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Determining Program Study Using AHP with Dynamic Criterias and Weights Based on GIS-Mobile

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ABSTRACT

This research aim to develop a decision support system based on GIS-Mobile Apps using Analytical Hierarchy Pro-cess (AHP) Algorithm and softmax function for dynamic weight. The stages of AHP dynamic criteria in this system is the preparation of a hierarchy, prioritization, consistency, and the weight of priority). The use of AHP in this system involves four criteria which keywords, department accredi-tation, accreditation of colleges and colleges location dis-tance that can be set by the user dynamically. Experience Programming (XP) is model development that choosed by author for process development system. The step begin with planning, design, coding, and testing. The result of this re-search is a GIS-Mobile Apps to determine a list of recom-mended program study with the greatest weight from user input criteria.

I. INTRODUCTION

There are 2553 universities in Indonesia based website http://forlap.ristekdikti.go.id per April 20, 2019. With the large selection of colleges especially in Indonesia it needs a decision support systems or Decision Support System (DSS) to facilitate graduate from high school/vocational/MAN to continue higher-level studies. Basically DSS is a further development of management information systems computerized designed in a way that is interactive with the wearer so as to facilitate integration between the various komponnen in the process of decision making procedures, policies, analytical techniques, as well as the experience and insight into the managerial order to establish a framework decision be flexible [1].

In this study, the developed system will use DSS method Analytical Hierarchy Process (AHP). AHP is one method that can be used in solving problems in decision-making. The analytic hierarchy process is a decision-making methodology for ranking and selecting decision alternatives when multiple decision making criteria must be taken into consideration [2]. Many problems solved with the help of multi-criteria decision making Analytic Hierarchy Process (AHP), although it did not rule out the possibility, in practice there are still certain shortcomings [3].

Similar research has been pretty much done by other researchers, but in this study the authors will propose some uniqueness compared to other studies. The uniqueness in question is the integration of AHP with Softmax function so that the weight given to the dynamic system according to the number of criteria used. Further uniqueness is the result of a study program recommendations will appear in the page that contains the Maps and information on the study program in Mobile Apps or can be called Mobile-GIS.

So from that background, the paper will explain a GIS-based information system development-Mobile to determine the course of study based on dynamic criteria using AHP algorithm and Softmax function.

II. Materials And Methods

In the development of these systems use a development method of Extreme Programming (XP). Extreme Programming methods often also known as XP method. This method proposed by Kent Beck, an expert in software engineering. Extreme programming is a software development model that simplifies the various stages of the development of the system becomes more efficient, adaptive and flexible. In this method, there are four (4) working steps, namely planning, design, coding and testing [4], The elaboration of each step in this research is as follows:

A. *Planning*

The planning phase was conducted studies of user needs and the design of the system design and application along with the collection of data for Prodi majors based on the official website of each college. As for the needs of users in this application is recommended majors into a GIS based criteria. The design of the system is in accordance with Figure 1.

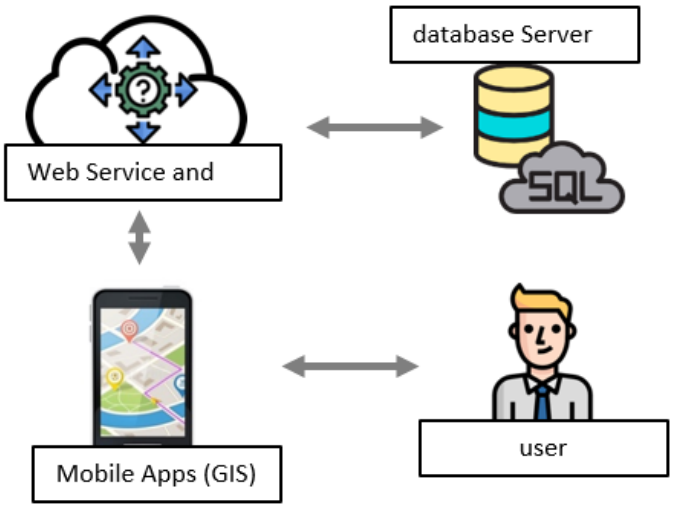

Fig. 1. Flow Systems

In the use of the application there are several rules in the use of applications and application of AHP algorithm to provide recommendations to the user associated with the given study program. The rule in question is as follows

1) First rule

There are four criteria that can be used by users to look for study programs in higher education namely Keywords, University Accreditation, Study Program Accreditation, and Radius. In the use of these criteria users can change priority settings dynamically.

2) Second rule

In the use of AHP algorithm in a web service then dynamically weighted as shown in Figure 2.

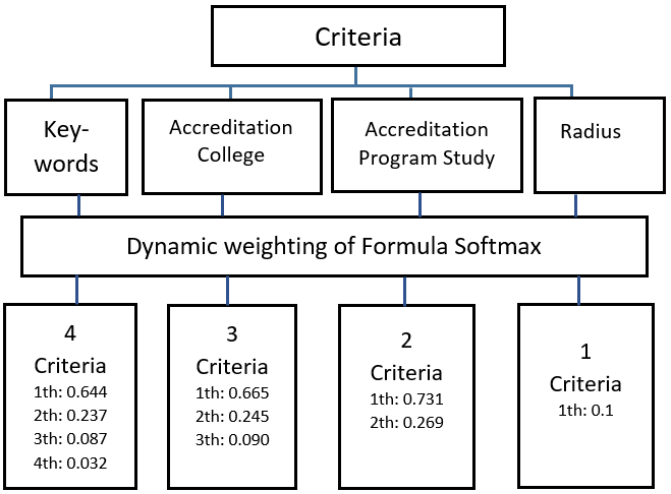

Fig. 2. Criteria and Weights Dynamic

3) Third rule

Dynamically weighting is done by using the formula Softmax (1) [5].

$$\Pr[i] = \frac{\exp(\mathrm{Q_i})}{\sum_{j=1}^{m} \exp(\mathrm{Q_i})} \quad (1)$$

Softmax general formula is often used in the late stages of activation in the classification function. But in this research the formula will be used for the weighting of each criterion that is dynamic in terms of numbers. The scheme is designed to be implemented in a system for weighting Figure 3.

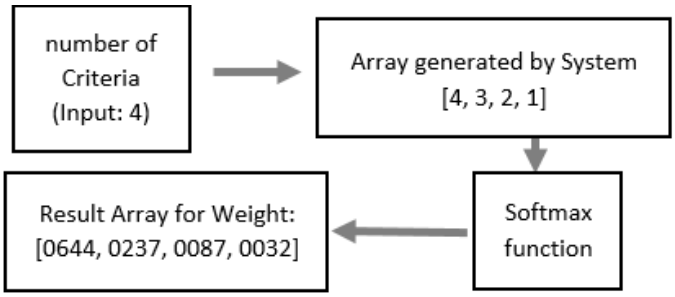

Fig. 3. Use of Softmax Function

4) Fourth rule

If in the criteria there are keyword criteria then the weight given previously will be added again with the weight of the search into four text data, among others, in the data of the objectives, vision, mission, and name of the study program with weight according to Figure 3. the sub-keywords of Figure 3 will be multiplied by weighting the keyword values based on the criteria weights in Figure 4 then added to the main weight of each.

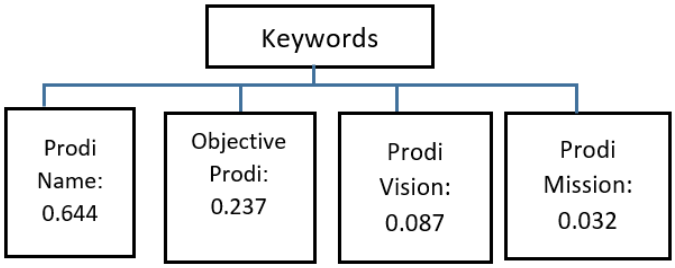

Fig. 4. Weight of the Sub Criteria Keyword

5) Fifth rule

If the assessment requires a radius, the system will perform calculations using the formula from [6] in measuring the distance from the location of the college with the location.

B. Design

Applications developed a client server-based system so that developers create a database design for data storage purposes such as Figure 5.

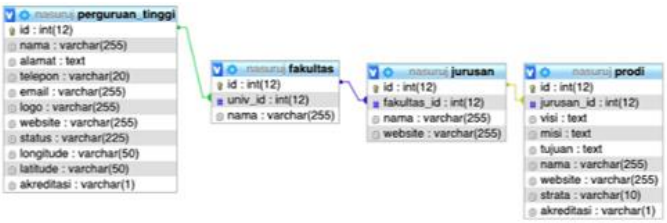

Fig. 5. Draft Database

In the database there are four tables namely Study Programs, departments, faculties, and universities, each of which has data to be processed by the DSS web service. After designing the database developers creates a system use case diagram shown in Figure 6.

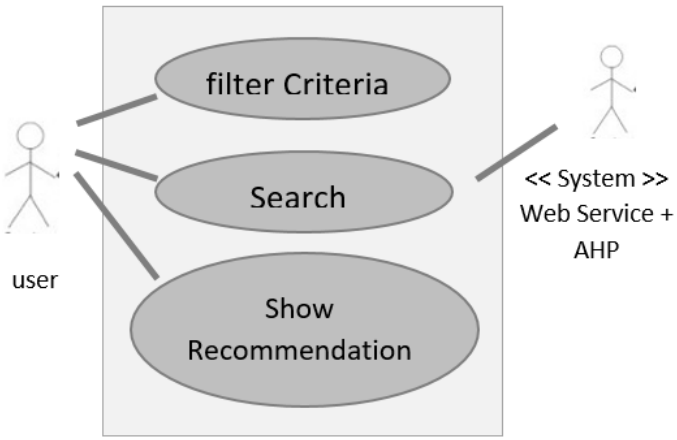

Fig. 6. Use Case Diagram Class Main

The next design is the use case models. Use Case model and the Use Case Descriptions are both very important in software development [7]. There are also use case models that will be used in the system according to Figure 1.

The next design is the design of the application display that will be used by user according to Figure 7. This design has similarities design with the design of the study design of [8] with additional drawer right side menu to enter the criteria used.

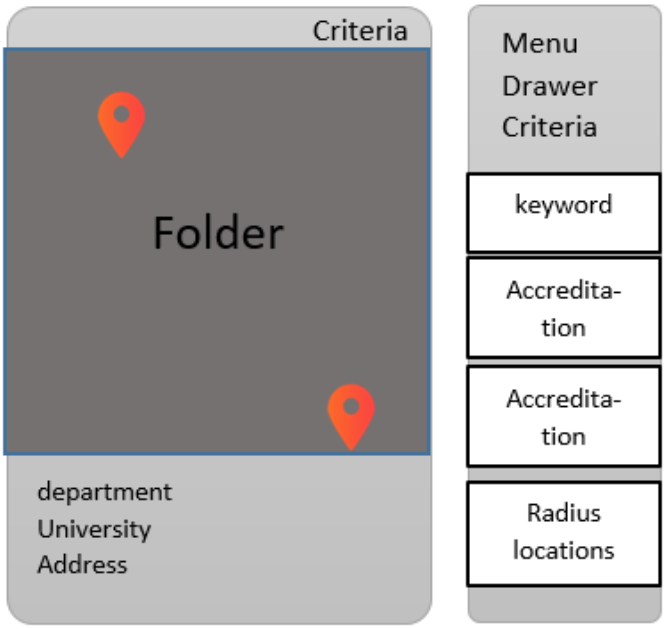

Fig. 7. Design Main Page GIS-Mobile

C. Coding

In the coding stage after the two previous stages in this research will be coding in two parts namely mobile for users and web-service that is used to perform data processing of the database and the application of AHP algorithm.

Stages coding in mobile apps, researchers will use Android Studio IDE with Kotlin as the primary programming language and XML for UI design in the application. In the integration of GIS systems will be used the help of Google Maps SDK library that is integrated in the application.

Web-service will use Visual Studio IDE, and the programming language uses PHP with the Yii2 Framework Integration . Regarding communication web-service with mobile apps, the data will be displayed in JSON shaped according to requirements. The database and RDBMS which are used MySQL and PHPmyAdmin for storing system databases.

D. Testing

In the testing stage researchers conducted the limit in this stage does not perform validation studies to external applications and user validation. Researchers only blackbox validation conducted by researchers themselves to test the use of AHP algorithm in finding GIS-based study program in accordance with a predetermined design.

III. DISCUSSION

The result of this research is the system GIS-Mobile applications and web service that implement AHP Algorithm with softmax function. The example in this discussion, author will use a case study to be entered as input in to GIS-Mobile

apps criteria with the keyword criteria is ‘teknologi, then the accreditation department is ‘A’, and the accreditation of the college is ‘A’, also set a radius is 3 km from the user's location. The goal of this system is recommending a program study in college based on the user criteria.

Input criteria page in GIS-Mobile apps can be seen in Figure 7. This input criteria are dynamic because users can use some or all of the four criteria as filter. In addition users can also change the priority order of each of the criteria. It will affect the weighting in the results list of program study in college by systems that use AHP algorithm and Softmax function. This is because the Analytical Hierarchy Process (AHP) Algorithm is very effective and is a better choice for prioritizing weights in a system process [9]–[11]. Result of the previous case can be seen in Figure 8. This is a main page for GIS-Mobile apps.

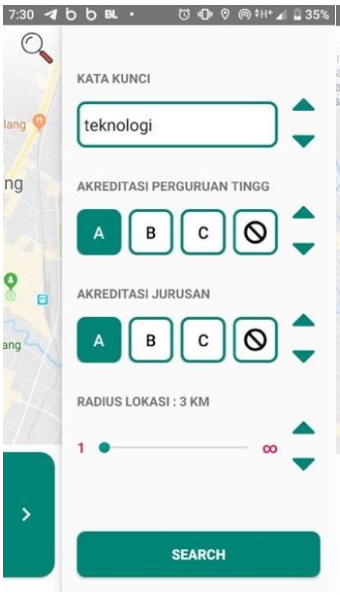

Fig. 8. Dynamic Input Display Criteria

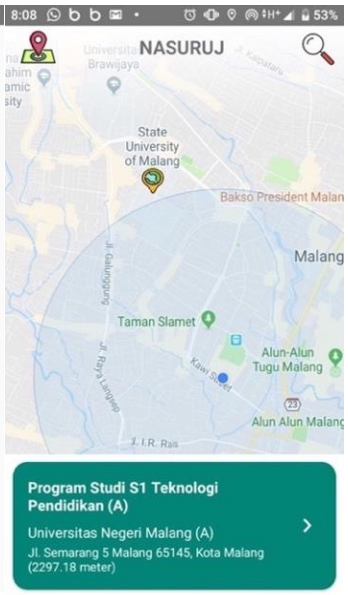

Fig. 9. Results of Study Program Recommendations based on GIS-Mobile

In this page, system will display a map with marker location and description of the recommendation program study. From the result can be seen that S1 Teknologi Pendidikan Program Study in the State University of Malang is most recommended by System. This is because that study has greater weight than others.

Next disucussion we will specific explain about AHP algorithm work in this system. From the example case above, first, we must determine count of criteria input by user and the priority. The count criteria is 4. The first priority kriteria is keyword with value “teknologi”. After user set this criteria and click search button system will generate weight dynamic using softmax function. This code with PHP language programming, can be seen below.

```
public function getWeightSoftMax($level, $max) {
   $arrayWeight = [];
   for ($i = $max; $i > 0; $i--) {
     array_push($arrayWeight, $i);
   }

   $arrayWeight =
array_map('exp',array_map('floatval',$arrayWeight));
   $sum = array_sum($arrayWeight);

   foreach($arrayWeight as $index => $value) {
       $arrayWeight[$index] = $value/$sum;
   }
   return $arrayWeight[$level-1];
}
```

Variable level is order priority and variable max is count of criteria. From function above, for keyword criteria with priority/level is 1 and count criteria (max) is 4, so the weight is 0.644.

Then the system make query to request data in database which program study have string ‘technology’ in prodi_visi, prodi_misi, prodi_tujuan, and prodi_nama coloumn. Then system will give default value from softmax function before (0.644) to The results of data from a database in weight coloumn. Then based rule of author give before (Figure 4), if user add filter keyword criteria there is weight addition to every row data. For example in prodi_id 5, the weight addition for sub criteria is (1 * 0.644) with the result of 0.644. The value of 1 is because in the 4 columns in the table there are keywords "technology" so that the number of each weight for sub keywords is 1. Then from weight sub criteria will add into main criteria with the result is 1.288 from 0.644 (main weight) + 0.644 (additional weight) .

Next step, the result of keyword criteria shown in Table 1. From the data, the weight every data will be canged by add the value from criteria weight for the accreditation of the college where that value is "A" into main weight before. As for the result with integration of AHP algorithm in accordance with Table 2 with the addition of 0.237 from softmax function, the result can be seen in Table 2.

Furthermore, the third criteria namely assigning weights to the accreditation of study programs are worth an "A" while the value of weight on this criteria is 0.087. the result can be seen Table 3.

TABLE I. THE RESULT OF THE KEYWORD CRITERIA

prodi_id	prodi_visi	prodi_misi	prodi_tujuan	prodi_nama	weight
5	Visi Jurusan **Teknologi** Pendidikan Fakultas I…	Misi Jurusan **Teknologi** Pendidikan Fakultas Ilmu Pendidikan, …	1. Menghasilkan pengembang **teknologi** pendidikan/pembelajaran yang mampu merancang, …	S1 **Teknologi** Pendidikan	1.288
6	Menjadi perguruan tinggi unggul dan rujukan …	Misi Program Studi **Teknologi** Pembelajaran (TEP), …	Untuk mewujudkan visi dan misi di atas, program studi **Teknologi** …	S2 **Teknologi** Pembelajaran	1.135
7	Menjadi perguruan tinggi unggul dan rujukan d…	Misi Program Studi **Teknologi** Pembelajaran (TEP), …	Untuk mewujudkan visi dan misi di atas, program studi **Teknologi** …	S3 **Teknologi** Pembelajaran	1.135
1	Prodi yang unggul dan menjadi rujukan dalam …	1.Menyelenggarakan pembelajaran yang mendidik di bidang bimbingan dan konseling. …	1. Menghasilkan lulusan yang mumpuni dan mampu menyelenggarakan …	S1 Bimbingan dan Konseling	1.115
3	Program Doktor Bimbingan dan Konseling menjadi …	1.Menyelenggarakan pendidikan dan pembelajaran …	1. Menghasilkan lulusan yang bertaqwa kepada Tuhan …	S3 Bimbingan dan Konseling	1.115
2	Visi Prodi Magister BK Pascasarjana UM adalah …	1.Menyelenggarakan pendidikan dan pembelajaran program studi …	1. Menghasilkan lulusan tenaga ahli berkualitas bidang bimbingan …	S2 Bimbingan dan Konseling	1.058

TABLE II. THE RESULT OF THE ACCREDITATION COLLEGE CRITERIA

prodi_id	prodi_nama	akreditasi_pt	weight
5	S1 Teknologi Pendidikan	A	1.525
6	S2 Teknologi Pembelajaran	A	1.372
7	S3 Teknologi Pembelajaran	A	1.372
1	S1 Bimbingan dan Konseling	A	1.352
3	S3 Bimbingan dan Konseling	A	1.352
2	S2 Bimbingan dan Konseling	A	1.295

TABLE III. THE RESULT OF THE ACCREDITATION PROGRAM STUDY

prodi_id	prodi_nama	akreditasi_prodi	weight
5	S1 Teknologi Pendidikan	A	1.612
6	S2 Teknologi Pembelajaran	A	1.459
7	S3 Teknologi Pembelajaran	A	1.459
1	S1 Bimbingan dan Konseling	A	1.439
2	S2 Bimbingan dan Konseling	B	1.383
3	S3 Bimbingan dan Konseling	A	1.352

The last criteria is radius criteria. As for the value criteria radius input by user is 4 km radius from the user's location. And the user's location for this case is -7.9776683 (latitude) and 112.6237758 (longitude). Therefore, by using the formula [6], last data results within a user's location to college in the study program can be seen in Table 4.

TABLE IV. WEIGHTS RADIUS RESULTS

prodi_id	prodi_nama	Jarak (km)	weight
5	S1 Teknologi Pendidikan	1.976	1.644
6	S2 Teknologi Pembelajaran	1.976	1.491
7	S3 Teknologi Pembelajaran	1.976	1.491
1	S1 Bimbingan dan Konseling	1.976	1.461
2	S2 Bimbingan dan Konseling	1.976	1.415
3	S3 Bimbingan dan Konseling	1.976	1.384

So based on the above analysis in the application of the system with AHP algorithm and softmax function, the result is S1 Teknologi Pendodokan from the State University of Malang has the highest weight that is displayed in the order above in GIS-Mobile. As it has been observed that forming a AHP-Gray relationship level model to analyze the comprehensive benefits brought in a project, the practicality of the model and its results has been proven [10], [12].

IV. CONCLUSION

Based on the objectives for this research which develop a GIS-Mobile System for determine program study using AHP algorithm with dynamic criteria and weight using softmax function, So the result is success for integration that method in system and the result of data recomendatition has already appropriate with the plan set. Next, this research need further development research for analysis compare with other method to make more better result.

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