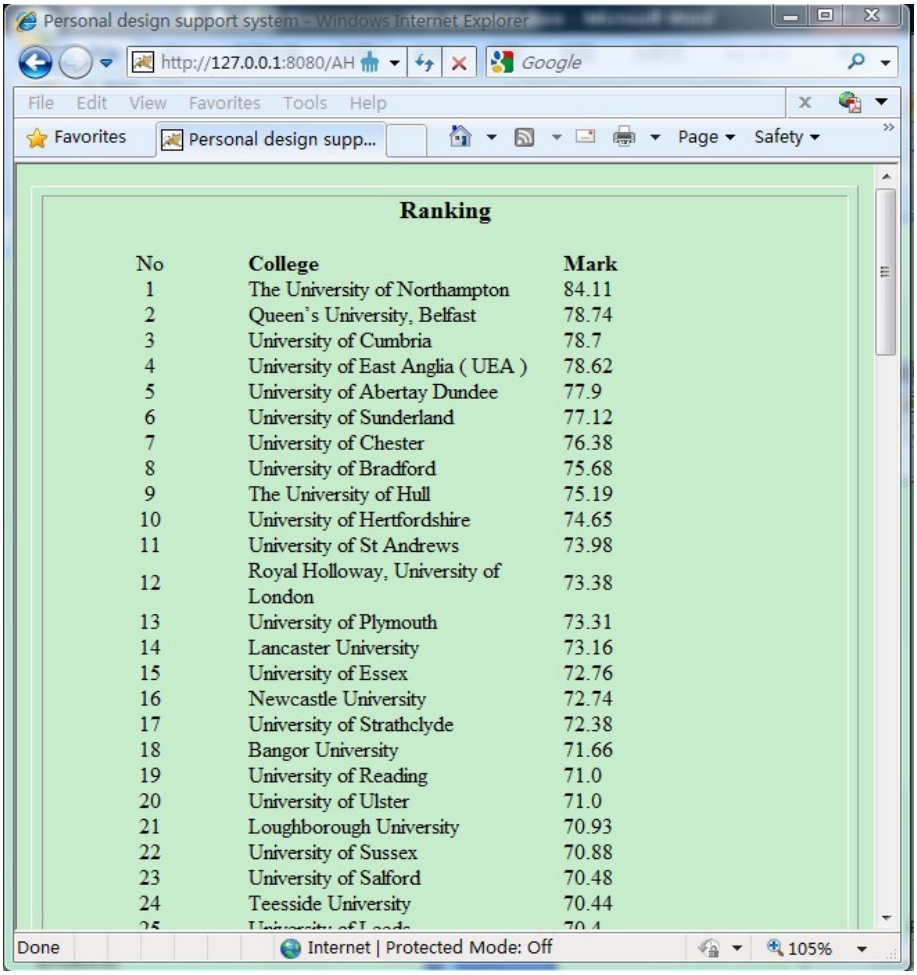



**Figure 5.13 The Result of Weights defined by User Page**

Next, AHP is chosen as the ranking method. The first step in this ranking method is to choose Locations as shown in Figure 5.14. Here, Plymouth is chosen as an example. From Figure 5.15 to Figure 5.18, it shows the process of the AHP method.

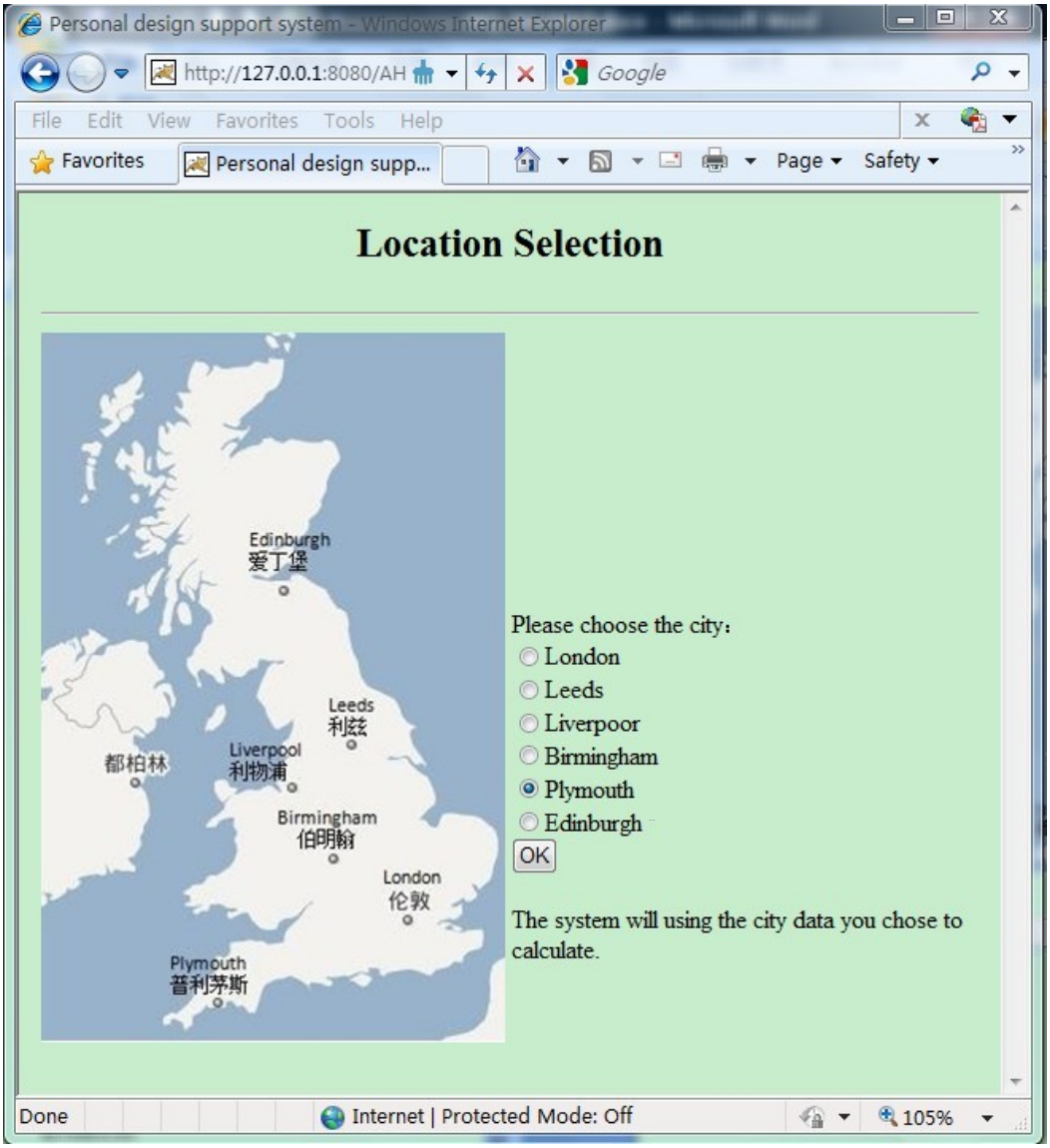



**Figure 5.14 Location Selection Page**

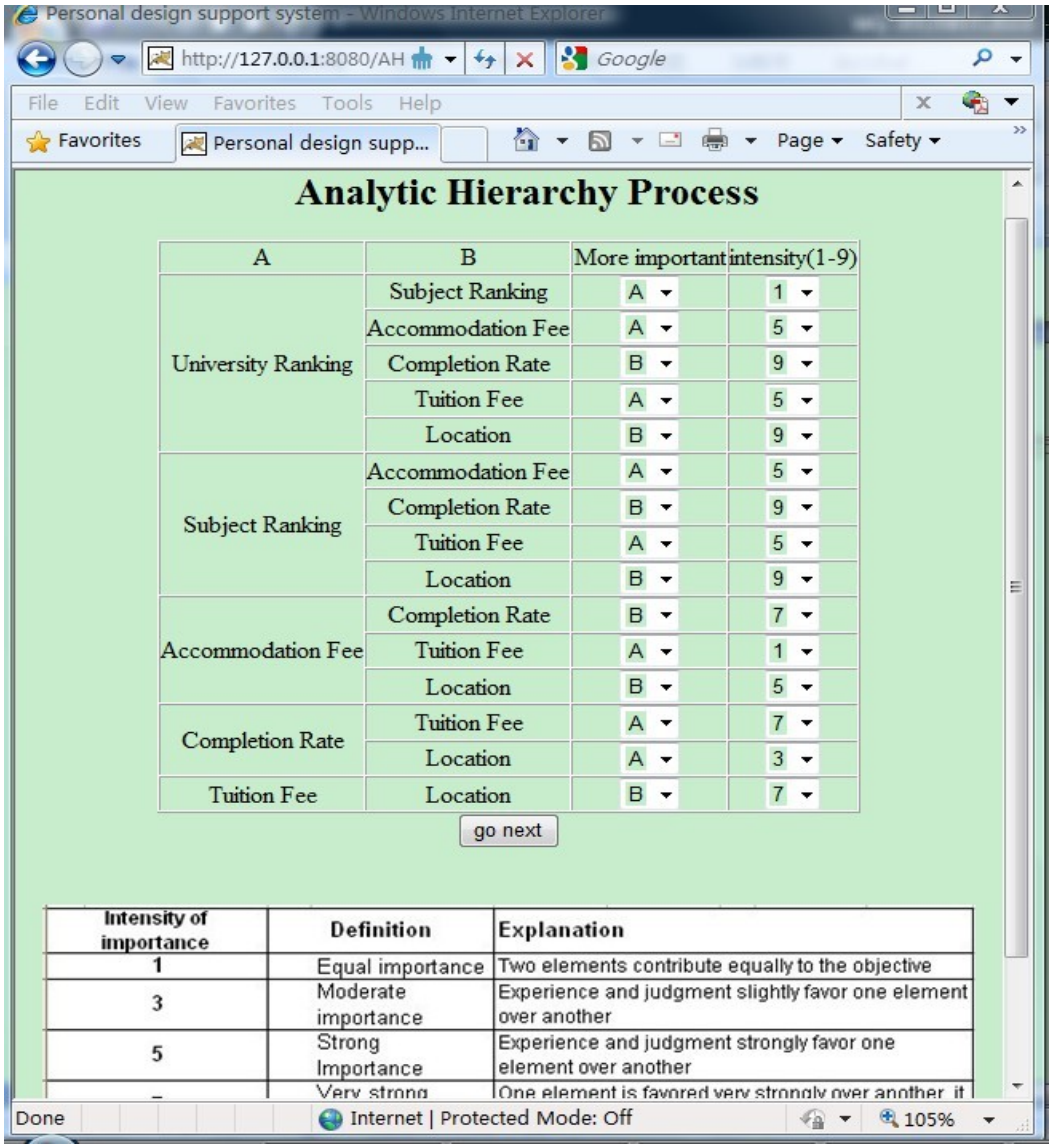



**Figure 5.15 AHP Pairwise Page**

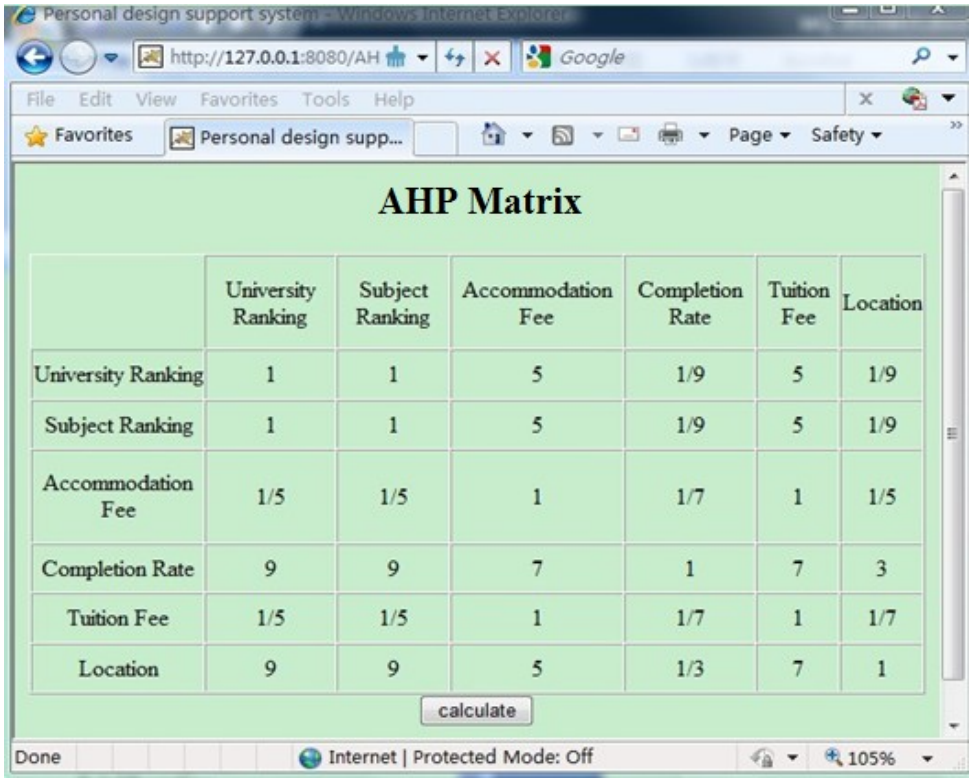



**Figure 5.16 AHP Matrix Page**

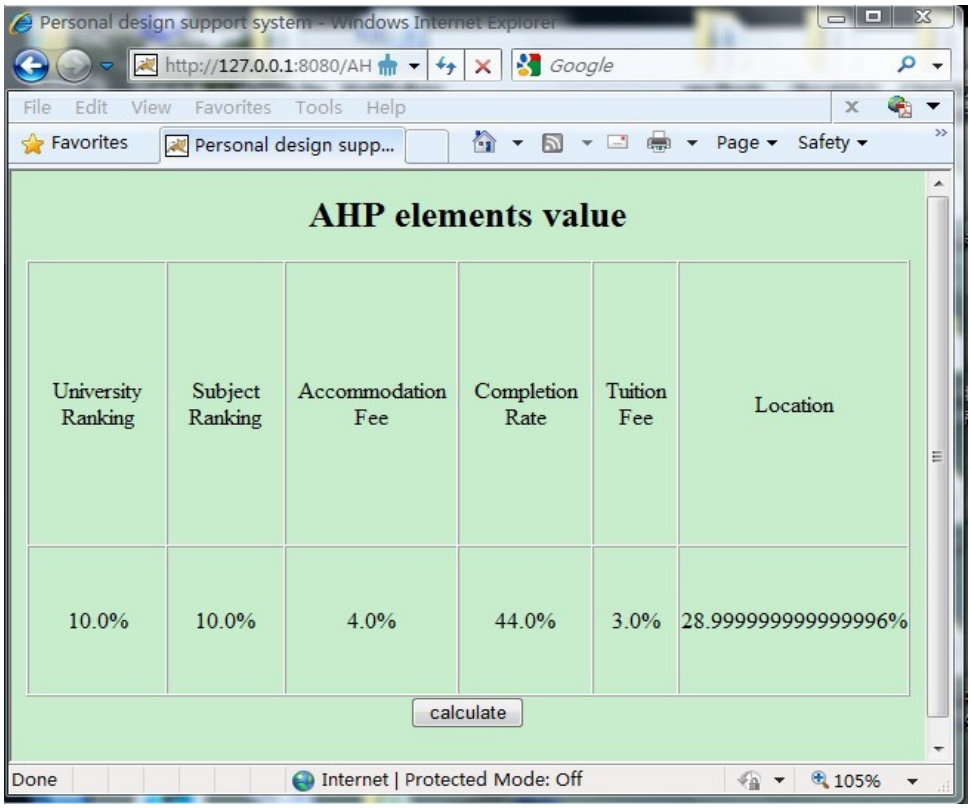
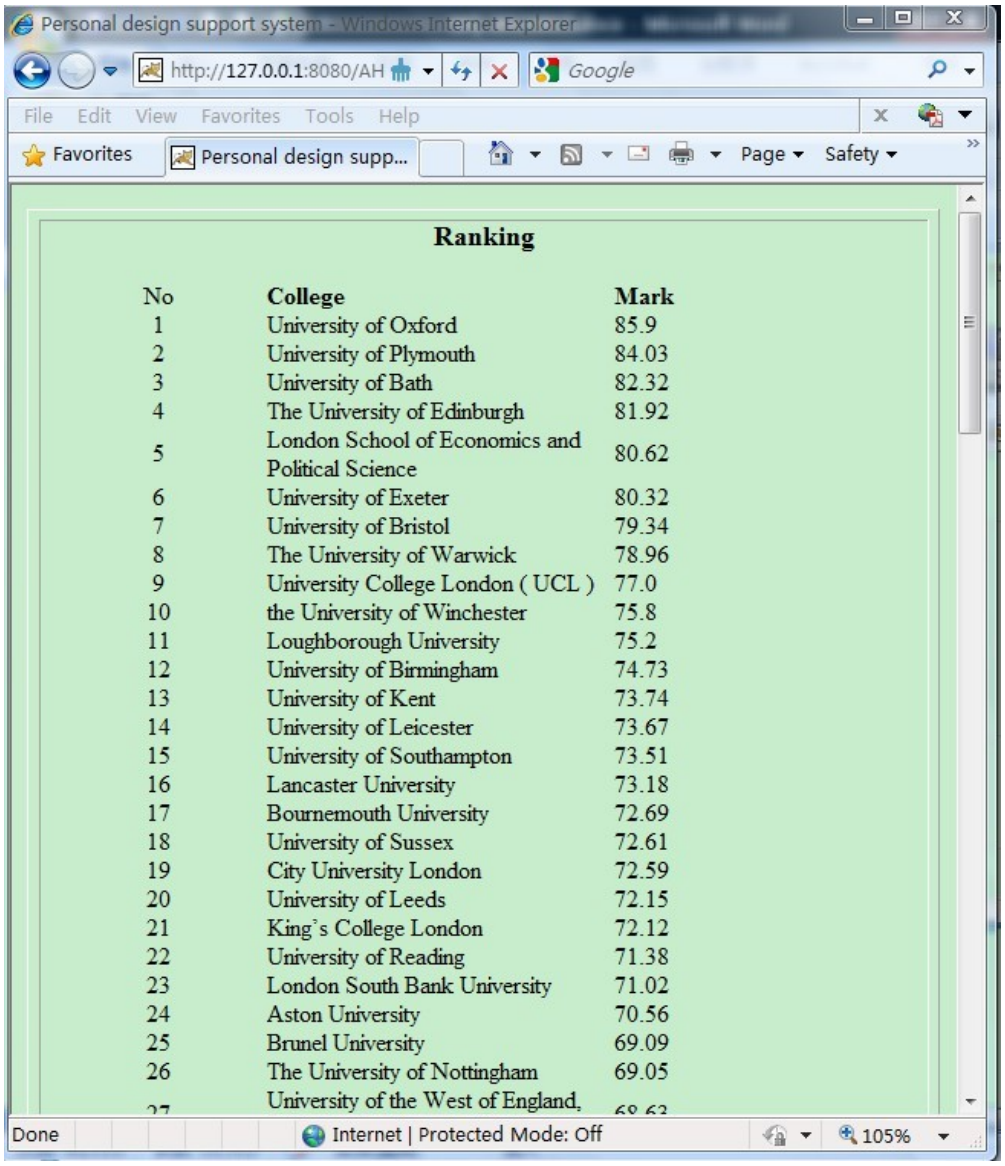



**Figure 5.17 Weight Calculate by AHP Page**




**Ranking**

| No | College | Mark |
|---|---|---|
| 1 | University of Oxford | 85.9 |
| 2 | University of Plymouth | 84.03 |
| 3 | University of Bath | 82.32 |
| 4 | The University of Edinburgh | 81.92 |
| 5 | London School of Economics and Political Science | 80.62 |
| 6 | University of Exeter | 80.32 |
| 7 | University of Bristol | 79.34 |
| 8 | The University of Warwick | 78.96 |
| 9 | University College London ( UCL ) | 77.0 |
| 10 | the University of Winchester | 75.8 |
| 11 | Loughborough University | 75.2 |
| 12 | University of Birmingham | 74.73 |
| 13 | University of Kent | 73.74 |
| 14 | University of Leicester | 73.67 |
| 15 | University of Southampton | 73.51 |
| 16 | Lancaster University | 73.18 |
| 17 | Bournemouth University | 72.69 |
| 18 | University of Sussex | 72.61 |
| 19 | City University London | 72.59 |
| 20 | University of Leeds | 72.15 |
| 21 | King's College London | 72.12 |
| 22 | University of Reading | 71.38 |
| 23 | London South Bank University | 71.02 |
| 24 | Aston University | 70.56 |
| 25 | Brunel University | 69.09 |
| 26 | The University of Nottingham | 69.05 |
| 27 | University of the West of England, | 68.63 |

**Figure 5.18 Ranking Results by AHP Page**

DSS-US interface and functions have been described above from Figure 5.5 to Figure 5.18. It can be seen that DSS-US is an easy-to-use system and works successfully.

## 5.4 System Evaluation

DSS-US system evaluation is based on the user's evaluation of the system's usability. There are two definitions about system usability evaluation. One of them comes from ISO9241-11 (1994), the other comes from Nielsen (1993). According to ISO9241-11 (1994), usability includes three quality components: effectiveness, efficiency and satisfaction. According to Nielsen (1993), usability includes five quality components, ease of learning, efficiency of use, memorability, errors frequency and severity, and subjective satisfaction. Based on these two concepts, Chou and Lin (2004) presented three quality components as ISO9241-11, which are effectiveness, efficiency and satisfaction. This research follows these three components.

Nielsen (1993) gives nine system evaluation methods. In this study, as illustrated in 3.3, the Think Aloud method will be used to evaluate DSS-US. All the evaluation participants come from ICB as mentioned in 4.1. Each test lasts forty minutes (minimum) to one hour (maximum). According to Monique (2009), the number of subjects should be limited to about eight for the reason that the Think Aloud method provides a rich source of data. That suffices to achieve a complete understanding of task behaviour (Ericsson, 1993) or to identify the main usability problems with a computer system (Nielsen, 1994). Consequently, this research will collect seven participants (students) as subjects and for analysis.

A test environment is usually created similar to the real one, and the potential users could perform the aim of the system; researchers need to observe and record the whole test process, and might have to communicate with users to get useful data; analyzing the data reveals the feedback and the evaluation results (Nigel, 1993).

### 5.4.1 Testing Criteria and Tasks

As presented above, the research follows these three criteria to evaluate, effectiveness, efficiency and satisfaction.

- Effectiveness: DSS-US can or cannot choose a suitable university according to the user's input.

- Efficiency: DSS-US is either user friendly or not.

- Satisfaction: Users are either satisfied by the functions of DSS-US or not

In order to evaluate the DSS-US system by means of think-aloud protocols, the three different methods to rank universities as the main tasks are used, and the different results in three methods compared at the same time. All tasks are designed for testing DSS-US system functions, and the advantage and disadvantage of DSS-US. The entire set of tasks was as follows:

- Using Weight Defined by User method to rank universities;

- Using AHP method to rank universities;

- Comparing the results of those two methods;

- Using Default Weight method to check out the different weight between the user and the results from the questionnaires.

### 5.4.2 Evaluation Results

This part presents the evaluation results in three parts according to the three criteria: effectiveness, efficiency and satisfaction. The advantages and disadvantages of each criterion are discussed in detail as follows.

#### 5.4.2.1 Effectiveness Evaluation Results

There are several advantages in effectiveness aspect.

First, DSS-US definitely helps users to make a better decision on university selection. Participants claimed that the DSS-US helps them to rank universities that exactly meet their needs. And they were all satisfied about the ranking results. DSS-US could rank universities according to individual demand. One of them said that 'I really don't care about the fee, and what I am really concerned about are Complete rates and Location. This system really gives me what I want.' All the criteria in DSS-US matched their desire. Some of them claimed that the six criteria in DSS-US was exactly what they cared most about. DSS-US includes all universities in the UK (in the business area). The system is perceived as very useful by the students participated in the evaluation. It suggests that this type of the system may have a great market prospect. All of seven system test participants were strongly agree to the system usability and effectiveness after using DSS-US. It can be concluded that DSS-US may have great potential on improving decision making for Chinese students who plan to study in UK to pursue postgraduate degree.

Second, AHP is truly a very useful and effective method to help users to define weight. AHP has many advantages and a main strong point is that it is both methodologically sound and user-friendly. Users make the comparisons just between two criteria at one time. It is usually considered to be one of the best ways to elicit judgments using

pairwise comparisons. According to the results of DSS-US system, AHP is able to generated weights truly reflect the user's personal preference as it is difficult for students to rank allocate weights to each criteria when there are many criteria to consider. When using Weight Defined by User method to decide the weight, users cannot provide an accurate answer by giving a numerical number. When using AHP method, it is easy for users to compare two criteria and using Linguistic Measures of Importance to represent their preferences. This is the reason why AHP is more accurate and effective than other methods. Therefore, the incorporation of AHP in DSS-US proved to be effective.

Third, the Default Weight method could let them refer to other students' opinion. It may help them get rid of their prejudice about some criteria and calibrate their standards. For example, one of the participants said that she never considered the difference between university ranking and subject ranking before, and she never even thought about subject ranking! But she would consider it carefully after she saw subject ranking take such a high weight in DSS-US.

Fourth, there are another two methods that could help them compare the different ranking results by using different criteria weight. Six out of seven subjects chose input weight directly (default weights were set by the user) at first to get a result quickly. After that, users were able to try the AHP method too. When the criteria weight result came out by using AHP, participants were all amazed by the big difference between the two methods. For example, when they input criteria weight, they usually input 10 percent for the least concerned one or two criteria and 30 percent for the criterion most cared about. But the AHP results showed the same criterion may be just 2 or 3 percent at the lowest and 40 or 50 percent at the highest. Some of them could not

control their voice and asked loudly about why AHP could show such a different result. However, all participants agreed that the AHP results were more accurate than the other method, and they believed that the AHP results represented what they had really thought in their minds.

Fifth, it was also found the effectiveness of the DSS-US is enhanced by the use of the Location criterion. The location can impact on the result. When a user chooses different Location from six cities, the results are different. It can be seen from that, this university selection system is able to personalize the system to meet the needs of users with different location priorities.

Last but not least, most participants said that there are some other very convenient functions in DSS-US. For example, DSS-US could send the result to their Email address after the result came up.

There are also some disadvantages.

Firstly, the user interface is not friendly enough and system instructions need to be revised. But compared with function, the interface is not that important for them just like one of them said ‘system function is the most important part, and the user interface is not as important as the system function’. Because all the participants come from mainland China, they hope DSS-US adds Chinese instructions so that they can read more quickly and understand the contents more clearly.

Besides, all the participants indicated that they would make a mistake if they were not careful enough when they fill in the AHP compare form.

Last, some details should be added to DSS-US. One of participants hopes that DSS-US could have a brief introduction about each location. She thought that would be helpful when she decided which city or area she likes better. And some of them want to see further details about the universities. So they recommend that DSS-US should be able to show not only the six criteria data, but also more specific introductions.

#### 5.4.2.2 Efficiency Evaluation Results

All seven participants completed all tasks smoothly and no user expressed difficulty.

Almost all the subjects (users) mentioned that DSS-US was very personalized and could save a huge amount of time. Some of their responses are as follows. ‘Oh, it really has a big difference with the commercial University Ranking’, and ‘I wish I could have used this system earlier.’ etc. DSS-US could save time especially by using their IELTS score and Bachelor's Honour Degree Class. Some of them admit that when they make decisions on universities selection, they spend plenty of time on searching universities' websites to find out the entry requirements.

However, some details in the system need to be improved in future research.

Firstly, some participants said that when using Weight defined by User method, they had to calculate themselves to make sure the six criteria weight sum was 100 percent at the Weight Default by User part. It took time and it was not good enough.

What’s more, one of the users advised that it might be easier to use multi-choice questions instead of the form format when doing the AHP pairwise part. Some users

mentioned that it might match the wrong criteria when doing the pairwise in different rows.

#### 5.4.2.3 Satisfaction Evaluation Results

All seven participants indicated that the DSS-US was very useful. It can be seen from both effectiveness and efficiency aspects that DSS-US helps users a lot. All seven participants agreed that they were satisfied about DSS-US's function and they would use DSS-US to help them on university selection.

### 5.4.3 System Final Implementation in Future

According to the system evaluation results in 5.4.4, DSS-US should refine some of the functions as follows:

Firstly, DSS-US should revise the input way in Weight Default by User method. Users should input weight under the prompt of DSS-US instead of doing summation by themselves.

Secondly, modify interface to make it more friendly and add the Chinese description. At the same time, some brief introductions about each area of the United Kingdom, such as weather, should be added in the description as well.

Thirdly, DSS-US should provide links of each university's official website on the results page so that users can find further information of the universities they are interested in more conveniently.

Last but not least, the AHP pairwise part should use multi-choice questions instead of the form format. Now users have to do the pairwise in one form, that makes them

easily get lost among different rows. It should be easier by changing the format to multi-choice questions (or to say “questionnaires”).

## 5.5 Chapter Summary

This chapter presents the system development process and the result of system evaluation. Although DSS-US is a small scale system, it includes enough functions and follows a complete design process. The results show that the system is perceived useful by students. The system evaluation results show that DSS-US is perceived to be effective, efficient and usable. For effectiveness, users believe that DSS-US has the potential to help them make better decision through personalization in terms of decision making criteria and weight allocation. For efficiency, students find that the system can save them significant amount of time when making their decision by helping them tom access the necessary information and data. Regarding the system usability, all the participants indicate that they were satisfied about the function of DSS-US. In addition, user can ‘play’ with DSS-US system to explore different scenarios. They can try different weights to explore different results.

# Chapter 6: Conclusions and Future Research

This chapter presents conclusions of the study. The first part of this chapter summarizes the procedure of the study. The second part lists key findings. The last part discusses limitations and future research.

## 6.1 Summary of the Study

Effective decision making is a complex process and can be affected by many factors. Over past decades, DSS have been developed and used to help individuals (most of them are managers) to make better decisions. Although DSS has been successful since its development, there are still gaps in DSS research and applications. For example, their applications in education sector are still limited, especially in supporting students in their decision making. With the challenges that decision makers are constantly facing due to the information overload, uncertainty and risks involved in the decision making environment, the need for using more effective tools to make better decision is becoming more imperative. University selection is one of the most important decisions that many international students have to make when they decide to pursue postgraduate degrees abroad. They have to face many problems such as information overload, and too many criteria to consider. This research acknowledges that extensive research has been done on developing decision support systems for enterprise or managers, while some of DSS has developed for individuals in business area, such as personal banking online shopping, etc. but very limited research has been done to focus on ordinary individuals, such as students. Much research contributed to university ranking, but there is very limited studies focusing on how to

choose a suitable university for individuals. Few studies considered students as the users. It seems that there is no recent attempt to explore the use of DSS helping student make a better decision on university selection.

Therefore, this research aims to explore a better way to build up a personal decision support systems for individuals to make better decision. To achieve the aim, the study takes university selection as an example to illustrate DSS application in personal decision making. This research developed a decision support tool for international students. More specially, the study has attempted to:

- Understand the decision support needs of international students.

- Develop and test a decision support system for international students to select the best suitable university for their postgraduate study in the UK.

To achieve the research objectives, this research adopted qualitative analysis approaches and develops a decision support system for students. Extensive literature review was conducted to establish initial understanding of decision support process. To investigate the key criteria for students on university selection, semi-structured interviews and questionnaires were carried out. Ten semi-structured interviews, five third-year undergraduate students and five postgraduate students have contributed to the criteria selection. Questionnaires were distributed to 50 students and 45 valid responses were received. AHP method was used in the system and Java was the programming language. Think Aloud method was adopted to evaluate the usability of DSS-US.

## 6.2 Key Findings

The key findings can be highlighted in two main research objectives outlined in 6.1. The first research objective is to identify the key criteria of university selection from the student point of view. To achieve this objective, semi-interview and questionnaire surveys were taken place for data collection, and the findings were discussed in Chapter 4. The key criteria are University ranking, Subject ranking, Completion rate, Location, Accommodation costs, Tuition fees, Degree class demand, and IELTS requirement. The second objective is to develop and evaluate the DSS-US system. The details were presented in Chapter 5. The results show that the system is perceived useful by students. The key findings are presented following sections.

### 6.2.1 Finding from Literature Review

Through literature review of decision making process, multi-criteria decision making and DSS, it is found that current decision making system has been widely used in various fields by experts, managers, and business people. However, limited systems are developed to support individuals who are not managers or decision makers in business organisations. Much research has been reported on the method of ranking universities, analysing the advantages and disadvantages of each ranking method, or how to improve the method for university ranking. There is no research focusing on how to help students to make better decision on university selection. Therefore, it is necessary to find a solution that can deal with the information overload and the influence from the commercial university ranking information.

### 6.2.2 Findings from Semi-structured Interview and Questionnaire

As 100% interviewers and 95.8% survey respondents believe that DSS-US would be very useful and they will definitely use it to help their decision making if it is available.

The first finding is about the key decision making criteria of international students on university selection. From the interview we know that there are various criteria impacting on the result of student selection and different students focus on different criteria. Almost all the students have to face the information overload problems when they began to do the university selection. There are so many sources to receive the information but there is a lack of explanation on how to identify the most useful information. Questionnaires have been designed for the semi-structured interviews to explore the students' needs, challenges and decision criteria. The results of questionnaires show that the key decision criteria of university selection of students are University Ranking, Major Ranking, Completion Rate, Location, Accommodation costs, Tuition fees, Degree class requirement, and IELTS requirement. Degree classification and IELTS are entry requirements, so they are used as extra conditions in the system. As proposed in Chapter 5, the weight of each criterion was shown in Table 5.3. The first two most important criteria are university ranking (24.77%) and subject ranking (24.08%). While the less important criteria based on this questionnaire are the rest of four, that are Completion rate, Location, Living costs, Tuition fees which occupy from 11.76% to 14.55%.

The second finding is about a special criterion, university's recognition. The recognition is extremely significant not only for individuals but also for an organization such as company and university. The findings show that a university's

recognition plays an important role in influencing student selection, but people from different countries have different views on a university's recognition. Take two universities, University of Birmingham and University of Exeter, as a pair of compare example for Chinese students. Students in China who want to study abroad do not know the education market very well in developed countries. Because of the lack of information and investigation, some students in China select a university based on their familiarity of the university's name. University of Birmingham is one of the most widely known universities in China. It is not only known by young people who have open mind, but also known by elderly people who have been never go aboard. Most people think University of Birmingham is a good university although they don't know the exactly ranking or other information about the university. University of Exeter, which is also highly ranked, may not be well recognized by Chinese. As a result, students may choose University of Birmingham instead of University of Exeter. University's recognition is very difficult to measure quantitatively. It is not adopted as a criterion in DSS-US. But it is an interested issue to be further explored in the future.

### 6.2.3 Findings from System Development Evaluation

There are a number of important findings from the system evaluation.

First, the system is perceived as very useful by the students participated in the evaluation. It suggests that this type of the system may have a great market prospect. All of seven system test participants were strongly agree to the system usability and effectiveness after using DSS-US. It can be concluded that DSS-US may have great potential on improving decision making for Chinese students who plan to study in UK to pursue postgraduate degree.

Second, AHP is truly a very useful and effective method to help users to define weight. AHP has many advantages and a main strong point is that it is both methodologically sound and user-friendly. Users make the comparisons just between two criteria at one time. It is usually considered to be one of the best ways to elicit judgments using pairwise comparisons. According to the results of DSS-US system, AHP is able to generated weights truly reflect the user's personal preference as it is difficult for students to rank allocate weights to each criteria when there are many criteria to consider. When using Weight Defined by User method to decide the weight, users cannot provide an accurate answer by giving a numerical number. When using AHP method, it is easy for users to compare two criteria and using Linguistic Measures of Importance to represent their preferences. This is the reason why AHP is more accurate and effective than other methods. Therefore, the incorporation of AHP in DSS-US proved to be effective.

It was also found the effectiveness of the DSS-US is enhanced by the use of the Location criterion. The location can impact on the result. When a user chooses different Location from six cities, the results are different. It can be seen from that, this university selection system is able to personalize the system to meet the needs of users with different location priorities.

## 6.3 Research Contributions

This research contributes to the personal DSS research and applications in the following aspects.

Firstly, it addressed a gap in the current DSS research by designing and applying DSS for personal decision making using AHP because personal DSS reported in the literature is designed to serve business users.

Secondly, it identifies key criteria in students' decision making on university selection through student interviews and surveys. The key criteria are University ranking, Subject ranking, Completion rate, Location, Accommodation costs, Tuition fees, and Entry requirements.

Thirdly, the system evaluation results show that DSS-US is perceived to be effective, efficient and usable. For effectiveness, users believe that DSS-US has the potential to help them make better decision through personalization in terms of decision making criteria and weight allocation. For efficiency, students find that the system can save them significant amount of time when making their decision by helping them tom access the necessary information and data. Regarding the system usability, all the participants indicate that they were satisfied about the function of DSS-US. In addition, user can 'play' with DSS-US system to explore different scenarios. They can try different weights to explore different results.

## 6.4 Research Limitations and Future Research

There are a number of limitations in this study. One limitation is types of the users involved in the study. The target users in the study are the international students who came from China. They participated in interviews, questionnaires and evaluation. The sample group size is small. Key decision criteria on university selection are complex and personal. The six adopted criteria in the study are mainly based on Chinese students' requirements and concerns. They may not be suitable for students from other

counties due to the different cultural and personal preference issues. Thus any attempt to apply the findings in different context should be cautious and fully aware of the limitations although the system can be easily adapted to suit other students groups.

The other limitation in the study is that the system is only a prototype system and significant work will be required to make it fully usable online. This includes the improvement on the user interface and the system database. Database in this research should be designed to be updated automatically while at present it is only collected manually.

The study aimed to demonstrate the process and the benefit of a personal DSS in the context of students' university selection. DSS-US is used as an example to present the basic theory and process in personal DSS design and development. University selection is a difficult and critical decision for all students, but the process involves multi-criteria and requires most updated information. The future research should continue to explore the potential improvement of DSS-US in terms of including non-quantifiable criteria (e.g. reputation) and the ways to link the database to a wide range of sources with automatic data feeds.

# APPENDICES

Appendix A – Interview Outline for Postgraduate Students

1. Is it difficult for you to decide which university you will be chosen for your further study? Why?

2. Could you tell me all the factors you care about?

3. What's the most important factor for you when selecting a university? And what's the least important factor? Can you list all the factors you considered? (such as location, fees, ranking, your parents advice….)

4. As a postgraduate student, is there any experience about how to choosing a university? Such as the factor you missed last year, the factor you considered as an important one last year but you found it is not as important as you thought now?

5. If there is a system or a website which can help you to do the choice when you make a decision on university selection, will you use it? Or do you think it can help you when you have to deal with vast quantities of information? What functions should be included in the system or website?

6. About university information. Is it very easy to find out? Where are you found it? And how?

Appendix B – Interview Outline for Undergraduate Students

1. Is it difficult for you to decide which university you will be chosen for your further study? Why?

2. Could you tell me all the factors you care about?

3. What's the most important factor for you when selecting a university? And what's the least important factor? Can you list all the factors you considered? (such as location, fees, ranking, your parents advice….)

4. Have you already begun to apply university for your further study? How you make a decision when you choosing the university?

5. If there is a system or a website which can help you to do the choice when you make a decision on university selection, will you use it? Or do you think it can help you when you have to deal with vast quantities of information? What functions should be included in the system or website?

Appendix C – Questionnaire

Questionnaire for university selection

There is a research about university selection. We will appreciate if you can take a few minutes to finish the questionnaire. All information and data collected will be only used in this research. Thank you.

1. What are the factors you concern about when you choosing the university for your postgraduate study? (Please sign √, multiple choices)

□Location □Campus setting □Subject ranking □School size (students number)

□Facilities □Tuition fees □University ranking □Degree class demand

□Ethnicity □Graduation rate □Gender mix □IELTS demand

□Reputation □Living costs □Job prospects □Parents opinion

□Others (Please write on the line) _____

2. Please rank those factors from the most important to the least important use the number 1, 2, 3…. You can sign X on the line if the factor is not of your concern. You are welcome to add factors not included in the table.

| Factors | No. | Factors | No. |
|---|---|---|---|
| Location | | Campus setting | |
| Facilities | | Subject ranking | |

| | | | |
|---|---|---|---|
| Ethnicity | | Graduation rate | |
| Living costs | | University ranking | |
| Tuition fees | | School size (students number) | |
| Reputation | | Degree class demand | |
| Gender mix | | IELTS demand | |
| Job prospects | | Parents opinion | |
| | | | |

3. If there is a decision support system or a website which can help you make a decision on university selection,

   Do you think it can help you when you have to deal with vast quantities of information?

   □ Yes □ No Why _____

   Will you use it?

   □ Yes □ No Why _____

4. What information should be included in the system or website? (Please sign √, multiple choices)

   □Location □Tuition fees □Degree class demand

□University ranking □Graduation rate □IELTS demand

□Subject ranking □others _____ □others _____

5. About factor weight(权重，比重) consideration (Please sign √, Single choice),

□I think each of these factors is equally important.

□I think some factors are more important than others.

6. What functions should be included in the system or website? (Please select as many as you think is necessary, and you are welcome to provide your opinions).

□ Universities ranking by authority, such as the *Times*.

□ Universities basic information, such as IELTS demand, Location and so on.

□ I can choose the factors I am concerned about; the website then c generates a list of candidate universities according to my input.

□ The system or website could score each university according the factors I concerned about, to help me make a decision.

□ Others _____

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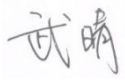
# DECLARATION

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.

Name of candidate: Qing Wu Signature: 

Date: 3rd Oct. 2012