IMPLEMENTATION OF DECISION SUPPORT SYSTEM FOR CHOOSING PRE-WEDDING PHOTO SERVICE

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ABSTRACT

Decision making is the selection of a course of action from a number of possible alternatives on the various forms of evidences. Multi-criteria decision making (MCDM) is a discipline to support the decision makers who faced with making numerous and conflicting evaluations. Analytical Hierarchy Process (AHP) is one of the problem solving techniques of MCDM and a popular multiple-criteria decision making tool based on hierarchical structure. AHP can be used with both quantitative and qualitative data.

In this system, AHP is applied to develop the best selection among various pre-wedding photo service packages among decision criteria such as price, location, number of dresses, dress type, makeup, number of photos, special frame and popular rate that also satisfied with desire of the user. The user can compare eight alternatives based on eight criteria. According to the priority values of each criterion, this system apply the AHP method to find the best package that is suitable with user desired. Therefore, the user can easily decide and choose the pre-wedding photo service packages by using this system. This system is implemented by using C#.NET and ASP.Net programming language with Microsoft SQL Server 2010 database.

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CHAPTER 1

INTRODUCTION

In this century, most couples are very interesting in pre-wedding photography shooting before their wedding time. Shootings of Pre-wedding may be a relatively new trend but they come with various benefits such as it can ensure to describe the modern living standard. Some couples choose to have their pre-wedding photographs taken at their wedding venue, whilst others decide to option an entirely different location. Some people choose to enlist the services of others who want to work with them on their wedding day. Mostly, every couple prefers to have the printed vinyl and put it on their wedding ceremony, whilst others may upload them onto their social media accounts to show to their friends and family. Some couples may even decide to keep them as private visual documents.

The major benefit of taking the pre-wedding services is that it enables couples to focus on enjoying their memorable day once it arrives. If the couple takes the pre-wedding service, the couple does not need to drag away from friends and family in time and time again for shooting photographs to be taken in their ceremony. That is why, every couple is crazy to shoot pre-wedding photograph. There are many pre-wedding studios (services) in Myanmar. They offer a lot of packages with various prices and attractive services by competition of each other studio, respectively. This system is intended to guide the couples who wish to take memorable photos for their wedding.

1.1 Decision Support System (DSS) and its Types

The principal objective of decision support system is computer-based technology to support a human decision maker when the process of arriving at a decision. Multi-Criteria Decision Making (MCDM), also called multi-criteria decision analysis (MCDA). MCDA is aimed at supporting decision makers who are faced with making numerous and conflicting evaluations. The purposes of MCDA is highlighting these conflicts and deriving a way to come to a compromise in a transparent process [11]. Analytic Hierarchy Process (AHP) is one of the problem solving techniques of MCDM and based on hierarchical structure. The AHP can be used with both quantitative and qualitative data. One reason for it is the popularity of AHP among researchers and practitioners are relatively compared with the other methods for multi-criteria analysis.

1.2 Motivation of Thesis

Decision support system is interactive and a computer-based system which aid the users in the judgment and choice activities. The decision support system (DSS) used in various popular domains including the business, military, engineering, medicine and banking, respectively. They are valuable for an unaided human decision maker in conditions in the amount of available information is prohibitive for the intuition, in the precision and optimality are importance. They may provide human cognitive deficiencies by integrating various sources of information. They are able to provide the intelligent access to relevant knowledge, and aiding the process of structuring decisions. They can employ with the artificial intelligence methods to address heuristically problems that are intractable by formal techniques. Decision-making tools for appropriate application increases efficiency, effectiveness and productivity [4]. They can also give a lot of comparative advantage in businesses over their competitors, allowing them to make optimal choices for their parameters and investments, planning business operations or logistics, technological processes correspondingly.

The decision support system (DSS) can also be identified as the information systems because it assists the user to make a decision by supporting information, models and analysis tools. A model is a representation for some aspect of the real world. General application areas of decision support system are the management military, health care and planning in business and any other area in which management can encounter complex decision situations. This system is usually used for strategic and tactical decisions faced by top management level decisions with a reasonable high potential consequences and low frequency [17].

There are three basic planning methodologies for the decision support systems development [1]. The quick-hit method consists of the single decision support systems development with little or no thought given to subsequent applications. With a ‘staged development’ method, the effort expended in creating the first system is reused in developing the second. This can affect the selection of these decision support system generator, therefore it is appropriate for use with multiple applications. The final method is a ‘complete’ decision support system (DSS) method, where prior to the development of any specific DSSs, generator, a complete set of DSSs tools is acquired and organizational issues related to DSSs are decided.

The DSSs development processes are idea generation and approval, information requirements determination, design, development, and maintenance, respectively. Decision support system application tends to reply heavily upon an interactive development process which involves multiple executions of a combined analysis-design-implementation effort. Decision support systems are a combination of complex data, advanced engineering models, geographic information system (GIS), analysis techniques and graphical user interface (GUI), respectively. Decision support system usually includes a system to manage the data, model to process the data, to generate information, to support decision-making, report generators to portray information to the person who makes decision, and an interface of user to make the system easy to apply [7].

1.3 Related Works

There are many application areas which applied the AHP method. AHP include the factors for decision comparison that are not easy to quantify that especially suitable for decision which are complex [11]. According to their common characteristic, the natural human reaction is to cluster the decision elements s when faced with a complex decision.

Ho, W. [12] implemented the optimal maintenance alternative selecting for an integrated gasification combined cycle plant by using AHP. In the case study is left with six of the most important criteria: down time length, safety, equipment, failure frequency and operating conditions. In this case, machines are divided into three main categories based on the consequences of failure. The outcome of the study showed that predictive maintenance facilitates Group 1. Group 2 reveals a slight preference for opportunistic maintenance, whereas preventive maintenance and corrective maintenance suit Group 3.

Jureen Thor, Siew Hong Ding, Shahrul Kamaruddin [13] discussed about the AHP method to select the optimal maintenance alternative for a machine used in virtual learning aimed at increasing reliability and availability levels.

L. Wang and J. Chu, J. Wu [16] also presented the AHP method to decide the suitable maintenance alternative for a wind turbine machine by taking implications of cooperative alliances into consideration during decision making process.

M. Bevilacqua, M. Braglia [17] described the use of AHP to measure health, safety, environment awareness, and cost issues during maintenance alternative decision making in the oil and gas industries.

M. Ilangkumaran and S. Kumanan [18] explained how the AHP method is used to choose the most practical maintenance alternative for machines with different operational functions in the oil refinery industry.

Kamal M and Al-Subhi Al-Harbi [15] described about application of the AHP in project management paper. The Xerox Corporation uses AHP for decisions on portfolio management, technology implementation, and engineering design selection. AHP is also used to help make marketing decisions regarding market segment prioritization, product market matching, and customer requirement structuring [4].

ALsubhi al and Harbi K.M [2] defined the decision support system as an interactive, flexible, and adaptable CBIS specially developed for supporting the solution of a non-structured management problem for improved decision making (p.77). Their first characteristic is “decision support systems provide support for decision makers mainly in semi structured and unstructured situations by bringing together human judgment and computerized information. A more consistent definition of decision support system and “characteristics” should also improve communications about these important computerized systems with students and decision support system practitioners. The following is the list of characteristics of a decision support system [13].

- **Facilitation**. Decision support systems support and facilitate specific decision-making activities and/or decision processes.
- **Interaction**. Decision support systems are computer-based systems designed for interactive use by decision makers or staff users who control the sequence of interaction and the operations performed.
- **Ancillary**. Decision support systems can support decision makers at any level in an organization. They are NOT intended to replace decision makers.
- **Repeated Use**. Decision support systems are intended for repeated use. A specific DSS may be used routinely or used as needed for ad hoc decision support tasks.
- **Task-oriented**. Decision support systems provide specific capabilities that support one or more tasks related to decision-making, including: intelligence

and data analysis; identification and design of alternatives; choice among alternatives; and decision implementation.

- **Identifiable**. Decision support systems may be independent systems that collect or replicate data from other information systems OR subsystems of a larger, more integrated information system.
- **Decision Impact**. Decision support systems are intended to improve the accuracy, timeliness, quality and overall effectiveness of a specific decision or a set of related decisions.

1.4 Objectives of the Thesis

The main objective of the thesis is to suggest the customer who wants to take the best services among various pre-wedding photo services. The other objectives are as follows:

- To study the concept of multi-criteria decision making technique
- To understand how to implement the system using Analytical Hierarchy Process (AHP) Method
- To study the step by step calculation and process of AHP method
- To help the couple for choosing their sweet memorable pre-wedding photo service
- To guide the user who can easily decide and choose the nice packages among various packages that are also stratified with their criteria

1.5 Organization of the Thesis

The five major parts are composed in this thesis. Chapter 1 describes about the introduction to the decision support system (DSS) and its types, the motivation of this thesis, the related works, the objectives and organization. Chapter 2 explains the theoretical background. Chapter 3 presents the nature of AHP method, the system design and step by step explanation of the system by applying the AHP method. Chapter 4 describes how to define dataset and how to implement the system to give the best advice to the user who wants to take the pre-wedding photo services within a short period. Finally, Chapter 5 concludes this thesis with beneficial point and further extension.

CHAPTER 2

BACKGROUND THEORY

2.1 Perception of Decision Making and Decision Support System

Decision support system is a type of information system whose principal objective is to support a human decision maker during the process of arriving at a decision. Decision making is the selection of action from a number of possible alternatives on various forms of evidence. And, another mean is the intellectual or mental process of forming an opinion or evaluation by discerning and comparing.

2.1.1 Decision Making

The process of decision making is the process of developing and analysing alternatives to make a decision which is a choice from the available alternatives. Most decisions are made in response to a problem which is a discrepancy between a desirable and an actual decision and also involve judgment which is the cognitive aspects of decision making process. Decisions can be classified as either programmed or non-programmed. Programmed decisions are repetitive or routine and can be solved through clear-cut mechanical procedures, such as applying the rules to find the best solution [11]. Up to 90 percent of management decisions are programmed. Non-programmed decisions are exceptional or nonrecurring, and they are often made under crisis conditions which involve so much ambiguity that specific procedures or programs are not available. Therefore, managers who must make non-programmed decisions rely on judgment, creativity, and intuition, respectively.

There are step-by-step decision making processes:

- **Step 1 - Identify the decision:** If somebody realizes that he needs to make a decision, then he should try to clearly define the nature of the decision that he must make. This first step is very important.
- **Step 2 - Gather relevant information:** Before making decision, the decision maker needs to collect some pertinent information that what kind of information is needed, the best sources of information, and how to get it. In this step involves both internal and external "work." The decision maker needs to find it online, in books, from other people, and from other sources. This is

called external. Otherwise, the decision maker seeks it through a process of self-assessment is internal information.

- **Step 3 - Identify the alternatives:** The decision maker may surely identify several possible paths of action, or alternatives. The decision maker may also use his additional information and imagination to construct new alternatives. In this step, the decision maker can list all possible and desirable alternatives.
- **Step 4 - Weigh the evidence:** The decision maker need to structure on information and emotions to imagine what it would be like if the decision maker carried out each of the alternatives to the end. Evaluate whether the need identified in Step 1 would be met or resolved through the use of each alternative. As the decision maker go through this difficult internal process, the decision maker can start to favour certain alternatives: those that seem to have a higher potential for reaching the goal. Finally, the decision maker needs to put the alternatives in a priority order, based upon own value system.
- **Step 5 - Choose among alternatives:** Once the decision maker has weighed all the evidence, the decision maker is sure to select the alternative that seems to be best one. The decision maker may choose a combination of alternatives. The decision maker select in Step 5 may very likely be the same or similar to the alternative, the decision maker put at the top of this list and at the end of Step 4.
- **Step 6 - Take action:** By beginning to implement the alternative they chose in Step 5, the decision maker should sure to take some positive action.
- **Step 7 - Review decision and its consequences:** In this final step, consider the results of decision and evaluate whether or not it has resolved the needs identified in Step 1. If the decision has *not* met the identified need, the decision maker may want to repeat certain steps of the process to make a new decision. For example, the decision maker might want to gather more detailed or somewhat different information or explore additional alternatives.

The process of decision making consists of three main stages. They are intelligence, design, and choice, respectively.

- **Intelligence**: Fact finding, problem and opportunity sensing, analysis, and exploration.

- **Design**: Formulation of solutions, generation of alternatives, modelling and simulation.
- **Choice**: Goal maximization, alternative selection, decision making, and implementation.

2.1.2 Decision Support

The term decision support refers to support the person who is making the decision. The decision support is often used in a variety of perspectives which related to decision making [10]. Inescapably, decision support is the part of decision making processes. A decision is defined as the choice of one among a number of alternatives, and decision making refers to the whole process of making the choice, which includes assessing the problem, collecting and verifying information, identifying alternatives, anticipating consequences of decisions, making the choice using sound and logical judgment based on available information, informing others of decision and rationale, and evaluating decisions. An active decision support system actually processes data and explicitly shows solutions based upon that data. The passive decision support models that just collect data and organize it effectively. They do not suggest a specific decision and they only reveal data [3]. The system when data is collected, analysed is called a cooperative decision support system. It is provided to a human component which can help the system revise or refine it. It means that both a human component and computer component work together to come up with the best solution.

Many companies constantly download and analyse budget sheets, sales data forecasts and they update their strategy once they analyse and evaluate the current results. Most companies have actually integrated this system into their day to day operating activities. The result of decision support systems is to congregate the data, analyse the data and shape the data which is collected [6].

Decision support systems are interactive information systems that depend on a (having different things working together as one unit) set of user-friendly hardware and software tools to produce and present information that is targeted to support the management in the decision-making process. The decision support systems help the management decision-making by combining data, fancy (or smart) models and user-friendly software into a single powerful system that can support semi-structured or (without rules, schedules, etc.) decision-making. The decision support system is under user control, from early beginning to final putting into use and daily use. Decision support system helps to close the information gap to enable managers to improve quality of their decisions. While MIS is carefully thought believed useful for structured decisions, decision support system is carefully thought about to be more useful for decisions at the strategically/strategic levels, where decision-makers are often angrily stood up to with complex decisions which are beyond their human abilities to (creation/combination) properly the factors involved [5]. Decision support system points out to a class of systems, which support in the process of decision-making and does not always give a decision itself. These systems can be used to validate decision by performing sensitivity analysis on different guidelines of the problem.

Decision support systems are powerful tools integrating with the scientific methods for supporting complex decisions with techniques developed in information science, and are gaining an increased popularity in many domains. They are especially valuable in situations in which the amount of available information is prohibitive for the intuition of an unaided human decision maker and in which precision and optimality are of importance. DSS aid human cognitive deficiencies by integrating various sources of information, providing intelligent access to relevant knowledge, aiding the process of structuring, and optimizing decisions [2]. The information systems technologists and researchers have structured and investigated decision support systems since almost 40 years ago. This means that the system helps companies to make better business decisions have been around since computers came into widespread use.

The subsystems of DSS intended to help decision makers use communications data, documents, knowledge, technologies and models to complete decision process tasks. A decision support system may present information graphically and may include an expert system or artificial intelligence. Typical information that a decision support application might gather and present would be in accessing all information assets, including comparative data figures, projected figures based on new data or assumptions, legacy and relational data sources, given past experience in a specific context, benefits of different decision alternatives.

My approach has been to use a "big tent" definition and include business intelligence systems, some workflow systems, groupware, conferencing software, management expert systems and model-based analytic systems as decision support systems [8]. Alternative identification of three major characteristics of decision support system is as follow:

- Decision support systems are designed specifically to facilitate decision processes,
- Decision support system should support rather than automate decision making, and
- Decision support system should be able to respond quickly to the changing needs of decision makers.

Decision support systems provide benefits when the combination of the system plus a decision maker (or makers) is superior to the performance of software or humans alone. Often, combining the best attributes of fast computation, large disk storage, graphic displays, and intelligent software with the insights of human decision makers can achieve excellent decision quality or an excellent decision-making process. The benefit of a decision support system is better decisions, a better decision-making process, or both.

- **Saving the Time**

  Research has demonstrated and substantiated for all categories of decision support systems reduced decision cycle time, more timely information and increased employee productivity for decision making. The time savings that have been documented from using computerized decision support are often substantial. Researchers have not always demonstrated that decision quality remained the same or actually improved.

- **Improve Effectiveness**

  A second category of advantage, decision making effectiveness and better decisions improve that has been widely discussed and examined. Decision quality and decision making effectiveness are however hard to document and measure. Most researches have tested soft measures like perceived decision quality rather than objective measures. Supports of building data warehouses identify the possibility of the better analysis that can improve decision making.

- **Enhance Interpersonal Communication**

  Decision support system can improve collaboration and communication among decision makers. In appropriate conditions, communications driven and group decision support system have had this impact. Model driven decision support system supports a means for sharing facts and assumptions. Data driven decision support system makes 'one version of the truth' about company operations available to managers and hence can encourage fact-based decision making. Improved data accessibility is often a major motivation for building a data driven decision support system. This advantage has not been sufficiently demonstrated for most types of decision support system.

- **Competitive Advantage**

  Vendors frequently cite this advantage for business intelligence systems, performance management systems, and web-based decision support system. Although it is possible to gain a competitive advantage from computerized decision support, this is not a likely outcome. Vendors routinely sell the same product to competitors and even help with the installation. Organizations are most likely to gain this advantage from novel, high risk, enterprise-wide, inward facing decision support systems. Measuring and may continue to be difficult.

- **Reduction the Cost**

  Some researches and especially case studies have documented decision support system cost saving from labour savings in making decisions and from lower infrastructure or technology costs. This is not always a goal of building decision support system.

- **Decision Maker Satisfaction Increasing**

  The novelty of using computers has and may continue to confound analysis of this outcome. Decision support system may reduce frustrations of decision makers, create perceptions that better information is being used and/or creates perceptions that the individual is a "better" decision maker. Satisfaction is a complex measure and researchers often measure satisfaction with the decision support system rather than satisfaction with using a decision support system in decision making. Some studies have compared satisfaction with and without computerized decision aids. Those studies suggest the complexity and "love/hate" tension of using computers for decision support.

- **Promote learning**

  Learning can occur as a by-product of initial and ongoing use of a decision support system. Two types of learning seem to occur: learning of new concepts and the development of a better factual understanding of the business and decision making environment. This potential advantage has not been sufficiently examined.

- **Increase organizational control**

  Business transaction data available for performance monitoring and ad hoc querying are made by data driven decision support system. Such systems can enhance management understanding of business operations and managers perceive that this is useful. What is not always evident is the financial benefit from increasingly detailed data.

2.2 Decision Support System Architecture

Decision support system architecture involves obtaining an in-depth understanding about how a user is going to interact with the system and how information can flow from one point to another. Decision support system architecture is concerned about conception of the structure, model and behaviour of a system which is to be developed. A well-defined decision support system architecture scheme addresses the problem definition that a decision support system is expected to resolve, the objectives of a decision support system, the components of a decision support system and connection between them, the development and maintenance schedule, the skills, tools, funds and other support required for decision support system development, the anticipated enhancements and project participants and their roles, respectively [9]. A decision support system consists of many parts:

- **Data management subsystem-** A decision support systems uses one or more data stores (databases, sets of files and/or data warehouses) to provide relevant information to the decision support system. Some of them are maintained by the decision support system itself and some are external data sources. Some database primarily used and maintained by another information system with its own database management system (DBMS) and some decision support system applications may have no separate decision support system database. The data are entered into the decision support system as needed.

- **Model management subsystem-** This subsystem is a software package that includes and manages quantitative and qualitative models. Quantitative models provide the system's analytical capabilities.
- **Dialogue subsystem** or **user interface-** The decision support system communicates with the decision maker via this subsystem. The user supplies information to the decision support system and commands the decision support system using this subsystem. The information supplied determines what data need to be extracted from the data sources.
- **Knowledge management subsystem-** This optional subsystem can act as an independent component or support any of the other subsystems. It supports knowledge for the solution of the specific problem.

The above components are considered to constitute the software portion of the decision support system, the final part being the decision-maker himself. This kind of components are put together by programming them from scratch or by using comprehensive tools or by gluing them together from existing components, called decision support system generators.

2.3 Types of Decision Support System

The decision support systems can be categorized into five types. They are data driven decision support system, document driven decision support system, communications driven decision support system, knowledge driven decision support system and model driven decision support system, respectively.

(i) Data Driven Decision Support System

In these systems consist of file drawer and management reporting systems, Executive Information Systems (EIS) and Geographic Information Systems (GIS), data warehousing and analysis systems. Business Intelligence Systems are also examples of Data driven decision support system. It support system emphasize access to and manipulation of large databases of structured data and especially a time-series of internal company data and sometimes external data. Simple file systems accessed by query and retrieval tools provide the most elementary level of functionality [12].

Data warehouse systems that allow the manipulation of data by computerized tools tailored to a specific task and setting or by more general tools and operators provide additional functionality. Data driven DSS with Online Analytical Processing (OLAP) provide the highest level of functionality and decision support that is linked to analysis of large collections of historical data.

The data driven model decision support system places its emphasis on collected data that is then manipulated to fit the decision maker's needs. This data can be external, internal and in a variety of formats. This is emphasizing access to and manipulation of a time series of internal company data and sometimes external and real time data. Simple file systems accessed by query and retrieval tools provide the most elementary level of functionality. Most data driven decision support systems are targeted at managers, staff and also product per service suppliers. It is used to query a database or data warehouse to seek specific answers for specific purposes. It is deployed via a main frame system, client server link or via web. Examples: computer-based databases that have a query system to check including the incorporation of data to add value to existing databases. Data driven decision support system emphasize access to and manipulation of large databases of structured data and especially a time-series of internal company data and sometimes external data.

(ii) Document Driven Decision Support System

The document driven decision support system, is evolving to help managers retrieve and manage unstructured documents and Web pages. A variety of storage and processing technologies are integrated with this system to provide complete document retrieval and analysis. Large document databases are provided by the Web access to including databases of sounds, documents hypertext, video and images. This is the samples of document based decision support system which is product specifications and policies, procedures, corporate historical documents and catalogues, consisting of corporate records, minutes of meetings and important correspondence. A powerful decision-aiding tool associated with a document driven decision support system is a search engine Document driven decision support systems are more common, targeted at a broad base of user groups. The purpose of such a decision support system is to search web pages and find documents on a specific set of keywords or search terms [8]. The usual technologies used to set up such decision support systems are via the web or a client/server system. Processing technologies and computer storage are used s to provide document analysis and retrieval. In this driven, using documents in a variety of data type such as text documents, spreadsheets and database records to come up with decisions and manipulate the information to refine strategies. The usual technology used to set up such decision support systems are via web or a client/server system.

(iii) Communication Driven Decision Support System

This system consists of collaboration, communication and decision support technologies that do not fit within that the types of decision support system identified by Steven Alter. So that the communications driven decision support system need to be identified as a specific category of (DSS). Communications driven decision support system are also well known as the term group decision support system. This is a hybrid decision support system that emphasizes both the use of communications and decision models. It is an interactive computer-based system intended to facilitate the solution of problems by decision-makers working together as a group. Group are supporting scheduling, sharing document, electronic communication and other group productivity and decision support enhancing activities.

This kind of decision support system supports many persons working on a shared task. Most communications driven decision support systems are targeted at internal teams, including partners. Large amount of collaborators work together to come up with a series of decision to set in motion a solution or strategy. The most common technology used to deploy the decision support system which is a web or a client server. Generally, video conferencing, group decision, audio and bulletin boards are the basic technologies for this driven decision support.

The communication driven decision support system consists communication, collaboration and coordination. The group decision support system focuses on supporting groups of decision makers to analyse problem situations and performing group decision making tasks. Most communications driven decision support systems are focused at internal teams, including partners. Its purposes are to help conduct a meeting, or for users to collaborate [13]. The most common technology used to deploy the decision support system is the internet technology. Such as online collaboration, net-meeting, systems chats and instant messaging software.

(iv) Knowledge Driven Decision Support System

This kind of decision support systems driven are a catch-all category covering a broad range of systems covering users within the organization setting it up, but may also include others interacting with the organization, for example, consumers of a business. It uses special rules stored in a computer or used by a human to determine whether a decision should be made. These rules or facts are used in order make a decision. In this decision support systems are person-computer systems with specialized problem-solving expertise. The "expertise" consists of knowledge about a particular domain, understanding of problems within that domain and "skill" at solving some of these problems. A related concept is data mining. Mining tools can be used to create hybrid data driven and knowledge driven (DSS).

(v) Model Driven Decision Support System

Model driven decision support systems are complex systems that help analyse decisions or choose between different options. This decision support system specialise access to and manipulation of financial, optimization and/or simulation models. Simple quantitative models provide the most elementary level of functionality. It use limited data and parameters provided by decision makers to aid decision makers in analysing a situation, but in general large data bases are not needed for model driven decision support system. Managers and staff members of a business or people who interact with the organization use this system for a number of purposes depending on how the model is set up. These decision support systems can be applied via software / hardware in stand-alone PCs, client/server systems or the web.

It consist the systems that use representational models, optimization models, accounting and financial models. This driven decision support system emphasizes access to and manipulation of a model. Simple analytical tools and statistical provide the most elementary level of functionality [2]. Some OLAP systems that allow complex analysis of data may be classified as hybrid decision support systems supporting data retrieval, modelling and data summarization functionality. And also use data and parameters provided by decision-makers to aid them in analysing a situation, but they are not usually data intensive.

2.4 Components of Decision Support System

Decision support systems vary greatly in application and complexity, but they share some specific features. There are four fundamental components of DSS. They are data management, model management, knowledge management and user management, respectively.

(i) Data Management Component

The method of data management is a subsystem of the computer-based decision support system, and has a number of subcomponents of its own. The database management system; the database can be relational or multidimensional and is managed by software called the database management system (DBMS). The integrated decision support system database, which includes data extracted from internal and external sources, data which can be maintained in the database or can be accessed only when is useful. It is used to collect and organize data. The data dictionary, implying a catalogue containing all the definitions of database data; it is used in the decisional process identification and definition phase.

(ii) Model Management Component

The component of model management consists of the use of a model to turn data into information. The software package that includes management science, financial, statistical or other quantitative models that provide the system's analytical capabilities, and appropriate software management. Modelling language for building custom models is also included. It is also called a model-based management system.

(iii) User Interface Management Component

The component of user interface is a component that provides the communication between the decision support system and the user. The appropriate design of this component is really important because it is the only one the user actually deals with. DSS need to be equipped with intuitive and easy-to-use interfaces because their users are often managers who are not computer trained. These interfaces aid in model building, but also in interaction with the model. The basic responsibility of this system is to improve the ability of the system user to utilize and advantage from the DSS.

2.5 Classifications of Decision Support Systems

There are several ways to classify DSS. It is arranging from the totally data-oriented systems to the more powerful model-oriented systems.

- **Data Access Systems**

  These systems can provide user-friendly ad hoc access to the database. This capability is equivalent to what is offered by most DBMSs through a query language. However, such systems "open up" a database.

- **Data Analysis Systems**

  These systems help analyse historical and current data, either on demand or periodically. Only very simple models are employed in data analysis systems.

- **Forecast-Oriented Data Analysis Systems**

  The systems for data analysis generally provide in developing product plans, including sales forecasts, market segment forecasts and analyses of competitive action. Their operation is based on access to a variety of internal and external marking and product databases, including series of historical data. Ad hoc use for planning purpose by a staff analyst of a marketing manager is typically. The systems in this category include only the simpler of the variety of marketing models, which show how existing trends in the marketplace may extend in the future if similar conditions prevail.

- **Systems Based on Accounting Models**

  DSSs are used to consider alternative options for planning purposes, based on accounting definitions and relationships. Such systems typically produce estimated income statements, balance sheets, or other measure of financial performance.

- **Systems Based on Representational Models**

  These systems go beyond the use of ready standard formulas, such as those employed in systems that rely on accounting models. Rather, representational models show the dependence between a controllable variable, such as the price of a product, and an outcome, such as sale.

- **Systems Based on Optimisation Models**

  Optimisation models are developed by management scientists to determine optimal allocation of resources or best possible schedules. Using the techniques of linear programming, Example: one can establish the mix of products that must be produced to maximize an objective such as profit, subject to a variety of constraints. Using such a model, a company faced with temporary shortages was able to adjust the supply of raw materials it needed for its products to meet this temporary constraint.

- **Systems with Suggestion Models**

  These systems are considered by actually suggesting decisions, rather than merely responding to the user's request to evaluate an alternative. This models suggest solutions within narrow domains of knowledge and sometimes combine a DSS with an expert system. Such suggest the production volume or rate of insurance renewal, product price.

2.6 Development of Decision Support System

The decision support systems are a set of manual or computer-based tools that assist in some decision-making activity. Information systems can significantly support managerial decision making and help in the intelligence stage by providing information about different conditions. Decision Support Systems (DSSs) are a major category of management information systems and computer-based technology solutions that provide interactive information support to help complex decision making and problem solving.

Since the early 1970s, DSS have evolved enormously. A DSS was defined as a computer system dealing with a problem where at least some stages are structured, semi-structured or unstructured. Because decision makers must also deal with unstructured portion of a DSS problem, flexible query language and modelling environment are needed for decision support.

In today's business environment, however, decision support systems (DSS) are commonly understood to be computerized management information systems designed to help business owners, executives, and managers resolve complicated business problems and/or questions. Good decision support systems can help business people perform a wide variety of functions, including cash flow analysis, forecasting, product performance improvement, and resource allocation analysis. Previously regarded as primarily a tool for big companies, DSS has in recent years come to be recognized as a potentially valuable tool for small business enterprises as well.

DSS once supported individual decision-makers. Beginning in 1985, Group Decision Support System (GDSS) evolved to provide brainstorming, idea evaluation, and communication facilities to support team problem solving. This resulted in appearing artificial intelligence and expert systems. Beginning in the early 1990s, four powerful tools emerged for building DSS. The first new tool for decision support was the data warehouses were Online Analytical Processing (OLAP) and data mining. The fourth new tool set is the technology associated with the World Wide Web which is the most permanent technology in the beginning of 21^{st} century. Classic DSS tool design comprises components for:

- Sophisticated database management capabilities with the access to internal and external data, information, and knowledge
- Powerful modelling functions accessed by a model management system
- Powerful, yet simple user interface designs that enable interactive queries, reporting, and graphing functions.

2.7 Decision Support System Application

There are theoretical possibilities of building such systems in any knowledge domain.

- One example is the clinical decision support system for medical diagnosis. Other examples include a bank loan officer verifying the credit of a loan applicant or an engineering firm that has bids on several projects and wants to know if they can be competitive with their costs.
- Decision support system is extensively used in business and management. Executive dashboard and other business performance software allow faster decision making, identification of negative trends, and better allocation of business resources.
- A growing area of decision support system application, concepts, principles, and techniques is in agricultural production, marketing for sustainable development. There are, however, many constraints to the successful adoption on decision support system in agriculture.
- Decision support systems are also prevalent in forest management where the long planning time frame demands specific requirements. All aspects of forest

management, from log transportation, harvest scheduling to sustainability and ecosystem protection have been addressed by modern decision support systems. A comprehensive list and discussion of all available systems in forest management is being compiled under the COST action.

- A specific example concerns the Canadian National Railway system, which tests its equipment on a regular basis using a decision support system. A problem faced by any railroad is worn-out or defective rails, which can result in hundreds of derailments per year [7].

2.8 Multiple Criteria Decision Making (MCDM)

Many decision-making problems involve a number of criteria (factors). For example, if you are planning to buy a new car, factors of importance to this problem may include fuel economy, engine power, new or used, model, spares availability, service intervals, warranty and cost. Many people subjectively and intuitively consider the various criteria when making a selection but when a large number of criteria or factors are present, a quantitative approach weights and each alternative is evaluated in terms of these criteria. Decision making is the selection of a course of action from a number of possible alternatives on the basis of various forms of evidence. And another means is the mental or intellectual process of forming an opinion or evaluation by discerning and comparing.

Multi-criteria decision making consists of two related paradigms (1) Multi-alternative Decision Making (MADM): these problems are assumed to have a predetermined, limited number of decisions alternatives. (2) Multi-objectives Decision Making (MODM): the decision alternatives are not given instead the decision alternatives is explicitly defined by constraints using multiple objective programming. The number of potential decision alternatives may be larger. All MCDM methods have some aspects in common. These are the notions of alternatives, and attributes (or criteria). Alternatives represent the different choices of action or entities available to the decision maker. Usually, the set of alternatives is assumed to be finite, ranging from several to hundreds. They are supposed to be prioritized and eventually ranked. And also each MCDM problem is associated with multiple attributes. Attributes are also referred to as “decision criteria” and are commonly understood as parameters or characteristics.

In this system, one of the MCDM methods, namely, Analytic Hierarchy Process (AHP) is used for decision making. AHP is logical approaches and is proved to be useful for modelling and analysing various types of decision making situations in numerous fields of science and technology.

2.8.1 Problem Solving Steps of MCDM

MCDM has eight steps to solve the problem. They are:

1. Establish the decision context, the decision objectives (goals), and identify the decision maker(s).
2. Developing alternative systems for attaining the goals (generating alternatives);
3. Identify the criteria (attributes) that are relevant to the decision problem.
4. For each of the criteria, assign scores to measure the performance of the alternatives against each of these and construct an evaluation matrix (often called an options matrix or a decision table).
5. Standardize the raw scores to generate a priority scores matrix or decision table.
6. Determine a weight for each criterion to reflect how important it is to the overall decision.
7. Use aggregation functions (also called decision rules) to compute an overall assessment measures for each decision alternative by combining the weights and priority scores.
8. Perform a sensitivity analysis to assess the robustness of the preference ranking to changes in the criteria scores and/or the assigned weights.

2.8.2 Problem Solving Techniques

Some problem solving techniques are:

- Weighted Sum Method (WSM)
- Weighted Product Method (WPM)
- Technique for Order Preference by Similarity to Ideal Solution (TOPSIS)
- Goal Programming
- Elimination Et Choice Translating Reality (ELECTRE)

- Preference Ranking Organization Method for Enrichment Evaluation (PROMETHEE)
- Simple Additive Weighting (SAW)

2.8.3 Multi-criteria Decision Analysis

Multi-criteria decision analysis (MCDA) and computer-based decision support systems (DSS) provide ways to systematically structure and analyse complex decision problems. The field of multi-criteria decision making is a full-grown branch of operations research, concerned with the mathematical and computational tools to support the subjective evaluation of a finite number of decision alternatives under a finite number of performance criteria. A decision is a choice out of a number of alternatives and the choice is made in such a way that the preferred alternative is the "best" among the possible candidates. Usually, there are several criteria to judge the alternatives and there is no alternative which outranks all the others under each of the performance criteria. Hence, the decision maker does not only judge the performance of the alternatives under each criterion. Multi-criteria Decision Making (MCDM) is a discipline aimed at supporting decision makers who are faced with making numerous and conflicting evaluations. MCDA aims at highlighting these conflicts and deriving a way to come to a compromise in a transparent process. In general, MCDA problems involve six components:

- A goal or a set of goals the decision maker wants to achieve,
- The decision maker or a group of decision makers involved in the decision making process with their preferences with respect to the evaluation criteria,
- A set of evaluation criteria,
- The set of decision alternatives,
- The set of uncontrollable variables or states of nature (decision environment),
- The set of outcomes or consequences associated with each alternative attribute pair.

MCDA techniques can be used to identify a single most preferred option, rank options, to list a limited number of options for subsequent detailed evaluation, or to distinguish acceptable from unacceptable possibilities. A criterion is a measurable quantity whose value reflects the degree to which a particular objective is achieved.

An objective is a statement about the desired state of the system under consideration. Objectives are related to, or derived from a set of criteria. MCDM problems require that choices be made among alternatives described by their criteria. The set of criteria is given explicitly and multi-criteria problems have a finite set of feasible alternatives. A weight can be defined as a value assigned to each criterion which indicates its importance relative to other criteria under consideration. This is the simplest method for evaluating the importance of weights which includes that every criterion under consideration is ranked in the order of decision maker’s preferences. Due to its simplicity, the method is very attractive.

CHAPTER 3

ANALYTICAL HIERARCHY PROCESS MODEL

The analytical hierarchy process (AHP) is a structured technique for dealing with complex decisions. The analytic hierarchy process is a powerful and flexible decision making process. The analytic hierarchy process assists the decision makers to find the one which is the best suit for their requirements. It is an approach which is suitable for dealing system related to make a choice from multiple alternatives and which provides a comparison of the considered options.

The AHP is based on the subdivision of the problem in a hierarchical form. Then, AHP synthesizes the results by reducing complex decisions to a series of simple comparisons and rankings and not only helps the analysts to arrive at the best decision, but also provides a clear rationale for the choices. One of the main advantages of AHP is very easy because it handles multiple criteria. The core of AHP is the pair-wise comparison with preference matrix. The comparisons are done by using a fundamental scale of judgments that represents, one of the element influences to another.

3.1 Analytical Hierarchy Process (AHP)

Analytical Hierarchy Process (AHP) was originally designed to solve complicated multi-criteria decision problem (Saaty, 1980), beside that AHP is appropriate whenever a target is obviously declared and a set of relevant criteria and alternatives are offered. AHP is a popular model to aggregate multiple criteria for decision making. In AHP, the problems are usually presented in a hierarchical structure and the management is guided throughout a subsequent series of pairwise comparisons to express the relative strength of the elements in the hierarchy.

In general, the hierarchy structure encompasses of three levels, where the top level represents the goal, and the lowest level has the study program under consideration. The intermediate level contains the criteria under which each study program is evaluated. The final score obtain for each study program across each criterion is calculated by multiplying the weight of each criterion with the weight of each study program [3]. Study program which has got the highest score is suggested as the best study program and decision maker may consider that one as the best decision choice.

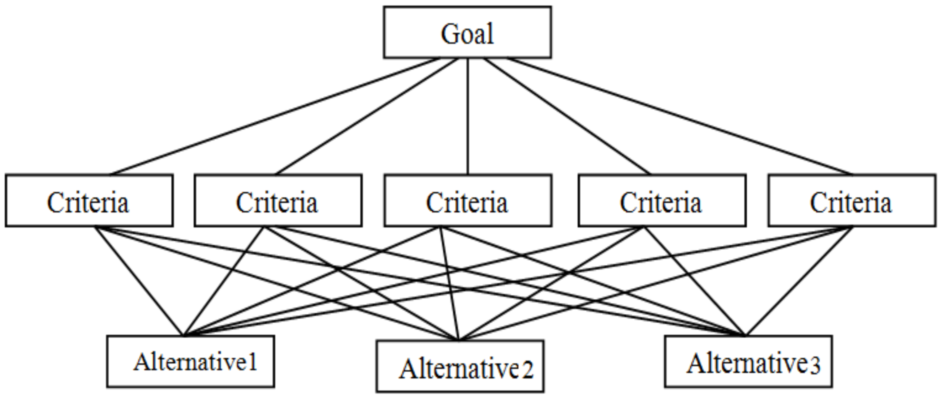

Figure 3.1 Hierarchical Structure

Four steps are used to solve a problem with the AHP methodology, shown in Figure (3.2).

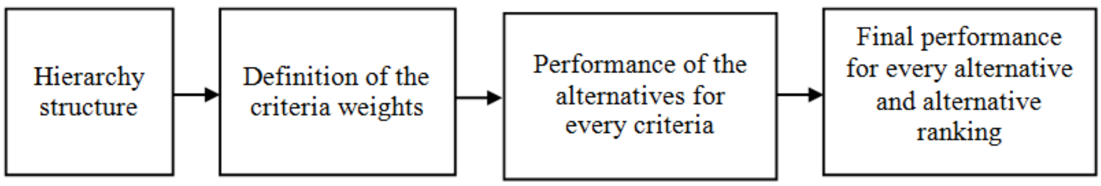

Figure 3.2 Analytical Hierarchy Process (AHP) Methodology

The first step includes the building of the problem into a hierarchical structure. The goal is at the top of the hierarchy; the next level affecting the decision of the criteria and finally, the alternatives are placed at the bottom of the hierarchy. The second step defines priorities between elements of the hierarchies by means of pairwise comparisons (i.e. comparing elements in pairs with respect to a given criterion). In the AHP approach, pairwise comparisons are used for establishing priorities or weights among elements of the same hierarchical level [10]. They are compared in pairs with respect to the corresponding elements in the next higher level, obtaining a matrix of pairwise comparisons. For representing the relative importance of one element over another, a suitable evaluation scale is introduced (Saaty 1988, 1992), called 'Saaty's scale'. It defines and explains the values 1 to 9 assigned to judgments in comparing pairs of elements in each level with respect to a criterion in the next higher level. When element 'i' compared with j is assigned one of the above numbers, then element j compared with 'i' is assigned its reciprocal. For each criterion C, an n-by-n matrix A of pairwise comparisons is constructed. The components a_{ij} (i, j = 1, 2, …,n) of the matrix A are numerical entries, which express (by means of Saaty's scale) the relative importance of the element 'i' over the element 'j' with respect to the corresponding element in the next higher level. Therefore, the matrix A has the form:

$$A \equiv \begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ a_{n1} & a_{n2} & \cdots & a_{nn} \end{bmatrix}$$

where:

$$a_{ii} = 1, a_{ji} = \frac{1}{a_{ij}} \; and \; a_{ij} \neq 0$$

The W_i reflects the importance of the i^{th} criterion and is estimated as the average of the entries in row 'i' of the A matrix normalized. Equation (3.1) and Equation (3.2) are used to check the consistency of the pairwise comparisons [21].

$$\lambda_{max} = \frac{1}{n}\sum_{i=1}^{n} \frac{i^{th} entry \; in \; AW^T}{i^{th} \; entry \; in \; W^T} \qquad (3.1)$$

Where λ_{max} is the maximum Eigen value

A is the pairwise comparison matrix and

W is the weight vector.

The Index for Consistency (CI) is defined as:

$$CI = \frac{(\lambda_{max}) - n}{n - 1} \qquad (3.2)$$

where λ_{max} is the maximum Eigen value from the previous equation.

n is the number of alternatives

The CI is then compared to the Random Index (RI) for the appropriate value of n as shown in Table 3.1.

The consistency ratio (CR) calculation is

$$CR = \frac{CI}{RI} \qquad (3.3)$$

Where CR is the consistency ratio, CI is the consistency index and RI is the random consistency ratio.

Serious inconsistencies may exist when CI/RI > 0.10. The degree of consistency is considered satisfactory when CI/RI < 0.10.

Table 3.1 Random Consistency Ratio

Size of Matrix	Random Consistency
1	0
2	0
3	0.58
4	0.9
5	1.12
6	1.24
7	1.32
8	1.41
9	1.45
10	1.49

The third step is finding the score of each alternative for each criterion. A matrix for pairwise comparison of each aim must be constructed. In the end, the best alternative (in the maximization case) is the one that has the greatest value in the following expression:

$$AHP_i = \sum_{j=1}^{n} \frac{a_{ij}}{\sum_{i=1}^{m} a_{ij}} \times w_j \qquad (3.4)$$

Where AHP_i is the score of the i^{th} alternative, m is the number of alternatives, n is the number of the criteria, a_{ij} represents the actual value of the i^{th} alternative in terms of the j^{th} criterion and w_j is the weight of importance of the j^{th} criterion.

When qualitative criteria such as environmental or political impacts, are considered, the AHP is particularly relevant. It is broadly used for energy planning problems because of its plainness and its ability to check consistency. Moreover, throughout this method, the hierarchy is revealed after the breakdown of the problem, which enables understanding and defining the process itself. It is also suitable for dealing with technological characteristics and future aspects that are not well-known. It should be noted that AHP can indirectly consider potential associations amongst many components, as it performs poorly when different levels are independent, which implies that the method is unsuccessful in representing the complicated connections among the components [20]. A few extensions of the AHP method have been proposed that are able to deal with these problems, such as the Analytic network process (ANP) method.

(i) Hierarchy Structure

The first step of AHP is building the hierarchy to a decision problem one structures the problem with a goal at the top and then criteria (and often sub criteria at several levels, for additional refinement) and alternatives of choice at the bottom. The criteria can be subjective or objective depending on the means of evaluating the contribution of the elements below them in the hierarchy. Criteria are mutually exclusive and their priority or importance does not depend on the elements below them in the hierarchy. The number of alternatives should be reasonably small because there would then be a problem with improving the consistency of the judgments.

When building hierarchies one must include enough relevant details to represent the problem as thoroughly as possible, but not so much as to include the whole universe in a small decision. One need to consider the environment surrounding the problem, identify the issues or attributes that one feels influence, contribute to the solution, and identify the participants associated with the problem [7]. Arranging the goals, attributes, issues, and stakeholders in a hierarchy serves three purposes:

- It provides an overall view of the complex relationships inherent in the situation.
- It captures the spread of influence from the more important and general criteria to the less important ones.
- It permits the decision maker to assess whether he or she is comparing issues of the same order of magnitude in weight or impact on the solution.

(ii) The Prioritization Procedure

In the next level, elements in each level are compared pairwise with respect to their importance to an element, starting at the top of the hierarchy and working down, a number of square matrices called preference matrices are created in the process of comparing elements at a given level. Judgments of preference are made on pairs of elements in the structure using as "the fundamental scale of AHP" which is reproduced in Table 3.2.

The fundamental scale used in AHP enables the decision maker to incorporate experience and knowledge in an intuitive and natural way. This scale is insensitive to small changes in a decision maker's preference, thereby minimizing the effect of uncertainty in evaluations [10]. AHP is an absolute scale in which people use numbers to express how much one element dominates another with respect to a common criterion. The scale derived from these absolute numbers is a ratio scale.

Table 3.2: Fundamental Scales for Pairwise Comparison

Numerical Scale	**Definition of Important**	**Explanation**
1	Equally important	Two activities contribute equally to the objective.
3	Moderately important	Experience and judgment slightly favour one activity over another.
5	Strongly important	Experience and judgment strongly favour one activity over another.
7	Very Strongly important	An activity is favoured very strongly over another; its dominance demonstrated in practice.
9	Extremely important	The evidence favouring one activity over another is of the highest possible order of affirmation.
1/3	Less important	An activity is slightly less favoured over another.
1/5	Lesser important	An activity is not much more favoured over another.
1/7	Very Lesser important	The evidence favouring one activity over another is far less important.
1/9	Least important	The evidence favouring one activity over another is extremely not important.

(iii) Synthesizing

When the preference matrices building, the process moves to the third step of deriving relative weights for the various elements. The relative weights of the elements of each level with respect to an element in the next higher level are computed as the components of the normalized eigenvector associated with the largest eigenvalue of their comparison matrix. The composite weights of the decision alternatives are then determined by aggregating the weights throughout the hierarchy. This is done by following a path from the top of the hierarchy to each alternative at the lowest level and multiplying the weights along each segment of the path. The outcome of this aggregation is a normalized vector of the overall weights of the options.

The ratings mode includes pairwise comparison of the criteria with respect to the goal. Then rating levels, such as excellent, very good, good, average, poor, and very poor, are specified for each criterion. Pairwise comparisons among the rating levels of each criterion are then conducted to yield a set of priorities (weights) for these levels. For each criterion, the rating level priorities are divided by the maximum rating weight of that criterion to yield scaled weights. Within each criterion, each alternative is assigned a rating level and the associated scaled weights. The final score of an alternative is the sum of the product of the criterion weights times the scaled weight with respect to that criterion, where the sum is taken across all the criteria [17].

(iv) Consistency and Inconsistency

A simple lack of concentration or pressing a wrong button can introduce inconsistency. The users are human and it is easy to make mistakes when the user enters several comparisons. When the users do not have enough information to make consistent comparisons, or the users are uncertain. In this case, the judgment is sometimes not as accurate as the user like**.** The users are human beings, the users are inconsistent. In AHP, the users make pairwise comparisons using a special scale which contains the values 1 to 9. This can even introduce inconsistency at some time. This can only have a marginal effect on the total consistency, especially if the number of comparisons is not very large. The main important point to resolve problems with consistency is avoiding more than nine elements to compare**.** It is easier to be consistent on smaller set of comparisons, and the mass of research into AHP suggests that the decision maker should try not to compare more than nine items using pairwise comparisons. Moreover, the decision maker does not let to compare elements which are extremely different in priority/weight. The nine is the maximum value on the scale and it should be enough. If the decision maker allows over using large scores, he may have problems with capped scale. There are some obvious contradictions that the decision maker might do. For example, if you say that A > B > C > A… well, there's a contradiction that needs to be sorted out [21].

AHP support the person who makes decision with a useful way of checking and improving consistency. A by-product of solving the eigenvalue problem to measure priorities to obtain the principal eigenvalue, λ_{max}, from which can be derived the consistency index (C.I) by using Equation (3.2). The consistency measure affects whether the decision maker understands and captures the interactions among different factors of the problem or his decision is a matter of random hitting the target. In real life, problem solving perfect consistency is hard to achieve. Consistency must be precisely one order of magnitude important than inconsistency, or simply 10% of the total concern with consistent measurement [14].

The AHP Method

The AHP method approaches the five steps.

Step 1: Pair-wise comparison of criteria

Step 2: Establish priority vector for criteria

(i) Sum the values in each column of the pair-wise comparison matrix.
(ii) Divide each element in the pair-wise comparison matrix by its column total.
(iii) Compute the average of the elements in each row of the normalized pair-wise comparison matrix; these averages provide the priorities for the criteria.

Step 3: Pair-wise comparison of alternatives

Step 4: Establish priority vector for alternatives

Step 5: Obtaining the overall ranking

This system uses the numerical values for preferences, in each of the comparison step. These preferences had been described in fundamental scales table. In pairwise comparisons, a ratio scale of 1,3,5,7 and 9 is used to compare any two elements. The reciprocal value is assigned to the inverse comparison; that is, $a_{ij}=1/a_{ji}$, where a_{ij} (a_{ji}) denotes the importance of the i^{th} (j^{th}) element.

AHP Algorithm

Begin

Step 1. Accept each weight value for criteria (n)

Step 2. Set priority matrix for Overall Criteria

2.1 settingMatrix (n)

2.2 normalizingMatrix (n)

2.3 calculatingPriorityVector (n)

Step 3. Set priority matrix for Each Criteria

3.1 settingMatrix (totalRecord)

3.2 normalizingMatrix (totalRecord)

3.3 calculatingPriorityVector (totalRecord)

Step 4. Set priority matrix for Overall Ranking

4.1 setRanking (n, totalRecord)

4.2 calculatePriorityVector (n, totalRecord)

Step 5. Find the Maximum Priority value and Maximum Ranking value

End

Procedure settingMatrix(n)

```
for(int i=0;  i<n(n-1)/2;  i++)
begin
for(int   j=0;  j<n(n-1)/2;  j++)
  begin
          if   (i==j)   then   aij=1
          else if   (i<j)   then    aij= related value
          else      aji=1/ aij
  end
end
for(int i=0;  i<record;  i++)
begin
```

```
for(int   j=0;  j<record;  j++)
  begin
           if   (i==j)   then   aij=1
           else if   (i<j)   then    aij= related value
           else      aji=1/ aij
  end
end
```

```
Procedure   normalizingMatrix(n)
for(int i=0;  i<record;  i++)
begin
for(int   j=0;  j<record;  j++)
  begin
           colsum[i]+=pwcMatrix[j,i]
  end
end
```

```
Procedure   calculatingPriorityVector (n)
for(int i=0;  i<record;  i++)
begin
for(int   j=0;  j<record;  j++)
 begin
           priority[i]+=pwcMatrix[i,j]
  end
priorityVector[i]=priorityVector[i]/record
end
```

```
Procedure   overallRanking(n)
for(int i=0;  i<n;  i++)
begin
for(int   j=0;  j<record;  j++)
  begin
        overAllRank[j,i]+=priorityVector[j];
  end
        overAllRank[j,i]/n;
end
```

3.2 Consistency Ratio Analysis

Consistency can check matrix for pairwise comparison to make sure the person who makes decision comparisons were consistent or not with the four steps. The first step is finding the weighted sum matrix which can be calculated by multiplying each column and their priority vectors in pair wise comparisons matrices of alternatives for each criteria. The second step is dividing all the element of the weighted sum matrices by their respective priority vector element, then compute the average of these values to obtain (λ_{max}) [21]. The third step finds the index for consistency CI is calculated by applying Equation (3.2).The last step is choosing the appropriate value of random consistency ratio, RI, for a matrix size using the Table 3.1.The calculation for consistency ratio is calculated by Equation (3.3).If the value of CR is less than 0.1, the judgments are acceptable. Otherwise, the judgments aren't acceptable. A value less than 0.1 (10%) is good, but the threshold of 0.1 is a rule of thumb. The lower values are better than higher values, but values above 0.1 can be acceptable. It depends on the nature of your project. When the user processes the inputs from a group (several participants), it happens that individual CRs are above 10%, but the consolidated matrix CR is also acceptable.

CHAPTER 4

DESIGN AND IMPLEMENTATION OF THE SYSTEM

4.1 Detailed Explanation of System Design

This system intended to implement the pre-wedding photo service by choosing user preference. The design of this system has been clearly defined. Therefore, the system design and the detail system explanation with sample data are presented in this section

4.1.1 Design of the System

This system supports two types of users such as user Figure 4.1 and administrator as shown in Figure 4.2. In this system, the administrator can manage the list of pre-wedding photo services such as inserting, updating and deleting the existing packages or studio, respectively. Firstly, the user must input their preferences to the system in order to choose the best packages. The satisfied results may be more than one package for taking the pre-wedding photo service. Many pre-wedding photo services lead for confusing the mind, such as, “That package is a nice”, “This package is also I like”, “These facts are also I consider to take the services”, and so on. These confusion leads to the times and energy consuming. In this situation, user needs to take suggestion from consultant. Therefore, this system is implemented to overcome from bewildering choices by applying AHP method. After giving the user’s preferences, this system can report the best packages as the decision result according to their AHP method.

The system makes the pair-wise comparison for each criterion by using the fundamental scales as shown in Table 3.2. “Can each factor be more important on other factor?" question is used on the eight criteria. The relative importance of each factor in accomplishing the overall goal compares all criteria with each other to determine. The importance of the factor on the left relative to the importance of the factor on the top fills the matrix with numerical values denoting. Example, Price is considered to be three times as important as number of make-up.

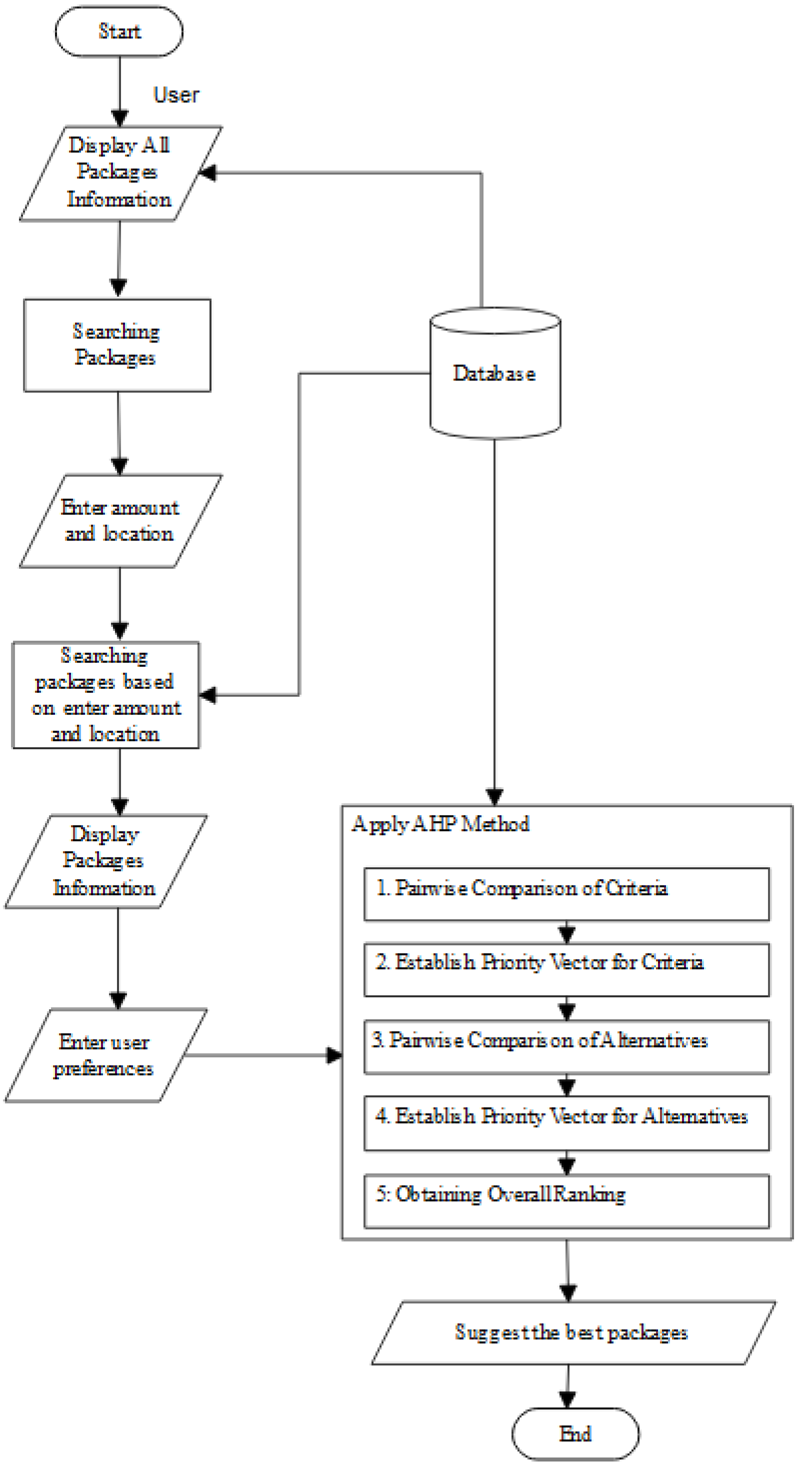

Figure 4.1 System Flow for the User

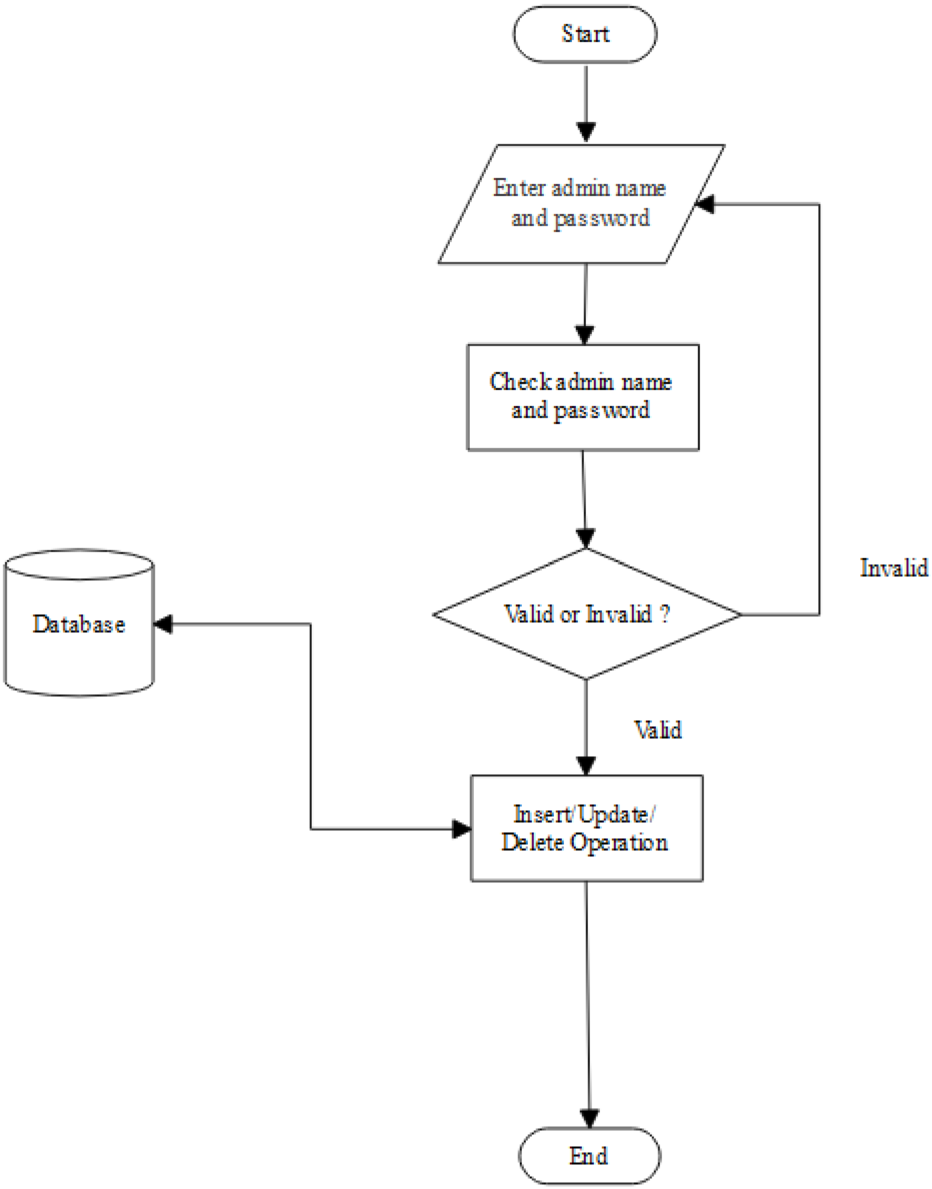

Figure 4.2 System Flow for the Administrator

4.1.2 Detailed Explanation of System with Sample Data

This system collects the various pre-wedding photo services packages from each agent and then store in database. Therefore, this system firstly requests the user for affordable amount and desired location in order to reduce the processing time. And then, AHP is applied to suggest the best service among the user desired services. This system uses a simple weighing approach to calculated comparisons of pair wise and vector of priority. After that the system proceeds to calculate the global values and makes the overall ranking on these global values to suggest the best under the user's consideration.

AHP method is using to build the hierarchy which states the overall goal, criteria and alternatives. The goal is to find out the best package. The second level consists of different factors (criteria) that contribute to the gaol. The factors (criteria) of the system are price, location, number of dress, dress type, makeup, number of photo, special frame, popular rate, respectively. The third level describes the alternatives which are to be valued in terms of the criteria in the level above. The system hierarchy as shown in Figure 4.3.

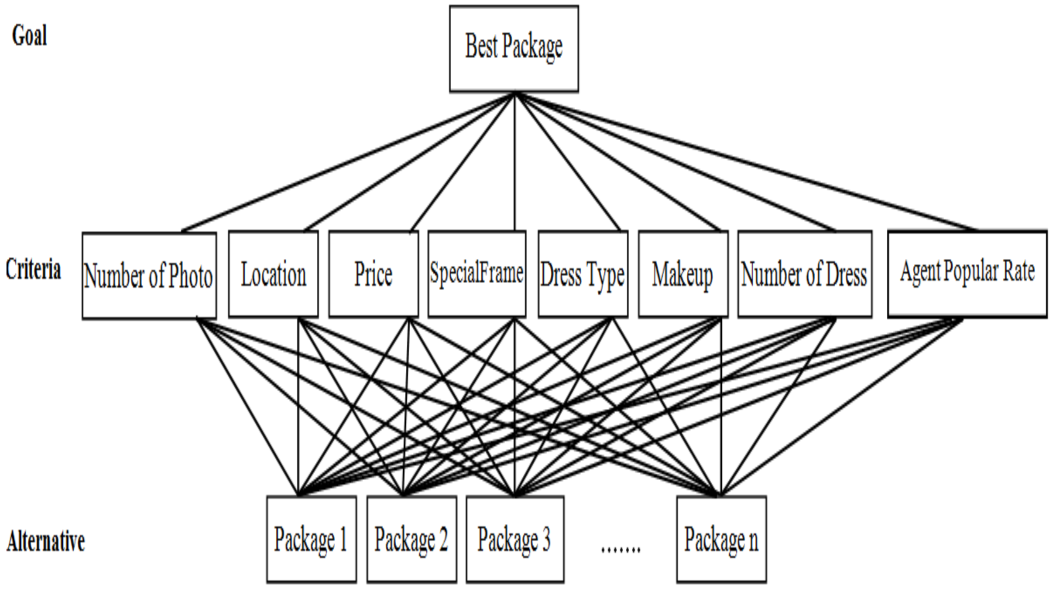

Figure 4.3 System Hierarchy

Step 1: Pairwise comparison of criteria

First step, the relative importance of each factor in the accomplishing the overall goal compares all criteria with each other to determine.

Table 4.1 Pairwise comparison matrix for Overall Criteria

###	Price	Location	NumofDress	DressType	Makeup	NumofPhoto	SpecialFrame	PopularRate
Price	1	5	7	3	9	7	9	1
Location	0.2	1	3	0.333	7	1	5	1
NumofDress	0.143	0.333	1	3	5	7	3	0.2
DressType	0.333	3.003	0.333	1	5	7	3	1
Makeup	0.111	0.143	0.2	0.2	1	5	0.2	0.111
NumofPhoto	0.143	1	0.143	0.143	0.2	1	0.333	0.333
SpecialFrame	0.111	0.2	0.333	0.333	5	3.003	1	0.143
PopularRate	1	1	5	1	9.009	3.003	6.993	1

Step 2: Establish priority vector for criteria

The system may sum values of column sum (each criteria) for the pair wise comparison matrix. And then, it divided by its column total with each element in the pair wise comparison matrix. Finally, it calculated the average of the elements in each row of the matrix that provides the priorities for the criteria. This is the priority vector calculation for each criterion.

Table 4.2 Priority Vector matrix for Overall Criteria

###	Price	Location	NumofDress	DressType	Makeup	NumofPhoto	SpecialFrame	PopularRate
Price	0.329	0.428	0.412	0.333	0.218	0.206	0.316	0.209
Location	0.066	0.086	0.176	0.037	0.17	0.029	0.175	0.209
NumofDress	0.047	0.029	0.059	0.333	0.121	0.206	0.105	0.042
DressType	0.11	0.257	0.02	0.111	0.121	0.206	0.105	0.209
Makeup	0.037	0.012	0.012	0.022	0.024	0.147	0.007	0.023
NumofPhoto	0.047	0.086	0.008	0.016	0.005	0.029	0.012	0.07
SpecialFrame	0.037	0.017	0.02	0.037	0.121	0.088	0.035	0.03
PopularRate	0.329	0.086	0.294	0.111	0.219	0.088	0.245	0.209
Priority Vector	0.306	0.118	0.118	0.142	0.036	0.034	0.048	0.198

Step 3: Pairwise comparison of alternatives

The system performs comparison process repeatedly for all of each criterion and each one consist of two matrixes. They are matrix for pairwise comparison and normalized matrix of pairwise comparison, respectively.

Table 4.3 Pairwise comparison matrix for Dress Type

###	Forever	Aroma	Dior
Forever	1	3	9
Aroma	0.333	1	0.111
Dior	0.111	9.009	1

Table 4.4 Normalized comparison matrix for Dress Type

###	Forever	Aroma	Dior
Forever	0.693	0.231	0.89
Aroma	0.231	0.077	0.011
Dior	0.077	0.693	0.099
Priority Vector	0.605	0.106	0.29

Table 4.5 Pairwise comparison matrix for Makeup

###	Forever	Aroma	Dior
Forever	1	7	0.2
Aroma	0.143	1	3
Dior	5	0.333	1

Table 4.6 Normalized comparison matrix for Makeup

###	Forever	Aroma	Dior
Forever	0.163	0.84	0.048
Aroma	0.023	0.12	0.714
Dior	0.814	0.04	0.238
Priority Vector	0.35	0.286	0.364

Step4: Establish priority vector for all alternatives

Table 4.7 Priority Vector for all Alternatives

	Price	Location	Number of Dress	Dress Type	Makeup	Number of Photo	Special Frame	Popular Rate
Forever	0.333	0.333	0.134	0.333	0.134	0.333	0.187	0.771
Aroma	0.333	0.333	0.746	0.333	0.120	0.333	0.158	0.105
Dior	0.333	0.333	0.120	0.333	2.237	0.333	0.655	0.124

Step 5: Obtaining the overall ranking

By mathematically combining the alternative priority matrix and criteria priority vector from step 1 to step 4, the final step is to obtain the overall ranking of the alternatives. The higher the value, the most suitable of the packages is for user. The final result as shown in following Table 4.8. According to the calculation result, this system can give some advices to user for taking a service.

Table 4.8 Priority and Rank for each services

Overall Priority Packages Ranking	
Aroma	0.04796425
Forever	0.04345475
Dior	0.03359450

The last step in this system is calculating the consistency of pairwise comparison matrix to make sure decision-makers comparisons were consistent or not. The decision is acceptable when the value of CR is less than 0.1.

The time complexities of the system with containing consistency checking and without consistency checking are also compared, in Figure 4.4.

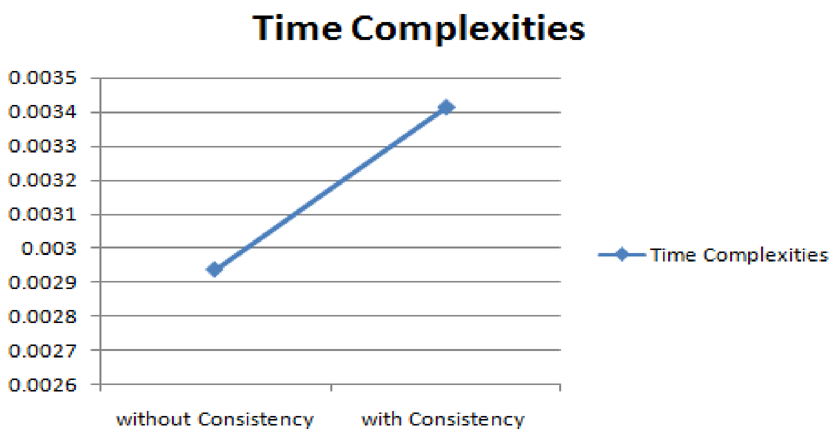

Figure 4.4 Time Complexities of the System

This system implementation is intended to give a valuable suggestion for user to choose pre-wedding photo service which matches with the desire of the user. In this system, data are collected from various agencies from Myanmar. The major aim of AHP is to support the person who has faced with numerous conflicting evaluations.

4.2 Dataset Description

This system is designed to give the best suggestion for the user who wants to take the memorable pre-wedding photo services. In this system, various pre-wedding photo services are collected and stored as the records in database. The "Packages" table is created to store the various pre-wedding photo services information. In this "Packages" table, ten related attributes are composed to represent for each of the pre-wedding photo services information. Figure 4.5 shows the table definition of the "Packages" table concerning with each column name and its related data type.

dbo.Packages: Ta...RVICEPACKAGE.MDF)

Column Name	Data Type	Allow Nulls
PackageNum	nvarchar(50)	☐
Agent	nvarchar(100)	☐
Price	real	☐
Location	nvarchar(50)	☐
NumofDress	int	☐
DressType	nvarchar(50)	☐
Makeup	int	☐
NumofPhoto	int	☐
SpecialFrame	int	☐
PopularRateofAgent	int	☐
		☐

Figure 4.5 Design View of the Package Table

There are two hundred lists of different packages currently collected as data. These data has been stored in the "Package" table of the database as shown in Figure 4.6.

Packages: Query(...RVICEPACKAGE.MDF)

PackageNum	Agent	Price	Location	NumofDress	DressType	Makeup	NumofPhoto	SpecialFrame	PopularRateof...
P001	Forever	250000	Indoor	2	All	1	10	1	4
P002	Forever	350000	Indoor	4	All	2	20	2	4
P003	Aroma	250000	Indoor	3	All	1	10	1	3
P004	Dior	250000	Indoor	2	All	2	10	2	3
P005	Yes I Do	400000	Indoor	3	All	2	30	1	4
P006	Dior	350000	Indoor	2	All	2	10	2	3
P007	Aroma	400000	Indoor	4	All	2	10	4	3
P008	Forever	550000	Outdoor	4	All	2	20	4	4
P009	Forever	400000	Outdoor	3	Traditional	2	40	0	0
P010	Forever	300000	Indoor	6	Bridial	2	40	0	0
P011	Forever	390000	Indoor	3	Bridial	2	30	6	5
P013	Forever	300000	Indoor	1	All	3	20	6	5
P015	Dior	400000	Indoor	3	Evening Grown	2	40	5	3
P016	Dior	350000	Indoor	2	Evening Grown	5	40	6	3
P017	Peter The Bridal...	750000	Outdoor	3	All	3	40	4	2
P018	My Dream Wed...	250000	Indoor	3	Evening Grown	3	20	2	2
P019	Mirror Bridal Se...	250000	Indoor	1	Bridal	1	10	2	1
P020	Mirror Bridal Se...	350000	Indoor	2	Bridal	2	20	2	1
P021	Mirror Bridal Se...	450000	Indoor	3	Bridal	3	30	3	1
P022	My Dream Wed...	450000	Indoor	3	All	2	30	2	2
P023	My Dream Wed...	350000	Indoor	2	All	2	20	1	2
P024	Kaung Myat Oo...	820000	Outdoor	3	All	3	200	1	1
P025	Romanza	350000	Indoor	3	All	3	40	2	1

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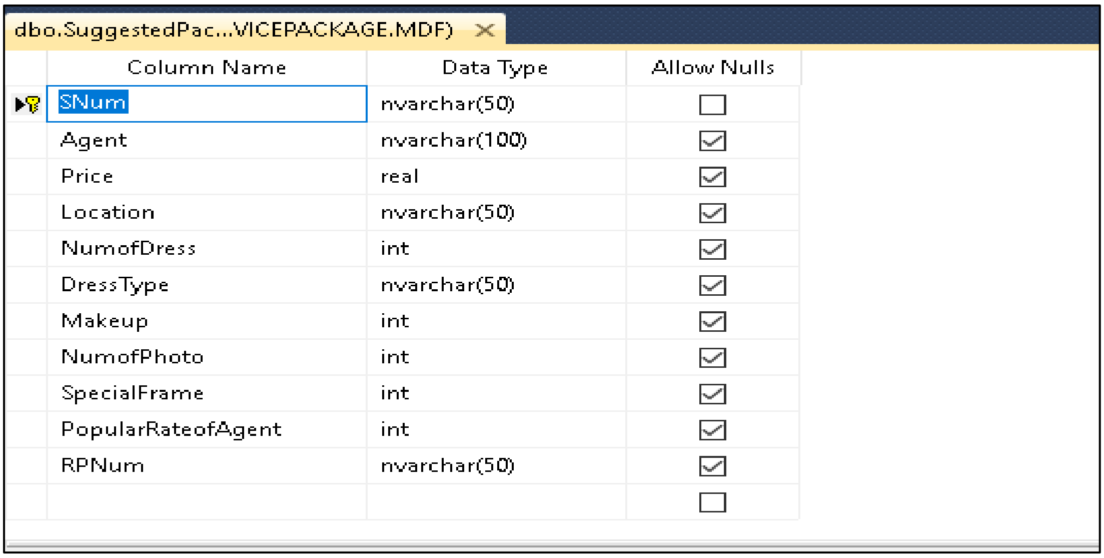
Figure 4.6 Data sheet View of the "Package" Table

The "Suggested Package" table contains eight attributes to represent for each result of pre-wedding photo service information which is queried by user. Figure 4.7 shows the table definition of the "Suggested Package" table concerning with each column name and its related data type.



dbo.SuggestedPac...VICEPACKAGE.MDF)

Column Name	Data Type	Allow Nulls
SNum	nvarchar(50)	☐
Agent	nvarchar(100)	☑
Price	real	☑
Location	nvarchar(50)	☑
NumofDress	int	☑
DressType	nvarchar(50)	☑
Makeup	int	☑
NumofPhoto	int	☑
SpecialFrame	int	☑
PopularRateofAgent	int	☑
RPNum	nvarchar(50)	☑
		☐

Figure 4.7 Design View of the "Suggested Package" Table

4.2 Implementation

The system has intended to implement the decision support system for choosing pre-wedding photo service by using AHP method. This system is applied to support the valuable suggestion based on the user preferences. The AHP method makes the comparison based on the customer's rating. By using this system, user can search many pre-wedding photo services and can choose the preference services easily. This system is implemented by using C# programming language and SQL server 2010. The main objective of this system is to advice the user who can easily decide and choose the nice services during his short period of valuable times. In this system, there are over three hundred different pre-wedding photo services from various agents. Only the authorized user can manage those data from database. Therefore, this system is divided the user level as two types. They are administrator and end user, respectively.

(i) System Administrator

In order to manage this system, the system administrator can enter the system by typing the admin user name and password in the login page. Following Figure 4.8 shows the login page of the system.

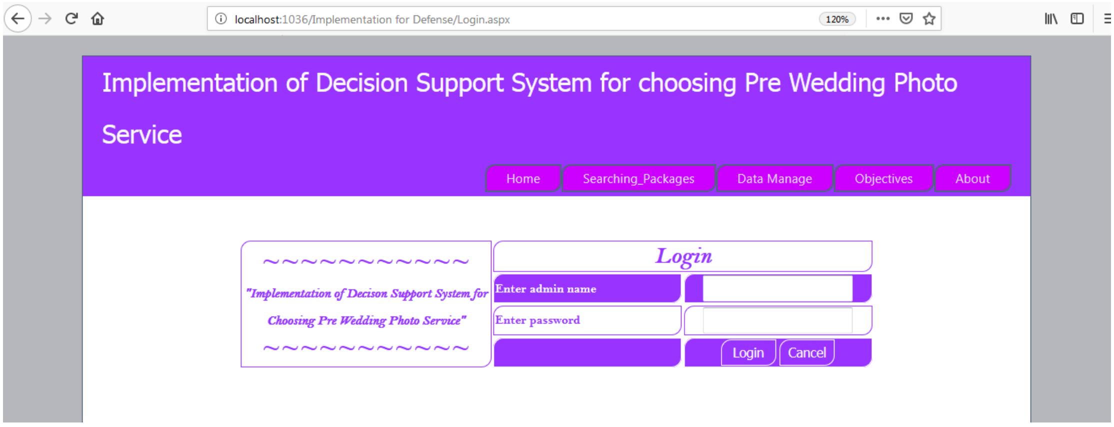
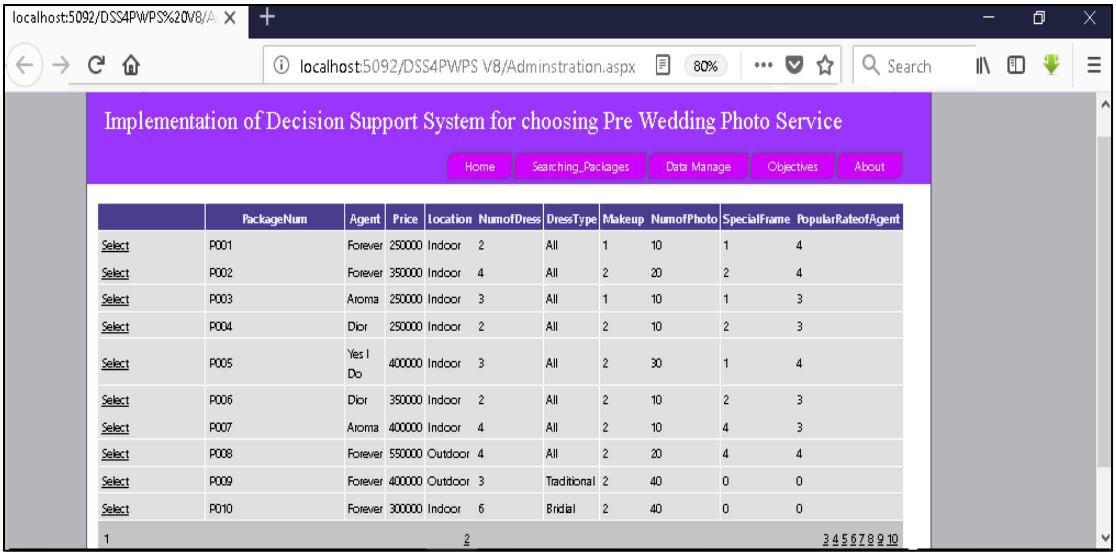


Figure 4.8 Login Page of the System

After successfully passing the “Login” page, the administrator can be viewed the package information as shown in Figure 4.9. The various pre-wedding photo services information is displayed in that page.



	PackageNum	Agent	Price	Location	NumofDress	DressType	Makeup	NumofPhoto	SpecialFrame	PopularRateofAgent
Select	P001	Forever	250000	Indoor	2	All	1	10	1	4
Select	P002	Forever	350000	Indoor	4	All	2	20	2	4
Select	P003	Aroma	250000	Indoor	3	All	1	10	1	3
Select	P004	Dior	250000	Indoor	2	All	2	10	2	3
Select	P005	Yes I Do	400000	Indoor	3	All	2	30	1	4
Select	P006	Dior	350000	Indoor	2	All	2	10	2	3
Select	P007	Aroma	400000	Indoor	4	All	2	10	4	3
Select	P008	Forever	550000	Outdoor	4	All	2	20	4	4
Select	P009	Forever	400000	Outdoor	3	Traditional	2	40	0	0
Select	P010	Forever	300000	Indoor	6	Bridal	2	40	0	0
1				2						3 4 5 6 7 8 9 10

Figure 4.9 Information of the Pre-wedding Photo Services

The administrator can handle the “Packages” table by adding new pre-wedding photo services information, updating pre-wedding photo services information, and removing a pre-wedding photo services which is expired via in that “Administration” page as shown in Figure 4.10. In this system, the new pre-wedding photo services identification number can automatically be added in “Package Number” textbox when adding new pre-wedding photo services information. This point leads the system to avoid duplicated package number of pre-wedding photo services.

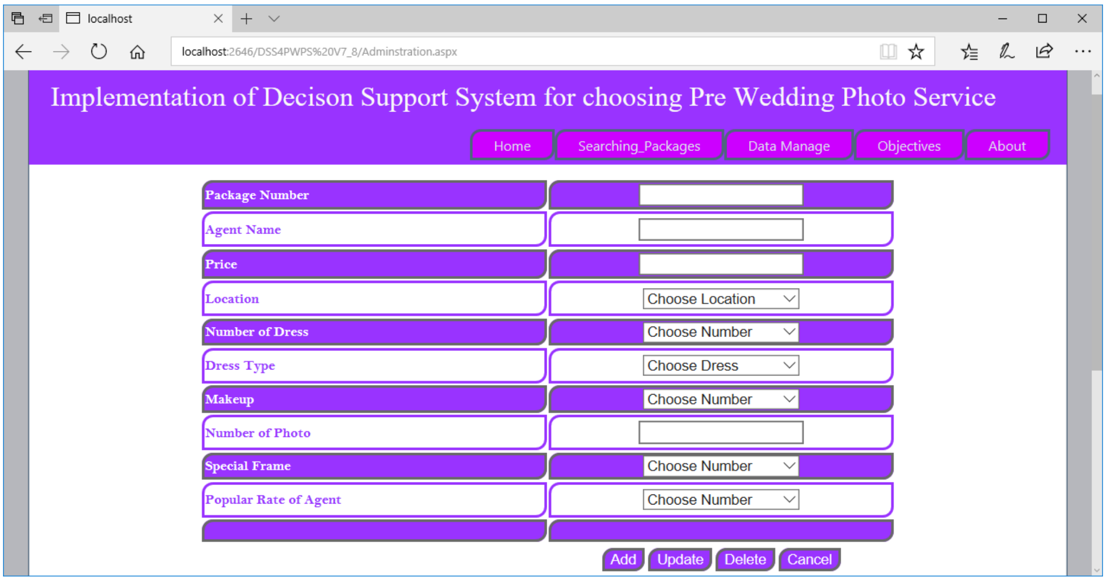


Figure 4.10 Administration Page of the Pre-wedding Photo Services Information

(ii) End User

Firstly, the users need to enter amount and desired location to take the pre-wedding photo services because each customer would like to choose his or her effort cost and type of location (such as indoor services or outdoor services).This system may advise the user to choose the most reasonable pre-wedding photo service that is compatible with user satisfaction by applying AHP method. The users need to enter data which is shown in as shown in Figure 4.11. The end user must input two main points because every customer would like to check the cost of services depending upon the affordable amount and preferred location to get suggestion.

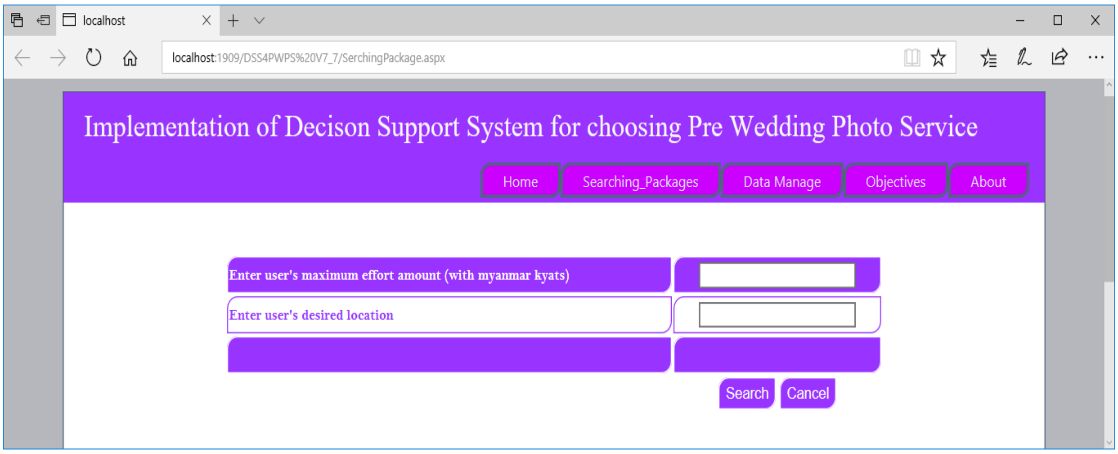
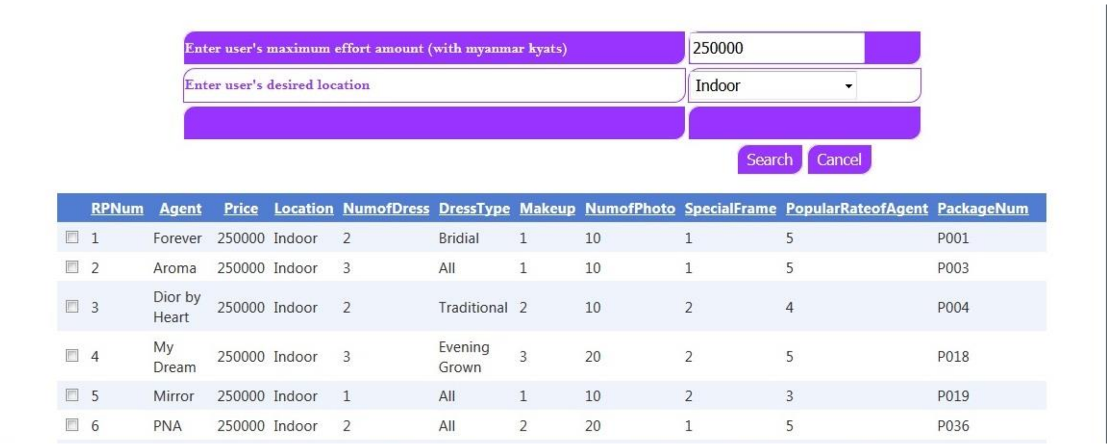


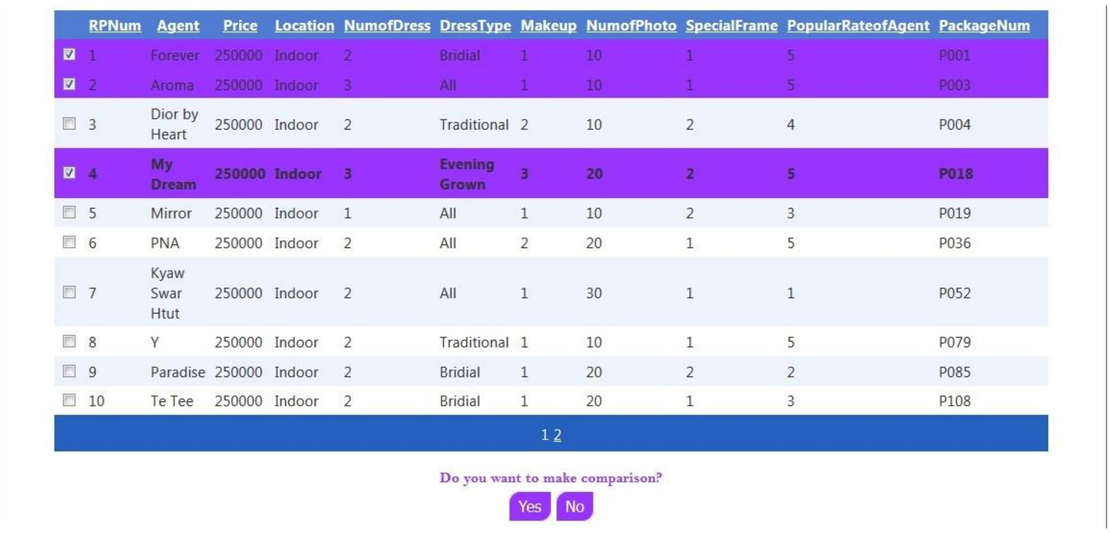
Figure 4.11 Searching Packages Page of the System

In Figure 4.12, the system retrieves the all possible packages that satisfied by the desired of the current user when the user inputs his preferences on amount and location criteria.



	RPNum	Agent	Price	Location	NumofDress	DressType	Makeup	NumofPhoto	SpecialFrame	PopularRateofAgent	PackageNum
☐	1	Forever	250000	Indoor	2	Bridial	1	10	1	5	P001
☐	2	Aroma	250000	Indoor	3	All	1	10	1	5	P003
☐	3	Dior by Heart	250000	Indoor	2	Traditional	2	10	2	4	P004
☐	4	My Dream	250000	Indoor	3	Evening Grown	3	20	2	5	P018
☐	5	Mirror	250000	Indoor	1	All	1	10	2	3	P019
☐	6	PNA	250000	Indoor	2	All	2	20	1	5	P036

Figure 4.12 Result Packages according to the User Preferences



	RPNum	Agent	Price	Location	NumofDress	DressType	Makeup	NumofPhoto	SpecialFrame	PopularRateofAgent	PackageNum
☑	1	Forever	250000	Indoor	2	Bridial	1	10	1	5	P001
☑	2	Aroma	250000	Indoor	3	All	1	10	1	5	P003
☐	3	Dior by Heart	250000	Indoor	2	Traditional	2	10	2	4	P004
☑	4	My Dream	250000	Indoor	3	Evening Grown	3	20	2	5	P018
☐	5	Mirror	250000	Indoor	1	All	1	10	2	3	P019
☐	6	PNA	250000	Indoor	2	All	2	20	1	5	P036
☐	7	Kyaw Swar Htut	250000	Indoor	2	All	1	30	1	1	P052
☐	8	Y	250000	Indoor	2	Traditional	1	10	1	5	P079
☐	9	Paradise	250000	Indoor	2	Bridial	1	20	2	2	P085
☐	10	Te Tee	250000	Indoor	2	Bridial	1	20	1	3	P108

Figure 4.13 User Select Packages

In this system, the user needs to select the packages to compare which alternatives and criteria they preferred in Figure 4.13. The user must select at least two packages to compare which one is the best for them. The user can select at most eight packages. This system request the detail user preference for each criterion when user clicks the ‘Yes’ button as shown in Figure 4.14(a).

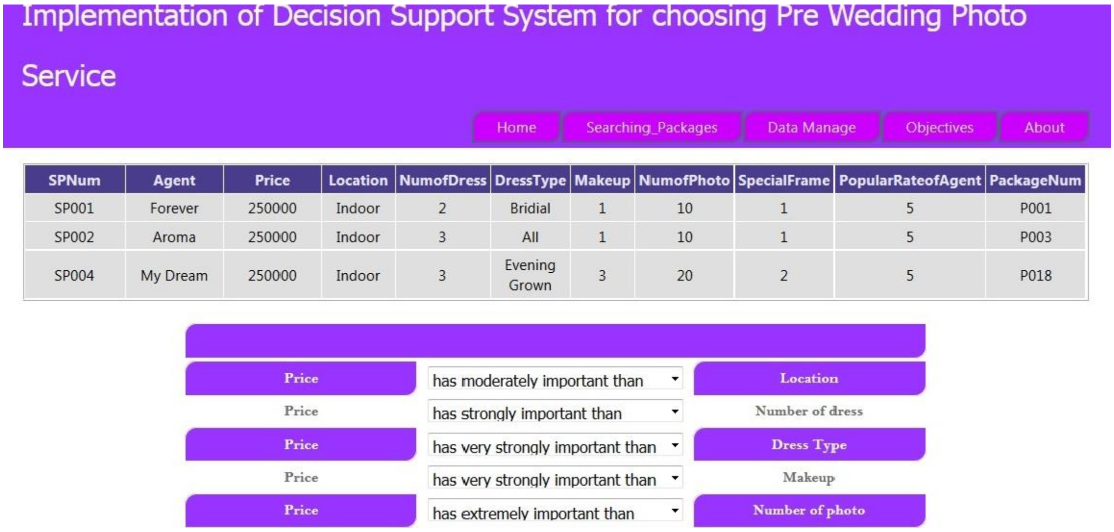


Figure 4.14 (a) Choosing the User Preference on Criteria

Detail priority level on the price, location, number of dress, dress type, makeup, number of photos, special frame and popular rate constraints in Figure 4.14 (b) and Figure 4.14 (c).

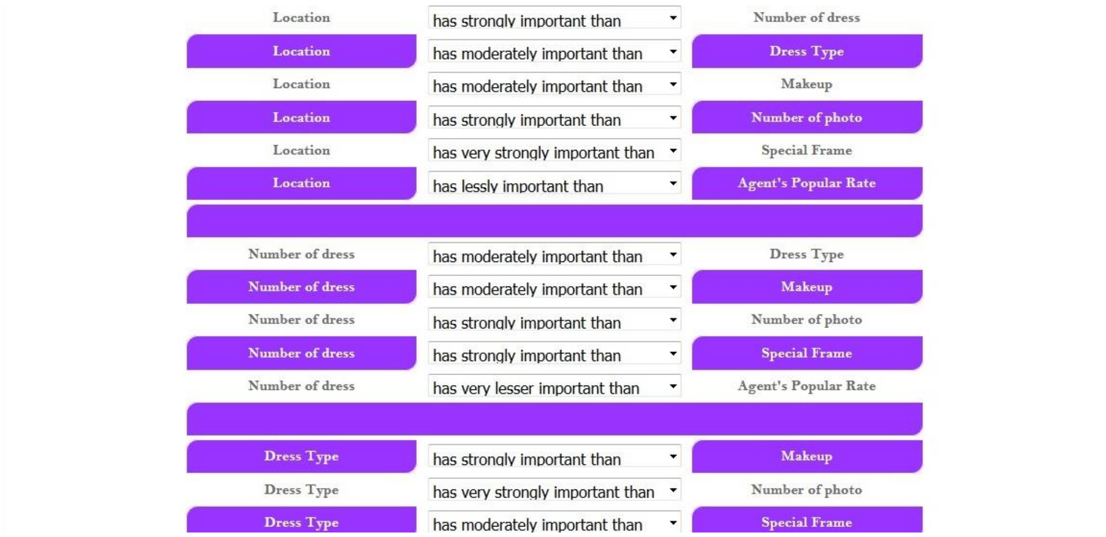


Figure 4.14 (b) Choosing the User Preference on Criteria

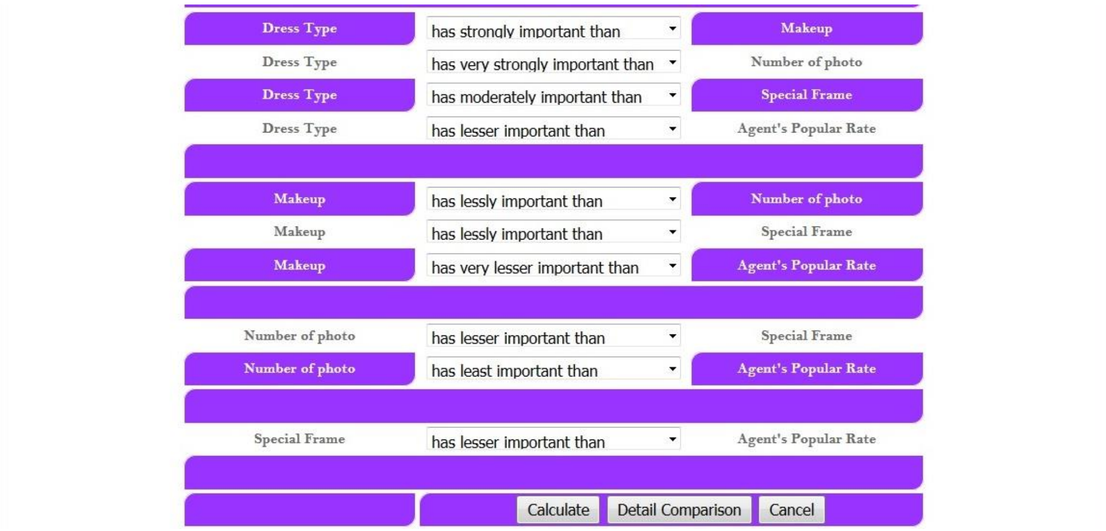


Figure 4.14 (c) Choosing the User Preference on Criteria

When user clicks the 'Calculation' button, this system calculates the result of user preference value as priority vector for overall criteria. Moreover, there are eight criteria in this system. They are price, location, number of dress, dress type, makeup, the number of photo, special frame and agent's popular rate criteria, respectively. Therefore, this system request and calculate the result of each other criteria as shown in each related Figures, respectively.

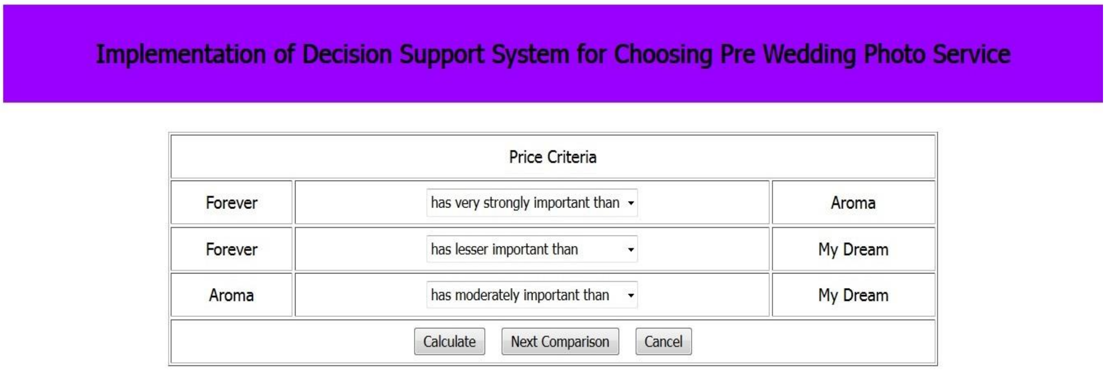


Figure 4.15 Choosing the User Preference on Price Criteria

In this step, user must choose preference on each alternative for price criteria, and click 'Calculate' button in Figure 4.15. Result of the priority vector on price criteria as shown in Figure 4.16.

###	Forever	Aroma	My Dream
Forever	1	7	0.2
Aroma	0.143	1	3
My Dream	5	0.333	1

###	Forever	Aroma	My Dream
Forever	0.163	0.84	0.048
Aroma	0.023	0.12	0.714
My Dream	0.814	0.04	0.238
Priority Vector	0.35	0.286	0.364

Figure 4.16 Result of the User Preference on Price Criteria

In the second step, user needs to compare on each alternative for location criteria, and click ‘Calculate’ button in Figure 4.17. Result of the priority vector on location criteria as shown in Figure 4.18.

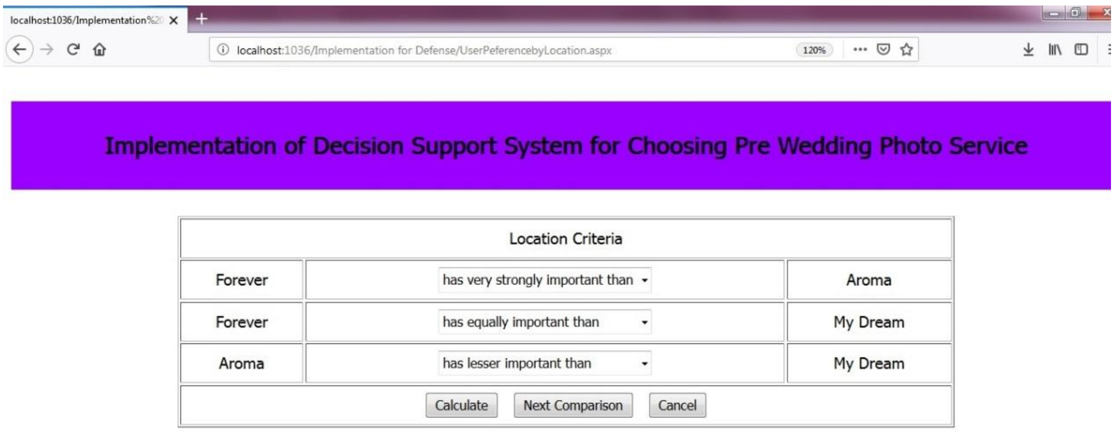


Figure 4.17 Choosing the User Preference on Location Criteria

###	Forever	Dior by Heart	My Dream
Forever	1	7	1
Dior by Heart	0.143	1	0.2
My Dream	1	5	1

###	Forever	Dior by Heart	My Dream
Forever	0.467	0.538	0.455
Dior by Heart	0.067	0.077	0.091
My Dream	0.467	0.385	0.455
Priority Vector	0.487	0.078	0.436

Figure 4.18 Result of the User Preference on Location Criteria

The next step, user sets the preference for number of dresses Figure 4.19 and calculates for the result of the priority vector for number of dresses criteria.

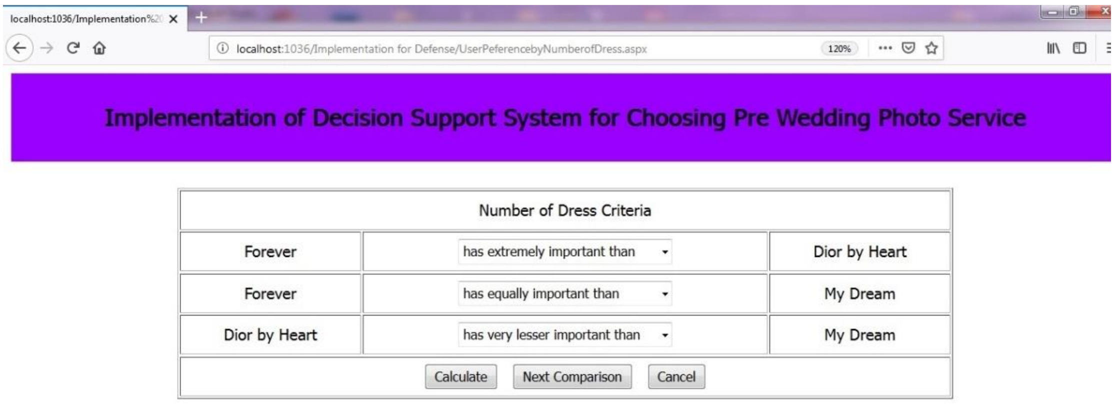


Figure 4.19 Choosing the User Preference on Dress Criteria

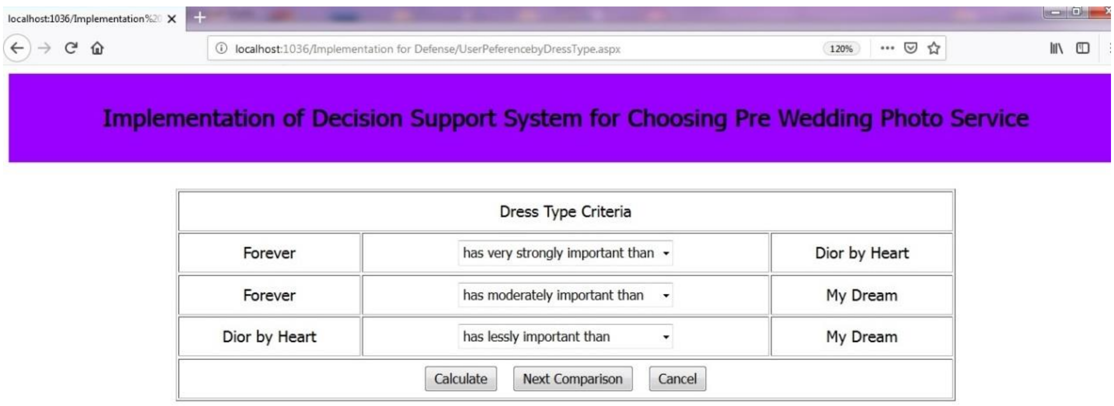


Figure 4.20 Choosing the User Preference on Dress Type Criteria

After comparing the number of dresses criteria, user needs to compare the dress type criteria for each alternative Figure 4.20. And also calculate the priority vector for the dress type criteria, respectively.

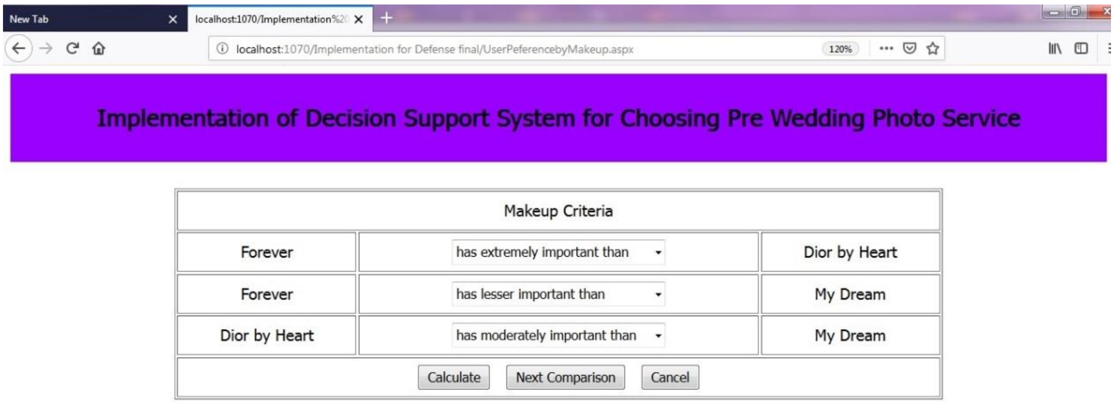


Figure 4.21 Choosing the User Preference on Makeup Criteria

In this stage, the user preference on makeup criteria must choose and click calculation button for the priority vector Figure 4.21. And then user must continuously choose the other remaining criteria such as number of photo, special frame and popular rate, respectively.

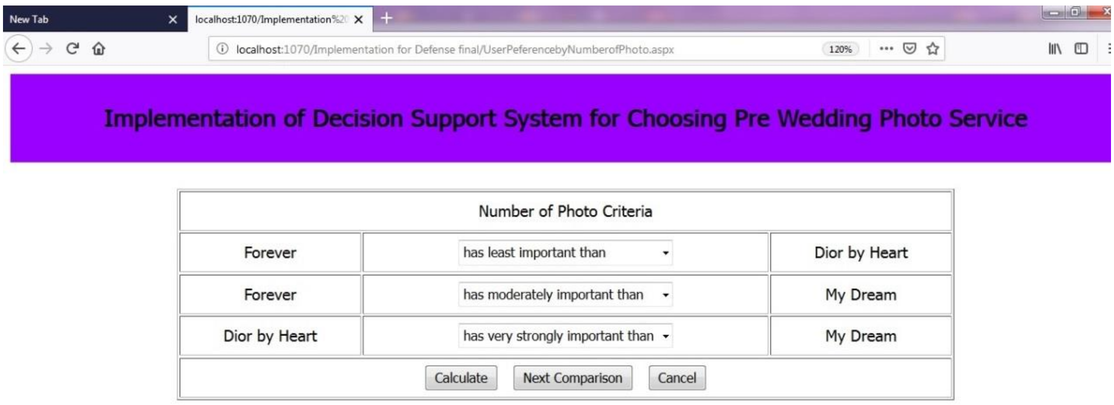


Figure 4.22Choosing the User Preference on Number of Photo Criteria

The system may also calculate the priority vector for all alternatives by clicking the calculate button. The last stage calculates the overall priority vector and ranking the packages.

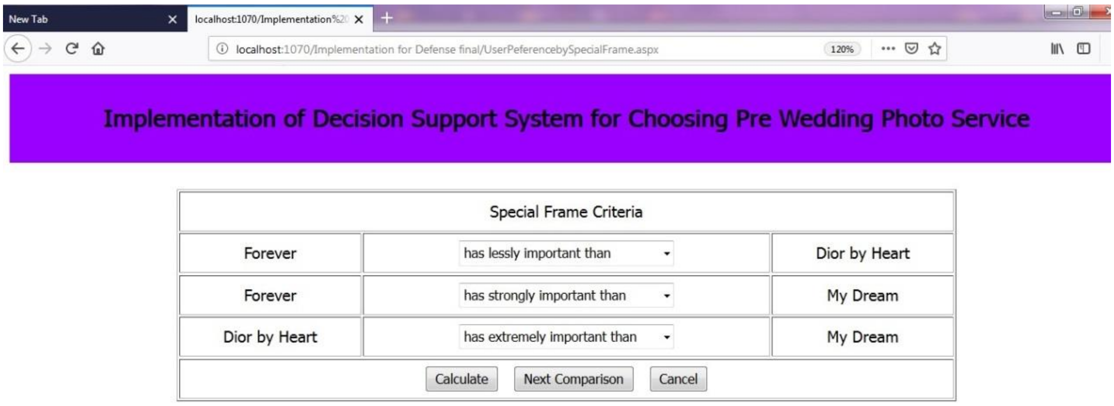


Figure 4.23 Choosing the User Preference on Special Frame Criteria

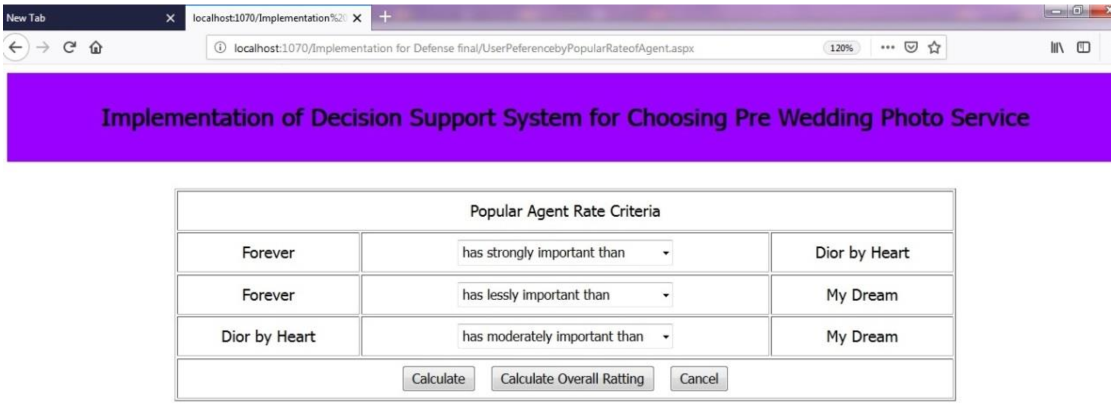
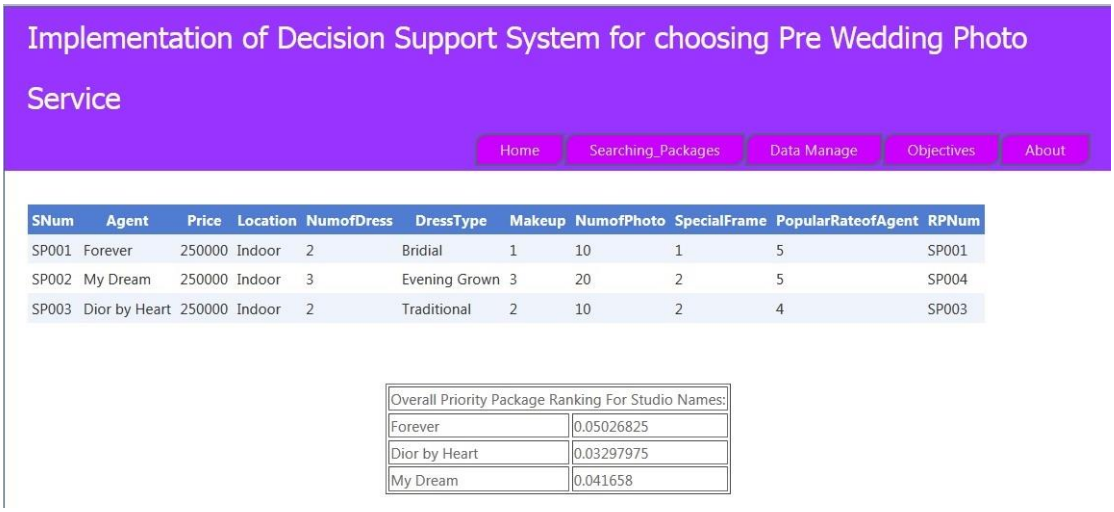


Figure 4.24 Choosing the User Preference on Agent's Popular Rate Criteria

. The last stage calculates the overall priority vector and ranking the packages. And also show that the consistency result based on user's preferences on each criteria. In Figure 4.25 and Figure 4.26, the final information shows to determine whether the decision makers have been consistent in their choices.

Figure 4.25 Overall Priority Ranking



Consistency Checking for Overall Criteria			
L_Max = 3.1	CI = 0.05	RI = 0.58	CR = 0.0862
Overall Criteria is consistent			

Figure 4.26 Result of Consistency checking

The system advice the most suitable package information based on the user criteria. Moreover, the end user can be viewed about the developer information of the system by clicking the link button via the navigation bar. The developer information page is shown in Figure 4.27.

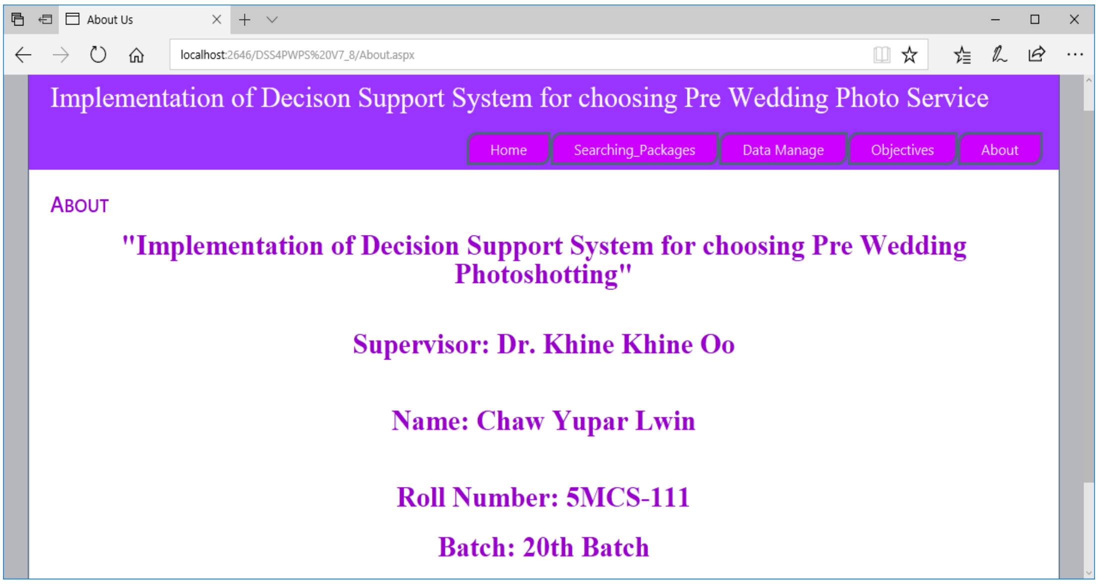


Figure 4.27 The "About" Page of the System

CHAPTER 5

CONCLUSION

Nowadays, a large number of applications used the AHP method to provide some structure on a decision making process. The user can see the easy way to use the powerful technique of AHP, which is used to monitor building quality. Furthermore, the user can use the technique in other areas. This is used for competitive analysis to assess the overall quality of the system relative to major competing system. As the software developed environment continues to measure, techniques like the analytic hierarchy process can increasingly become important components of user's software engineering skill set. AHP provides an artificial of the work and of the decision. AHP is powerful, mathematically elegant and effective way to help making decisions based on the customer criteria. The efficiency of AHP allows the user to meet their goal in a timely manner without making hard decisions and difficult discussion.

The AHP method is widely used for getting a qualitative decision based on users (his/her) preferences. This method is easy to understand and the simplest way for solving the complex decision. The system presents the decision making system for choosing pre-wedding photo packages using AHP. The system has intended to implement the decision support system by using AHP and provides the most suitable packages within a short time. By using this system, user can find various pre wedding packages and can choose the preference packages easily. Moreover, it can save the time and cost to choose the best packages because of giving suggestion with the list of priority.

5.1 Advantages of the System

The AHP method is applied in this system for finding the best pre-wedding photo services according to the user requirements. Therefore, this system leads to make easy decision making by the user without consulting from any agency. This system helps the couple for choosing their sweet memorable pre-wedding photo service during a short period of time without costing any fee. This system also guides the end user who can easily decide and choose the pleasant packages among various pre-wedding photo services packages that are also stratified with their criteria.

5.2 Limitation of the System

Some limitations are described in this section. This system is intended for the user who wants to take pre-wedding photo services. This system cannot advise to any other photo services such as convocation, birthday event, and any other ceremony and events, respectively. These are the limitation of this system from application point of view. Moreover, AHP method uses matrix in the calculation of pairwise comparison. If there are too many criteria and alternatives, the size of the matrix can be grown and the performance of the system can be degraded.

5.3 Further Extension

In this section, some extensions can propose for this system to improve the capabilities and efficiency. The importance of mobile phones in our everyday life and activities is undeniably unending. Therefore, this system could also be implemented using android or iOS version for mobile application version. This system is considered upon the eight criteria and at most eight alternatives. For further extension, eight criteria should be changed which are more preferable for the pre-wedding packages, and sub-criteria can be considered, and more than eight alternatives should be considered. As next further extension, this system can develop to allow criteria and alternatives by dynamically. The AHP method can also be applied in other decision support system such as convocation event, launching a new product ceremony event, etc.

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