



## AHP (ANALYTICAL HIERARCHY PROCESS) ELECTORAL COLLEGE MAJORS IN INDONESIA BASED ON ANDROID MOBILE

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### ABSTRACT

The development of the Android platform on mobile devices is experiencing rapid increase in Indonesia. This confirms that the Android mobile platform is still a favorite mobile system operation for Indonesia society. Along with this, nowadays almost all high school students in Indonesia wished to continue their education to university after graduation. However, not all this prospective students know the majors or courses that suit with them. algorithm is one of the swarm intelligence that evolve fast for almost area of optimization and engineering. To solve this problem, we suggest building an application that can calculate several possible courses relevant to students based on certain matters. Based on the DSS (Decision Support System) and using the method of AHP (Analytical Hierarchy Process) as one of the methods of expert system, this application can be calculating and displays the results in the form of courses that correspond to users that the candidate based on ideals, interests, values, academic advice, and their financial ability. These applications are built on the mobile platform Android which is being favored by Indonesian society, and society also aims to be a practical and easy to use anywhere and anytime. Based on the results of the questionnaire, the results obtained from the application can be accepted as input to select majors at university. Based on the data obtained in the questionnaires, the most important criteria are ideals. Ideals the most attention in choosing college majors with percentage of 48.9%, followed by interest (25.2%), the value of academic (11.6%), financial (8.7%), and the nearest person advice (5.7%).

**Keywords:** AHP, android, DSS, college major, mobile, university.

### 1. INTRODUCTION

Based on the data that we get on page of the site of the Ministry of education and culture of the Republic of Indonesia (KEMENDIKNAS), there is a growing number of schools who register their students for national selection sign in universities (DEYBAC) in 2013. This increase occurred as much as double that of the previous year which was only 7.713 schools to over 13 thousand schools from all over Indonesia in 2013. This proves that the candidate who most are students who have just graduated from high school have a strong desire to continue their education at the college level [6].

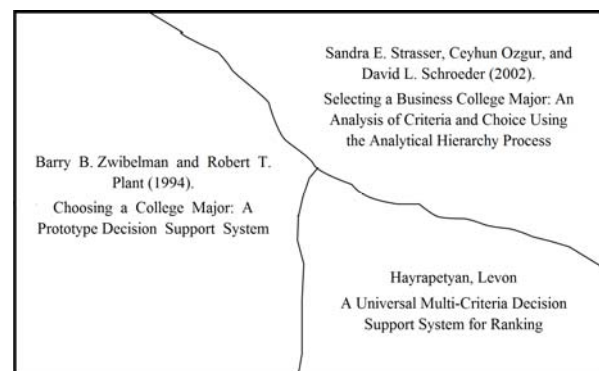
To avoid errors in determining the appropriate college courses with prospective students, we found a conclusion that we need to built a tool used to help choose college majors. In this study we try to built a mobile Android-based applications to help choose college majors for prospective students.

According to Triantaphyllou, and Mann (1995) Analytical Hierarchy Process (AHP) is one method of Multi Criteria Decision Making (MCDM) which was developed by Prof. Thomas L. Saaty. AHP is a decision support tool that can be used to solve a complex decision. AHP uses a hierarchical structure of multi-level criteria, sub-criteria, and alternative [4].

By using the method of analytical hierarchy process (AHP) which is the approach of multiple-criteria decision making (MCDM). And by using computer calculations that was built on the Android mobile platform, the application was developed services to choose college majors.

### 2. RELATED WORK

There are several related publications with our research has been identified. Sandra E. Strasser, Ceyhun Ozgur, and David L. Schroeder, have research focusing on the selecting a business college major [3]. Barry B. Zwibelman, and Robert T. Plant, focusing on prototype to selecting a college major [5]. And Hayrapetyan Levon, focusing on a universal multi-criteria decision support system for ranking [1].



**Figure-1.** Related work.

### 3. RESEARCH METHODOLOGY

In this study, we are conducting research activities gradually by following the plan of research activities in the form of a framework of thought. The



framework of thought that we use in this research can be seen in the picture below:

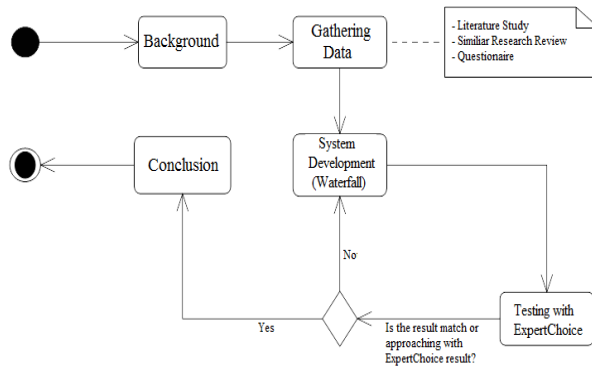


Figure-2. Research methodology.

#### 4. DISCUSSIONS

Here are the results of the implementation and testing of the simulation physics on serious game:

##### A. Problem identification

From the results of a questionnaire that had been deployed, when given the statement "You never feel difficulty when determining majors in College after graduating from high school." 21% of respondents answered strongly agree, agree, answer 52%, 17% answering disagreed, and 10% replied strongly disagree. From this data it can be concluded that most of the respondents have experienced difficulties in determining which college majors will they take after graduating high school.

It is a concern for some people in General is wrong in choosing a major in college. This can be evidenced by the answers of the respondents associated the problem when wrong in choosing a major in college. When given the statement "you have worries if you are wrong in choosing college majors", 33% of respondents answered strongly agree 19% of respondents answered agree, 17% of the respondents answered did not agree, and 5% respondents answer strongly disagree. From these results it can be concluded that many respondents have concerns if they don't choose college majors with precision. If less precise in choosing college majors then it indirectly will have an effect on their future. This can be evidenced by the answers of respondents regarding the proposed statement "You assume that the College Department you choose determines your future." 19% replied strongly agree, 52% answered agree, 17% disagree, and 12% replied strongly disagree.

##### B. Data collection

On the study of data collected by way of reading literature on similar research studies and questionnaires.

##### C. Analysis of AHP method

The application of the AHP to the complex problem usually involves four major steps:

- Break down the complex problem into a number of small constituent elements and then structure the elements in a hierarchical form
- Make a series of pair wise comparisons among the elements according to a ratio scale
- Use the eigen value method to estimate the relative weights of the elements
- Aggregate these relative weights and synthesizes them for the final measurement of given decision alternatives [10].

This section later on will be explained about the steps to calculating a decision support system which is done by using the method of AHP manually.

In the description below, we will perform calculations against a case study with the following conditions:

- users have ideals for lectures in the major of computer science
- user has an interest in Math major
- the recommended courses for users is majoring in Medical
- academic/subjects score (added by user):
  - Score of subject Bahasa Indonesia: 8,5
  - Score of subject English Language: 8,0
  - Score of subject Math: 8,0
  - Score of other subject 1: 8,5
  - Score of other subject 2: 8,2
  - Score of other subject 3: 8,0
- financial capabilities of user belongs into: economic middle.

##### D. Modelling AHP algorithm

Before doing the calculations based on the above case study, we will model the AHP algorithm. Here is a picture of AHP algorithms based on this research:

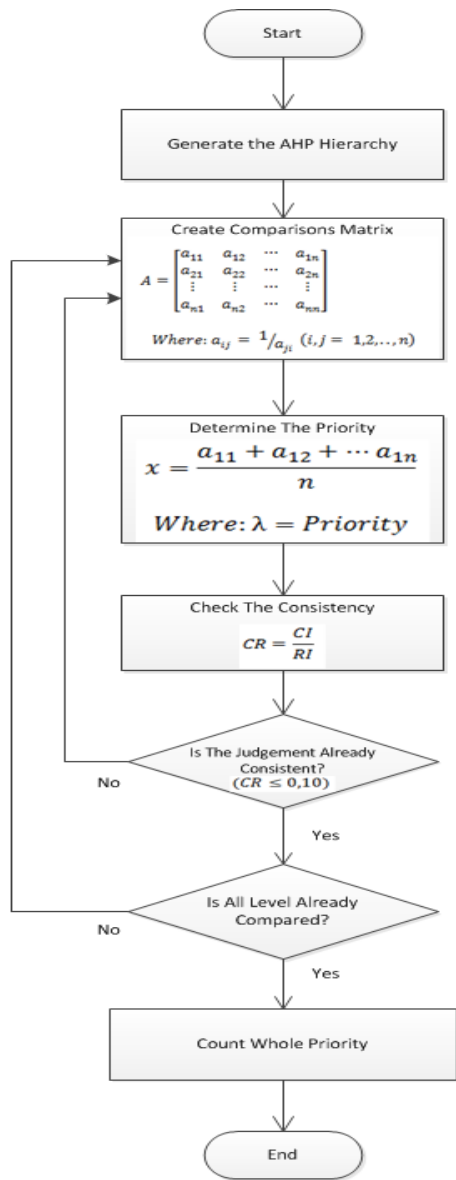


Figure-3. AHP algorithm.

**Determining criteria**

Based on the study of literature and the literature studies, we define a few influential criteria in determining college majors for prospective students. The criterias that have been specified will be used in the calculation of AHP. These include:

1. Ideals
2. Interest
3. Suggestion
4. Academic Scores
5. Financial Capability

To compare each criteria between each other, is required to giving weight to each criterion. To find out the number of comparisons to be made, we can refer to the

table of comparison to find out the number of comparisons that will be done. The formula is:  $\frac{n(n-1)}{2}$  [2].

Table-1. The number of comparisons.

<b>Number of criteria</b>	1	2	3	4	5	6	7	<b>n</b>
<b>Number of comparison</b>	0	1	3	6	10	15	21	$\frac{n(n-1)}{2}$

Saaty (1980) [9] proposed carrying out paired comparisons between the different elements because the human brain is perfectly designed to make comparisons between two elements, so he invented the table of weighting scales:

Table-2. Scale of weighting.

Intensity of importance	Definition	Explanation
1	Equal importance	Two activities equal to the objectives
3	Moderate importance	Experience and favor slightly favor one activity over another
5	Strong importance	Experience and favor strongly favor one activity over another
7	Very strong or demonstrated importance	One activity is favored very strongly over another, its dominance demonstrated in practice
9	Extreme importance	The evidence favoring one activity over another is of the highest possible order of affirmation
2,4,6,8	For compromise between above values	Sometimes one need to interpolate a compromise judgement numerically because there is no adequate word to describe it.



With reference to the table, because in this research criteria that we used were 5 pieces thus obtained as many as 10 comparison of amount of fruit. The following is the awarding of the weighting for each criterion by which we can be based on the questionnaire:

1. Ideals 7 times more important than Interest
2. Ideals 7 times more important than Suggestion
3. Ideals 6 times more important than Academic Score
4. Ideals 7 times more important than Financial
5. Interest 7 times more important than Suggestion
6. Interest 7 times more important than Academic Score

7. Interest 7 times more important than Financial
8. Suggestion 2 times more important than Academic Score
9. Financial 6 times more important than Suggestion
10. Academic Score 9 times more important than Financial

**The paired comparisons for criteria**

After determining the weighting for each criterion, next is to enter each value paired comparison matrix into the weights in the form of fractions. Here is a comparison matrix between the paired criteria:

**Table-3.** Paired comparison table to the criteria.

	Ideals	Interest	Suggestion	Academic score	Financial
Ideals	1	$\frac{7}{1}$	$\frac{7}{1}$	$\frac{6}{1}$	$\frac{7}{1}$
Interest	$\frac{1}{7}$	1	$\frac{1}{7}$	$\frac{1}{7}$	$\frac{1}{7}$
Suggestion	$\frac{1}{7}$	$\frac{1}{7}$	1	$\frac{2}{1}$	$\frac{1}{6}$
Academic score	$\frac{1}{6}$	$\frac{1}{7}$	$\frac{1}{5}$	1	$\frac{9}{1}$
Financial	$\frac{1}{7}$	$\frac{1}{7}$	$\frac{6}{1}$	$\frac{1}{9}$	1

Next up is the changing form of fractional decimal form became so the resulting matrices in the following table:

**Table-4.** Paired comparison table of criteria in decimal form.

	Ideals	Interest	Suggestion	Academic score	Financial
Ideals	1,000	7,000	7,000	6,000	7,000
Interest	0,143	1,000	7,000	7,000	7,000
Suggestion	0,143	0,143	1,000	2,000	0,167
Academic score	0,167	0,143	0,500	1,000	9,000
Financial	0,143	0,143	6,000	0,111	1,000
Σ	1,595	8,429	21,500	16,111	24,167

By dividing the elements in each column with the corresponding number of columns, the matrix values retrieved will be the criteria. The value of the median of

the values produced priority - an element for each row. The result can be in the following table:

**Table-5.** Look for the priority in paired comparison table of criteria.

	Ideals	Interest	Suggestion	Academic score	Financial	Priority
Ideals	0,107	0,080	0,250	0,133	0,071	0,128
Interest	0,321	0,240	0,250	0,200	0,286	0,259
Suggestion	0,036	0,080	0,083	0,133	0,071	0,081
Academic score	0,321	0,480	0,250	0,400	0,429	0,376
Financial	0,214	0,120	0,167	0,133	0,143	0,155



From the results of the calculation of the matrix above, as we can see on priority it can be concluded that the criterion of intellectual are the most important criteria. It have 0,376 percent of all criteria. This was followed by interest in second position with weights 0,259 percent. Financial on the third position with weights 0,155 percent, as well as on the fourth and fifth positions, followed by ideals and suggestion with weights respectively and 0,128 and 0,081 percent weight.

### Determining alternatives

To determine the college majors that will be used as an alternative, we using data which issued by the QS Top Universities.

Based on the results of a survey conducted by the QS Top Universities are issuing the data in the form of a ranking of 10 most popular majors at the moment, we determined the 10 courses will become an alternative calculation of AHP on this research.

Based on that data, then the Departments is used as the alternative is this majors: Computer Science, Medicine, Law, Economics, Engineering, Psychology, Electrical Engineering, Mathematics, Physics, And Geography [7]. Here is the code name of the courses that is used in this calculation system:

A1	=	Medical
A2	=	Computer Science
A3	=	Law
A4	=	Economics
A5	=	Engineering
A6	=	Psychology
A7	=	Electrical Engineering
A8	=	Mathematics
A9	=	Physics
A10	=	Geography

### The calculation of paired comparison for criteria

Here is the calculation of the ratios of pairs is done to compare each alternative against the criteria of the ideals. In the above case studies, users want to study in the major of Computer Science.

As already described in the previous section, that each criterion must be compared to each other, the same thing was done on alternatives. Any alternative must be compared to each other by giving attribute weights.

After being given the weight, then the matrix be rated reciprocal and then converted into decimal form.

Here's a comparison table between the criteria already given the weights:

**Table-6.** Comparison table between the criteria already given weights.

	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
A1	1	1/3	3	3	2	2	3	1/3	2	2
A2	2	1	3	2	2	2	2	2	2	3
A3	1/3	1/3	1	1/3	1/2	1/2	1/3	1/3	1/2	1/3
A4	1/3	1/2	1/3	1	1/2	1/2	1/3	1/3	1/2	1/3
A5	1/2	1/2	2	2	1	3	2	1/3	1/2	2
A6	1/2	1/2	2	2	1/3	1	1/3	1/3	1/2	1/3
A7	1/3	1/2	3	3	1/2	3	1	1/3	1/2	1/3
A8	2	1/3	3	3	3	3	3	1	2	2
A9	1/2	1/2	3	3	2	3	2	1/3	1	2
A10	1/2	1/3	3	3	1/2	3	3	1/3	1/2	1

The next step is still same with previous step to making the comparison in pairs on the criteria. We use table and we call it: table matrix. It had to be converted

into decimal form, and then the whole value in each column should be added.

Then is determining the priority of each alternative. Here are the results:



**Table-7.** Determine Priorities on a comparison table between the criteria Already Given Weights.

	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	Priority
A1	0,125	0,097	0,115	0,134	0,162	0,095	0,176	0,081	0,211	0,150	0,135
A2	0,250	0,194	0,115	0,090	0,162	0,095	0,118	0,324	0,211	0,225	0,178
A3	0,042	0,065	0,038	0,015	0,041	0,024	0,020	0,054	0,035	0,025	0,036
A4	0,042	0,097	0,115	0,045	0,041	0,024	0,020	0,054	0,035	0,025	0,050
A5	0,063	0,097	0,077	0,090	0,081	0,143	0,118	0,054	0,053	0,150	0,092
A6	0,063	0,097	0,077	0,090	0,027	0,048	0,020	0,054	0,035	0,025	0,053
A7	0,042	0,097	0,115	0,134	0,041	0,143	0,059	0,054	0,053	0,025	0,076
A8	0,250	0,097	0,115	0,134	0,243	0,143	0,176	0,162	0,211	0,150	0,168
A9	0,063	0,097	0,115	0,134	0,162	0,143	0,118	0,081	0,105	0,150	0,117
A10	0,063	0,065	0,115	0,134	0,041	0,143	0,176	0,081	0,053	0,075	0,095

The next step is to determine the priority for alternatives against criteria such as interests, academic score, suggestion, and financial capabilities. After determining the priorities in each department or an alternative, then the next step is to calculate the overall comparison by multiplying the priority criteria and priorities of each alternative against each criterion. The following is the calculation process:



**Figure-4.** Calculation Process.

**Conclusion calculation**

Based on the calculations that have been done on the order of priority of each Department as a whole can be seen in the following table:

**Table-8.** Table Conclusion of Calculation.

Alternative	Priority number
Medical	0,141
Computer Science	0,162
Law	0,036
Economics	0,059
Engineering	0,089
Psychology	0,061
Electrical Engineering	0,075
Mathematics	0,166
Physics	0,114
Geography	0,097

After sorted, this is the positions of each majors according to their priority value:

No.	Alternative	Priority number
1.	Mathematics	0,166
2.	Computer Science	0,162
3.	Medical	0,141
4.	Physics	0,114
5.	Geography	0,097
6.	Engineering	0,089
7.	Electrical Engineering	0,075
8.	Psychology	0,061
9.	Economics	0,059
10.	Law	0,036

So, the appropriate Department or 3 matches users based on this calculation is:

<b>1</b>	<b>Mathematics (0, 16%)</b>
2	Computer Science (0,16%)
3	Medical (0,14%)
4	Physics (0,11%)
5	Geography (0,09%)
6	Engineering (0,08%)
7	Electrical Engineering (0,07%)
8	Psychology (0,06%)
9	Economics (0,05%)
10	Law (0,03%)

And this is the graphic of the result:

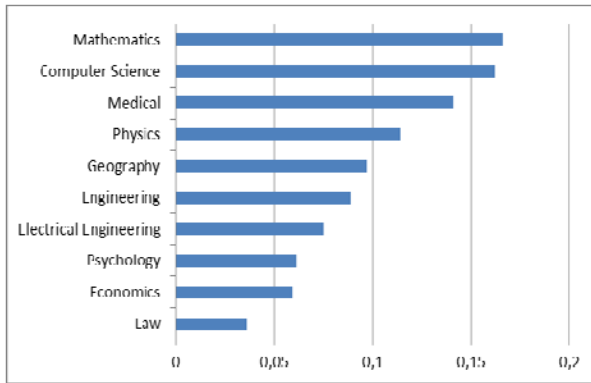


Figure-4. Result of manual calculation.

Screenshot of application



Figure-5. Main page.



Figure-6. Summary of user choices.



Figure-7. Top three of result.



Figure-8. The Rest of result.



Figure-9. Graphical result.

Compare the result of manual calculation with software expert choice

To proving are the calculation is doing correctly or not, after do the manual calculation, we will comparing the result between manual AHP calculation and the calculation of AHP which is done by using software.



Expert Choice is software of decision making which is based on MCDM (multi-criteria decision making). Expert Choice is used to help user to take decision. In the process, Expert Choice implementing AHP method. Expert Choice is already used in many certain sectors like manufacture industry, environment management, farming, etc. Expert Choice is created and developed by Thomas L. Saaty as the founding of AHP method, and his partner, Ernest Forman in 1983.



Figure-10. Splash screen of expert choice 11.

We are using software Expert Choice to compare result of manual AHP calculation which is already studied on previous chapter. We still use the same case study.

This is the view of Expert Choice software after all data (goal, criteria, and alternatives) included:

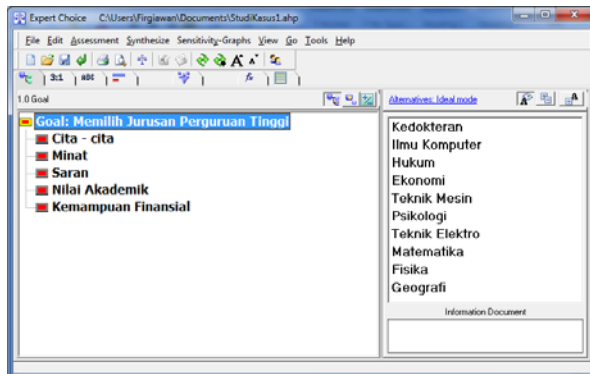


Figure-11. The view of expert choice after data (goal, criteria, and alternative) included.

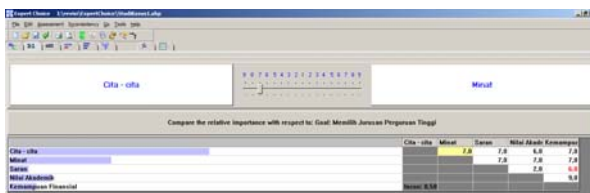


Figure-12. Pairwise comparison between criteria on expert choice.

In the picture above we can see the weights which is included on pairwise comparison between criteria, and inconsistency value or CR in amount of 0, 04.

Next step is giving the weights of comparison each alternative to criteria. Following is the picture about comparison of each alternative to criteria:

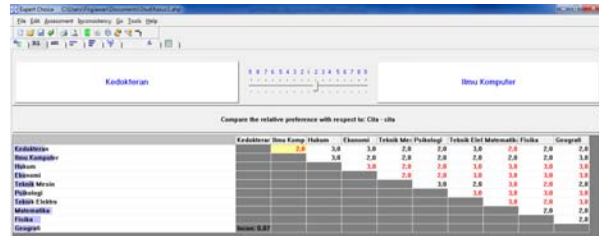


Figure-13. Pairwise comparison of each alternative to criteria of ideals

Pairwise comparison of each alternative to criteria of interest.

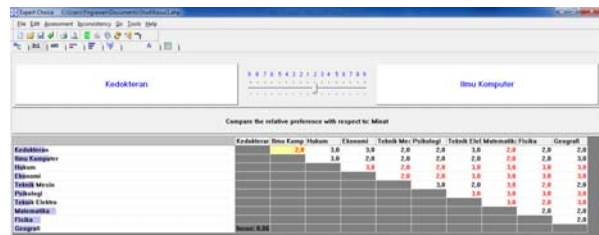


Figure-14. Pairwise comparison of each alternative to criteria of interest.

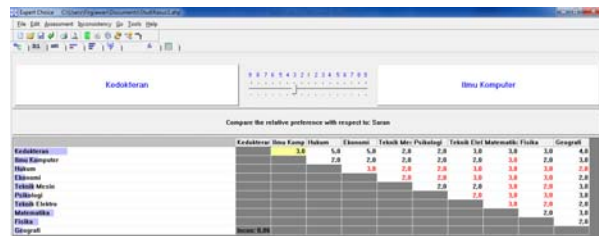


Figure-15. Pairwise comparison of each alternative to criteria of suggestion.

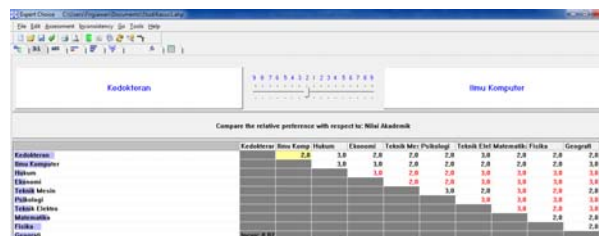


Figure-16. Pairwise comparison of each alternative to criteria of academic scores.



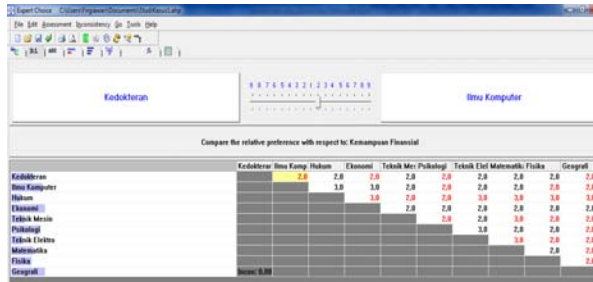


Figure-17. Pairwise comparison of each alternative to criteria of financial capability.

**Viewing the result of calculations**

After the comparison process is done, the result of calculation will be automatically appear on the main page of Expert Choice software. This is the picture:

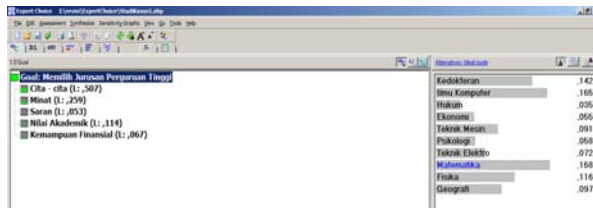


Figure-18. Final result of ahp calculation by using expert choice software.

**Summary of calculations**

According to the calculations which already done by using Expert Choice software, we got the result as the ranking of majors. This is the picture:

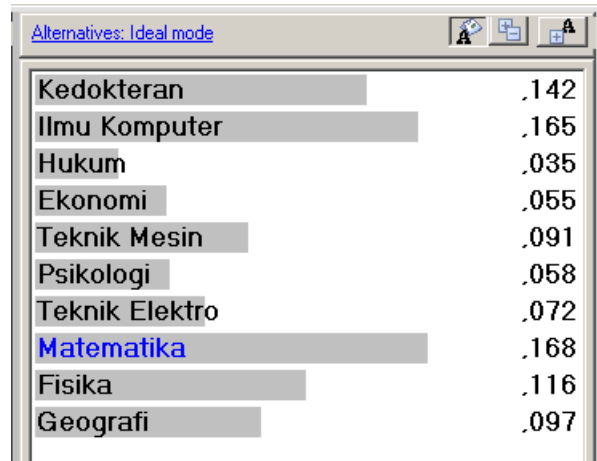


Figure-19. Graphics of AHP calculations by using expert choice.

After performing the two calculations above, next is comparing the results between the two calculations above. The things which is using as benchmark in this comparisons is the conformity or closeness of the result between the manual and the Expert Choice calculations.

If the whole manual calculations is same or closing the calculation of Expert Choice, it can be considered that the manual calculation which already done is appropriate and can be implemented to the developed application in this research. However, if otherwise, the calculation will be repeated and fixed.

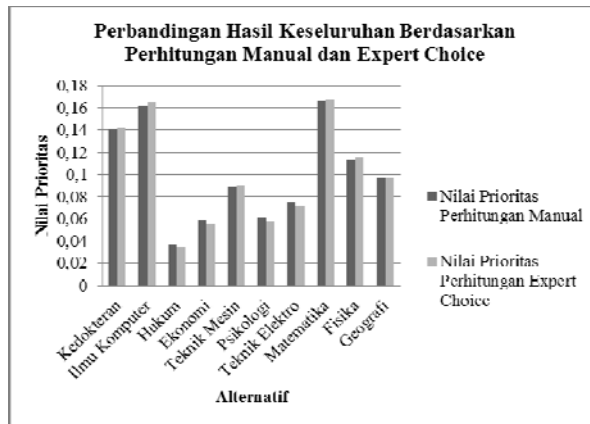
Following is a table of comparison between manual and Expert Choice results:

Table-9. Comparison whole results between manual and expert choice calculations.

Alternatives	Priority of manual calculation	Priority of expert hoice calculation	Difference
Medical	0,141	0,142	0,001
Computer Science	0,162	0,165	0,003
Law	0,036	0,035	0,001
Economics	0,059	0,055	0,004
Engineering	0,089	0,091	0,002
Psychology	0,061	0,058	0,003
Electrical Engineering	0,075	0,072	0,003
Mathematics	0,166	0,168	0,002
Physics	0,114	0,116	0,002
Geography	0,097	0,097	0,000



This is the graphics:



**Figure-20.** Comparison the whole results between the manual and expert choice calculations.

#### Implementing the calculations to pseudocode

After do the calculations and tested, next step is implementing the calculations which already done into the pseudo code. This step is intended to simplify the calculation into the source code application. This is a few of pseudo code with the pieces of source code from AHP calculation which already done:

Pseudocode to create comparison matrix.

```

Start
Input: Comparison Weight
Output: Comparison Matrix A =  $(a_{ij})$ 
1. insert weight into matrix A in fractions form
2. generate reciprocal values R =  $(1/a_{ij})$ 
3. change fractions form into decimals
4. sum each column of matrix A
End

```

#### 5. CONCLUSION AND FUTURE WORK

This study has a few conclusions there are:

- Based on the questionnaire and literature review, choosing a major in college there are 5 important criteria that must be considered are: ideals, interests, suggestions from close people or siblings, the academic value, and financial capability.
- Based on the data obtained in the questionnaires, the most important criteria are ideals. Ideals the most attention in choosing college majors with percentage of 48.9%, followed by interest (25.2%), the value of academic (11.6%), financial (8.7%), and the nearest person advice (5.7%)

Further development can be done on the development of multi-platform so it's not just limited to the Android platform only. The necessity of renewal of weights each good comparison criteria and alternatives in the calculation of AHP.

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