University Academic Lifecycle and the Academic Factors Taxonomy for Malaysian Comprehensive University

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Abstract
Purpose: This study aims to redefine, consolidate, and develop the data attributes taxonomy for Education Data Mining (EDM) subject to the nature of the academic lifecycle for Malaysian Comprehensive University category.
Design/methodology/approach: A comprehensive flow-relationship and category of data attributes of academic lifecycle processes subject to the Malaysian Comprehensive University category has been studied and identified.
Findings: The standard data taxonomy has been introduced to the process of flow-relationship by considering all the academic lifecycle processes in the perspective university's academic management.
Research limitations/implications: The proposed data taxonomy may have different definitions subject to the different management style and terminology of the universities within the same category.
Practical implications: This data taxonomy can be used as a base of Education Data Mining (EDM) formulation and development process for university knowledge discovery initiatives that could help the universities in enhancing their teaching and learning approaches. Ultimately, allow the university to dynamically re-strategize their management strategies in preparing their students to meet future job needs and requirements.

Originality/value: The result of this study contributes to the universities in maximizing the capacity and advantages of data analytics initiatives by understanding comprehensively about the national educational pathway and the university academic lifecycle.

Keywords: Data analytics, educational data mining, learning experience, Malaysian comprehensive university, academic lifecycle

Introduction

The landscape of higher education institutions (HEIs) management becomes very dynamic and challenging (Ministry of Higher Education [MOHE], 2015a; Malini, 2016; Krishna & Charlotte, 2016; Norliza et al., 2017). The impact of digitalization, globalization, and information technology innovations changes the economic sectors and disrupts global business processes and sectors, including the education sector (Malini, 2016). Universities need to adapt and adopt new approaches and strategies to stay relevant in a very competitive environment. Furthermore, these HEIs' annual achievements and capabilities are evaluated and ranked by international bodies such as QS ranking, Times Higher, and others to portray its impact and visibility to global societies. A radical transformation initiative is required for these institutions to produce knowledgeable and versatile talents that can compete locally and globally (Chang, Morshidi & Dzulkifli, 2015; MOHE, 2015a; Meylinda, Faaizah, & Naim, 2018). Consequently, Malaysian HEIs need to be more dynamic and creative in meeting global requirements in ensuring the graduates' competitiveness (Malini, 2016). Similarly, HEIs also need to design academic programs that meet the future demand for employment of their graduates to fulfill local job market requirements and can be accepted internationally (Ainon & Rosmaizura, 2018).

Due to this goal, HEIs have been encouraged to offer educational initiatives such as career path and personal development, strategic learning centers, and industrial-based growth and human resources development through flexible education approaches (MOHE, 2015a; Ainon & Rosmaizura, 2018). Thus, it provides broader access to higher education opportunities worldwide (Malini, 2016). However, the change of university's requirements and roles in adapting global demands incur costs (Chang, Morshidi, and Dzulkifli, 2015). The government's limitation of funds may jeopardize any university's transformation efforts in achieving the ministry's Key Performance Indicators (KPIs) and performance indicators (MOHE, 2015a). Indirectly, it will encourage universities to be more prudent in offering their academic programs and invest in their facilities and resources to attract more potential students either locally or internationally as their choice of university.

With the advancement of information technology, these institutions can utilize technology to understand, predict, and implement the best identified strategic approaches to achieve KPIs and Key Intangible Performance (KIPs) (Masron et al. 2012; MOHE, 2015a). The Educational Data Mining (EDM) approach can be utilized by these universities as a knowledge discovery platform in formulating the academic strategies in many aspects of academic performance. It can also provide valuable insights into the data originating from an academic setting. A complement to the EDM, a data-driven approach based on big data analytics technology can be utilized as a core of the decision-making process by the management (Amirah et al., 2015; Sumyea et al., 2018; Nurafifah et al., 2019a). As a result, it will enhance the organization's abilities in facing uncertainties, demands, and requirements. For instance, universities need to utilize the university's resources to improve its effectiveness and efficiency of the university's teaching and student learning practices that should be focused on by the university management (Sumyea et al., 2018). Yet, this issue's complexity can be considered difficult to be solved since many internal and external factors may

contribute to its outcomes, such as social and cultural background, academic qualification, economic, national obligations, etc. (Malini 2016).

This paper aims to discuss a comprehensive academic life cycle of Malaysian higher learning from the perspective of Universiti Teknologi MARA (UiTM) as a Malaysian Comprehensive University, and its data attributes taxonomy. This paper is organized as follows. Section 2 presents the elaboration of the topic's background. Section 3 will discuss the nature of a specific focus. Section 4 explains the university academic lifecycle, and Section 5 will discuss the roles of Educational Data Mining. Meanwhile, Section 6 describes the data attributes taxonomy subject to the lifecycle, and the final discussion concludes in the last section of the paper.

Literature Review
Background of Malaysian Universities

Malaysia needs to equip its citizens with the best training and education options to build up and contribute to the nation's aspiration to be a high-income nation (OECD, 2019). Consequently, universities' role as the leading higher learning education platform needs to be excellent not only at the national and regional level but also at the international level (Malini 2016). Currently, the Malaysia Ministry of Higher Education governs 20 public universities that offer various academic programs according to their unique niche areas and expertise (MOHE, 2015a; MOHE, 2015b; Ainon & Rosmaizura, 2018). Fig. 1 maps all 20 public universities in Malaysia subject to their respective clusters. The ministry groups these universities into their specific operational focus, namely, the Malaysian Research University (MRU), the Malaysian Comprehensive University (MCU), and the Malaysian Technical University Network (MTUN) (MOHE, 2015a; MOHE, 2015b).
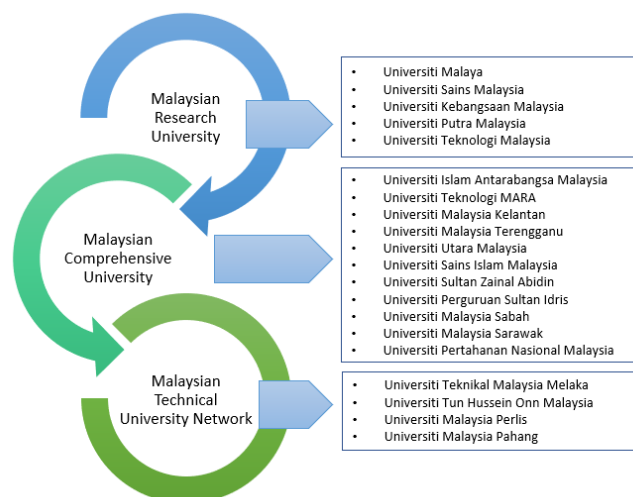

Figure 1: Malaysian University Clusters

MRU focuses on extensive and comprehensive multi-disciplinary research activities with a high population of postgraduate students. On the contrary, MCU offers a broader range of high-quality academic programs ranging from undergraduate to postgraduate level that prioritizes innovative program design. These universities have their concentration fields and educational philosophy by specializing either management and social science or science and technology as a core of their university education aspiration. Meanwhile, MTUN emphasizes technical vocational education and training (TVET) programs with industrial and professional

collaboration. To date, Universiti Teknologi MARA (UiTM) is the Malaysian largest MCU in the perspective of number enrolment, academic programs, and campuses.

Universiti Teknologi MARA as Comprehensive University (MCU)

The quality of graduates' academic programs is becoming very important to the university in meeting the job market either locally or globally (UiTM, 2019a). Universiti Teknologi MARA (UiTM) focuses more on teaching and learning than research and consultation and plays a vital role in talent development in Malaysia (MOHE, 2015b). According to the statistical report of MOHE's tracer study 2017 (Ministry of Education [MOE], 2018), UiTM is the largest graduate contributor to the national workforce, with 52,491 graduates. Thus, it shows the importance of this university in supporting the national economy and development plan. In the future, the UiTM's enrolment of students is expected to reach 200,000 students (UiTM, 2019a).

Being the largest university in Malaysia, UiTM groups the faculties into three clusters; i) Science and Technology, ii) Business and Management, and iii) Social Sciences and Humanities. The admission qualifications are different subject to the offered academic programs across these faculties. These faculties and centers actively promote their academic programs to the public, primarily undergraduate programs, through a centralized unit, Student Intake Division. As in Session 1 2019/2020, the student enrolment is more than 160,000 students (UiTM, 2019b) in 14 state campuses supported with 21 satellite campuses throughout the university system. Most of the postgraduate programs are conducted in Selangor campuses, while other state campuses concentrate more on undergraduate programs. It has become crucial for university management to fully understand its current internal and external scenarios, mostly in academic matters. UiTM's academic programs are based on the zoning allocation strategy to the specific campuses based on facilities, equipment, and campus capacity of space, staff, and resources. Due to the massive number of students and academic programs, this approach has optimized all the university resources by minimizing the operational costs and managerial issues related to the academic resources.

The yearly intake allocation for Diploma programs is the biggest compared to other program academic levels that consist of not less than 50% of the overall university's academic intake allocation. Meanwhile, the undergraduate degree programs represent 40% of the overall university intake and 10% for postgraduate programs intake (UiTM, 2019b). In this perspective, student enrolment becomes vital to UiTM's survivability as the most significant national workforce source for skill and professional professions (MOE, 2018).

Malaysian Comprehensive University Academic Lifecycle

There are three phases for a student in the university academic lifecycle: (i) potential student, (ii) registered student, and (iii) graduate and alumni, as illustrated in Fig. 2. These stages reflect the unique academic processes and requirements, and study experience of a student either indirectly or directly, contributing to the relevant information and data attributes.
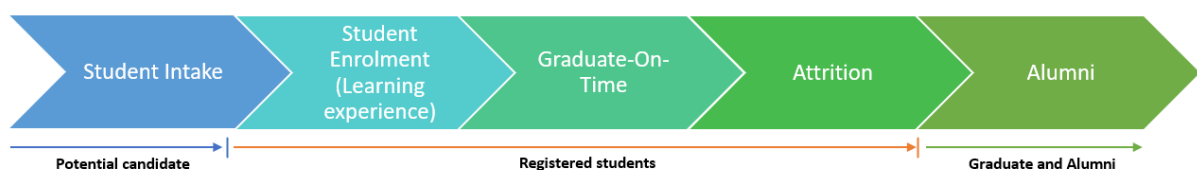

Figure 2: University's academic lifecycle

The study duration is defined based on their academic programs' study plan subject to the classification of MOHE' Silver Book (MOHE. 2015b; Syahirah et al., 2019a). All non-engineering academic programs except for the medical program require a 3-year or 6-semester study plan. In contrast, the engineering-based programs have a 4-year or 8-semesters study plan.

Student Intake

UiTM offers more than 500 academic programs from a number of faculties and academies (UiTM, 2019b). It is one of several universities in MCU category that offers diploma and degree programs. Fig. 3 shows the programs' entry requirements according to each entry level. To enter such programs, students are required to obtain the Malaysian Certificate of Education (MCE - *Sijil Pelajaran Malaysia - SPM*) for the diploma program. Whereas students are required to have the Malaysian Higher School Certificate (MHSC or *Sijil Tinggi Persekolahan Malaysia-STPM*), foundation, or matriculation certification for bachelor's degree programs (MOE, 2019a; MOE, 2019b). In addition to diploma and bachelor's degree programs, MCU universities also offer postgraduates courses (MOHE, 2015a; MOHE, 2015b). Nonetheless, most of the student intake is the diploma and bachelor's degree programs rather than the postgraduate programs.
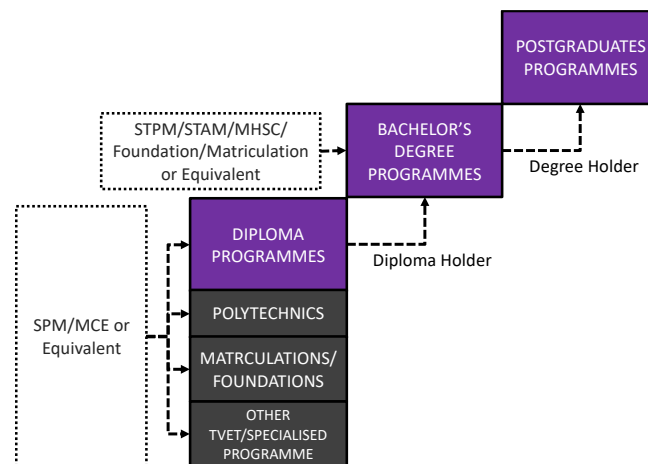

Figure 3: Programmes' entry requirements, levels, and education pathways

Referring to Fig. 4, there are many tertiary education institutions' pathways subject to the secondary education of school level qualification either MCE (SPM) or MHSC (STPM) certifications in Malaysian higher education viewpoint. Any potential students are required to apply their HEIs application through the ministry's systems, called *Unit Pusat Universiti* (UPU) system (Yunus et al., 2019; MOE, 2019a; MOE, 2019b). The applicants only need to apply once for several courses of any related public HEIs by using this system (Yunus et al., 2019; Nurafifah et al., 2019a).
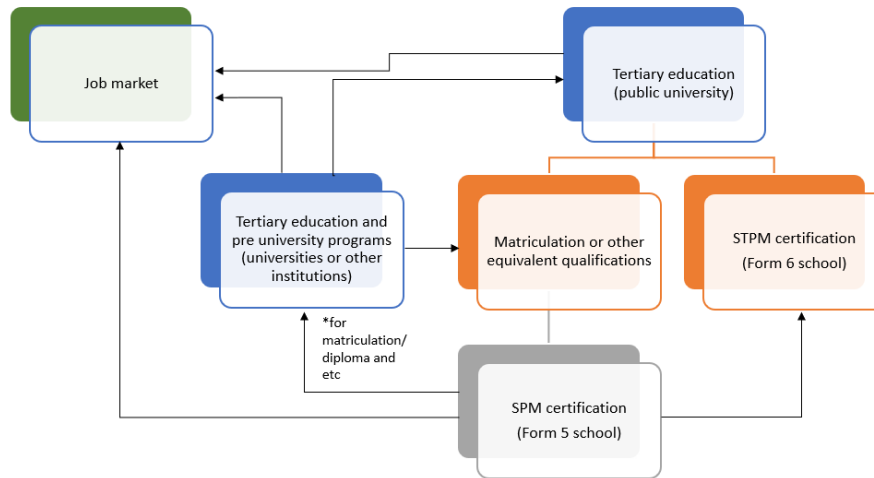
Figure 4: Malaysian education flow of MCE (SPM) certification qualification

Based on the UPU application system results, the respective HEIs will offer to the successful applicants (MOE, 2019a; MOE, 2019b). Any unsuccessful applicants can appeal from the same system for the second admission offer exercise conducted by MOHE. The UPU's appeal procedure will be opened immediately after the first batch student intake is completed by the involved universities subject to only any available places of the offered programs.

As illustrated in Fig. 3, UiTM's diploma programme level will be offered to any school leavers based on SPM certification. Thus, this university also needs to compete with matriculation centres, polytechnics, specialized education training programs that require the same entry qualification (Nurafifah et al., 2019a; Nurafifah et al., 2019b). It becomes an immense challenge for the university to predict those applicants who are being offered to accept the offer. Meanwhile, bachelor's degree programs are offered to any diploma qualification or equivalent or recognized qualifications to diploma qualification. Overall, most Malaysian universities, either public or private, face stiff competition in getting more students to enrol in their programs (Yunus et al., 2019; Nurafifah et al., 2019).

In the context of UiTM, the university will prepare a comprehensive yearly basis student admission projection based on the availability of space capacity and academic resources such as lab, studio, lecturers, and classrooms for every faculty and campus (UiTM, 2019b). Negotiation and verification process for this projection involving all academic programs, either diploma or undergraduate degree programs will be conducted by all faculties and campuses at least 6 months before the next primary academic session begins.

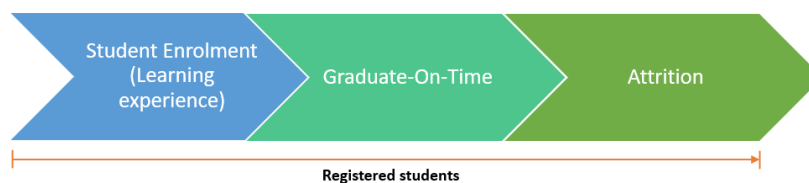**Student Enrolment, Learning Experience, and Attrition**

Figure 5: The phase of Registered students

In the second phase, as in Fig. 5, the student's academic performance indirectly reflects the outstanding ability and achievement of HEIs (Amirah et al., 2015). Therefore, it is necessary

for the university to continuously improve its facilities and support systems to establish a conductive teaching and learning ecosystem. Thus, it will create a new learning experience that may increase students' academic performance by maximizing their knowledge and experiences. Consequently, the students will finish their study within a designated study plan (classified as *graduate on time* (GOT)) and will directly reduce attrition rate of the university (Ainon & Rosmaizura, 2018; Nurafifah et al., 2019b). According to Amirah et al. (2015) and Nurafifah et al. (2019a), as in Malaysia, most of the HEIs use the final grades in accessing their students' academic performance, especially the *cumulative grade point average* (CGPA) method as a practical evaluation approach. This approach also has become the most studied factor of academic performance by researchers. By examining students' academic performance, several initiatives can be implemented by HEIs through data mining techniques such as students' profiling and personalization, academic module enhancement, strategic study improvement, and academic performance prediction (Amirah et al., 2015; MOHE, 2015b; Sumyea et al., 2018).

At the same time, the faculties can also utilize the personalization of student learning experience in optimizing their students' study interest, by offering elective courses to the students across faculties and field of studies. Student profiling process can be done in the early stage, especially during the first semester of their study. Through this effort, the university indirectly can reduce the possibility of attrition among these students by monitoring their academic performance regularly. The high attrition rate will reflect the university's intangible losses (MOHE, 2015b; Sumyea et al., 2018). Subsequently, the university often implements several intervention plans to ensure its students can complete their studies according to the study plan (MOHE, 2015b; Syahirah et al., 2019a; Syahirah et al., 2019b). The optimization of the experiences' personalization among the students could also reduce the impact of student attrition and may ultimately increase the university's productivity rate (MOHE, 2015b; Nurafifah et al., 2019b). The finding of the learning and attrition impacts can be used to enhance academic programs' quality. Subsequently, it can allow the university to be more dynamic towards changing and adapting current or future industrial trend. For example, the current impact of COVID-19 pandemic on students' teaching and learning experiences requires a drastic action from the university's normal practices. Although it has disrupted most of the academic activities, the university must take active interventions especially in the teaching and learning process to ensure the students learning experiences are not interrupted.

Nonetheless, a student's academic performance may be influenced by internal and external factors during their study tenure. Based on previous studies, the researchers had identified many common factors that can be applied in analyzing and predicting the student's performance (Pauziah et al., 2013; Usamah et al., 2013; Amirah et al., 2015; Ainon & Rosmaizura, 2018; Sumyea et al., 2018; Nurafifah et al., 2019a; Nurafifah et al., 2019b). Some specific factors may differ from an HEI to another, which cannot be generalized. In UiTM's perspective, all the students are strictly to follow the study plan of their academic programs through a class or small group-based teaching concept. The students are required to take 6 to 7 courses per semester with an approximation of 21 to 24 credit hours per week. Any course failure will automatically lead to the possibility of a *non-graduate on time* (N-GOT) status to the related student. The impact of *graduate on time* (GOT) will directly contribute to the university's academic operation costs (MOHE, 2015b). If GOT is low, the university academic operation costs will increase since the students need to prolong their study duration in completing their study (MOHE, 2015b; Nurafifah et al., 2019b). It is indirectly will incur additional costs that can be dedicated to new student cohorts.
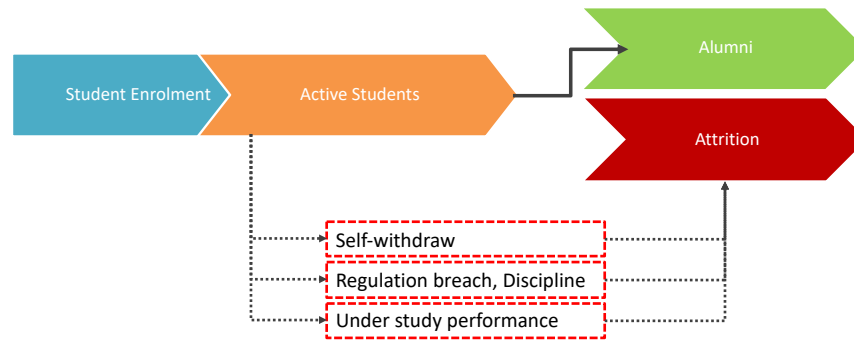
Figure 6: The three possible causes of attrition in the academic lifecycle processes.

Malaysian Ministry of Higher Education (MOHE) defines attrition as a study quitting action by any student of the related cohort for whatever reason subject to their study plan (MOHE, 2015b; Syahirah et al., 2019a). Fig. 6 shows the three leading possible causes of student attrition that influence student's decision for discontinuing their study; i) self-withdraw that caused by lack of study interest, ii) regulation breach-discipline problems, and iii) understudy performance (Syahirah et al., 2019a).

From the ministry's viewpoint, an institution's higher attrition rate reflects the students' lower success rate. It portrays the quality of offered academic programs, teaching and learning process, and academic productivity of the related institutions (MOHE, 2015b).

Graduate and Alumni

Graduation is the final phase of the tertiary education life cycle, where the students had completed their study plan by passing all courses and completing the program's required credit hours. In this phase, an individual student's status is associated with the student's ability to complete their study within the given study duration (MOHE, 2015b). If the student could not complete his or her study within the study plan duration, the student will be considered as a *non-graduate on time* (NGOT). Any increment number of NGOT students will impact the overall performance and credibility of the institutions' ranking evaluation (MOHE, 2015b). All graduates are automatically considered as alumni of the university (Ng et al., 2015). The information of alumni is crucial for the university in tapping the future potential of collaboration and contribution with its alumni (Ng et al., 2015; Ummi Naiemah et al., 2017).

The university must assess its achievement and impact on the society and nation through alumni establishment as a catalyst for economic and community development. Alumni contributions can be either in monetary or non-monetary activities, such as talk series, sponsorship, grants, etc., that can benefit universities and their campus residents (Ng et al., 2015; Ummi Naiemah et al., 2017). With MOHE's initiative, a website-based graduate trace study of alumni has been developed that allows the alumni from any Malaysian HEIs to update their current employability status (MOE, 2019c).

With the rising of university's direct and indirect educational operation costs on a yearly basis, it has required for more alumni's roles in supporting and contributing towards universities' fundraising initiative efforts such as endowment, *sadaqah*, and *waqf* (Dzuljastri et al., 2016; Ummi Naiemah et al., 2017). These monetary contributions will be utilized by the universities for teaching and learning purposes, mainly for research, facilities, student allowances, and others (Dzuljastri et al., 2016). Indeed, the alumni themselves will be an essential platform for the university to ensure its excellent legacy continuity in the future (Ng et al., 2015).

Education Data Mining of UiTM

As discussed in the previous sections, the role of data analytics is vital for the university since the crucial decision is required in deciding the best actions to be taken by the top management (MOHE, 2015b; Nurafifah et al., 2019b). Subject to the academic lifecycle, the application of data mining applies to all phases as in Fig. 2. For example, in the context of student admission, several effective and efficient strategic options can be planned and implemented by the university when dealing with and managing, especially with a massive number of student intake projections and the actual number of student enrolment. Specific groups of potential students need to be identified where a concentrated effort can be maximized to enroll in the university.

Several data analytics efforts have been academically reported that relate to the Education Data Mining (EDM). These include student intake predictions (Yunus et al., 2019), student learning experience, and *graduate on time* (GOT) (Pauziah et al., 2013; Usamah et al., 2013; Amirah et al., 2015; Nurafifah et al., 2019a; Nurafifah et al., 2019b), and attrition (Syahirah et al., 2019a; Syahirah, 2019b). Based on the application data, the university can predict all applicants' general patterns that are highly possible to accept the program offered (MOHE, 2015b). In the meantime, the university also can investigate those who had rejected the offers. The findings are a valuable input to re-strategize the marketing or promotion initiatives for future potential students. In general, the academic program's offer will be on the meritocracy evaluation and quota of the program. Subject to the agreement during UPU's application submission, the applicant will be offered any program if the applicant's first choice program is full or cannot be offered to this applicant. High possibility to this applicant may reject this proposed academic program. If this situation occurs, it will deny other applicants the opportunity to get this program since the placement allocation has been offered to the earlier applicant.

Nurafifah et al. (2019a) explained the categories of data types that generally use data mining. Fig. 7 depicts the pyramid chart-based data type representation can be divided into four main levels, namely, i) UPU data, ii) academic offer or intake data, iii) enrolment data, and iv) graduate data. The UPU data is the foundation of this chart, represents the most massive HEI's application data volume. This data is based on the entry application by the applicants from the UPU system. On the other hand, academic offer or intake data is categorized as the second layer of the pyramid chart that typically represents the university's academic offer program to the qualified applicants. The applicant will strictly get an offer from one institution only. Once the applicants accept the offer and registered themselves to the respective university, the university will categorize it as enrolment data. This data consists of specific related student's admission and course information and represents the third layer of the pyramid chart with a smaller volume than the intake data. The graduate data is the highest layer of pyramid chart data type with the smallest volume of data against other pyramid charts. This data is considered a complete student-study information consisting of any academic, convocation, and other activities involvement information of the student during his or her study period and can be considered as internal alumni data by the university.
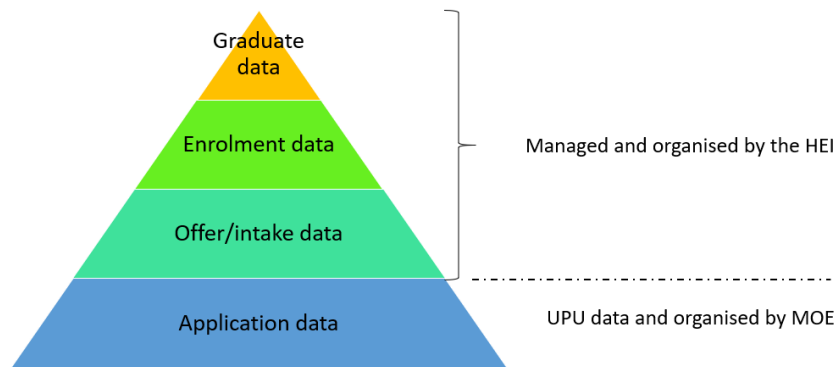
Figure 7: Pyramid chart of data types by Nurafifah et al. (2019a)

Data Attributes Taxonomy of UiTM Academic lifecycle

Based on the University Academic Lifecycle and discussion in the previous sections, EDM researchers suggest the significant attributes in evaluating and producing the best and accurate data mining process (Pauziah et al., 2013; Amirah et al., 2015; Nurafifah et al., 2019b). Suggestions and justification on data mining techniques also have been highlighted and tested based on their specific data and preferences (Pauziah et al., 2013; Amirah et al., 2015; Yunus et al., 2019; Nurafifah et al., 2019b; Syahirah et al., 2019a).

Fig. 8 details the list of attributes that have been identified and categorized based on previous research works by Yunus et al. (2019), Nurafifah et al. (2019b), and Syahirah et al. (2019a), together with a consolidation of attributes of tracer study survey of MOE (2019c). They had comprehensively analysed, discussed, and justified all attributes by the past research works reported since the 1990s until today.
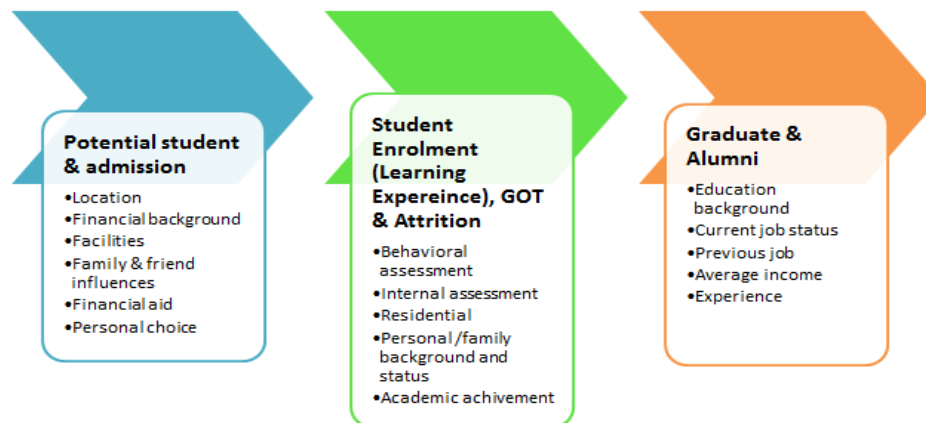

Figure 8: The main influential factors for UiTM data analytics requirement

Yunus et al. (2019) identified the financial and location as the most influential factors that researchers commonly considered. These factors have strongly influenced the applicant's decision to accept or reject the study offer. Besides, the university's distance and facilities accessibility also play an important role for the applicants since most of them prefer to be closer to their family (Ainon & Rosmaizura, 2018; Yunus et al., 2019). Since most of these applicants do not have first-hand experience in the university, the family and friend factors could influence the applicants' decision. In the Malaysian perspective, the applicants' financial factor will generally be solved once the applicants are enrolled to the respective HEI

and will be allowed to apply for any financial assistance or scholarships from the government or private agencies (Yunus et al., 2019). These specific findings give useful insights that facilitate the university's management to devise strategic decisions. In the case of the descriptive demographic analysis of the rejected offers, it gives a clearer indicator to the management on how the university's efforts can be affected by the applicants' decisions.

As in the student enrolment phase, the main concentration issues are student academic performance and their study experience in the campus (Pauziah et al., 2013; Usamah et al., 2013; Amirah et al., 2015; Ainon & Rosmaizura, 2018; Sumyea et al., 2018; Nurafifah et al., 2019a; Nurafifah et al., 2019b). Based on the previous studies, CGPA or GPA is considered the most influential factor or indicator of the researchers' student performance. Since the proposed attributes are various and unique subject to the institutions, Nurafifah et al. (2019a) and Syahira et al. (2019a) have classified the most applied and significant attributes into five main categories for GOT and attrition, which are; i) behavioral or psychological assessment, ii) internal assessment, iii) residential, iv) family background and status, and v) academic achievement.

In the phase of the Graduate and Alumni, the category of factors reflects the personal achievement and enhancement of alumni are based to the program they had enrolled in the university (MOE 2019c). The findings from this data are so important for the involved HEIs to improve further their academic programs in meeting the current and future demand but at the same time to tap their alumni experience and industrial connection for the university's global visibility (Dzuljastri et al., 2016; Ummi Naiemah et al., 2017). Since the allocation of the annual government grants for the universities is limited, the alumni contributions especially in the monetary aspects could ease the HEI's financial burden and could allow these institutions to increase their performance and productivity, especially in academic productivity (MOHE, 2015a; MOHE, 2015b). Through this approach, it will allow these HEIs to reduce financial dependency on the government (Malini, 2016).

Conclusion

Understanding the overall scenario of the academic life cycle will help the researchers to be more aware in selecting and deciding any data analytics modelling initiative. Thus, it contributes to producing more strategic and relevant management approaches in handling the university in the future. With more than 70,000 applications per year and approximately more than 170,000 students per academic enrolment session, it is difficult for UiTM to personally manage its students to ensure the university's KPIs can be achieved successfully. The implementation of analytics in the university will increase its management efficiency and effectiveness in all phases of the life cycle. This allows the university to accomplish its objective to be the primary choice of higher learning institution among potential applicants with an excellent academic program attraction. Through the analytics initiative, the university can further improve its academic programs to be more futuristic and fulfil the upcoming job market. Student learning experience aspects should also be utilized through an analytics process where the university can continuously learn and formulate the best formula to effectively ensure the best teaching and learning processes can be delivered to the students. Indeed, it can indirectly reduce the impact of Non-GOT or attrition among the enrolled students and ensure they complete their study within the stipulated study duration.

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