

Implementation of Weighted Product Method in the Decision Support System of University Selection in Australia

Ameliana, Windarto
Universitas Budi Luhur

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Abstract: Choosing a university for high school students is the main thing for them to continue their study to a higher level. Today there are many universities, both at domestic universities and overseas universities. Each university began to offers based on prices, level of accreditation, the choice of departments, up to the facilities at the University. With the increasing number of universities, more students will find it difficult to determine the university they would choose. This is because there are too many suggestions to determine certain university from other people, expensive tuition fees, and there are still many students who do not have a mature plan to continue their study to a higher level. Velocity International Inc. is a company engaged in the field of educational consulting. The company has services to help students who want to continue their education abroad, by providing consultations on universities abroad, especially in Australia. During the consultation period, the counselor will provide many university choices to students and explain one by one about the university that will be offered. After getting an explanation from the counselor, there are still many students who have difficulty in choosing the university recommended by the counselor. This is caused by information and recommendations given by the counselors to students are still not appropriate. With this problem, the solution that might be needed is to make a decision support system application that can help to provide conclusions in the form of recommendations so it can be used as references for students to decide which university to choose. In this study, the method which applied to a decision support system is the Weighted Product (WP) method. The criteria used in this study are cost, accommodation, major, and IELTS score, whereas each non-interdependent criterion will be evaluated to produce several alternative choices. The result of this study is the realization of a decision support system that is able to produce recommendations for university selection for students.

1. BACKGROUND

Choosing a university for high school students is the main thing for students to pursue higher education. At present, there are many universities, both those in the country and abroad. Many universities began to offer prices, level of accreditation, and choice of majors available to facilities at the University. In addition, the more universities, the more students who have difficulty in deciding which university they will choose because there are too many suggestions about the University to be addressed by others, expensive tuition fees and many students who do not have a mature plan to proceed to higher education level.

Velocity International Inc. is a company engaged in the field of educational consulting. This company helps students who want to continue their education abroad by providing consultations on universities in foreign countries, especially in Australia. During the consultation period, the counselor provides many Universities as choices to students and explains one by one about the University offered. After being explained by the counselor, there are still many students who have difficulty in choosing a university given by the counselor because the counselor is still not right in providing information about the University to students.

There are many ways that can be done as a solution to solve these problems, one of them is by

developing a decision support system to determine the best universities in order to help students choosing the desired university. This system will help students to choose the University according to the category desired by students such as the range of tuition fees, desired courses, and so on. With the existence of a decision support system application is expected to help provide conclusions or decisions that can be taken as a reference for students to determine the university to be addressed. With the existence of a decision support system application is expected to help provide conclusions or decisions that can be taken as a reference for students to determine the university to be addressed. One of the methods that can be used in decision support systems is the Weighted Product (WP) method. The reason for choosing this method is because this method can be used in each alternative against four criteria which are cost, accommodation, major, and IELTS score that is not interdependent. The data analysis technique used in this method is by powering the values of each criterion by the weight values which are then multiplied (Ahmadi and Wiyanti, 2014).

2. THEORY

a. Decision Support System

The DSS or Decision Support System (DSS) was first disclosed in the early 1970s by Michael S. Scott Morton with the term Management Decision System. The system is a computer-based system that is intended to help make decisions by utilizing certain data and models to solve various unstructured problems (N.Syafitri, Sutradi and Dewi, 2007). Decision Support System is a computer-based information system that approaches to produce various alternative decisions to assist certain parties in handling problems using data and models. Decision making is the result of a selection process of various alternative actions that may be selected with certain mechanisms, with the aim of producing the best decisions. A DSS only provides alternative decisions and the final decision is then left to the user (Nurjannah, Arifin and Khairina, 2015).

b. Basic of Decision Making

Decision making is a form of the selection process of many alternatives through a certain method that will produce a decision at the end. The model that describes the decision-making process consists of

four phases that are: (Nurjannah, Arifin and Khairina, 2015):

a. Intelligence

This stage is the stage of defining the problem and identifying the information needed that is related to the problems faced and the decisions that will be made.

b. Design

This stage is a process to represent the system model that will be built based on the assumptions that have been set. In this stage, a model of the problem is created, tested, and validated.

c. Choice

This stage is a process of testing and choosing the best decision based on certain criteria that have been determined and leads to the objectives to be achieved.

d. Implementation

This stage is the implementation stage of the decisions that have been taken. At this stage, a series of planned actions need to be developed so that the results of the decisions can be monitored and adjusted if improvements are needed.

c. Objectives, Strengths, and Disadvantages of Decision Support System

The objectives of a Decision Support System (DSS) is to increase the ability of decision-makers by providing more or better decision alternatives and to help formulate problems and conditions faced. Thus, DSS can save time, effort, and cost. So simple it can be said that the objective of DSS is to increase effectiveness and efficiency in decision making. Nevertheless, the emphasis of a DSS is on increasing the effectiveness of decision making rather than efficiency (Abadi, 2015).

The Decision Support System (DSS) can provide several benefits for the user. According to Turban (Turban, E. Aronson and Liang, 2007) these benefits include:

- a. Extending the ability of decision-makers in processing data or information for decision making.
- b. Save time needed to solve problems, especially various problems that are very complex and unstructured.
- c. Produce solutions faster and the results are reliable.
- d. Able to provide various alternatives in decision making, even if the DSS is not able to solve problems faced by decision-makers, but can be

used as a stimulant in understanding the problem.

- e. Strengthen the confidence of decision makers in the decisions they make.
- f. Providing competitive advantages for the organization as a whole with saving time, effort, and cost.

Although it was designed very carefully and considered all the factors, according to Turban (Turban, E. Aronson and Liang, 2007) DSS has weaknesses or limitations, that is:

- g. There are several management abilities and human talents that cannot be modeled so that the models that exist in the system do not all reflect the real problem.
- h. DSS is limited to providing an alternative to the knowledge given to it at the time of designing the program.
- i. The processes that can be carried out by DSS usually also depend also on the capabilities of the software used.
- j. Continuous changes must always be made to adapting the environmental conditions changing so that the system is up to date.
- k. However, it must be remembered that DSS is designed to assist or support decision making by processing information and data needed, and not to take over decision making.

d. Decision Support System Architecture

Things that must be considered to make DSS architecture that is:

- a. Strategic, tactical, and operational decisions.
- b. Unstructured, semi-structured, and structured decisions.
- c. All levels of management and staffs who have knowledge in the company.
- d. All major functional positions, products, and business lines, and geographical positions of a company.

e. Multi Attribute Decision Making (MADM)

Multi Attribute Decision Making (MADM) is a method used to find the most optimal alternative from a number of optimal alternatives with certain criteria (N.Syafitri, Sutradi and Dewi, 2007). The essence of MADM is to determine the weight value for each attribute, then proceed with a ranking process that will select alternatives that have been given (N.Syafitri, Sutradi and Dewi, 2007). The approach

that can be done in the Multi Attribute Decision Making (MADM) method is in two stages, that is:

- a. Grouping decisions on each alternative.
- b. Ranking of alternative decisions based on decisions that have been grouped before.

f. Weighted Product Method (WP)

Weighted Product (WP) is one of the methods used to solve MADM problems. WP is a method that uses multiplication to link the rating of an attribute, where the rating of each attribute should be pre-populated with the corresponding weights. This process is similar to the normalization process. The WP method can be helpful in taking a laptop selection decision, but the calculations using this WP method only produce the largest value that will be voted as the best alternative. The calculation will correspond to this method if the selected alternative meets the predefined criteria. This WP method is more efficient because of the time required in shorter calculations. The weight for the benefit attribute serves as a positive rank in the multiplication process, while the cost weight serves as a negative rank. (N. Syafitri, Sutradi and Goddess, 2007)

Weight fixes for $\sum W_j = 1$ using equation (1)

$$W_j = \frac{w}{\sum w} \dots \dots \dots (1)$$

Variable W is the positive value power for profit attribute and negative value for cost attribute. The preference for S_i alternatives is given by equation (2).

$$S_i = \prod_j^n x_{ij}^{w_j} \dots \dots \dots (2)$$

by $i = 1, 2, \dots, m$ and $j = 1, 2, \dots, n$ as an attribute Whereas:

- Π : Product
- S_i : Score of each alternative
- X_{ij} : The i-th alternative value towards the j-th attribute
- W_j : Weight of each attribute or criterion
- n : Number of criteria

To find the best alternative done with equation (3)

$$V_i = \frac{S_i}{\prod_{j=1}^n (x_j^*)^{w_j}} \dots \dots \dots (3)$$

Whereas:

- V : Alternative preference is analogous as vector V
- X : Scores of criterion
- W : Weight of criterion/ sub criterion
- i : Alternative
- j : Criterion
- n : Number of criteria
- * : The number of criteria that have been assessed in vector S

The biggest V_i value states that A_i alternative is chosen. The steps in the calculation of the WP method are as follows.

- 1) Switches all attributes for the entire alternatives with W (weight) as a positive power for the profit attribute and negative value for the cost attribute.
 - 2) The results of the multiplication are aggregated to generate value on each alternative.
 - 3) Divides the V values for each alternative with the total value of all alternatives.
 - 4) Found the best alternative in order to be a decision.
- (a) 6.0, having a weighted value of = 2
 (b) 6.5, having a weighted value of = 1

3. DESIGN

a. Program Flow

In this program, there are several pages that will be created, namely the Start Page, menu page, weight input page, university page, consultation page, report page, and help page. On the Start page, the user can select the "GO!" button to go to the menu page. On the menu page, there is weight input, university page,

consultation page, report page, and help page. First, the user can select the weight input page. On this page, the user can fill in the criteria's name and weight. Once completed, the user can choose the University page to input the university data according to the available weights and criteria. If any student wants to consult, the user can choose a consultation page. User can select the criteria that the student wants and then press the "Result" button to see the university name that will be the university recommendation that has been selected according to user needs. If the user wants to view the student's personal data and the selected university results, the user can select the report page. Weighted Product method runs on the consultation page, where the user pressing the "result" button came to the calculation of the Weighted Product method which will generate university name as a recommendation chosen by the student previously.

b. Design

The screen design is an important aspect for the user to give the idea of a program so that users feel comfortable and have no trouble using the program. Here are some of the screen designs to be created:

a. Weight Input Page Design

On the input criteria page, the user can enter the criteria data and weights to be saved into the database.

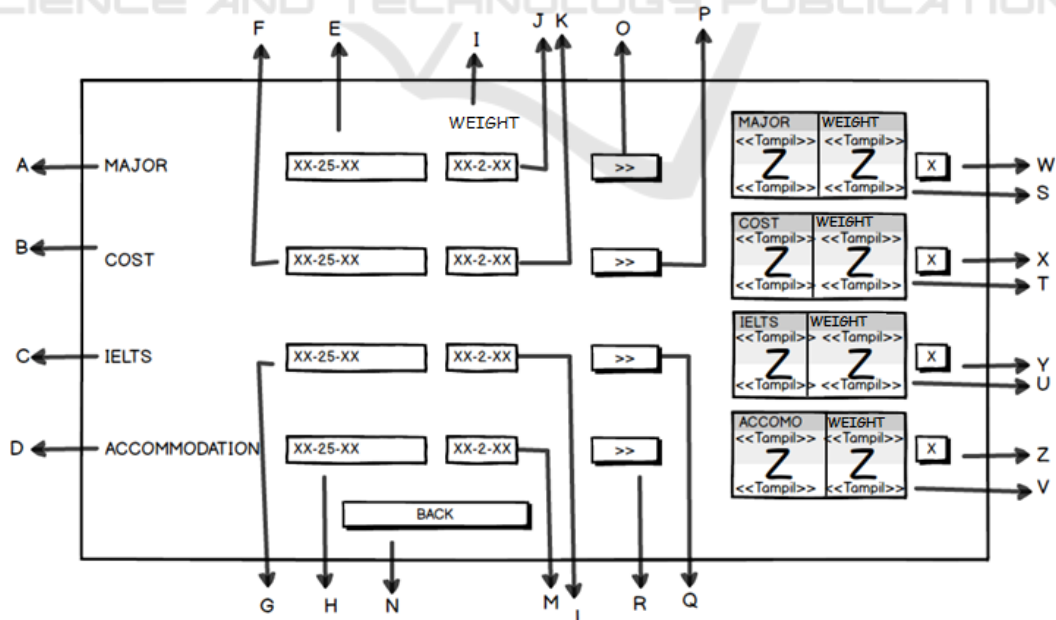


Figure 1. Weight Input Page Screen Design

Detail for figure 1:

- A. Label "MAJOR"
- B. Label "COST"
- C. Label "IELTS"
- D. Label "ACCOMMODATION"
- E. Text Field to input Major
- F. Text Field to input Cost
- G. Text Field to input IELTS
- H. Text Field to input Accommodation
- I. Label "WEIGHT"
- J. Text Field to input weight of Major
- K. Text Field to input weight of Cost
- L. Text Field to input weight of IELTS
- M. Text Field to input weight of Accommodation
- N. Button Back to return to menu page
- O. Button ">>" to input into the list of Major
- P. Button ">>" to input into the list of Cost

- Q. Button ">>" to input into the list of IELTS
- R. Button ">>" to input into the list of Accommodation
- S. List of criteria and weight of Major
- T. List of criteria and weight of Cost
- U. List of criteria and weight of IELTS
- V. List of criteria and weight of Accommodation
- W. Button "X" to delete data from the list of Major
- X. Button "X" to delete data from the list of Cost
- Y. Button "X" to delete data from the list of IELTS
- Z. Button "X" to delete data from the list of Accommodation

b. University Page Screen Design

In this page, user can input universities data and put weights to each university to be saved into the database.

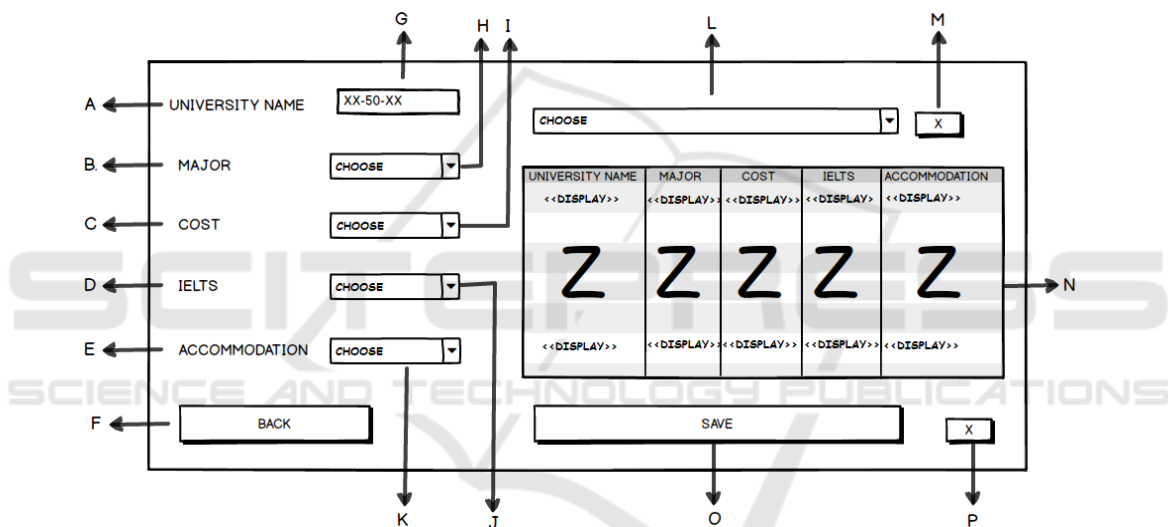


Figure 2. University Page Screen Design

Detail for figure 2:

- A. Label "UNIVERSITY NAME"
- B. Label "MAJOR"
- C. Label "COST"
- D. Label "IELTS"
- E. Label "ACCOMMODATION"
- F. Button back to return to menu
- G. Text Field to input name of university
- H. Combo box to choose name of Major
- I. Combo box to choose name of Cost
- J. Combo box to choose name of IELTS
- K. Combo box to choose name of Accommodation

- L. Combo box to choose name of University
- M. Button X to delete name of University from the Combo Box
- N. List to show name of university and its criteria
- O. Button Save to save data
- P. Button X to delete data from the list

c. Consultation Page Screen Design

In this page, students who assisted by the counselor can input the weight of criteria based on the existing criteria

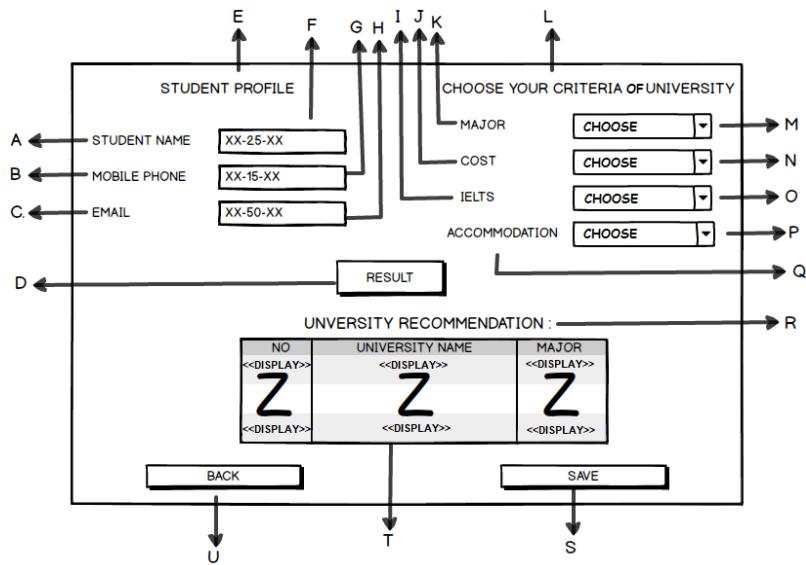


Figure 3. Consultation Page Screen Design

Detail for figure 3:

- A. Label "STUDENT NAME"
- B. Label "MOBILE PHONE"
- C. Label "EMAIL"
- D. Button Result to show recommendation results
- E. Label "STUDENT PROFILE"
- F. Text Field to input student's name
- G. Text Field to input student's cellphone number
- H. Text Field to input student's email
- I. Label "IELTS"
- J. Label "COST"
- K. Label "MAJOR"
- L. Label "CHOOSE YOUR CRITERIA UNIVERSITY"
- M. Combo box to choose Major
- N. Combo box to choose Cost
- O. Combo box to choose IELTS
- P. Combo box to choose Accommodation
- Q. Label "ACCOMMODATION"
- R. Label "UNIVERSITY RECOMMENDATION"
- S. Button Save to save data
- T. List to show recommendation result
- U. Button Back to return to menu page

4. SCREEN DISPLAY

- a. Screen display of weight input page

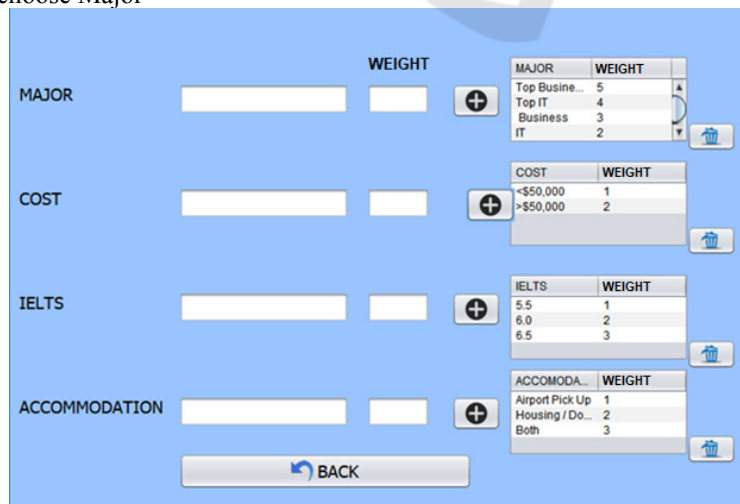


Figure 4. Weight input page screen display

b. Screen display of university page

Figure 5. University page screen display

c. Consultation Page Screen Display

UNIVERSITY	COST	IELTS	ACCOMMODATION	SCORE
Academia College	<\$50,000	5.5	Both	0.38192509317517825
Boxhill Institute	<\$50,000	6.0	Both	0.34025657593539593
Holmesglen Institute	<\$50,000	6.0	Housing / Dormitory	0.277818330889426

Figure 6. Consultation page screen display

5. PROGRAM EVALUATION

Program evaluation aims to know the results and determine both shortcomings and advantages of the system that has been created. Therefore, an experiment was conducted to evaluate successful access or failed access based on several conditions.

Table 1. Weight Input by Student

Criterion	Weight
C1	5
C2	2
C3	3
C4	3

Afterwards, the weight of each criterion needs to be fixed first before being used for normalizing calculations using formula $\frac{W_i}{\sum W}$.

$$W_{first} = 5+2+3+3 = 13$$

$$W1 = \frac{5}{5+2+3+3} = 0.38461538461538464$$

$$W2 = \frac{2}{5+2+3+3} = 0.15384615384615385$$

$$W3 = \frac{3}{5+2+3+3} = 0.23076923076923078$$

$$W4 = \frac{3}{5+2+3+3} = 0.23076923076923078$$

After obtaining the latest W_i value, it will be normalized to get S_i value by rounding up the latest W_i value.

University Alternative A1

$$S1 = (5^{0.38461538461538464}) * (2^{-0.15384615384615385}) * (2^{-0.23076923076923078}) * (3^{0.23076923076923078}) \\ = 1.832984339228869$$

University Alternative A2

$$S2 = (2^{0.38461538461538464}) * (2^{-0.15384615384615385}) * (2^{-0.23076923076923078}) * (3^{0.23076923076923078}) \\ = 1.2885607692309613$$

University Alternative B1

$$S3 = (3^{0.38461538461538464}) * (1^{-0.15384615384615385}) * (2^{-0.23076923076923078}) * (2^{0.23076923076923078}) \\ = 1.5258371159564497$$

University Alternative B2

$$S4 = (2^{0.38461538461538464}) * (1^{-0.15384615384615385}) * (2^{-0.23076923076923078}) * (2^{0.23076923076923078}) \\ = 1.3055116977098093$$

University Alternative B3

$$S5 = (1^{0.38461538461538464}) * (1^{-0.15384615384615385}) * (2^{-0.23076923076923078}) * (2^{0.23076923076923078}) \\ = 1$$

University Alternative C1

$$S6 = (3^{0.38461538461538464}) * (1^{-0.15384615384615385}) * (1^{-0.23076923076923078}) * (3^{0.23076923076923078}) \\ = 1.9661338478579946$$

University Alternative C2

$$S7 = (1^{0.38461538461538464}) * (1^{-0.15384615384615385}) * (1^{-0.23076923076923078}) * (3^{0.23076923076923078}) \\ = 1.2885607692309613$$

University Alternative D1

$$S8 = (4^{0.38461538461538464}) * (2^{-0.15384615384615385}) * (3^{-0.23076923076923078}) * (2^{0.23076923076923078}) \\ = 1.3951239160136684$$

University Alternative D2

$$S9 = (3^{0.38461538461538464}) * (2^{-0.15384615384615385}) * (3^{-0.23076923076923078}) * (2^{0.23076923076923078}) \\ = 1.2489913293790396$$

University Alternative E1

$$S10 = (3^{0.38461538461538464}) * (2^{-0.15384615384615385}) * (3^{-0.23076923076923078}) * (2^{0.23076923076923078}) \\ = 1.2489913293790396$$

University Alternative F1

$$S11 = (5^{0.38461538461538464}) * (2^{-0.15384615384615385}) * (2^{-0.23076923076923078}) * (3^{0.23076923076923078}) \\ = 1.832984339228869$$

University Alternative F2

$$S12 = (4^{0.38461538461538464}) * (2^{-0.15384615384615385}) * (2^{-0.23076923076923078}) * (3^{0.23076923076923078}) \\ = 1.6822311574409705$$

University Alternative G1

$$S13 = (1^{0.38461538461538464}) * (1^{-0.15384615384615385}) * (2^{-0.23076923076923078}) * (3^{0.23076923076923078}) \\ = 1.0980862271455496$$

$$\sum S = 1.832984339228869 + 1.2885607692309613 + 1.5258371159564497 + 1.3055116977098093 + 1 + 1.9661338478579946 + 1.2885607692309613 + 1.3951239160136684 + 1.2489913293790396 + 1.2489913293790396 + 1.832984339228869 + 1.6822311574409705 + 1.0980862271455496$$

$$\sum S = 18.71399683780218$$

After obtaining the S_i value, the next stage is to calculate V_i to get the best employees ranking using formula $\frac{S_i}{\sum S}$.

University Alternative A1

$$V1 = \frac{1.832984339228869}{18.71399683780218} = 0.09794723997848763$$

University Alternative A2

$$V2 = \frac{1.2885607692309613}{18.71399683780218} = 0.06885545511197666$$

University Alternative D2

$$V9 = \frac{1.2489913293790396}{18.71399683780218} = 0.06674102492398007$$

University Alternative B1

$$V3 = \frac{1.5258371159564497}{18.71399683780218} = 0.08153453958452457$$

University Alternative E1

$$V10 = \frac{1.2489913293790396}{18.71399683780218} = 0.06674102492398007$$

University Alternative B2

$$V4 = \frac{1.3055116977098093}{18.71399683780218} = 0.06976124389807965$$

University Alternative F1

$$V11 = \frac{1.832984339228869}{18.71399683780218} = 0.09794723997848763$$

University Alternative B3

$$V5 = \frac{1}{18.71399683780218} = 0.05343593934888377$$

University Alternative F2

$$V12 = \frac{1.6822311574409705}{18.71399683780218} = 0.08989160209981824$$

University Alternative C1

$$V6 = \frac{1.9661338478579946}{18.71399683780218} = 0.10506220904592727$$

University Alternative G1

$$V13 = \frac{1.0980862271455496}{18.71399683780218} = 0.058677269033594194$$

University Alternative C2

$$V7 = \frac{1.2885607692309613}{18.71399683780218} = 0.06885545511197666$$

University Alternative D1

$$V8 = \frac{1.3951239160136684}{18.71399683780218} = 0.0745497569602836$$

Table 2. University Ranking Process

Name of University	Calculation Results	Ranking
Academia College, major: Business	0.10506220904592727	1
Victoria University, major: Top Business	0.09794723997848763	2
Deakin University, major: Top Business	0.09794723997848763	3
Deakin University, major: Top IT	0.08989160209981824	4
Holmesglen Institute, major: Business	0.08153453958452457	5
RMIT University, major: Top IT	0.0745497569602836	6
Holmesglen Institute, major: IT	0.06976124389807965	7
Victoria University, major: IT	0.06885545511197666	8
Academia College, major: Hospitality	0.06885545511197666	9
Swinburne University, major: Business	0.06674102492398007	10
RMIT University, major: Business	0.06674102492398007	11
Boxhill Institute, major: Hospitality	0.058677269033594194	12
Holmesglen Institute, major: Hospitality	0.05343593934888377	13

From the calculation above, the university recommendation for Top Business major according to user input (student) is Deakin University or Victoria University with a value of 0.09794723997848763.

- a. Advantages
 1. Facilitate the counselor of Velocity International Inc. in providing university recommendations according to the student's criteria.
 2. Calculation results are 100% accurately using the Weighted Product method.
 3. Provide the university recommendation according to the student's selected major.
 4. This app helps counselors if there is a better university than the previous counselor's recommendation.
- b. Disadvantages
 1. This application is desktop based so it can not be accessed using the Internet network.
 2. There is a similar calculation result based on weight value inputted
 3. This application has predefined criteria and cannot be changed.
 4. The calculation results are always in the form of rank despite there is a similar calculation result of more than one university.

6. RESULT

a. Summary

Based on the analysis that has been done during a series of processes from design to implementation of the University Recommendation Decision Support System, it can be concluded that:

- a. This decision support system can generate several university recommendations according to the student's selected criteria.
- b. By implementing the Weighted Product (WP) method in this decision support system can provide the results of the University recommendation, which is the highest calculation results of Weighted Product (WP) method.

b. Suggestion

As for the suggestions needed to make this system running better:

- a. This application can be developed using other methods.
- b. This application can be developed for the addition of other criteria according to the

system user's needs, so it can improve system performances.

- c. This application can be developed into online based application or other display based (not only desktop-based).
- d. Can be added add criteria feature for subsequent needs.

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