MOBILE UITM QUALIFICATION CHECKING SYSTEM USING ANALYTICAL HIERARCHY PROCESS (AHP) TECHNIQUE

*Zawawi Ismail@ Abdul Wahab, Nur Fadhlina Ab Rahman

Faculty of Computer and Mathematical Sciences
Universiti Teknologi MARA (UiTM) Terengganu
23000 Dungun, Terengganu, Malaysia

*Corresponding author's email: zawawi@tganu.uitm.edu.my

Abstract

UiTM has developed a web-based system called *Selangkah ke UiTM* for candidates especially secondary school leavers who have undergone SPM examination to check qualified programmes offered in the university. From an initial study conducted, it is found that the sytem has not been built to meet some preferences of the candidates such as duration and field of study. In addition, the candidates need to get persistent connection to the Internet in order to log on to the system. Therefore, a mobile application using Analytic Hierarchical Process (AHP) or called m-Selangkah is proposed to help the candidates in selecting their preferred programmes based on the SPM result. m-Selangkah allows the user to use it anywhere anytime once it is downloaded to the mobile phone. The application is integrated with multi-criteria decision making (MCDM) AHP method will allow the users to choose their qualified programmes based on their preferences. It is developed based on phases in the RAD model which are preliminary study, system analysis, system design, system development, system testing and evaluation, and finally documentation. The functionality of m-Selangkah application has been tested using real data by focusing the scope to programmes offered by Terengganu campus. The usability of this application is evaluated by conducting a set of questionnaires to the random respondents. The results showed that most of the respondents agreed the proposed application has the potential and moderately useful.

Keywords: Analytical hierarchy process; mobile application; multi-criteria decision making

1.0 INTRODUCTION

Universiti Teknologi MARA (UiTM) is one of the public universities in Malaysia. It currently runs 24 faculties and three academic centres offering 373 programmes from foundation up to the doctorate level. There are 35 state, branch and satellite campuses all around Malaysia. With such a huge academic services, UiTM has developed many applications that can be used by the students and potential students such as web-based *Selangkah ke UiTM* system. *Selangkah ke UiTM* system enables the potential students especially SPM leavers to check qualified programmes in UiTM based on their SPM qualifications. However, only few of the potential students uses the system as it need to be accessed through the website using persistent Internet connection (Malaysian Public Sector Open Source Competency Centre [OSCC], 2010). The system requires the users to submit information of SPM result and it will display all programmes that are qualified for the users to apply. The users themselves have to select and decide which programmes they are interested in and yet they may not know whether or not the programmes meet their expectation. Due to these problems, Mobile UiTM Qualification Checking System Using Analytical

Hierarchy Process (AHP) Technique or called m-Selangkah is proposed. The application integrates the use of mobile computing technology and a heuristic method called Analytic Hierarchical Process (AHP) to assist the users in making decision about the best qualified programmes they may apply based on their preferences.

Mobile computing is the technology that enable people to access network services and application anyplace, anytime or anywhere. A mobile applications is a computer program designed to run on smartphones, tablet computers and other mobile devices and can be use either offline or online (Federal Trade Commision [FTC], 2015).

Analytic Hierarchical Process (AHP) is a heuristic technique that may applies multi-criteria decision making (MCDM) methods. It is a structured technique for organizing and analysing complex decisions, based on mathematics and psychology. It was developed by Thomas L. Saaty in the 1970s and has been extensively studied and refined since then (Vahidnia, Alesheikh, Alimohammadi, & Bassir, 2003). This method takes a multi-standards approach that can be used for analysis and consist of qualified programs with student preferences. The method is based on pairwise comparison between several factors that affect the selection of the best programmes. Three user preferences are selected for evaluating decision, such as entry requirement, preferred field and duration of study. For each, a matrix of pairwise comparison between programmes will be measured.

2.0 RELATED WORK

2.1 *Selangkah ke UiTM* System

In the UiTM system, the UiTM programmes qualification checking system has been developed. To make use of the system, the users need to log on to the website of "Selangkah ke UiTM" via http://pengambilan.uitm.edu.my/semak-syarat-kelayakan (Universiti Teknologi MARA [UiTM], 2014). The system will check the results of SPM and display the programmes that are qualified to be applied by the users.

2.2 Factors that influence students in choosing a programme in universities

Studies have been carried out in discovering what elements have influenced the SPM leavers in selecting their field of study in universities. Table 1 demonstrates the summary of essential factors that influence students' decisions in choosing a university programme.

Table 1 Factors that Influence Students in Choosing a Programme in Universities

Author	Important Factors
Cannon, Broyles, & Techb (2006)	• Self-interest to the field • Salary prospect • Job Prospect • Starting salary • Prestige of the profession
Crampton,Walstrom, & Schambach, (2006)	• Quality of teaching Institution's reputation • Marketability of degree • Job opportunities • Tuition fees • Program Structure • Time required for completion • Facilities

	• Availability of courses • Entry requirement
Gottfredson (1999)	• Field of study • career goals • campus environment • campus location • institution's reputation

2.3 Multi Criteria Decision Making (MCDM)

Multi-criteria decision making (MCDM) methods deal with the process of making decisions in the presence of multiple objectives. A decision-maker is required to choose among quantifiable or non-quantifiable and multiple criteria. The objectives are usually conflicting and therefore, the solution is highly dependent on the preferences of the decision-maker and must be a compromise (Pohekar & Ramachandran, 2004).

MCDM allows decision makers to select and rank alternatives according to different and conflicting criteria and is classified on the major components: Multi-Objective Decision-Making (MODM) and Multi-Attribute Decision-Making (MADM) (Karami, 2011).

Besides the information held in the decision matrix, all but the simplest MADM techniques require extra information from the decision maker to get in at a final ranking or selection. There are common MADM techniques which are Simple Additive Weighted (SAW), Analytical Hierarchical Process (AHP) and Technique for Order Preference by Similarity to Ideal Solution (TOPSIS). Table 2 shows the strengths and weaknesses of each of the techniques.

Table 2 Strength and Weakness of MADM Techniques

Method	Strength	Weakness
SAW	• Strong in single dimensional problems.	• Difficulty emerges on multidimensional problems.
AHP	• Appropriate for Group Decision Matrix Handles multiple criteria • Does not involve complex mathematics • Easy to capture and convenient	• Perfect consistency is very difficult. • Time consuming with large numbers. • Does not take into account the uncertainty.
TOPSIS	• Fairly intuitive physical meaning based on consideration of distances from ideal solutions.	• TOPSIS in its standard form is deterministic and does not consider uncertainty in weightings.

This research has chosen one of the MCDM techniques that can assist the SPM leavers to determine whether or not the qualified programmes are suitable by using Analytic Hierarchy Process (AHP) technique. AHP uses both qualitative and quantitative decision making approaches.

By using AHP, decision makers can arrange the serious aspect of a problem into the hierarchical of structure. It is the same concept with a family tree. The AHP pairwise comparison is often preferred to be utilized in making the decision as it is easy to handle. The weight and scores of each criteria of choice can be easily gained instead of comparison matrices weight or scores directly.

AHP caters both certain factors and uncertainties. It illustrates how possible changes in priority at upper levels have an effect on the priority of criteria at lower levels. It provides the students with an overview of criteria, their function at the lower levels and goals as at the higher levels. A further advantage of AHP is

its stability and flexibility regarding changes within and additions to the hierarchy (Shahroodi, Keramatpanah, Amini, Shiri, & Najibzadeh, 2012). The method is able to rank criteria according to the needs of the students which also lead to more precise decision concerning programmes selection.

2.4 Mobile Computing

Mobile computing implies that a program constructed for a mobile, tablet and portable computer which is the operating system is mobile base such as Android, windows mobile and others.

While on the move, information or data can be gained from any device on any network available and easy for users to run anywhere. This computing system may consist of network, software and hardware of diverse mobile devices. It permits the users to perform the process at anywhere and anytime (Nosrati, Karimi, & Hasanvand, 2012).

Mobile computing consists of operating systems for mobile devices, mobile database, mobile connection and mobile application. A computing environment is supposed to be mobile if it fulfils one or more of these features which is user mobility, device mobility, network mobility, session mobility, host mobility and mobility service.

2.5 Related Research

One of the mobile applications related to this research is *Make Decision* application. This application uses AHP method and helps users to make decision more easily by using AHP method. What users have to do is just put some data and do not have to calculate. The result will be served as a bar chart and number. Each data can be stored and deleted. This application uses only the first layer of a true analytic hierarchy process and proves to be rather not useful. It takes to the point of working out what seems to be a (non-normalized) preference vector measured against criteria.

3.0 RESEARCH METHODOLOGY

The methodology which is RAD (Rapid Application Development) model consists of several approaches which are preliminary study, system analysis, system design, system development, system testing and evaluation and finally the documentation.

3.1 System Design

The selection process of the system involves seven phases as shown in Figure 1. Explanation for each phases are explained as follows and all of the explanations for phase one until phase six are summarized in (i) and (ii) while phase seven is summarized in (iii).

i. The process to receive input from the user / input. Process input in the form of software is the real value, the value that is only worth 1 until 5. Until all inputs have to be filled in by the user, so that the input from the user can be made based on the calculation method of AHP. The scale of the least important to the most important significance is numbered from 1 up to 5.

ii. AHP calculation process (pairwise comparison). This process will carry out calculations for local priority value, then after all criteria are filled in, it will do a global priority calculation,

so at the end of this process it will produce the right choice, that fits the available data, which can be seen from the highest value of ranking.

iii. The process of feature selection results/ outputs. This process is the last process, which will show results based on the calculation of the largest value in the alternatives as shown in phase seven.

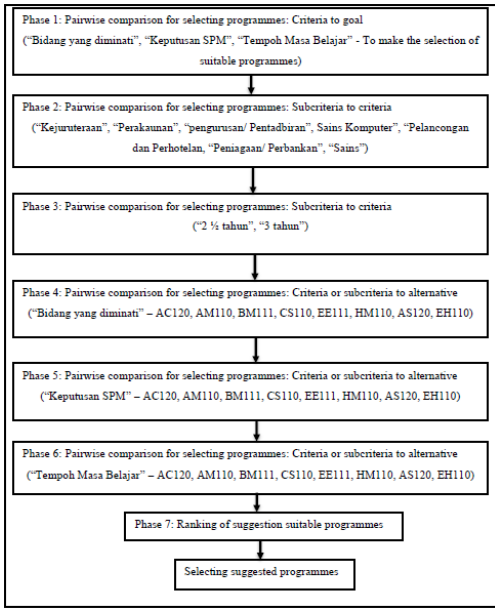

Figure 1 AHP Step Measurements

3.2 System Development

The development phase of the proposed application follows after the system design phase.

System Design Architecture

Figure 2 shows the general architecture of m-Selangkah. At the client side, the users can download the application from the Play Store. Next, the users can input data such as detail, preferences and SPM result which will be store into the SQLite database that comes together with the application. Then, AHP takes place to calculate and select the best qualified programmes. Using the steps in AHP technique, the application ranks the qualified programmes and display the result to the users.

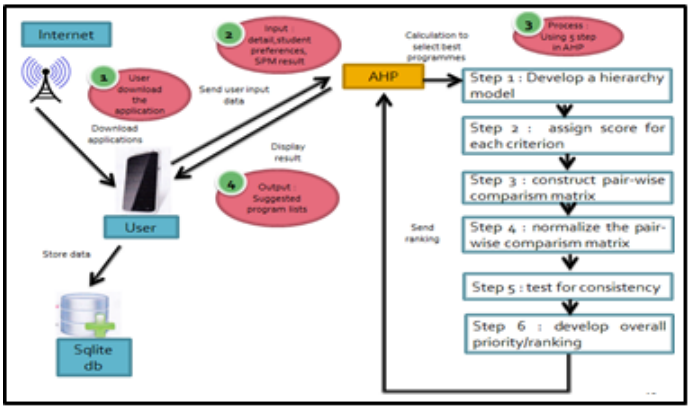

Figure 2 General Architecture of m-Selangkah

System Design Interface

Designing the interface properly is important in order to develop an application that is easy to use. Adobe Photoshop is used in order to design the interface. An attractive and understandable features of the interface is the way to attract the users to use the application and should be more user-friendly. Figure 3 shows an initial interface of the application.

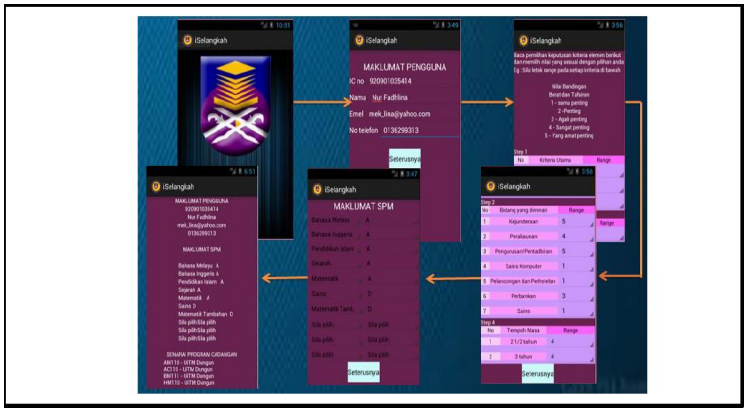

Figure 3 User Interface Designs of m-Selangkah.

Design AHP Algorithm

The following six steps are required to determine the priority/ranking of each criterion:
Step 1: Develop a hierarchy model
Step 2: Assign score for each criterion
Step 3: Construct pair-wise comparison matrix
Step 4: Normalize the pair-wise comparison matrix
Step 5: Check consistency
Step 6: Overall priority/ranking
Step 1: Develop a hierarchy model

First step is to develop a hierarchy model. The arrangement on AHP hierarchy is divided into three levels. At the top level is the goal or objectives of the project. The goal is to achieve objectives of this project. The second level of hierarchy is the criteria selection. These criteria will be used by the users in order to select the programmes. Then, for the bottom level of the hierarchy is to determine the best alternative. These three levels of hierarchy AHP in the system is shown in Figure 4.

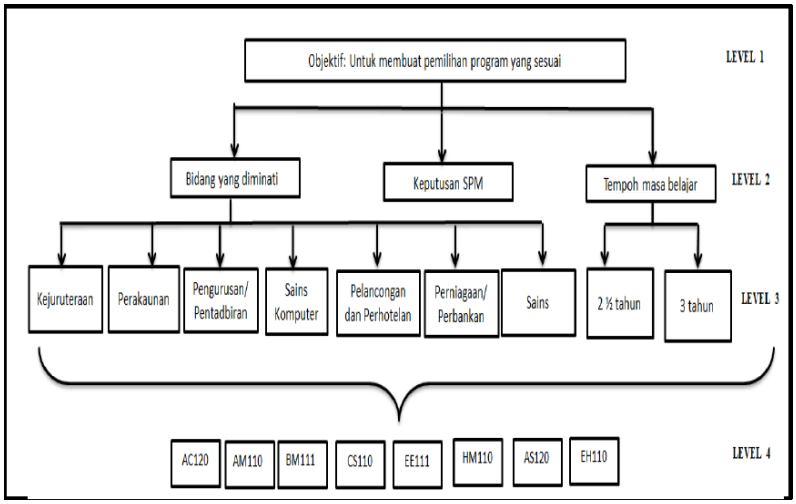

Figure 4 Hierarchy of AHP for Programmes Selection of m-Selangkah

Step 2: Assign score for each criterion
The second step is to give score to each criterion. The score of each criterion in this study is based on 1-5 preference scale.

Step 3: Construct Pair-Wise Comparison matrix
Third step is to construct a pair-wise of comparison matrix which will involve each criteria and alternatives in this project. The values of relative comparison across alternative common criteria adapted to a predetermined judgment to produce weight and priority. Weight and priority are then calculated by manipulating the matrix or through mathematical equations solution.

Let assume three options of main criteria (*Bidang yang diminati*, *Keptusan SPM*, and *Tempoh masa belajar*) are converted into three criterions (*spinMain1*, *spinMain2* and *spinMain3*). The formula for pair-wise comparison between two criteria with score is given by the following equation as depicted in Figure 5. Then it will result in the following pair-wise comparison matrix for each of the criterion. The same method is then used to determine the relative weighting of criteria in relation to each other. It will then be used to arrive at the overall ranking of options, where *main11* represents the rating criteria *spinMain1* than *spinMain2* criteria in the criteria matrix, sometimes referred as the judgment matrix as shown in Table 3.

$$a_{ij} = \begin{cases} t_i - t_j + 1 & if \quad t_i - t_j \geq 0 \\ \dfrac{1}{t_j - t_i + 1} & if \quad otherwise \end{cases}$$

Figure 5 Formula of Pair-wise Comparison

Table 3 Pair-wise Comparison Matrix

	spinMain1	**spinMain2**	**spinMain3**
Main[0] spinMain1	main11	main12	main13
Main[1] spinMain2	main21= (1/main13)	main22	main23
Main[2] spinMain3	main31= (1/main13)	main32= (1/main23)	main33
	Vmain1	Vmain1	Vmain1

Step 4: Normalizing the Pair-Wise Comparison

The pairwise matrix has to be normalized so that the sum of each column is equal to one. In order to accomplish that, we need to calculate the ratio between the entries in the matrix with their respective column totals. The entries of normalized pairwise matrix *B = [bij]* can be calculated as depicted in Figure 6.

$$b_{ij} = \frac{a_{ij}}{\sum_{i=1}^{n} a_{ij}}$$

Figure 6 Formula to Nomalized Pair-wise Matrix.

The weightage of each criterion, *ci1*, is determined by calculating the average of each row of matrix B as illustrated in Figure 7.

$$c_{i1} = \frac{1}{n} \sum_{j=1}^{n} b_{ij}$$

Figure 6 Formula to Nomalized Pair-wise Matrix.

The following are examples on how to do the calculations:

i. Interest = (1 / 3) * (Vinterest1 + Vspm1 + Vtime1)
ii. Spm = (1 / 3) * (Vinterest2 + Vspm2 + Vtime2)
iii. Time = (1 / 3) * (Vinterest3 + Vspm3 + Vtime3)

Step 5: Check Consistency
The consistency validation is not done in this project. It is not used in this project because the project is evaluated based on the goal. The priority of the ranking is used to rank the programmes and produce the qualified programmes for SPM leavers.

Step 6: Overall priority/ranking
After consistency checking, the overall rating can be determined. Evaluation in this case means that put to alternative rating. From this evaluation, a decision can be achieved and finally made.

System Evaluation

Evaluation of the proposed application is done by conducting evaluation sessions. It measures the ability of the application to work according to its use. On the client side, usability and functionality of m-Selangkah is measured by its ability to function as the existing system and to get the qualified programmes based on user preferences using AHP algorithm in simple clicks.

4.0 RESULT AND ANALYSIS

This section will show the results and findings of this project. The most important finding is the architecture of the proposed project. This section also provides the screen shots of m-Selangkah application. Functionality and usability are tested and analysed.

System Testing
The application has been tested by lecturers of Computer Science and Mathematic who is an expert in application development and in the functionality of the AHP technique.

Qualitative Analysis
The summary result is based on data gathered from a survey that involved 10 respondents. In the evaluation process, 10 questionnaires were distributed to the 10 respondents which all of them are real users of the system. Figure 8 shows the result that most of the respondents were agreed with the elements A1 which is the text on the screen is easily to read.

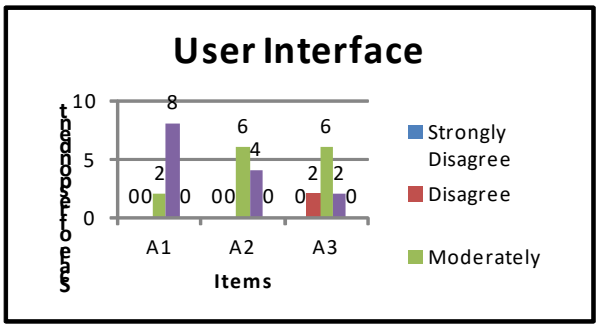

Figure 8 Result for User Interface of m-Selangkah

Most of the respondents were agreed with the elements B3 which is the application provides clear guideline on what to do for each step as depicted in Figure 9.

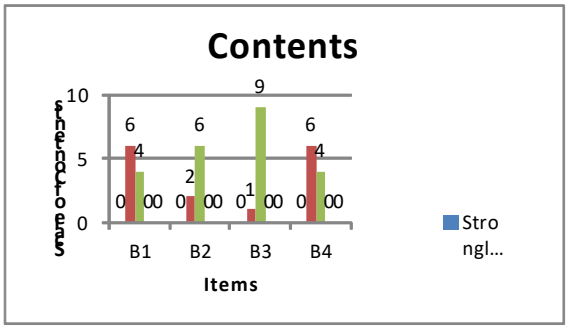

Figure 8 Result for User Interface of m-Selangkah

5.0 CONCLUSION

The proposed application m-Selangkah has been moderately accepted as an alternative to the existing web-based system in assisting SPM leavers to make decision on which university's programme that may be best meet their preferences. Although the project objectives have been attained, the projects still have their bounds and there should be an improvement for future work. Additional preferences such as skills, health record, and preferred location of study could be considered for future enhancement.

References

Shahroodi, K. Keramatpanah, A., Amini, S, Shiri, E., Najibzadeh, M. (2012). Application of analytical hierarchy process (AHP) technique to evaluate and selecting suppliers in an effective supply chain, *Kuwait Chapter of Arabian Journal of Business and Management Review 1*(6), 119–132. Retrieved from https://www.arabianjbmr.com/pdfs/KD_VOL_1_6/9.pdf

Cannon, J., Broyles, T. W., & Tech, V. (2006). Factors influencing gifted and talented students' college decisions, *Journal of Southern Agricultural Education Research 56*(1), 136–149, doi: 10.1.1.597.8255

Crampton, W. J., Walstrom, K. A., & Schambach, T. P. (2006). Factors influencing major selection by college of business students, *Issues in Information Systems VII* (1), 226–230, Retrieved from http://iacis.org/iis/2006/Crampton_Walstrom_Schambach.pdf

Vahidnia, M. H., Alesheikh, A., Alimohammadi, A., & Bassiri, A. (2003). *Fuzzy analytical hierarchy process in GIS application*, Paper presented at International Society for Photgrammetry and Remote Sensing, pp. 593-596. Retrieved from http://www.isprs.org/proceedings/XXXVII/congress/2_pdf/4_WG-II-4/15.pdf

Gottfredson, G. D. (1999). John L . Holland ' s contributions to vocational psychology : A review and evaluation, *Journal of Vocational Behavior, 55,* 15–40. doi: http://dx.doi.org/10.1006/jvbe.1999.1695

Karami, A. (2011). Utilization and comparison of multi attribute decision making techniques to rank bayesian. *Master Degree Project in Informatics*: University of Skovde. Retrieved from http://www.diva-portal.org/smash/get/diva2:438047/fulltext01.pdf

Universiti Teknologi MARA (2014). Selangkah ke UiTM: Portal pengambilan pelajar UiTM. Retrieved from http://pengambilan.uitm.edu.my/semak-syarat-kelayakan

Nosrati, M., Karimi, R., & Hasanvand, H. A. (2012). Mobile computing: Principles, devices, and operating systems. *World Applied Programming*, *2*(7), 399-408. Retrieved from http://www.it.iitb.ac.in/frg/wiki/images/3/38/Android_wifi_working_principles.pdf

Federal Trade Commision (2015). OnGuard online: Understanding mobile apps. Retrieved from https://www.onguardonline.gov/articles/0018-understanding-mobile-apps.

Pohekar, S. D., & Ramachandran, M. (2004). Application of multi-criteria decision making to sustainable energy planning—A review. *Renewable and Sustainable Energy Reviews*, *8*(2004), 365–381. doi:10.1016/j.rser.2003.12.007.

Malaysian Public Sector Open Source Competency Centre (OSCC) (2010). Sistem semakan syarat kelayakan akademik universiti (selangkah). Retrieved from http://knowledge.oscc.org.my/practice.../oss-case-study-awards-2010/...selangkah.../file