SUPPLIER SELECTION DECISION SUPPORT SYSTEM (DSS)

(COMPUTER SELECTION)

By

Siti Hajar Binti Minhad

Dissertation submitted in partial fulfillment of
the requirement for the
Bachelor of Technology (Hons)
(Business Information System)

JULY 2009

Universiti Teknologi PETRONAS
Bandar Seri Iskandar
31750 Tronoh
Perak Darul Ridzuan

CERTIFICATION OF APPROVAL

Supplier Selection Decision Support System (DSS)

(Computer Selection)

by

Siti Hajar Binti Minhad

A project dissertation submitted to the
Business Information System Programme
Universiti Teknologi PETRONAS
in partial fulfillment of the requirement for the
BACHELOR OF TECHNOLOGY (Hons)
(BUSINESS INFORMATION SYSTEM)

Approved by,

(DR P.D.D DOMINIC)

Dr. P.D.D. Dominic
Senior Lecturer
Department of Computer & Information Sciences
Universiti Teknologi PETRONAS
Bandar Seri Iskandar, 31750 Tronoh,
Perak Darul Ridzuan, MALAYSIA.

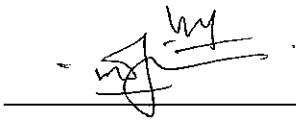
UNIVERSITI TEKNOLOGI PETRONAS

TRONOH, PERAK

July 2009

CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgements, and that the original work contained herein have not been undertaken or done by unspecified sources or persons.



SITI HAJAR BINTI MINHAD

ABSTRACT

Decision making process is a huge and crucial activity that must be given high attention by decision makers and managers as it affects all business strategies in organizations. Computer Based Decision Support System (DSS) is built and developed to assist decision makers in the activity of decision making process. DSS includes different components that integrate together out of which the most important part is the model based system.

As a result of rapidly increasing and sustainable needs of organizations, suppliers have become essential to any business. On the other hand, decision makers and managers face challengers when they are about to select suppliers due to the strong competitiveness among suppliers, obstacles that they will face when poor decisions are made and many other reasons. Evaluating and selecting suppliers has been considered as the most critical and important process among the whole purchasing processes.

This research intends to develop a system using linear weightage model base DSS for supplier selection process that can guarantee better decision making and provide a robust tool for assisting decision makers and managers to make the right decision and select the most suitable supplier. The proposed model has been validated using a real life case study to assess its effectiveness.

ACKNOWLEDGMENT

After completing this research and system of supplier decision support system in computer selection, I would like to express my sincere gratitude to my supervisor Dr. P.D.D. Dominic for his advise, guidance, and revisions in improving my research and system.

I would also like to thank to Miss Shakirah Binti M Taib for her comments, supports and helping in programming part and suggest the best algorithm to use during developing of this project.

Huge thanks also to my sisters and my lovely brothers for their endless love, even when the distance kept us away and less communication. Special thanks extended to my friends for their consistent support, help and encouragement.

This project is quite tough for me as it has many calculations and I have to consider many things such as user friendliness, error checking, and take into consideration several processes especially the processes involved in the main part of this project. The process will be more difficult if I failed to run the system in the middle part of the processes. I found that the most important things in completing this project is to depend on myself in order to explore more about the languages that I used which are PHP and MySQL. All that I've learned in the class during my first year is very basic but it really helps in order to further my knowledge in PHP and MySQL. Besides, the most important for me and I believe is also beneficial to others is to always ask the lecturer or supervisor in order to complete the given tasks because they can give advices, supports and help us.

Finally, thank God for all the blessing and strength that I have received in order to complete my system and successfully accomplish the Bachelor Degree.

ACKNOWLEDGMENT

After completing this research and system of supplier decision support system in computer selection, I would like to express my sincere gratitude to my supervisor Dr. P.D.D. Dominic for his advise, guidance, and revisions in improving my research and system.

I would also like to thank to Miss Shakirah Binti M Taib for her comments, supports and helping in programming part and suggest the best algorithm to use during developing of this project.

Huge thanks also to my sisters and my lovely brothers for their endless love, even when the distance kept us away and less communication. Special thanks extended to my friends for their consistent support, help and encouragement.

This project is quite tough for me as it has many calculations and I have to consider many things such as user friendliness, error checking, and take into consideration several processes especially the processes involved in the main part of this project. The process will be more difficult if I failed to run the system in the middle part of the processes. I found that the most important things in completing this project is to depend on myself in order to explore more about the languages that I used which are PHP and MySQL. All that I've learned in the class during my first year is very basic but it really helps in order to further my knowledge in PHP and MySQL. Besides, the most important for me and I believe is also beneficial to others is to always ask the lecturer or supervisor in order to complete the given tasks because they can give advices, supports and help us.

Finally, thank God for all the blessing and strength that I have received in order to complete my system and successfully accomplish the Bachelor Degree.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER 1
INTRODUCTION

PROJECT WORK BACKGROUND

Decision making is one of the crucial activities conducted in organizations by managers. It involves multiple participants and requires conflicting resolution as well as multiple information sources. The outcome of the decision making process absolutely affect company. Supporting those decision makers is highly recommended and desirable.

Suppliers are necessary to any business and affecting the whole processes, therefore the process of selecting suppliers is extremely important. According to (Wei Kang, Wu Wen, W.B Chang, and Hao-Chen Huang, 2006), supplier selection and evaluation is the process of finding the suppliers who are capable of providing customers with the products or services that have the right quality, right price, right quantity and at the right time. Decision makers and managers often face challenges when they are about to select the best supplier among the candidate suppliers in their final decision.

The inappropriate supplier chosen in some cases as a result of poor decision could negatively affect the entire business processes within the organization. Although the complexity of the supplier selection problem and how difficult to deal with such decision, DSS still highly regarded as a robust and effective tool that can absolutely handle the situation of helping the decision makers and managers to come up with the right decision of selecting the best supplier among whole various alternatives wisely.

1.1 Problem Statement

Supplier selection decisions are usually dependent upon various involved criteria which influence the decision making process. Decision makers/managers often concentrate on the price of purchased materials or services due to their prompt attempt to reduce the cost and unfortunately they give less attention to the rest of the criteria which is leads to poor decision. Even in some firms where they use software to help in the supplier selection decision still we can clearly notice those software focus on the cheapest prices as well. The poor decision might be taken definitely will be affecting the entire business process within the organizations. Obviously, managers/decision makers are having difficulty in supplier selection. There is an urgent need for a method that can handle the selection decision to provide the required support to decision makes/managers, besides the ability to yield optimum and fair decision concerning multi attributes that usually involve in supplier selection problem.

1.2 Objective

Regarding the great role has been played by suppliers in the business world beside the importance of selection decisions in organizations, supplier selection problem has been a research area for long time and it became an interesting topic for researchers to figure out what is the best possible method for achieving the supplier selection decision successfully concerning the aid of DSS. All the previous researchers were trying to support the decision makers/ managers for being to make their right decisions and being capable of handling the decision making activity by proposing different methods and suggestions.

This research intends to introduce an optimal solution for the supplier selection problem by develop a website to propose a linear weightage model. The proposed model includes the concepts of Linear Weightage Model. The Linear Weightage Model through website development will be able to handle the supplier selection problem and support the decision making process successfully.

1.3 Scope of Study

This research concentrates on building a website to enhance the performance of the decision making activity within organizations, especially in supplier selection decisions. It also intends to improve the models which are using as methods in DSS when decision making activity is taking place. This research proposes a website development using a linear weightage model to be used in supplier selection decisions.

Since supplier selection decision is one of most complicated problems as its involving multi criteria, the models that used to support decision maker should be capable of considering both quantitative criteria as well as qualitative criteria in computer selection decision. However, this website development will take the quantitative criteria

- This research proposes a linear weightage model through website development to be used in supplier selection decision limited to computer selection.
- The main purpose of developing the website for this model is to evolve the performance of decision making process and provide the ability for making better and satisfactory decisions.
- The proposed model takes into account both strengths and limitations that exist in most of the current models. Thus, it definitely represents a reliable model that can also fulfill the model base functions in DSS frameworks for supplier selection.

CHAPTER 2
LITERATURE REVIEW

2.1 Introduction

This chapter shows the DSS software that have been developed for assisting decision makers in different business directions and particularly supplier selection decision and all various criteria that may involve in its relative importance. This chapter also discusses the complexity of this process. This chapter is provides all methods and approaches and used in supplier selection decisions in literature.

2.2 Supplier Selection Decision

Supplier selection decision is one of the most important aspects that organizations must take into their account when considering strategies (Prabot Kaur, Rakesh Varma, N.C, and Soubhik Chakraborty, 2007). Regarding the increasing importance of purchasing process, supplier decisions have become more strategic.

Many studies show the great importance of purchasing process and vendor/supplier selection in Supply Chain Management (SCM), (Weber C.A, Current J.R and Benton W.C, 1991) mentioned that in the automotive industry, cost of purchase components and items may total more than 50% cost of the total cost for high technology companies, beside that supplier selection decisions have an effect on the management of different services of the firm as well as its competitive position in the market.

In the literature, the importance of purchasing processes can be easily observed. Some researchers have mentioned a statistical operation that shows the percentage of the amount of money paid for purchased materials. More details declare by (Moynihan G.P, Puneet Saxena, and Fonseca D.J, 2006) talking about 60% of the manufactures sales dollars are paid to supplier for purchased materials. However, automobile manufacturers

spend about 60% of the total manufacturing cost, oil refineries spend about 80%, food processors spend about 70%, and about 65% paid to supplier in the case of farm manufacturers. From these percentage mentioned above, the importance of purchasing processes can clearly be observed and that leads to more attention have to be paid by decision makers towards this critical process.

Supplier selection problem typically consists of four stages as reported in (Shuo Yan Chuo, and Yao-Hui Chang, 2007, Aboulhas Conrad Tsahat Onesime, Xu Xiofel, and Zhan Dechen, 2004). These four stages namely:

1) Defining the problem and realizing the needs.
2) Formulation of decision criteria.
3) Qualification of potential suppliers.
4) Final selection of suppliers.

2.3 Supplier Selection Criteria

Supplier selection is multi-criteria problem as it has been described in literature and it does involve various criteria. These criteria can be divided into qualitative and quantitative criteria (Reza Mohammad Garfamy, 2005, Ghodspour S.H and Brien C.O, 1998).

There are many criteria might be involved in the process of selecting an appropriate supplier and here some of them are given below:-

- Product price: It should be concerning the unit price, price for large quantities and the ability of any negotiations may lead to discount. Companies give a lot of attention to product prices, as a result of their willing to obtain the requested products and services against reasonable prices. More than often, companies tend to reduce the cost of purchased materials and make tradeoff between quality and price.

- Quality of material: Does the supplier have quality certification such as International Standardization of Organization (ISO) or it is certified by the buying company? Does the supplier meet the quality of materials which required

by the buyer? Such question can be taken into account to insure that supplier is able to provide high quality of materials and services.

- Reliability: It represents the Supplier's history of meeting the requirements of the customers/ buyers consistently.

- After sales services: Most of the suppliers provide some kind of Services such as replacement of detective parts, instructions on equipment use, repairs or update of products and so on. All these services and others make the supplier more preferable.

- Warranty: In addition, the length of warranty that the supplier has provided to the customer/buyer is one of the main factors that play a major role in supplier evaluation to determining and influencing after sale services.

- Supplier location: Location of supplier can impact delivery time, transportation cost, and respond for rush or replacement order, firms may choose to purchase in the country in which they operate rather than overseas. Also firms might decide to buy locally in order to participate in the strategy of improving the local economy.

Throughout the history of purchasing process, suppliers have been selected according to the criteria which have mentioned before. The most criteria ever use in supplier selection that mentioned by Dickson (1966), he ranked a number of various criteria taking the relative importance of each criterion into consideration.

Based on empirical data gathered from 170 purchasing managers and members of national association of purchasing management, Dickson identify quality, cost, and delivery performance history as the three most important criteria in supplier selection. According to recent view, 74 articles discussed about supplier selection criteria, quality was deemed to be the most important, followed by delivery performance and cost (Nelson et. Al, 2005). Dickson's criteria have become the most commonly used in supplier selection decisions (Dan Wang, Yezhuang Tian, and Yunaquan Hu, 2004). Dickson's criteria are depict in table 2-1.

Rank	Factor
1	Quality
2	Delivery
3	Performance history
4	Warranties and claim policies
5	Production facilities and capacity
6	Price
7	Technical capability
8	Financial position
9	Procedural compliance
10	Communication system
11	Reputation and position in industry
12	Desire of business
13	Management and organization
14	Operating controls
15	Repair services
16	Attitude
17	Impression
18	Packaging ability

19	Labor relation record
20	Geographical location
21	Amount of past business
22	Training aids
23	Reciprocal arrangements

Table 2-1. Dickson's Supplier Selection Criteria

Many authors have discussed the criteria of evaluating and selecting suppliers in terms of the relative importance of each criterion, the number of criteria involves, and so on. The relative importance of the evaluative criteria varies depending upon many factors such as place, the time, purchase and evaluation situation, and the nature of selection situation (Reza Mohammady Garfamy, 2005).

The six most mentioned were price, delivery, quality, facilities and capacity, geographic location, and technical capability, although the numbers of selection criteria can be adjusted regarding rules in different firms, to go well with the individual company policies (Shuo-Yan Chua, and Yao-Hui Chang, 2007).

Once the relative importance of the supplier selection criteria have been decided upon and that implies some criteria have the greatest impact whilst some other have less influence. Decision makers / managers concentrate on different levels of importance while they dealing with the supplier selection criteria. Different organizations assess their supplier using different criteria. (Juang-Jyh Shyur, and Hsy-Shih Shih, 2005) list some of those criteria by types of business. Table 2-2 shows the seven kinds of companies which are considered in this research. Undoubtedly, price, quality and delivery are three most important criteria for vendor selection.

SNO	Lines of business	Attributes/Criteria
1	Baby food manufacturer	Price, Quality, Delivery
2	Bicycle manufacturer	Quality, Delivery, Price, Facilitiy, Technical capability, Financial position, Past performance attitude, Flexibility, Service.
3	Bottling machinery industry	Product price, Shipment quality, delivery performance
4	Equipment manufacturer	Acquisition cost, Product quality, delivery reliability.
5	High-tech company	Technical, Market, Organizational.
6	Public road and rail transportation	Make-up, Processing time, Prototyping time, Design revision time, Quality system, Co-design, Technology level.
7	Telecommunications company	Cost (capital expenditure, operating expenditure), Quality (technical, operational, vendor).

Table 2-2:- 7 kinds of companies which are considered in this research. Source: (Huang-Jyh Shyur, and Hsy-Shih Shih, 2005).

An empirical study done by (Dan Wan, Yazuang Tian, and Yunquan Hu, 2004) in which data for this study have been collected from the United State, and United Kingdom, Norway, China and Australia; it is found that quality of products or services as the most influencing factors in supplier selection decisions. It tallies with Dickson's ranking of the evaluation criteria.

2.4 Complexity of Supplier Selection Problem

Decision makers or managers are often responsible for making purchasing decision which definitely not an easy job. They should be aware of choosing the appropriate and the right supplier among pool of potential suppliers. The best supplier also should be selected among others according to the capability of satisfying whole materials or services which have been requested by the buyer.

On the other hand, suppliers have to be recognized that business can perform in a better way when they understand and satisfy all the needs of the customers (Chee-Cheng Chen and Ching-Chow Yang, 2002).

It's agreed in the literature that the supplier selection decision is so complicated and difficult to deal with. According to (Mahmut Sonmez, 2006, Dongjoo lee, et.al, 2006, J.shi, et.al, 2000, Hongwei Ding, Lyes Benyoucef, and Xiaollan Xie, 2003, Wei-Kang Wang et.al, 2006, Shuo-Yan Chou, and Yao Hui Chang, 2007, Reza Mohammady Garfamy, 2005,Lei-Lei Chen, and Mei-Xian Jiang, 2005,Mosaad A. Badri, and Mohammad H.Abdulla, 2004), there are many reasons which are making supplier selection problem is a complex process.

First, supplier selection involves a huge number of criteria. Therefore, decision makers or managers have been forced to consider all of them. Beside that they should also taking the relative importance of the criteria into their account.

Second, supplier selection problem is complicated by involving multiple evaluated criteria that some of them are quantitative such as the price, delivery while others are qualitative such as flexibility and service.

Third, it may become more complicated as a result of conflicts among criteria; low price could be conflicting to the quality and so on. Frequently, these evaluation criteria involve tradeoffs. For example, one supplier may offer higher quality items, with uncertain delivery time. Therefore, setting up tradeoffs is extremely important.

Fourth, changing in criteria itself may happen across time and place, beside the number of selection criteria can be adjusted due to the certain strategy in various firms. Furthermore, the importance of criteria differs from one purchase to another.

Finally, the huge number of alternatives might be including in selection process due to the competitiveness among them. This number of alternatives may also create a vast amount of information. Moreover, decision makers are required to achieve further series of comparisons when more alternatives involved.

From other point, (Ching Chow Yang, and Bai-Sheng Chen, 2006) reported the following points that play a vital role in the complexity of supplier selection problem

- Selecting suppliers only on the basis of managers' personal knowledge is neither efficient nor scientific according to inherent risk of subjective decision and lack of systematic analysis.
- Several evaluation models such as total cost of ownership (TCO), linear weighting (LW), and mathematical programming (MP). Obviously, an LW model seems not to include quantitative criteria, while the mathematical programming models do not include qualitative criteria.
- In practical application of supplier selection model, there is shortage in decision support system in supporting organization in the evaluation and selection of supplier which aggravates the complexity of the mathematical analysis.

2.5 Integrated Models for Supplier Selection

On the other hand there are some studies attempted to come up with much better methods which can enhance the performance of decision making process. For achieving this goal, researchers integrate different type of methods together and propose to use that new integrate methods in decision making activity. This idea aims to develop new type of integrating models by merging the concepts of either mathematical, weighting, or statistical models in order to build new models that can encompasses various advantages. Moreover the new integrated models always try to avoid the shortcomings in each one of the integrated approaches.

As one of these studies done by (Fadihlah Ahmed et.al, 2007), which its main purpose is proposing a framework for improving single criteria decision model. Authors proposed a model that integration of statistical, weight, and Guided Analytic Hierarchy Process (GAHP) model. GAHP is proposed term for AHP data entry matrices compound with the systematic guidance for a decision maker (DM) to enter data into the system.

In (Prabot Kaur et.al, 2007) an integration of standard score and linear programming is proposed to consider tangible and intangible attributes as well. The proposed approach used for selecting the best vendors. Besides, it situates the optimal order quantities among vendors.

Some authors have applied mixed integer, goal and multi-objective programming to supplier selection problem. Because these models are mathematical, they are not capable of considering qualitative attributes which are so significant for supplier selection decision. (S.H. Ghodsypour, and C. O'Brien, 1998) proposed an integration of analytic hierarchy process and linear programming to consider both tangible and intangible factors when choosing the best supplier. The model applies AHP which uses pairwise comparisons to make tradeoff between tangible and intangible factors and calculate suppliers' rating as coefficients of an objective function in linear programming distributes order quantities among suppliers.

In other article, an integrated model for supplier selection has been developed by (Ching-Chow Yang, and Bai-Sheng Chen, 2006). It's include the use of AHP method to systematically integrate different judgments from various evaluators and obtain the weights of qualitative criteria, in addition to application of Grey Relational Analysis (GRA) that adopts qualitative and quantitative criteria.

2.6 Linear Weightage model

The web development using linear weightage model intends to provide more robust software model that can handle the activity supporting the supplier selection decision. Linear weightage model represents one of the weighting models for supplier selection decision. This model is dependent upon decision's makers' judgment as they have to assign weights to the criteria that involve in decision making process. In most cases

there are some criteria considered as more important than others, such as product price, and delivery time.

Managers / decision makers should assigned weight to each individual criterion in order to determine the relative importance of each one. Hence decision makers/ managers should be conscious and precise when assigning weights to these criteria besides taking the preference of criteria into their considerations. These weights are playing vital role in decision making process and extremely affect the final decision.

Many of the existing decision methods and models are considering just the quantitative criteria, although the supplier selection problem involves both quantitative and qualitative factors (Ching-Chow Yang and Bai-Sheng Chen, 2006). In this section, linear weightage model have been proposed as it can easily handle both tangible and intangible criteria of evaluating and selecting the best vendor/supplier. Linear weightage model has many features that make it able to support decision making process in general. Such features can be summarized in several points as follows:

- The simplicity of this model can be clearly witnessed when applying to supplier selection process as there are no complicated calculations or complex mathematical procedures to follow.

- The model can easily include a tremendous number of criteria as well as huge number of different decision alternatives without reducing model sufficiency of affecting any results.

- The final result are usually obtained in a form of scores, therefore there is no chance for confusion when the highest score indicates best supplier overall.

- The linear weightage model is capable of considering quantitative factor as well as qualitative.

However linear weightage model is suitable for supplier selection decision; it has limitation apparently via the assignment of weight for each decision criterion. These weights could be assigned by decision maker based on his/her experience which they may lead to variation in the final decision.

Linear weightage model consists of sequence functions and mathematical calculations should be followed to make the final decision. First of all decision maker/ manager have to identify all criteria that involve in the certain process first before performing any other steps. After identifying all the attributes/ criteria related to supplier selection decision, manager/decision maker has to determine thresholds for each attribute/criterion. In fact, threshold can be divided into two types maximum and minimum hence, each attribute / criterion either has maximum or minimum threshold. To establish a threshold to criterion, manager should classify all criteria two groups. The first group known as "Larger is better" while the other known as "Smaller is better". The best supplier location is required to be the closest one to the buyer company or the customer, the short delivery time is desirable, and low cost of products is preferable, so delivery time, supplier location, and product cost can be categorized as "Smaller is better" and the threshold for this type of criteria must be maximum. On the other hand, most of the qualitative criteria can be considered as "larger is better" such as warranty where threshold must be minimum.

After determining the thresholds for the whole criteria or attributes, calculate the vendor values have to be established. It is often represented in the form of matrix which contains various of numerical values for each vendor in respect with each single attribute or criterion. Once the attribute was considered as maximum type of thresholds, formula 1 should be used.

$$V_{max} = \frac{Max - Vendor}{Max - Min} \qquad (1)$$

Where

Vmax = vendor value that has maximum type of threshold in respect with a particular attribute / criterion.

Vendor = specific vendor that is considered at a time.

Max = maximum value of particular attribute/ criteria among all vendors/ suppliers.

Min = minimum value of the same attribute among the whole suppliers.

In other case, when the attribute was classifies under the minimum type of threshold, formula 2 is the solely one option for calculating the vendor's value.

$$V_{min} = \frac{Vendor - Min}{Max - Min} \qquad (2)$$

Where

Vmin = vendor value that has minimum type of threshold in respect with a particular attribute / criterion.

Vendor = specific vendor that is considered at a time.

Max = maximum value of particular attribute/ criteria among all vendors/ suppliers.

Min = minimum value of the same attribute among the whole suppliers.

The idea of using formula 1 and 2 is extremely valuable because they provide a method that enables the comparisons among decision criteria. Usually decision criteria have different units of measure so any comparisons among those criteria are not logically acceptable. By using the data normalization concepts which represented in formula 1 and formula 2, all the criteria will be having the weights instead of variety of measurement and then the comparisons can simply made.

On the other hand, the decision makers / managers should not only be aware of the whole criteria that involved into the supplier selection process but also to which degree each criterion is more important than the other. Regarding this concept the managers/ decision makers should assign weight to each criterion in accordance with the relative importance of the criterion among the others and that has been considered as the major limitation in this model.

When all values of the criteria matrix are calculated, series of calculation should be achieved by multiplying weights of criteria by the whole values within the matrix. The total should be calculated for each vendor which represents the vendors' scores. The final decision table includes a score for each vendor / supplier and the one who gains the highest score is recommended as the best vendor / supplier.

CHAPTER 3
METHODOLOGY

3.1 Purpose of Research

Research and practitioners often seek for the most appropriate method that can provide reliability, simplicity, and satisfactory performance to enhance supplier selection decisions. On the other hand, decision makers would like to have an efficient method to assist them throughout the activity of decision making particularly in supplier selection problem.

The main objective of this research is to develop software which is website development to propose model for supplier selection decision. The development of website that proposed model is based on the most common used model in supplier selection decision which they named linear weightage model approach. The proposed model is more powerful and reliable, as it's based on the robust approaches. On the other hand, the most suitable system development methodology for this system is prototyping.

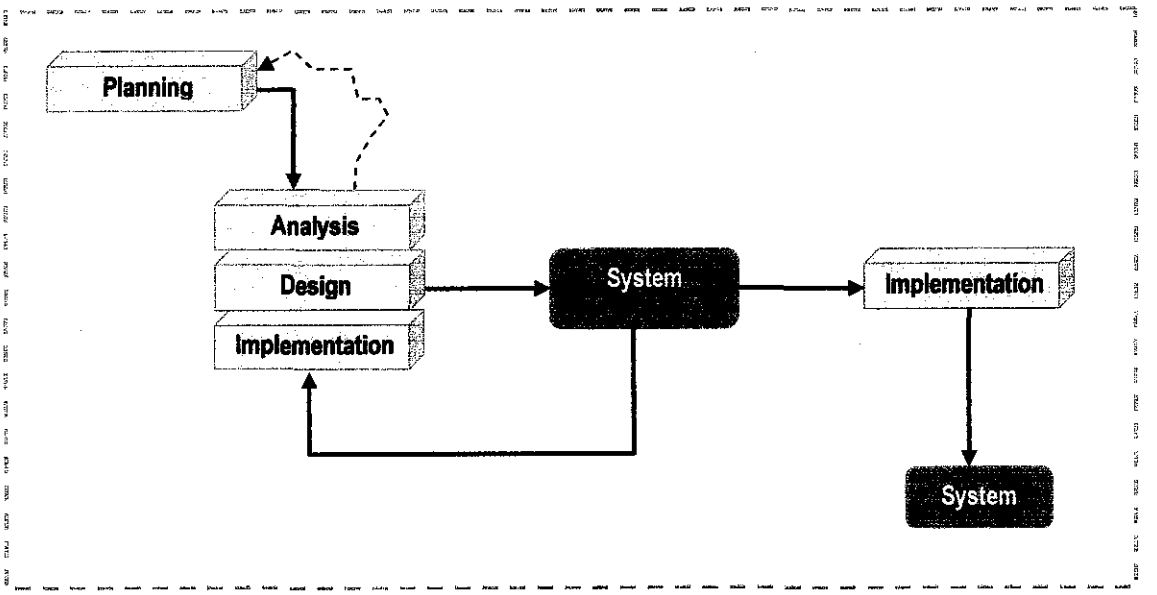


Figure 3-1: Prototyping Model

Figure 3-1 illustrates different phases to develop this system which based on proposed a new hybrid model. This web development starting with planning and continues throughout analysis, design and implementation. The reasons of choosing this methodology are:-

- Quickly provide a system for the user to interact with
- Used existing software
- Less time consume because more quickly to refine the real requirements
- Can be reanalysis, redesign until the system complete.
- Involvement of user is required.
- It also can reduce development cost.
- Since users know what to expect, it will facilitates system development.

3.2 Planning

The planning phase is most important in this system development. The planning phase for this system development includes the problem statement, objectives and scope of study that has been stated earlier.

3.3 Analysis

For the analysis phase, research will be done to find out more about the case being studied which is the Linear Weightage Model and the software that will be used for the development of the system should be determine as research element in this stage.

3.4 Design

The design phases for this project involve interfaces design of this system, flow chart of system and database or entity relationship diagram (ERD) design. The design has been constructed in various ways. For this system, the interfaces design has been used is Macromedia Dreamweaver 8 meanwhile the tool that required to design flow chart and entity relationship diagram is Microsoft Visio.

3.5 Implementation Phase

The core of this research is mainly focused on software development or implementation of website for this proposed model. This phase concerns various view points and different aspects that should be given attention in order to yield sufficient results. It starts with scanning most of the existing models in the literature and determining the most commonly used models in supplier selection problem. Based on the previous studies there are some models which have shown their capabilities and sufficiency when applied in supplier selection decision. Those models have been under the focus and so can easily specify the strengths as well as shortcomings. The urgent need for a robust and efficient model becomes so obvious. It has been found that weighting models are the most common category among all other categories.

Linear weigthtage model is multi criteria method. The limitation in the model, the strength of this model and other concepts will be widely discussed later on. Moreover,

composing and formulating the proposed model taking into account concepts of linear weigthtage model. The testing and evaluation of the linear weightage model has been taking place, the proposed model should be tested in the real business world through developed and implement a system of supplier selection process in computer selection.

3.6 Software Used

Here is the list of recommended software needed in order to develop the application:

Software	**Minimum Requirement**
Browser	Internet Explorer 6 and above
Operating System	Windows XP
Supporting Software	Macromedia Dreamweaver 8 EasyPHP for PHP and MySQL platform. MySQL 5.1.22 (community release) MySQL GUI Tools

Table 2-3:- Software used

CHAPTER 4
RESULT AND DISCUSSION

Based on the methodology identified in the Methodology section, *Figure 4-1 and Figure 4-2 below* shows the flow chart of the system.

FLOW CHART LOGIN SYSTEM FOR SUPPLIER SELECTION DECISION SYSTEM.

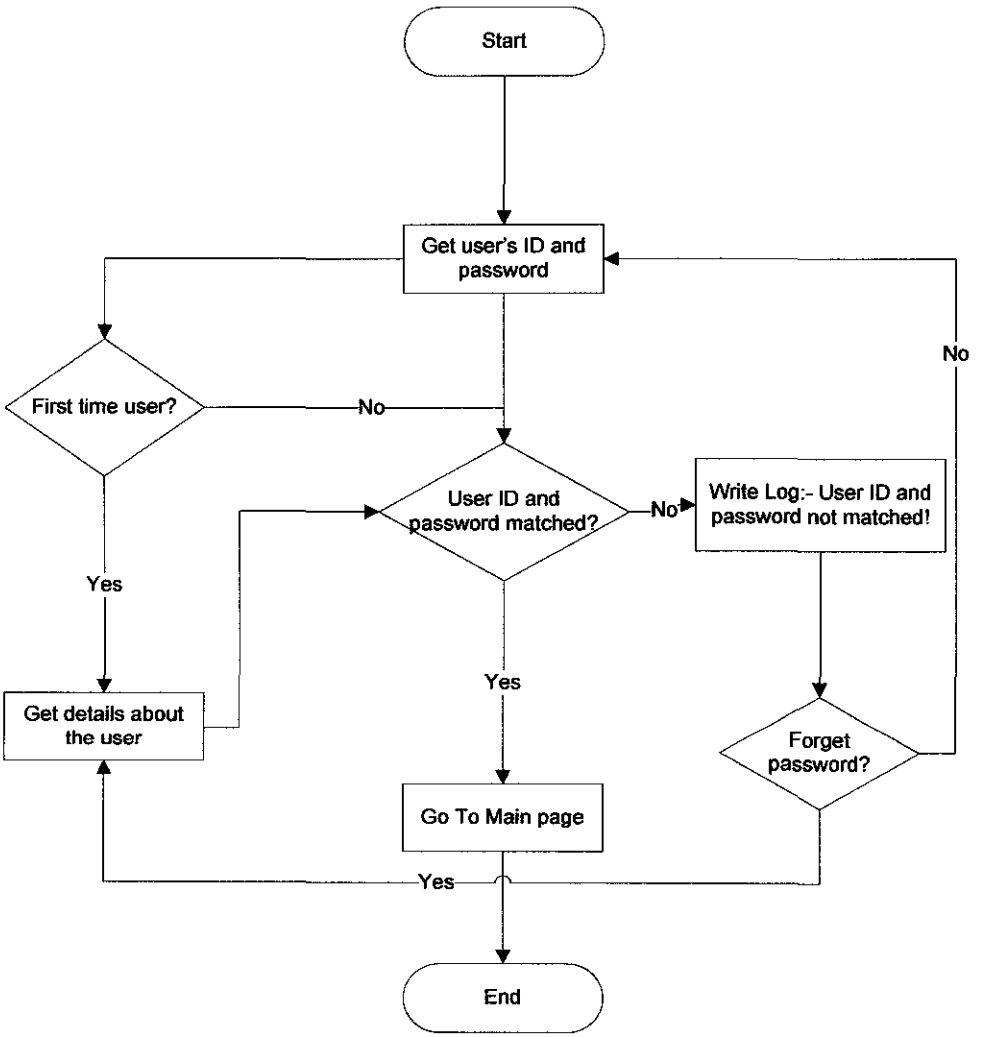


Figure 4-1:- Flow chart login system for supplier selection DSS.

FLOW CHART COMPUTER SELECTION FOR SUPPLIER SELECTION DECISION SYSTEM.

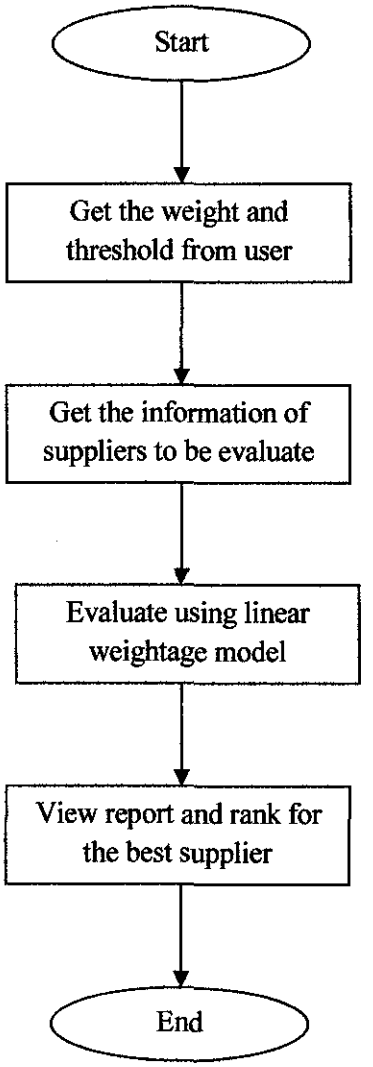


Figure 4-2:- Flow chart for supplier process in Supplier Selection Decision Support System (DSS) (Computer Selection)

Figure 4-3 until Figure 4-18 below show the interfaces for the system.

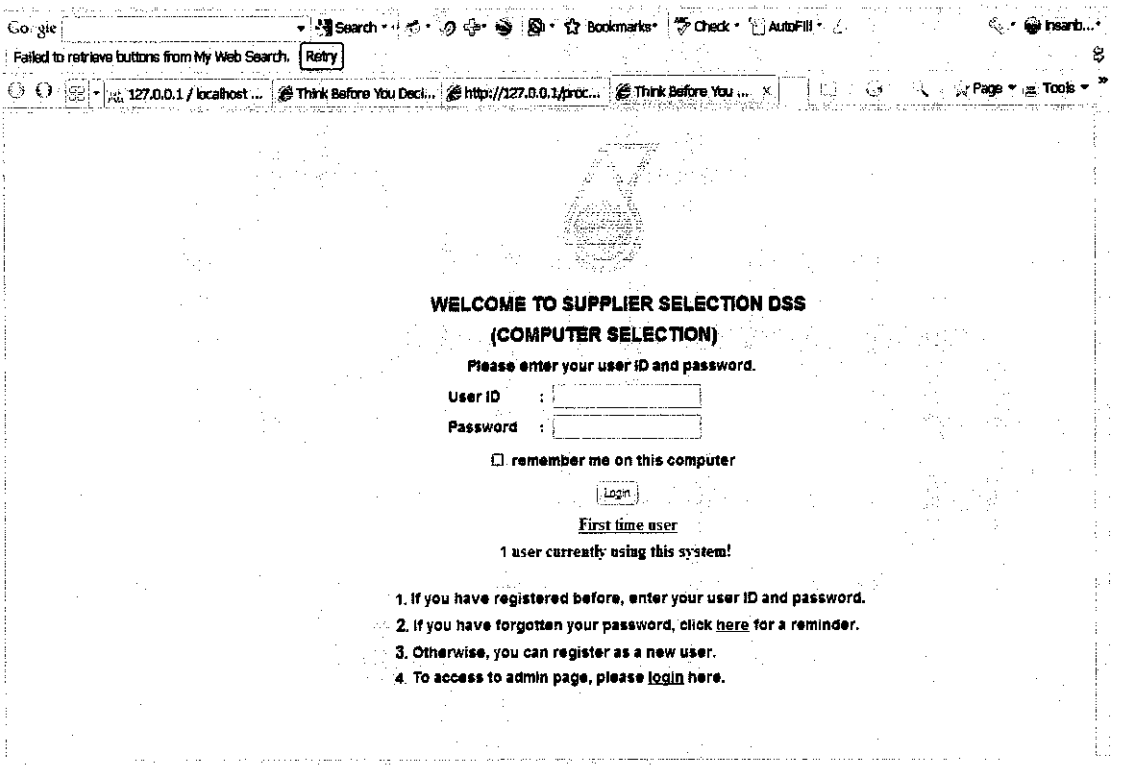


Figure 4-3:- Login page for user

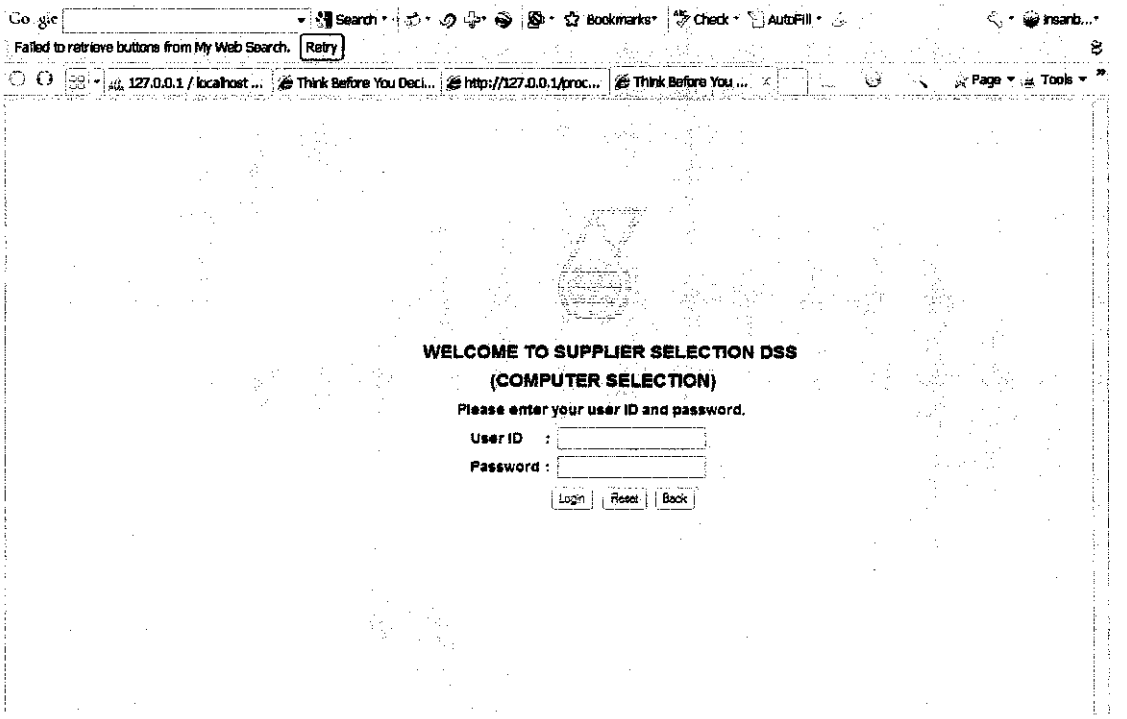


Figure 4-4:- Login page for administrator

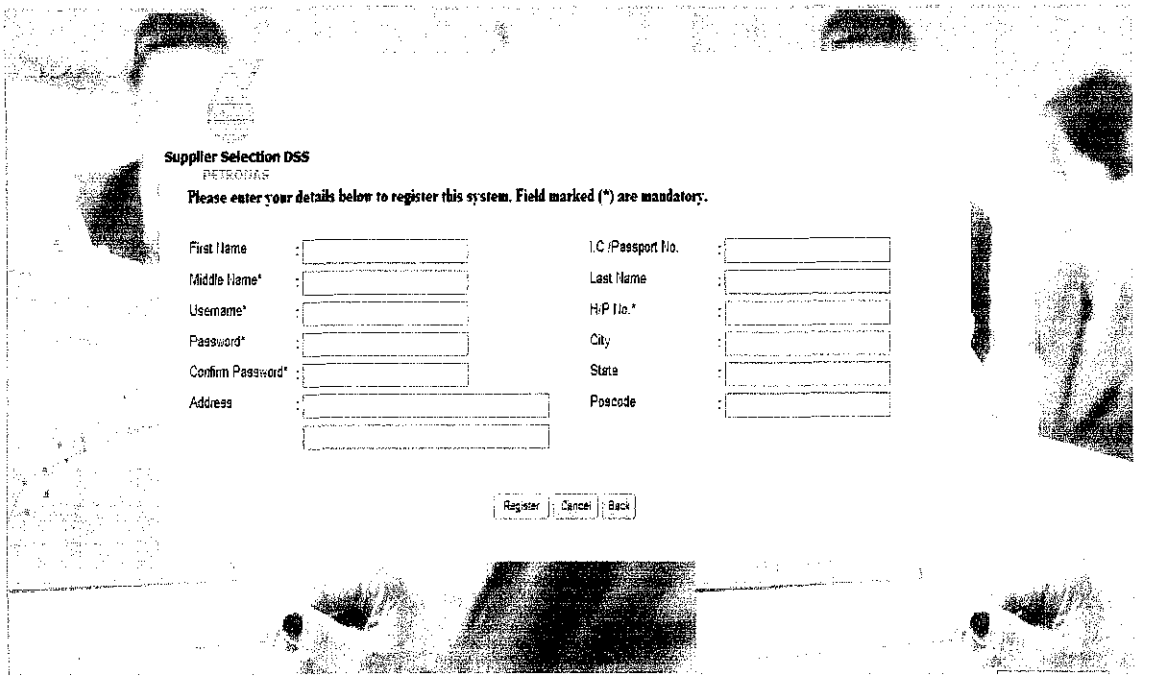


Figure 4-5:- Register page

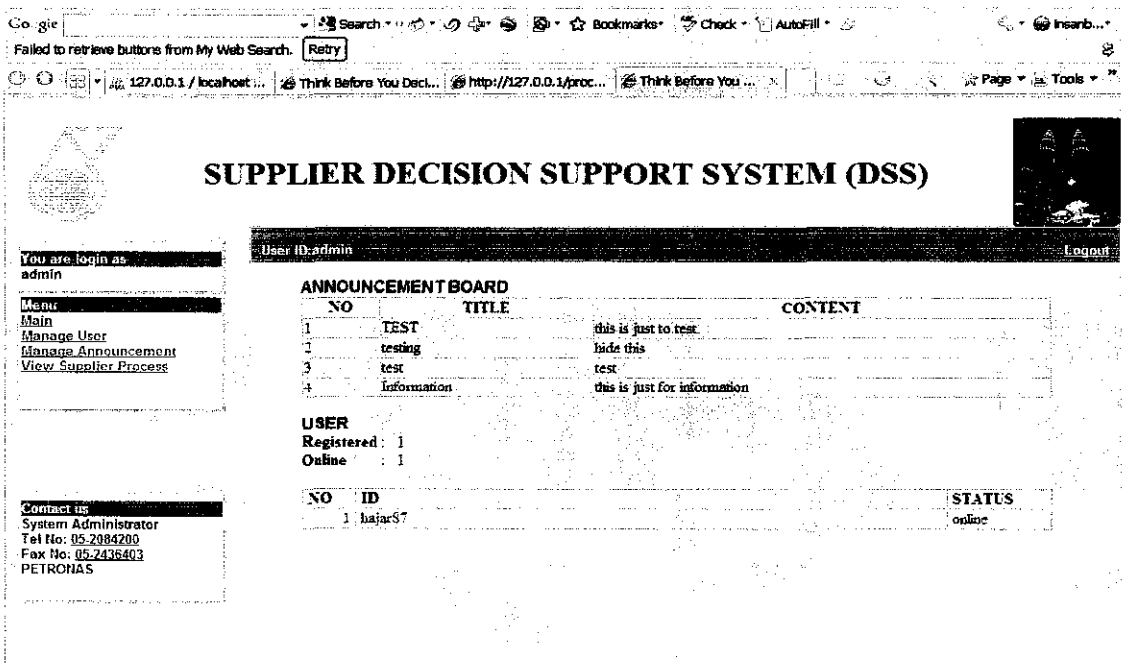


Figure 4-6:- Main page for administrator which consists of announcement board, user registered and user status.

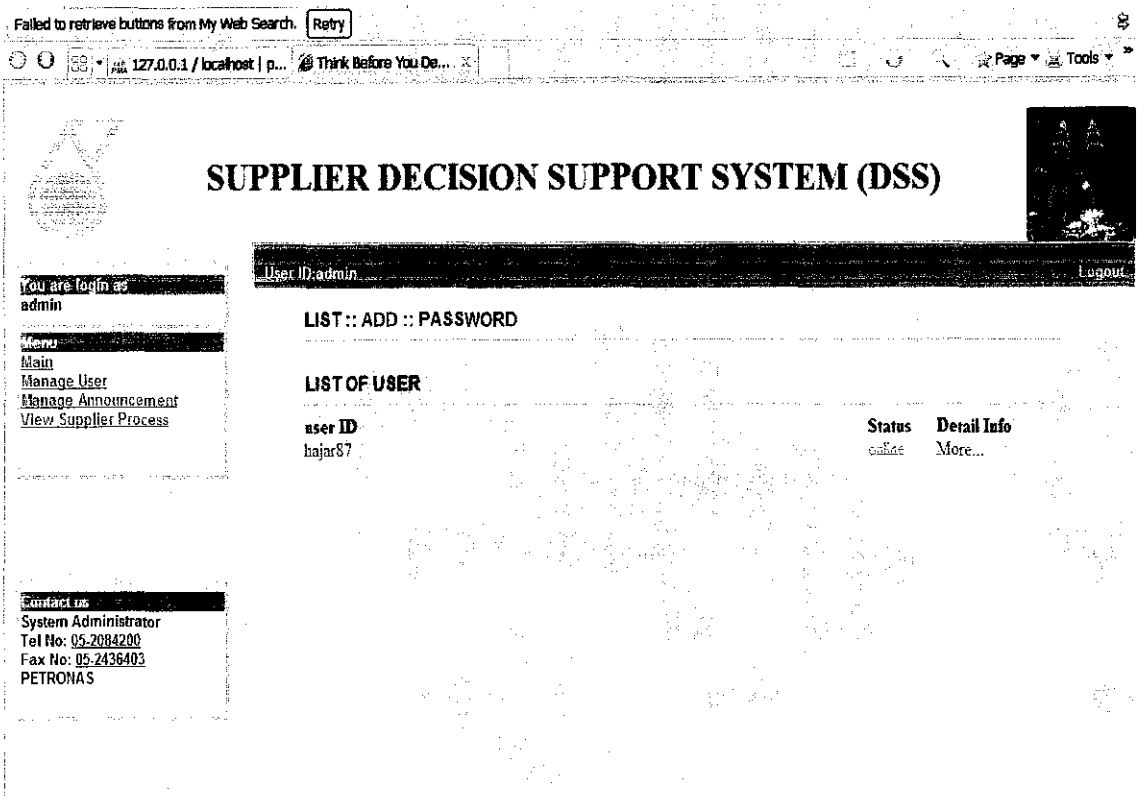


Figure 4-7:- Administrator page to manage user information which administrator can add and view user information .

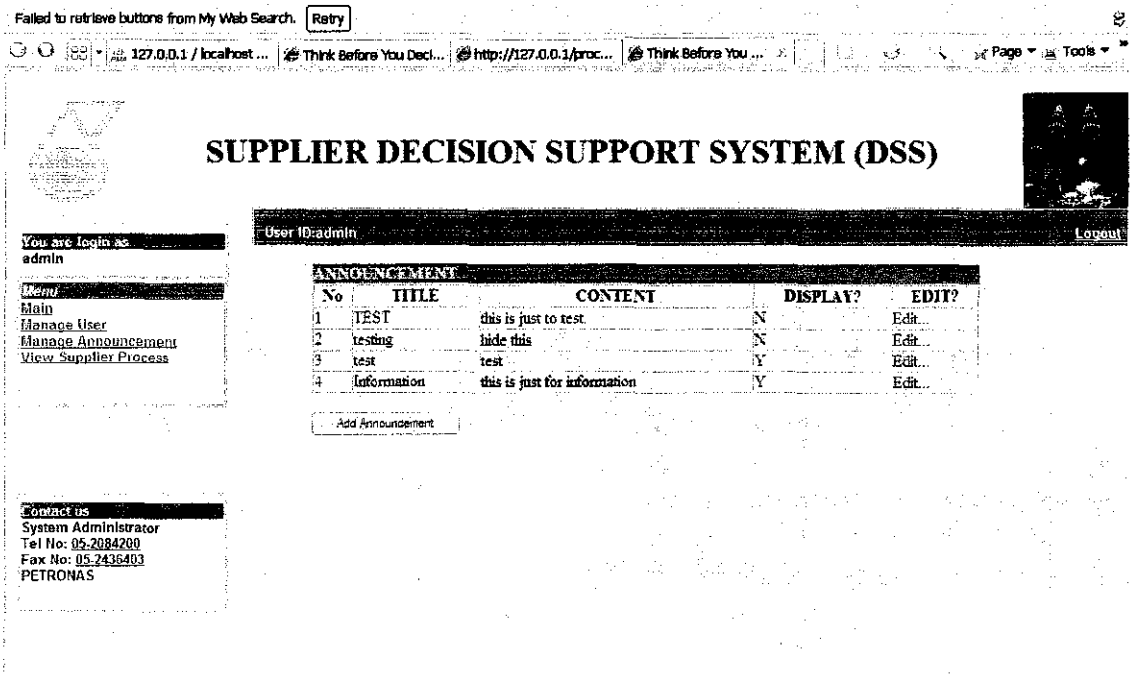


Figure 4-8:- Manage announcement page for administrator to update user for any information regarding this system.

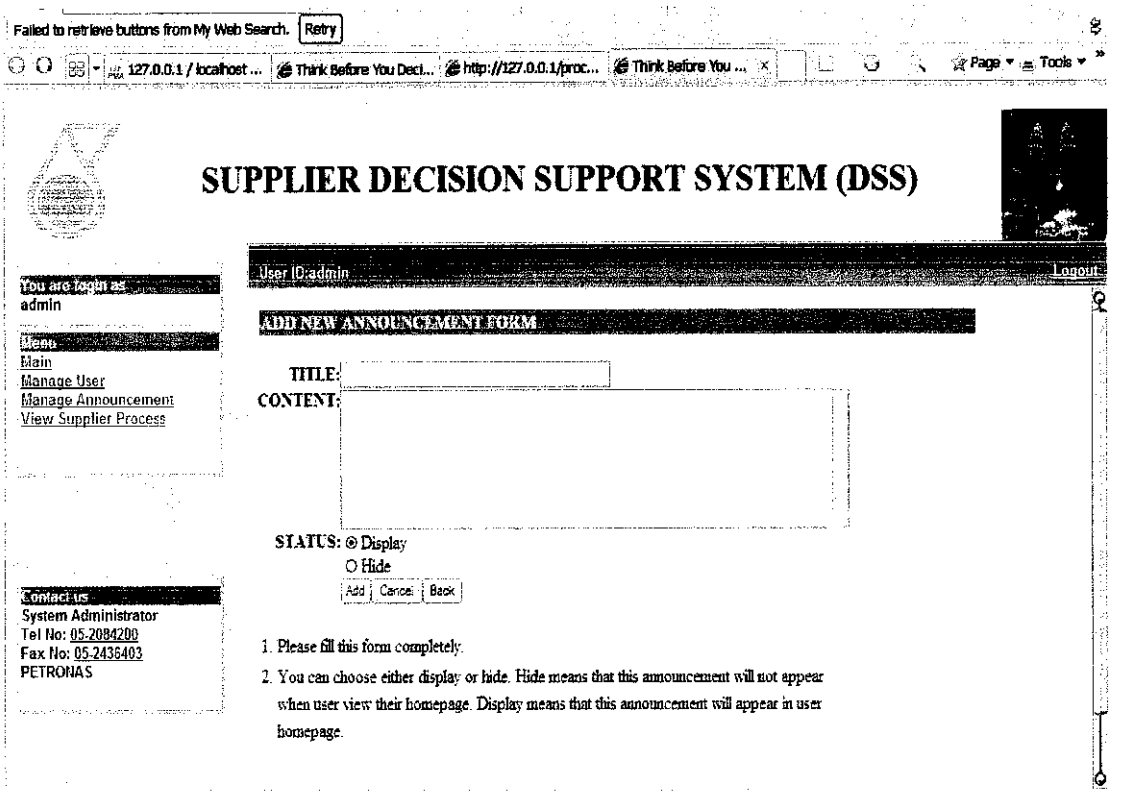


Figure 4-9:- This page named "Add new announcement form" will be appeared when admin click on "Add announcement" button.

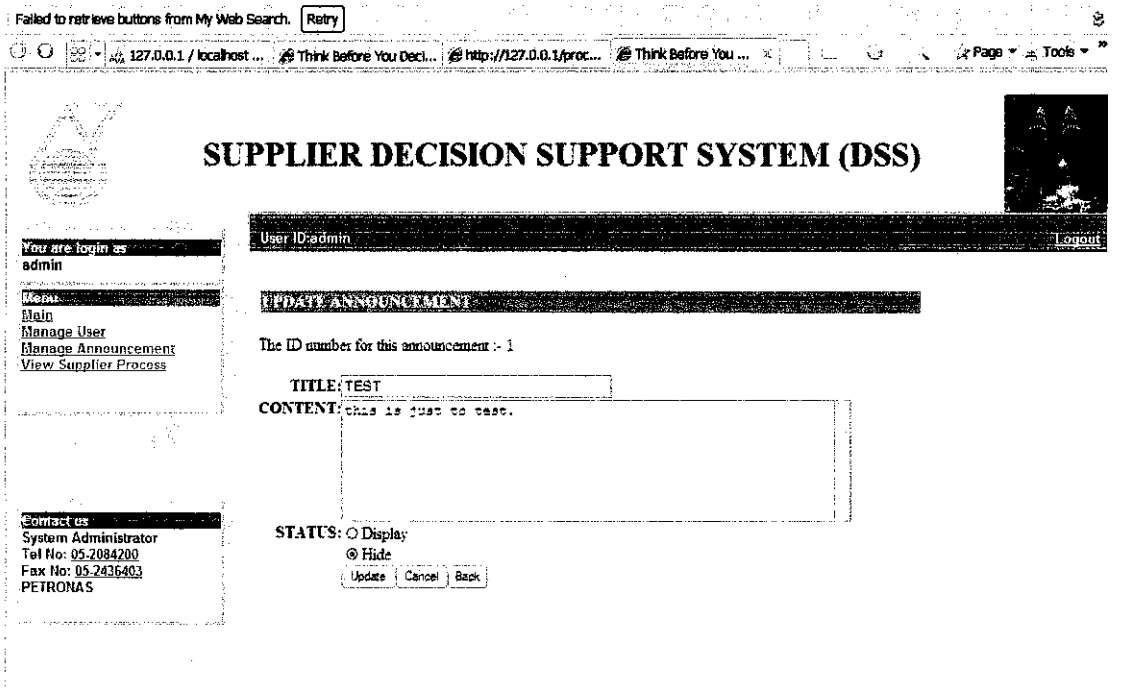


Figure 4-10:- The administrator can edit or update the announcement when click on "Edit" button.

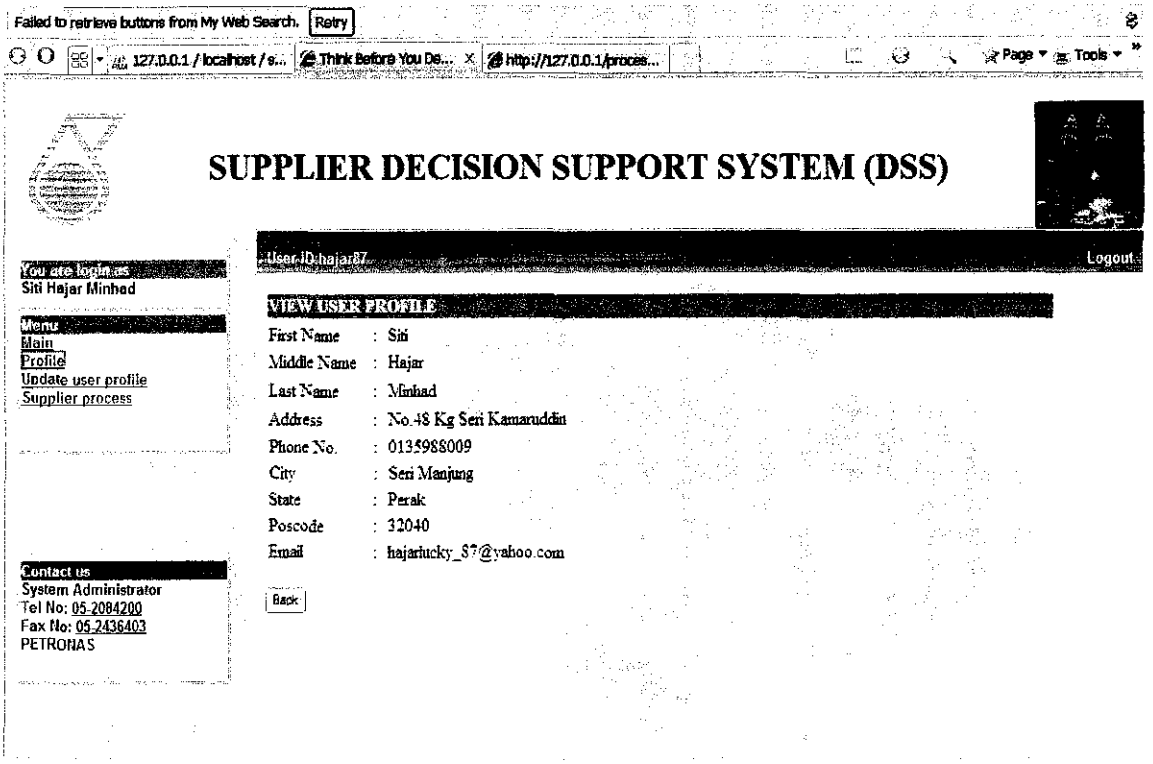


Figure 4-11:- User view profile

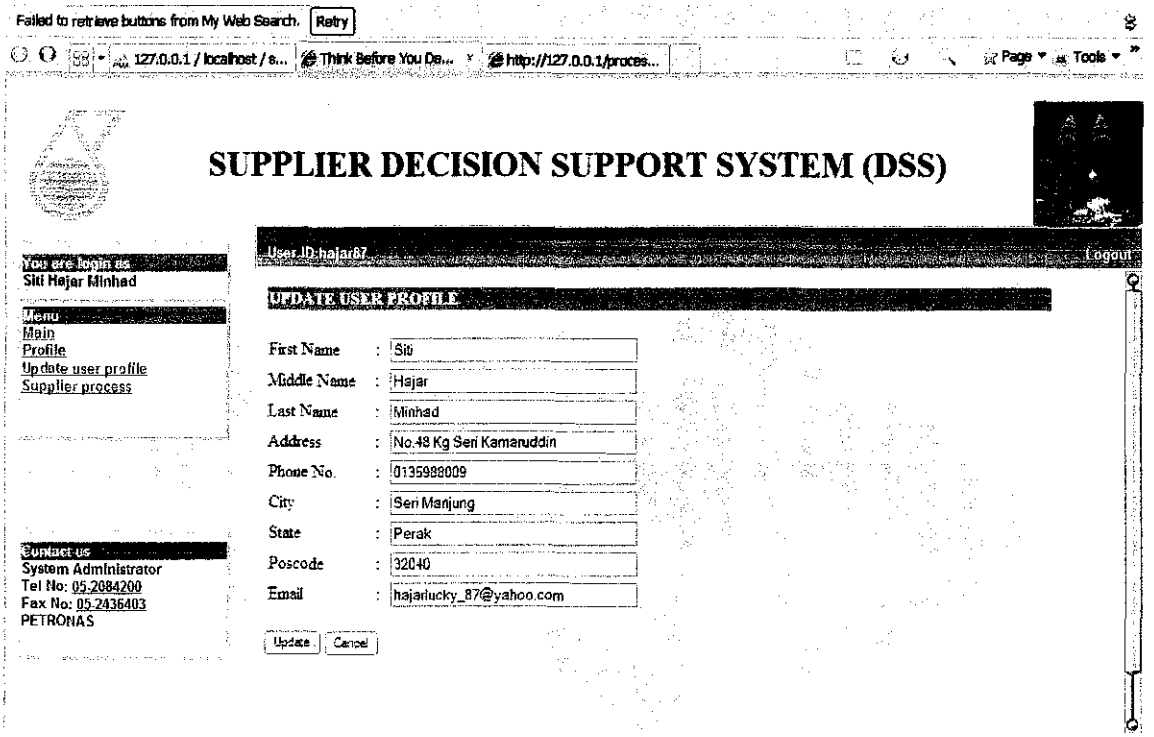


Figure 4-12:- user can update their profile through "update user profile" link.

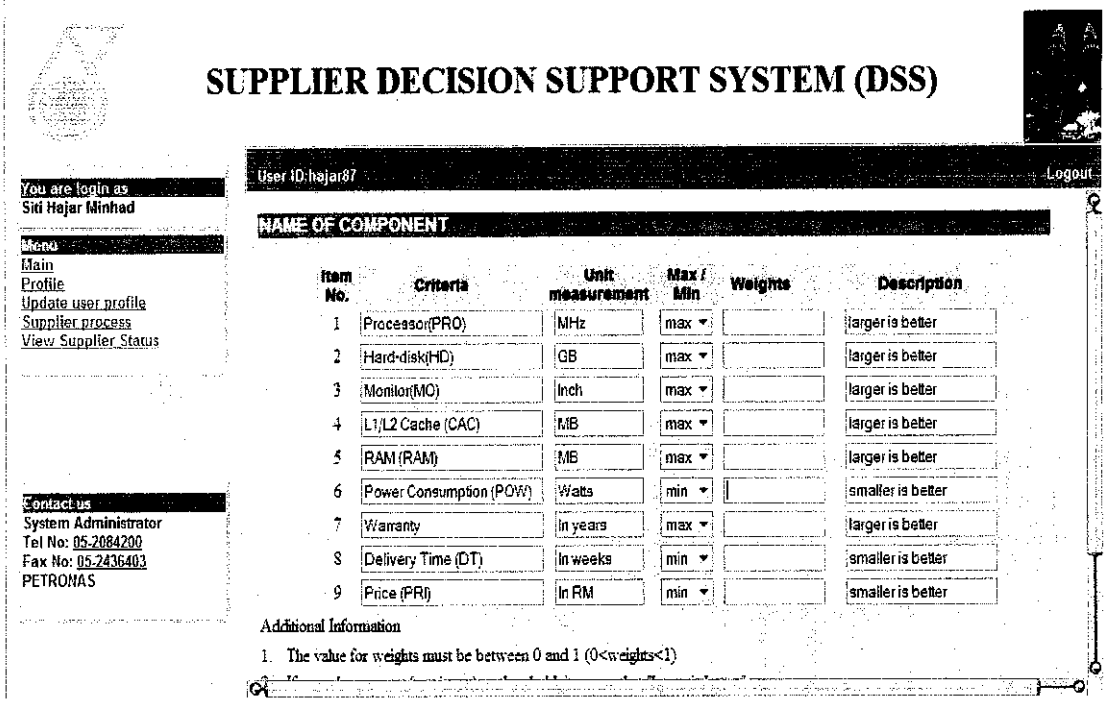


Figure 4-13:- Insert the weights and choose either the variable is maximum or minimum.

The page above will be appear when user go to "Supplier process" link. The criteria and unit measurement has been fixed by the system. User only have to choose the threshold which is either maximum or minimum and fill the weights of the variable. When user click submit button, the page below will be appear:-

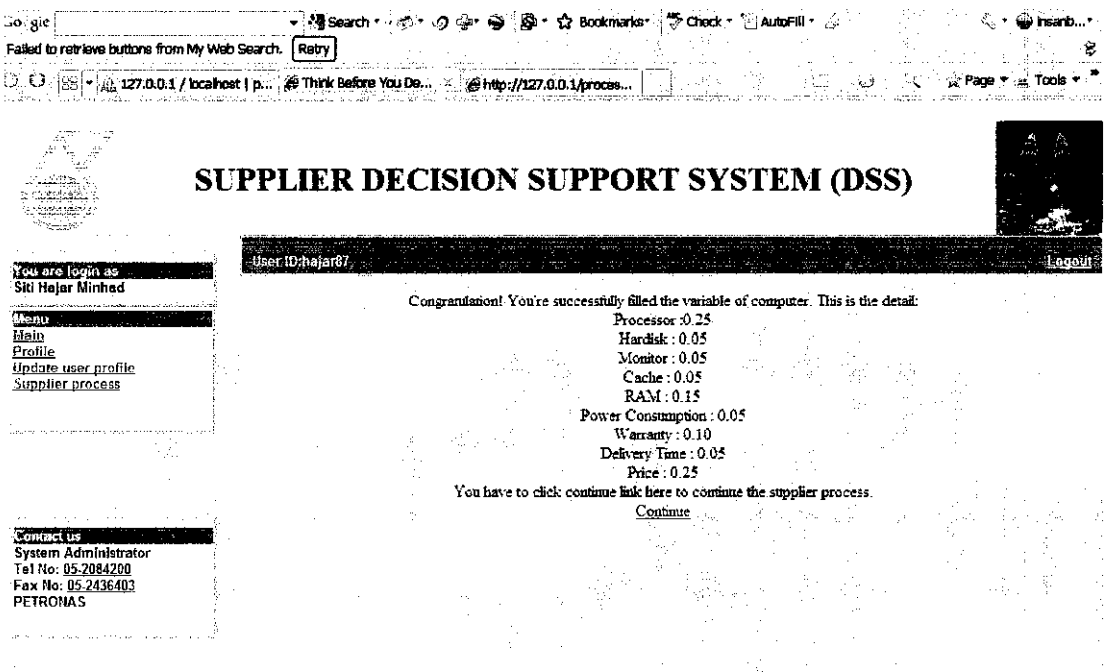


Figure 4-14:- The "continue" link to continue the supplier process for the next step.

After users click "Continue" link, users have to fill the information of supplier such as supplier no, name, address, telephone number, fax number and value of each criteria. The page for supplier details is as below:-

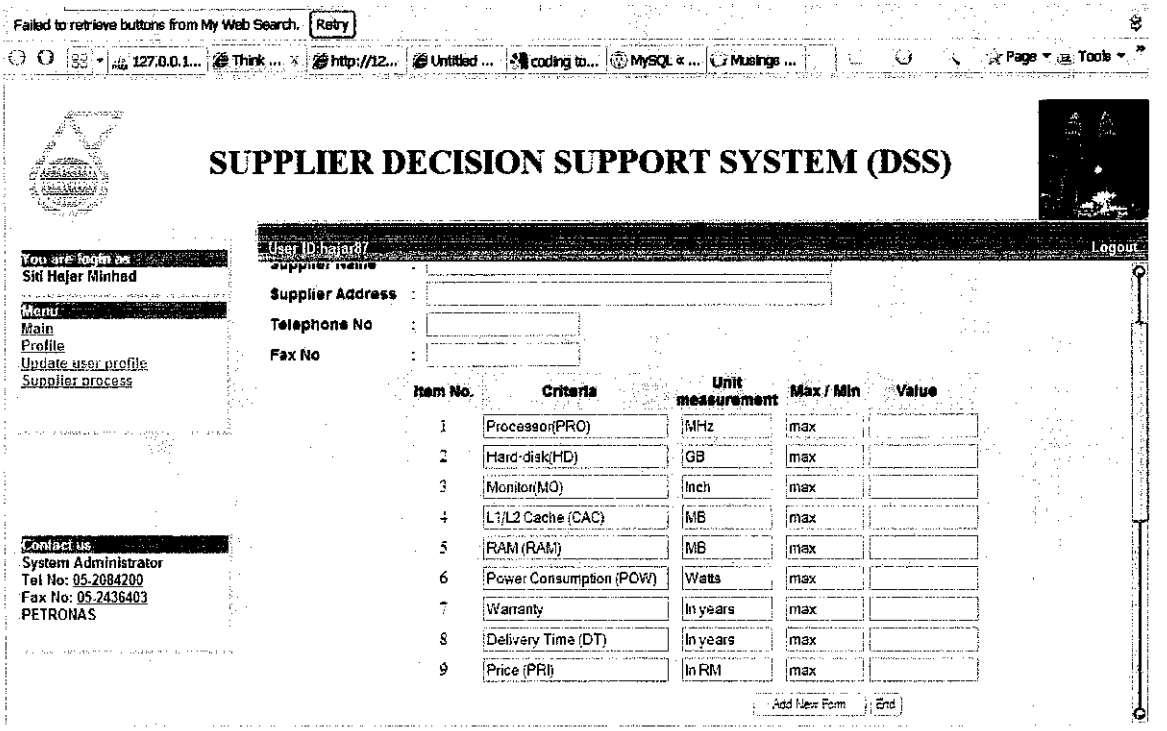


Figure 4-15:- The page to fill the information of supplier.

The system provides two buttons which are "Add New Form" button and "End" button. If users click on "Add New Form" button, user can fill another supplier into the form. Meanwhile if users click on "End" button, the process will continue to the supplier final decision to display all suppliers that has been evaluated using weightage model. The supplier after evaluate process is as below:-

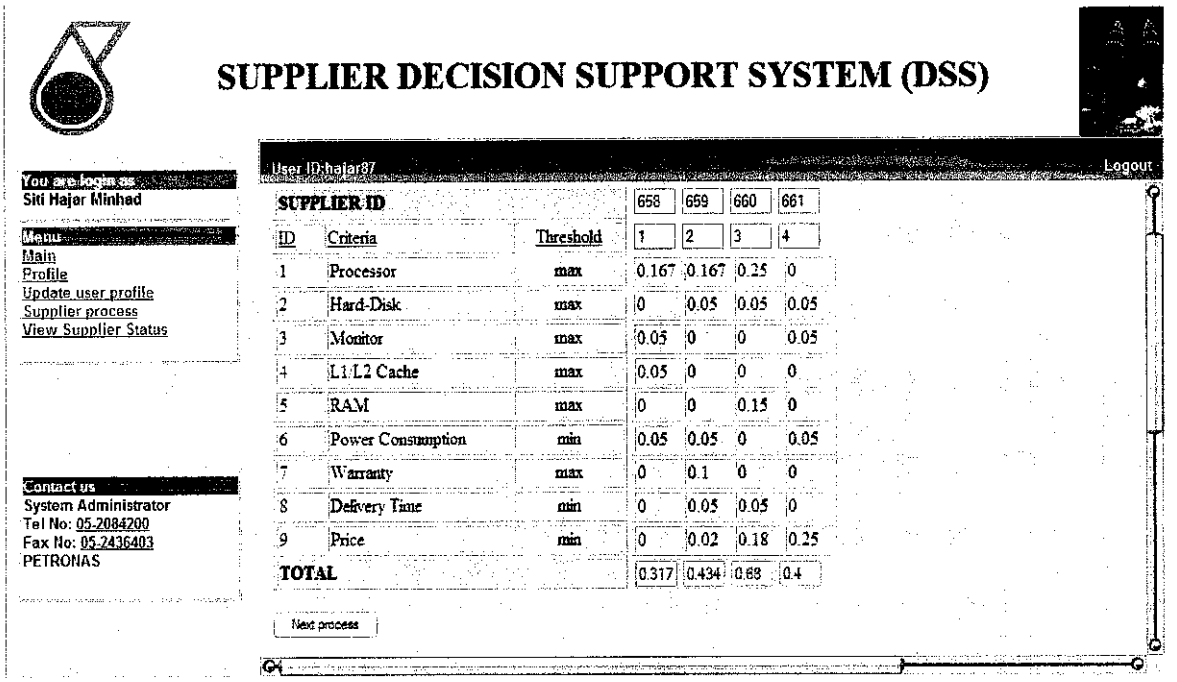


Figure 4-16:- Displayed the total value of the supplier after using weightage model.

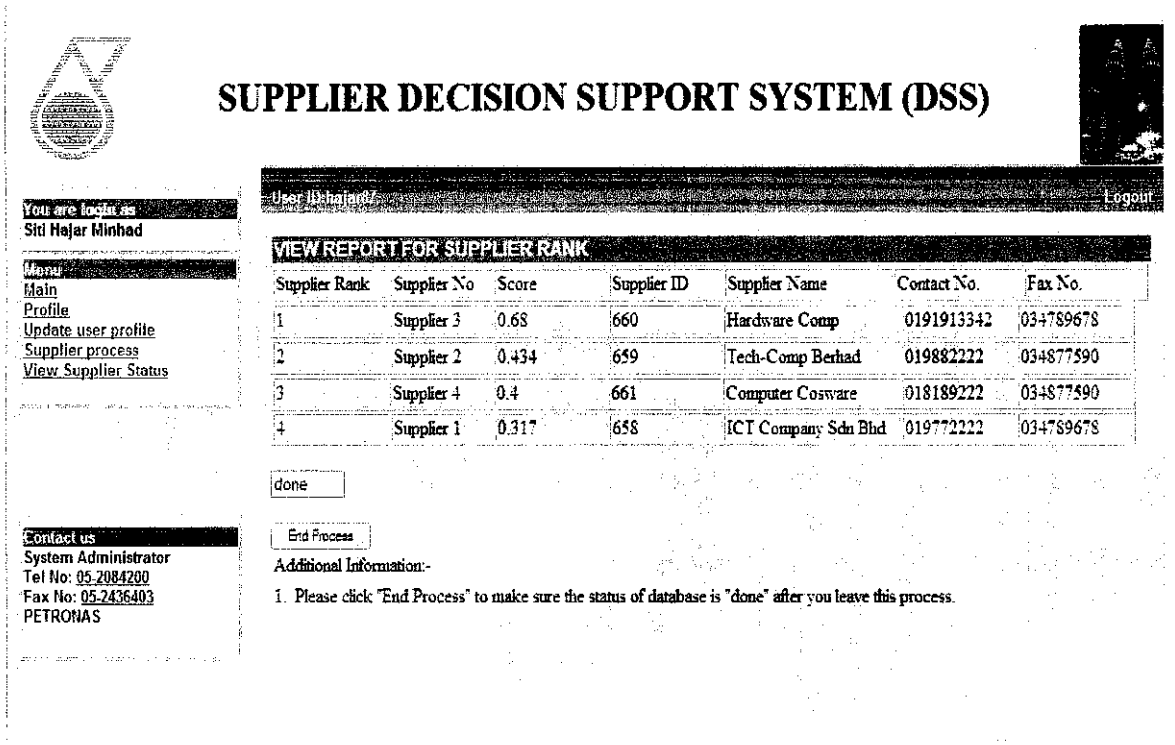


Figure 4-17:- Final result of report for supplier rank.

To complete the system and avoid uncertainty, user have to click the "End process" button. This is important to make sure the database will not include previous information when user insert the new evaluation. When user click on this button, the page in Figure 4-18 will appear:-

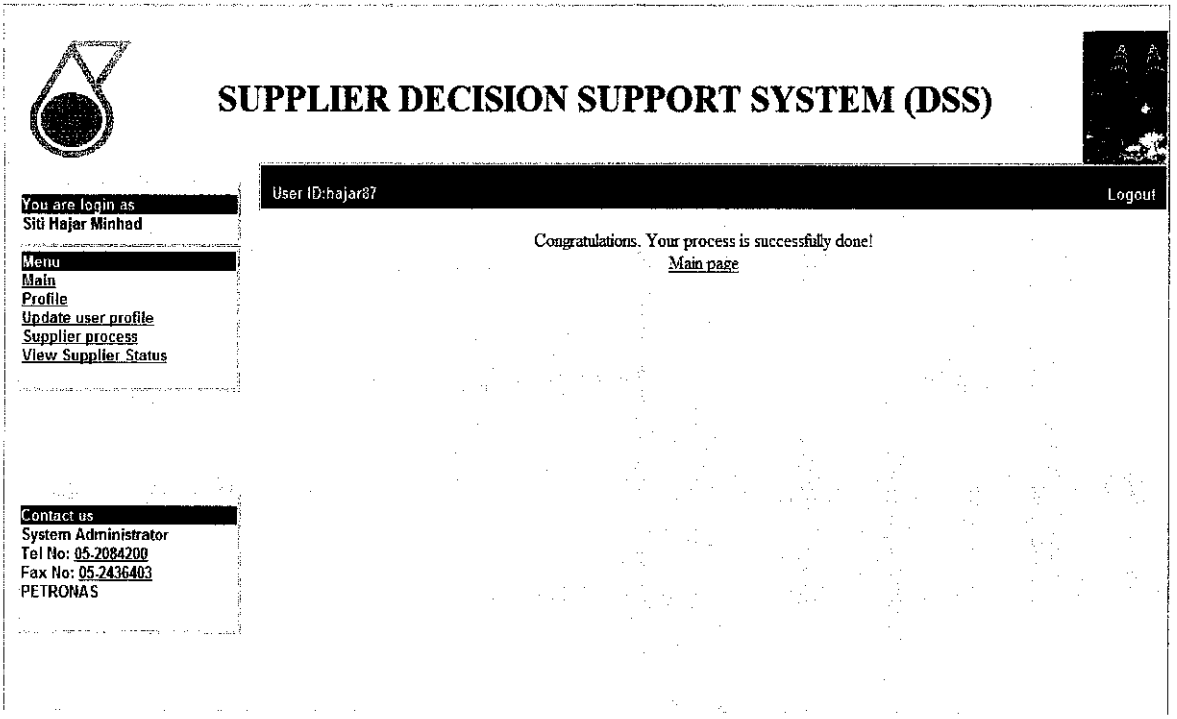


Figure 4-18:- Complete process of supplier system.

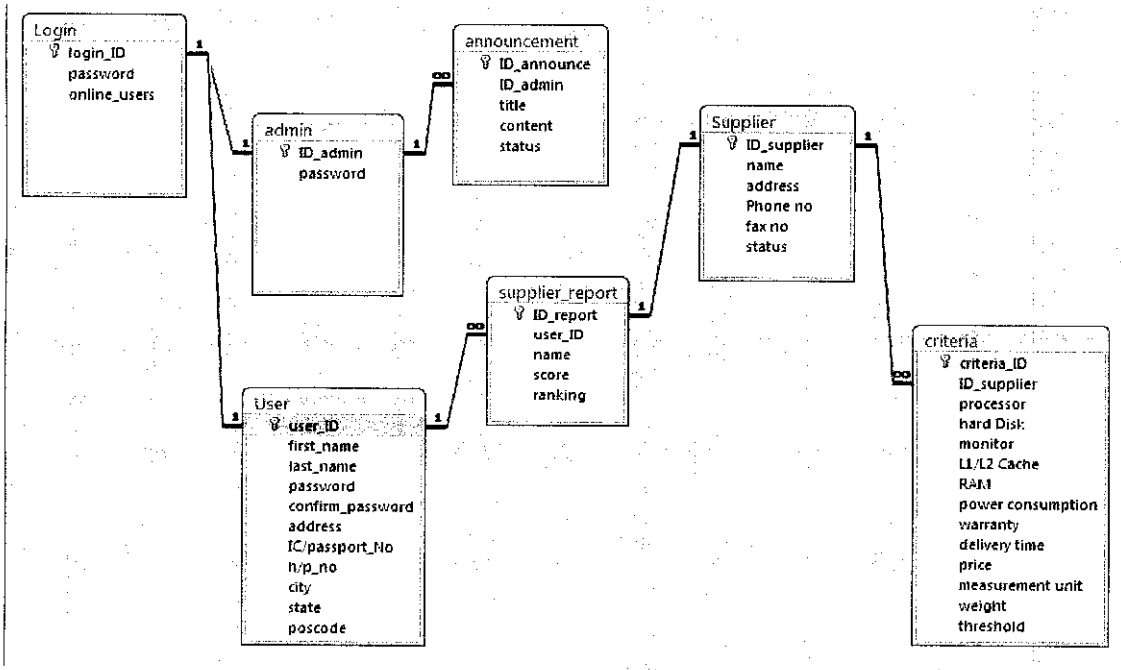


Figure 4-19:- Entity Relationship Diagram in Supplier Selection DSS.

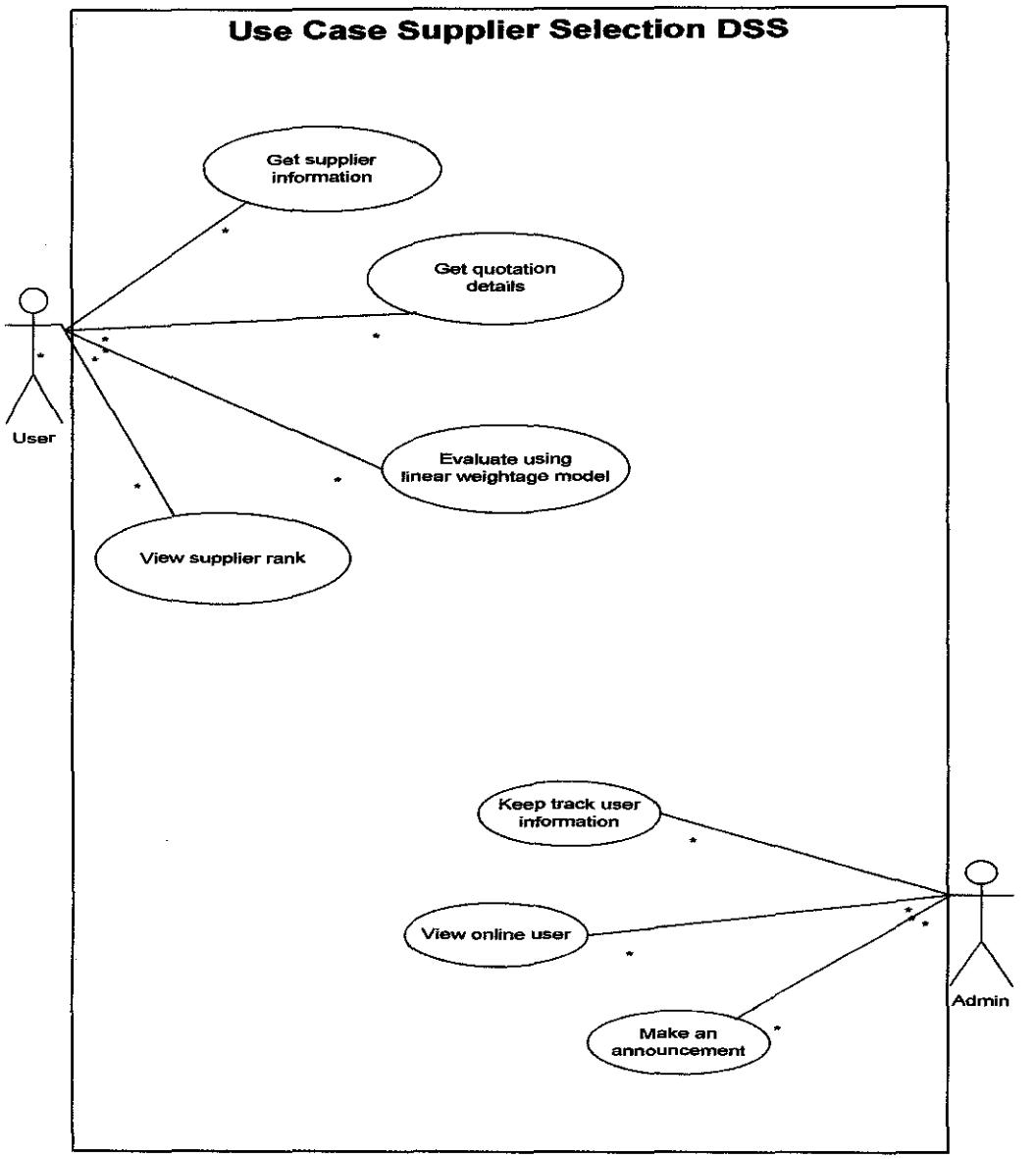


Figure 4-20:- Use Case Diagram for Supplier Selection DSS

CHAPTER 5
CONCLUSION

5.1 Introduction

This chapter mainly present and discusses the contribution of the research besides major concepts that this research intends to do. Moreover, the contributions of the website development for the linear weightage model are stated, the limitation of this research is stated too. Finally some future directions may be done as expected works for more improvements and better results are explained.

5.2 Research Contribution

The main contributions of this research are illustrated in the following points:

- The website development that proposed model is really represent a robust model for supplier selection process as it integrates the advantages of linear weightage.
- The website development that proposed model does save time and effort and that will strongly accelerate the supplier selection decision as well as improving the whole business processes within organizations in turn.
- The website development that proposed model with the capability to eliminate human judgment on suppliers that participate in the purchase process, besides the human judgment criteria as well.
- The website development that proposed model can be considered as core of DSS when designing DSS for supplier selection problem. It can play vital role through taking control of model base management system in DSS framework.

5.3 Research Limitation

The limitation of most researchers related to DSS is observed in the obstacles that have been facing managers when understanding how DSS selects the supplier as general. In addition, they also find that understanding of the mathematical models is not easy job for them regarding the gap between DSS and the knowledge backgrounds of those managers.

Sometimes decision makers urge to select more than one supplier, as a result of no one supplier satisfy all the requirements. The second drawback is that the proposed model did not consider the concepts of multi source supplier. This web development also has limitation when only consider the computer selection. Therefore, in the future, it may consider not only computer selection but available to any selection.

REFERENCES

Aboulhas Conrad Tsahat Onesime, Xu Xiofel and Zhan Dechen, "Decision support system for supplier selection process", *International journal of information technology& decision making*, 2004, Vo.13, pp.453-470.

Kaur P, Verma R, Mahanti N.C, and Chakraborty S., "A fuzzy-statistical comparative approach to vendor selection problem", 2007.
http://interstat.statjournals.net/YEAR/2007/articles/0707002.pdf

Weber C. A, Current J. R, and Benton W.C, "Vendor selection criteria and methods", *European journal of operational research*, 1991, Vol. 50, No.2, pp.2-18

Wei-Kang Wang, Wu Wen, Chang W.B., and Hao-Chen Huang, "A knowledge-based decision support system for government vendor selection and bidding", *JCIS-2006 proceeding*, 2006, pp.170-176.

Moynihan G.P, Saxena P, and Fonseca D. J, "Development of a decision support system for procurement operations", *International journal of logistics systems and management*, 2006, Vol.2, No.1, pp. 1-18.

Shuo-Yan Cou, and Yao Hui Chang, "A decision support system for supplier selection based on a strategy-aligned fuzzy SMART approach", *Journal of expert system with application*, 2007, pp.2-13.

Reza Mohammady Garfamy, "A data development analysis approach based on total on cost of ownership for supplier selection", *Journal of enterprise information management*, 2005, Vol.19, No.6, pp.662-678.

Chee-Cheng Chen, and Ching-Chow Yang, "Customer-Oriented Evaluation System of Supplier Quality Performance", 2002, http://en.scientificcommons.org

Mahmut SONMEZ, "A review and critique of supplier selection process and practices", business school, Occasion papaers series, 2006.

Fadihlah Ahmed, Saman M.Y.M, Mohamed Noor N.M, and Aida Othman, "DSS for tendering: integrating statistical single- criteria model with MCDM models", IEEE, 2007, pp.863-868.

Ghodsypour S.H, and O'Brien C, "A decision support system for supplier selection using an integrated analytic hierarchy process and linear programming", *International journal of production economics*, 1998, pp.200-212.

Derek L. Waller, *Operation management a supply chain approach*, Thomson, London, 2003.

Dan Wang, Yezhuang Tian, and Yunaquan Hu, "Empirical study of supplier strategies across the study chain management in manufacturing companies", IEEE, 2004, pp. 85-87.

Huang-Jyh Shyur, and Hsu-Shih Shih, "A hybrid MCDM model for strategic vendor selection", Mathematical and computer modeling, 2006, pp.749-761.

APPENDICES

The coding for login page including (not complete coding):-

```
<?php
        session_start();
        include "mysqi.php";
        $_POST['username'] = addslashes($_POST['username']); // sqi injection
        $_POST['password'] = addslashes($_POST['password']);
        $password = ($_POST['password']); // password variable
        $userrow = mysql_query("SELECT * FROM `supplier_login` "
. "WHERE `login_ID` = '" . $_POST['username'] . "'"
. " AND `login_password` = '" . $password ."';");

        if(mysql_num_rows($userrow) != "1"){
                //If invalid password and ID
                echo "<font color='red'><b> Login Failed!User ID and password not matched!</b></font>";
                include "login.php";
        } else{


                // 1 row found, go to next page
                $_SESSION['ID'] = $_POST['username'];
                $_SESSION['password']=$_POST['password'];
                mysql_query("UPDATE supplier_login SET login_status='online' WHERE login_ID='$_SESSION[ID]'");

                header("Location: homepage.php");


        }
```

In register page, there are some security issues that have to be considered such as mandatory information which required user to fill the data or character limitation. The algorithm are as below:-

```
<?php
session_start();
$con = mysql_connect("localhost","root","");
if (!$con)
  {
  die('Could not connect: ' . mysql_error());
  }// some codemysql_close($con);
mysql_select_db("supplier", $con);
$phone = isset($_POST['notel']) ? $_POST['notel'] :"";
$checkuser = mysql_query("SELECT user_ID FROM supplier_user WHERE user_ID='$_POST[username]'");
$username_exist = mysql_num_rows($checkuser);
$check_notel = mysql_query("SELECT user_phone FROM supplier_user WHERE user_phone='$phone'");
$IC_exist = mysql_num_rows($check_notel);

$flag="OK";
$msg="";        // Initializing the message to hold the error messages
$username = isset($_POST['username']) ? $_POST['username'] :"";
$password = isset($_POST['password']) ? $_POST['password'] :"";
if(strlen($username) < 5 ){    // check userID must more than 5 length
$msg=$msg." Your username must more than 5 character <BR>";
$flag="NOTOK";   //setting to not ok.
}
if(strlen($password) > 12 ){
$msg=$msg." Your password must not more than 12 character or number.<BR>";
$flag="NOTOK";
}
if($flag <>"OK"){
 echo "<center>$msg <br> <input type='button' value='Try Again' onClick='history.go(-1)'></center>";
  unset($IDPengguna);
    exit();
} //
elseif($username_exist > 0){
    $msg=$msg."Sorry, You username has been existed in the database. Please choose another username. Thank you!<BR>
    echo "<center>$msg <br> <input type='button' value='Try Again' onClick='history.go(-1)'></center>";
    unset($IDPengguna);
    exit();
```

Through the announcement form, admin also can choose to hide or display the announcement. The coding to generate this form and insert into database are as below:-

```
REQUIRE "mysql.php";
echo "<form name='new_annonce' action='process_new_annouce.php' method='post'>";
    echo "<table width='60%' border='0' align='left' cellpadding='0' cellspacing='0'>";
        echo "<tr>";
            echo "<th align=right class=style17>TITLE</th>";
            echo "<th class=style17> : </th>";
            echo "<td><input type='text' size=40 name='title' value=''></td>";
        echo "</tr>";
        echo "<tr>";
            echo "<th valign=top align=right class=style17>CONTENT</th>";
            echo "<th valign=top class=style17> : </th>";
            echo "<td><textarea cols=60 rows=7 name='content'></textarea></td>";
        echo "</tr>";
        echo "<tr>";
            echo "<th align=right valign=top class=style17>STATUS</th>";
            echo "<th valign=top class=style17> : </th>";
            echo "<td>";
                echo "<input type='radio' name='status' value='Y' checked>Display</br>";
                echo "<input type='radio' name='status' value='N' >Hide</br>";
            echo "</td>";
        echo "</tr>";
        echo "<tr>";
            echo "<th></th>";
            echo "<td></td>";
            echo "<td></td>";
        echo "</tr>";
        echo "<tr>";
            echo "<th></th>";
            echo "<td></td>";
            echo "<td><input type='submit' name='submit' value='Add'><a href='add_announce.p
value='Cancel'><input type='button' value='Back' onClick='history.go(-1)'></a></td>";
        echo "</tr>";
    echo "</table>";
echo "</form>";
?></p>

 */
REQUIRE "mysql.php";
$title=$_POST['title'];
$content=$_POST['content'];
$status=$_POST['status'];
$tm_sql="
        INSERT INTO supplier_announce (announce_title,announce_content,announce_status)
        VALUES ('$title','$content','$status')
        ";
$tm_query=mysql_query($tm_sql);
header("location:add_announce.php");
?>
```

The coding to update user profile is as below (not complete algorithm):-

```
<?php
session_start();
$user_ID = $_SESSION['ID'];
include 'mysql.php';
//Just to make sure user login this system
if(!$user_ID)
    {
    echo "<br>You're not login. Please login this system first.<br>";
    }
else
    {
    //Get the variable from update profile form
    $fname = $_POST['fname'];
    $mname = $_POST['mname'] ;
    $lname = $_POST['lname'];
    $address = $_POST['address'] ;
    $phone = $_POST['phone'] ;
    $city =  $_POST['city'];
    $state = $_POST['state'];
    $poscode = $_POST['poscode'];
    $email = $_POST['email'] ;
    //If user leave the textbox blank
    if(!$fname AND !$mname AND !$lname AND !$address AND !$phone AND !$city AND !$state AND !$poscode AND !$email)
        {
        echo "
        <b>Please insert the data.</b>
        <br>";
        }
    //If user change the profile
    if($fname)
        {
        mysql_query("UPDATE supplier_user SET user_FName='$fname' WHERE user_ID='$user_ID'");
        }
    if($mname)
        {
        mysql_query("UPDATE supplier_user SET user_MName='$mname' WHERE user_ID='$user_ID'");

        }
     if($lname)
         {
         mysql_query("UPDATE supplier_user SET user_LName='$lname' WHERE user_ID='$user_ID'");
         }
     if($address)
         {
         mysql_query("UPDATE supplier_user SET user_address='$address' WHERE user_ID='$user_ID'");
         }
     if($phone)
         {
         mysql_query("UPDATE supplier_user SET user_phone='$phone' WHERE user_ID='$user_ID'");
         }
     if($city)
         {
         mysql_query("UPDATE supplier_user SET user_city='$city' WHERE user_ID='$user_ID'");
         }
     if($state)
         {
         mysql_query("UPDATE supplier_user SET user_state='$state' WHERE user_ID='$user_ID'");
         }
     if($poscode)
         {
         mysql_query("UPDATE supplier_user SET user_poscode='$poscode' WHERE user_ID='$user_ID'");
         }
     if($email)
         {
         mysql_query("UPDATE supplier_user SET user_email='$email' WHERE user_ID='$user_ID'");
         echo "<font color='red'><center>Profile Updated!!!</strong></br>";
         echo "<input type='button' value='Back' onClick='history.go(-2)'></center>";
         }
    }
?><style type="text/css">
```

All of the variable and threshold will be insert in the database through process_variable_comp. php. The system also make sure that the weight total is 1. If not, user have to fill the weights again. The algorithm is as below:

```
$flag="OK";
if(!$weights1 AND !$weights2 AND !$weights3 AND !$weights4 AND !$weights5 AND !$weights6 AND !$weights7 AND !$weights8 AND !$weights9)
        {
        echo "
        <center>Please insert the weights. The weight must be between 0 and 1
        <br>";
        echo "<input type='button' value='Back' onClick='history.go(-1)'></center>";
        $flag=="NOTOK";
        }
elseif($weights1 + $weights2 + $weights3 + $weights4 + $weights5 + $weights6 + $weights7 + $weights8 + $weights9 != 1)
        {
        echo "
        <center>Please check the value of the weight. It must be 1 after sum up all the value.
        <br>";
        echo "<input type='button' value='Back' onClick='history.go(-1)'></center>";
        $flag=="NOTOK";
        }


$addcriteria_sql="INSERT INTO supplier_criteria
(criteria_name,criteria_name2,criteria_name3,criteria_name4,criteria_name5,criteria_name6,criteria_name7,criteria_name8,criteria_name9,criter
ia_measure_unit,criteria_measurement_unit2,criteria_measurement_unit3,criteria_measurement_unit4,criteria_measurement_unit5,criteria_measurem
ent_unit6,criteria_measurement_unit7,criteria_measurement_unit8,criteria_measurement_unit9,criteria_threshold,criteria_threshold2,criteria_th
reshold3,criteria_threshold4,criteria_threshold5,criteria_threshold6,criteria_threshold7,criteria_threshold8,criteria_threshold9,criteria_wei
ght,criteria_weight2,criteria_weight3,criteria_weight4,criteria_weight5,criteria_weight6,criteria_weight7,criteria_weight8,criteria_weight9)
VALUES('$processor','$hardisk','$monitor','$cache','$ram','$power','$warranty','$delivery','$price','$MHz','$GB','$inch','$MB','$MB2','$watt'
,'$in_years','$in_weeks','$in_RM','$select','$select2','$select3','$select4','$select5','$select6','$select7','$select8','$select9','$weights
1','$weights2','$weights3','$weights4','$weights5','$weights6','$weights7','$weights8','$weights9')";
$addcriteria_query=mysql_query($addcriteria_sql);



echo "<center>Congratulation! You're successfully filled the variable of computer. This is the detail:</strong></br>";
echo "Processor :".$_POST["weights1"];
echo "</br>Hardisk : ".$_POST["weights2"];
echo "</br>Monitor : ".$_POST["weights3"];
echo "</br>Cache : ".$_POST["weights4"];
echo "</br>RAM : ".$_POST["weights5"];
echo "</br>Power Consumption : ".$_POST["weights6"];
echo "</br>Warranty : ".$_POST["weights7"];
echo "</br>Delivery Time : ".$_POST["weights8"];
echo "</br>Price : ".$_POST["weights9"];
echo "</br>You have to click continue link here to continue the supplier process.";
echo "<center><a href= supplier_details.php>Continue</strong></br>";
}
?>
```

The algorithm to display the total after evaluate using linear weightage model supplier data is as below (not complete algorithm):-

```
$query = "SELECT MAX(details_value) as processor FROM supplier_details WHERE details_status = 'in process'";

 $result = mysql_query($query) or die(mysql_error());

  $query2 = "SELECT MIN(details_value) as processor2 FROM supplier_details WHERE details_status = 'in process' ";

 $result2 = mysql_query($query2) or die(mysql_error());


 while($row = mysql_fetch_array($result)){

   $max = $row['processor'];
 }
  while($row2 = mysql_fetch_array($result2)){
  $min = $row2['processor2'];
}
while($row2 = mysql_fetch_array($result2)){
  $min = $row2['processor2'];
}

 $totall=0;
 $arr = array();
 $arr1 = array();
 $arr2 = array();

 echo "<table border='1' name='totall'>";
 $k=0;


$result = mysql_query ("SELECT * FROM supplier_details WHERE `details_status` = 'in process'");
    for($i=0; $i<$result; $i++)
{


    while($row_weight = mysql_fetch_array($profile2)){
    while($row = mysql_fetch_array($result)){
{

       echo '<td width="40" valign="center">';

       //loop thru the serials to create three columns
       $i = 0;
       while ($i<'1')
       {
       if ($row['details_threshold']=='min'){
        $avg_min = @(($row[14]-$min)/($max-$min));
        $wmin_result = @($avg_min * $row_weight['criteria_weight']);
        //echo $row[15];
        echo round($wmin_result,3);
        $arr[$k]= $wmin_result;
       $i++;
        }
        else{
        $avg_max = @(($max-$row[14])/($max-$min));
        $wmax_result = @($avg_max * $row_weight['criteria_weight']);
        echo round($wmax_result,3);
```

```
        $arr[$k]= $wmax_result;
       $i++;
        }
        }
        }
        $k++;
       echo "</td>";
    }
  }
}
  ?>

,

$j=30;
$display_columns =$j++;
$query = "SELECT * FROM `supplier_details` "
. "WHERE `details_status` = 'in process ';";

// We do the query, and find out how many items we'll need to list.
$result = mysql_query($query);
$count = mysql_numrows($result);

// We have enough to figure out how many empty spaces there'll be left at
// the bottom of the table.
$padding =($display_columns-1)-(($count-1)%$display_columns);
//
// We also know enough to know how many rows there'll be, but I for one
// don't really care about that right now.
$total = array();
for ($m=0; $m<$count; $m++){
    //$total[$m]=80;
    $total[$m]=$arr[$m]+$arr1[$m]+$arr2[$m]+$arr3[$m]+$arr4[$m]+$arr5[$m]+$arr6[$m]+$arr7[$m]+$arr8[$m];

}
```