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Computer-Aided in Choosing Education Programs (CASCEP)

[1]Fatihah Mohd, [2]N.M. Mohamad Noor and [3]Yuhanis Yusof
[1]Department of Computer Sciences, College of Technology Bestari,
22100 Setiu, Terengganu, Malaysia
[2]Department of Computer Science, Faculty of Sciences and Technology,
Malaysia University of Terengganu, 21030 Kuala Terengganu, Terengganu, Malaysia
[3]Department of Computer Sciences, College of Arts and Sciences,
Utara University of Malaysia, 06010 Sintok, Kedah, Malaysia

Abstract: Computer-Aided Decision Making (CADM) has been widely used in various decision contexts. This study is focused on CADM for Choosing Education Programs (CASCEP) to rank the performance of a set of decision alternative with respect to multiple criteria. CASCEP has been developed in Visual Basic (VB) that will select and rank the programs that are more suitable to the Malaysian Certificate of Education (SPM) leavers based on 2 inter-related factors: the student's SPM results and minimum programs requirements. In this prototype, 5 programs are offered by Universiti Teknologi Malaysia (UTM) have been selected as a sample programs. Rule-based reasoning technique is used as an engine in order to search the most suitable education program. In this engine, score or value of each program is generated to rank the programs.

Key words: Computer-Aided Decision Making (CADM), Decision Support System (DSS), rule-base, selecting program, education

INTRODUCTION

Computer-Aided Decision Making (CADM) is widely used in decision making contexts include managing all the sub-decision, educating decision maker and consumer purchase in an online sales environment (Grosser and Ghaed, 2004) and also, to assist decision makers in the building industry (Papamichel *et al*., 1999). Decision Support System (DSS) can be used in problem solving to recommend the best alternative solution to human (Barkhi *et al*., 2005). DSS can be classified into soft computing techniques, knowledge engineering techniques and agent-based techniques. The first technique uses the concepts related to rough set theory, fuzzy logic, neural networks and genetic algorithms. The second technique uses knowledge-based systems and expert systems (Sueyoshi and Tadiparthic, 2008). DSS can be also integrated with agent element that can be implemented by using rule-based reasoning, knowledge based reasoning and fuzzy agent's techniques. Venkatramana built the decision support system and hence a rule-based approach was chosen as the implementation model for technical problem in inventory issue (Venkatraman and Venkatraman, 2000).

In this study, agent acts as a decision making tool to facilitate student with a list of suitable programs that Malaysian Certificate of Education (SPM) leavers could apply for. Open Certificate System has widen the choice of educational programs that student is qualified for, hence in order to be offered a place at Malaysia Public Higher Learning Institution (IPTA), it is very important for students to make the right choice in applying the right programs. The student must determine their subject strength in making decision to avoid selecting unsuitable programs. In short, it is hard to find, which program (s) is (are) most suitable based on their result. Therefore, CASCEP has been developed to assist them in decision making process effectively. In order to improve, the effectiveness of decision making, DSS can be integrated with agent elements using rule-based reasoning, knowledge-based reasoning and fuzzy agent's technique (Wu *et al*., 1992). In this study, agent acts as a decision making tool to facilitate student with a list of suitable programs that SPM leavers could apply for. The agent will match the students SPM results with programs requirements to search the most suitable education programs. Therefore, any misunderstanding about the programs requirements can be avoided. In this study,

Corresponding Author: Fatihah Mohd, Department of Computer Sciences, College of Technology Bestari, 22100 Setiu, Terengganu, Malaysia

5 programs offered by Universiti Teknologi Malaysia (UTM), are chosen as the sample education programs of the prototype system (Anonymous, 2002).

Related research: This study discussed past research and issues on decision making in education, decision support system and rule-based.

There are many factors, which one should consider before making a decision in choosing education program. Ibrahim (2002) indicated in this study, SPM leavers should make the right choice in program selection. The strength of the subject must be determined to avoid bad selection program. The student needs a counseling session in order to choose the most suitable education program. Hence, it is important to have counseling teacher to give advice and monitor the student in making decision (Yahya, 1999). Therefore, many past studies developed Computer Aided Decision Making (CADM) to aid people in decision making include managing all the sub-decision, educating decision maker and consumer purchase in an online sales environment (Grosser and Ghaed, 2004), construction (Papamichel *et al*., 1999) and selection problems. Song (1992) conducted a study on using computer-aided decision-making system to assists educational practitioners in making curriculum decision about innovative programs features and implementation requirements recommended by the system.

The selection of an appropriate university or college is of vital importance to the student for acquisition of proper educational experience. There are thousands of universities and programs out there. The information available to students about each program is plentiful but is rather tedious to be obtained. The decision process of college selection is further complicated by many factors such as curriculums, location, rank, size of the universities and so forth. These factors play an important role in the final selection of a college. Wu *et al.* (1992) developed a computer-based decision support system to help users make better decisions in the selection of a college. It can be run on any IBM XT/AT or compatible machines with a DOS environment. It will allow users to make better decisions in their college selection process. Mohamad *et al.* (2005) integrated Fuzzy Multiple Attribute Decision Making MADM with an expert system for selecting a university program, which involves program assessment based on multiple criteria of the user's SPM results. The prototype focused on UiTM's Science and Technology Cluster (college) 6 diploma programs, which are selected from 6 different faculties of each sub-group grouping. Paul *et al.* (2004) explained the development and implementation of a Group Decision Support System (GDSS) in selection and prioritization of the attributes of Master of Business Administration (MBA) programs. They use a collective memory concept in an iterative decision. This may help decision makers adopt less conflicting decision.

Sieker *et al.* (2006) defined DSS as an integrated, interactive computer system, consisting of analytical tools and information management capabilities, designed to aid decision makers in solving relatively large, unstructured problems. DSS is applied to guides and supports an improved water resources management on the level of small watersheds. DSS in oil spill management (Pourvakhshouri *et al*., 2006) aids the decision maker to choose the most reasonable combating method for prevention, control and/or cleanup way against the oil spills pollution. DSS is also increasingly in tourism (Laniado *et al*., 2004). SFIDA can be used to generate information and stimulate participation, making the decision transparent, repeatable and participated.

Sueyoshi and Tadiparthic (2008) in their study combined soft computing, knowledge-based and agent-based techniques to build an intelligent decision making tool. The proposed software uses soft-computing techniques such as probabilistic reasoning and reinforcement learning. The software uses a knowledge-base to fully utilize knowledge on a wholesale market of electricity. Each player in the wholesale market is represented by an intelligent agent. Nammuni *et al.* (2004) used rule-based to build DSS that assists trial designers in designing and planning clinical trials. It knowledge base included medical, statistical, ethical and trial design information, to provide guidance during the trial design process and thus help produce more rigorous protocols more rapidly and easily. Lazarov and Shoval (2002) presents a system for automatic assignment of technicians to service faults. A rule-based selection was used to refine the decision that is, to choose the most appropriate technicians from the list of relevant technicians. Dupuit *et al.* (2007) integrates rule-based reasoning and non-parametric measurement for the optimal sampling points and to control the wastewater quality and its progression over time in industrial wastewater network management.

Rule-based approach has been in use for a couple of decades and their usefulness has been demonstrated in many domains such as agriculture (Debaeke *et al*., 2006), farming (DelaOssa *et al*., 2007), pattern recognition (Frauel *et al*., 2006) and construction industry (Furusaka *et al*., 2000). Venkatraman and Venkatraman (2000) mentioned in their study, the use of rule-based for a typical inventory problem of steel pipes in a construction industry where the scrap has to be minimized. They describe that every knowledge system consists of 2 core components. There are knowledge representation schemes and inference strategies.

For the inventory problem, the expert knowledge is coded into a rule-based system by transforming the knowledge and constraints into a set of if-then rules. They have used the forward chaining inference strategy for implementation. The study also, brings out the benefits that this rule-based system offers to the organization such as scrap reduction and lead time reduction. DelaOssa *et al.* (2007) stated the capability of Rule-Based System (RBS) as predictive systems that is, the system can be used to infer the output for a target variable given an input. RBS is also described as descriptive systems that is, the rules describe interesting relations between the problem variables. Based on that capability, they developed application to a farming problem.

MATERIALS AND METHODS

The aim of this study, is to develop a prototype of Computer-Aided Decision Making in Choosing Education Programs (CASCEP) at the higher educational institutions using rule-based search agent for the SPM leavers. This study focuses on SPM leavers, who wanted to apply for the programs that are offered by IPTA.

DSS is developed using agent element to search for suitable programs to be applied by SPM leavers as their 1st step to study in IPTA. In this prototype system, it is based only on SPM result and minimum program requirements. In this study, the following 5 programs offered by Universiti Teknologi Malaysia (UTM), form the education programs of the prototype system (Anonymous, 2002).

- Diploma in civil engineering
- Diploma in computer science (information technology)
- Diploma in electrical engineering
- Bachelor in electrical engineering
- Bachelor of engineering (computer)

Architecture design of agent: In this prototype, the agent is used to suggest the most suitable education programs to the user. Figure 1 shows the basic agent architecture for rule-based search agent. The rule-based engine consists of initial rule base, content rule base and final rule base. The data that has been key-in by the user will be stored in the database. The agent will then use the data to fire the rules in the rule-based engine. The output of the rule-based engine is the most suitable education programs.

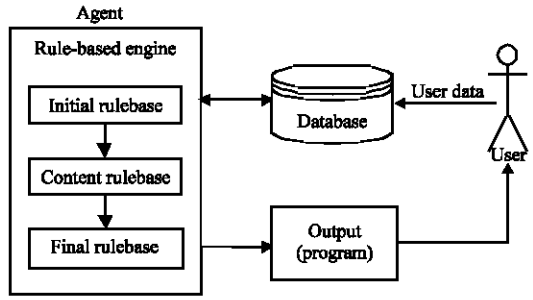

Fig. 1: Basic agent architecture for rule-based search agent

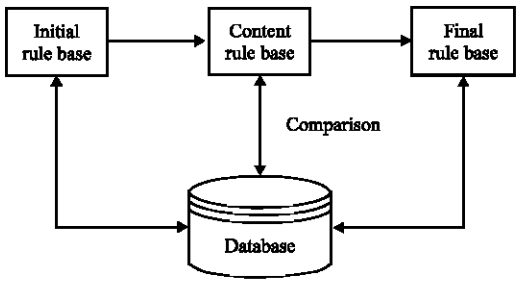

Fig. 2: Rule base sequence

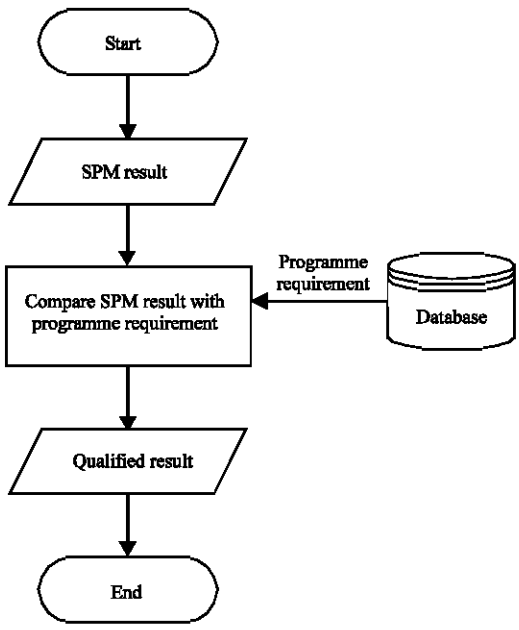

Fig. 3: Initial rule base

Rule-based engine: The rule-based engine is divided into initial rule-based, content rule base and final rule base (Fig. 2). The engine will compare the data in the database with rules, to produce the suitable education programs.

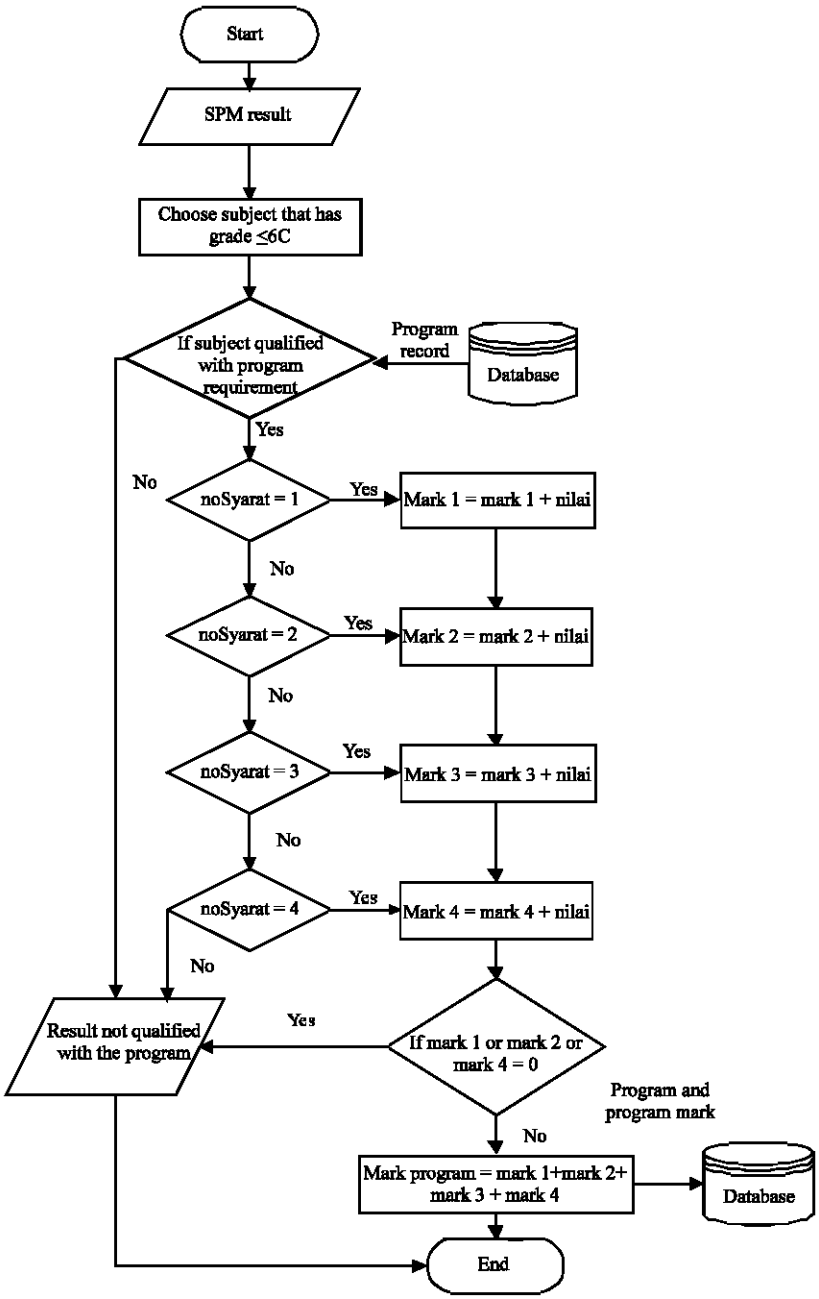

Fig. 4: Content rule base flow

Initial rule base: The initial rule base contains initial rules. The flow of the initial rule base start by filtering subject requirement for each program extracted from the database to produce qualified result (Fig. 3).

Content rule base: Content rule base is used to generate the total scores of the programs. The calculation of the total scores is shown.

Total scores	=	Total 1 + 2 + 4
Total 1	=	Total 1 + nilai
Total 2	=	Total 2 + nilai
Total 4	=	Total 4 + nilai

Total 1 represents the scores for group one, where else total 2 for group 2 and total 4 for group 4. Nilai is the grade's value.

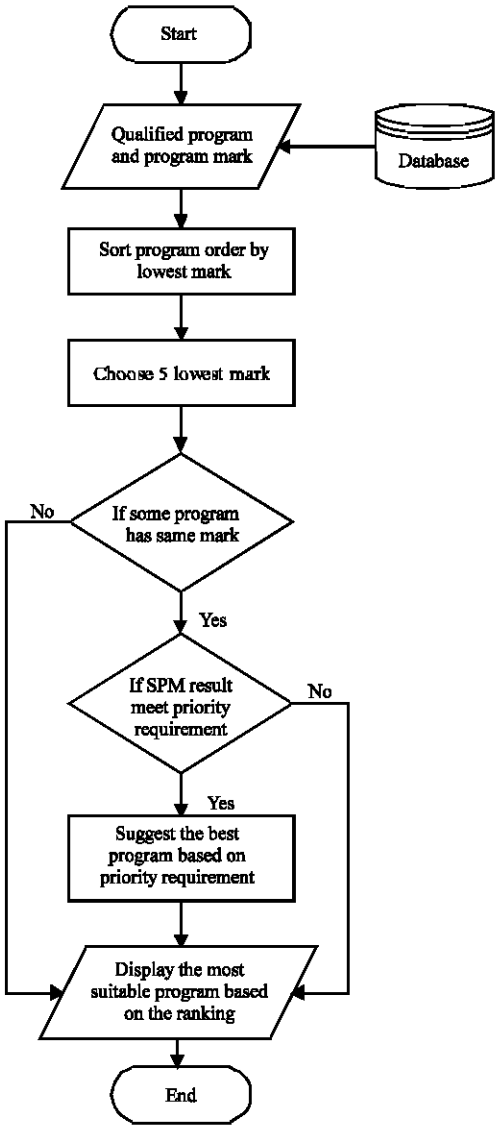

Fig. 5: Suggested education programs flow

The score calculation process can be illustrated in the flowchart as shown in Fig. 4. The input to the process is SPM result. Subjects that are graded ≤6C are chosen. The subjects will be compared with programs requirements from the database to produce the qualified result. The qualified results must fulfill the condition of each group in order to calculate the total score. Otherwise this calculation process will be stopped.

Final rule bas: The final rule base is used to generate the result. In this part, 5 programs are selected based on the lowest score. In the case, where the total scores for the programs are found to have the same value, then Rule 3 (priority requirement) will be applied. The calculation to

Table 1: Sample of SPM result

Subject code	Subject name	Level	GCE-O
1103	Malay Language	3 A	
1119	English	7 D	8E
1223	Islamic Education	1 A	
1249	History	2 A	
1449	Mathematic	1 A	
3472	Additional Mathematic	6 C	
3756	Principal of Account	2 A	
4541	Chemisty	6 C	
4551	Biology	5 C	
4531	Physics	5 C	

Examination syndicate ministry of Malaysian education. Malaysian certificate of education (2001), Qualify to get certificate, Examination director

Table 2: Education programs sample

Programs code	Programs
T001	Diploma in civil engineering
T002	Diploma in computer science (information technology)
T004	Diploma in electrical engineering
T018	Bachelor of engineering (civil)
T022	Bachelor of engineering (computer)

generate the scores for rule 3 is Total 3 = Total 3 + nilai. For the programs that met the rule 3 requirement, it will be ranked ahead among the programs that have the same scores. Figure 5 shows the process flow to display the result. The data from temporary file is the input to the sorting process. The programs are sort based on the lowest score. Then, the best 5 programs will be chosen. However, in the condition where programs generated the same value, then rule 3 is the decision factor. Whichever, programs that meet Rule 3 requirement is chosen.

Actual implement: In this prototype, system analysis phase seeks to systematically analyze data input, data clustering and process modeling. There are 2 categories of inputs. SPM result as a user input and programs requirements. SPM result as a user input (Table 1).

Programs requirements to generate rules: Information on minimum requirement for education programs are referred to university programs handbook (Anonymous, 2002). The prototype focused on UTM 5 programs, which are selected from difference faculties (Table 2). Diploma in civil engineering is used as a sample to represent the whole process.

Raw data: Table 3 shows the raw data, which is indicated the minimum program requirements for T001. These data will be used to generate rules.

Clustering: The raw data in Table 3 is then clustered into 4 groups (Table 4).

The clustering requirement in Table 4 then could be further simplified as presented in Table 5. Referring to

Table 3: Minimum program requirement for T001

General requirement (Group 4)
Pass in Sijil Pelajaran Malaysia (SPM) with distinction in
Malay Language
Mathematic
Special Requirement
a. At least 2 subjects pass with distinction (Group 2)
Additional Mathematic
Physic
Chemistry
Information Technology or Innovation
Additional Science or Science or Biology
Engineering Technology or Civil Engineering Study or Building Construction Technology
Engineering Art or Geometry Art and Building Construction
English or Islamic Syariah Studies (Islamic Law) or Islamic Tasawwur or Al-Quran and As-Sunnah Studies or Islamic Education or Moral Education
b. One of the above subjects in 2 (a), must be one of the following subjects (Group 1)
Additional Mathematic
Physic
Chemistry
Information Technology or Innovation
Additional Science or Science
Priority is given to candidate that pass with distinction in Additional Mathematic and Physic (Group 3)
Programs: Diploma in Civil Engineering (T001)

Table 4: Clustering requirement for T001

Group	Subject code	Subject
1	3472	Additional Mathematic
	4531	Physic
	4541	Chemistry
	3765	Information Technology
	3763	Innovation
	4561	Additional Science
	1511	Science
		At least one subject must be scored with distinction
2	4551	Biology
	3764	Engineering Technology
	3760	Civil Engineering Technology
	8814	Construction Building Technology
	3759	Engineering Art
	8816	Geometry Art and Building Construction
	1119	English
	1249	History
	2280	Geography
	5228	Islamic Syariah Studies (Islamic Law)
	5226	Islamic Tasawwur
	5227	Al-Quran and As-Sunnah Studies
	1223	Islamic Education
	1225	Moral Education
		At least 2 subjects must be scored with distinctions
3	3472	Additional Mathematic
	4531	Physic
		Both subjects must be scored with distinctions
4	1103	Malay Language
	1449	Mathematic
		Both subjects must be scored with distinctions

the group column, G1, G2 and G4 are categorized as compulsory requirement and G3 is categorized as priority requirement. Referring to the requirement column, No. 1 or 2 refers to the number of subjects and ≤6C refers to the minimum grade scored by the mentioned subject (s). The purpose of clustering is to simplify the process of calculating score for each group (the detail process will be explained in the content rule base phase). The clustered data is then used to build rule base (Table 6).

Table 6 shows the rule base for T001. In the rule base, the set of rules is coded in IF-THEN structure which where particular rule is fired. Goal is executed if all the rules are true. The calculation algorithm is developed to find score for each program.

```
i. Calculate score for Group 1
    Do while record not EOF
     If no S=1 then
      Total1=total1 + nilai
       X = X + 1
       If  X = 1 then exit do
     End if
     Loop
   If  X<>1 then total1=0
ii. Calculate score for Group 2
    Do while record not EOF
     If noS=2 then
       Total1 = total1 + nilai
        X = X + 1
        If  X = 2 then exit do
    End if
      Loop
      If X<2 then total1=0
iii. Calculate score for Group 3
     Do while record not EOF
      If noS = 3 then
         Total1 = total1 + nilai
         X = X + 1
         If X = 1 then exit do
      End if
      Loop
     If X<>1 then total1=0
iv. Calculate score for Group 4
  Do while record not EOF
   If noS = 4 then
      Total 1 = total1 + nilai
       X = X + 1
       If X = 2 then exit do
    End if
    Loop
   If X<2 then total1=0
v. Calculate score for programs (T001)
   If total1 or total2 or total4 = 0 then
     Memo = not qualified
     Score T001=0
   Else
     Memo = qualified
     Score T001 = total1 + total2 + total3 + total4
```

Table 5: Simplified clustered requirement of T001

Group	Requirement
G1	1 (≤6C)
G2	2 (≤6C)
G3	2 (≤6C)
G4	2 (≤6C)

Table 6 : Rule base for T001 programs

Target	T001
Rules	
Rule 1	(Group 1)
IF	Group = 1
Then	Total 1 = total 1 + nilai and count group
Rule 2	(Group 2)
IF	Group = 2
Then	Total 2 = total 2 + nilai and count group
Rule 3	(Group 3)
IF	Group = 3
Then	Total 3 = total 3 + nilai and count group
Rule 4	(Group 4)
IF	Group = 4
Then	Total 4 = total 4 + nilai and count group
Goal	
IF	Total 1 or total 2 or total 4 = 0
Then	Score T001 = 0
Else	Score T001 = Total 1 + total 2 + total 3 + total 4

RESULTS AND DISCUSSION

Initial rule bas: The output to the initial process is to identify qualified result. The sample of SPM result from Table 1 will be summarized as indicated in Table 7. It shows the result that has been used to match with programs requirements. There are only nine subjects from SPM result having a grade not >6C.

Table 8 shows the qualified subjects for each program for sample data after filtering process. Only T018 have nine subjects to fulfill the program requirement. The rest of the programs need 8 subjects.

Content rule bas: In this rule base, the total score for the programs were generated. Qualified subjects from the initial rule base then will be used in score calculation process for each subject's group. Grade is presented as a value for each subject and it will be calculated if the subject meets the group's requirement. Otherwise, the score for that group will be zero and the total score for the programs will also be zero. This means the student is not qualified for the particular program. Table 9 shows the calculation score for T001 is 13. The SPM result meets all of the requirements for all of the groups.

Table 10 shows the calculation number of subject score for T002 is 13. T001 and T002 are similar due to the same requirement of G1, G2 and G4. T002 does not have G3 and only T001 has this group. In this phase, group 3 is not used to generate score for program but it will be useful when more than one group has same total score.

Table 7: Summarized SPM result for ID: 840508-05-5151

Subject code	Subject name	Grade
1103	Bahasa Melayu	3B
1119	English	7D
1223	Islamic Education	1A
1249	History	2A
1449	Mathematic	1A
3472	Additional Mathematic	6C
3756	Principle of Account	2A
4541	Chemistry	6C
4551	Biology	5C
4531	Physic	6C

Identity card number: 840508-05-5151

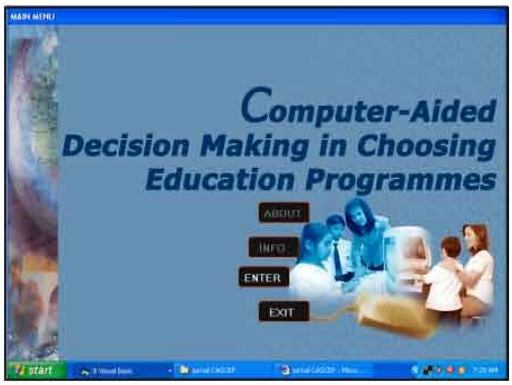

Fig. 6: GUI of main menu

Fig. 7: GUI of student menu

Table 11 shows a total score for T004 is zero. This is because, student must have 2 qualified subjects for G1 and if not, the score for G1 will be zero. If either one of group, has zero score then the overall score will be zero.

Table 12 and 13 show that the total score for T018 and T022 are also zero. In this case, this means there is no subject that is qualified for group 1. Table 14 is summarizing score for all of the programs. It is found that only T001 and T002 have score and the others are zero.

Final rule base: The results in the initial rule based and the content rule based shows the most suitable education

Table 8: Simplified qualified subjects and subject groups for all programs

Subject code	1103	1223	1249	1449	3472	3756	4541	4551	4531
Program code/subject group									
T001	G4	G2	G2	G4	G3	-	G1	G2	G3
T002	G4	G2	G2	G4	G1	-	G1	G2	G1
T004	G4	G2	G2	G4	G3	-	G1	G2	G3
T018	G4	G2	G2	G4	G1	G2	G2	G2	G1
T022	G4	G2	G2	G4	G1	-	G2	G2	G1

Identity card number: 840508-05-5151

Table 9: Calculation score for T001

Group	Requirement	Subject code	Grade	Score
1	1 (≤6C)	4541	6C	6
2	2 (≤6C)	1223	1A	
		1249	2A	3
3	2 (≤6C)	1103	3B	
		1449	1A	4
			Total score	13
4	2 (≤6C)	3472	6	12
		4531	6	

Identity card number: 840508-03-5151; Program code: T001

Table 10: Calculation score for T002

Group	Requirement	Subject code	Grade	Score
1	1 (≤6C)	3472	6C	6
2	2 (≤6C)	1223	1A	
		1249	2A	3
4	2 (≤6C)	1103	3B	
		1449	1A	4
			Total score	13

Identity card number: 840508-03-5151; Program code: T002

Table 11: Calculation score for T004

Group	Requirement	Subject code	Grade	Score
1	2 (≤6C)	4541	6C	0
2	1 (≤6C)	1223	1A	1
4	2 (≤6C)	1103	3B	
		1449	1A	4
			Total score	0

Identity card number: 840508-03-5151; Program code: T004

Table 12: Calculation score for T018

Group	Requirement	Subject code	Grade	Score
1	2 (≤4B)	3472	6C	
		4531	6C	0
2	2 (≤4B)	1223	1A	
		3756	2A	3
4	2 (≤6C)	1449	1A	
		1103	3B	4
			Total score	0

Identity card number: 840508-03-5151; Program code: T018

Table 13: Calculation score for T022

Group	Requirement	Subject code	Grade	Score
1	2 (≤4B)	3472	6C	
		4531	6C	0
2	2 (≤4B)	1223	1A	
		1249	2A	3
4	2 (≤6C)	1449	1A	
		1103	3B	4
			Total score	0

Identity card number: 840508-03-5151; Program code: T022

programs for identity card number: 840508-05-5151 T001 is suggested as a first choice because the SPM result has met priority requirement for T001 whereas T002 does not have this requirement. Both of the suggested programs are offered by UTM (Table 15).

Table 14: Score for each program

Programs	Score
T001	13
T002	13
T004	0
T018	0
T022	0

Table 15: Final suggested education programs

Rank	Programs code	Programs	Institutions
1	T001	Diploma in civil engineering	UTM
2	T002	Diploma in computer science (Information technology)	UTM

Identity card number: 840508-05-5151

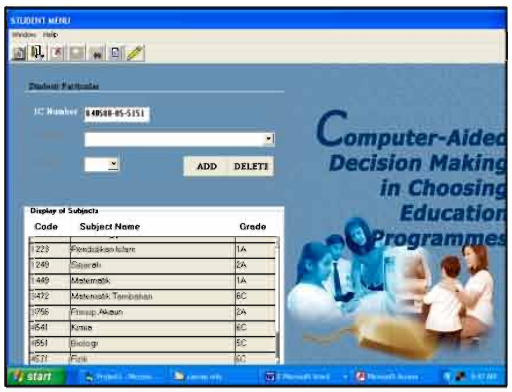

Fig. 8: GUI of student menu with input

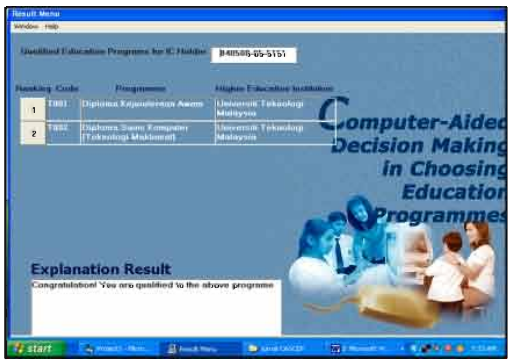

Fig. 9: GUI of CASCEP result

Figure 6-9 demostrate the Graphical User Interface (GUI) of CASCEP. Users only need to key in SPM result on student menu (Fig. 7) and CASCEP will display the output on result menu (Fig. 9).

CONCLUSION

Generally, the main purpose of the system, which is to develop a prototype of computer-aided decision making system in choosing education programs for SPM holders have been achieved. The CASCEP uses rule-based search agent to search the most suitable education programs by matching the SPM result with the programs requirements. The agent is capable of assisting the student in choosing the right education programs that is suitable with their SPM result. By using the CASCEP, the possibility of choosing the wrong education programs can be decreased.

The sample of the education programs that are suggested by the agent in the prototype are only five education programs. By including more education programs from different higher education institutions, the agent could make comparison and would be able to suggest more education programs to the user. It is also hoped that this system can be enhance to Web based application programs (Noor *et al*., 2006; Wena *et al*., 2008; Zhang and Goddard, 2007). In such a case, every user will be able to access the system anywhere and use it as a mechanism in helping them to make the right decision. The prototype employed the rule-based technique and search agent. In future, the study could be carried out using other techniques such as fuzzy neural networks (Kuo and Chen, 2004), genetic algorithm (Lee, 2008) and additive value function (Noor *et al*., 2006).

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