Covid19 and Higher Education: A Degree Course Recommender System Based on Personality Using Rule-Based

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Abstract. As a result of the pandemic Covid19 and the enforcement of Movement Control Order (MCO) in Malaysia, it is difficult for the Ministry of Education to explain the selection of courses at the university. Current systems such as “Selangkah ke UiTM,” "eSemak Politeknik” and "EduAdvisor" concentrate only on SPM graduates. As a result, this study proposes a recommendation system that can provide recommendations for the course to suit students' personalities. Diploma of Computer Science students from the Faculty of Computer and Mathematical Science (FSKM) at UiTM Melaka are selected as a case study. This system uses the rule-based approach that took psychometric test results: "Inventori Minat Kerjaya” and mapped it to the traits needed for the five courses offered at the faculty to help students determine the most appropriate course. This prototype system consists of 170 test questions, and the results of the top 3 IMK personalities are chosen to be mapped to the courses offered. Usability and accuracy testing has been carried out at an average rate of 77.5%, and accuracy is 66.7%.

1. Introduction
Every year, those who have completed “Sijil Tinggi Persekolahan Malaysia” (STPM), Matriculation, Foundation or Diplomas from public universities apply for admission to the university to pursue their studies at the degree level [1]. The Ministry of Higher Education will also hold the "Jom Masuk IPT" National Higher Education Carnival every February to April every year. This roadshow will be joined by public and private higher learning institutions in Malaysia to assist students in selecting university degree courses. The response was very positive; for example, the carnival visitors in the Northern Zone had reached as many as 50,000 people. Unfortunately, this Covid19 pandemic has hampered this initiative and has had a significant impact on students [2]. The assistance provided to students is provided by the dissemination of information on the official website of the “Unit Pengambilan Universiti” (UPU), which is a centralized platform that manages the application process for Public Universities (UA), Polytechnics, Community Colleges, and Institut Latihan Kemahiran Awam (ILKA) in Malaysia. Apart from that, information can be obtained through UPU's official Facebook and Twitter.

Enforcement of Movement Control Order (MCO) limits students to seek a source of information on the direction of their interest. There is a recommender system to assist students called "Selangkah ke UiTM". However, this system can only be used by SPM students to check what course UiTM offers that they can submit on the grounds of their SPM results. As such, “Selangkah ke UiTM” does not apply to non-SPM applicants. The other choice is their academic advisor or school counselor.
Conversely, the information provided by academic advisors or counselors may not be reliable or predisposed to prejudice since they are not experts in the specific course the student is asking for. Besides, these consultations do not consider the students’ personality in recommending a degree course. As a result, students select a degree course purely from an academic advisory point of view instead of selecting a degree course that fits their personality.

To overcome this problem, there is a need to develop a recommender system that can measure students’ interests and personality and match them with a suitable degree course. For the purpose of this study, students from Diploma of Computer Science (CS110) of Fakulti Sains Komputer dan Matematik (FSKM) from UiTM Cawangan Melaka (UiTMCM) and the staff of Unit Kerjaya dan Kaunseling (UKK) of UiTM Cawangan Melaka Kampus Jasin (KJM) are taken as a case study. The recommender system will recommend five of the FSKM degree courses that is offered at KJM. The system will implement a psychometric test to evaluate a student’s personality. With the psychometric test result, the system will use a rule-based technique to recommend a degree course.

The rest of the paper is structured as follows. Section 2 outlines the relevant issues regarding the psychometric test and a ruled-based expert system. Section 3 detail the process of developing the system. Section 4 addresses the outcome of the prototype system and results of usability and accuracy testing. Section 5 draws some conclusions and possible future work.

2. Related Works

The definition of personality can be defined in various aspects, but the general idea is that personality distinguishes an individual by their characteristics [3]. Personality has two primary meanings that have evolved from a psychological standpoint. The first is the consistent differences between people, while the second meaning highlights that people are all alike, which distinguishes man from other species [4].

There are several personality classifications, such as the Big Five Personality Traits [5]-[7], the “Inventori Personaliti Warna”, and the “Inventori Minat Kerjaya” (IMK) [8], as shown in Table 1. Each of these classifications has different viewpoints on the individual's personality classification.

| Table 1. Comparison of 3 psychometric test |
|-------------------------------------------|
| Big Five Personality Traits                | Personaliti Warna | Inventori Minat Kerjaya |
| Personality traits could be categorized into the Extraversion, Agreeableness, Conscientiousness, Neuroticism, and Openness to Experience | A person can be classified as a Blue, Gold, Green, or Orange. | People can be categorized into six personality types which are: Realistic (R), Investigative (I), Artistic (A), Social (S), Enterprising (E), and Conventional (C), which is also known as RIASEC for short. |

The best psychometric test to be carried out for this system, advised by UKK staf, is IMK. This is because IMK is more career-oriented than “Inventori Personality Warna” and Big Five Personality Traits. Besides, IMK is built to cater to the Malaysian environment, making it much more reliable and relatable for the person answering the test. The test comprises of 170 questions of Yes or No set of questions and Likert-scale format. Points will be given from each answer. 6 outcomes can be obtained through this test. But the top three scores will better reflect the student's personality. The results will be Realistic, Investigative, Artistic, Social, Enterprising, and Conventional.

Recommendation systems assist the user by offering recommendations for things that may be of interest to the user. It typically answers questions about what to do next or what to buy next. In general, recommender systems have three common approaches: collaborative filtering, content-based filtering, and knowledge-based recommendation. The knowledge-based recommendation is a
recommendation task that seeks to classify a collection of things that best match the consumer's needs [9]. It also recommends products by manually or automatically creating a range of collection rules [10]. Information-based guidelines emphasize explicit domain knowledge as well as implicit consumer knowledge.

Much research has been done on implementing the recommended system for different applications, such as music, online shopping, and hospitality [12]. A study done by [13] shows that rule-based is applied in a 2-phase process to recommend a movie to the user. Using the content-based group-recommender, the researcher will refer to the user's viewing history and the movies' ratings, which are used as rules of construction. In the meantime, [14] used a rule-based with fuzzy logic to eliminate uncertainty in decision making to classify significant factors as characteristics of students who affect their career decisions. This research used a feature selection technique to predict student performance. A food recommendation uses a rule-based methodology to prescribe and suggest acceptable food for an allergic baby [15]. The system can assist the parent and caregiver by reducing the time required to find the right food for their allergic infant. This system is being built on a mobile platform.

There are a few programs that offer recommendations for courses to students. “Selangkah ke UiTM” focuses mainly on SPM and STPM certificate holders who are interested in joining UiTM but are uncertain of which courses are suitable based on their results. The students need to include their identification number and the SPM/STPM/Muet result before their application is processed. The green tick shows that the program is eligible for the student while the red cross indicates that it is not applicable. Politeknik advised students interested in furthering their studies at Politeknik to first check their qualifications before applying by using “eSemak”. Politeknik also has stated that the outcome is solely based on the candidate’s academic result that they have previously achieved. The results only reflect the diploma programs and certificates that the student will be eligible to apply for based on their academic qualifications. EduAdvisor Course Recommender helps SPM students in deciding what is the best path to continue their studies. It is mainly for students who are unsure of which path of education to continue. Therefore, EduAdvisor helps by suggesting a pre-university course that is ideally suited to the SPM candidate, such as continuing for foundation or going for matriculation or even going for A-Levels.

Based on the above discussion, there is a great need for a recommendation system that measures students' personality and maps them to the characteristics of the course.

3. Research Methodology

The Waterfall model will be the ideal method for implementing this system since it involves a limited number of developers and can also be used by individual developers. This methodology's phases do not overlap, making it easier for the developer to use and understand them. This section briefly discussed the process involved in developing the system.

3.1 Waterfall system development life cycle

The gathering and analyzing of requirements were the first phase that has been implemented in this project. Several activities were done to complete this phase, such as reading various literature as preparations for the interview with stakeholders and conducting an interview with the stakeholder. To determine what personality is best suited for a degree course, several FSKM lecturers were interviewed. Data obtained through these interviews are analyzed, and the rule-based criteria are designed. In addition, the findings from interviews are transformed into a use case diagram.

This system has 18 use cases used by two actors: the student and staff, as shown in Table 2. The diagrams produced, the product functionality, and the system designs, and implementation constraints are all documented. This system is developed Eclipse IDE (Lunar), which is a Java Programming Language, and the database used is Oracle. The system is developed based on Model-View-Controller (MVC) architecture or also known as the 3-layer architecture. The deliverable of this activity would be a working prototype of the degree course recommendation system. Usability and accuracy testing are carried out at the end of this cycle to learn the customer's acceptance and the accuracy of the system performance.
The system flow for this study as shown in Figure 1. Firstly, students need to answer the personality test questions in the system. The answer Yes and No will be given a score either 0 or 1 using the standard set by IMK. After all 170 questions have been answered, the results will be given on the basis of the category: Realistic, Investigative, Artistic, Social, Enterprising, and Conventional. Based on the results obtained, the top 3 categories will be used in the engine inference system to be match with the rules in the database. The rules are designed based of the characteristics required for the FSKM course. The outcome of inferencing is a course recommended to students.

### Table 2. Identified use case based on requirements

| System User | Student | Staff |
|-------------|---------|-------|
| Use Case    |         |       |
| 1. Create Student | 1. View Personality Test | |
| 2. View Student | 2. Create Personality Test | |
| 3. Update Student | 3. Update Personality Test | |
| 4. View Personality Test | 4. Delete Personality Test | |
| 5. Answer Personality Test | 5. View Questions | |
| 6. View Results | 6. Update Questions | |
| 7. View Recommendations | 7. Create Questions | |
|                | 8. Delete Questions |       |
|                | 9. Manage Criteria | |
|                | 10. View Results |     |
|                | 11. View Recommendations | |

**Figure 1. System flow**

3.2 Design rule-based criteria

Several FSKM lecturers have been interviewed to assess which personality is ideally suited for a degree course. The lecturers interviewed are experienced lecturers in their profession. This is done to obtain correct information on the personality ideal for a degree course based on the IMK. Based on Table 3, all five courses contain the personality trait of Investigative and Enterprising within their most significant trait. This indicates that these five courses share these two characteristics of
personality as a shared characteristic. The main reason for five courses shares these characteristics is that FSKM is a faculty where students must have good analytical and problem-solving skills defined by the Investigate personality trait. The Enterprising characteristic is reflected by the student’s need to achieve their objectives, as well as to work in teams to achieve those objectives.

Table 3. FSKM courses and their personality

| Courses                                      | Personality                                   |
|----------------------------------------------|-----------------------------------------------|
| Computer Science (CS230)                     | Investigative, Conventional, Enterprising, Artistic, Realistic, and Social |
| Information Systems Engineering (CS246)      | Investigative, Social, Enterprising, Realistic, Artistic and Conventional |
| Data Communications & Networking (CS245)     | Investigative, Enterprising, Realistic, Social, Artistic and Conventional |
| Netcentric Computing (CS251)                 | Artistic, Investigative, Enterprising, Realistic, Social and Conventional |
| Multimedia Computing (CS253)                 | Investigative, Realistic, Artistic, Social, Enterprising and Conventional |

4. Result and Discussion

4.1 Prototype System
The prototype system is developed with students from the Diploma of Computer Science is the primary target user. Using information acquired from the interview, a set of rules has been constructed as shown in Table 4. The construction method is based on the information obtained through a personal interview with the stakeholder and the respective lecturers. IMK has chosen as an instrument of psychometric testing to cater to the Malaysian environment, and the questions will capture the data more precisely. Mapping three of IMK’s highest personality requirements with the characteristics required for degree courses, 375 rules have been created. Based on these rules, a recommendation for a suitable degree Course that corresponds to the student’s personality is given, as shown in Figure 2.

Table 4. Part of rules constructed

| No. | Rules Generated                                                                 |
|-----|---------------------------------------------------------------------------------|
| 1.  | IF result_category1 = Realistic AND result_category2 = Investigative AND result_category3 = Artistic THEN course_name = Multimedia, Netsentric, Network |
| 2.  | IF result_category1 = Realistic AND result_category2 = Investigative AND result_category3 = Social THEN course = Multimedia, ISE, Network |
| 3.  | IF result_category1 = Realistic AND result_category2 = Investigative AND result_category3 = Enterprising THEN course = Network, ISE, Netsentric |
| 4.  | IF result_category1 = Realistic AND result_category2 = Investigative AND result_category3 = Conventional THEN course = CS, Multimedia, Network |
| 5.  | IF result_category1 = Realistic AND result_category2 = Artistic AND result_category3 = Investigative THEN course = Multimedia, Netsentric, Network |
4.2 Usability Testing

Usability testing is a test conducted to assess user approval of the design or use of the system. This test adopts the System Usability Scale (SUS) consisting of 10 Likert-Scale questions. Table 5 displays the SUS questionnaire, which has been distributed to 10 participants who are diploma students. They are required to view the website in order to test the system and answer the questions. Using the standard formula, where the score from the odd number question is deducted by 1, and the score from the even number question is subtracted by 5, the SUS raw score for each participant is acquired by adding all the scores. The raw score is then multiplied by 2.5 to get the final score. The outcome of the SUS survey is translated into a SUS score, as shown in Table 6. The average score obtained is 77.5. Based on this analysis, the system can be concluded accepted by users with some space for improvement.

The majority of the users believe the system was easy to use as this category’s score is the highest. However, most users agreed that the system is unnecessarily complex as the score for this category is the lowest. This is because the users believed that the number of questions to be answered are numerous. This can also be deduced that the users do not understand the importance of each question.

Table 5. SUS questionnaire

| No | Question                                                                 | Scale: 1-Strongly Disagree, 2-Disagree, 3-Neutral, 4-Agree, 5-Strongly Agree |
|----|--------------------------------------------------------------------------|--------------------------------------------------------------------------------|
| 1  | I think that I would like to use this system frequently                  | 1 2 3 4 5                                                                     |
| 2  | I found the system unnecessarily complex                                 | 1 2 3 4 5                                                                     |
| 3  | I thought the system was easy to use                                    | 1 2 3 4 5                                                                     |
| 4  | I think that I would need the support of a technical person to be able to use this system | 1 2 3 4 5                                                                     |
| 5  | I found the various functions in this system were well-integrated        | 1 2 3 4 5                                                                     |
| 6  | I thought there was too much inconsistency in this system               | 1 2 3 4 5                                                                     |
| 7  | I would imagine that most people would learn to use this system very quickly | 1 2 3 4 5                                                                     |
| 8  | I found the system very cumbersome to use                               | 1 2 3 4 5                                                                     |
| 9  | I felt very confident using the system                                  | 1 2 3 4 5                                                                     |
| 10 | I needed to learn a lot of things before I could get going with this system | 1 2 3 4 5                                                                     |
Table 6. Result of usability testing

| Question Type | Question No. | T1  | T2  | T3  | T4  | T5  | T6  | T7  | T8  | T9  | T10 |
|---------------|--------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Odd           | 1            | 4   | 5   | 2   | 4   | 4   | 5   | 5   | 4   | 4   | 4   |
| Numbered      | 3            | 5   | 5   | 4   | 5   | 5   | 5   | 4   | 4   | 4   | 4   |
| Questions     | 5            | 4   | 5   | 3   | 4   | 5   | 5   | 5   | 3   | 5   | 3   |
|               | 7            | 4   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   |
|               | 9            | 4   | 4   | 4   | 5   | 5   | 5   | 4   | 5   | 4   | 4   |
| Total (Odd)   |              | 21  | 24  | 18  | 23  | 24  | 25  | 20  | 23  | 20  | 20  |
| Even          | 2            | 2   | 1   | 3   | 3   | 3   | 2   | 3   | 2   | 2   | 3   |
| Numbered      | 4            | 1   | 5   | 2   | 1   | 2   | 1   | 2   | 4   | 2   | 4   |
| Questions     | 6            | 2   | 4   | 1   | 1   | 1   | 1   | 1   | 4   | 5   | 1   |
|               | 8            | 1   | 1   | 1   | 2   | 1   | 2   | 2   | 1   | 5   | 1   |
|               | 10           | 5   | 1   | 1   | 3   | 2   | 3   | 2   | 4   | 4   | 2   |
| Total (Even)  |              | 11  | 12  | 8   | 10  | 9   | 9   | 10  | 15  | 18  | 11  |
| SUS Raw Score |              | 30  | 32  | 30  | 33  | 35  | 36  | 35  | 25  | 25  | 29  |
| SUS Final Score|             | 75  | 80  | 75  | 82.5| 87.5| 90  | 87.5| 62.5| 62.5| 72.5|
| Total Average |              | 77.5|

4.3 Accuracy Testing

Accuracy testing was conducted to ensure that the user's outcome is consistent with the course to which they are currently enrolled. This is to increase the believability of the user of the system. Each of the results was examined by the tester to verify the results were correct. The test is conducted on 12 undergraduate students from different courses, and the result of testing is shown in Table 7. Referring to Table 7, 66.7% of respondents had enrolled in the course recommended by the system. This signifies that the system is capable of delivering a reasonably reliable recommendation to the customer. Some of the users indicated that some of the suggested courses were what they wanted to apply, but they were uncertain about the course's suitability.

Table 7. Result of accuracy testing

| Questions                                                                 | Yes   | No   |
|---------------------------------------------------------------------------|-------|------|
| Are the courses that you are currently taking listed within the recommendation? | 66.7% | 33.3%|
| Will you apply the courses recommended to you by the system?              | 75%   | 25%  |
| How accurate does the personality that you obtained described yourself?   | 75%   | 25%  |
| How accurate are the courses recommended to you?                          | 83.3% | 16.6%|

5. Conclusion

Unpredicted situations call for unprecedented intervention. With the advancement of digital technology, there is no reason to explore an alternative solution. Students who yet to discover their potential make it difficult for them to choose the field they want to explore. Using this system and results obtained, they will learn their strengths and be matched with appropriate courses. Some enhancements can be added to the system in the future as improvements. The current system only uses IF-THEN statements based on the rules in the database. To achieve much more precise course recommendation, a certainty factor should be implemented to increase accuracy. The certainty factor would improve the accuracy since each course's experts will decide how much weightage the personality trait affects the student's suitability for the degree course.

6. References

[1] Bahagian Kemasukan Pelajar IPTA, 2020
[2] Shah, A. U. M., Safri, S. N. A., Thevadas, R., Noordin, N. K., Rahman, A. A., Sekawi, Z., ... Sultan, M. T. H. (2020). COVID-19 outbreak in Malaysia: Actions taken by the Malaysian
government. International Journal of Infectious Diseases, 97, 108–116. https://doi.org/10.1016/j.ijid.2020.05.093

[3] Kuravatti, K. P. B., & Malipatil, R. P. (2017). Factors Affecting Of Personality Development

[4] Holzman, P. S. (2019). Personality. Encyclopaedia Britannica, Inc. https://doi.org/10.1002/ejoc.201200111

[5] Bornstein, M. H. (2018). Big Five Personality Traits. The SAGE Encyclopedia of Lifespan Human Development, 2(March). https://doi.org/10.4135/9781506307633.n93

[6] Nyarko, K., Kugbey, N., Amissah, C., Ansah-Nyarko, M., & Dedzo, B. (2015). The Influence of the Big Five Personality and Motivation on Academic Achievement among University Students in Ghana. British Journal of Education, Society & Behavioural Science, 13(2), 1–7. https://doi.org/10.9734/bjesbs/2016/19618

[7] Lounsbury, J. W., Studham, R. S., Steel, R. P., Gibson, L. W., & Drost, A. W. (2011). Holland’s Vocational Theory and Personality Traits of Information Technology Professionals. Global Business, 2087–2101. https://doi.org/10.4018/978-1-60960-587-2.ch716

[8] Ucheagwu, V., Okoli, P. & Ugokwe-Ossai, R. Some Neuropsychological Profiles and Personality Traits of Undergraduate Regular Online Football Gamblers (a New Online Gambling Game) in Nigeria. J Gambl Stud 35, 171–180 (2019). https://doi.org/10.1007/s10899-018-9812-9

[9] Juhari, M., Ku Johari, K. S., Mahmud, M. I., & Rahman, M. F. A. (2020). Descriptive Analysis of Multiple Intelligence and Career Interest. 464(Psshes 2019), 708–712. https://doi.org/10.2991/assehr.k.200824.159

[10] Sturm, J. (2016). Persuasive technology. Handbook of Smart Homes, Health Care and Well-Being, (June), 3–12. https://doi.org/10.1007/978-3-319-01583-5_56

[11] Bahram Amini, Roliana Ibrahim, & Othman, M. S. (2011). Discovering The Impact Of Knowledge In Recommender Systems: A Comparative Study. International Journal of Computer Science & Engineering Survey, 2(3), 1–14. https://doi.org/10.5121/ijcses.2011.2301.

[12] J. Lu, D. Wu, M. Mao, W. Wang, and G. Zhang, “Recommender system application developments,” Decision Support Systems, vol. 74, Jun., pp.12–32, 2015.

[13] Sharma, M., Ahuja, L., & Kumar, V. (2020). A novel rule based data mining approach towards movie recommender system. Journal of Information and Organizational Sciences, 44(1), 157–170. https://doi.org/10.31341/jios.44.1.7

[14] Sayoc, V. R., Dolores, T. K., Lim, M. C., Sophia, L., & Miguel, S. (2019). International Journal of Advanced Trends in Computer Science and Engineering Available Online at http://www.warse.org/IJATCSE/static/pdf/file/ijatcse68832019.pdf Computer Systems in Analytical Applications. 8(3), 195–200.

[15] A. A. Shari et al., “Mobile Application of Food Recommendation For Allergy Baby Using Rule-Based Technique,” 2019 IEEE International Conference on Automatic Control and Intelligent Systems (ICACIS), Selangor, Malaysia, 2019, pp. 273-278, doi: 10.1109/ICACIS.2019.8825026.

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